A CAHNERS PUBLICATION

DECEMBER 22, 1988

EDN®

SPECIAL ISSUE—Part 2
Product Showcase No 28

Highlighting key trends in hardware, instruments, computers & peripherals, and components

Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

PRODUCT SHOWCASE

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It's no secret that the faster you can design your ASICs, the faster you can get your products to market. Which is why Fujitsu lets you decide which design tools to use. Then we provide you with all the on-site support you need to breeze through not only product development but also product verification.

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When it comes to design tools, there's only one thing you need.

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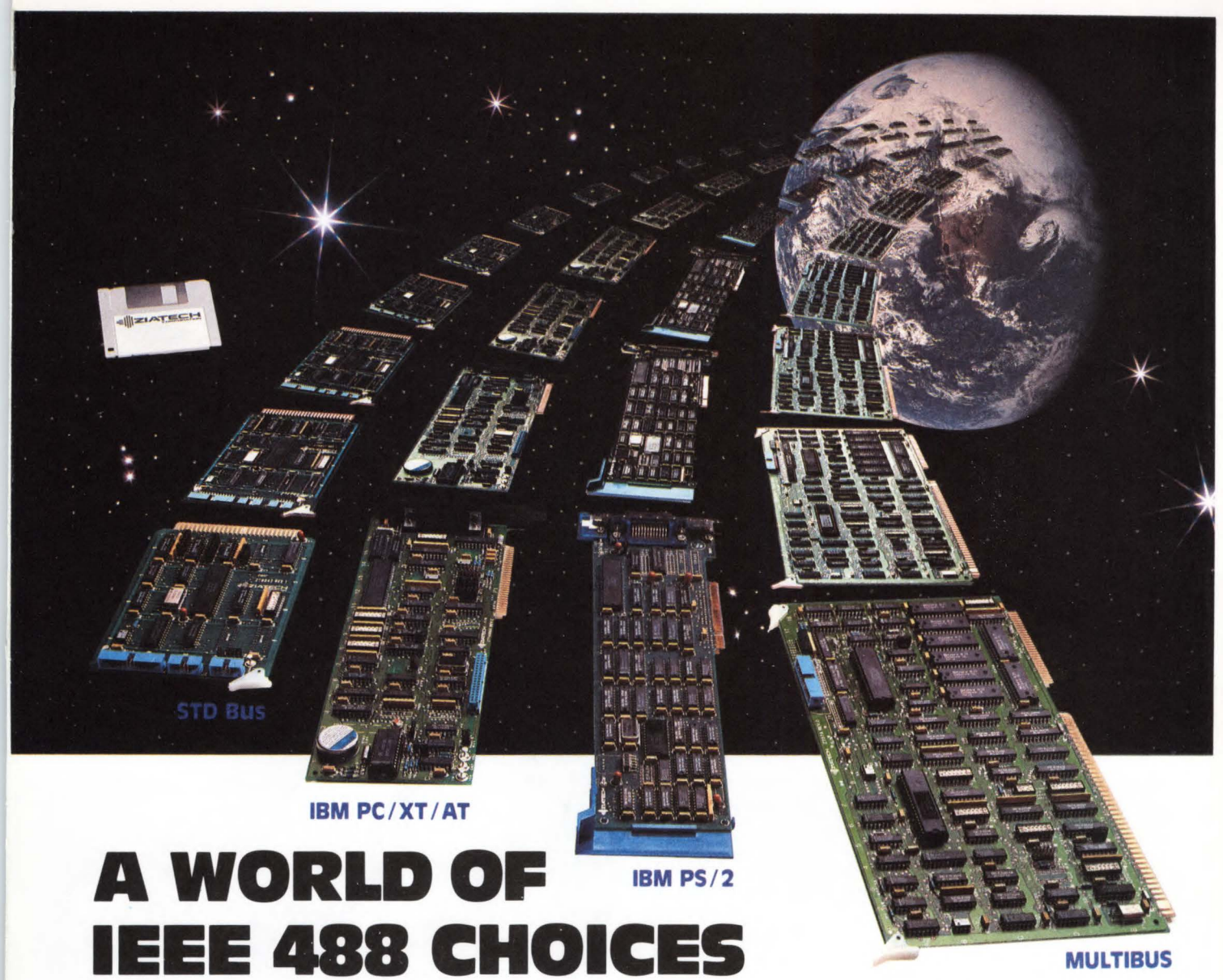

A WORLD OF IEEE 488 CHOICES

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Hardware interfaces and software drivers for OEMs who depend on superior products, pricing and technical support to make their products succeed.

Hardware interfaces for the IBM PS/2, PC/XT/ATs, STD Bus and MULTIBUS systems.

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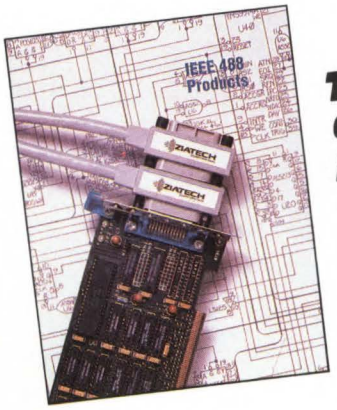

The WORD on IEEE 488 choices

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CIRCLE NO. 99

WHY VTC? ASK THE VME CONSORTIUM.

"For a bunch of companies that don't always agree on everything, we sure were unanimous on VTC."

The VME Consortium needed an economical, yet highly functional VME bus interface chip, to minimize design time . . . and to help raise the VME standard to higher levels.

"We looked at the leading suppliers," said Joe Ramunni, consortium chairman (and president of Mizar), "and VTC came out on top. Their CMOS standard-cell ASIC approach gave us the high drive capability we needed, optimized for bus interfacing. And, it proved much more cost-effective, with higher performance, than gate array technology."

The VME Consortium is made up of such firms as Plessey Microsystems, Omnibyte Corporation, Mizar Inc., Ironics Inc., Heurikon Corporation, Matrix Corporation, and Clearpoint Inc., among others. What did they look for in a supplier?

"We needed a credible business partner," said Ramunni, "with a proven track record, who could provide a turnkey package . . . both design and fab. A supplier that could produce in quantity, and provide technical support to the market at large.

"We also needed a firm with an international marketing structure, because we expect this chip to be the de facto standard worldwide.

"But, we needed *people* we could work with, too. VTC had the right 'comfort factor'."

Jack Regula, consortium technical director (and VP-R&D, Ironics) added: "Our requirements for high speed, high gate-count, low power consumption, and VME bus drive capability were all met well with VTC's 1-micron CMOS standard cell library. And we were extremely impressed with VTC's facilities, its people, and its customer list."

In the future, the VME bus chip (VIC) will become a standard cell within VTC's CMOS library, to allow customers to further customize the chip.

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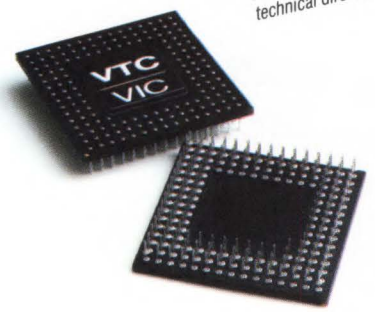
VTC Incorporated, 2401 East 86th Street, Bloomington, MN 55420. (In Minnesota, 612/851-5200.) Telex 857113.

CALL 1-800-VTC-VLSI

Joseph Ramunni, chairman (left), and Jack Regula, technical director, VME Technology Consortium.



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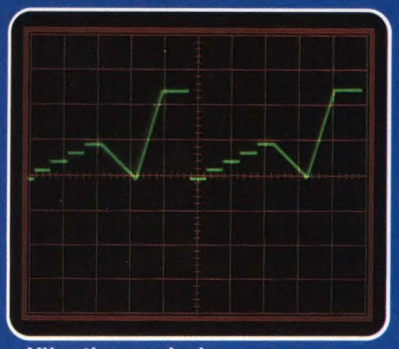
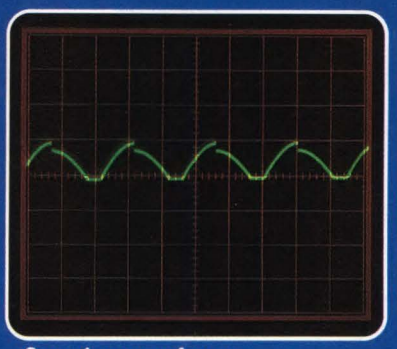
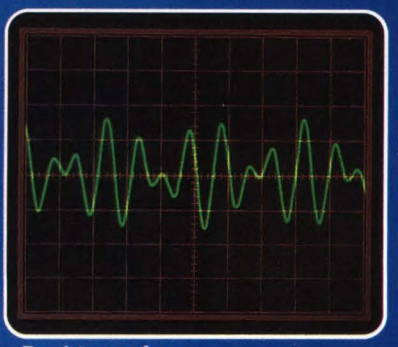


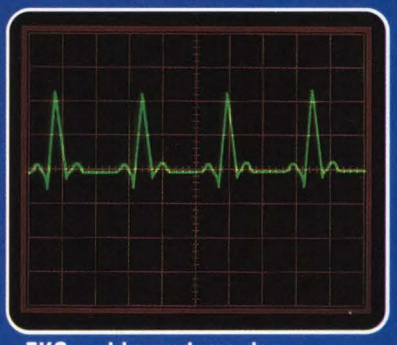
Vibration analysis with stop and hold.



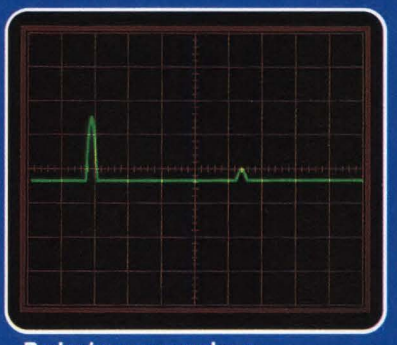
Complex waveforms for servo drives.



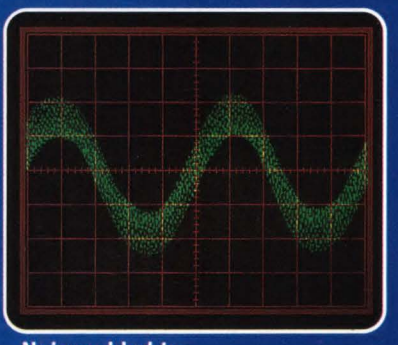
Dual tones for telephone testing.



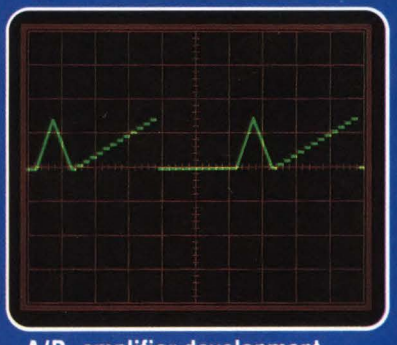
EKG and hemodynamic waveforms.



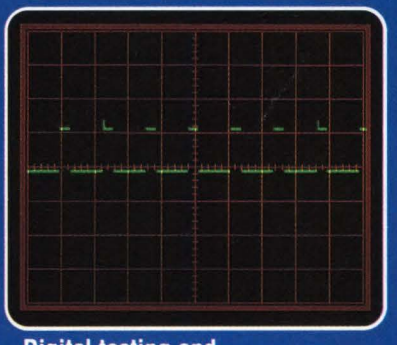
Radar/sonar envelope simulation.



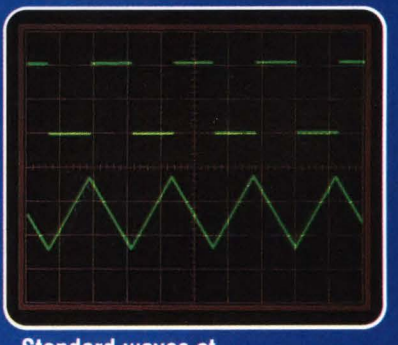
Noise added to any waveform.



A/D, amplifier development and calibration.



Digital testing and troubleshooting.



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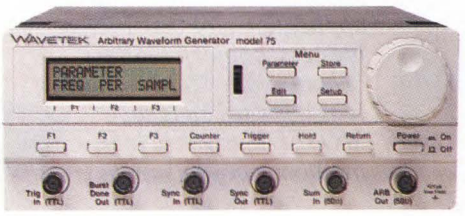
We've been making waves for 25 years. Now it's your turn.

A quarter-century ago, Wavetek brought you the first waveforms produced by a solid-state function generator. Now our Model 75 Arbitrary Waveform/ Function Generator puts you in control.

Model 75 lets you generate waveforms without entering x/y coordinates. Thumbtack and rubberband modes allow easy development and editing of any waveform. There are also nine standard functions which you can use at the push of a button.



Waveforms are stored in nonvolatile memory, with more than 4,000 vertical points and 8,000 horizontal points of resolution. They can be played back at any rate, up to 500ns per point.

By linking two or more Model 75's together, you can superimpose waveforms to introduce phase displacement or other special effects. And at the low price of $2295, you might want to buy several.

For literature or to arrange an amazing demonstration, call or write Wavetek San Diego, Inc., P.O. Box 85265, San Diego, CA 92138. Phone (619) 279-2200; TWX (910) 335-2007.

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CIRCLE NO 124

WAVETEK

The smallest big move in motor control.

Siliconix' new surface mount MOSPOWER Half Bridge Driver delivers a powerful 2 A while occupying less space than DIPs & DPAKs.

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Save space! Improve reliability! Use your new half bridge driver in a tiny SO-16 surface mount package to replace two bulky MOSFETs in your motor control circuits.

And now that the through-hole devices are eliminated your assembly can be totally automated, reducing manufacturing cost and complexity.

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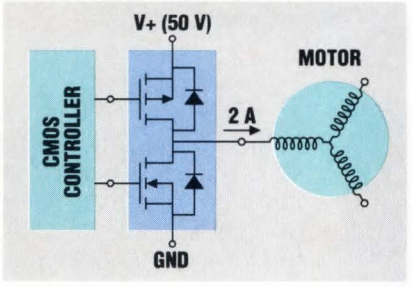

The Si9950 MOSPOWER driver is the perfect way to get more power into less space in motor control applications for disk drives, printers, copiers, plotters & battery-powered systems. It also makes an ideal MOSFET driver in high frequency power supplies.

Make your big move to Siliconix' small Si9950 MOSPOWER half bridge driver. Dial our toll-free hot line now! Call 1 (800) 554-5565, Ext. 942 for your free MOSPOWER Half Bridge Driver Design Kit. It includes your sample, data sheet and application note.

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EDN Magazine Edition

Volume 33, Number 26 December 22, 1988

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

On the cover: *Part 2 of EDN's Product Showcase No 28 can help in your search for the best product for your application. Staff-written reports lead off each one of four product categories: hardware and interconnect devices (pg 52), instruments (pg 94), computers and peripherals (pg 128), and components (pg 168). (Photography by Kevin Bryan; photo colorization by Kim Fisher; art direction by Ken Racicot)*

DESIGN FEATURES

Hardware and Interconnect Devices

Products and services can facilitate ESD control 52

As a design engineer, you might often view the damage caused by electrostatic discharge as someone else's problem. But only by using your engineering knowledge to understand the phenomenon can you wisely choose among the products that claim to offer protection.—*Dan Strassberg, Associate Editor*

Instruments

High-performance DSOs present users with plenty of choices 94

An impressive collection of 100-MHz-and-above DSOs (digital storage oscilloscopes) have made their debut in the last year. —*Doug Connor, Regional Editor*

Computers and Peripherals

Helical-scan drives store gigabytes on tiny tape cartridges 128

Tape drives that use helical-scan recording technology can store more than a gigabyte of data on 4-mm digital audio tape or 8-mm video tape cartridges. However, issues such as data-format standards, alternate sources, and cost may prove more important than the typical drive specs.—*Maury Wright, Regional Editor*

Components

Crystal oscillators hit higher frequencies in smaller packages 168

Like other components, TTL- and CMOS-compatible pc-board crystal oscillators are moving into true SMD packages. And although ECL-compatible devices still come in standard metal cans, they now provide clock frequencies as high as 400 MHz to handle high-speed logic families.—*Peter Harold, European Editor*

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CIRCLE NO 115

This Product Showcase *covers a wide variety of hardware and interconnect devices (pg 69), instruments (pg 111), computers and peripherals (pg 143), and components (pg 176).*

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Express Request

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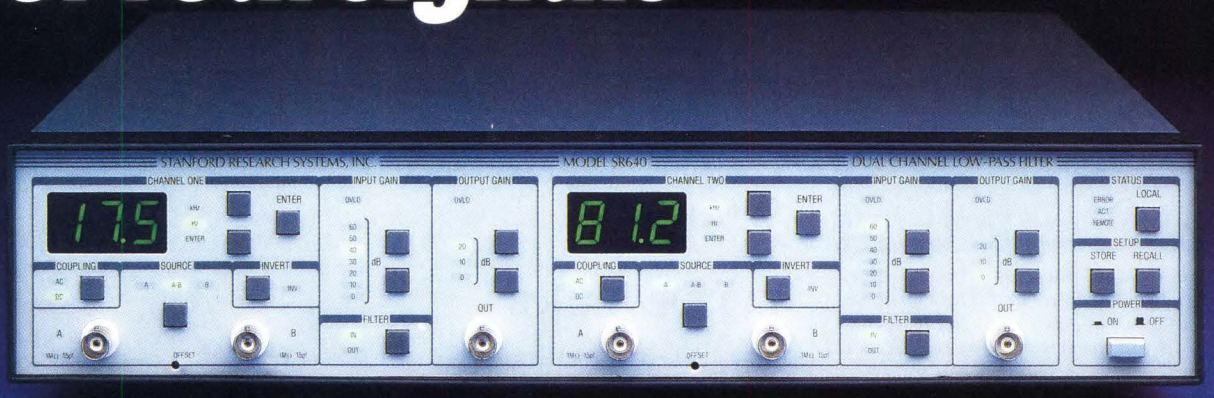
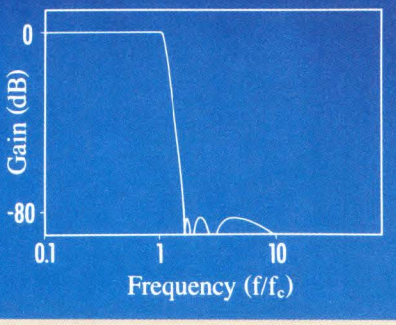
The low-pass filter for real signals



The SR640 dual channel, programmable, low-pass filter.

115 dB/octave rolloff. $2990.



The SR640 offers a unique combination of filter specifications, preamplifier performance, and programmability at a price far less than other instruments. Featuring two fully independent 8-pole, 6-zero elliptic filters with less than 0.1 dB p-p passband ripple and 115 dB/octave rolloff, the SR640 is the ideal filter for general purpose signal processing as well as anti-aliasing for digital signal processing systems.

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SR640	**$2990**

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EDITORIAL 49

New computer programs seem to chew up more and more memory, but we may not be actually programming any better than we did in the days of CP/M.

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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 July.

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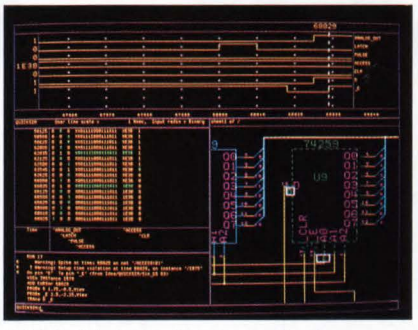
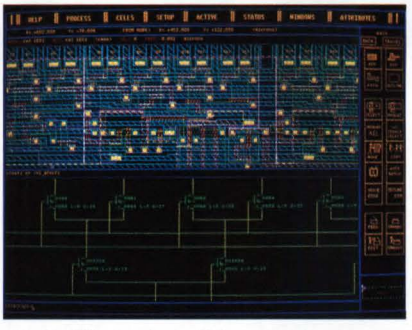
Before you open all those strange boxes, call us toll-free for an overview brochure and the number of your nearest sales office.

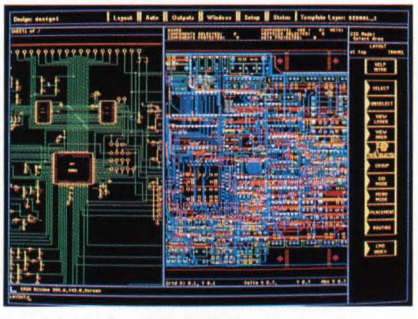
Phone 1-800-547-7390 (in Oregon call 284-7357).



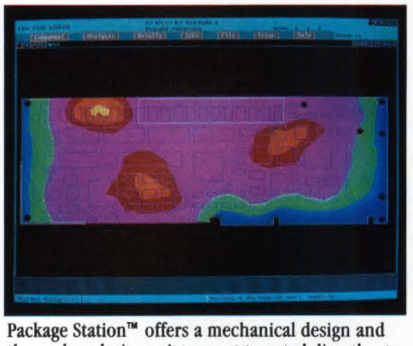
QuickSim™ logic simulation tools offer the broadest modeling support available and allow ASICs to be included in system-level simulations.



ChipGraph™ provides an IC layout environment rich with advanced features such as symbolic cell representation, yet programmable to emulate your current layout tools.



Board Station® promotes rapid, error-free PCB layout by permitting any combination of automation and interaction the professional board designer feels is necessary for a particular design.



Package Station™ offers a mechanical design and thermal analysis environment targeted directly at the needs of electronic packaging engineers.

Mentor Graphics®

Your ideas. Our experience.

How the fa

Our new 7.5ns PAL® device is fast enough to prove that standard logic shouldn't set the standard anymore.

It's also fast enough to finally let today's new microprocessors run at the speeds for which they were designed—breathtaking.

Raising your standard.

How fast would you like your standard logic?

How about faster than any TTL logic around? Even FAST™ or AS? You've got it with the 7.5ns PAL device.

And the fact that you can configure it yourself means you can get exactly what you want.

If you want to redesign something, you change the PAL device. Not the board.

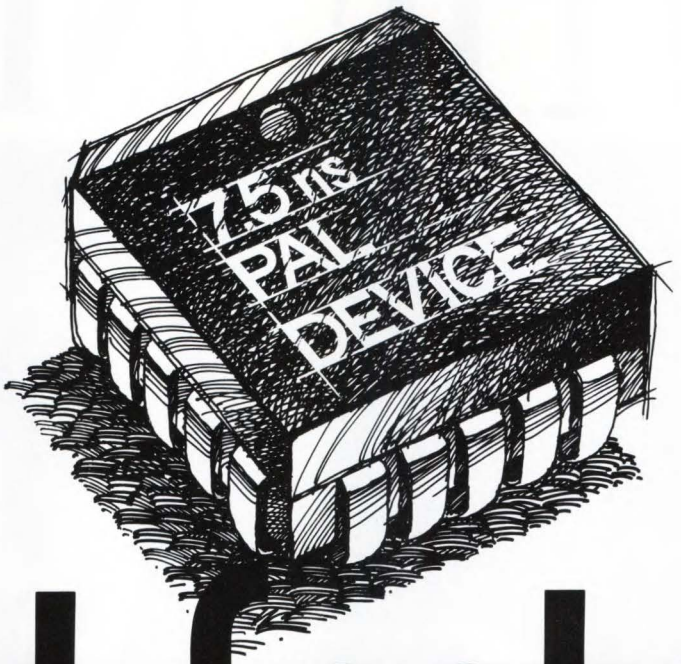
Not only is this the fastest way to get high speed logic, it's also the most practical. One 7.5ns PAL device replaces two to six standard TTL devices.

Which cuts down on board size.

And cuts down chances for a device failure.

7.5ns PAL Device vs. FAST & AS

SSI/MSI		FAST	AS	7.5ns PAL Device
Combinatorial				
74138 Decoder	tPD	8.0	10.0	7.5
74151 Mux	tPD	11.0	15.0	7.5
Register/Latch				
74374 Octal Register	tCO	10.0	9.0	6.5
74373 Octal Latch	tPD	8.0	6.0	7.5
	tLEO	13.0	11.5	7.5
Counters				
74161 Four bit Ctr	tS	5.5	8.0	7.0
	tCO	11.0	13.5	6.5
74269/869 Eight bit Ctr	tS	2.5	5.0	7.0
	tCO	10.0	11.0	6.5



st get faster.

What to give the microprocessor that has everything.

We suggest the first PAL device that can keep up with it.

The 7.5ns PAL device runs at 74 Mhz. It can deliver the speed the new high performance microprocessors need.

Processors like the 29K, the 386 and the 68030.

This PAL device delivers 25% more speed than any other PAL device.

We even have the fastest 22V10.

Our 15ns 22V10 runs at 50Mhz. That's 10ns faster than anyone else on the market. And it lets you run at twice the rate of the new 25Mhz microprocessors.

We've been shipping 20 pin 10ns PAL devices for eighteen months. And now you can get the new 24 pin 10ns PAL device as well.

There's plenty of service and support to get and keep your project moving. And all our fast PAL devices are available in volume when you need them. Now, for example.

For all the facts about our fast PAL devices, drop us a line. Or call us at (800) 222-9323.

Because you can never be too fast.

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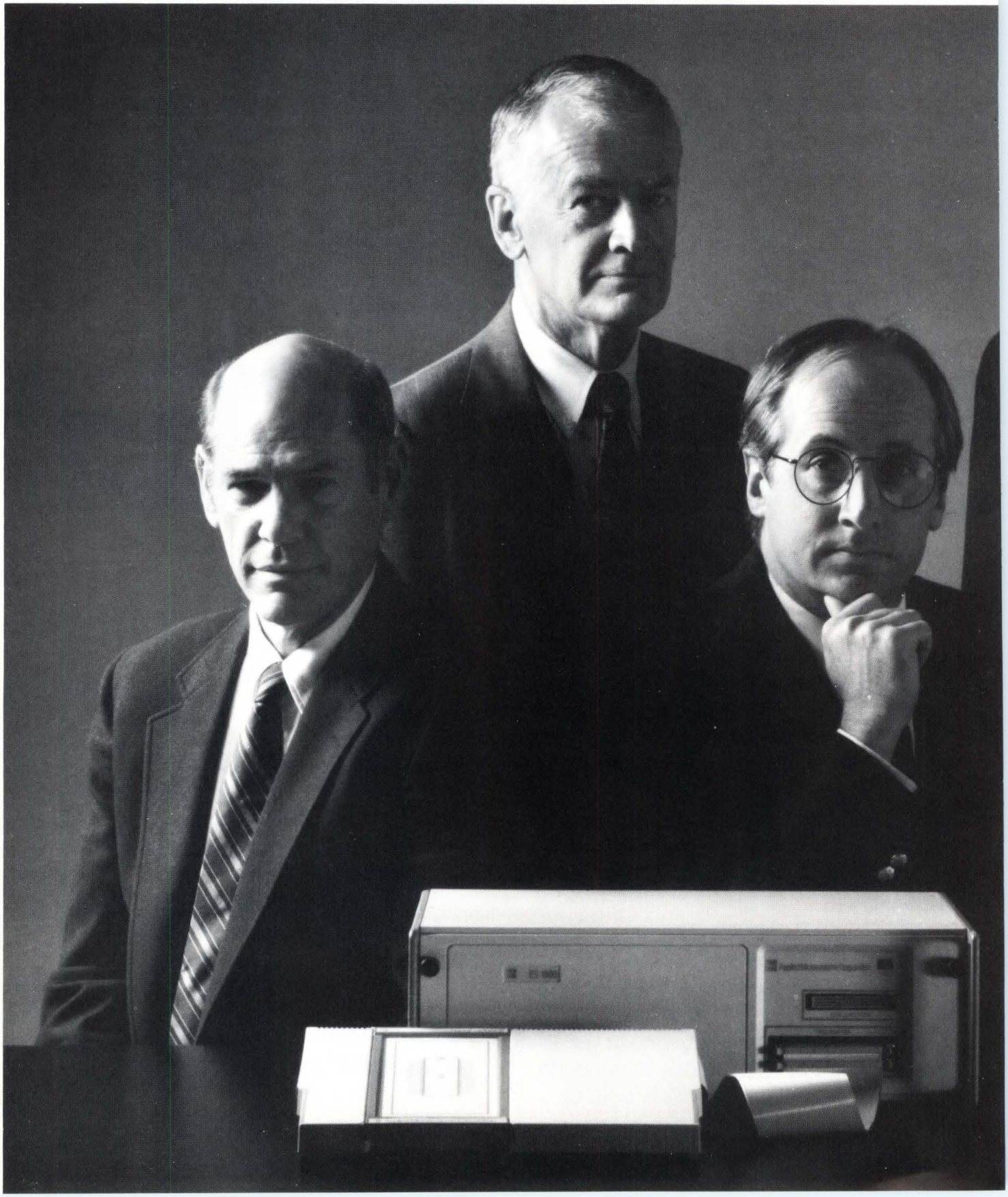

KER'S PICK.

Many of the world's most demanding engineers are already sold on the ES-1800 microprocessor development system from Applied Microsystems.

Because it's the only closely coupled system that includes emulators, debuggers, SCSI, two megabytes of overlay memory and transparency at operational speeds.

And because we've kept it state-of-the-art by constantly expanding and upgrading the system.

Now the ES-1800 supports most every popular processor, including 68020 at 25 MHz, 80C186 at 16.0 MHz and 68000 at 16.7 MHz. As a result, you don't need to replace your development system every time you select a new microprocessor.

There just isn't a more comprehensive, effective, efficient or experienced development system around. Not Intel ICE. Not Hewlett Packard.

Nearly 10,000 units out there continue to debug embedded systems more reliably than any of the others. By doing more. Faster, easier and more accurately. After all, thousands of nit pickers can't be wrong.

For a demonstration, write Applied Microsystems Corporation, P.O. Box 97002, Redmond, Washington, USA 98073-9702. Or call (800) 426-3925, in WA call (206) 882-2000.

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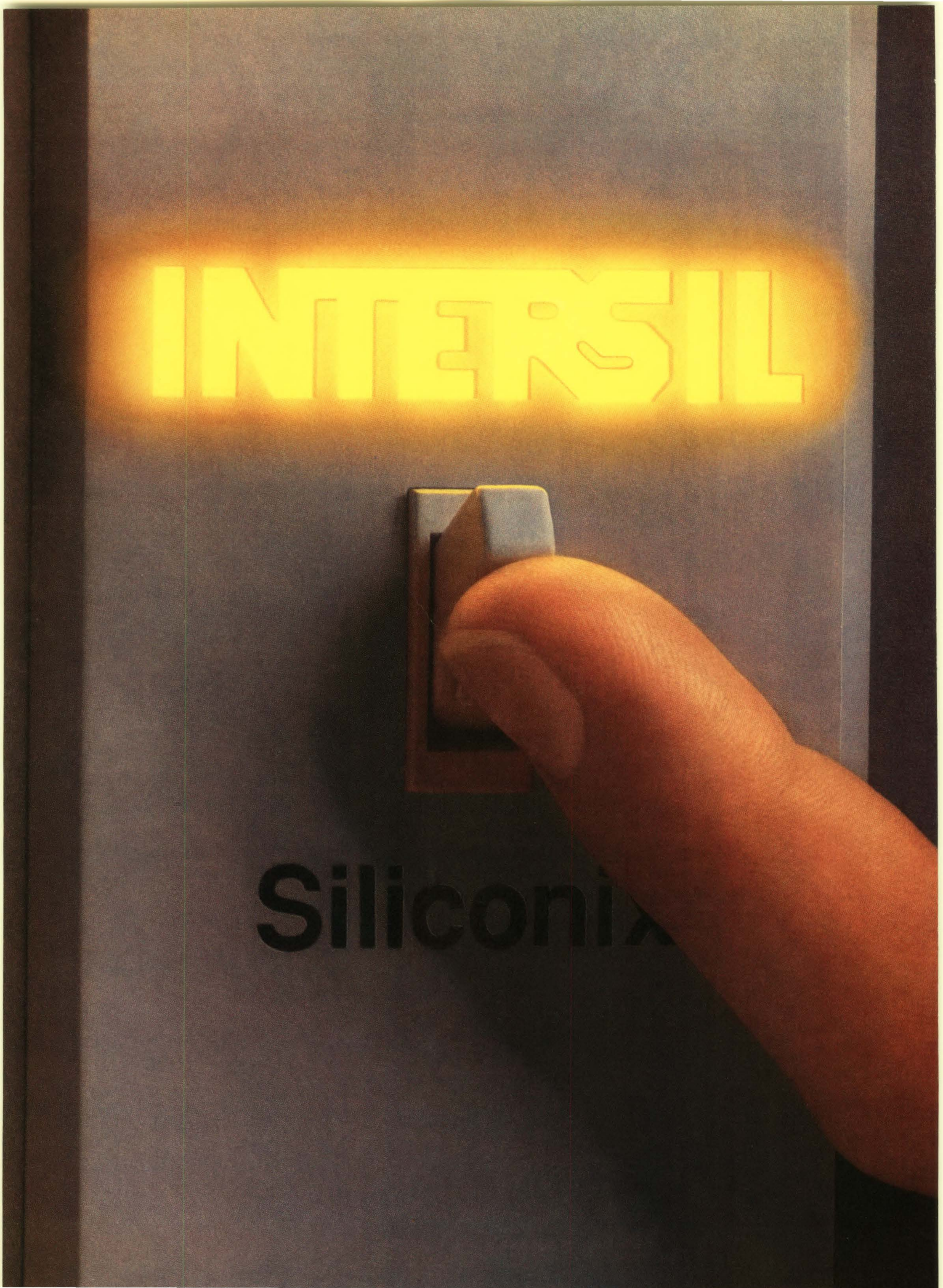
AMC-239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Siliconi

The switch is on.

We offer a very broad capability in analog switch solutions, technologies and MIL parts. No wonder people are turned on.

When you need high-quality/high-performance analog switches and multiplexers, why not come to the people who have more than 600 device types and a wide variety of MIL-STD 883B, Rev C, DESC Standard Military Drawings and JAN38510 types.

A small sample of what we can offer:

Switch	Description
DG200/DG201	CMOS Dual/Quad
DG211/DG212	CMOS Low-cost Quad
DG300A/303A	CMOS TTL Compatible
DG308A/309	CMOS Quad
IH5040-IH5047	High-level CMOS
IH5140-IH5145	Improved High-level CMOS
IH5148-IH5149	High-Level CMOS
IH 5341/5352	CMOS Dual/Quad/Video/RF
IH6108/6208	CMOS 8-/4-Channel Differential Mux
IH6116/6216	CMOS 16-/8-Channel Differential Mux
IH5108/IH5208	CMOS 8-/4-Channel Diff. Fault Protected Mux
IH5116/5216	CMOS 16-/8-Channel Diff. Fault Protected Mux
Coming soon:	
DG508A/509A	8-/4-Channel Differential Mux
DG528/529	8-/4-Channel Differential Mux with Latches
IH9108	8-Channel High-Voltage Mux with Latches
DG201A/202	CMOS 44V Quad

Choose your technology.

With a selection like ours, you can choose from nearly every major technology, including metal gate CMOS, JFET, DI CMOS and DMOS.

And you can choose the cost/performance that's best for your application. From our DG211 CMOS family at 35 cents per channel, to our standard-setting IH5341/5352 video switch family.

A multitude of multiplexers.

If it's multiplexers you're looking for, we won't disappoint you. We offer a full family of CMOS monolithic multiplexers, including our new IH9108 8-channel High-Voltage Mux with Latches. It's designed for especially low drain-on, drain-off and source off-leakage.

Tops in military.

Look at this roll call: more than 150 switches and multiplexers that meet MIL-STD-883B Rev. C. And over 90 devices that are on DESC Standard Military Drawings and QPL.

That's more than anyone else in the business. We can deliver these parts in volume from our four certified Fab flows that are DESC-certified for JAN 38510 CMOS and bipolar production.

Switch to solutions.

Perhaps most important, when you switch to Intersil, you switch to solutions. We offer extensive applications engineering support. And we're developing solutions to the problems you face every day.

So, to get the widest variety of switches and multiplexers, in the widest variety of packages and technologies, there's just one thing you have to do:

Switch to Intersil.

For information on getting the right switch or mux for your military, computer, disk drive, instrumentation or communications equipment, contact your local GE Solid State sales office or distributor. Or call toll-free, 800-443-7364, extension 27.

In Europe, call: Brussels, (02)246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm (08) 793-9500.

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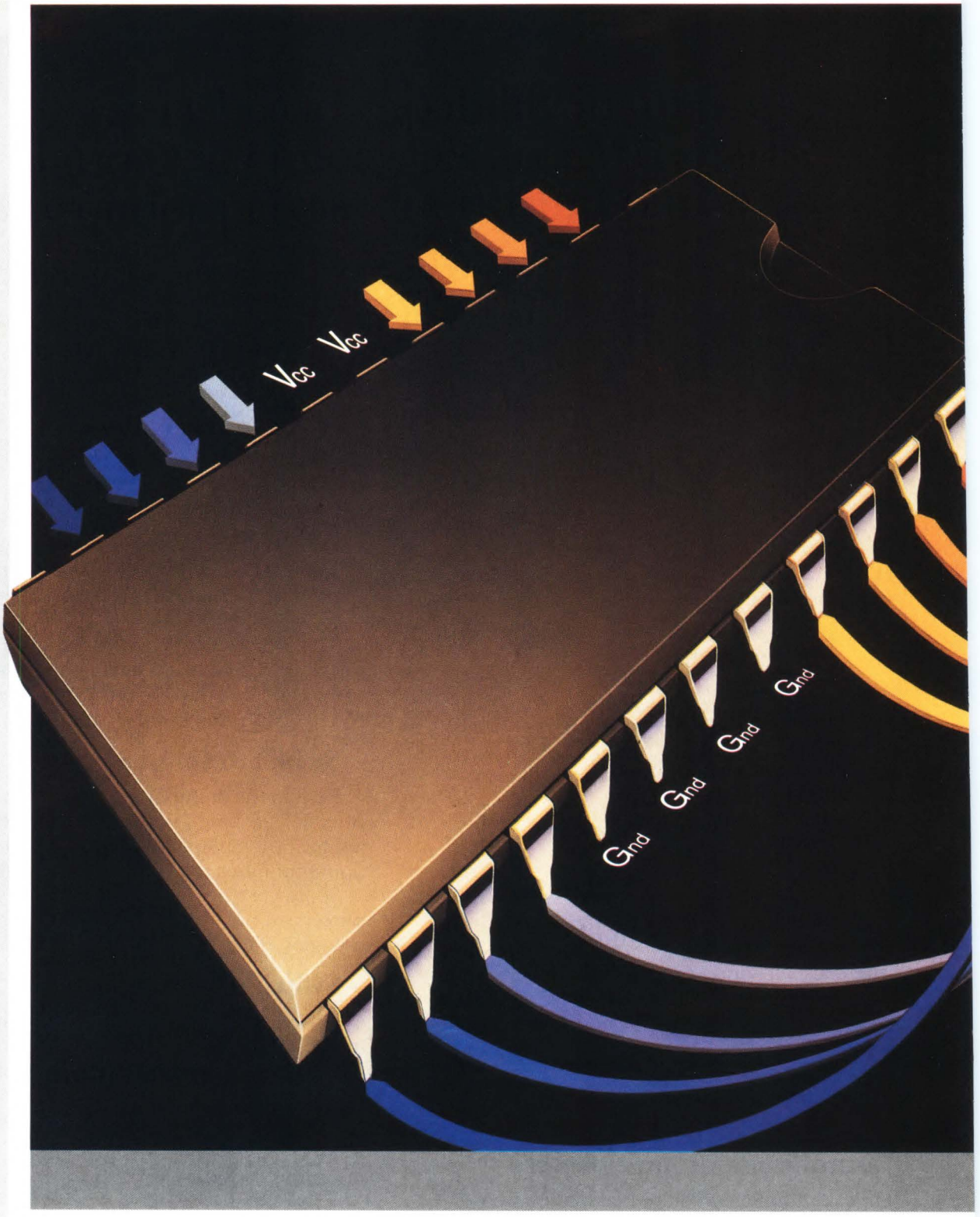

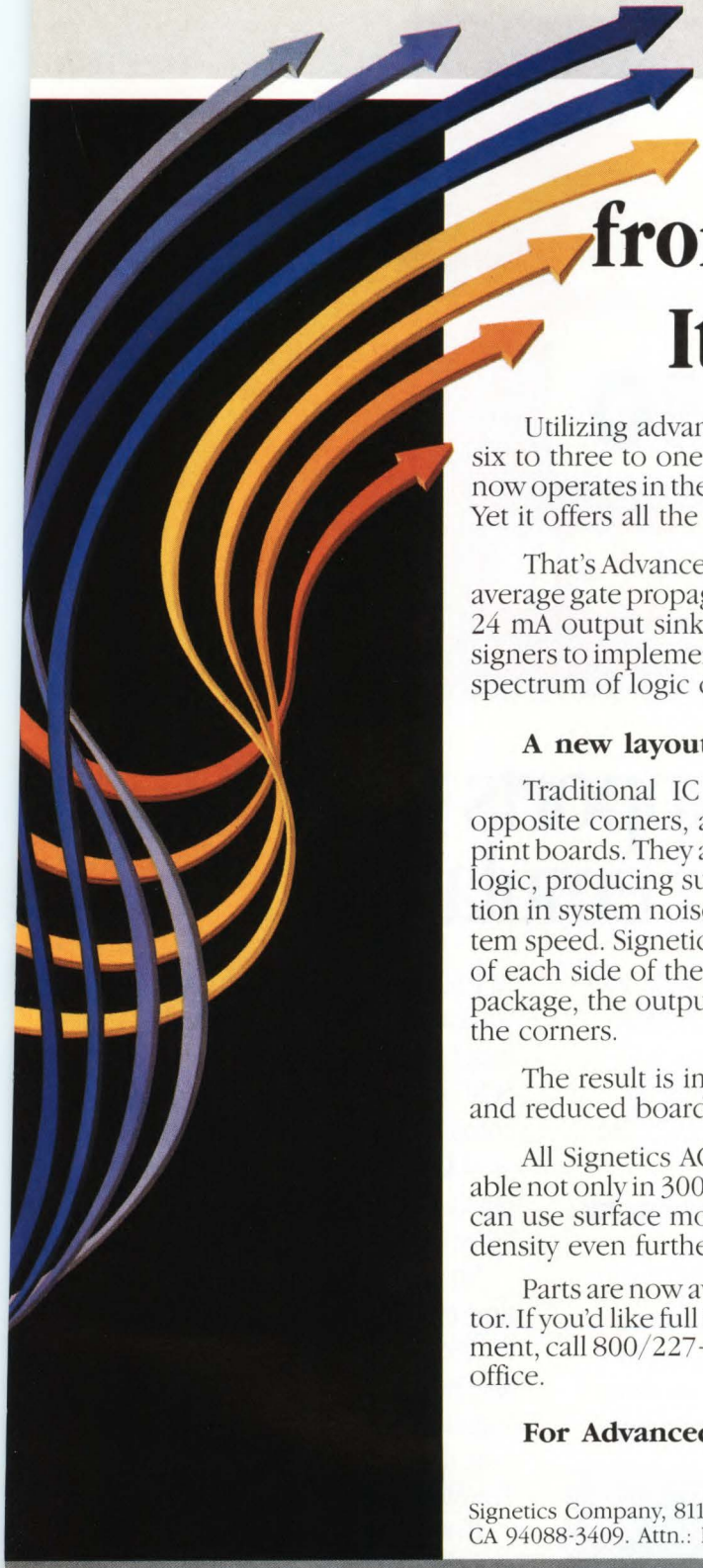

ACL from Signetics. It's logical.

Utilizing advances in fabrication technology, moving from six to three to one micron gate lengths, Signetics CMOS Logic now operates in the realm of the most advanced bipolar families. Yet it offers all the acknowledged CMOS benefits.

That's Advanced CMOS Logic (ACL) from Signetics. With an average gate propagation delay of 3 ns (150 MHz operation) and 24 mA output sink/source capability, Signetics ACL allows designers to implement the CMOS benefits across the whole speed spectrum of logic circuitry.

A new layout for a new technology.

Traditional IC pin-outs, with supply pins at diagonally opposite corners, are a remnant from the days of single-sided print boards. They are inherently unsuitable for advanced CMOS logic, producing supply and ground noise resulting in a reduction in system noise margins, loss of stored data and lower system speed. Signetics ACL has multiple supply pins at the center of each side of the package, the input pins on one side of the package, the output pins on the other side and control pins at the corners.

The result is improved system reliability, simplified design and reduced board area.

All Signetics ACL ICs (74 AC/ACT11XXX family) are available not only in 300 mil wide DIP but also in SO packages, so you can use surface mounting techniques to increase PCB packing density even further.

Parts are now available through your local Signetics distributor. If you'd like full information on this important logic development, call 800/227-1817 ext. 983 or call your local Signetics sales office.

For Advanced CMOS Logic, the name is Signetics.

Signetics Company, 811 East Arques Avenue, P.O. Box 3409, Sunnyvale, CA 94088-3409. Attn.: Publication Services MS27. Telephone: 408/991-2000

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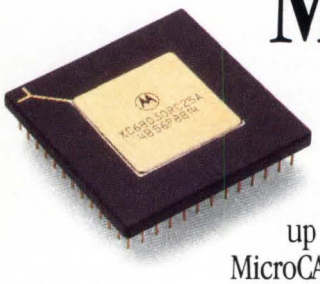
NOW SERVING 68030 EMULATION

MicroCASE supports the 68030 with 25 MHz emulation.



Step right up to the MicroCASE 68030 PROBE™ In-Circuit Emulator. The first, the fastest, the best 68030 support of its kind.

The 68030 PROBE incorporates the same unique features as our highly successful 68020 PROBE™ — the debugging tool chosen by hardware and software engineers in a wide variety of leading high technology equipment manufacturers world-wide.

Pre-fetch pipeline dequeueing

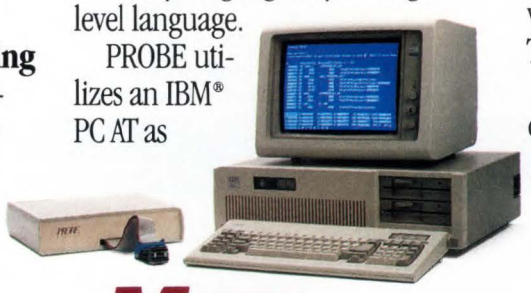
The 68030 PROBE provides in-circuit emulation — at speeds up to 25 MHz. PROBE also features pre-fetch pipeline dequeueing, so it's easy to figure out which instructions actually execute, and which bus cycles relate to those instructions.

And by merely changing the probe tip, the 68030 PROBE also supports the 68020.

True source-level debugging

The 68030 PROBE provides on-line debugging of high-level language software. Real source statements are displayed, eliminating lengthy translations from assembly language to your high-level language.

PROBE utilizes an IBM® PC AT as its instrumentation chassis, so you can get compiled code to its target via Ethernet, VAXNet, SUNNet, SCSI or RS-232. Whether you compile on a PC, a workstation or VAX,® MicroCASE supports more object code formats than any other vendor.



No need to wait any longer. Real-time emulation and dequeueing for the 68030 and 68020 are available now. From the number one supplier of hardware-assisted software debuggers for the 68000 series. The Atron Division of MicroCASE.

If you'd like more information, or a short product demonstration, call us today at **408-253-5933.** Or circle the number on the reader service card.

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408-253-5933

NEWS BREAKS

EDITED BY JOANNE CLAY

RISC PROCESSOR CAN RUN AT ONE INSTRUCTION PER CYCLE

The ultimate goal of all reduced-instruction-set computers (RISCs) is to operate at a rate of one clock cycle per instruction—one CPI. Most RISC μP chips approach the one-CPI limit; ranges of 1.25 to 2.6 CPI are typical. (Generally, basic arithmetic and logic operations require only one clock cycle, but often the load-and-store operation and some types of branch operations require extra processing time.) Fujitsu Microelectronics Inc (San Jose, CA, (408) 922-9000), however, expects to meet the one-CPI goal with its SPARC H chips; the company expects to have the chips available in the second quarter of 1989. The H family extends the manufacturer's SPARC family and will include a floating-point arithmetic unit as well as cache-memory and memory-management ICs. The manufacturer won't release technical details until it's closer to having ICs available.—Jon Titus

DIAGNOSTIC BOARD FOR PC BUS DISPLAYS SELF-TEST PROGRESS

The Postcard from Award Software Inc (Los Gatos, CA, (408) 370-7979) makes it easier to troubleshoot a malfunctioning IBM PC's (or compatible computer's) mother board. The $399 card uses onboard LED displays to display a 2-digit code generated by the mother board's BIOS-ROM-based power-on self-test (POST). In addition, the Postcard contains its own diagnostic PROM that can test the computer's memory, video functions, hard- and floppy-disk drives, parallel and serial I/O ports, keyboard, and math coprocessor. The diagnostic PROM can also perform looped diagnostics for burn-in applications.—Steven H Leibson

CURSOR-POSITIONING DEVICE FITS INTO TIGHT SPOTS

Mice and trackballs share two key disadvantages when used as cursor-positioning tools—they force the touch-typist to move away from the keyboard's home row, and they require a substantial amount of room in the keyboard or on a desk. The Isopoint, a positioning-control device demonstrated last month (November) at Comdex/Fall '88 by ALPS Electric (USA) Inc (San Jose, CA, (408) 432-6000), overcomes both of these problems. Developed over several years by San Francisco inventor Craig F Culver, the oblong Isopoint measures only about 1×4 in. and derives positioning information from a rotating, sliding roller that you operate with your thumb. The roller drives two minuscule optical rotary encoders. A working prototype, installed below the space bar of a Toshiba laptop PC, was demonstrated at Comdex. The prototype device adds only ½ in. to the front edge of the computer. ALPS estimates that the Isopoint would add less than $30 to a computer keyboard in OEM volumes.—Steven H Leibson

FIVE SIMULATION VENDORS WILL OFFER HARDWARE MODELER

Five vendors of logic and fault simulators have signed agreements with Logic Modeling (San Jose, CA, (408) 922-0870) that will allow the simulator vendors to integrate Logic Modeling's hardware modeler in their logic and fault simulators. Logic Modeling's hardware modeler allows you to design your system or ASIC with actual VLSI circuits and pc boards as simulation models for design verification. The five simulation vendors are Gateway Design Automation (Lowell, MA), GenRad (Milpitas, CA), LSI Logic (Milpitas, CA), Valid Logic Systems (San Jose, CA), and Viewlogic Systems (Marlboro, MA). Besides selling its hardware modeler through OEM relationships with simulation vendors, Logic Modeling also markets the modeler directly to large companies that have proprietary simulators.—Michael C Markowitz

NEWS BREAKS

ETHERNET TERMINALS IMPLEMENT X-WINDOWS SERVER PROTOCOL

Proving that the X-Windows graphic-display protocol for Unix isn't just for workstations, the 640 XDS (X display station) from Visual Technology Inc (Lowell, MA, (617) 459-4903) and the Xebra Model 100 from Acer Counterpoint Inc (San Jose, CA, (408) 434-0190) perform the server functions of the X Windows protocol for Unix systems, and couple to networks through Ethernet (IEEE 802.4) interfaces and the TCP/IP network protocol. The 640 XDS, which costs $1995, features a 1024×800-pixel, monochrome display; its 82-Hz screen-refresh rate eliminates screen flicker. The Xebra Model 100 has a 640×480-pixel, monochrome screen and costs $995 in small OEM quantities. Both terminals have 14-in. CRTs and include mice for cursor positioning.—Steven H Leibson

12-BIT D/A AND 10-BIT A/D CONVERTER OPERATE AT 25 MHz

The CLC912 D/A converter and the CLC920 A/D converter from Comlinear Corp (Fort Collins, CO, (303) 226-0500) feature maximum operating rates of 25 MHz. The 12-bit CLC912 employs on-chip latches to minimize data skew. For video and frequency-synthesis applications that are sensitive to spectral purity, the company has added SINAD (signal-to-noise-and-distortion ratio) and harmonic-suppression ratings and spectrum plots to the D/A converter's data sheet. For example, noise and distortion are 59 dB below a 1-MHz signal generated by a CLC912 operating at a 20-MHz update rate. The device achieves reduced glitch energy by implementing the six most significant bits with 63 matched current sources instead of a conventional R-2R resistor-ladder network. The 24-pin converter costs $35.70 to $118.75 (1000), depending on linearity and temperature ratings and packaging.

The 10-bit CLC920 flash A/D converter takes 25M samples/sec and features a full-scale, bipolar signal-input range of ±0.5 to ±2V. Like the data sheets for the D/A converter, the CLC920's data sheets include SINAD, SNR, and harmonic-distortion ratings for applications that are sensitive to spectral purity. The A/D converter dissipates 3.75W (typ) and is packaged in a 64-pin DIP with an integral heat sink. Commercial versions of the device cost $175 (100).—Steven H Leibson

CASE-TOOL PRODUCT LINE IS AVAILABLE UNDER GSA CONTRACT

Pursuant to a new procurement agreement with the Government Services Administration (GSA), Interactive Development Environments (San Francisco, CA, (415) 543-0900) will now offer its Software Through Pictures computer-aided software engineering (CASE) product line under GSA Contract Number GS00K89AGS5508. The contract comes under GSA Group 70, Part I, Section A, which encompasses automated data processing. Software Through Pictures tools assist software engineers in analyzing, designing, and documenting software. You can tailor the tools to meet your project's individual requirements. The programs run in the native windowing environments of Apollo, DEC, Hewlett-Packard, and Sun Microsystems workstations. —Joanne Clay

Stay Generations Ahead in Video/RF 12-Bit ADCs

When it comes to the industry's highest performance 12-bit, 10 MSPS converters, TRW LSI can keep you out front. Whatever your data acquisition problem, TRW LSI's THC1200 Series provides the solution.

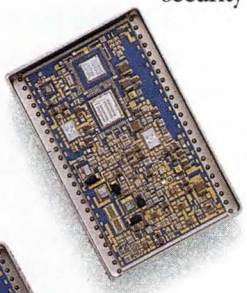
Take the THC1201: It's completely self-contained, including track/hold and all timing circuitry. Signal in, data out, all in a 46-pin hermetic DIP. Standard ±1.0V input range, ±15V and ±5V supplies, TTL interface and synchronous data output make this the easiest part of your system design.

Really cramped for space? Try the THC1202. You get the same leading-edge performance as the THC1201, but in a 40-pin package that's 40% smaller. And, as an extra bonus, you can dump that -15V power supply. And accommodate bipolar or unipolar input signals. That's not all . . .

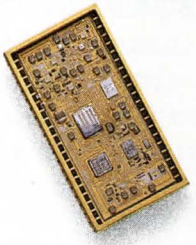
If you have signals down in the mud, our THC1200 is the solution. It offers a full scale input range of ±167 millivolts. That means you won't need that extra low-noise gain stage. But, the whole world doesn't speak softly, so the THC1200 has a gain switch that gives you a ±2.5V input range. That's a gain shift of 15X, extending the dynamic range by over 23dB.

Need more? Give us a call. We have many other leading-edge conversion products on the drawing board. Or we'll do one just for you.

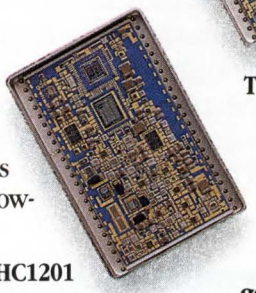
Even if you have already solved your 12-bit acquisition problem, talk to us. Remember, we guarantee full-spec performance. Plus, we can show you how to save time, space, power and money — and obtain multiple-source security without a redesign.



THC1200

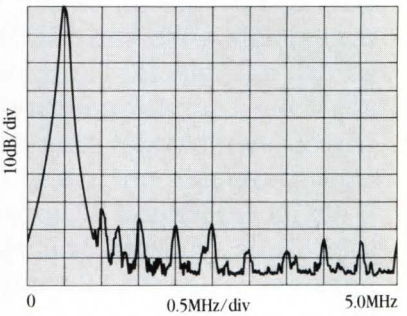


THC1202



THC1201

TRW LSI Products — Bringing the worlds of Data Acquisition and DSP together to keep you generations ahead.



Part Number	Analog Input Range (V)	Package Style	Area (Sq. In.)	Power (W)
THC1202	±1.0	40-Pin DIP	2.3	5
THC1201	±1.0	46-Pin DIP	3.8	5
THC1200	±2.5 and ±0.167	46-Pin DIP	3.8	9

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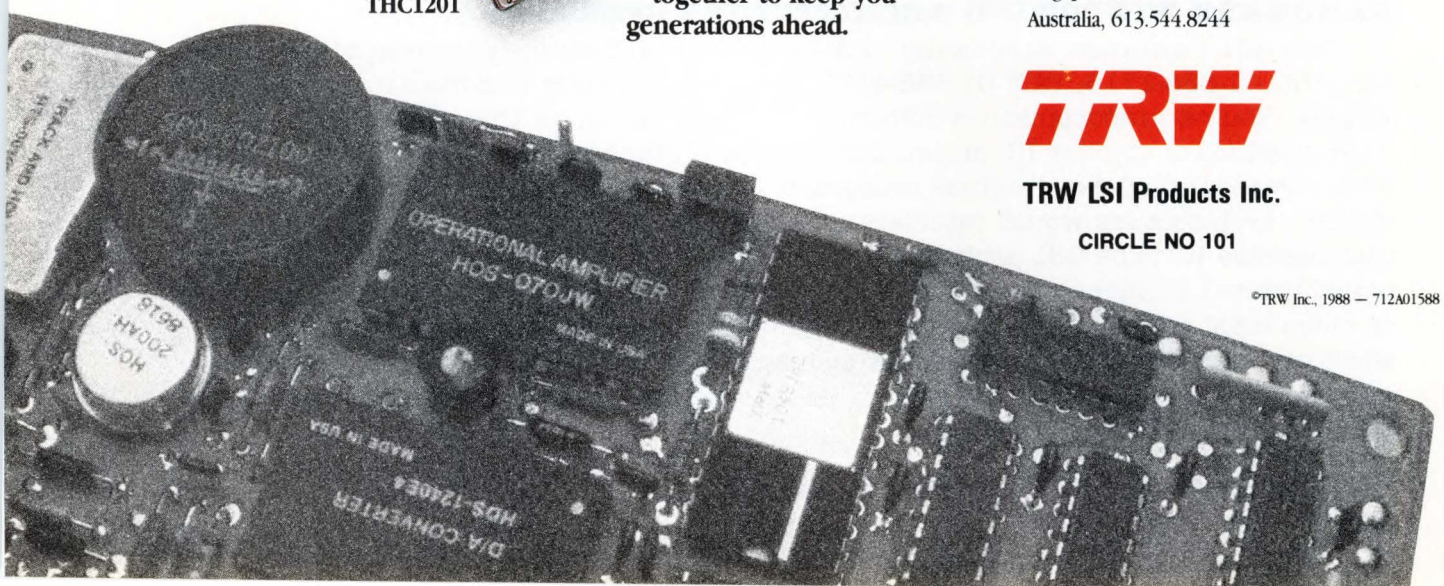


NEWS BREAKS: INTERNATIONAL

ENHANCED 8-BIT MICROCONTROLLER HANDLES 16-BIT MATH

Targeting applications that require both control and computational capabilities, the 80C517 enhanced microcontroller from Siemens AG (Munich, West Germany, TLX 5210025; in the US: Santa Clara, CA, (408) 980-4500) includes a math unit capable of performing 16 × 16-bit multiplication, 32 × 16-bit division, and 32-bit shifts. A 16 × 16-bit multiplication takes around 4 μsec to execute. Although it remains fully compatible with the 80C51 instruction set and architecture, the 80C517 includes additional special-function registers and eight separate data-pointer registers. In addition, the microcontroller has an impressive range of on-chip peripherals, including an event timer that can compare events on as many as 21 I/O-port lines and capture events on five I/O lines; a 12-channel, 15-μsec, 8-bit A/D converter; seven 8-bit bidirectional I/O ports; and two serial I/O ports. By using a 2-pass conversion technique, you can increase the A/D converter's resolution to 10 bits, and you can optionally use its 12 input channels as additional digital input lines. A conventional watchdog timer allows you to monitor program flow, and an additional watchdog circuit detects any failure of the microcontroller's clock oscillator. If the clock oscillator fails, the oscillator watchdog automatically holds the microcontroller in its reset condition. The microcontroller also has three separate power-down modes. Engineering samples of the 80C517 will be available during the first quarter of 1989, and production quantities will be available during the third quarter of 1989 at a price of around DM 25 (10,000).—Peter Harold

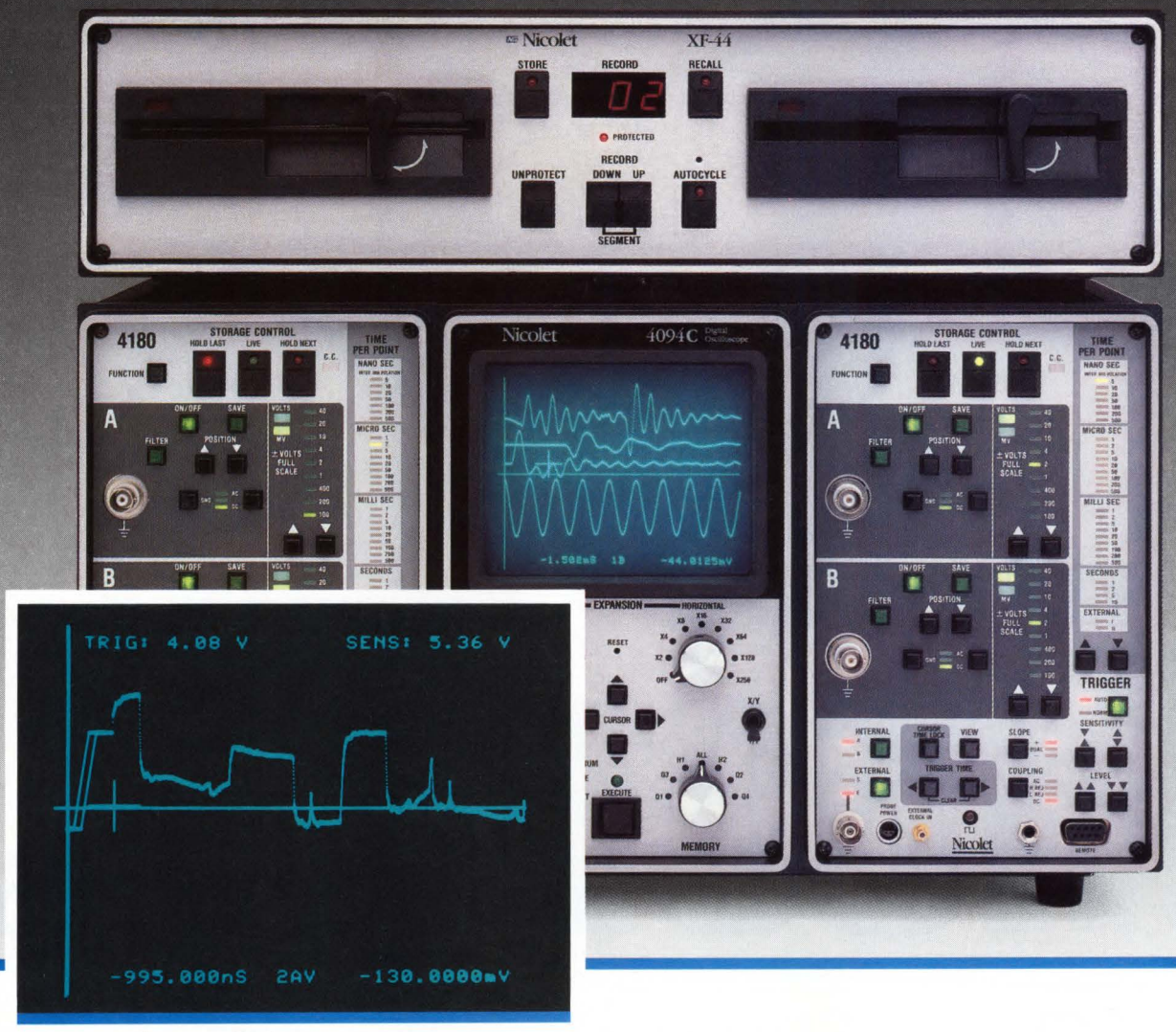
RUGGED MODULE PUTS ATARI ST INTO INDUSTRIAL APPLICATIONS

If you're looking for an industrial version of a commercial personal computer but the myriad IBM-PC-on-a-card-set clones don't meet your requirements, consider the 190ST from IBP Gerätebau GmbH (Hannover, West Germany, 0511-630963). The metal-clad 190ST module operates from a 5V power supply and incorporates the circuitry from Atari's ST series of computers, including both monochrome and color video interfaces, parallel and serial ports, floppy- and hard-disk interfaces, mouse and joystick ports, and even the three MIDI (musical instrument digital interface) ports. These various interface ports are available through seven D-type connectors mounted on the module's front panel. In addition, the 190ST implements a μP-bus interface for communication with other IBP modules on a Eurobus-E backplane. With 512k bytes of RAM, the 190ST costs DM 2240. The company is currently seeking a US representative.—Steven H Leibson

HARDWARE WINDOWING ARCHITECTURE SPEEDS GRAPHICS

The GS1 hardware windowing architecture from Caplin Cybernetics Corp (London, UK, 01-538-1716, FAX 01-538-4151) supports multiple windows in a graphics display. You can incorporate windowing circuitry based on the architecture in your VLSI graphics-controller IC, or you can develop a stand-alone windowing IC to use with a general-purpose graphics processor. For example, a windowing IC based on the GS1 architecture would interface to a graphics processor, video RAM, and a color-palette IC. (The GS1 architecture directly supports Brooktree palette ICs, but is not limited to them.) The windowing IC would calculate the appropriate sequence of video-RAM addresses in real time to move the windows smoothly or scroll the windows' contents. Such an IC could also arbitrate between overlapping windows and generate the pixel-display stream. Licensing fees for the architecture are about $350 per IC.—Margery S Conner

Flexible Triggering An Issue?



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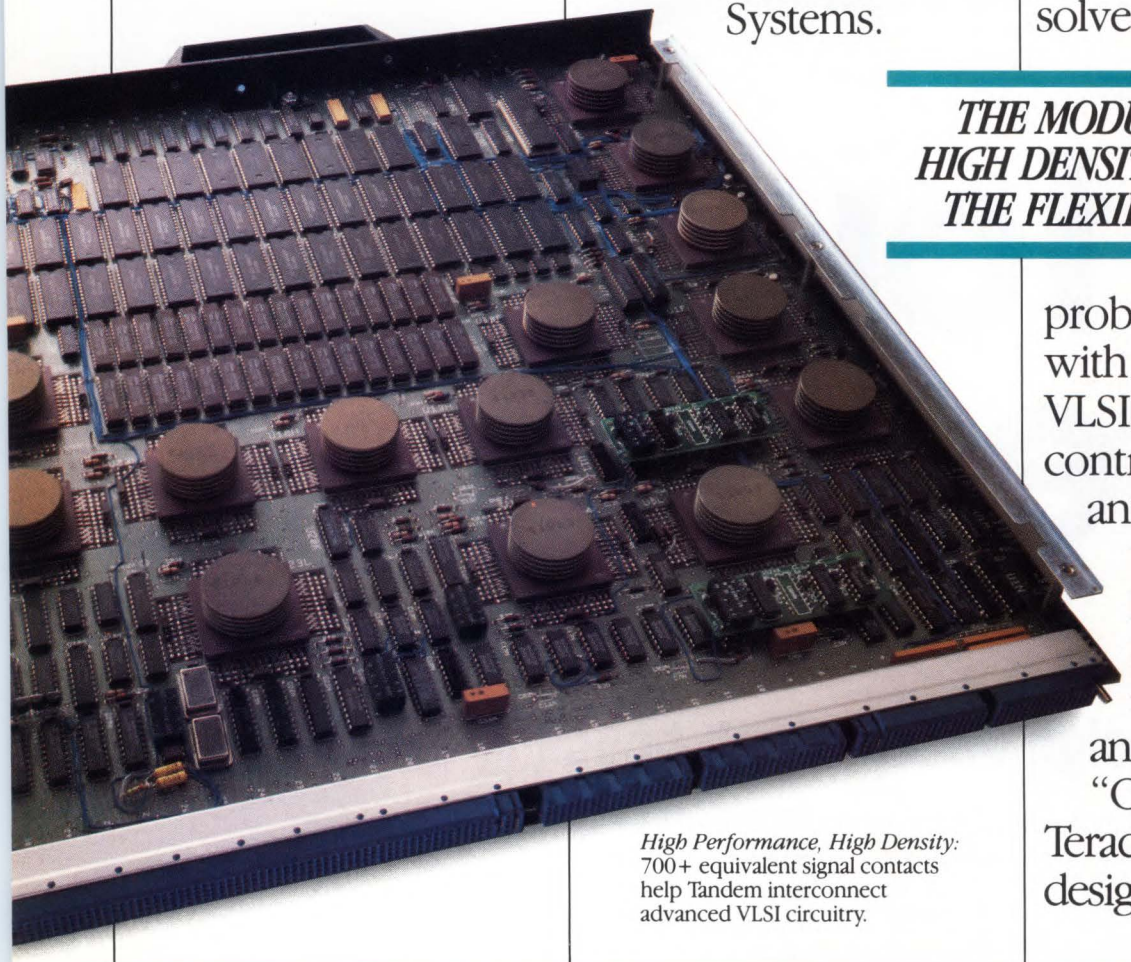

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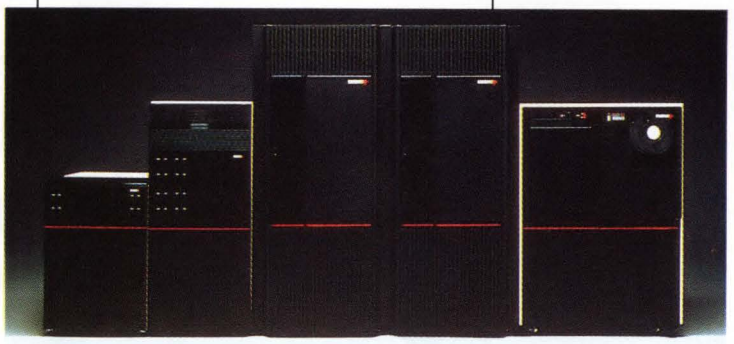

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SIGNALS & NOISE

An overview of algorithm sources

Shortly after reading Alan Clark's letter seeking a source of basic numerical algorithms (EDN, August 4, 1988, pg 31), I found a good overview of some books he may find useful. The overview appeared in the article "A designer's reference shelf: Part two" by P J Plauger, and it appeared in *Computer Language*, August 1988, pg 17.

Several of the books Plauger mentions are:

Sterbenz, Pat H, *Floating-Point Computation*, Prentice-Hall, Englewood Cliffs, NJ, 1974.

Hart, John F, et al, *Computer Approximations*, Robert E Krieger Publishing Co, Malabar, FL, 1968, 1978.

Abramowitz, Milton, and Stegun, Irene A, eds, *Handbook of Mathematical Functions*, Dover Publications, New York, NY, 1965.

My source for basic numerical calculations has been my vast collection of magazines (mostly *Byte*, but I've been leaning towards *Computer Language*), a few math texts, some digital-signal-processing texts, and various books on assembly-language programming. I usually need to use several of these sources—and the index is in my head, so the search for the answer to a simple problem can sometimes turn into a major mess. (However, I often find things of interest that are unrelated to the original problem.)

I'll be interested to see what other sources are available.

Eric Edin
Grants Pass, OR

Knowledge at $35 per volume

With respect to Alan Clark's request for a source of algorithms:

The source of all knowledge is *The Art of Computer Programming* by Donald Knuth (Addison-Wesley, Reading, MA, 1969, ISBN 0-201-03822-6). Knowledge costs about thirty-five bucks a volume.

Knuth covers most common programming problems, giving both practical algorithms and a theoretical basis for choosing the appropriate one. The examples are written for a mythical but simple computer and can be implemented on most microcontrollers and in any language. These books (there are now three volumes, I believe) are not cookbooks, and they're probably overkill for someone looking for a quick-and-dirty routine.

For specific microcontroller help, I recommend the assembly-language texts by Osborne/McGraw-Hill and Sybex (Rodnay Zaks, Ed). Both series are easy to read and contain sufficient information for most simple (conversion, integer arithmetic) programming problems. These run about $20.

Graphics algorithms are harder to come by, as they are often very hardware-dependent. This fact is due to the calculation efficiency needed to achieve good performance. Graphics is also a rapidly evolving field for the same reason. There are some specific (academic) texts, but most of the "graphics on the PC (Amiga, Apple, etc)" texts are written for Basic and use built-in Basic functions—the ones you need to write.

Good luck!

Jan Lambert
Lambert Systems
Oakland, CA

The all-purpose algorithm

Herein is a response to Alan Clark's request for an all-purpose algorithm for computing floating-point and trigonometric functions (EDN, August 4, 1988, pg 31).

There does exist a unified algorithm for elementary functions

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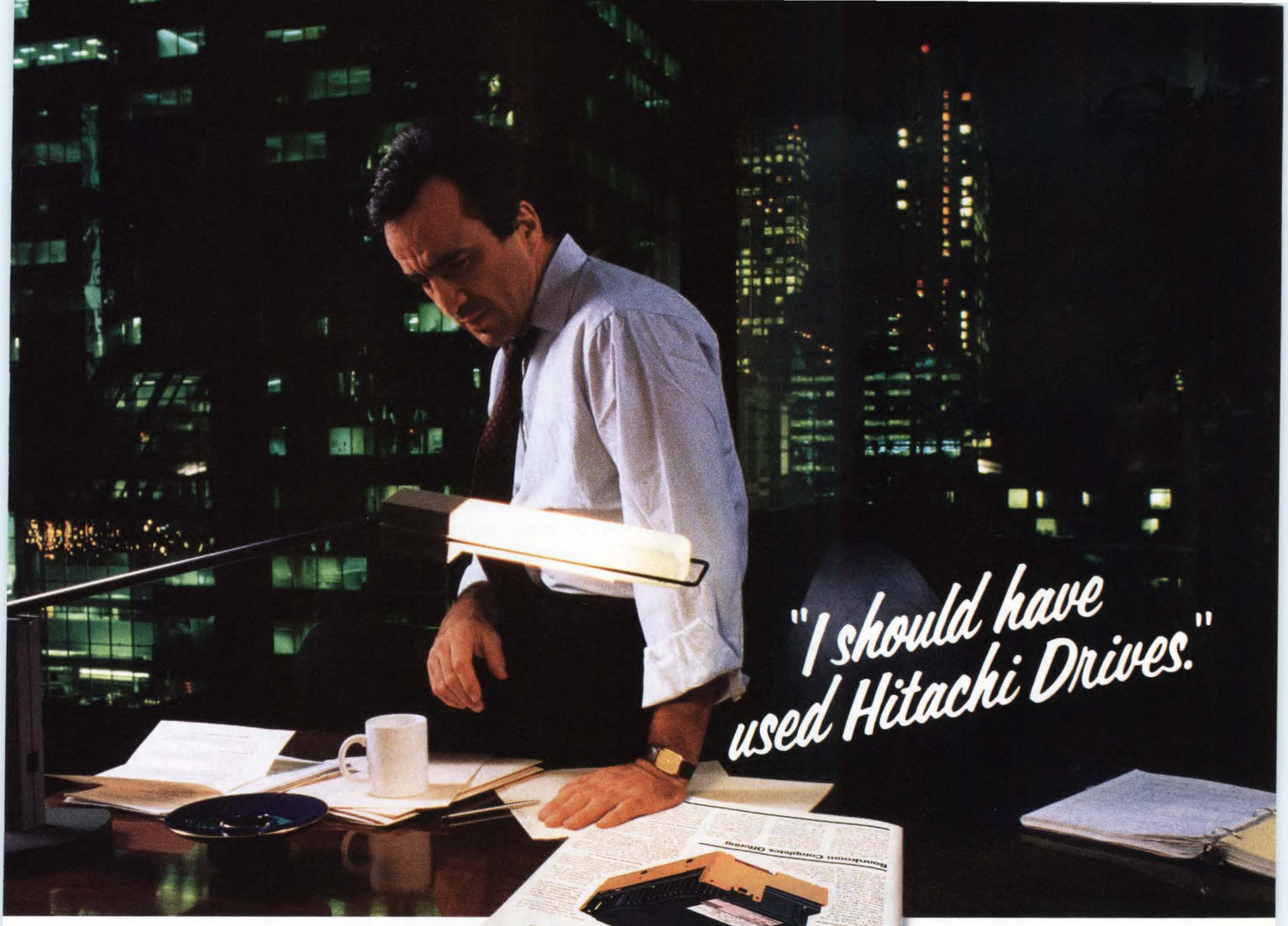

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called CORDIC (Coordinate Rotation Digital Computer), which was used in a floating-point math package for the RCA COSMAC 1800 microprocessors, as well as in Hewlett-Packard's 9100 Series calculators. The algorithm calculates elementary functions, including multiplication; division; sine, cosine, tangent, and arctangent; hyperbolic sine, cosine, tangent, and arctangent; natural logarithm; exponentiation; and square root. There are also techniques for performing decimal-to-binary conversion (and vice versa) with CORDIC. The algorithm is based on coordinate rotation in a linear, circular, or hyperbolic coordinate system.

See Walter, J S, *A Unified Algorithm for Elementary Functions*, IEEE Spring Joint Computer Conference, 1971.

Charles L Elliot
Elliot Geophysical Co Inc
Tucson, AZ

Consultants share their library

Our company is a consulting firm in South Florida. Our designers and product developers have often required algorithms similar to those Alan Clark requested. In our search for solutions, we have found the following publications to be *very* useful:

Knuth, Donald E, *The Art of Computer Programming, Volume 2: Seminumerical Algorithms*, Addison-Wesley Publishing Co, Reading, MA, 1969. This volume contains many of the mathematical algorithms Alan is seeking.

Giloi, Wolfgang K, *Interactive Computer Graphics*, Prentice-Hall Inc, Englewood Cliffs, NJ, 1978. This book describes the techniques necessary to create graphic images.

Bennet, William Ralph, Jr, *Scientific and Engineering Problem Solving with the Computer*, Prentice-Hall Inc, Englewood Cliffs, NJ, 1976. This publication describes some of the more fundamental numerical and conversion algorithms Alan is seeking.

I honestly do not know if any of these books are still in print. They have all been useful to me personally, as well as to the rest of the staff.

Thomas Peterick
Consultant
The Systems Group
Pompano Beach, FL

YOUR TURN

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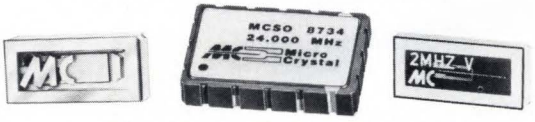

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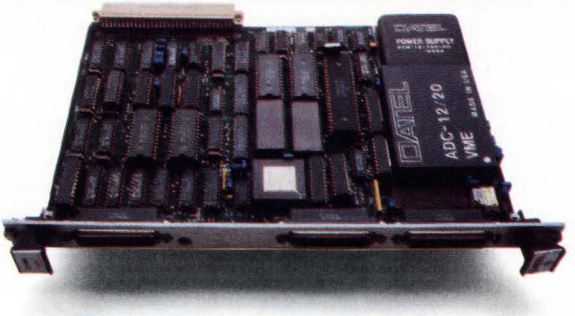

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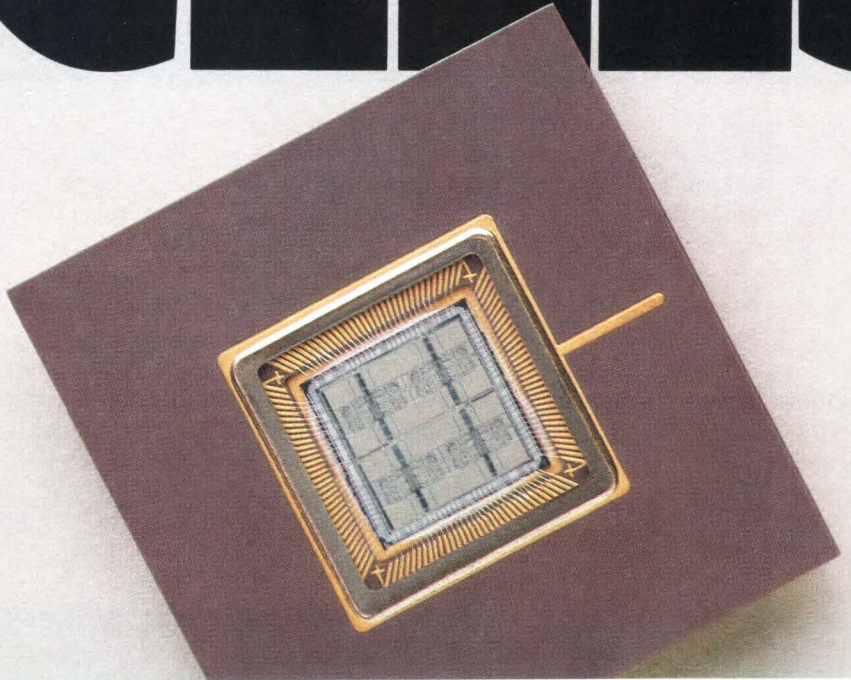

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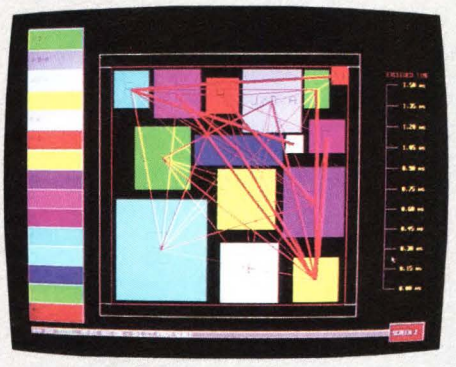

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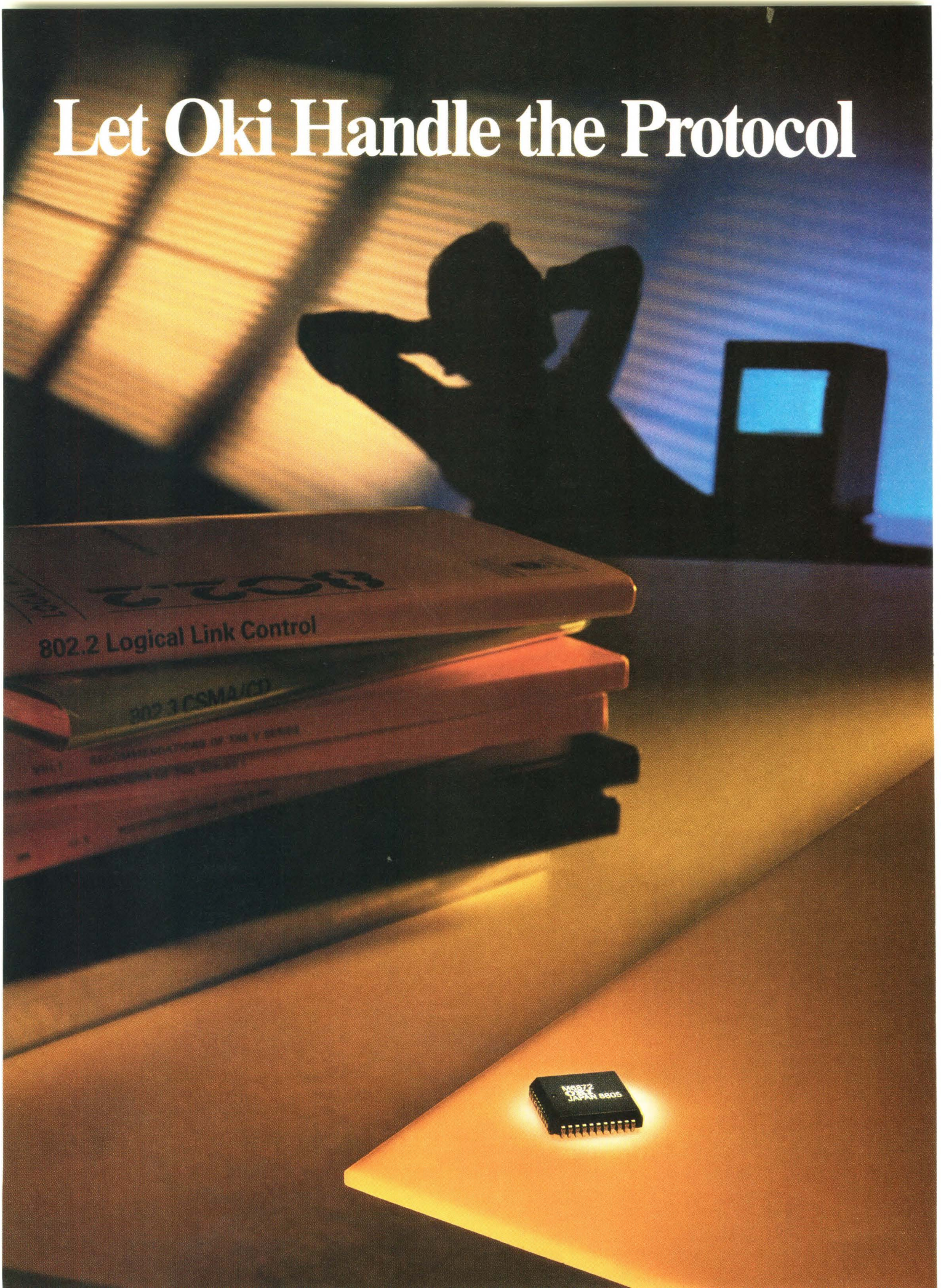

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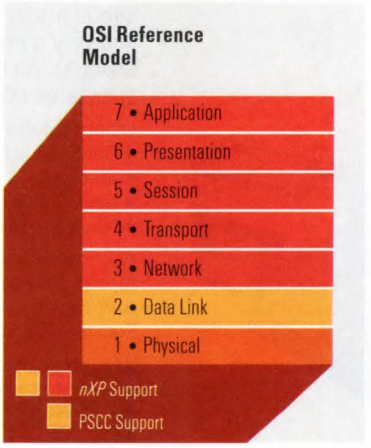

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CALENDAR

Real-time System Design: A Hands-on Workshop (short course), Washington, DC. John Valenti, Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (231) 417-8888. January 10 to 13.

SC Global '89, San Francisco, CA. Superconductor Applications Association, 24781 Camino Villa Ave, El Toro, CA 92630. (714) 586-8727. January 11 to 13.

OE LASE '89, Los Angeles, CA. Society of Photo-Optical Instrumentation Engineering (SPIE), Box 10, Bellingham, WA 98227. (206) 676-3290; in Europe: SPIE, Koblenzer Strasse 34, D-5300 Bonn 2, West Germany, 49-228-36-15-46, TWX 172-283-747. January 15 to 20.

Fifth Annual Computer Graphics New York Show, New York, NY. Exhibition Marketing & Management Co, 8300 Greensboro Dr, Suite 110, McLean, VA 22102. (703) 893-4545. January 17 to 19.

The 1989 Optical Disk Systems Conference: From the Mail Room to the Board Room, Phoenix, AZ. CAP International Inc, 1 Longwater Circle, Norwell, MA 02061. (617) 982-9500. January 23 to 25.

ATE & Instrumentation Conference West, Anaheim, CA. MG Expositions Group, 1050 Commonwealth Ave, Boston, MA 02215. (800) 223-7126; in MA, (617) 232-3976. January 23 to 26.

Winter 1989 Unix Technical Conference, San Diego, CA. Usenix conference office, Box 385, Sunset Beach, CA 90742. (213) 592-1381. January 30 to February 3.

Electromagnetic Interference—Characteristics and Control (seminar), Center for Continuing Engineering Education, University of Wisconsin-Milwaukee, 929 N Sixth

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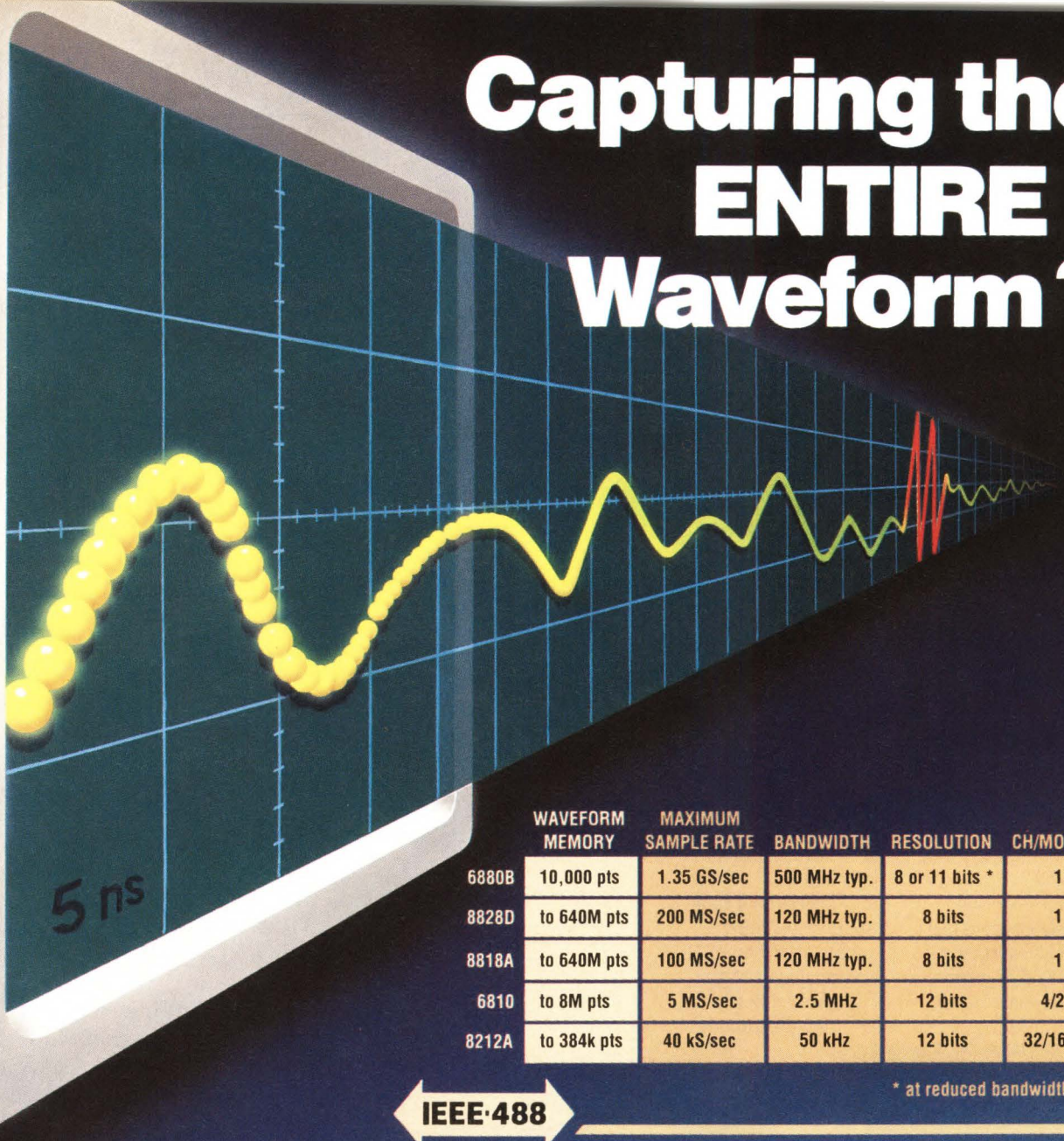

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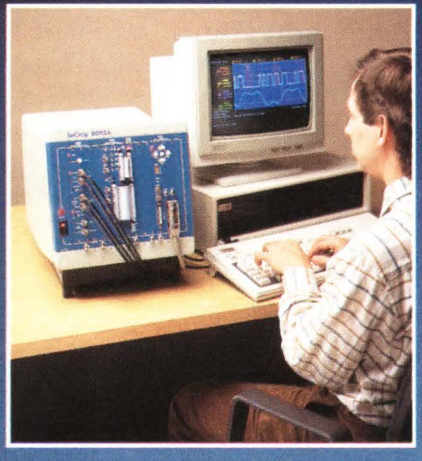

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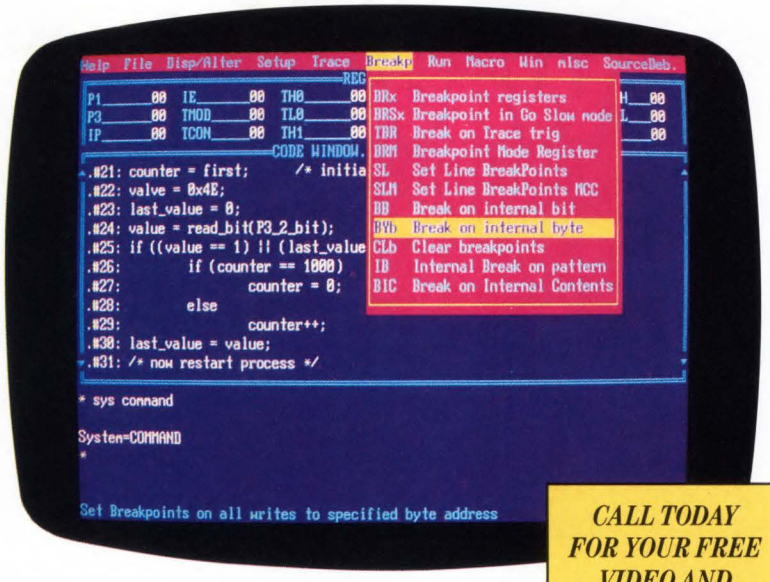

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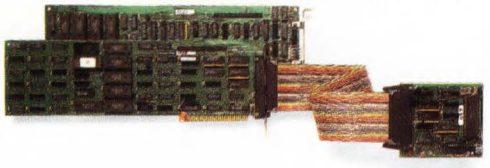

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CIRCLE NO 6

DID YOU KNOW?

Half of all EDN's articles are staff-written.

EDN

CALENDAR

St, Milwaukee, WI 53203. (414) 227-3120. January 31 to February 2.

Power Electronic Conference '89, Santa Clara, CA. Conference Management Corp, 200 Connecticut Ave, Norwalk, CT 06854. (203) 852-0500. February 7 to 9.

Software Development '89, San Francisco, CA. Miller Freeman Publications, 500 Howard St, San Francisco, CA 94105. (415) 995-2471. February 14 to 17.

Power Supply Design Seminar, Tampa, Orlando, and Fort Lauderdale, FL; Huntsville, AL. Unitrode Corp, 580 Pleasant St, Watertown, MA 02172. (617) 926-0404. February 21 to 24.

Compcon Spring '89 (34th IEEE Computer Society International Conference), San Francisco, CA. Kenichi Miura, Fujitsu America, 3055 Orchard Dr, San Jose, CA 95134. (408) 432-1300. February 27 to March 3.

Systems Engineering for Integrated Hardware/Software Applications (short course), Los Angeles, CA. John Valenti, Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (231) 417-8888. March 7 to 10.

The Executive Forum on Supercomputing, San Jose, CA. Pat Westly, Westly Enterprises, 3697 S Court, Palo Alto, CA 94306. (415) 494-7115. March 9 to 10.

APEC '89 (IEEE Applied Power Electronics Conference and Exposition), Baltimore, MD. Trey Burns, Data General Corp, 4400 Computer Dr, E213, Westboro, MA 01580. (508) 870-9182. March 13 to 17.

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Microcontroller	ROM†	RAM†	Special Features	Timers	Serial Communications	I/O Port	Package	A
80C51/87C51	4K	128	All packages available	2 Std.	Full duplex UART	4 8-bit	40 DIP 44 LCC**	N
83C451/87C451	4K	128	7 Ports Mailbox Port 6	2 Std.	Full duplex UART	7 8-bit	64 DIP 68 LCC**	N
83C751/87C751	2K	64	Small package full performance	16-bit Autoload & fixed rate (2 total)	I²C*	2 8-bit 1 3-bit	24 SDIP 28 PLCC	N
83C652/87C652	8K	256	Pin for pin 80C51 compatible	2 Std.	Full duplex UART & I²C*	4 8-bit	40 DIP 44 LCC**	
83C552/87C552	8K	256	10 bit A/D conv.; 8 high speed outputs; 3 Compare/4 Capture registers 2 PWM outputs	2 Std.; Capture/Compare; Watchdog (4 total)	Full duplex UART & I²C*	6 8-bit	68 LCC**	
83C752/87C752	2K	64	8-bit A/D conv.; 1 PWM output	16-bit Autoload; fixed rate	I²C*	2 8-bit 1 5-bit	28 DIP 28 PLCC	

*Inter Integrated Circuit Serial Communications Bus
**LCC refers to availability in ceramic or plastic packaging
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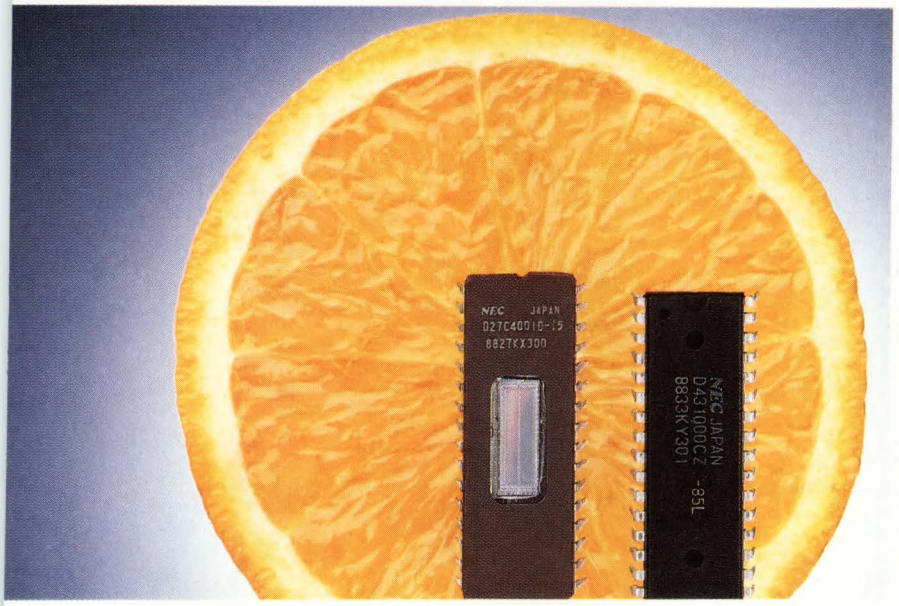

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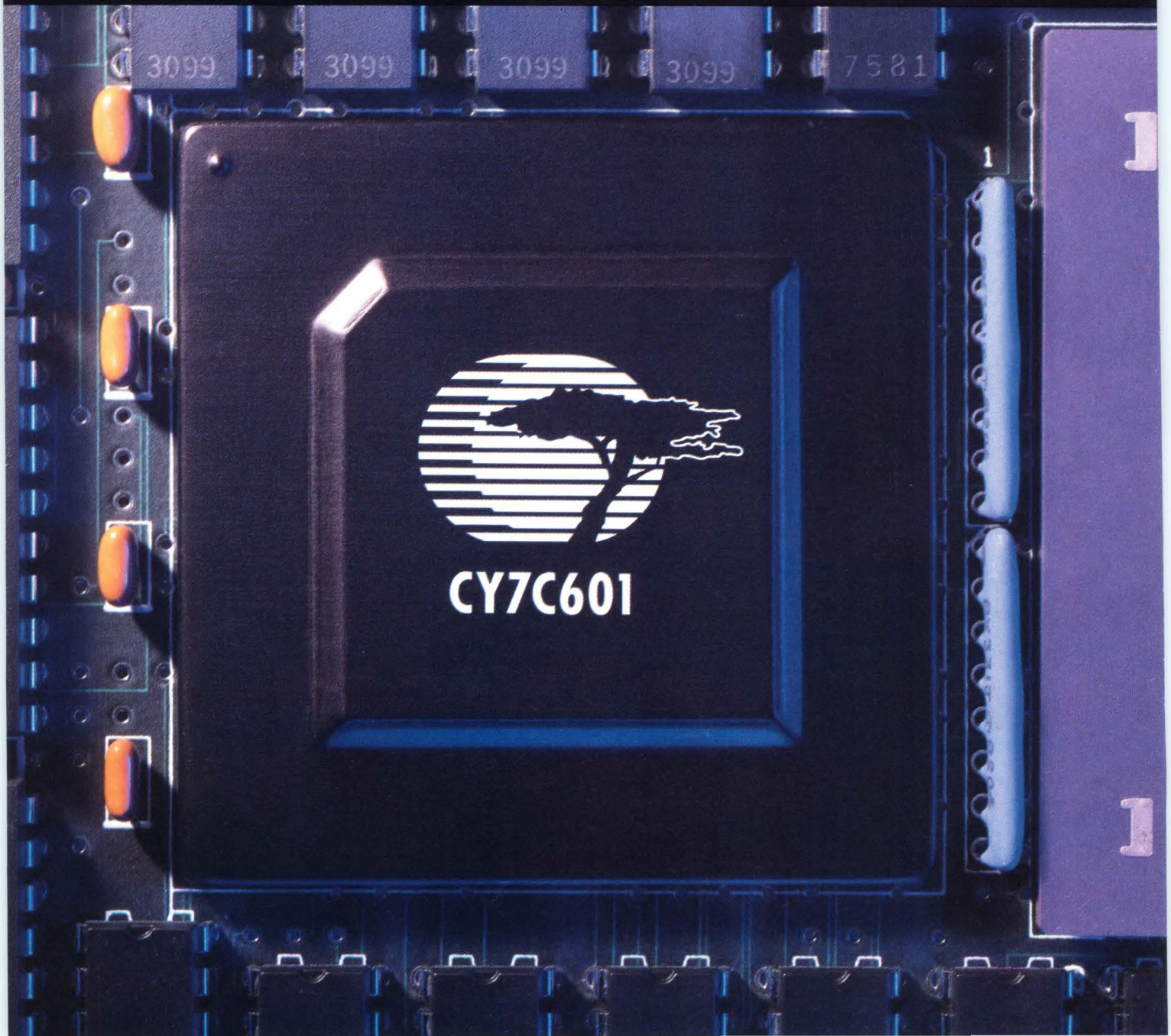

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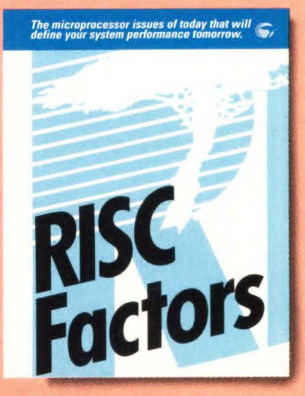

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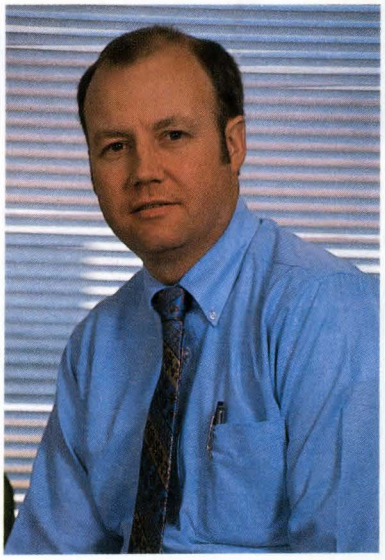
EDITORIAL

Programmers hate open memory



If asked about our computer needs today, many of us would shout "More memory!" Our desire for more and more computer memory has persisted because programmers, in their eagerness to enhance their products, usually fill so-called open or free memory as fast as they possibly can.

In the early '70s, I programmed a PDP-8/L minicomputer that supplied 8k words of memory. The computer did a fine job of automating many data-acquisition and number-crunching tasks. We couldn't believe our luck when a 32k-word disk was added to the system. Unfortunately, the operating system and all the enhanced application programs quickly filled the disk. The computer did the same jobs, we said, but it did them better.

When we moved to microcomputers that provided 64k bytes of storage space, we thought we'd have lots of extra memory for data storage and manipulation, but it just was not to be. Instead, the size of our CP/M application programs expanded, too. Certainly the expanded programs offered more capabilities and we could select from a larger range of options, but basically they did the same things as their predecessors. What's more, there was little free memory.

In the early '80s, the IBM Personal Computer enlarged the available memory space tenfold to 640k bytes, but the program-expansion trend continued. For example, a communications program that required about 2k bytes of memory in our CP/M computer now needs about 20k of memory in the PC. Again, our expanded program provides enhancements, but it doesn't offer a decade's leap in performance.

The OS/2 operating system makes matters worse. Before you can run OS/2 on existing IBM PCs and PC-compatible computers, you must expand the memory to 2M bytes at a minimum. You can still run MS-DOS-type application programs, but the OS/2 software's needs shrink the available space to about 540k. That's 100k, just for part of the operating system.

It seems inevitable that program expansion will continue. Users may view small computers that offer 16M bytes of memory as the answer to their expanding memory needs. Of course, there will be new applications that really need large quantities of memory—a circuit-simulation program is a good example. But while we're expanding memory space and shrinking computer systems, we ought to be looking for better software-production techniques as well. Based on my own experience, we have a long way to go.

Jesse H Neal
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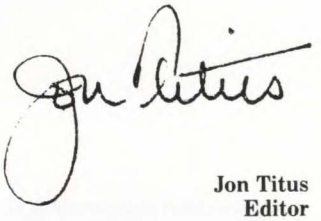
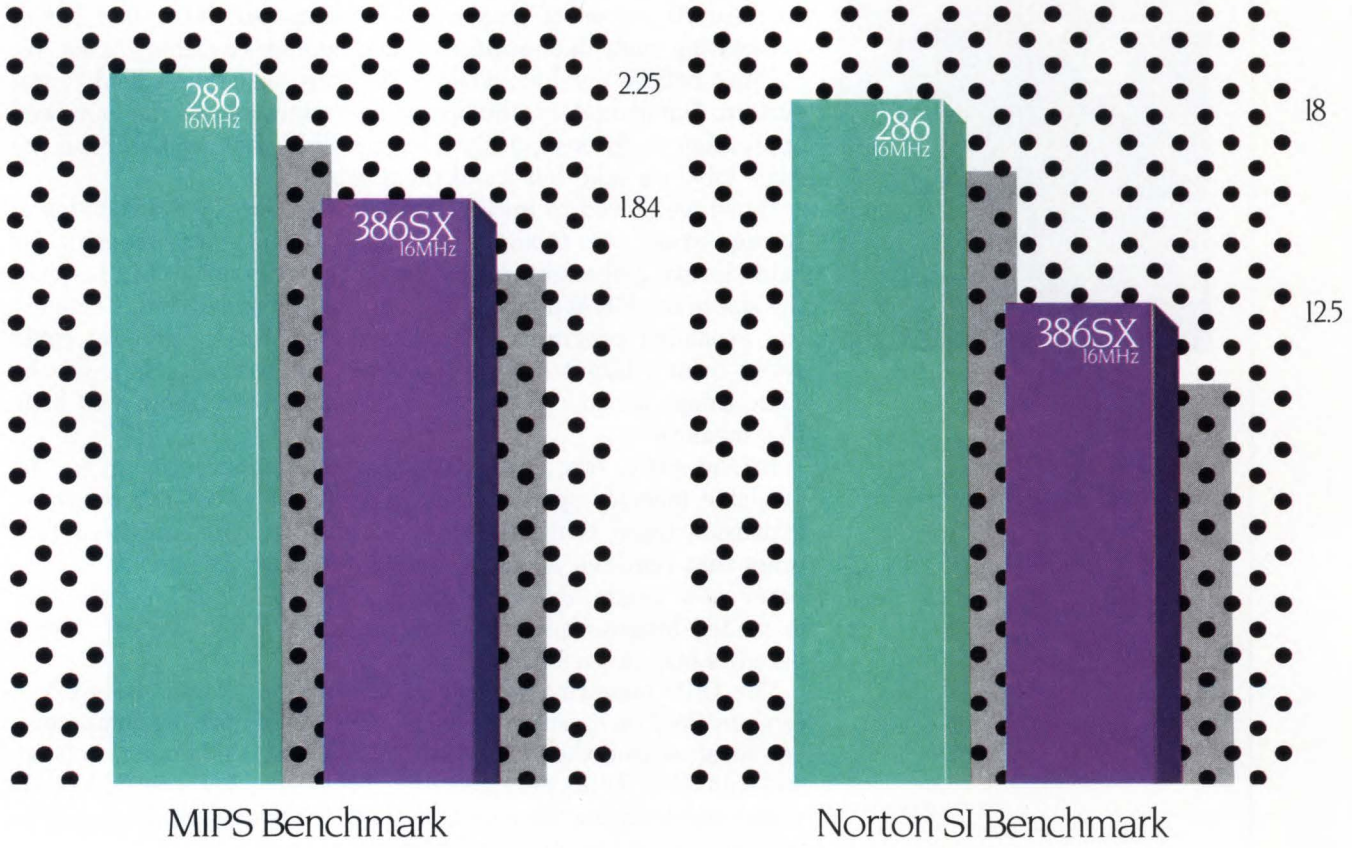
1988, 1983, 1981



Jon Titus
Editor

The 386SX: Good who want slower,



All benchmarks performed with an Everex Step 286-16 with 0 wait states and a Compaq Deskpro 386S™ with 0 wait states. Both systems running 16-bit DOS and OS/2 software. Dhrystone 1.1 compiled with Microsoft® C compiler with no optimization. Run under DOS 3.31. Norton SI by Peter Norton Computing, Inc. performance reported relative to an IBM PC-XT® MIPS written by Chips and Technologies. Chip cost based on 1000 piece quantity. Product names mentioned herein may be trademarks and/or registered trademarks of their respective companies.

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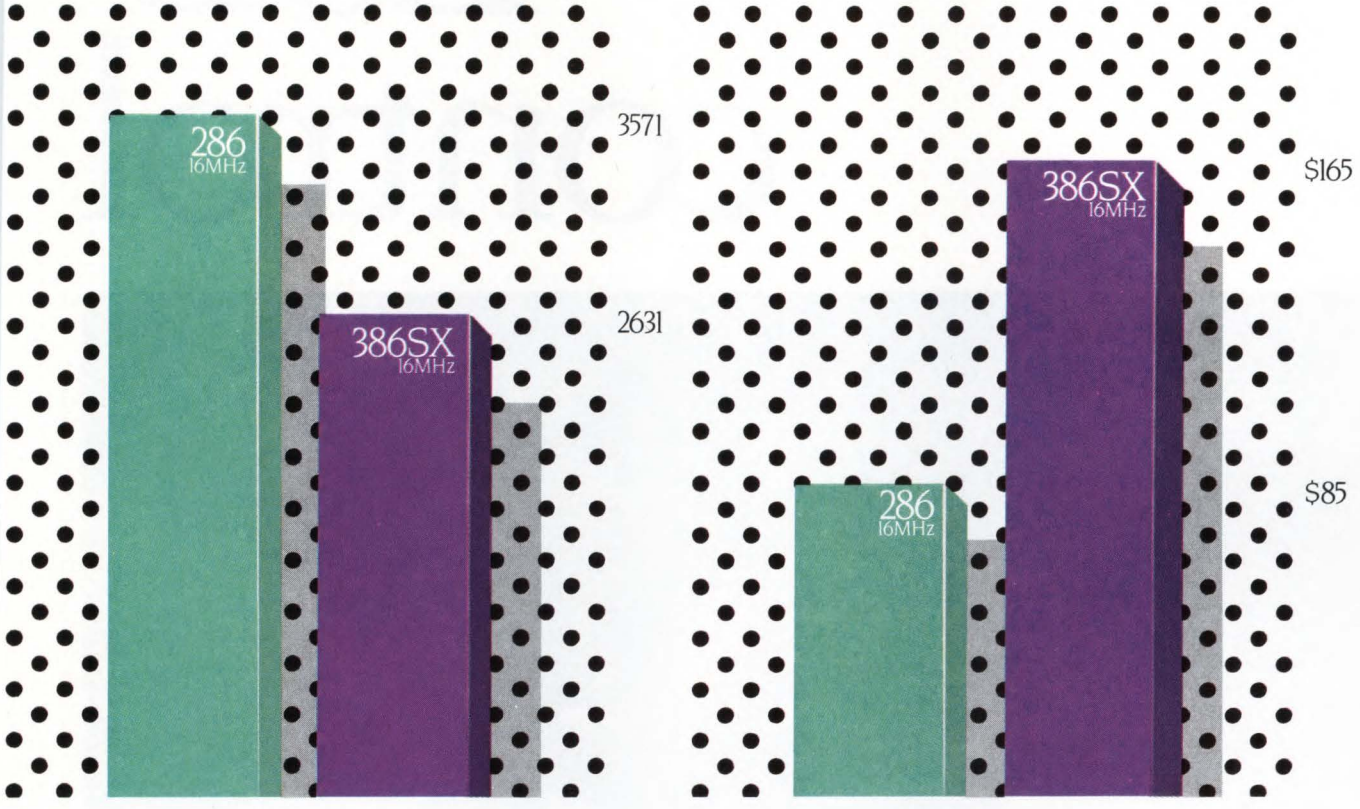

For a benchmark report on the 16MHz 286,™ just call (800) 222-9323.

Advanced Micro Devices

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Products and services can facilitate ESD control

An ESD simulator that can inject transients by contact or through the air (Keytek Instrument Corp)

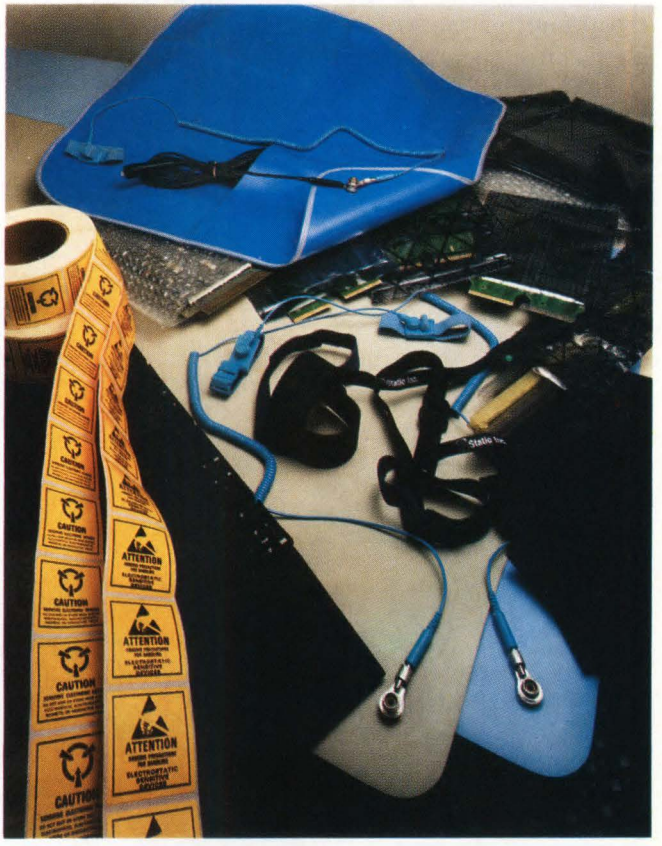
As a design engineer, you might often view the data loss and damage caused by electrostatic discharge as someone else's problem. But only by using your engineering knowledge to understand the phenomenon can you wisely choose among the thousands of products that claim to offer protection.

Dan Strassberg, *Associate Editor*

Electrostatic discharge (ESD) isn't like most of the other phenomena that trouble electrical engineers. Though it *can* do so, ESD doesn't usually cause immediate, outright catastrophic failures. More often, ESD-related problems range from the corruption of data, to system lock-up, to the creation of "walking-wounded" devices destined to fail prematurely—after you ship your product.

As a result of the widespread use of ESD-susceptible ICs, such as high-speed logic chips and VLSI devices, the electronics industry has begun to realize ESD's potential costs. In response to this realization, hundreds of vendors now offer thousands of products to help manufacturers control ESD effects. By one estimate, the value of the ESD-control products and services sold in the US in 1986 exceeded $200 million. Unfortunately, though, too many ESD-control measures are selected on the basis of mythology and folklore rather than as a result of a solid understanding of the problems. Moreover, design engineers too often think that ESD control is the province of people in manufacturing and field service, when, in fact, steps taken during the design phase could make many products substantially more resistant to the ravages of ESD.

Despite the mythology and folklore, there are logical explanations for the mechanisms that cause ESD-induced damage in devices and systems. But, improving the accuracy with which discharge-susceptibility tests simulate real-world conditions still poses a significant challenge. Consequently, many standard-setting organizations continue to work on refining the circuit models that describe discharges and on characterizing discharge waveforms. This work is likely to continue for years.



Warning labels and conductive straps, mats, and bags *(Static Inc)*

ESD-related problems range from the corruption of data, to system lock-up, to the creation of "walking-wounded" devices destined to fail prematurely.

ESD-control measures at plants that manufacture electronic systems and subsystems take two basic forms. The most common form consists of process-oriented programs that are supposed to reduce the likelihood of damage to components and assemblies. Such programs usually affect factory areas and occasionally affect design-engineering labs. Personnel who load, test, and troubleshoot pc boards wear grounding wrist straps and, sometimes, conductive footwear. Floors may be covered with conductive tiles. Boards and components travel in conductive containers. Conductive mats cover benchtops, and air ionizers and humidity controllers may be used to condition the ambient air.

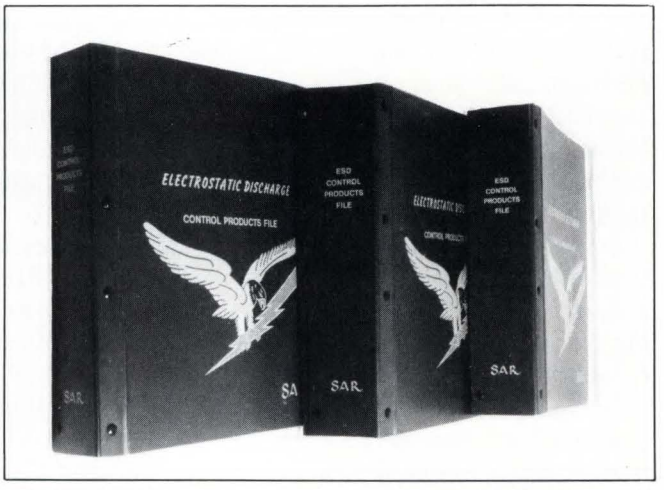
Process-oriented programs make no attempt to alter the design of the products being manufactured, and all too often the effectiveness of such programs is questionable. Nonetheless, fewer companies use a second form of ESD control: limiting product vulnerability by design. Through an understanding of discharge phenomena, you can design products with inherent immunity to ESD. Then you can perform controlled tests to verify the ability of such products to survive.

A knowledge of how electrostatic potentials arise is invaluable in selecting the appropriate control products as well as in designing your product for ESD immunity. Though the derivation of these values is beyond the scope of this article, your capacitance to ground while wearing ordinary insulating shoes is somewhere between 100 and 500 pf. Because the soles of women's shoes are usually thinner than those of men's, women typically have higher capacitance to ground than do men. And, if you are standing on an insulating floor and then sit down on an insulating chair, raise or lower an arm, or lift your feet off the floor while seated, you change your capacitance to ground.

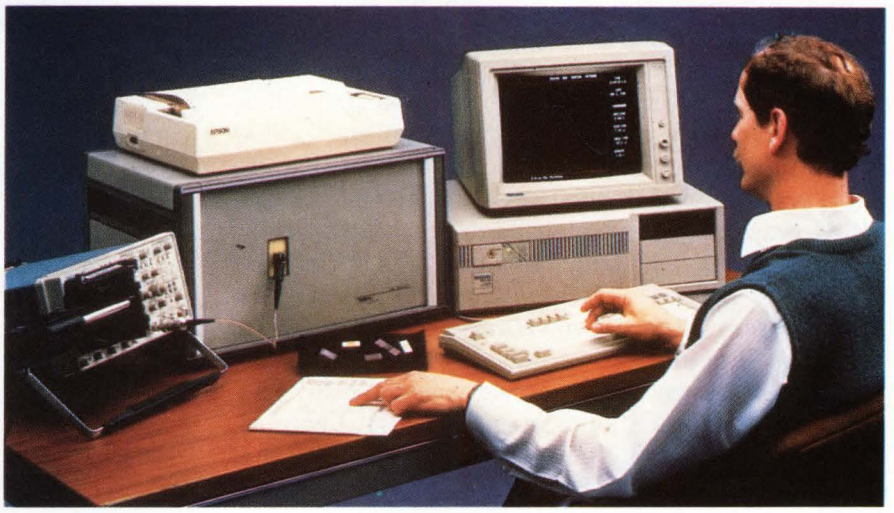
Conductive gaskets that keep discharges from injecting noise through openings *(Tecknit)*

Small energy . . . big trouble

When you walk across an insulating surface or shift your position on the insulating seat of your chair, triboelectric effects, commonly known as friction, cause your body to become charged. That is, the potential of your body with respect to ground changes. You are actually converting mechanical energy into electrical energy, and the electrical energy is stored in your body capacitance. Small currents, in the order of nanoamperes, flow through your body to charge its capacitance in seconds. Both the charge and the energy stored are relatively small: $W = \frac{1}{2}CV^2$; $Q = CV$. Potentials on the order of 5 kV, which is more than enough to rupture an insulating oxide layer in an IC, are commonplace. If your body potential is 5 kV and your capacitance to ground is 150 pf, the energy stored in



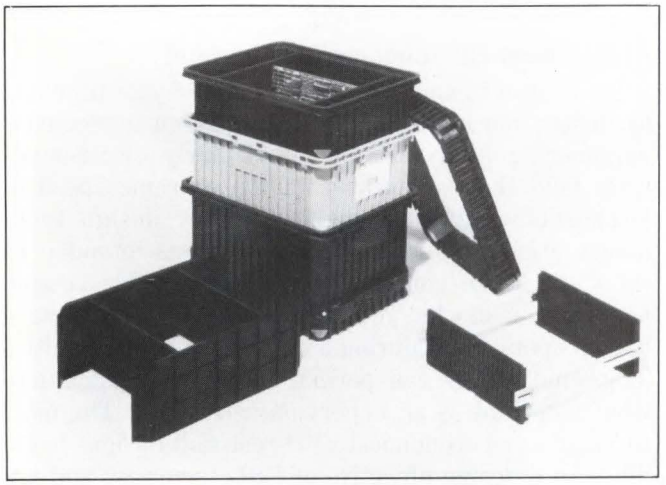
Directory provides extensive data on thousands of ESD-control products *(SAR Associates)*



System characterizes components according to the latest MIL-STD-883 requirements *(Trisys Inc)*

your body capacitance is approximately 19 mJ or 19 mWsec, and the charge is 0.75 μC.

Because there is little resistance or inductance to limit the current, grounding yourself or touching an object at a different potential with respect to ground—actions that change the charge stored in your body capacitance—can cause destructive results. The change in stored charge takes place rapidly; therefore, the peak current can be quite large. At present, researchers in the field believe that the discharge currents can reach a peak in less than 100 psec and possibly as quickly as 30 psec. In the above example, the capacitor discharge can give rise to peak currents ranging from 0.5A to more than 30A. If such currents were to flow through practically any logic IC, they would cause irreversible damage by vaporizing some of the deposited metal stripes.



Stackable conductive containers that help protect pc boards from ESD *(Buckhorn Corp)*

Thus, ESD-induced damage occurs after small currents charge small capacitances to high voltages. Destructively large currents then flow when the small capacitances discharge rapidly. A mitigating factor is corona, which causes the air to become conductive when electric field gradients become large enough. Corona limits the potential difference between your body and its surroundings to a maximum of 40 kV and also slows down the leading edge of discharges.

Process-oriented ESD control is based on the idea that by connecting people and equipment to a common ground, you can limit ESD-induced potential differences to the order of a few hundred volts and hence limit stored energy and the currents that can flow. Furthermore, by surrounding sensitive components and assemblies with high conductivity material, such as antistatic bags, you can divert any current that does flow away from circuit nodes susceptible to damage.

Attitude is key to process-control success

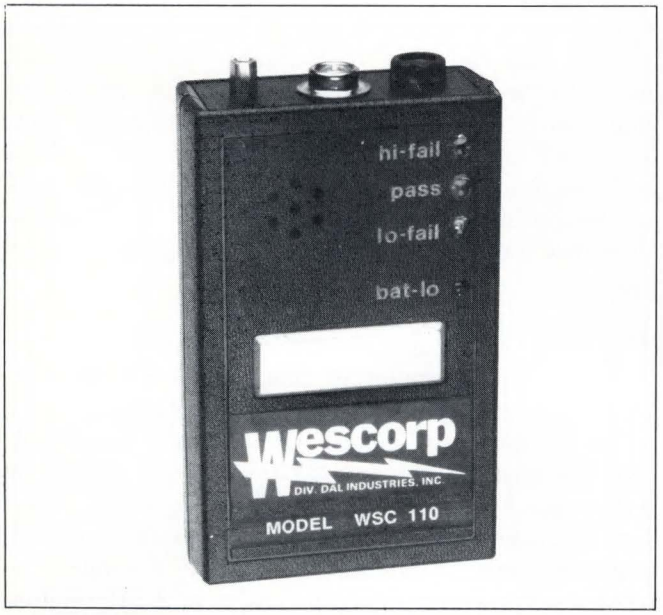
Many vendors maintain that failures of process-oriented control programs don't occur because of the industry's imperfect understanding of ESD waveforms. Nor are such failures caused by inherent defects in ESD-control products, the majority of which are effective when properly applied. Rather, process-oriented programs most often fail because the personnel involved don't understand the basics of ESD. Failure to observe ESD-control procedures can cause problems that don't become apparent for months.

A knowledge of how electrostatic potentials arise is invaluable in selecting the appropriate control products and designing your product for ESD immunity.

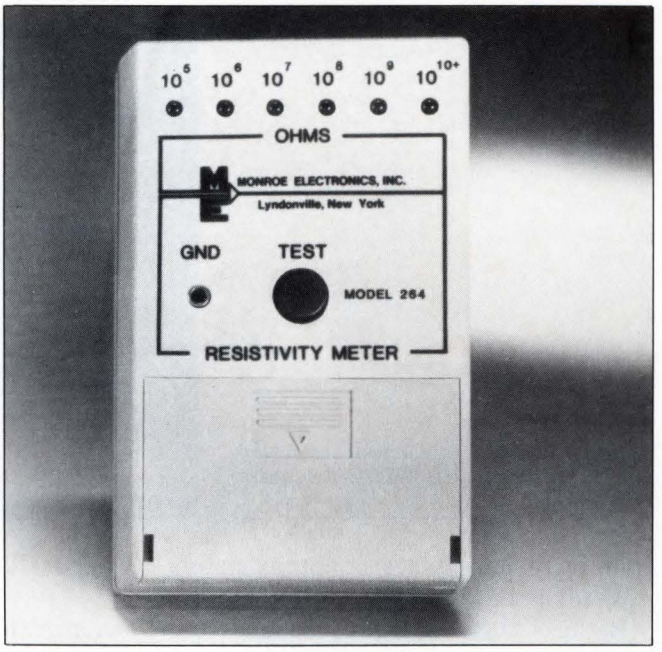
And, although the failures can be expensive—especially when customers are the ones who discover them—improper handling of components and assemblies usually causes failures only a small percentage of the time. As a result, personnel who must follow control procedures often get the impression that the extra process steps are unnecessary. This cavalier attitude toward static control leads to breakdowns in the use, monitoring, and maintenance of static-control equipment: A process-oriented approach to static control requires continuous vigilance.

Dozens of products are available to help you implement the necessary vigilance. For example, many companies offer wrist-strap testers; prices start at approximately $100. Not only do these devices indicate that the mandatory 1-MΩ resistor in a wrist strap is neither open nor shorted, they also indicate whether a strap is making satisfactory contact with the wearer. It is easy to wear a strap so loosely that it does no good. Air ionizers are another type of product that you mustn't forget about after you install them. Ionizers can become clogged with dust. You can buy ionization detectors that indicate whether your ionizers are performing their intended function.

Proponents of vulnerability limitation by design maintain that if you design your product to survive ESD, you don't need to be quite as careful while you're building it or after you install it. One of the problems with vulnerability limitation by design, however, is conducting meaningful tests to prove that the product is immune to ESD. Standards for ESD-susceptibilty tests abound; so do stories of products that passed such standardized tests and still exhibited unacceptable levels of failures traceable to ESD. A standard that has come in for more criticism than most is MIL-STD-883C. Criticism of the standard may be the reason why the Department of Defense has recently changed the specification's ESD-test provisions.



An economical tester that guards against ineffective wrist straps *(Wescorp)*



A battery-powered meter that indicates surface resistivity *(Monroe Electronics Inc)*

Always keep EE fundamentals in mind

If you elect to limit the vulnerability of your products by design you must pay careful attention to electrical engineering fundamentals, particularly electromagnetic field theory. Because of the extreme speed of discharge waveforms, high-frequency design techniques apply. Inductance in connections intended to carry discharge currents around susceptible components can make what you think is a short circuit behave like an open circuit during a discharge. Discontinuities in ground planes can permit energy to radiate into what you think is an impervious enclosure. The most successful and economical ESD-resistant designs begin life with a design objective of ESD immunity and are carefully tested by their designers to verify that the objective is met. Though you can and, indeed, some-

TABLE 1—REPRESENTATIVE ESD-CONTROL PRODUCTS AND SERVICES

VENDOR	PRODUCT TYPE	MODEL NUMBER OR NAME	US PRICE	COMMENTS
AMETEK	CUSHIONED SHIELDING POUCHES	MICRO-FOILER	$0.66 TO $3.28	PRICE BASED ON SIZE AND QUANTITY
BECKMAN INDUSTRIAL	HUMIDITY MEASURING INSTRUMENTS	HYGROLINE PRODUCTS	FROM $350	WIDE VARIETY OF METERS, SENSORS
BUCKHORN	ESD-SHIELDED TOTE BOXES, CONTAINERS	NESTIER		
CHOMERICS	SHIELDED FLAT CABLE	CHO-JAC	$1 TO $2 PER FT	34 WIRES, 10k FT DEPENDS ON SHIELD
	LAMINATED SHIELDS		$1 TO $5	$1k TYP SETUP FREE
DOW CHEMICAL	ANTISTATIC FOAM SHIPPING PACKAGES	ETHAFOAM	$0.50 TO $10.00	PRICE DEPENDS ON DESIGN AND QTY
	ANTISTATIC BAGS	CHIPLOC ES CHIPLOC DP	$0.04 TO $1.70	PRICE DEPENDS ON SIZE, QTY, TYPE
ELECTRO-TECH SYSTEMS	WIDE VARIETY OF RESISTIVITY AND FIELD MEASUREMENT INSTRUMENTS, DISCHARGE SIMULATOR		FROM APPROX $3k FOR MOST PRODUCTS	WRIST-STRAP TESTER $100
EOS/ESD ASSOCIATION	PROFESSIONAL SOCIETY		$20	ANNUAL MEMBERSHIP
GENERAL SEMICONDUCTOR INDUSTRIES	TRANSIENT VOLTAGE SUPPRESSORS	TRANZORB ZORB	$0.35 TO $84.70	
	TRANSIENT PROTECTORS		$1.45 TO $225	
HUB MATERIAL	CATALOG DISTRIBUTOR MARKETS MANY ESD-CONTROL PRODUCTS	WORK SURFACE MATS	FROM $113.60	
		PC-BOARD CONTAINERS	FROM $11.40	
		STATIC METER	$300	
		WRIST-STRAP TESTER	$276	
JULIE ASSOCIATES	CONSULTING SERVICES		VARIES	
KEYTEK INSTRUMENT	ESD SIMULATORS AND TEST SYSTEMS, SURGE TESTERS	MINIZAP	FROM $3620	
		SERIES 2000	FROM $3350	
KEITHLEY	ELECTROMETER/SOURCE	617	<$3000	
LIBERTY LABS	DIRECTORY OF LABS AND CONSULTANTS		$65	LOWER INTRODUCTORY PRICE TILL 3/31/89
3M	PROBABLY THE WIDEST LINE OF ESD-CONTROL PRODUCTS IN THE INDUSTRY	EXAMPLES: VELOSTAT PACKAGING, CHARGE-GUARD WRIST STRAPS		FOR DISTRIBUTOR-PRICING EXAMPLES ON A FEW PRODUCTS SEE HUB MATERIAL LISTING
MILLER-STEPHENSON CHEMICAL	STATIC ELIMINATOR SPRAY	MS-266 ENSTAT	$5.25/CAN	
MONROE ELECTRONICS	MANY CHARGE AND RESISTIVITY MEASURING INSTRUMENTS	EXAMPLE: ISOPROBE	FROM $395	
SAR ASSOCIATES	CONSULTING SERVICES, PRODUCT DIRECTORY	ESD-CONTROL PRODUCTS FILE	$335	
SEMTRONICS	IONIZATION-CURRENT METERS	ICOM-150	$1295	
SPECTRASCAN	WORKSTATION MONITORS CONDUCTIVITY TESTERS	STATIC SENTRY II	FROM $49.95	
STATIC INC	PACKAGING MATERIALS, IONIZERS, RESISTIVITY METERS, GROUNDING SYSTEMS			
TECKNIT	MATERIALS FOR MAKING ENCLOSURES CONDUCTIVE AT HIGH FREQUENCIES	EXAMPLES: GASKETS, MESH		SEE STORY FOR DISCUSSION OF IMPORTANCE OF HIGH-FREQUENCY GROUNDS
TRISYS	ESD TEST SYSTEM	MODEL 335	$75k TO $120k	FOR TURNKEY SYSTEM WITH SCOPE/CAMERA
WESCORP	MATS, WRIST STRAPS, PACKAGING MATERIALS COATINGS	EXAMPLES: WESTRAP, STAT-MAT	STRAPS FROM $4.45	
WILSON-FIBERFIL	CONDUCTIVE THERMOPLASTICS	ELECTRAFIL	FROM $1.50/LB	IN LARGE QUANTITY

Process-oriented ESD control consists of connecting people and equipment to a common ground to limit ESD-induced potential differences.

times must "engineer" ESD immunity into existing products, the experience can be painful and the costs significant.

Until recently, engineers have considered the problem of making products ESD immune to be soluble only by hardware approaches. "Not so," says Warren Boxleitner, director of engineering at KeyTek Instrument Corp, a manufacturer of ESD simulators such as the $3620 MiniZap. Boxleitner claims that software can play a major role in providing ESD immunity and can often be the least expensive way to combat ESD. He cites an example in a μP-based computer keyboard.

Most such keyboards have a few keys—CAPSLOCK, for example—that, when in a particular state, illuminate an indicator. ESD can cause the actual state of the key to differ with the displayed state. However, if you store the desired state of the display in three widely separated memory locations, the keyboard's μP can periodically determine whether the three locations contain the same information. If they do, the μP can set the displayed state to agree with the stored state. If one of the three memory locations contains a state

For more information . . .

For more information on the ESD-control products and services discussed in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Ametek Microfoam Div
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Rtes 1 and 202,
Chadds Ford, PA 19317
Phone (215) 358-1180
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Beckman Industrial Corp
80 Commerce Rd,
Cedar Grove, NJ 07009
Phone (201) 239-6200
TWX 710-994-5781
Circle No 352

Buckhorn Corp
1293 S Main St,
Akron, OH 44301
Phone (206) 253-5592
TLX 986321
Circle No 353

Chomerics Inc
77 Dragon Ct
Woburn, MA 01888
Phone (617) 935-4850
TWX 710-393-0173
Circle No 354

Dow Chemical Packaging and Industrial Foams
Midland, MI 48674
Phone (517) 636-1000
Circle No 355

Electro-tech Systems Inc
115 E Glenside Ave
Glenside, PA 19038
Phone (215) 887-2196
TLX 797137
Circle No 356

EOS/ESD Association Inc
201 Mill St
Rome, NY 13440
Phone (315) 338-2158
Circle No 357

General Semiconductor Industries Inc
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Tempe, AZ 85281
Phone (602) 968-3101
FAX (602) 966-6396
Circle No 358

Hub Material Co
33 Springdale Ave
Canton, MA 02021
Phone (617) 821-1870
Circle No 359

Julie Associates Inc
Box 141
Billerica, MA 01821
Phone (508) 667-1958
Circle No 360

KeyTek Instrument Corp
260 Fordham Rd
Wilmington, MA 01887
(508) 658-0880
Circle No 361

Keithley Instruments Inc
28775 Aurora Rd
Cleveland, OH 44139
Phone (216) 248-0400
Tlx 98-5469
Circle No 362

Liberty Labs Inc
4920 Johnson Ave NW
Cedar Rapids, IA 52508
Phone (319) 390-3646
FAX (319) 390-3802
Circle No 363

3M Static and Electromagnetic Control Div
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Austin, TX 78769
Phone (512)834-1800
Circle No 364

Miller-Stephenson Chemical Co
George Washington Hwy
Danbury, CT 06810
(203) 743-4447
Circle No 365

Monroe Electronics Inc
100 Housel Ave
Lyndonville, NY 14098
Phone (716) 765-2254
TLX 756662
Circle No 366

SAR Associates
1212 E Dominick St
Rome, NY 13440
Phone (315) 339-3968
FAX (315) 336-9134
Circle No 367

Semtronics Corp
Box 2248
Peachtree City, GA 30269
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in GA, (404) 487-6881
FAX (404) 487-1128
Circle No 368

SpectraScan
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Colorado Springs, CO 80907
Phone (719) 599-9254
TLX 312-194 SPECTRASCAN UD
Circle No 369

Static Inc
Old Sherman Turnpike
Danbury, CT 06810
Phone (203) 792-2360
TLX 221-062
Circle No 370

Tecknit
129 Dermody St
Cranford, NJ 07016
Phone (201) 272-5500
TLX 685-3079 TCKNT
Circle No 371

Trisys Inc
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Beaverton, OR 97006
Phone (503) 645-5504
Circle No 372

Wescorp
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Mountain View, CA 94041
Phone (800) 537-7828;
in CA, (800) 762-7828
TLX 345507
Circle No 373

Wilson-Fiberfil International
Box 3333
Evansville, IN 47332
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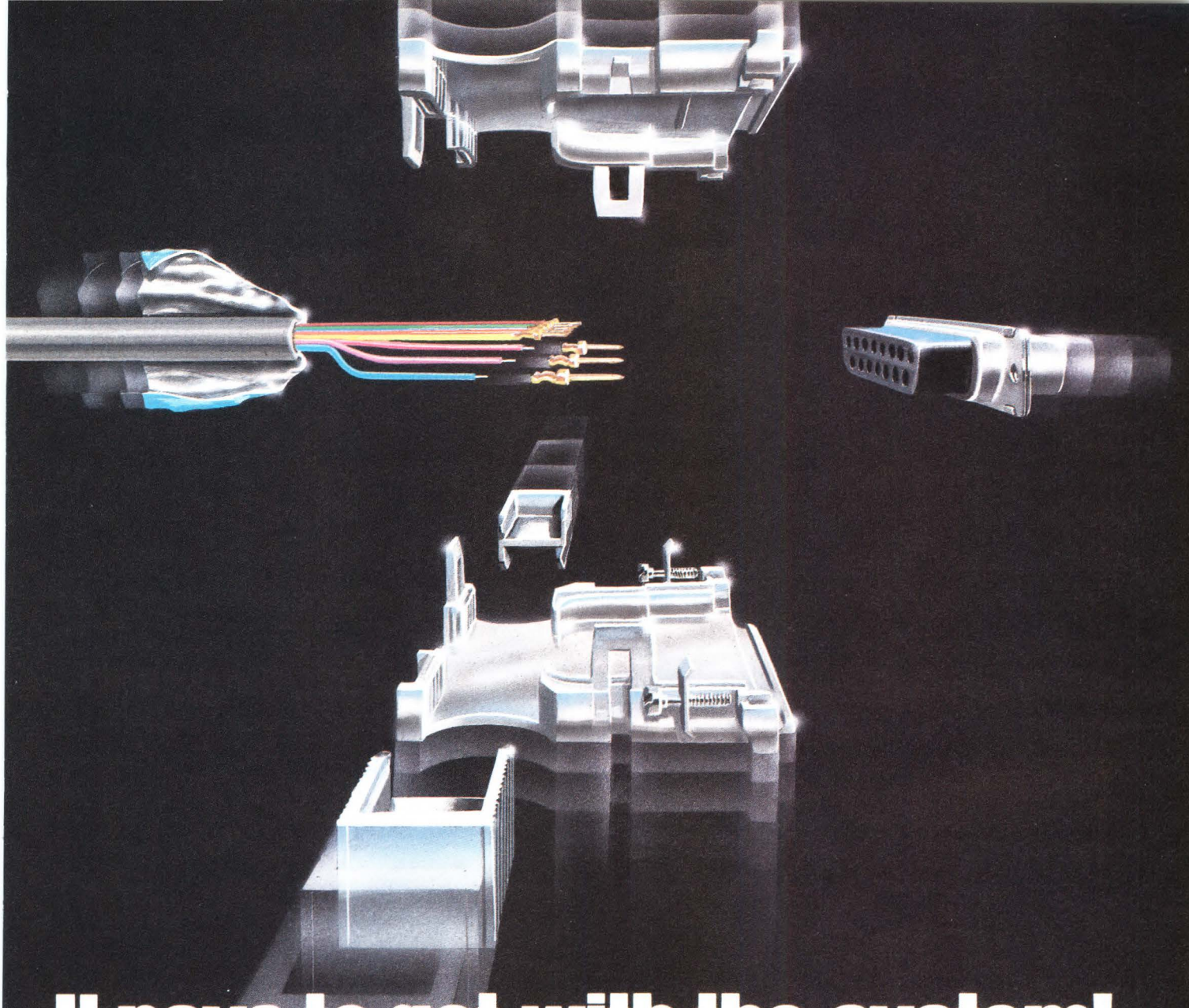
TLX 752708
Circle No 374



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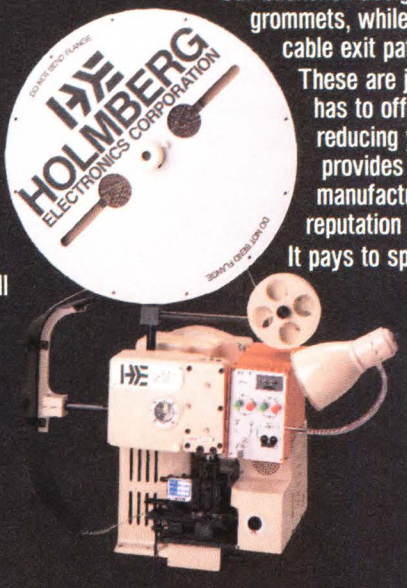

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CIRCLE NO 65

The most successful and economical ESD-resistant designs begin life with a design objective of ESD immunity.

indication different from that in the other two, the μP can set the displayed state to agree with the "consensus." Such an approach enlarges the keyboard's firmware; but, in an actual keyboard that uses the approach, the ESD-immune firmware fits easily in the same size PROM as did the susceptible firmware.

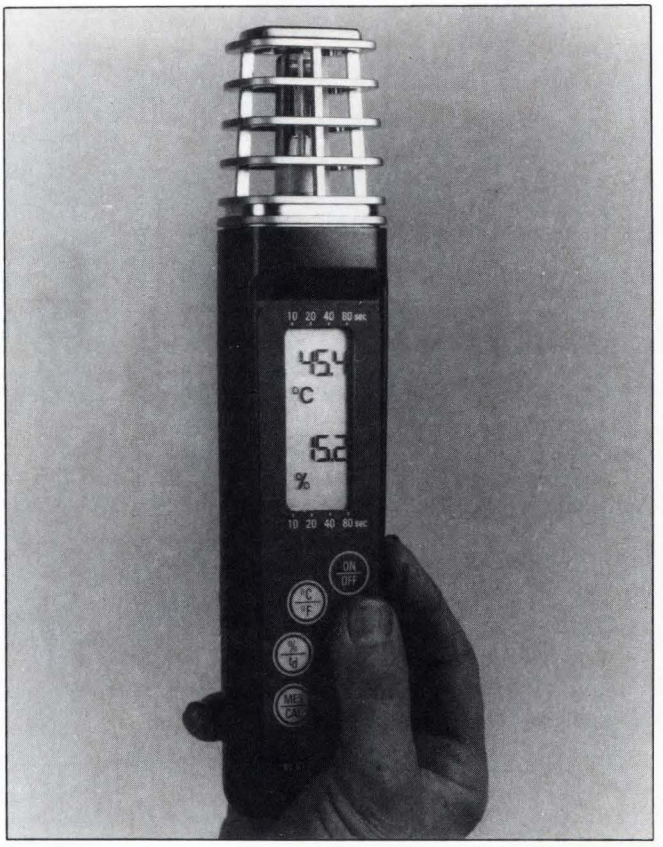
Line-transient and ESD protection are related

Many of the design techniques that make for ESD immunity also reduce a product's susceptibility to transients on the ac power line—for example, those caused by lightning. You can often save design time and help to control product costs by simultaneously considering your product's ESD and line-transient susceptibility. For example, you can improve a product's resistance to both line transients and ESD by placing networks that contain metal-oxide varistors (MOVs) and silicon-avalanche transient absorbers at the product's power inlet. Examples of transient absorbers are General Semiconductor Industries' Zorbs and Tranzorbs—available at prices ranging from $0.35 to $84.70 depending on rating and quantity.

Products for ESD control are enormously varied—it is impossible to provide a comprehensive listing of them in a few pages. **Table 1** lists just a few. But, if you are interested in an all-inclusive directory, you can get one—SAR Associates publishes the ESD control-products file. The publication is massive. It consists of three 8½×11-in. looseleaf binders containing copies of data sheets on thousands of ESD-control products organized by product type. The control-products file sells for $335.

Consultants' knowledge can save you money

If working in an unfamiliar technical area intimidates you, there are many places to turn for help. Several consulting firms specialize in ESD control. One of them is Julie Associates, whose president, Jerry Giuliano, calls attention to the savings that consultants can achieve. He cites a story about a company that was about to remove ordinary, insulating floor tiles from a large area and replace them with conductive tiles. The cost was to approach $100,000. A consultant pointed out that the concrete beneath the tiles exhibited acceptable conductivity. By removing the tiles and not replacing them, the company achieved its objective at little cost. Early in 1989, Liberty Labs is scheduled to publish a directory of consulting firms and test laboratories active in electromagnetic compatibility (EMC). Many of the firms to be listed also possess ESD expertise. After the introductory pricing expires on March 31, 1989, the directory will cost $65.



A battery-powered tester that determines if the humidity is high enough for ESD control *(Beckman Industrial)*

The ESD-control industry also has its own technical organization, the EOS/ESD Association. (EOS stands for electrical overstress.) The association holds a trade show and conference each September and publishes the proceedings. Membership for US residents costs $20. EDN

References

1. *Electrostatic Discharge (ESD) Protection Test Handbook, Second Edition*, Keytek Instrument Corp, Wilmington, MA, 1986.
2. *ESD-Control-Products File*, SAR Associates, Rome NY, 1988.
3. *EMC Test Lab and Consultants Directory*, Liberty Labs Inc, Cedar Rapids, IA, 1989.

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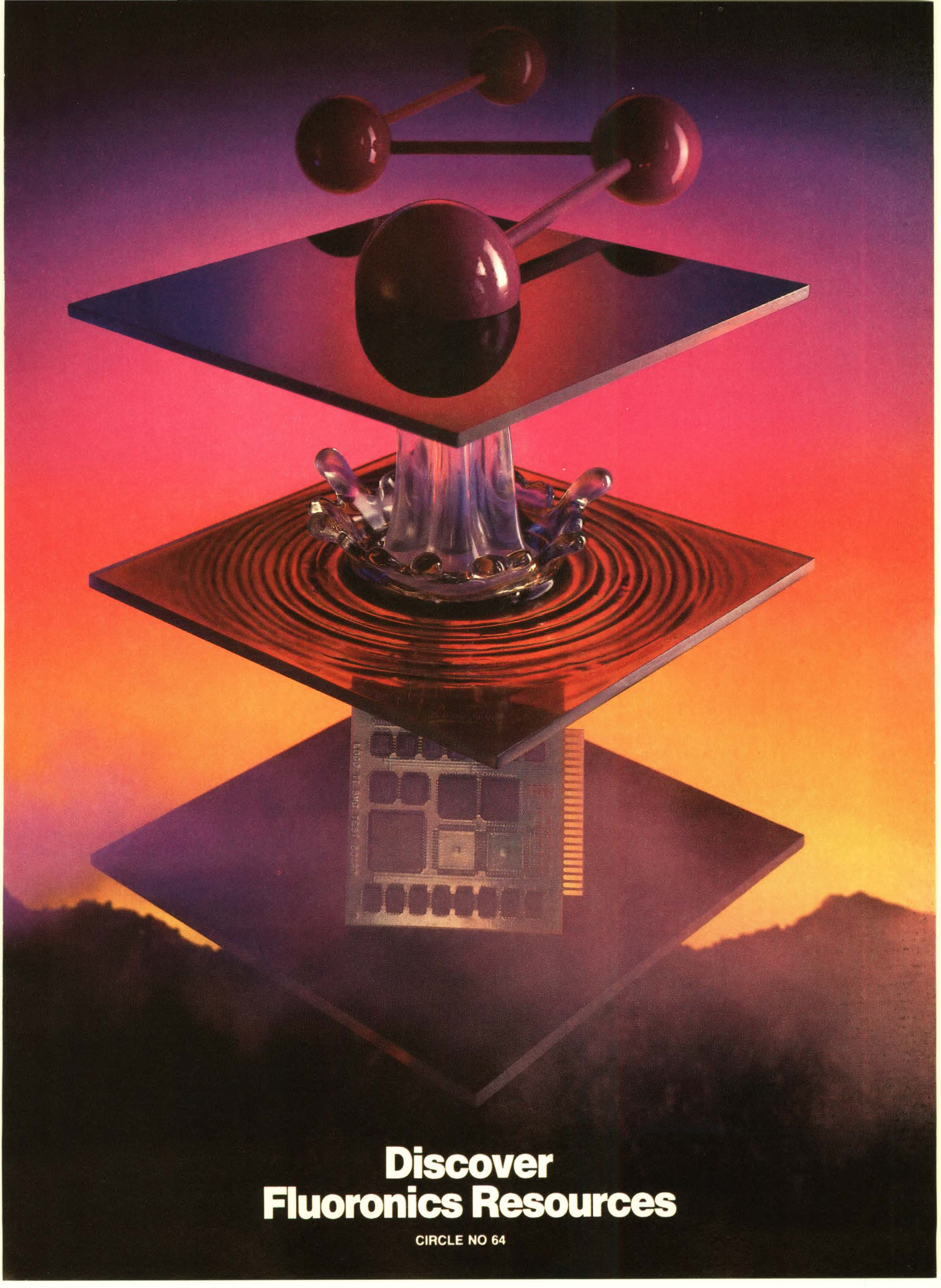

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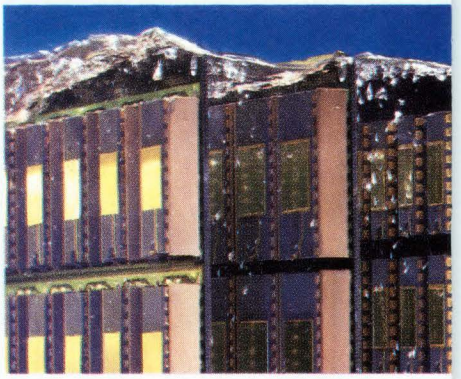
An exclusive 3M combination of innovative products backed by research and development, manufacturing expertise, technical data and service assistance built on more than 35 years' experience of pioneering in fluorochemistry.



3M has had a whole generation of experience in the development, manufacture and refinement of perfluorinated liquids. We first introduced these versatile liquids to electronics design, testing and production professionals in the fifties. Since then, Fluorinert Liquids have become the mainstays in electronic cooling, high reliability testing and vapor phase soldering.

Fluorinert Liquids, used as a direct contact heat transfer medium, offer a range of physical properties that make them particularly suitable for electronic uses. They are non-polar and exhibit no solvent action. They are colorless, low in toxicity, non-flammable and offer exceptionally high dielectric strength plus thermal and chemical stability. Most important, they have almost no chemical reactivity and they evaporate without leaving a residue on parts.

Buy the numbers

Our FC™ numbers — FC-40, FC-70, FC-77, etc. — are used to identify Fluorinert Liquids that offer certain physical characteristics to meet specific application needs. These FC numbers are solely 3M designations for various fluorochemical products.

Fluorinert Liquids are being used cost-effectively in cooling, high reliability testing and vapor phase soldering operations. When you are interested in applying these versatile liquids in your own production, 3M can provide an abundance of technical information and support.

Technical assistance: the main benefit of Fluoronics Resources

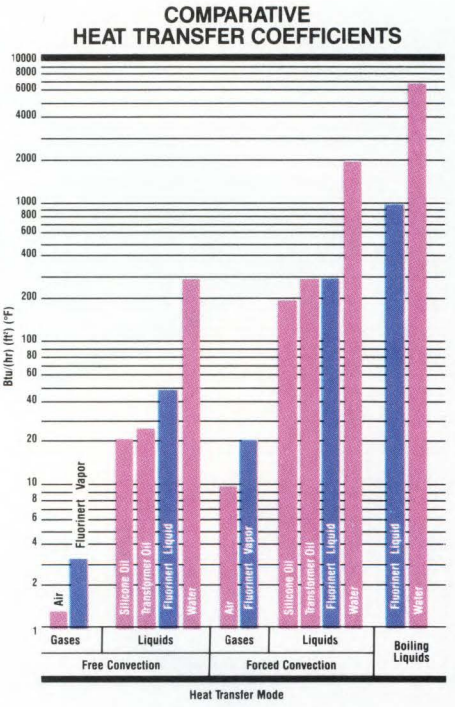
3M offers prompt assistance to help you solve many production and testing problems. We provide comprehensive technical recommendations for specific fluids. We consult with you on the proper application equipment and help you evaluate production methods and results. Our service bulletins bring you up to date on the most recent advances in vapor phase soldering and high reliability testing. Ask us about 3M's audiovisual materials and on-site application training seminars.

Discover Fluorinert™ Liquids' heat transfer capability

What are your needs? A precise degree of temperature control? Fast, uniform heat transfer? High dielectric strength? Fluorinert Liquids offer the broad range of physical characteristics required in most applications.

Fluorinert Liquids are an effective direct contact heat transfer medium whether used in a liquid or vapor state. Their unique properties enable you to use them in contact with sensitive components and substrates.

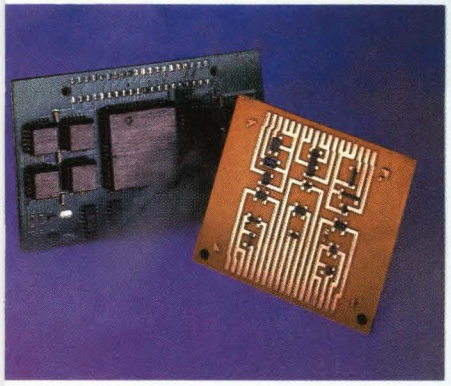
Major differences between the various products in the Fluorinert Liquids family can be seen in their boiling points. These can range from 56°C to 253°C. Should you need products with intermediate boiling temperatures, the 3M staff will work with you to fashion a product especially for your needs. It's an example of how 3M's Fluoronics Resources provide you with "customized" service to solve special problems.

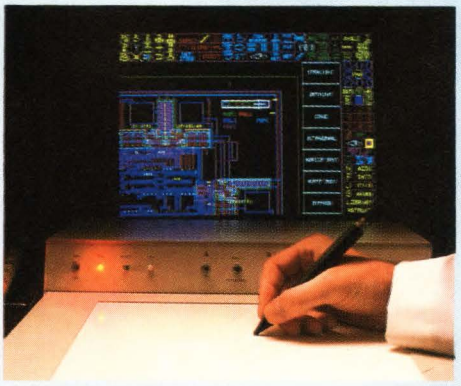


Fluorinert™ Liquids achieve accurate high reliability testing

It's a small world you work in. Where time ticks in nanoseconds and dimension is measured in Angstrom units. And as circuitry becomes more complex, a greater demand is placed on testing capability — not only in speed, but in higher reliability and accuracy.

Fluorinert Liquids meet those requirements by providing a controlled temperature environment and a high degree of electrical protection. They offer maximum compatibility between





the heat transfer medium and the device under test. Fluorinert Liquids reduce testing costs by reducing testing time substantially. They do this by rapidly reaching test temperature and providing precise and uniform temperature control. You'll minimize the number of faulty units by detecting defects before they become rejects.

These liquids provide cost-effective tests such as gross leak, thermal shock, liquid burn-in, ceramic crack detection, electrical environmental, temperature calibration and failure analysis/short detection.

Fluorinert Liquids are specified in the MIL-STD's for thermal shock and gross leak testing.

THERMAL SHOCK TEST CONDITIONS

Military Standard 883-1011			Military Approved Fluorinert Liquids	
Test Condition	Hot Test Step 1	Cold Test Step 2	Hot Test Step 1	Cold Test Step 2
A	100°C	−0°C	Water , FC-40	Water , FC-40, FC-77
B	125°C	−55°C	FC-40, FC-70, FC-5311	FC-77
C	150°C	−65°C	FC-40, FC-70, FC-5311	FC-77
D	200°C	−65°C	FC-70, FC-5311	FC-77
E	150°C	−195°C	FC-40, FC-70, FC-5311	Liq. N_2
F	200°C	−195°C	FC-70, FC-5311	Liq. N_2

GROSS LEAK TEST CONDITIONS

Military Standards	Military Approved Fluorinert Liquids		
	Indicator Fluids	Detector Fluids	Absorption Fluids
MIL-STD 883-1014	FC-40, FC-43	FC-72, FC-84	Do not apply
MIL-STD 750-1071	FC-40, FC-43	FC-72, FC-84	FC-43, FC-75, FC-77
MIL-STD 202-112	FC-40, FC-43	FC-72, FC-84	Do not apply

Discover higher yields in vapor phase soldering

Fluorinert Liquids have been the industry's fluid of choice since the vapor phase reflow soldering (VPS) process was introduced in 1975. There are a number of good reasons for this universal acceptance. VPS with Fluorinert Liquids produces highly reliable solder joints. The system reduces reject rates, increases production, and lowers production costs. With Fluorinert Liquids, you can be assured that your products will never be exposed to a temperature higher than the selected liquid's boiling point. (See above)

You'll avoid those problems usually associated with other systems — shadowing, uneven heating, and overheating. The liquids are non-flammable. Their low surface tension helps them evaporate quickly from the work pieces without leaving a residue.

VPS with Fluorinert Liquids is especially suited for boards with high mass or complex geometries. The liquid vapors completely surround the assembly and penetrate remote recesses to heat all surfaces evenly. The vapors are 15 to 20 times heavier than air so they can be contained easily within the work area. The system offers an oxygen-free, non-corrosive environment to minimize rejects from oxidation contamination.

Some typical applications using Fluorinert Liquids in VPS include surface mounted leaded or leadless components, through-hole leads and wire-wrap pins, lead frame attachment, reflow of electroplated solder or tin and miscellaneous metal joining.

VPS SELECTION GUIDE

Fluorinert Liquid	Boiling Point	Typical Solders
FC-43	174°C/345°F	70 Sn/18 Pb/12 In 100 In 58 Sn/42 In 58 Bi/42 Sn
FC-70, FC-5311 FC-5312	215°C/419°F	63 Sn/37 Pb 60 Sn/40 Pb 62 Sn/36 Pb/2 Ag
FC-71	253°C/487°F	100 Sn 95 Sn/5 Ag 60 Pb/40 Sn

Discover the unique cooling benefits of Fluorinert™ Liquids

As the package size decreases, your need for more efficient heat dissipation increases in proportion. 3M Fluorinert Liquids are very efficient as a direct contact heat transfer medium, with the added advantage of having the high dielectric characteristics needed to meet stringent demands of the diversified electronics industry. We offer 11 liquids with boiling points that range from 56°C to 253°C.

These stable liquids allow you to maximize power density and miniaturize your package. Yet they reduce failure rates and increase reliability.

Fluorinert Liquids are used in such demanding applications as:

- Radar transmitters • Power supplies
- High voltage transformers • Lasers
- Radar klystrons • Computer modules
- Computer memories • Fuel cells

Typical properties of Fluorinert Liquids used in cooling are:

Fluorinert Liquid FC-77 (English Units)	Liquid		Vapor
	Room Temp. (77°F)	Boiling Point (207°F)	Boiling Point 207°F @/ATM
Density lb./ft^3	111	100	0.85
Thermal Conductivity Btu/(hr) (ft^2) (°F/ft)	0.037	0.033	0.008
Specific Heat Btu/(lb.) (°F)	0.25	0.28	0.23
Viscosity c.p.	1.42	0.46	0.02
Coefficient of Thermal Expansion ft^3/(ft^3) (°F)	0.0008	0.0009	0.0015

Discover heating/curing with Fluorinert™ Liquids

Because they maintain their vapor temperature with absolute precision, Fluorinert Liquids can be used in many heating and/or curing operations. They serve as heat transfer media in solder mask and polymer thick film applications and for polymer processing. The non-corrosive vapors will not support oxidation. Ideal where solvent flash-off is a problem.

3M

Discover Fluoronics Resources

3M presents a unique short course in the use of Fluorinert™ Liquids for the electronics industry.

3M is now offering a series of "Applied Fluoronics" tapes demonstrating how Fluorinert Liquids are used in a number of applications. See first hand how these remarkable products can improve overall electronic production.

Three cassettes are available:

1. "Applied Fluoronics: High Reliability Testing"
2. "Applied Fluoronics: Vapor Phase Soldering"
3. "Applied Fluoronics: Direct Contact Cooling"

These informative VHS format tapes are available to qualified personnel in the electronics industry. Specify which cassette(s) you would like to view.

Write on your company letterhead, describing your general interest. Mail to: Fluoronics Resources, Industrial Chemical Products Division/3M, Building 223-6SE-04, 3M Center, St. Paul, MN 55144-1000.

For technical information or assistance on High Reliability Testing and Cooling, call 612/733-6282; for Vapor Condensation Heating assistance, call 612/733-7424.

3M

"A SINGLE AD IN **EDN NEWS EDITION** GENERATED AN INQUIRY LEADING TO A $2 MILLION OPPORTUNITY!"

John Poturny, President
Poturny & Associates
Northridge, CA

Fred Silver, Director of Marketing
Rantec
Chatsworth, CA

Advertising results. Agencies want them. Clients need them.

"When I was on the client side, I demanded sales results from my advertising dollars," says John Poturny, President of Poturny & Associates. "Today I'm on the agency side, and I expect the same for my clients — advertising that generates sales."

Advertising results. A publication must provide them.

"After running ads in EDN News Edition, our phones ring and proposal activity soars immediately for our military power supplies," says Fred Silver, Director of Marketing at Rantec, a division of Emerson Electric.

Advertising results. For Poturny & Associates and Rantec, EDN News Edition gets them.

"We traced prototype orders worth $2 million in sales to a lead generated by our ad in EDN News Edition," said Silver.

Both Silver and Poturny agree about the power of EDN News Edition, "it gets results."

John Poturny

Fred Silver

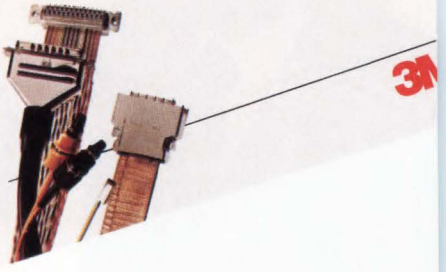
EDN News Edition works for marketing communication partners, Poturny & Associates and Rantec. It can work for you.

EDN

Where Advertising Works

"I need a supplier who can design, prototype, build and ship cable assemblies to *my* specs."

From concept to completion: 3M delivers quality application-specific cable assemblies.



Tough customers turn to 3M.

Turn to 3M for cable assemblies created for your specific application.

We'll help you right up front with design assistance to quickly turn your interconnect idea into a prototype. Manufacture as many finished assemblies as you need, to your most demanding specs. Then deliver everything you need–from pressed and molded to high-speed transmission line and fiber optic cable assemblies–to meet your most ambitious production schedule.

You get all the well-known 3M quality in assemblies that meet your demanding criteria. Without having to cope with rejects or in-house modifications. You get the reliability you need to help eliminate wasted time or field failures. And the just-in-time delivery programs that reduce inventory and materials handling costs.

There's only one place tough customers turn to no matter what their specs. 3M. For information, dial 1-800-CALL-EPD. Or call from your modem 1-800-444-8080 (300-2400 baud, 8 bit, no parity 1 stop bit) and enter the access code 3MEPD4 when prompted. Or write 3M Electronic Products Division, Department F, P.O. Box 2963, Austin, TX 78769-2963.

3M

LINEAR TECHNOLOGY

DESIGN NOTES

Number 18 in a series from Linear Technology Corporation *December, 1988*

A Battery Powered Lap Top Computer Power Supply

Brian Huffman

Most battery powered lap top computers require regulated multiple output potentials. Problems associated with such a supply include magnetic and snubber design, loop compensation, short circuit protection, size and efficiency. Typical output power requirements include 5V @1A for memory and logic circuitry and ±12V @300mA to drive the analog components. Primary power may be either a 6V or 12V battery. The circuit in Figure 1 meets all these requirements. The LT1071 simplifies the power supply design by integrating most of the switching regulator building blocks. Also, the off-the-self transformer eliminates all the headaches associated with the magnetic design.

The circuit is a basic flyback regulator. The transformer transfers the energy from the 12V input to the 5V and ±12V outputs. Figure 2 shows the voltage (trace A) and the current (trace B) waveforms at the V_{SW} pin. The V_{SW} output is a collector of a common emitter NPN, so current flows through it when it is low. The circuit's 40kHz repetition rate is set by the LT1071's internal oscillator. During the V_{SW} (trace A) "on" time, the input voltage is applied across the primary winding. Notice that the current in the primary (trace C) rises slowly as the magnetic field builds up. The magnetic field in the core induces a voltage on the secondary windings. This voltage is proportional to the input voltage times the turns ratio. However, no power is transferred to the outputs because the catch diodes are all reversed biased. The energy is stored in the magnetic field. The amount of energy stored in the magnetic field is a function of the current level, how long the current flows, the primary inductance and the core material. When the switch is turned "off" energy is no longer transferred to the core, causing the magnetic field to collapse. The voltage on the transformer windings is proportional to time-rate-of-change of the magnetic field. Hence, the collapsing magnetic field causes the voltages on the windings to change. Now the catch diodes are forward biased and the energy is transferred to the outputs. Trace D is the voltage seen on the 5V secondary and trace E is the current flowing through it. The energy transfer is controlled by the LT1071's internal error amplifier, which acts to force the feedback (FB) pin to a 1.24V reference. The error amplifiers high impedance output (V_C pin) uses an RC damper for stable loop compensation. If a 6V input is desired, use just one primary winding and an LT1070.

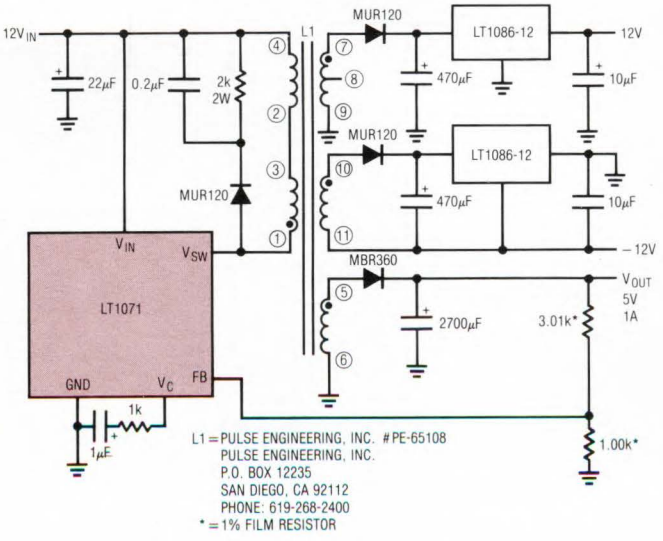


Figure 1. Multi-Output Flyback Converter

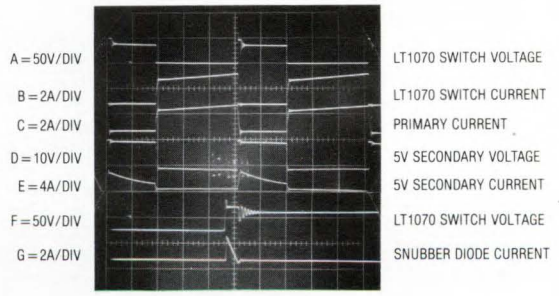


Figure 2. Waveforms for Continuous Mode Operation

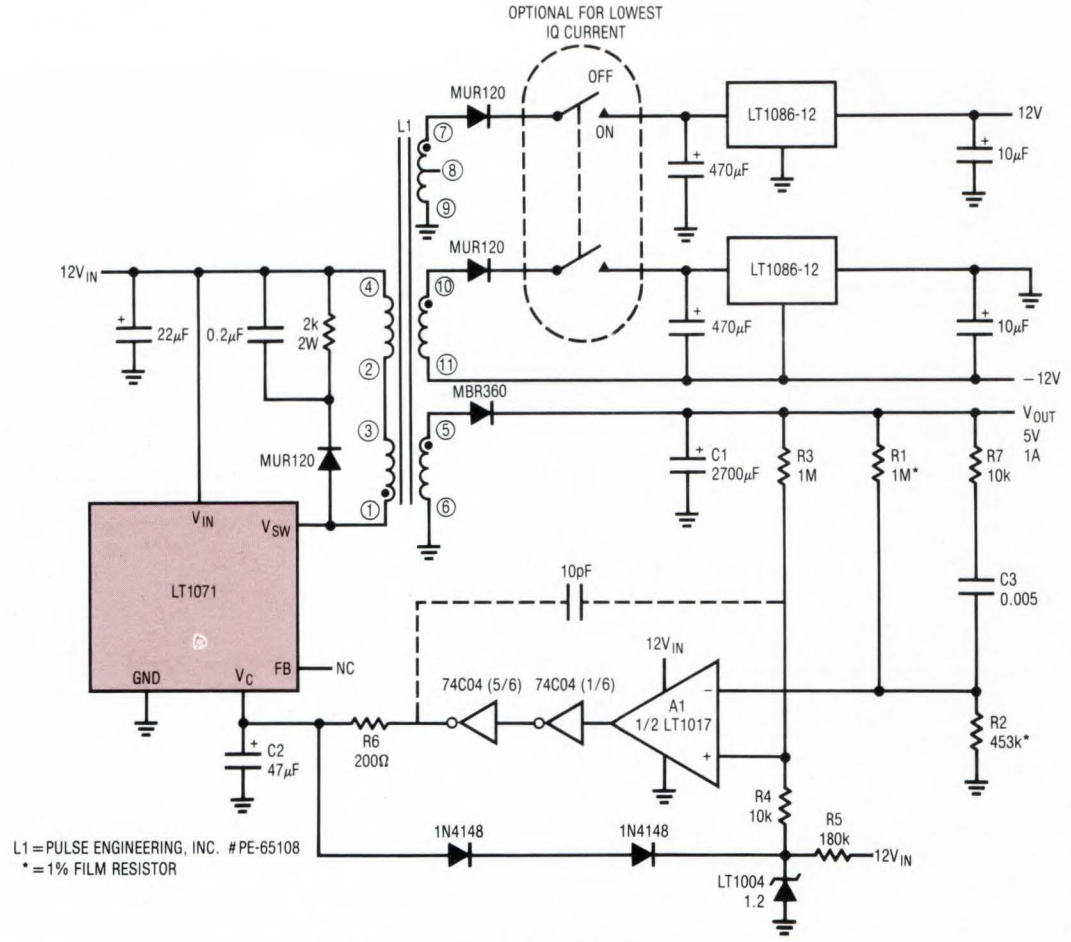


Figure 3. Multi-Output, Transformer Coupled Low Quiescent Current Converter

This is not an ideal transformer so not all the energy is coupled into the secondary. The energy left in the primary winding causes the overvoltage spike seen on the V_{SW} pin (trace F). This phenomenon is modeled by a leakage inductance term placed in series with the primary winding. When the switch is turned "off" current continues to flow in the inductor, causing the snubber diode to conduct (trace G). The snubber network clamps the voltage spike, preventing excessive voltage at the LT1071's V_{SW} pin. When the snubber diode current reaches zero, the V_{SW} pin voltage settles to a potential related to the turns ratio, output voltage and input voltage.

Post regulators are needed on the unregulated outputs if the cross regulation error is too great. Such error can be as much as 20% depending upon output loading conditions. Note that the floating secondaries allow a –12V output to be obtained with a positive voltage regulator. The isolation allows the input of the regulator to float above ground. The LT1086 positive voltage regulators maintain both positive and negative outputs within 1%.

If battery capacity is limited by size or weight this circuits 9mA quiescent current may be too high. Figure 3's modification offers output current in the ampere range with only microamps of quiescent drain. Further information about this circuit can be found in LTC Application Note AN29 "Some Thoughts on DC-DC Converters," page 8.

By using standard magnetics and a simplified switching regulator the design time needed to implement this power supply is greatly reduced. Although these circuits demonstrated a flyback topology, the LT1070/LT1071/LT1072 can easily handle other configurations including buck, boost, forward and inverting. Examples are given in LTC Application Notes; AN19 "LT1070 Design Manual," AN25 "Switching Regulators for Poets," and AN29 "Some Thoughts on DC-DC Converters."

For literature on Switching Regulators, call **800-637-5545**. For applications help, call (408) 432-1900, Ext. 361.

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7487 • (408) 432-1900
FAX: (408) 434-0507 • TELEX: 499-3977

IM/GP 1188 165K

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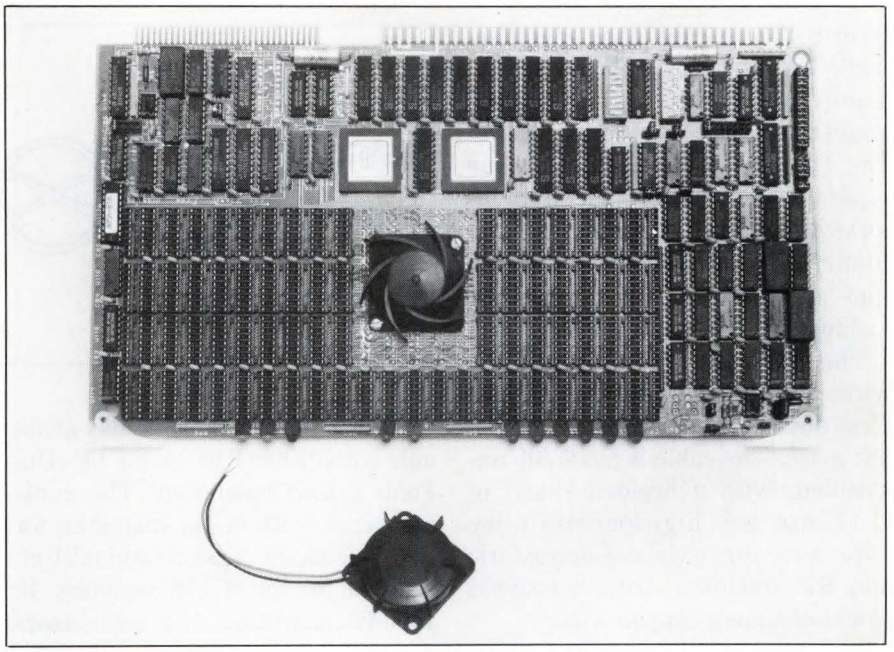
PC-board-mounted fan provides on-the-spot cooling

The TFDD50BMAW Series of brushless dc fans can be mounted directly on a pc board and move air radially off the board. With these board-mounted fans, you can concentrate cooling at the hottest spots in your system.

The fans measure 1.97-in. square by 0.47-in. thick; weigh 1.43 oz; and are available in 5, 12, and 24V models. All versions come with a standard tachometer output, which you can use as a fan-failure indicator. The manufacturer claims the units' solid-state drives emit minimal levels of EMI.

The fans consume approximately 0.5W and spin at 3300 rpm. The two basic versions of the fan move air at low pressure and high volume and high pressure and low volume, respectively. The TFDD50BMAW versions move 4.2 ft^3/min of air at 0.5-in. H_2O of pressure; the TFDD50BMALW versions move 2.6 ft^3/min at 2.5-in. H_2O of pressure. The fans' materials are UL recognized. $12.30 (100-499).



US Toyo Fan Corp, 4915 Walnut Grove Ave, San Gabriel, CA 91776. Phone (818) 287-5297. TWX 910-589-1540. FAX 818-287-7350.

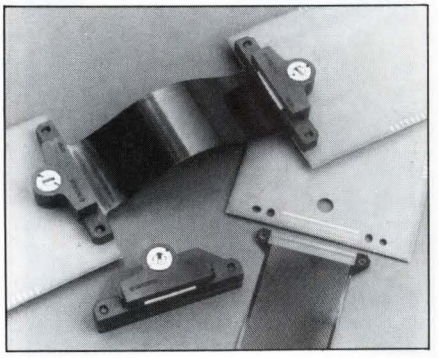
Circle No 442

Board-to-board jumper exhibits controlled, 50Ω impedance

The Invisicon board-to-board jumper has a characteristic impedance of 50Ω. The manufacturer claims that the jumper's terminations are virtually invisible—even to digital signals having rise times as short as 50 psec.

The jumper mates its controlled-impedance, flexible circuit to traces on your pc board. The jumper uses an elastomeric retainer to maintain contact force over time and make up for board-to-jumper gap tolerances.

The standard part is 4 in. long and has 51 signal contacts on 0.025-in. centers. The jumper's contacts provide 35 mils of wiping action during assembly. The device's crenellated contact pads have scraping edges that remove dust particles and nonconductive surface contaminants during wiping.



The flexible-circuit portion of the jumper is based on RO2500 circuit-board material rather than a polymide film. The RO2500 material offers better electrical properties and lower water absorption than polymide materials and has a dielectric constant of 2.5, a dissipation factor of 0.0025, and water absorption of 0.4%.

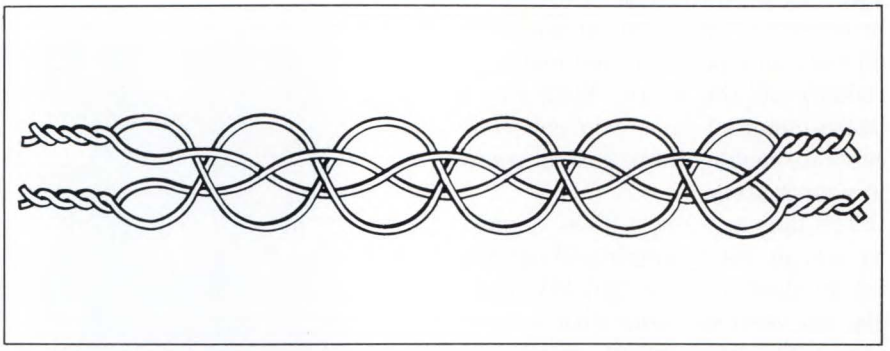
The standard jumper, part number 1ROBCK30B, costs $105 to $400 in evaluation quantities.

Rogers Corp, Box 700, Chandler, AZ 85244. Phone (602) 963-4584.

Circle No 443

Interwoven, 4-conductor cable beats performance of twisted-pair cables

Inter-8 Weave cable, the manufacturer claims, provides substantial improvement over the performance of a conventional twisted-pair cable. The Inter-8 Weave cable has four separate conductors braided into interlocking loops. In practice, you connect the adjacent conductors that are oriented 90° apart, thus yielding a 2-conductor cable.



The cable uses 24 AWG stranded wire; and, unlike twisted-pair cables, does not kink or untwist when left loose. The cable is available unshielded; with a braided shield of Co-Netic AA high-permeability wire; and, for optimal electrostatic and RF shielding, with a braided shield of tinned copper wire.

Inter-8 Weave cable is also available with either PVC or EFTE (DuPont Tefzel) insulation. The cable measures 0.23 in. in diameter for PVC-insulated versions and 0.21 in. in diameter for ETFE versions. In 1000-ft quantities, the cable costs between $0.34 and $2.70/ft.

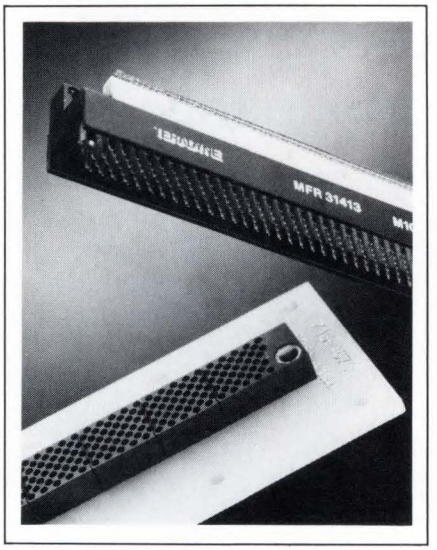
Magnetic Shield Corp, Perfection Mica Co, 740 N Thomas Dr, Bensenville, IL 60106. Phone (312) 766-7800. TWX 910-256-4815.

Circle No 444

Backplane interconnection system suits high-density applications

The VHSICon UHD is a high-density backplane interconnection system for VHSIC-based military/avionic applications. The system includes a controlled-impedance, multilayer pc-type backplane (KS1050 Series) and the 2-piece (backplane/daughter board) UHD connectors. The backplane-half of the connector mounts via solderless, compliant, press-fit contacts. A bare, custom pc backplane can have as many as 30 layers.

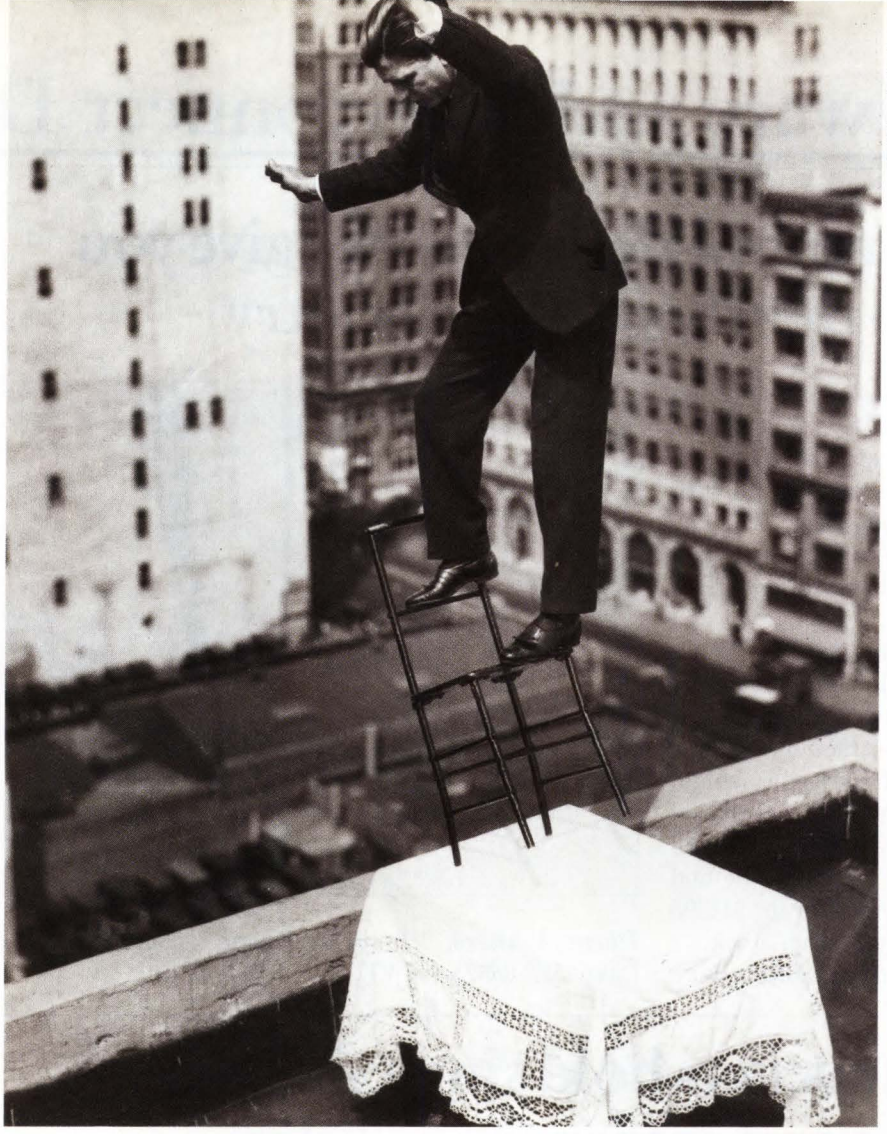
VHSICon UHD connectors adhere to the dimensions of SEM (Standard Electrical Module) format E, with connectors measuring 5.44-in. long by 0.58-in. wide. The connectors provide 396 contacts on a staggered 8-row, 0.1×0.05-in. grid. The daughter board and backplane connectors feature ten modular sections, which each contain 40 tuning fork or blade contacts. The daughter board connectors employ either flexible-circuit terminations (M1050) or rigid terminations (MF1050). Both the daughter board and the backplane connectors accept size-16 coaxial or size-16 or -20 fiber-optic contacts.



Key connector specifications include a 2A continuous current rating, a voltage rating of 600V, and a contact resistance of 30 mΩ. The operating range measures −55 to +105°C, and the contact life is 500 cycles. Materials for the backplane and daughter board contacts are beryllium copper and brass, respectively. The daughter board's body is extruded aluminum 6061-T6. Contact plating is 50 to 70 μin. of gold over 100 to 250 μin. of nickel. Excluding the backplane, the connectors cost $1 to $2 per mated line.

Teradyne Connection Systems Inc, 44 Simon St, Nashua, NH 03060. Phone (603) 889-5156. FAX 603-889-8185.

Circle No 445



The Bettman Archive, Inc.

Balancing mechanical and electrical requirements keeps us on the leading edge of interconnect technology.

What a challenge: making cable systems smaller, lighter, and more flexible without compromising signal fidelity, flex-life, or reliability. At Precision Interconnect we do it every day, for leading electronic equipment manufacturers all over the world.

Working with a variety of mechanical requirements, plus strict electrical parameters, we custom-design and produce complete interconnect systems. Micro-miniature cables, usually using 38 AWG and smaller conductors, can be terminated to standard or micro connectors and protected with flex-strain reliefs. Custom overmolds and sealing designs have been developed to protect interconnect systems in harsh environments. These cable assemblies provide the critical link in hand-held applications on diagnostic instruments, sensors, and medical and surgical devices.

Our expertise, increasing with each unique problem we solve, ensures that reliability is designed in, built in, and tested. So we can keep our balance. And assure a great performance every time.

Interconnect assembly for Medical Dynamics' hand-held surgical camera is sealed against sterilization solutions.

PRECISION INTERCONNECT

16640 S.W. 72nd Avenue
Portland, OR 97224
(503) 620-9400

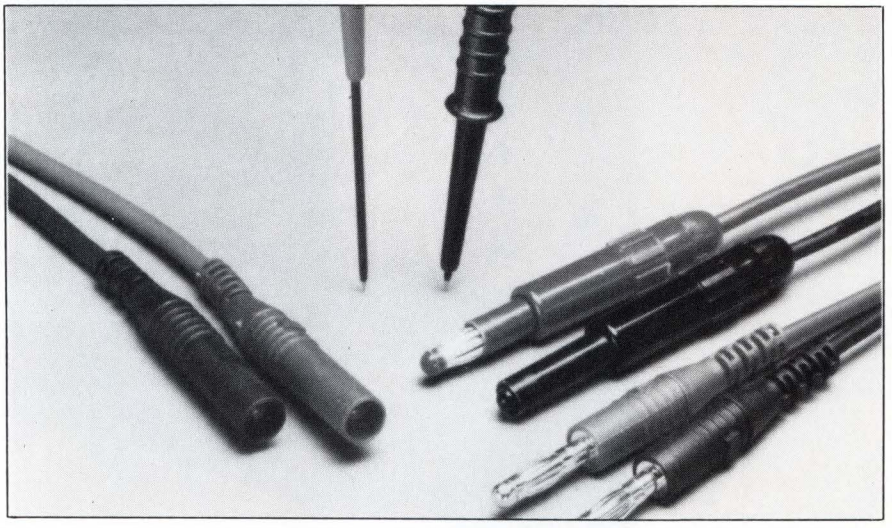
Offices in San Francisco, Boston, Wilmington and Düsseldorf.

CIRCLE NO 36

Surface-mount-device probes give you access to tightly packed circuitry

The ETK520 Series of probes suits electronic assemblies using SMDs and other densely packed circuitry. The series features a test prod with a tip that is extendable to 2 in. The phosphor-bronze tip is insulated with Kynar and has a diameter of 0.039 in.

The prods connect to 4-ft silicone-rubber test leads. Their banana connectors can be standard non-shielded types, retractable safety-shield types, or fixed safety-shield types. Models having gold-plated banana connectors are available. All models are rated for 1000V dc and 5A max. Prices range from $16.95 to $18.95; delivery is from stock.



OK Industries, 4 Executive Plaza, Yonkers, NY 10701. Phone (800) 523-0667; in NY, (212) 944-6600. FAX 212-994-4755.

Circle No 635

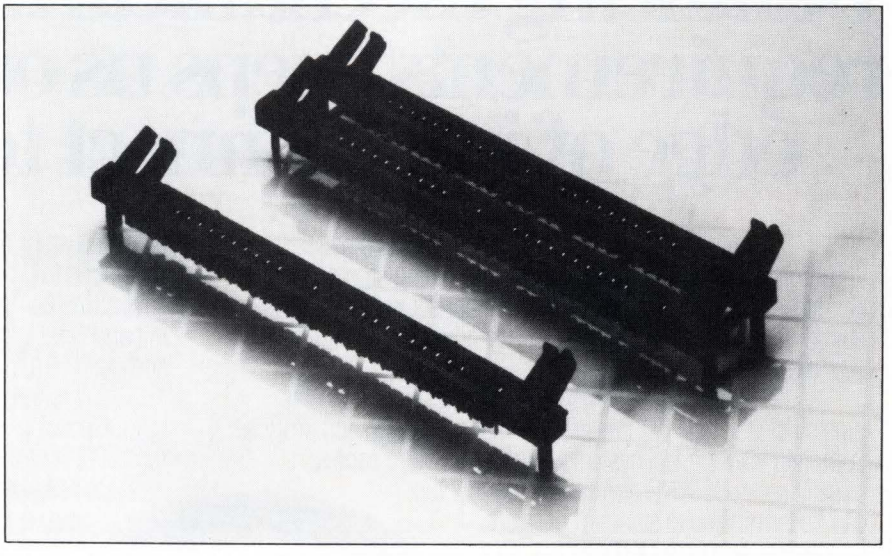
Snap-in sockets hold single-in-line packages and memory modules

Sockets for JEDEC-standard, single-in-line package (SIP) modules and memory modules (SIMM) adapt these modules to conventional thru-hole pc boards. Because the modules snap in and out, you can easily update or repair pc boards.

The sockets come in vertical versions and so-called right-angle (actually inclined at 25° from the pc board) low-profile versions. The single- and dual-row models both have 0.1-in. contact spacing.

The sockets feature zero insertion and extraction force and a mechanical lock to hold the modules in place. The units have visual and mechanical polarization for both the socket-to-board and module-to-socket connections. Internal contact bussing is also available.

The contact material is beryllium copper or phosphor bronze; the contact platings can be tin-lead or gold.



The socket body is black glass-filled polyethersulfone, which has a UL 94 V-O flammability rating. The sockets cost $0.03 to $0.04/contact in production quantities; delivery is from stock.

Methode Electronics Inc, Interconnect Products Div, 1700 Hicks Rd, Rolling Meadows, IL 60008. Phone (800) 323-6864. TWX 910-687-0760. FAX 312-392-9404.

Circle No 446

The VME Volksclosure. $995. Ready to Run.

Finally. The economies of mass production catch up with VME and Multibus II enclosures.

Introducing the Volksclosure, Electronic Solutions' economy model enclosure with turbo performance. All you do is add cards and peripherals for a complete, attractive desktop computer.

With the Volksclosure (also known as our Model One) everything comes standard: six VME or Multibus II slots, space for three half-height 5¼" disk drives, and a high-performance six-layer backplane all in a highly tooled enclosure with our handsome front panel that hides those ugly connectors and cables.

You do get a choice between two multiple-output power supplies: 190 Watts with 19A at +5V or 270 Watts with 30A at +5V. You can also choose a J2 backplane for VME extended addressing or iLBX II for a Multibus II system.

Most important, while the Volksclosure costs less, you don't get less. It fully reflects Electronic Solutions' commitment to quality and performance. For example, it meets UL and CSA safety standards and FCC Class A EMI/RFI specs to the letter.

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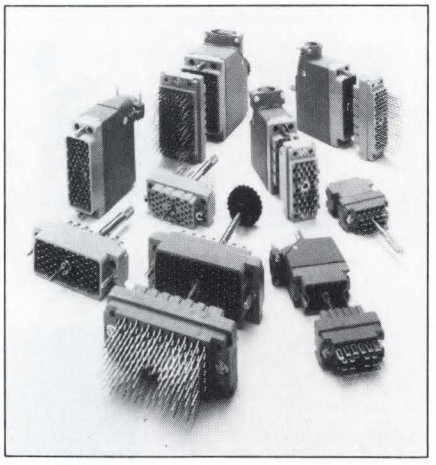
CIRCLE NO 52

Multipole connectors allow easy contact rearrangement

The 8016 Series of multipole rack and panel connectors features removable contacts that allow straightforward assembly and rapid alteration of the connectors to suit individual applications. The contacts mate with an orthogonal contact in the opposing connector to provide a gas-tight contact on four separate faces.

The contacts are available with crimp terminations, solder-cup terminations, or posts that are suitable for wire-wrapped connections. They conform to MIL-E-54000, MIL-E-8189, and MIL-T-21200 requirements.

The connectors are available in 20-, 38-, 56-, 90-, and 120-way versions, all of which incorporate screw-lock actuating mechanisms. They are also available with either male or female contacts to provide input or output connectors. The connectors meet MIL-C-21097 and MIL-C-28731 requirements. The following are representative prices: 38-way male contact housing, £2.07; female contact housing, £1.20; Varilok contacts, £4.40; connector covers, £2.31 (100).



Varelco Ltd, Exning Rd, Newmarket, Suffolk CB8 0BB, UK. Phone (0638) 664514. TLX 81519. FAX 0638-661233.

Circle No 645

Elco, Huntingdon Div, Huntingdon Industrial Park, Huntingdon, PA 16652. Phone (814) 643-0700. TWX 510-691-3117. FAX 814-643-0426.

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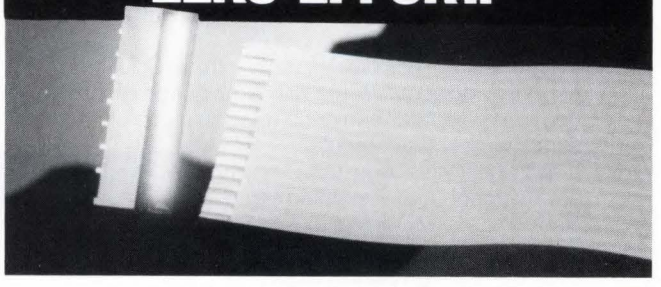

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Tough, low profile Gore LIF-ZIF jumpers provide fast, flexible board to board hookup. Just unpackage and plug in standard center spacings of 1.25mm, .050" and .100". Lengths from 2" up. UL listed and just-in-time delivery on shielded and unshielded cables. Send for the facts: Call or write W. L. Gore & Associates, 4747 E. Beautiful Lane, Phoenix, AZ 85076.

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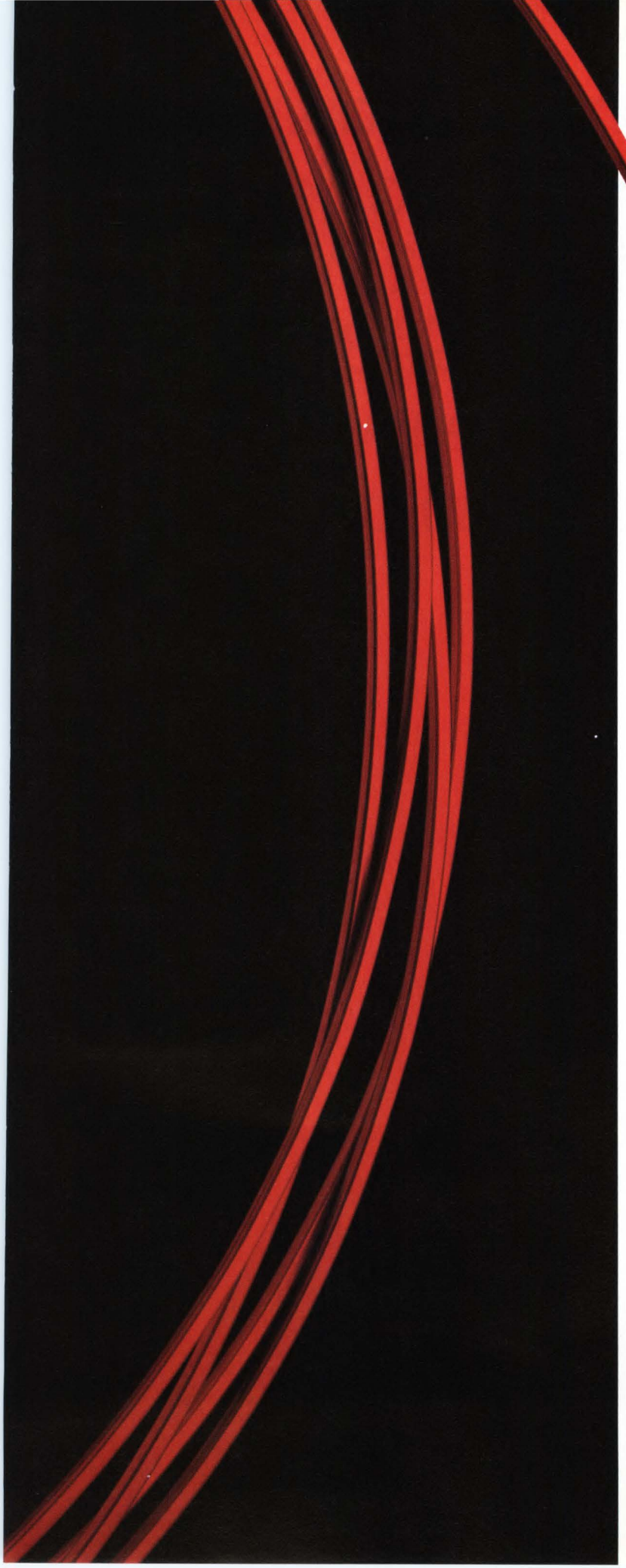
CIRCLE NO 8



MICROSQUARE™

MAGNET WIRE

For specialty coil and motor windings.

While product miniaturization allows less space for components, MWS MICROSQUARE film coated magnet wire lets you design compact coils and small motors that deliver more power in less space.

MICROSQUARE means miniature square and rectangular copper and aluminum magnet wire. Custom produced in sizes *smaller* than 14 AWG or 3500 sq. mil. cross-sectional area, MICROSQUARE is available in a wide range of solderable and high-temperature insulations in a variety of colors, with or without bondable overcoats.

MICROSQUARE magnet wire was developed to provide improved winding uniformity and maximum use of space. When you're looking for options to meet the most demanding coil, small motor, or other special application requirements, without size limitations or quantity minimums, take a good look at MICROSQUARE magnet wire.

Illustration of cross-section of typical coil winding using round magnet wire.

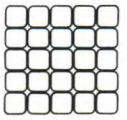
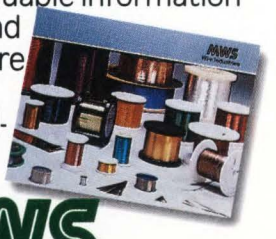


Illustration of cross-section of coil winding using MWS MICROSQUARE magnet wire. Note improved winding uniformity and maximum use of space.

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 MICROSQUARE are available upon request.



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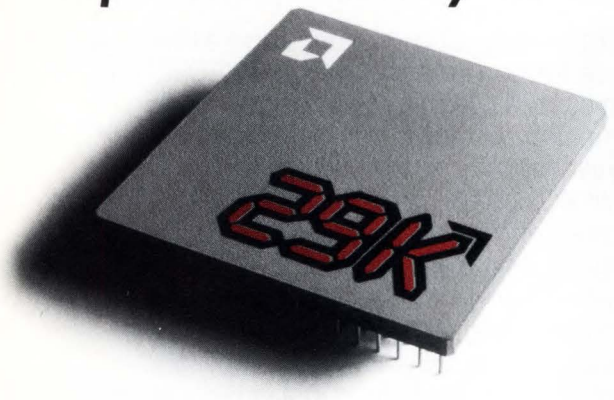
42,000 dhrystones with a single 32-bit RISC chip. Sustained. Seventeen MIPS. Real world MIPS. 25Mhz clock speed. Fifty MIPS by 1991. Blazing fast even with low-cost memory.



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CIRCLE NO 103

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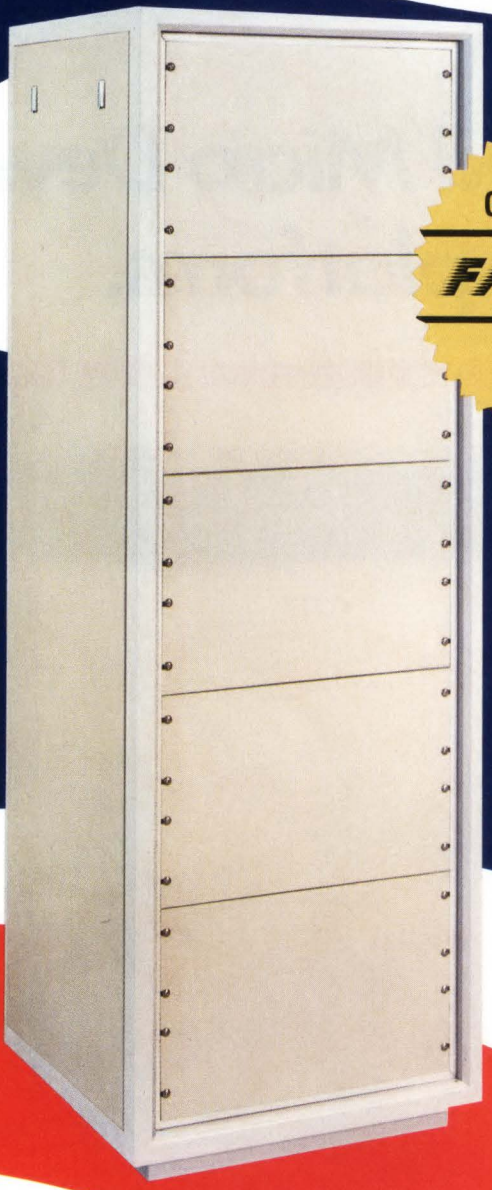

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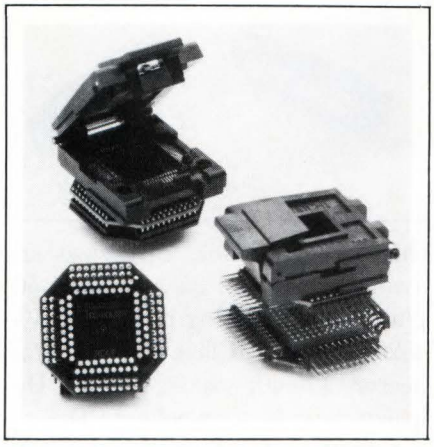
CIRCLE NO 109

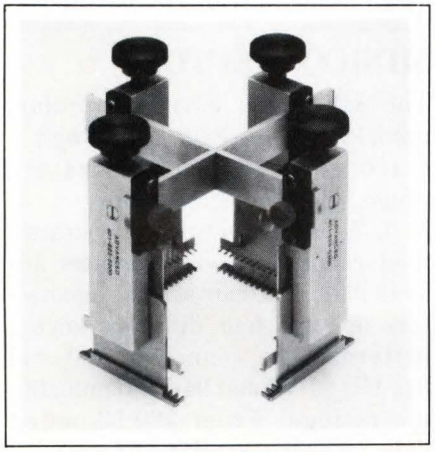


SOCKET CONVERTERS

Convert-a-Socket adapters allow you to convert production sockets to burn-in sockets and vice versa. The line comprises converters for PGAs, LCCs, or PLCCs. Using these converters you can replace a pc-board's low-insertion-force production sockets with zero-insertion-force burn-in sockets to transform the pc board into a device-testing fixture. $190.

Emulation Technology, 2368B Walsh Ave, Bldg D, Santa Clara, CA 95051. Phone (408) 982-0660.

Circle No 590

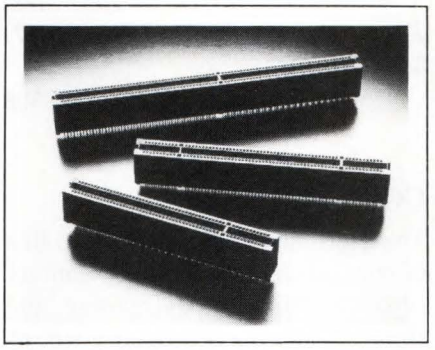


PGA EXTRACTOR

A 4-sided insertion/extraction tool for pin-grid-array packages places even pressure on all sides of a PGA device. The tool has adjustments to accommodate it to variously sized PGA devices. The tool features four sets of gripping teeth and push bars that grip the PGA device and allow you to remove or insert it by alternately turning four knobs. Gripping teeth and matching push bars are available with 7 to 19 teeth per side. $750 (1-99).

Advanced Interconnections, 5 Energy Way, West Warwick, RI 02893. Phone (401) 823-5200. FAX 401-823-8723. TWX 910-240-3454.

Circle No 592

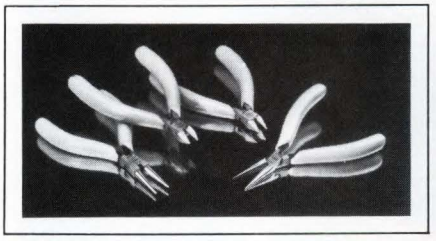


PS/2 CONNECTORS

The FCN224 Series consists of three connectors used on the controller board in the IBM PS/2 50, 60, 70, and 80. The series has 112, 132, and 182 pins on 0.05-in. centers that accommodate 0.63-in.-thick double-sided pc boards. The connectors' solder pins are arranged on a 0.1×0.1-in., staggered-row pc-board layout. From $5 to $8 (100).

Fujitsu Component of America Inc, 3330 Scott Blvd, Santa Clara, CA 95054. Phone (408) 562-1000. FAX 408-727-0355.

Circle No 591

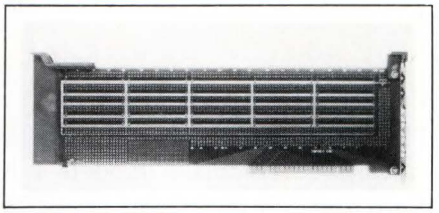


CUSHIONED PLIERS

The Utica line of electronics-assembly pliers now includes models with soft-foam, cushion-grip handles. The pliers have coil return springs. The soil-resistant cushions have an integral thumb flair and provide some ESD protection. The pliers include diagonal, flush, and tip cutters as well as chain- and round-nose pliers. All cutting edges are induction hardened. Ask for Bulletin No. UT-110/688. $13 to $21.

The Triangle Tool Group Inc, Box 1807, Orangeburg, SC 29115. Phone (803) 534-7010.

Circle No 593

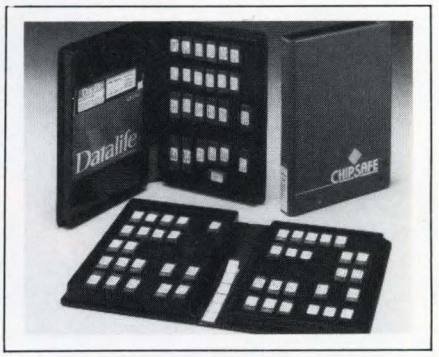


PS/2 PROTO BOARDS

A line of prototype pc boards for the IBM PS/2 includes models having prewired areas for a 16-bit data bus with video connection; a 32-bit data bus; a 16-bit data bus with I/O decoding; a 16-bit data bus extender; and a 32-bit data bus extender. The uncommitted areas of the prototype boards feature 0.038-in. plated-through holes on 0.01-in. centers. Design documentation and diagnostic software is also available. The boards come with power and ground planes and can accommodate both electrolytic and bypass capacitors. $35 to $95.

Advanced Microcomputer Systems Inc, 1321 NW 65th Pl, Fort Lauderdale, FL 33309. Phone (800) 972-3733. TWX 910-250-4806.

Circle No 594



CHIP HOLDERS

The ChipSafe and ChipStore line of IC-storage albums secure and pro-

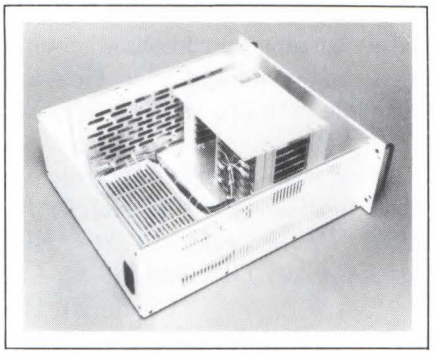
tect various ICs. The snap-fastened albums are crushproof, dust-tight, and provide antistatic protection. Models range from a pocket-size unit that holds six 24-pin ICs to a 7×10-in. unit that holds seventy 24-pin ICs. $6.95 to $16.95.

iTOI Enterprises, Box 59, Newton Highlands, MA 02161. Phone (617) 332-1010.

Circle No 595

CARD ENCLOSURES

The 508 Series card-level system enclosures comprise models for VME Bus, Multibus, and Multibus II pc boards. The enclosures accommodate 4 to 16 pc boards in 3½-, 5¼-, 8¾-, 10½-, and 12¼-in. high, 19-in. rack-mount and desk-top models. The series features postive-pressure, filtered-air cooling. You can mount both your power supply and one of the manufacturer's backplanes in the enclosures. $1400.

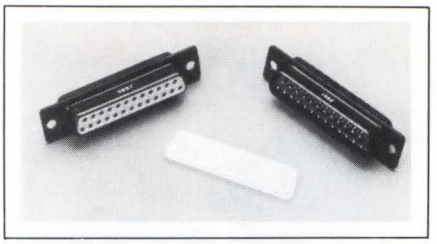


Mupac Corp, 10 Mupac Dr, Brockton, MA 02401. Phone (617) 588-6110.

Circle No 596

CONNECTORS

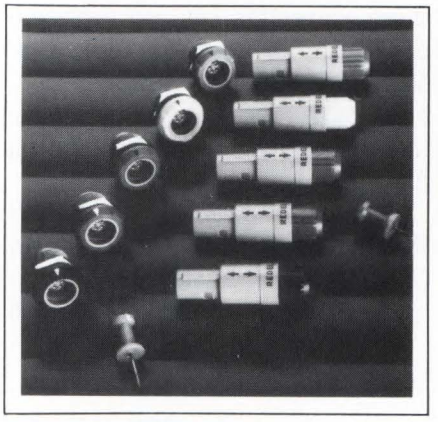
The Hermetic D Subminiature line of connectors accept mixed contact types including coaxial, power, and signal. The connectors are watertight and gastight even when unmated. You can replace a connector's silicone sealing device. The steel housing is galvanized and



chromated in black. Five sizes are available: 9-, 15-, 25-, 37-, and 50-pin. Contact plating meets MIL-G-45204, Type II, Class O specs. Connector, $15.40; socket, $17.57. Delivery, four to six weeks ARO.

Carrot Components Corp, 750 W Venture Blvd, Camarillo, CA 93010. Phone (805) 484-0540. FAX 805-987-5062. TWX 910-336-1237.

Circle No 597



MINICONNECTORS

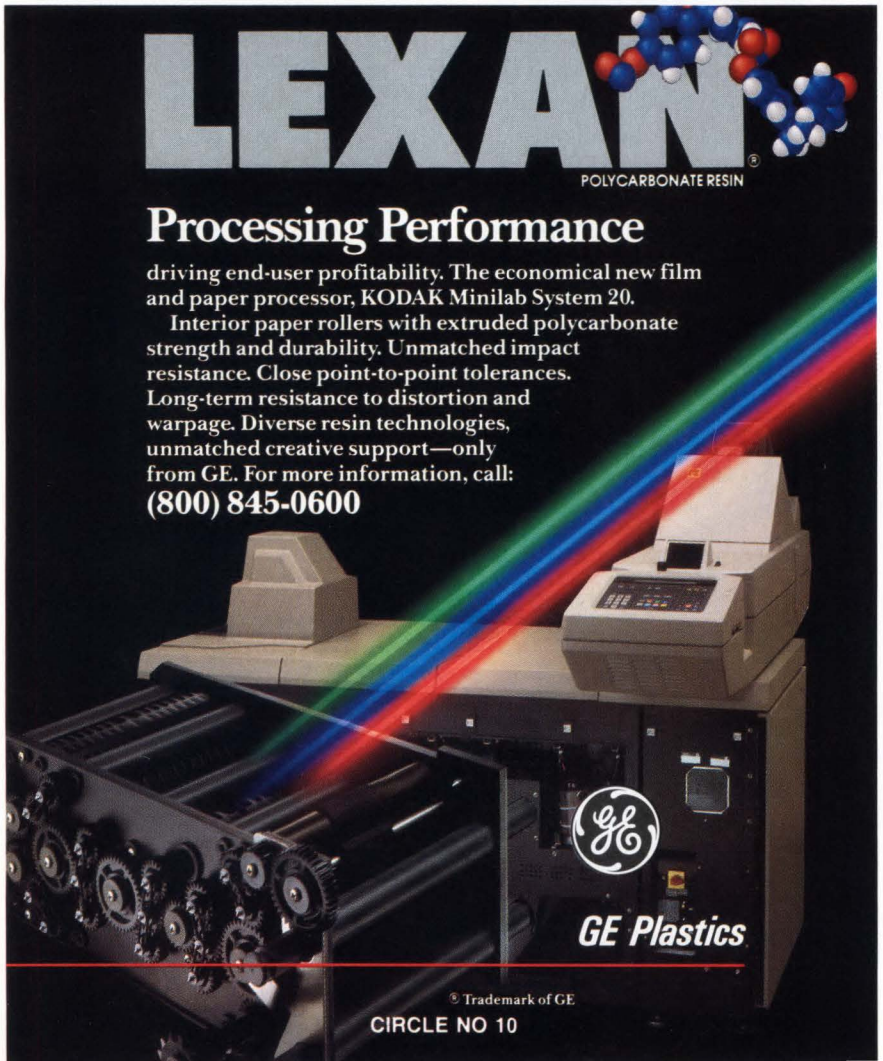
The 1P Series plastic, circular, miniature connectors withstand a −100 to +150°C temperature range. The connectors have 2, 4, 5, 6, 7, and 9 gold-plated contacts. Solder and pc-mount versions are available. You can set the connectors up with four different keying patterns. The connector material has UL 94-V0 and 94-V2 flammability ratings. From $20.93/mated pair. Delivery, stock to 12 weeks.

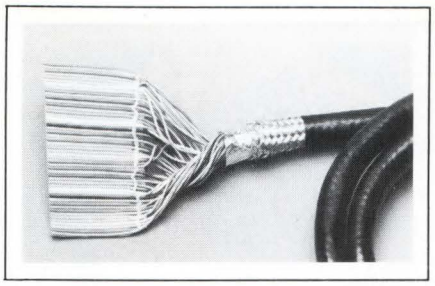
Lemo USA Inc, Box 11488, Santa Rosa, CA 95406. Phone (707) 578-8811. TLX 340933.

Circle No 598

TWISTED CABLE

Twist-N-Flat cable consists of #28-7 AWG tinned-copper, loose-

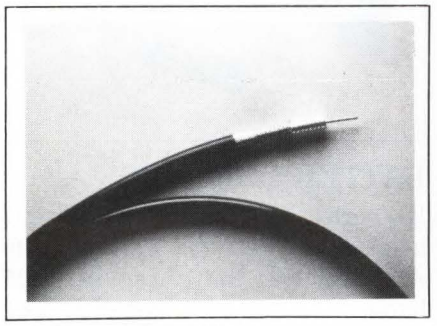




twisted-pair conductors with color-coded PVC insulation. Sections of the conductors measuring 2.5 in. are intermittently flattened out and laminated on 0.05-in. centers. This spacing accommodates industry-standard insulation-displacement connectors. The cable has an aluminum-polyester and copper-braid shielding. The temperature range is −20 to +105°C. The cable is UL recognized (Style 20381) and CL2 approved. CSA certification available upon request. 26-conductor cable, $114/100-ft coil; 50-conductor cable, $171/100-ft coil (1000 ft).

Amphenol Spectra-Strip, 720 Sherman Ave, Hamden, CT 06514. Phone (800) 572-2253; in CT, (203) 281-3200.

Circle No 599

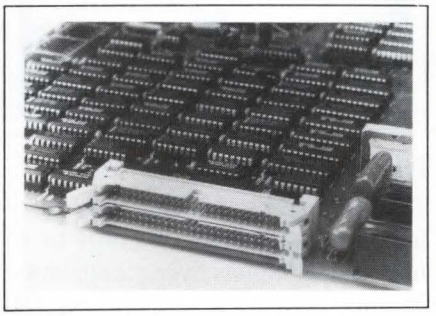


MAP CABLES

A pair of cables meet IEEE 802.4 specs for manufacturing automated protocol networks. The cables are also CL2X rated. Cable 1223A (RG-6/U type) is suitable for broadband and carrierband drop applications from the cable trunk to individual workstations. This cable features a #18 AWG solid copper-covered steel conductor and black PVC jacket. You can use cable 1224A (RG-11/U type) for either trunk or drop applications. This cable has a #14 AWG solid copper-covered steel conductor. The shield coverage is 79%. Both cables are available in 1000-ft putups. 1223A, $220.65; 1224A, $377.25.

Belden Wire and Cable, Box 1980, Richmond, IN 47375. Phone (800) 235-3364.

Circle No 600



STACKED HEADERS

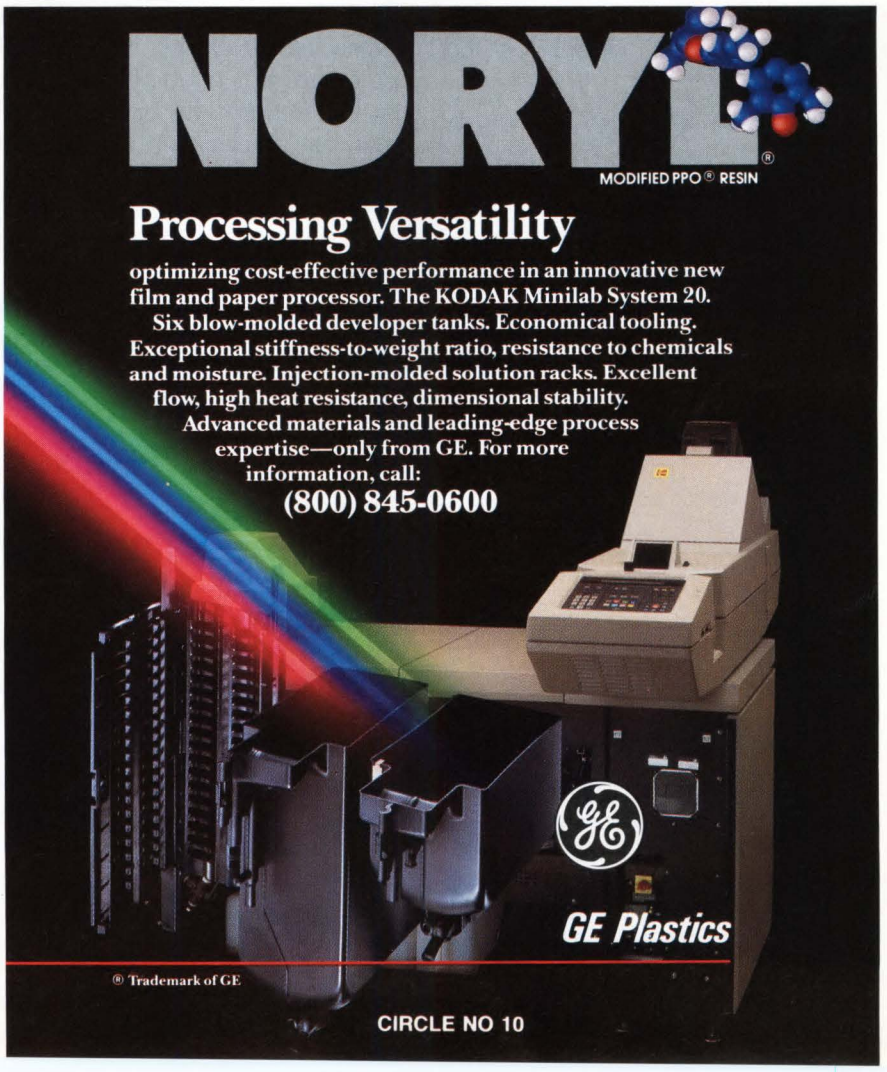
You can stack two right-angle, Condo headers, one atop the other, to double the number of connections to a pc board without using extra pc-board real estate. The latching Condo headers come in two models measuring 0.63 in. and 0.675 in. high per connector. The connectors are suitable for robotic insertion in pc boards having a 0.1 × 0.1-in. grid, and they offer 10 to 64 pins per connector (20 to 128 per assembly). The headers accept standard 0.1-in. flat-cable connectors. 50-pin header, $12.01 (1000). Delivery, four to six weeks ARO.

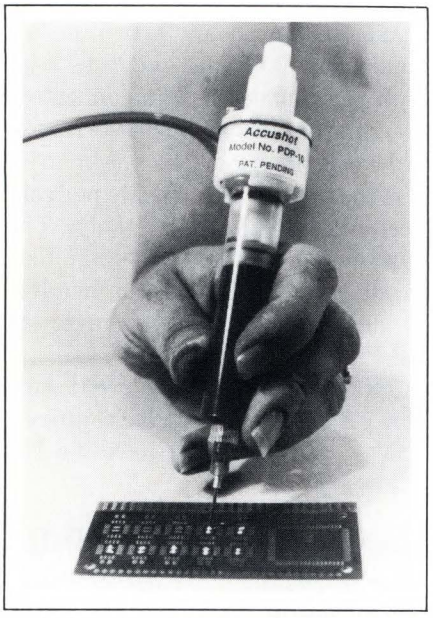
3M, Dept 3P27, Box 2963, Austin, TX 78769. Phone local office.

Circle No 603

HANDHELD DISPENSER

The Accushot PDP-10 positive-displacement, handheld dispensing pump handles a wide variety of viscous, noxious chemicals including adhesives, solvents, and solder pastes. The unit accepts 10-cc disposable syringes and dispenses 0.2- to 1.0-μl chemical dots measuring

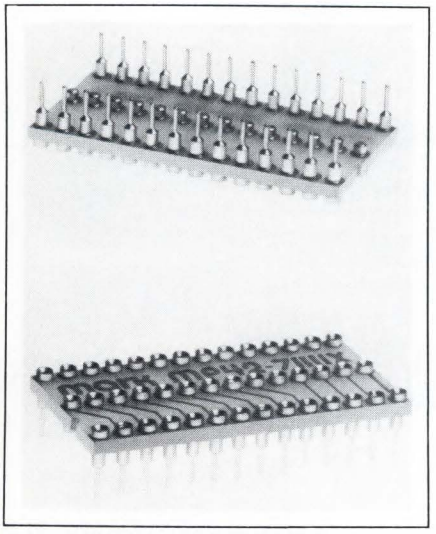




0.02 to 0.1 in. The dispensing rate is 2 dots/sec with ±10% volume repeatability. The unit weighs 2.5 oz. PDP-10/1, $419; PDP-10/2, $489.

Creative Automation Co, 11641 Pendleton St, Sun Valley, CA 91352. Phone (818) 767-6220. TWX 910-240-4767. FAX 818-767-0123.

Circle No 602

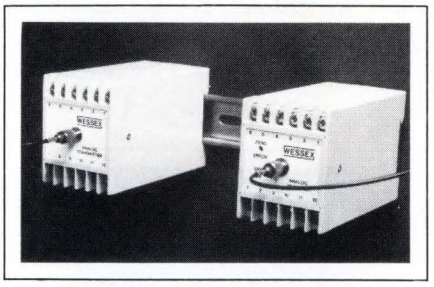


ADAPTER SOCKET

This 42-pin transition DIP socket adapts 0.3-in.-wide ICs (skinnydips) to existing pc boards having 0.6-in. spacing. The socket features center pins that are shorter than the outer posts to get the 0.6-in. center spacing to adapt to 0.3 in. $2.40 (1000).

Mark Eyelet Inc, 63 Wakelee Rd, Wolcott, CT 06716. Phone (203) 756-8847. TWX 510-600-7291.

Circle No 601



FIBER LINK

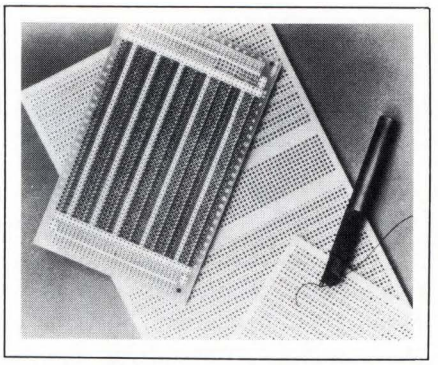
The Fibre-Link 2 analog signal isolator transfers 0 to 10V or 4 to 20 mA analog signals over a fiber-optic link for distances as great as 150 meters, using low-cost polymer optical fiber. The transmitter modulates the analog signal to transmit it over the optical fiber, and the receiver has a potentiometer for zero-error adjustment. The receiver continuously monitors the fiber link for transmission failures, and if a failure occurs it activates an alarm relay and reduces its output to 0V. Both the transmitter and receiver modules are mounted in DIN-standard, rail-mounting packages with screw terminals. Transmitter/receiver pair, £200.

Wessex Machine Controls Ltd, The Gallery, Brookside, Sandhurst, Camberley, Surrey GU17 8AP, UK. Phone (0344) 761613. TLX 858893.

Circle No 629

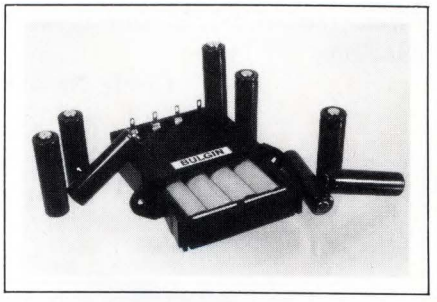
PROTOTYPING BOARDS

Providing an alternative to prototyping boards that require wire-wrapped connections, Eurocard-Plus prototyping boards use insulation-displacement connectors that are reuseable as many as 50 times. In addition to the insulation-displacement sockets, the board also has a matrix of through-hole plated holes in which you can mount discrete components. The boards are available in single- or double-Eurocard versions, either unpopulated or populated with sockets. The company will also manufacture custom versions. A wiring pen and suitable wire are available as accessories. Single-Eurocard version, £20.80 (10).



Gentech International Ltd, Grangestone Industrial Estate, Girvan, Ayrshire KA26 9PS, UK. Phone (0465) 3581. TLX 778500. FAX 0465-4974.

Circle No 630



BATTERY HOLDERS

BX-series panel-mounting battery holders are available to hold four AA (R6) size batteries, one PP3 battery, or two PP3 batteries. The batteries are contained in a removable magazine that slides into a panel-mounted housing. The magazine is marked internally with the correct battery polarities, and a latching mechanism holds the magazine in place. Terminals provide suitable push-fit or soldered connections. On the version that accepts AA-size batteries, these terminals are arranged so that you can connect all four batteries in series, or wire them as two separate series-connected pairs. $5.

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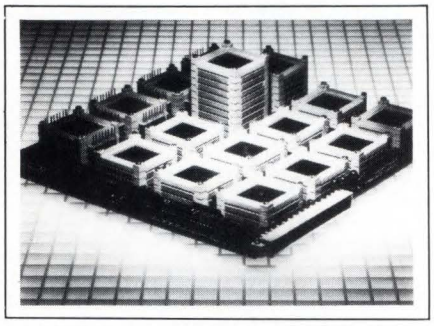
pass Rd, Barking, Essex IG11 0AZ, UK. Phone 01-594-5588. TLX 897255. FAX 01-591-6913.

Circle No 631



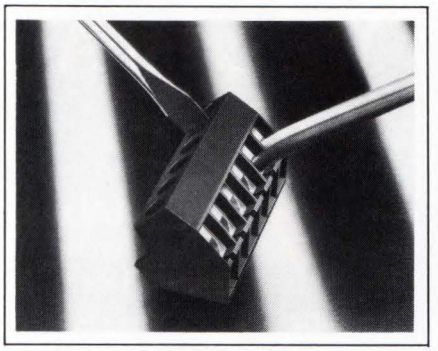
INTERCONNECT SYSTEM

The Chiprack interconnect system allows you to add a third dimension to the 2-dimensional interconnect patterns provided by pc boards. Comprising leadless chip carriers that have contact pads on both their upper and lower surfaces, and square frame connectors that connect the contact pads on the upper surface of one chip carrier to the contact pads on the lower surface of the chip carrier above it, the system allows you to create vertical stacks of circuitry above a conventional pc board or other substrate material. Bolt holes are provided that allow you to clamp these vertical assemblies to the pc board, thereby ensuring reliable contact between the contact pads and the connectors.

You have the alternative of soldering the contact pads and connectors together after assembly by using vapor-phase soldering techniques. Because all the vertical interconnections are available at the top and bottom of the stack, the Chiprack system eases the testing of completed assemblies. Chiprack connectors have nickel beryllium/copper contacts on a 1-mm pitch. The connectors and chip carriers range from 48- to 104-contact versions. 48-contact version, £2.75; 104-contact connector, £5. The devices are scheduled for US release in the middle of 1989.

Dowty Interconnect, Knaves Beech Business Centre, Loudwater High Wycombe, Bucks HP10 9UT, UK. Phone (0628) 810810. TLX 846874. FAX 0628-810813.

Circle No 632



TERMINAL STRIPS

With 0.197-in. contact spacing, Eurostyle 45° entry terminal strips provide access for field wiring to

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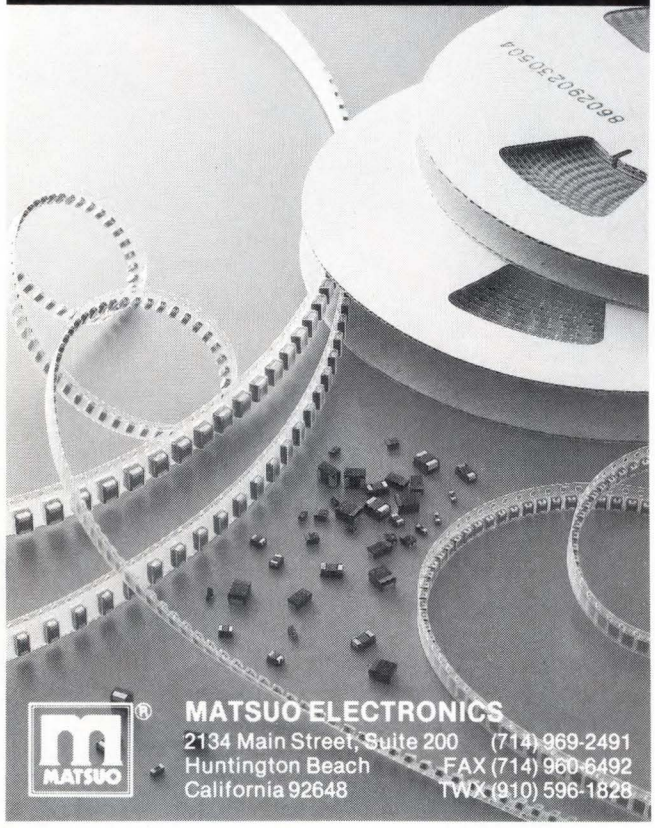

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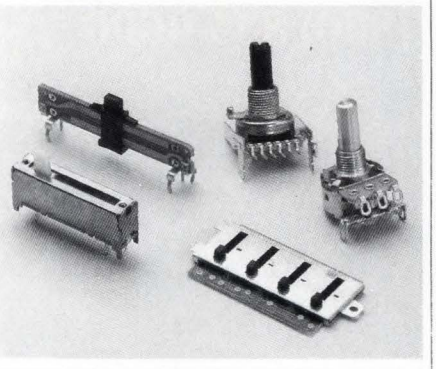

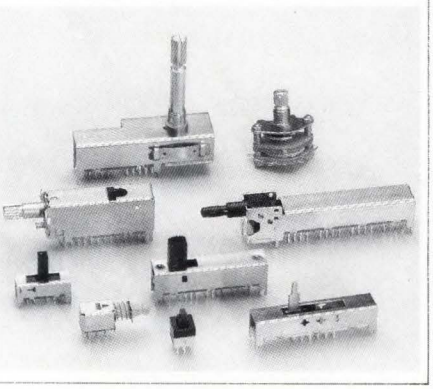

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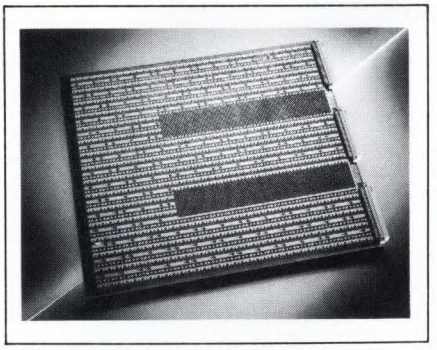
crowded pc boards. The terminals have touch-proof recessed terminals and wire-ready captive screws. The terminal strips carry a 15A UL-recognized current rating and will accommodate voltages to 300V. They will accept #14 AWG wires and have a closed side that acts as a wire stop. Their thermoplastic insulator material has a 130°C temperature index and carries a 94V-0 UL flame-retardant rating. $0.18/circuit (500).

Vernitron Corp, Beau Products Div, Box 10, Laconia, NH 03247. Phone (603) 524-5101. TWX 710-364-1843.

Circle No 611

PROTOTYPING BOARD

This 400-mm-deep triple-Eurocard prototyping board is compatible with the Sun computer system and allows you to interconnect circuitry using wire wrapping. The 4-layer



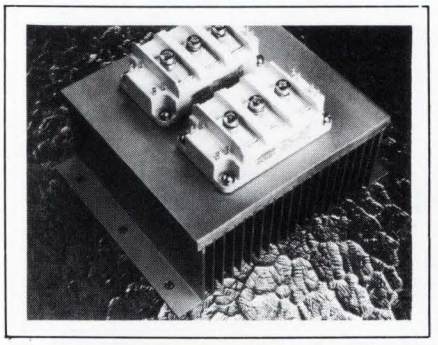
board allows you to use surface-mount and large-scale ICs, and has separate areas for pin-grid arrays. It is fitted with surface-mount capacitors to provide distributed power-supply decoupling. It is available either fully or partly populated with wire wrapping terminals. Fully populated board, approximately £1100; partly populated board, approximately £1000.

Bicc-Vero Electronics Ltd, Flanders Rd, Hedge End, Southampton SO3 3LG, UK. Phone (0703) 266300. TLX 477984. FAX 04215-64159.

Circle No 633

Bicc-Vero Electronics Inc, 1000 Sherman Ave, Hamden, CT 06514. Phone (203) 288-8001. TWX 510-227-8890.

Circle No 634



POWER-MODULE SINKS

The Series 6760 heat-sink series is suitable for both forced-air and natural-convection cooling of power-module assemblies. The heat sinks' bonded fins provide more

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The checklist below should help you save some time explaining to management why you chose Cabtron electronic enclosures (even though they should be promoting you for it). If they ask, just check off the ones that apply, tear out this ad, and send it to them so you can get back to more important things. For more complete information, contact your Cabtron representative or call: 1-312-498-6090.

MEMO

To: Management From: Engineering

Re: Why we specified Cabtron electronic enclosures.

☐ Durable Construction
Cabtron frames are built to stand up to tough environments and heavy loads. They utilize 12, 14, or 16 gauge steel, with 11 gauge corner gussets added for strength on vertical rack and console models. Significant components are even seam welded together for extra strength and rigidity. You just don't find that kind of quality anymore.

☐ Unique Features/Accessories
Cabtron is the only place you can get a blower system that's built into the base to save space. And with their wide selection of accessories such as receptacle strips, writing top drawers, chassis brackets, and 11 gauge mounting angles tapped on EIA patterns, we were able to get exactly what we needed with standard catalog items!

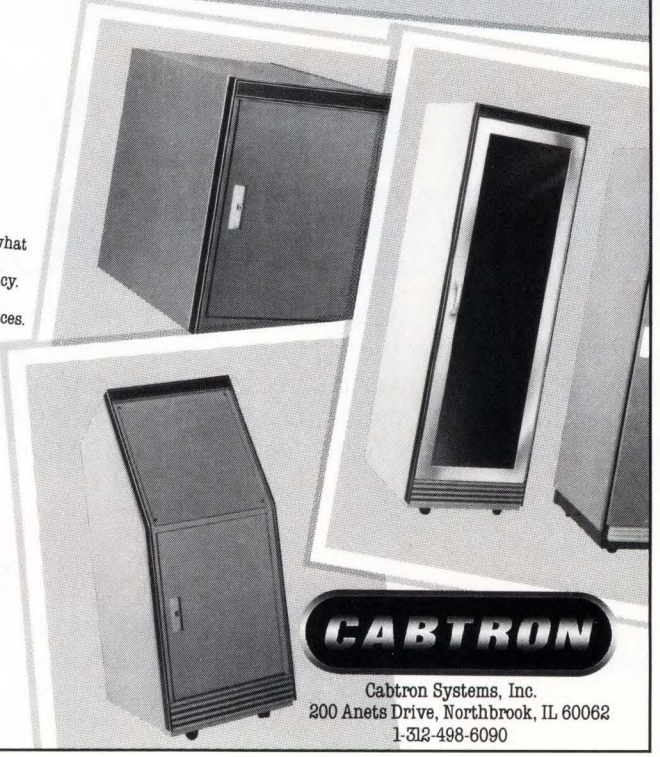
☐ Selection
Everything we needed was right there in one catalog. Cabtron has vertical racks, 19° "flat top" and 30° consoles, bench cabinets, turret cabinets, desk turrets—even wedges. We put together the whole system with one call.

☐ Customizing ability
When we told the people at Cabtron what we needed, they helped us design an enclosure that covers every contingency. Their flexibility gave us practically a custom enclosure at "off the floor" prices.

☐ Good looks
The enclosures', not the salesperson's. Cabtron has 10 standard textured finishes to choose from, and will even make combinations of those colors at no additional cost. We also got a choice of styles—computer style (with trim) or industrial (without trim).

☐ On-time delivery
Cabtron is famous for their delivery and service. Not just sometimes, or on certain models, but every time. We can't afford to wait around, and Cabtron makes sure we don't have to.

☐ All of the above



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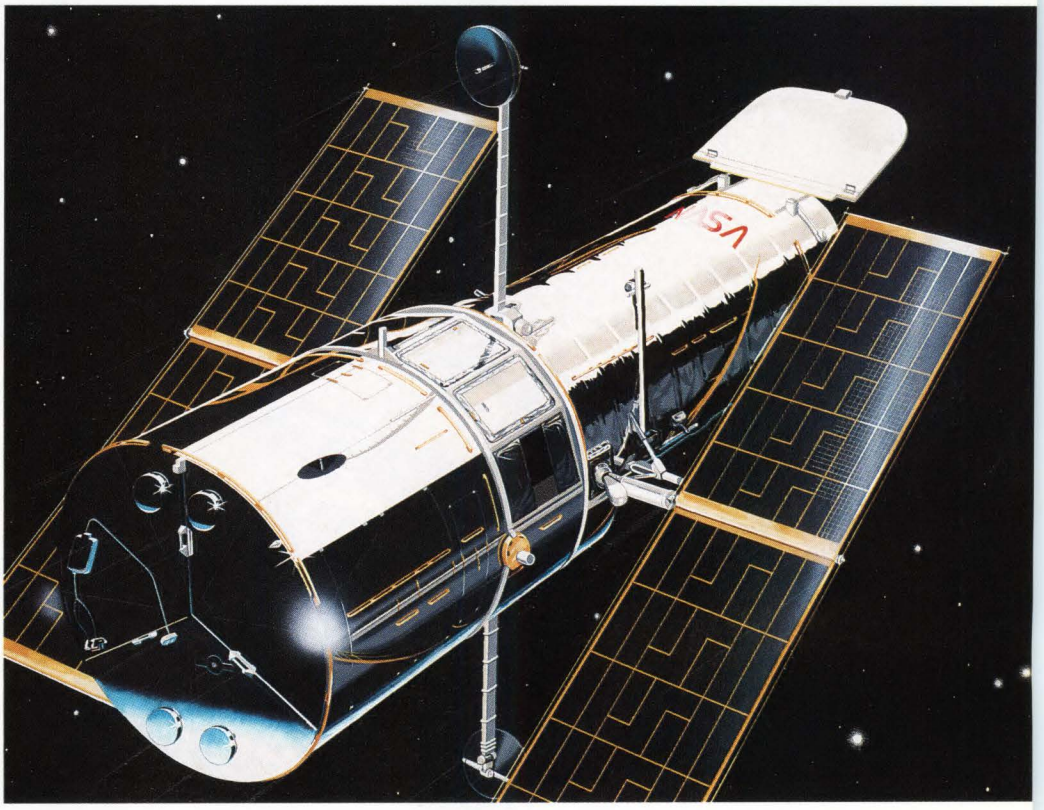

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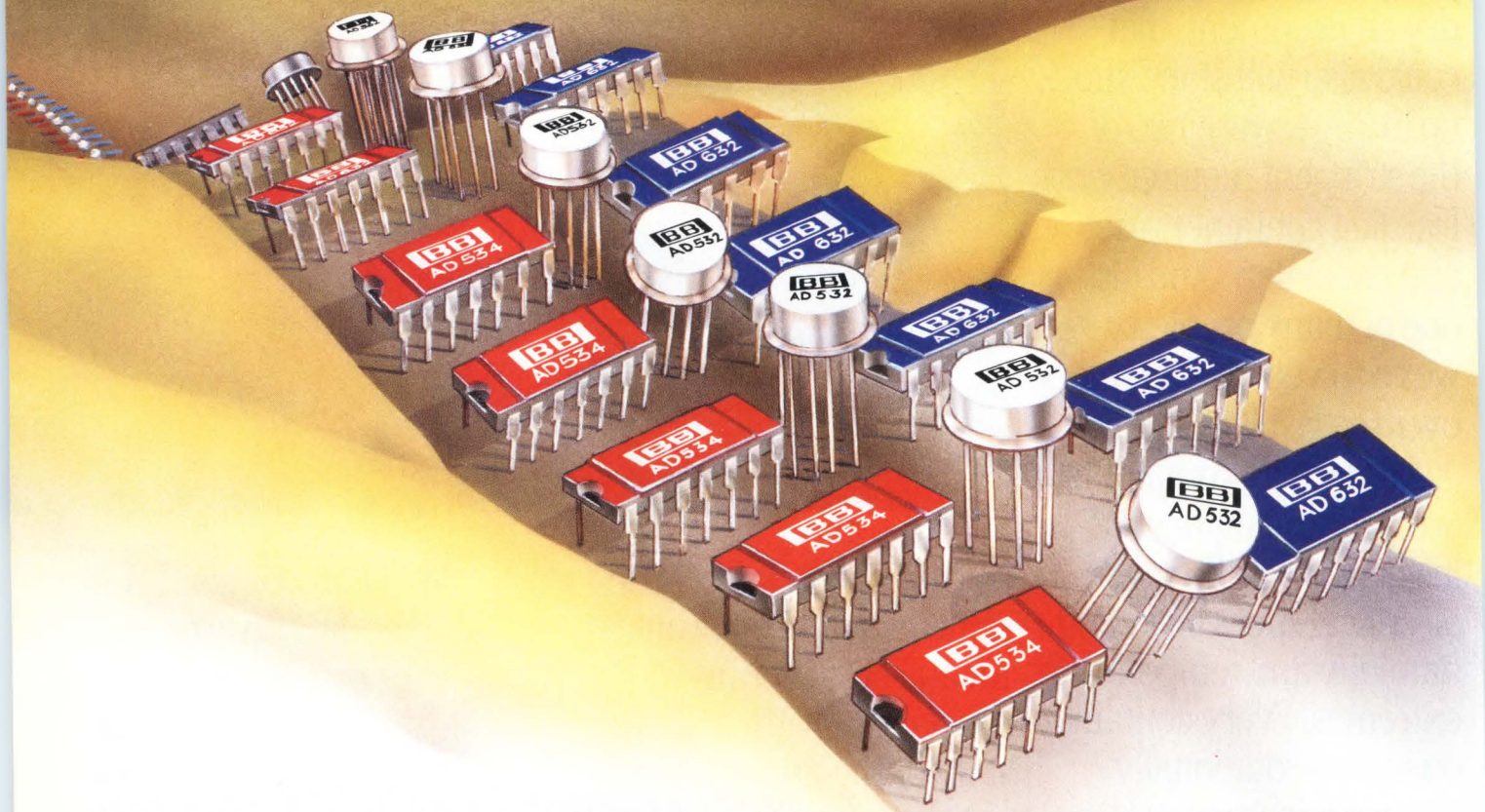

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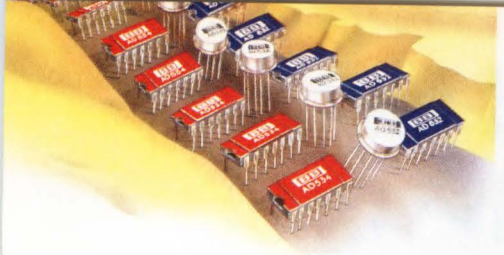

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Hardware

cooling area than cast or extruded fins do. The heat sinks are available in nine standard sizes. The forced-air models are 5.25 in. high and accept standard 4-in. muffin fans. The natural-convection models are 3.13 in. high. Thermal resistance ranges from 0.22°C/W to 0.3°C/W. A 7-in. long, natural-convection model with gold chromate finish, $39.27 (100). Delivery, 8 to 12 weeks ARO.

Aavid Engineering Inc, Box 400, Laconia, NH 03247. Phone (603) 528-3400.

Circle No 604

BUTT CONNECTORS

A series of butt connectors and solderless terminals are made of pure electrolytic (ETP) copper that's annealed and tin-plated. Available styles include vinyl-insulated and noninsulated ring-tongue, block-spade, flanged block-spade, and snap-spade types—all with butted seams. The connectors handle wire ranging from #10 to #22 AWG. $0.02 to $0.03 each.

Keystone Electronics Corp, 31-07 20th Rd, Astoria, NY 11105. Phone (718) 956-8900. TLX 353700. FAX 718-956-9040.

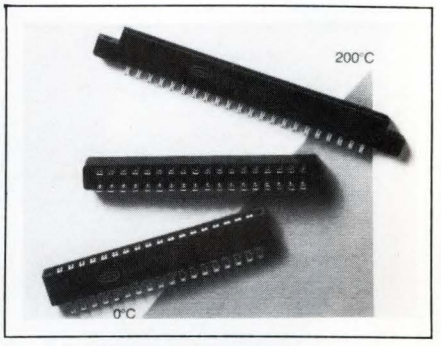
Circle No 606

50-MIL CONNECTORS

The Pak-50 ribbon connectors' 50-mil spacing doubles the pitch of conventional 100-mil ribbon connectors. The connectors substitute sliding, hermaphordidic contacts for conventional male-female, tuning-fork contacts. The connectors come in both straight and right-angle models having 20, 26, 30, 32, 34, 40, 50, 52, 60, 68, 80, and 100 pins. The connectors come with board-retention clips to stabilize the connectors during wave soldering. Integrated power ground pins and flangeless connector bodies are optional. Pak-50, $0.10/mated contact pair (1000). Delivery, four to six weeks ARO.

Robinson Nugent Inc, Box 1208, New Albany, IN 47150. Phone (812) 945-0211.

Circle No 605



CARD CONNECTORS

EB7D and EB8 dual-row board-edge connectors are suitable for high-temperature applications, including burn-in ovens. A high-temperature molding compound for the body and beryllium copper material for the contacts help them withstand 200°C operating temperatures. The connectors are available in a variety of terminations, including dip-solder, solder-eyelet, and card-extender styles. EB7D units are available with 6, 10, 12, 15, 18, 22, 36, and 43 contacts per row; EB8 connectors offer a choice of 6, 10, 12, 15, 18, 22, 24, or 25 contacts per side. EB8 connector with dual rows of 22/24 contact positions and card-extender terminations, $4.80 (1000). Delivery, four to six weeks.

Dale Electronics Inc, Dept 860, Box 609, Columbus NE 68601. Phone (605) 665-9301.

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ISP 9210 16x16 Multiplier Accumulator: innovative high-speed architecture (65 ns commercial, 75 ns military), low-power operation.

ISP 9216 16x16 Multiplier: low-power, industry-standard compatible to AM29516 and MPY016.

ISP 9520/21 Pipeline Register: high-speed access,

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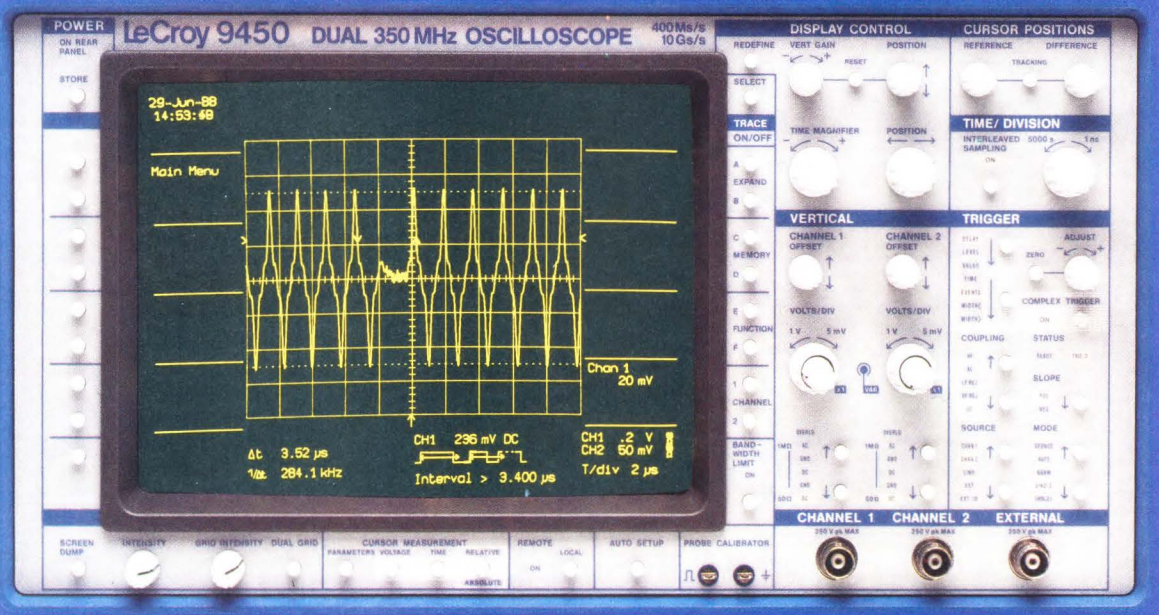

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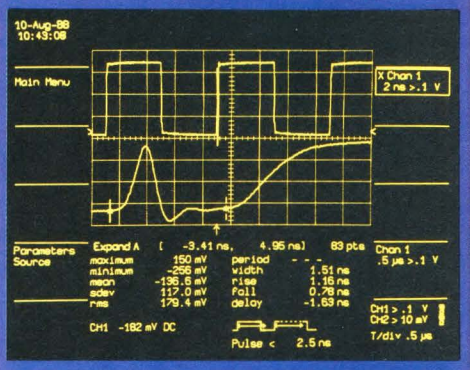

FASTGLITCH trigger mode is used to trigger on a glitch 1.51 nsec wide which occurs before the leading edge of a 500 kHz clock signal (top trace, see trigger arrow at the bottom of the graticule). Fast sampling rates, automatic pulse parameters and horizontal expansion by 250 times (lower trace) all combine to reveal the signal details.

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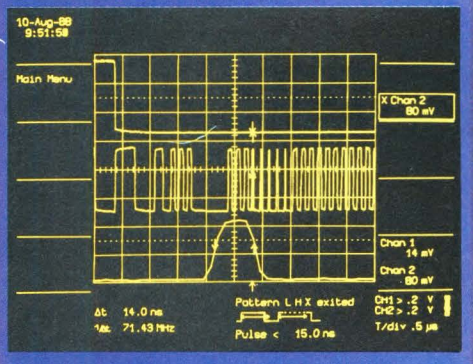
*And... you already know how to use it. A familiar front panel, together with a push-button **AUTO SETUP** facility, lets you rapidly learn to operate this new member of the LeCroy oscilloscope family.*



Logic conditions can be individually set for each of the 9450's inputs. PATTERN trigger mode is used to trigger only when the logic condition CH1 Low (top trace) and CH2 High (middle) is exited. The pattern must also be present for less than 15 nsec (lower trace). The trigger position is shown by the arrow at the bottom of the graticule.

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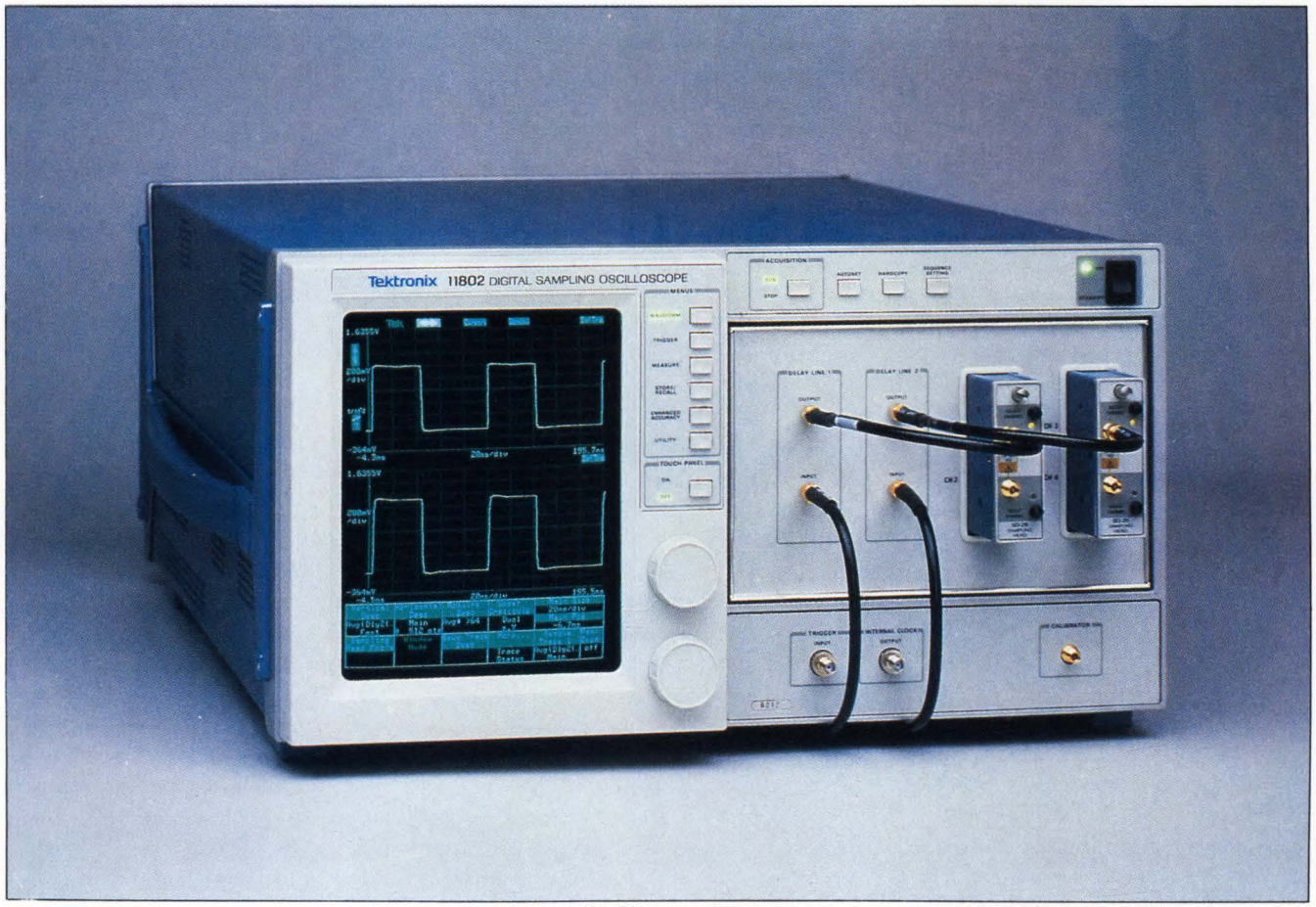


20-GHz sequential-sampling DSO provides differential TDR *(Tektronix Inc)*

An impressive collection of 100-MHz-and-above DSOs (digital storage oscilloscopes) have made their debut in the last year. Because the scopes' specifications and features are many and varied, you should familiarize yourself with the features available before you decide upon a particular DSO.

Doug Conner, *Regional Editor*

Unlike analog scopes, whose features tend to be standard regardless of the manufacturer, DSO capabilities differ from vendor to vendor. The primary performance specification for both analog and digital scopes is the analog bandwidth—the frequency at which an input suffers 3-db attenuation. Apart from the bandwidth specification, however, the capabilities of the two types of instruments diverge. You have to evaluate a DSO's capabilities in light of the waveforms you need to examine: single shot or repetitive.

500-MHz DSO that optionally can sample 2G samples/sec
(Hewlett-Packard)

The sampling rate may be unimportant

A DSO's sampling rate is only important if you intend to use the instrument in single-shot, or real-time, sampling applications. If you want to examine repetitive waveforms, a DSO's sample rate is unimportant. For this application you have a choice of either a sequential-sampling or a random repetitive-sampling DSO.

Sequential-sampling DSOs acquire a single sample after each trigger event; the DSO incrementally delays the taking of samples until it acquires a full image of the waveform. This method is compatible with bandwidths as high as 20 GHz, but it does present a drawback or two. For instance, you can't really observe pretrigger events. Some sequential-sampling DSOs provide an analog delay line in the signal path that lets you see pretrigger events, but you can't obtain more than a few nanoseconds of pretrigger display.

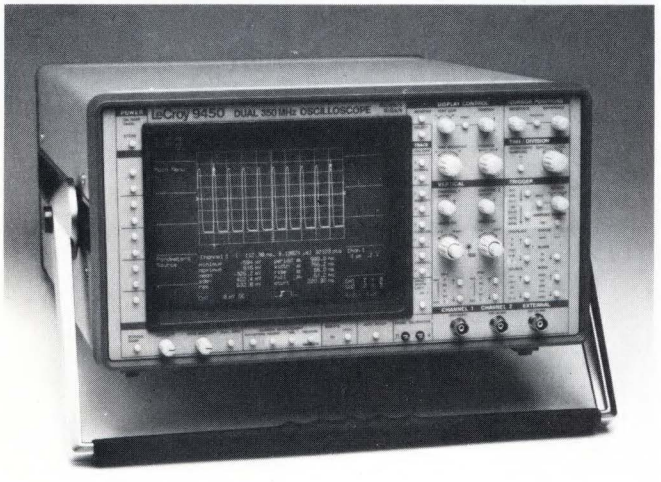
The sampling rate of a DSO is only important if you're going to be using the scope in single-shot sampling applications.

DSOs having a bandwidth of 1 GHz and above use random repetitive sampling. Typically, in a random repetitive-sampling scope an A/D converter is coupled to a shift register. The converter operates continuously, pushing new data into the shift register. If you've set the scope to acquire pretrigger data, acquisition can stop when the trigger system detects the trigger event. If you've set the scope for post- or delayed-trigger acquisition, the ADC will continue pumping values into the shift register until the specified delay time.

After each trigger event, the DSO interleaves newly acquired data with the data previously stored in memory. Because the sampling process runs asynchronously with the trigger event, after the scope has acquired and converted the data points, it must align them in time with the trigger event. This asynchronous operation means that consecutive trigger events lay down a set of acquired data points that have a random relationship to the previously acquired set; this set might fall right on top of the previous set or somewhere between the data points of the previous set. Given enough trigger events, a DSO running in a random repetitive mode will acquire enough data points to fill in a complete view of the waveform—limited only by the scope's bandwidth and resolution.

Getting the resolution you need

Ideally, you would think that a DSO and an analog oscilloscope having the same bandwidth and examining the same repetitive waveform would produce the same display. In reality, the resulting displays are somewhat different. In contrast to an analog scope, a DSO's digitizing resolution quantizes the data into discrete voltage levels. For example, if the scope has an 8-bit digitizer—a common value of many 100-MHz-and-over DSOs—it will quantize the data into 256 discrete levels.



350-MHz DSO with a 400M-sample/sec rate *(Lecroy Research Systems)*

2-GHz sequential-sampling DSO *(Philips Test and Measurement)*

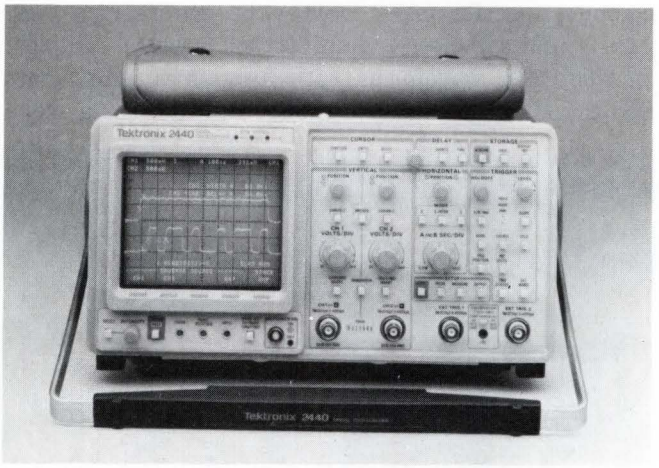
Actually, the digitizer resolution is seldom the limiting factor in a DSO's signal resolution. The DSO's sampling and conversion system will often introduce several bits of noise. The effective resolution of a DSO may be much less than the number of bits coming out of the digitizer. Unfortunately, DSO manufacturers don't always specify the effective resolution.

Averaging data points improves resolution

Many DSOs let you use averaging to remove noise and increase the effective resolution on repetitive waveforms. Repetitively sampling DSOs assume that the waveform is essentially constant from one trigger event to the next. You should be aware that, though averaging is useful for reducing noise produced within the DSO, it also reduces noise that is asynchronous with the trigger event in the circuit you are examining. For example, if you want to see how much 60-Hz power-line noise is coupling into a circuit and you are triggering on an event that is not synchronized with the power-line frequency, averaging will eliminate the noise you are looking for. Although averaging is a very useful feature, use it judiciously.

DSOs can have long re-arm dead times

When it comes to triggering, you'll find that a DSO has many of the features of an analog scope but some differences do exist. A significant one is the re-arm dead time, or the time it takes for the scope to display



300-MHz DSO with 500M-sample/sec rate *(Tektronix)*

the data and re-arm the trigger. An analog oscilloscope performs the re-arm operation quickly: After a sweep, it takes about a microsecond for it to re-arm the trigger. On a digital scope, the trigger isn't ready for the next event until the scope has finished every computation and put up the display for the last set of samples.

Typical DSO re-arm dead times range from about 10 to a few hundred msec. This figure varies so much because the re-arm dead time depends on what kind of signal processing or measurements are required for a particular scope setting. Inexplicably, most scope vendors don't specify the re-arm dead time, but it does have an effect on the user.

To familiarize yourself with a scope's re-arm dead time, you can run test cases. For example, suppose that you want to acquire and display 256 averaged waveforms. When you run a test case, you may find that you have to wait tens of seconds for the DSO to finish all the computations. If you try to change the trigger delay, you'll also see how the re-arm dead time can influence your display: Unless you change the delay slowly, a long re-arm dead time will cause the image to jump. A short re-arm dead time will make the image move smoothly, just as it would on an analog scope.

A long re-arm dead time has another undesirable effect. The DSO will trigger on only a very small fraction of the possible trigger events. If you're looking for glitches or other intermittently occurring problems, you probably won't see them unless the scope triggers on the event itself. Fortunately, some DSOs support glitch triggering (**Table 1**). Basically, this feature lets the scope trigger on a pulse that exists for less than a user-selected time span.

Sometimes your application may require more than the observation of repetitive waveforms. You may need to view single-shot waveforms—for example, if you're performing destructive testing or if you're looking for glitches that may take minutes or hours just to trigger once. When you need single-shot storage, you have to consider specifications different from those applicable to repetitive-waveform sampling.

Sampling at a sufficient rate

The most important DSO specification for single-shot storage is the sampling rate. Theoretically the Nyquist limit requires a sampling rate that is twice the rate of the highest frequency in the signal. Practical considerations dictate higher sample rates, depending on how the DSO processes and displays the data.

A DSO has essentially three ways to display single-shot data. The first is to display just the points actually acquired. This method gives you the real data but may result in visual aliasing—a situation where the points represent a waveform but are difficult to follow visually.

The second way of displaying single-shot data avoids the visual-aliasing problem by including a display capability that connects the data points in the display, interpolating linearly between points.

In any case, a sampling rate that is 10 times the maximum signal frequency is a good rule of thumb when using single-shot sampling DSOs that display only points or that perform linear interpolation. You may actually need more or less points, depending on the information you need to extract from the captured waveform.

The third way is to use waveform-reconstruction techniques to recover the sampled waveform. A DSO in the single-shot mode using these methods allows you to to capture the highest possible bandwidth signal. The scope performs interpolation between data points and the computed curves give a closer representation to the real waveform. For this technique, DSO vendors claim that sample rates anywhere from 2.5 to 4 times the highest frequency components in the signal are adequate. If you use sample rates of anything less than 4 times the signal frequency, you'll be making decisions based on sparse data.

Don't forget the record length

In addition to the sampling rate, you have to take into account the record length. Users often assume that a scope is always sampling at its maximum rate. In reality, the sample rate also depends on the time-

Sequential sampling does not let you see pretrigger events.

base setting and the record length, which is the number of data points the scope can store for a single waveform. For example, a DSO with a 50,000-word record length can maintain a 400M-sample/sec rates for timebase settings of 10 μsec/div. For a DSO with the same timebase setting but only a 1000-word record length—a common spec for many DSOs—the maximum sample rate is 10M samples/sec, or 100 nsec between samples. In this case, waveforms with frequency components above 5 MHz will suffer aliasing. In order for a scope

TABLE 1—REPRESENTATIVE DSOs (100-MHz-AND-OVER BANDWIDTH)

MANUFACTURER	MODEL	GENERAL FEATURES										SAMPLING MODES			
		BANDWIDTH (MHz)	DIGITIZING RATE (M SAMPLES/SEC)	NUMBER OF ADCs	DIGITIZER RESOLUTION (BITS)	INPUT CHANNELS	RECORD LENGTH (WORDS)	GLITCH CAPTURE (NSEC)	AUTO SETUP	ANALOG OPERATION	DUAL TIMEBASES OR WINDOWING	SINGLE-SHOT	RANDOM REPETITIVE	SEQUENTIAL	
GOULD	4072	100	400	2	8	2	1k	5	✓		✓	✓	✓		
	4074	100	400	4	8	4	1k	5	✓		✓	✓	✓		
HEWLETT-PACKARD	54100A	1000	40	2	7	2	1k		✓			✓	✓		
	54100D	1000	40	2	7	2	1k		✓			✓	✓		
	54110D	1000	40	2	7	2	1k		✓			✓	✓		
	54111D	500	1000	2	6–8	2	8k		✓			✓	✓		
	54112D	100	400	4	6	4	64k		✓			✓	✓		
	54120T	20,000		1	12	4	1k		✓					✓	
	54201A	300	200	2	6	2	1k					✓	✓		
	54201D	300	200	2	6	2	1k					✓	✓		
	54501A	100	10	2	8	4	500		✓		✓	✓	✓		
	16500	100	400	8	6	8	4k				○	✓			
HITACHI	VC-6045	100	40	2	8	2	2k			✓	✓	✓	✓		
	VC-6075	100	50	2	8	2	4k			✓	✓	✓	✓		
	VC-6175	100	100	2	8	2	4k			✓	✓	✓	✓		
	VC-6275	100	200	2	8	2	4k			✓	✓	✓	✓		
KIKUSUI	COM 7101A	100	50	1	8	4	1k			✓	✓	✓	✓		
	COM 7201A	100	50	1	8	4	1k			✓	✓	✓	✓		
LECROY	9400A	175	100	2	8	2	32k	10				✓	✓		
	9420	350	100	2	8	2	50k	2.5	✓			✓	✓		
	9450	350	400	2	8	2	50k	2.5	✓			✓	✓		
NICOLET	4094-4180	100	200	2	8	2	15,872					✓			
PANASONIC	VP5720A	100	40	1	8	2	8k			✓	✓	✓	✓		
PHILIPS	PM 3320A	200	250	2	10	2	4k	3	✓			✓	✓		
	PM 3340	2000		2	10	2	4k		✓					✓	
TEKTRONIX	2230	100	20	1	8	2	4k	100		✓		✓	✓		
	2430A	150	100	2	8	2	1k	2	✓		✓	✓	✓		
	2432A	300	250	2	8	2	1k	2	✓		✓	✓	✓		
	2440	300	500	2	8	2	1k	2	✓		✓	✓	✓		
	11201	400	20	1	9	4	10k		✓		✓	✓	✓		
	11401-11A52	500	20	1	10	8	10k		✓		✓	✓	✓		
	11402-11A71 (2)	1000	20	1	10	8	10k		✓		✓	✓	✓		
	11801-SD24 (2)	20,000		1	8	136	5k		✓		✓			✓	
	11802-SD24, SD26	20,000		1	8	136	5k		✓		✓			✓	

✓=STANDARD FEATURE ○=OPTION

with a 1000-word record length to sample at 400M samples/sec, you have to change the timebase setting to 200 nsec/div or less.

If you need high sample rates and slow sweep speeds, you'll also need long record lengths. They are extremely useful if you want to capture single-shot events that cannot be repeated easily or that are not identical from one trigger event to the next. Long record lengths bestow another benefit: high resolution when making timing measurements. When a DSO is

	TRIGGERING					DISPLAY/WAVEFORM PROCESSING											PRICE	NOTES
	PRETRIGGER	GLITCH OR PULSE WIDTH	DELAY BY TIME	DELAY BY EVENTS	LOGIC/STATE	AVERAGING	ENVELOPE DISPLAY	INFINITE PERSISTENCE	X-Y MODE	ROLL MODE	LINEAR INTERPOLATION	WAVEFORM RECONSTRUCTION	ENVELOPE TESTING	IEEE-488 INTERFACE	RS-232C INTERFACE	WEIGHT (LBS)		
	✓		✓	✓		✓			✓	✓	✓	✓	○	✓	✓	25	$8900	OPTIONAL INTERNAL COLOR PLOTTER
	✓		✓	✓		✓			✓	✓	✓	✓	○	✓	✓	25	$13,800	
	✓		✓	✓		✓		✓	✓					✓		42	$12,900	
	✓		✓	✓	✓	✓		✓	✓					✓		42	$17,600	
	✓		✓	✓	✓	✓		✓	✓					✓		59	$21,900	COLOR DISPLAY
	✓		✓	✓	✓	✓		✓	✓			✓		✓		59	$26,900	COLOR DISPLAY
	✓		✓	✓	✓	✓		✓				✓		✓		56	$22,900	COLOR DISPLAY
			✓			✓		✓	✓					✓		45	$27,850	COLOR DISPLAY
	✓		✓	✓		✓	✓				✓			✓		28	$7950	
	✓		✓	✓	✓	✓	✓				✓			✓		28	$9950	
	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		22	$3465	
	✓	✓	✓	✓	✓	✓		✓			✓			✓		48	$12,700	MODULAR LOGIC ANALYZER +DSO, PRICE INCLUDES 2 CHANNELS
	✓		✓			✓			✓	✓	✓	✓			✓	15	$3600	COMPACT; PORTABLE
	✓		✓			✓	✓		✓	✓	✓			✓		24	$8400	
	✓		✓			✓	✓		✓	✓	✓			✓		24	$9400	
	✓		✓			✓	✓		✓	✓	✓			✓		24	$10,400	100M SAMPLES/SEC; 2 CHANNELS
	✓		✓				✓	✓	✓	✓	✓	✓		✓		22	$4995	
	✓		✓				✓	✓	✓	✓	✓	✓		✓		22	$6695	200-MHz ANALOG BANDWIDTH
	✓		✓			✓	✓			✓	✓	✓		○	✓	30	$9900	PERFORMS FFTs
	✓		✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	33	$14,900	
	✓		✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	33	$18,900	
	✓		✓			✓	✓		✓			✓		✓	✓	42	$15,800	OPTIONAL DISK DRIVE
	✓		✓			✓			✓	✓	✓	✓	✓	✓		33	$6000	
	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓	○	○	39	$8900	FFTs OPTIONAL
	✓		✓			✓	✓		✓		✓		✓	✓	✓	41	$16,000	
	✓		✓			✓	✓		✓	✓	✓			○	○	18	$4995	
	✓		✓	✓		✓	✓		✓	✓		✓	✓	✓		24	$7950	
	✓		✓	✓		✓	✓		✓	✓		✓	✓	✓		24	$9500	
	✓		✓	✓		✓	✓		✓	✓		✓	✓	✓		24	$11,500	
	✓		✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	42	$11,900	
	✓		✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	44	$15,405	PRICE INCLUDES 2 CHANNELS
	✓		✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	46	$20,900	PRICE INCLUDES 2 CHANNELS
			✓			✓	✓	✓	✓					✓	✓	49	$33,500	DIFFERENTIAL TDR CAPABILITY; PRICE INCLUDES 2 CHANNELS
	✓		✓			✓	✓	✓	✓					✓	✓	53	$30,500	

A DSO operating in a random repetitive-sampling mode interleaves newly acquired data with the data previously stored in memory.

performing automatic rise- or fall-time measurements, long record lengths allow it to use a large number of samples to help determine 0% and 100% signal levels.

Some DSOs offset their lack of long record lengths by offering glitch capture in the form of peak detectors. The peak detectors capture positive and negative peaks between samples and display these at the sample points. These types of instruments indicate when activity is occurring between samples, but they suffer from poor time resolution. In effect, the peak detectors let you know that you are undersampling, but they don't let you obtain information on what is actually happening. You can't access the data unless you get better time resolution—which you can only do if you specify a faster timebase.

Regardless of the type of waveform you want to examine, almost every DSO lets you delay the acquisition of data for a certain interval after the trigger event (**Table 1**). Some let you delay by events in addition to time-specified delays. These delaying features compensate for a DSO's lack of dual timebases, which is what you would normally find on an analog scope. There are DSOs available that also have dual timebases; you can use these instruments just as you would an analog scope.

On other DSOs you'll find a similar feature called windowing, which gives you the ability to view a portion of a trace and look at a waveform on an expanded time scale. The Tektronix 11000 Series, for example, lets you use as many as seven windows so that you

Should you use an analog or digital scope?

The many differences between analog and digital scopes often make it difficult to decide which type is appropriate for your applications. When it comes to bandwidth per dollar, analog scopes have a definite advantage and probably will for years to come. Oftentimes, however, the reason you use a scope is to make measurements; because DSOs automate measurements such as rise and fall times, pulse widths, and amplitude, they can save you lots of time at the bench. Moreover, DSOs use an accurate crystal timebase for timing measurements, thereby giving you much better timing accuracy than is commonly available on an analog scope. So, even though the basic price of a DSO may be higher than an analog scope, the increased productivity you will enjoy may help offset the higher price.

Another feature inherent to a DSO is the ability to transmit waveforms to computers and printers or plotters. According to **Table 1** in the accompanying article, most DSOs include either IEEE-488 or RS-232C interfaces. These computer interfaces let you automate test sequences—uploading scope setups and downloading waveforms and measurement results. Another bonus of DSOs with computer interfaces is the ability to quickly get high-quality waveform hard copies with pertinent scope settings and measurement information.

Because DSOs let you store waveforms in memory, you can compare two waveforms easily by superimposing one on top of the other. Many scopes provide setup memories as well, so that you can quickly recall special setups you might want to use to perform measurements. If you need to power down a DSO because you need to move between projects or because you're using it in the field, you may want an instrument that has nonvolatile waveform and setup memories.

A feature common on most, but not all, DSOs is autosetup. All you have to do is connect the probes to the nodes of interest and press the autosetup button to get a triggered waveform with reasonable timebase and attenuator settings. On most scopes, autosetup works quickly and avoids timebase settings that undersample the waveform. Few analog scopes offer autosetup.

One caution: When shopping for a DSO, you should look the specs over carefully. Don't take anything for granted as you might when evaluating an analog scope. Differences in DSO features abound. For example, some DSOs have only ac coupling on the trigger, no dc coupling. Other DSOs have only dc coupling on the trigger and no ac coupling. Still other DSOs have all the triggering modes that you are accustomed to on analog scopes and some additional features as well. You have to take the time to find out.

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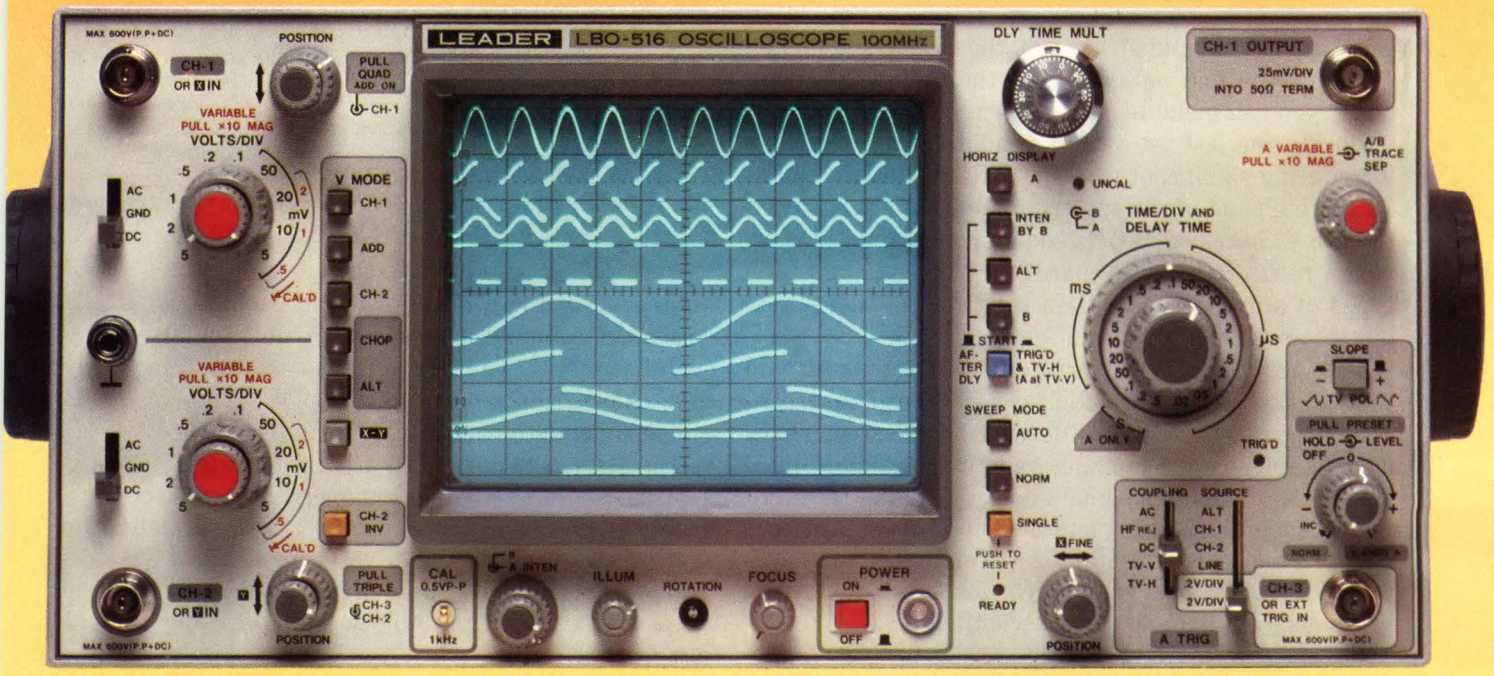

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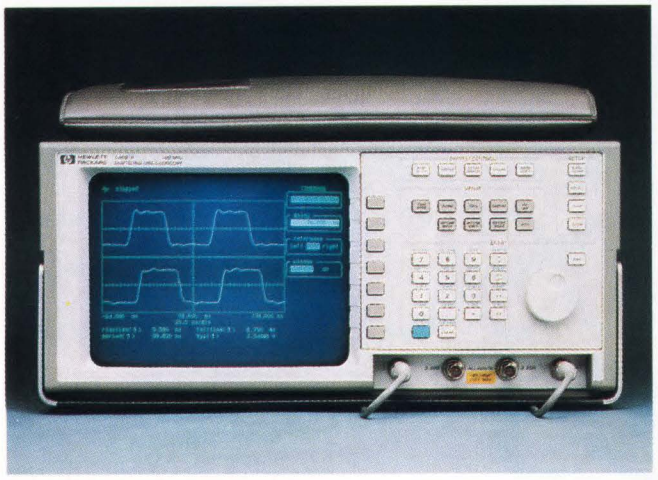
When performing repetitive sampling, you assume that the waveform is essentially constant from one trigger event to the next.



100-MHz DSO *(Hewlett-Packard)*

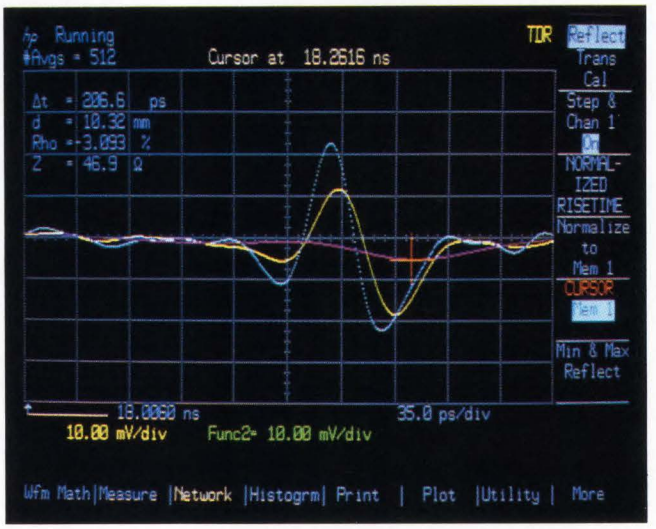


Fig 1—TDR testing capability along with a normalization feature *on the HP 54120 sequential-sampling DSO lets you look at how a transmission path will respond to different rise-time signals. This screen photo shows the TDR results of a 50Ω coaxial-cable/microstrip-launcher junction. The yellow trace shows the live 40-psec TDR response. The blue trace shows the results of a computed 25-psec rise-time pulse; the violet trace shows the computed 100-psec rise-time pulse. Automatic cursor readouts are visible in the upper left corner.*

can have an expanded view of the rising and falling edges of multiple pulses. Using these expanded windows, you can make high-resolution measurements.

During the last year, DSO vendors have been busy introducing significant new 100-MHz to 20-GHz DSOs. At the high end of the spectrum, Tektronix introduced the 11800 Series of 20-GHz sequential-sampling DSOs, which rivals Hewlett Packard's 54120. Although both types of scopes have 20-GHz bandwidths, their capabilities are actually quite different.

The 11800 Series offers true differential time-domain reflectometry (TDR) capability, a first for any oscilloscope—analog or digital. Differential transmission lines have excellent noise immunity and generate very little EMI, but to maintain signal fidelity you have to terminate them into their characteristic impedance. Any connections must also maintain the same impedance. Differential TDR allows you to measure the characteristic impedance and look for line discontinuities.

Standard single-ended TDR works fine on single-ended transmission lines, but not on differential lines. On differential transmission lines, you usually have two signal lines and a reference line—shielded twisted-pair cable, for example. Single-ended TDR leaves one of the three lines floating or connected to one of the other lines. Moreover, single-ended TDR systems cannot launch differential signals. Even unshielded twisted-pair cable exhibits a different characteristic impedance between single-ended and differential signals. If you want to perform differential TDR testing but you have a single-ended TDR system, you'll require additional equipment and a special setup (**Ref 1**).

Tektronix's 11800 Series of scopes also permits you to expand to 136 channels without compromising performance: All multiplexing is done after the high bandwidth sampling. The scopes perform autosetup quickly and acquire and display data rapidly. They also continuously update measurements and statistics.

The HP 54120 does not have differential TDR capability and offers only four channels, but it does offer a powerful normalization capability. The normalization feature complements the scope's single-ended TDR capability and lets you see how a transmission line will respond to the edge rate you will be using in your circuit (**Fig 1**).

Both the 54120 and 11800 scopes can display the "eye patterns" associated with communications work, but only the 54120 has the color display to provide histograms that show the data distribution in the eye pattern. The 11800 requires you to transfer the data to a computer to get the equivalent information.

Philips' newest sequential-sampling DSO is the PM3340. With a 2-GHz bandwidth, the PM3340 obviously can't compare with the 20-GHz bandwidth of the two scopes above. Nevertheless, at $16,000 it is considerably less expensive than the $28,000 to $31,000 you'd expect to pay, and it has at least twice the bandwidth of any other DSO available. In addition, the PM3340

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with unique "Preview" feature in new Kepco 100-Watt Bench-type Linear Power Supplies

Preset voltage and current for your circuit and systems prototyping and testing, using Kepco's unique "Preview Switch" feature. Model MSK *d-c off selection* allows you to pre-set voltage and current with the digital meters displaying the set values. No voltage is applied to the output terminals and no load current needs to be drawn to set the current control. The *d-c on selection* applies the set voltage to the output terminals. The appropriate mode indicator illuminates and the meters indicate actual voltage and current.

MSK MODEL TABLE	d-c OUTPUT RANGE		POWER
	Volts	Amps	Watts
MSK 10-10M	0-10	0-10	0-100
MSK 20-5M	0-20	0-5	0-100
MSK 40-2.5M	0-40	0-2.5	0-100
MSK 125-1M	0-125	0-1	0-125

Price: $595., each model.

The compact unit (only 5-3/4" x 8-1/8" x 13-5/32") includes two front-panel, 10-turn precision controls for setting voltage and current, two 3½ digit LCD displays, an LED mode indicator and a quiet, efficient fan. Its fully-dissipative series-pass stabilizer circuit assures low noise, high stability and accurate resettability.

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KEPCO
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Although the Nyquist limit gives an upper theoretical sampling limit, practical considerations dictate a higher sampling rate.

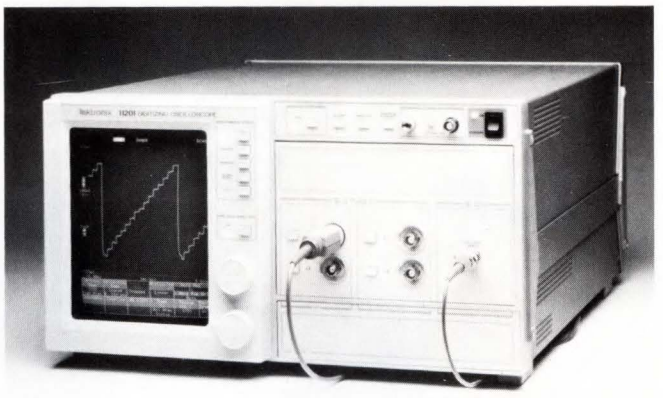
offers eye patterns with amplitude-probability histograms and many other measurement features you'd want in a lab DSO.

DSOs for high-speed digitizing

If you're interested in achieving the fastest single-shot real-time performance possible, you should consider the HP 54111D. This scope boosts its 1G-sample/sec digitizing rate to 2G samples/sec by working in tandem with the 54114A test set. The $1625 test set demultiplexes the single input channel into two digitizing channels. With this accessory, you only have one acquisition channel, but in return you get data samples separated by 500 psec on signal bandwidths to 500 MHz.

Tektronix's 2440 is another recent offering with a high sample rate. This 24-lb portable scope has a 300-MHz bandwidth and a 500M-sample/sec sample rate. Although portable, the unit (like other members of the 2400 family) can make 21 automated waveform measurements, giving it much of the capability usually found in lab instruments.

Lecroy's 9450 DSO offers high-performance features for both repetitive and single-shot applications. Its 350-MHz bandwidth provides good capability on repetitive signals, and its 400M-sample/sec digitizing rate coupled with a generous 50,000-word record length means that you can capture long waveforms with excellent timing resolution. The 9450 also lets you divide up the 50,000-word record length to use it for acquiring multiple events; the DSO time-stamps each record. To help you capture a single glitch in single-shot mode, the instrument offers glitch triggering.



***400-MHz DSO** (Tektronix Inc)*

In October, Tektronix added the 11201 to its 11000 Series of laboratory oscilloscopes. At $11,900, the 11201 is the lowest priced lab DSO available today. The 4-channel scope provides a 400-MHz bandwidth, nine bits of vertical resolution, and a 10,000-word record length. Although you can't change plug-ins for operations like differential probing, you do get all the same display and measurement features available on the 11400 Series.

In mid-year, HP introduced the $3465 54501, a 100-

For more information . . .

For more information on the DSOs discussed in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Gould Inc
3631 Perkins Ave
Cleveland, OH 44114
(216) 361-3315
FAX 216-811-4256
Circle No 427

Hewlett-Packard
Box 10301
Palo Alto, CA 94303
Phone local office
Circle No 428

Hitachi Denshi America Ltd
175 Crossways Park W
Woodbury, NY 11797
(516) 921-7200
FAX 516-496-3718
Circle No 429

Kikusui International Corp
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Torrance, CA 90503
(213) 371-4662
FAX 213-542-4943
Circle No 430

Lecroy Research Systems
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Chestnut Ridge, NY 10977
(914) 578-6097
FAX 914-425-8967
Circle No 431

Nicolet Test Instruments Div
5225 Verona Rd
Madison, WI 53711
(608) 273-5008
Circle No 432

Panasonic Industrial Co
2 Panasonic Way
Secaucus, NJ 07094
(201) 392-4050
Circle No 433

Philips Test and Measurement
Building HKF
5600 MD Eindhoven, The Netherlands
Phone local office
Circle No 434

In North America:
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Box C9090
Everett, WA 98206
(800) 443-5853
Circle No 435

Tektronix Inc
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Beaverton, OR 97075
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THE INSTRUMENTS:

The DATA 6100 permits complex signal analysis with or without computers. You get simple one-key access to 50+ processing functions, settling time to within 0.01% of final value in less than 10 ns, rise times as fast as 350 ps and resolution to 16 bits at 100 GHz effective sampling rate. **The MODEL 2020** generates waveforms in real time, lets you add noise, glitches, simulate phase shifts or degraded rise times with front panel entry, and features a 512K output memory.

THE SUB SOLUTION:

With the 650-1 Plug-In Digitizer's true 16-bit/1 MHz resolution, the DATA 6100 can determine "Who goes there?" in the undersea environment, easily differentiating seemingly identical screw and engine noises. With more than 50 resident functions and 32,000 data point storage, analysis and retrieval of key sensor data are greatly simplified.

THE BIOMEDICAL SOLUTION:

Studies of the effect of psychotropic drugs on brain electrical activity may lead to greater understanding of the etiology of mental disorders. The DATA 6100 acquires signals from 0.5 to 100 mV with durations of fractions of a millisecond in this advanced research program. In other applications, the Model 2020's direct entry, real-time waveform generation and modification enhances analysis.

THE VIBRATION SOLUTION:

The DATA 6100's extensive frequency and time-domain capabilities excel in industrial vibration analysis, such as the automatic testing of transmissions, alternators, and fuel pumps. For example, 6 FFT input types and 18 result options speed electric fuel pump fault detection through signature analysis.

THE DISK DRIVE SOLUTION:

Disk drive performance parameters such as position error signal (PES) symmetry and seek-time errors can be rapidly and cost-effectively tested with the DATA 6100 and the 620-1 plug-in. Testing PES resonance and PES spike is equally fast and efficient. The 6100's programmability and powerful algorithms provide single-key results.

Sub photo/General Dynamics

CIRCLE NO 83

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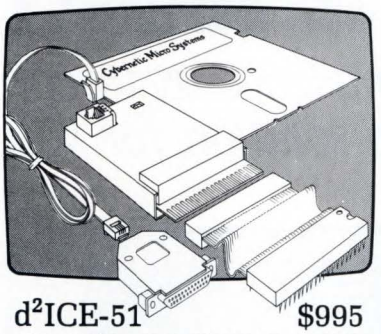
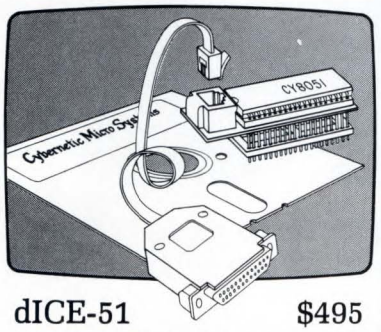
Low Cost 8051 Tools



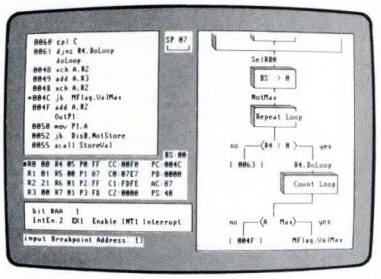
d²ICE-51 **$995**

This Real-Time ICE is the lowest cost and smallest sized full speed 8051 in-circuit emulator. Full access to hardware I/O. Includes all debugging features of Sim and dICE below. Fits in shirt pocket.



dICE-51 **$495**

This reduced-speed in-circuit 8051 debugger provides full access to I/O but will not run real-time. With the same user interface features as Sim8051 below, dICE-51 generates execution profiles during reduced speed execution. (CMOS and MIL also available.)



Sim8051 **$395**

This software Simulator/debugger allows 'no-circuit', debugging of 8051 code on IBM-PCs. All Cybernetics 8051 debug tools offer multi-window source code displays, symbolic access to data, single key commands, breakpoints, trace, full speed and single step execution, execution profiler, and more.

Other 8051 tools include:

Cross Assembler	$195
8751 Programmer	$195-$345
Debugger Demo Disk	$ 39

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CIRCLE NO 14

MHz DSO, which includes many high-performance features that HP calls Advanced Logic Triggering. The DSO has positive- or negative-edge triggering on any of its four input channels. In addition, you can use pattern triggering by designating the required high, low, or don't-care state for each of the four channels. Time-qualified pattern triggering lets you trigger on the first edge to exit from a pattern if the pattern is present for greater or lesser than a specified time, or if it is within a window (which you designate). You can adjust the qualification time from 20 nsec to 160 msec. The 54501's time-qualified pattern triggering lets you trigger glitches that are present for at least 7 nsec. A state-triggering mode uses three channels to qualify a pattern and the fourth channel as a clock input, which triggers when the desired pattern appears.

In addition, you can combine all of these trigger modes with delay-by-time or delay-by-event capability to achieve outstanding trigger flexibility. The 54501 also performs 16 automatic pulse-parameter measurements.

Judging by the above descriptions of some of the DSOs introduced in the past 12 months, you shouldn't have any trouble finding a DSO with a performance level to satisfy just about any application you may have in mind. Moreover, the stream of new high-performance DSOs shows no signs of letting up, so you can expect to see competitive prices and continuing increases in performance. EDN

Reference

1. Theorin, Craig, and Herb Van Duesen, "Differential TDR Testing Techniques," *20th Annual Connector Symposium Proceedings*, October, 1987.

Article Interest Quotient (Circle One)
High 488 Medium 489 Low 490

WORK WITH THE BEST

To be the best UNIVERSAL PROGRAMMER, you've got to set some pretty high standards.

Stag's Systems 3000 gives you standard features found in no other Universal Programmer.

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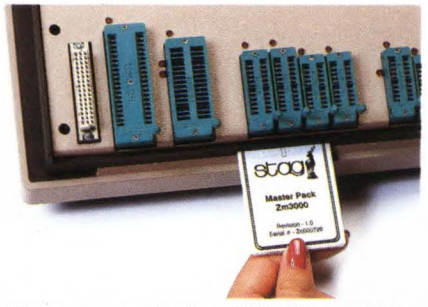
The System 3000 is designed to program PROMS, PLD's and Microcomputers in every known technology. The technology includes NMOS, CMOS, ECL, Fuse Link, AIM, DEAP and Isoplanar-Z. Surface mount devices can be programmed on an optional SMD chip-station.



Users can easily install the innovative 'Smart' Card to update new Device Support Libraries in seconds.

Built-In CRT

The System 3000 incorporates its own CRT display and keyboard allowing it to be used as a powerful stand-alone programmer. On-screen menus and prompts allow device selection and all system operation functions to be easily executed.
The System 3000 also gives you full-screen editing of both memory and logic data including test vectors. Light pen operation and custom Z-packs for life cycle testing and other specialized functions set the System 3000 apart from any other Universal Programmer.

Interface Flexibility

Four separate user interface ports, including two RS232C's, an IEEE 488 and a Handler Port, give the System 3000 unrivaled flexibility for communicating with peripheral equipment.

CIRCLE NO 54

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1600 Wyatt Drive, Santa Clara, CA 95054
Tel: (408) 988-1118 FAX#: (408) 988-1232

Stag Microsystems Inc.
3 Northern Boulevard, Amherst, NH 03031
Tel: (603) 673-4380 FAX#: (603) 673-1915

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All stand-alone functions are operational under remote control using either a mainframe or a personal computer.

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A unique feature of the System 3000 is that all device libraries and programming algorithms are contained on a Memory Card that can be changed instantly by the user as new devices become available. Data access is considerably faster than floppy disk-based systems.

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Semiconductor manufacturers' approval of our programming algorithms assures the user of the highest yield and device reliability.
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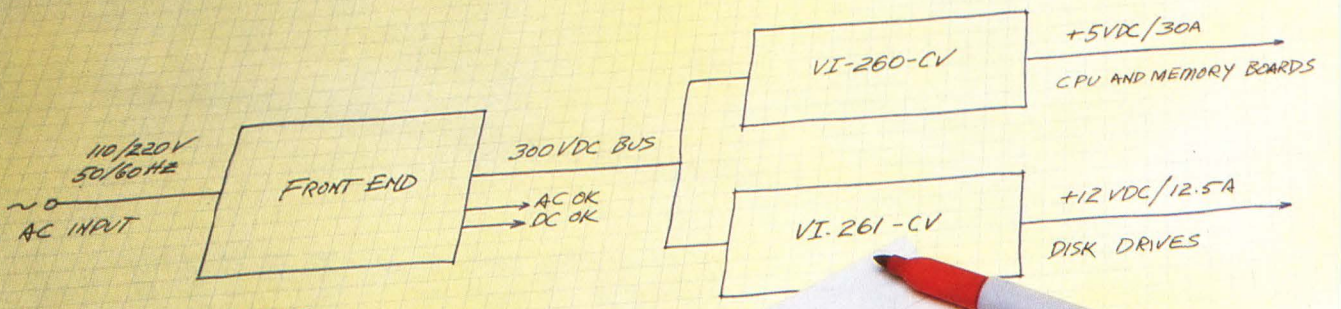

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DESIGN REVIEW TOMORROW 8:00AM

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- Size: 2.4" x 4.6" x 0.5"
- Remote Sense
- Thermal Shutdown
- Current Limit and OVP
- Compatible Power Boosters
- MTBF >700,000 hours

Product Highlights:

The VI-200 Series is Vicor's second generation family of "zero-current-switching" component-level, DC-DC converters. Operating at frequencies up to 2 MHz, VI-200 Series converters redefine the state-of-the-art in terms of power density, efficiency, noise performance, reliability and ease-of-use. Family features include: advanced output programmability, wide sense, wide input voltage ranges, current limiting, output OVP, logic control, thermal shutdown and low quiescent current. Agency approved, and rugged shock and

Driver Selection Chart

NOMINAL LINE (VDC)	BROWN OUT (VDC)	INPUT VOLTAGE LOW LINE (VDC)	INPUT VOLTAGE HIGH LINE (VDC)	TRANSIENT VOLTAGE* (VDC)	OUTPUT VOLTAGE 5V	12V	15V	24V	48V	OUTPUT POWER (W)
300	170	200	400	425	-	VI-261-CU	VI-262-CU	VI-263-CU	VI-264-CU	200
					VI-260-CW	VI-261-CW	VI-262-CW	VI-263-CW	VI-264-CW	150
					VI-260-CY	VI-261-CY	VI-262-CY	VI-263-CY	VI-264-CY	100
					-	VI-251-CU	VI-252-CU	VI-253-CU	VI-254-CU	75
					VI-250-CW	VI-251-CW	VI-252-CW	VI-253-CW	VI-254-CW	50
					VI-250-CY	VI-251-CY	VI-252-CY	VI-253-CY	VI-254-CY	200
150	85	100	200	215	-	VI-241-CU	VI-242-CU	VI-243-CU	VI-244-CU	150
					VI-240-CW	VI-241-CW	VI-242-CW	VI-243-CW	VI-244-CW	100
					VI-240-CY	VI-241-CY	VI-242-CY	VI-243-CY	VI-244-CY	75
					-	VI-231-CU	VI-232-CU	VI-233-CU	VI-234-CU	50
72	45	55	100	110	VI-230-CW	VI-231-CW	VI-232-CW	VI-233-CW	VI-234-CW	200
					VI-230-CY	VI-231-CY	VI-232-CY	VI-233-CY	VI-234-CY	150
					-	VI-221-CU	VI-222-CU	VI-223-CU	VI-224-CU	100
48	36	42	60	72	VI-220-CW	VI-221-CW	VI-222-CW	VI-223-CW	VI-224-CW	75
					VI-220-CY	VI-221-CY	VI-222-CY	VI-223-CY	VI-224-CY	50
					-	VI-211-CU	VI-212-CU	VI-213-CU	VI-214-CU	150
28	18	21	56	60	VI-210-CW	VI-211-CW	VI-212-CW	VI-213-CW	VI-214-CW	100
					VI-210-CY	VI-211-CY	VI-212-CY	VI-213-CY	VI-214-CY	75
					-	VI-201-CU	VI-202-CU	VI-203-CU	VI-204-CU	50
24	18	21	32	36	VI-200-CW	VI-201-CW	VI-202-CW	VI-203-CW	VI-204-CW	
					VI-200-CY	VI-201-CY	VI-202-CY	VI-203-CY	VI-204-CY	
	10	20		22						

Shaded modules available as boosters. Change VI-2XX-XX to VI-BXX-XX

Booster Selection Chart

OUTPUT VOLTAGE	OUTPUT POWER (W)
5V	200
12V	150
15V	100
24V	75
48V	50

Converter/Booster Specifications (At T_{BP} = 25°C, nominal line, nominal load (75%), unless otherwise specifie

PARAMETER	MIN	TYP	MAX	UNITS	TEST
INPUT CHARACTERISTICS					
In Rush Charge		60×10^{-6}	100×10^{-6}	I^2t	
Input Reflected Ripple Current - pp		10%		dB	
Input Ripple Rejection		$20 \times 20 \log \left(\frac{V_{in}}{V_{out}}\right)$		dB	
		$20 \times 20 \log \left(\frac{V_{in}}{V_{out}}\right)$		Watts	
		2		mA	
Input Ripple Rejection		1.35	9	%/1K hrs	
		6			
		0.02			
No Load Power Dissipation			1%		
Input Current Logic Disable			0.2%		
Long Term Drift		0.5%	0.2%		
		0.05%	0.02		
		0.05%	3%		
OUTPUT CHARACTERISTICS		0.01			
Set Point Accuracy		1%			
Load Regulation			0%		
Line Regulation			2%		
Output Temperature Drift					
Peak to Peak Output Ripple	110%	1%	135%		
High Trim/Program			125%		
Low Trim/Program	0.5	125%	130%		
Programming Accuracy	115%				
Total Remote Sense Compensation	105%				
OVP Set Point	20%				
Current Limit					
Short Circuit Current		10^{-2}			
		10^{-2}			
		10^{-4}			
		10^{-4}			
DYNAMIC CHARACTERISTICS					
Turn On Time from Power On					
Turn On Time from Logic Enable					
Line Transient Response		50			
Load Transient Response		100			
BOOSTER CHARACTERISTICS					
Gate Out Impedance					
Gate In Impedance	1				
Gate In High Threshold					
Gate In Low Threshold	0.95				
Current Sharing Accuracy	0.95				
Voltage Sharing Accuracy					
ISOLATION CHARACTERISTICS					
Isolation Voltage (Input to Output)	3,750				
Isolation Voltage (Output to Baseplate)	500		50		
Isolation Voltage (Input to Baseplate)	2,500				
			85%		

OFF-LINE Modular Power From 50 to 600 Watts!

*From AC line in, to highly regulated DC out, **VICOR** now offers the **total design solution through a complete family of Off-Line Front End and DC/DC modular power components.***

The system configuration changes...The power budget changes...What do you do about the power supply? If you are designing with modular power components, configuring the most effective power system is as straight forward as changing the mix of components used. **Configurable Power**...the most efficient and cost effective means to maintain flexibility and minimize time to market.

Off-Line Front Ends

The Front Ends are available in output power ratings of 250, 500, and 750 Watts and are designed to deliver an unregulated 300 Volt DC bus to Vicor's VI-26X Series of DC/DC converter modules.

FRONT END SELECTION CHART

MODEL	PACKAGE: PC MOUNT	PACKAGE: CHASSIS MOUNT	OUTPUT POWER: 250W	OUTPUT POWER: 500W	OUTPUT POWER: 750W
VI-FPE6-CUX	✓		✓		
VI-FKE6-CUX		✓	✓		
VI-FPE6-CQX	✓			✓	
VI-FKE6-CQX		✓		✓	
VI-FPE6-CMX	✓				✓
VI-FKE6-CMX		✓			✓

OPERATING PARAMETERS (ALL MODELS)			
	INPUT VOLTAGE (VAC)		
NOM	LOW	HIGH	TRANSIENT (1 SEC)
110	90	135	150
220	180	270	300

Strappable to provide operation from 90 VAC to 270 VAC single phase lines, the Front Ends feature conducted EMI/RFI filtering to VDE/FCC A & B, 50 msec holdup, active inrush limiting and a BUS-OK status output. An opto-isolated AC-OK output is provided for advance warning of DC BUS dropout due to AC line failure.

DC/DC Converters

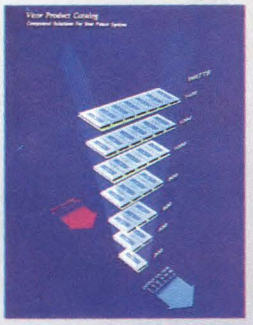
The VI-26X Series is Vicor's family of 300 Volt input, "zero-current-switching," component-level, agency approved, DC/DC converters. These converters represent the state-of-the-art in terms of power density, efficiency, noise performance, reliability and ease-of-use. Available in 38 standard combinations of power rating and output voltage, the VI-26X Series modules in combination with the Front Ends, offer unprecedented flexibility in providing off-the-shelf solutions to virtually any off-line power requirements.

CONVERTER/BOOSTER SELECTION CHART

Shaded modules available as boosters. Change VI-2XX-XX to VI-BXX-XX.

OUTPUT VOLTAGE* 5V	12V	15V	24V	48V	OUTPUT POWER (W)
—	VI-261-CU	VI-262-CU	VI-263-CU	VI-264-CU	200
VI-260-CV	VI-261-CV	VI-262-CV	VI-263-CV	VI-264-CV	150
VI-260-CW	VI-261-CW	VI-262-CW	VI-263-CW	VI-264-CW	100
VI-260-CX	VI-261-CX	VI-262-CX	VI-263-CX	VI-264-CX	75
VI-260-CY	VI-261-CY	VI-262-CY	VI-263-CY	VI-264-CY	50

*Other output voltages from 2 to 100 Volts are available as semi-custom modules. Consult factory or see page 30 of the Vicor Product Catalog.



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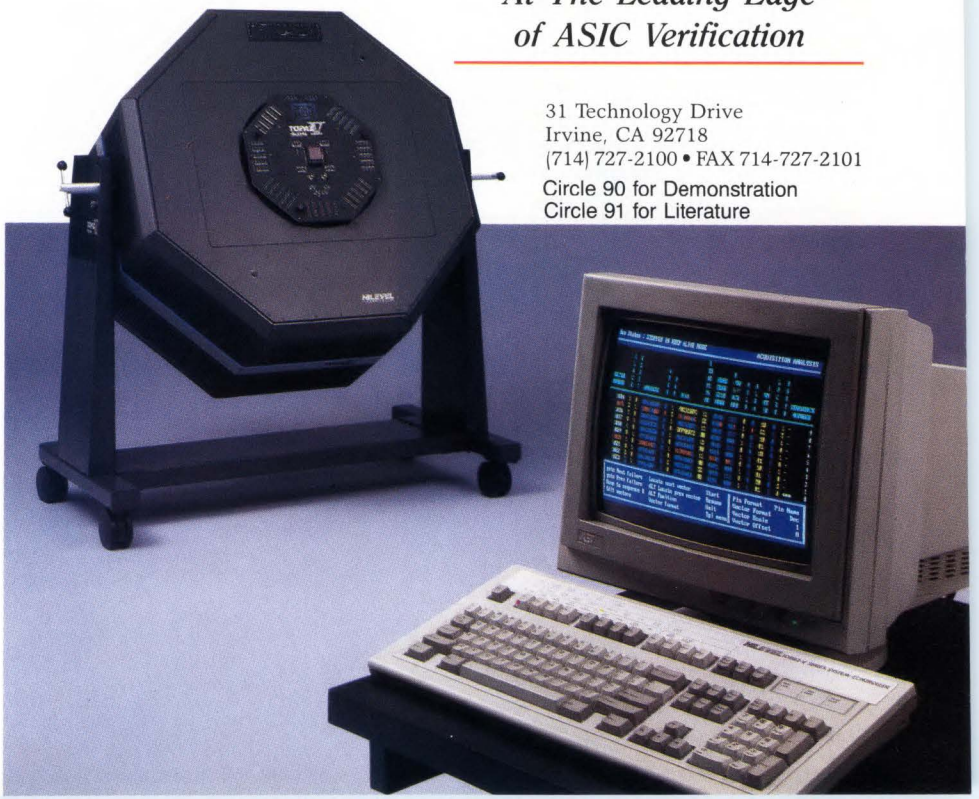
Circle 90 for Demonstration
Circle 91 for Literature



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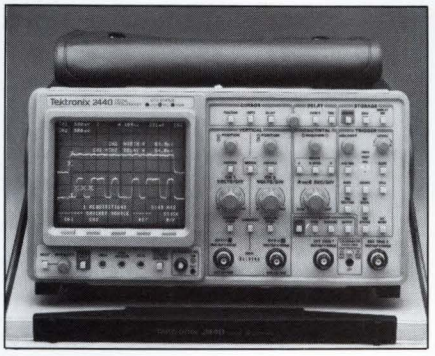
Digital scope simultaneously captures data from two sources at 500M samples/sec

The Tektronix Model 2440 digital-storage oscilloscope looks and acts much like a familiar analog instrument, yet it has many more features and operating conveniences. It offers a high sampling rate—500M samples/sec. The 2440 is similar in style to its predecessor, the 2430A, but it has a 300-MHz vertical bandwidth—twice that of the 2430A—and its greatest sweep speed (2 nsec/div in equivalent-time-sampling mode) is 2.5 times faster than the 2430A (equivalent-time sampling allows the storage of repetitive events that occur faster than the maximum digital oscilloscope sampling frequency).



The 2440 retains many of the features of the 2430A: simultaneous sampling of two inputs, 8-bit resolution, 2-mV/div max sensitivity (200 μV/div in average mode), and 1024-point record length. Its 6.3×13×18.9-in. size and the 24-lb weight are also identical to the 2430A.

Added conveniences include an automatic setup and an automatic measurement, which, among other things, can display 20 numerical parameters of a captured waveform. Using its automatic pass/fail test, you can define a waveform envelope, and then automatically monitor the scope's operation.

The scope's dual timebases give you access to a variety of display modes. You can also provide your own sampling clock with any frequency from 1 to 100 MHz. Further, it has a glitch-capture feature. Among the unit's interfacing features is an IEEE-488 port for printers and plotters. $11,500.

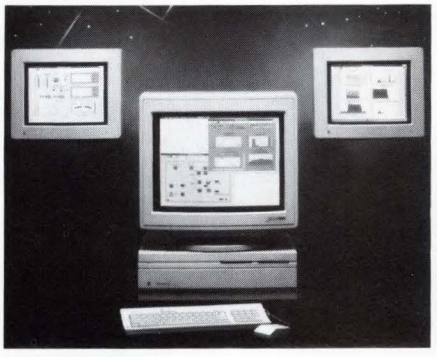
Tektronix Inc, Box 1700, Beaverton, OR 97075. Phone (800) 426-2200.

Circle No 437

LabView upgrade reduces execution time and adds graphics controls

LabView version 2.0, an upgrade of version 1.2, has a compiler that significantly reduces the execution time, provides editing capabilities like rubberbanding, and offers graphics controls such as panning and zooming.

This color, icon-based programming system simplifies engineering and scientific programming on Apple Macintosh computers by permitting you to design software-generated virtual instruments. You produce these instruments by drawing block diagrams that represent test and measurement functions, and then control the instruments via pictorial renditions of the types of switches, dials, and levers you might actually find on 3-D versions of such equipment.

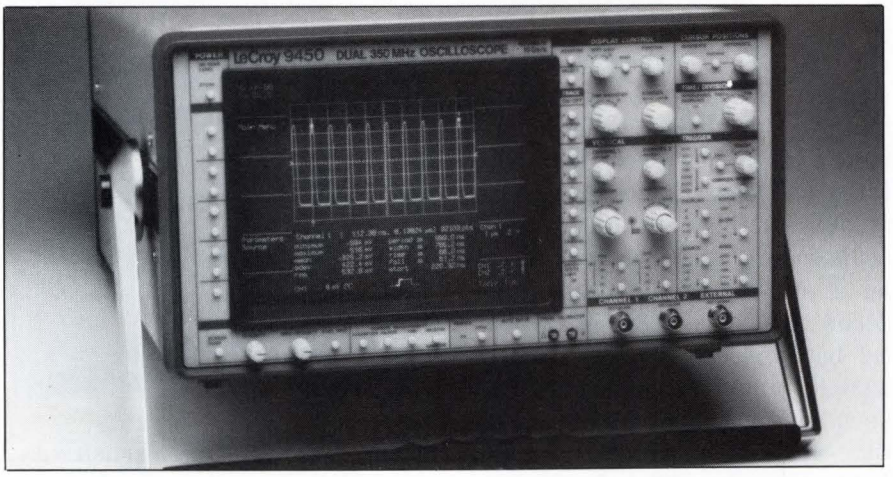


To reduce memory requirements and to further increase execution speed, LabView 2.0 adds multiple integer and floating-point data formats to the previous version's extended-precision floating-point data type. LabView 2.0 can run all the applications you've developed under version 1.2, and is available to owners of version 1.2 at no cost. Otherwise, you can buy version 2.0 for $1995. The company also plans to distribute libraries of LabView via the MacNet electronic bulletin board and on fourteeen 3½-in. disks. The disks cost $50 each; access charges for MacNet vary from $4 to $8 per hour.

National Instruments, 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (512) 250-9119. TLX 756737.

Circle No 438

400M-samples/sec digital scope stores 50k-word records



Using flash ADCs, the LeCroy 9450 digital oscilloscope can sample 2 channels simultaneously to 8-bit precision at 400M samples/sec, and it can do so with its sweep speed set anywhere from 1 nsec to more than 10 μsec/div. It owes this unusual ability to 2 acquisition memories that, with 50k words of battery-backed RAM for each of the scope's two channels, are approximately 50 times deeper than those of most competitive scopes. Each RAM can store a single waveform record, or you can partition it to store as many as 200 records.

A key feature of this scope is its flexible triggering: It can delay starting a sweep for a user-specified interval following a trigger condition, and it can also delay the sweep until it has registered a specified number of trigger events—the number of events can be as large as one billion. It features glitch-capture and pattern-triggering modes as well. The scope's controls mimic those of an analog scope, and its display helps you to avoid perceptual confusion because it draws lines between sampled data points and highlights them. The 9450 includes RS-232C and IEEE-488 ports, and you can power it from 110 to 220V ac from 48 to 440 Hz. $18,900.

LeCroy Corp, 700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977. Phone (914) 425-2000. TWX 710-577-2832.

Circle No 439

ASIC-verification system produces 200-MHz patterns

The HP 82000 ASIC verification system is designed both for the custom-IC design environment and for the test-development environment. The system uses a 68030-based HP 9000 Series 360 computer with 8M to 32M bytes of main RAM, a hard disk with at least a 120M-byte capacity, and a cartridge-tape backup unit. It runs under HP-UX (the vendor's real-time extension of the Unix operating system) and the XWindows graphics manager.

The desktop configuration of the verifier can accommodate 80 channels, and you can expand the test hardware to drive and sense 384 channels. Each channel can both drive and sense signals at 200 MHz, without sacrificing channel capacity. The total edge-placement error is 250 psec. The true tester-per-pin architecture eliminates fixture wiring for devices in many dual-in-line and pin-grid packages and allows you to reconfigure channels individually. The system can generate patterns in four formats: return to 1, return to zero, return to complement, and delayed nonreturn to zero.

To cut test-development time, the system software provides an automatic test generator and linkage to CAE programs. HP 82000 pricing begins at $65,000, and a 64-channel system costs $193,000. Delivery is scheduled for the first quarter of next year.

Hewlett-Packard Co, 19310 Pruneridge Ave, Cupertino, CA 95014. Phone local office.

Circle No 440

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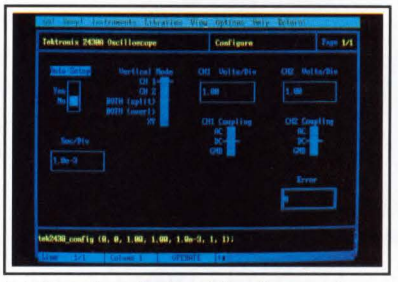
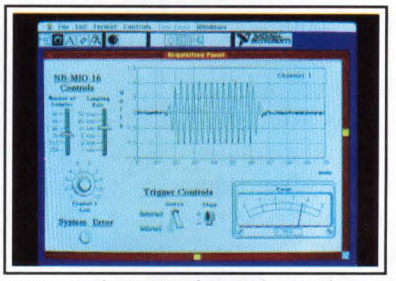
Acquisition

Integrated libraries for GPIB, RS-232, A/D-D/A-DIO plug-in cards, and modular instruments.



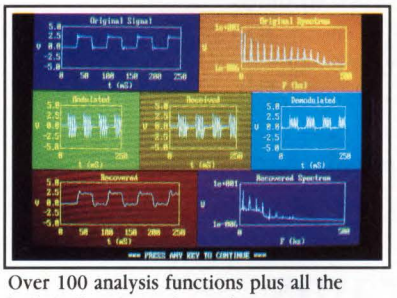
Intuitive character-based function panels that automatically generate source code.



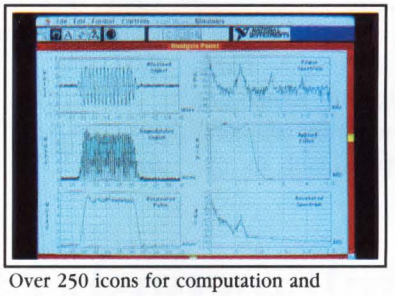
Front panel user interface with virtual instrument block diagram programming.

Analysis

Extensive libraries for data reduction, digital signal processing, and statistical analysis.



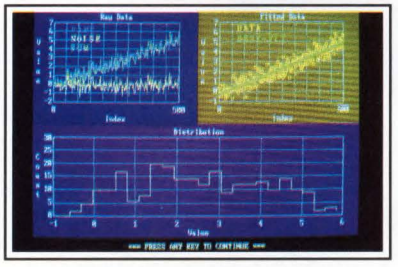
Over 100 analysis functions plus all the built-in functions of your language.



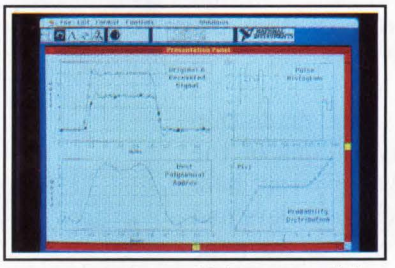
Over 250 icons for computation and analysis.

Presentation

Flexible high-performance graphics and report generation.



Extensive graphics support for CGA, EGA, MCGA, VGA, and Hercules.



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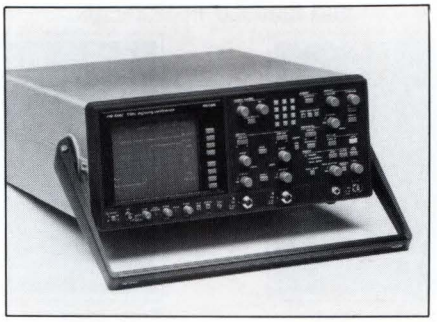
Sequential-sampling digital scope has 2-GHz bandwidth

The PM 3340 2-channel digital oscilloscope uses sequential sampling to essentially achieve a 2-GHz repetitive-signal bandwidth. According to the manufacturer, sequential sampling does not result in a longer waveform reconstruction time than that of other data-capture techniques, and its use allows for products with a superior price/performance ratio. The PM 3340 delivers a 2-GHz signal bandwidth, 2-GHz trigger bandwidth, 20-psec/div sweep speed, and 1-mV/div sensitivity. Furthermore, it digitizes with 10-bit resolution.



Insofar as possible, the scope's controls work as their counterparts on analog scopes do, but there are also many of the conveniences common to digital scopes, such as on-screen menus, and function selection via a row of soft keys to the right of the screen. Nonvolatile memory can store 250 control settings. For automated-test applications, the unit includes both RS-232C and IEEE-488 interfaces.

The scope also offers many signal-processing capabilities: signal averaging, FFT and amplitude histogram determination, four memory registers for waveform comparisons, and an eye-pattern display mode. Moreover, it can calculate some arithmetic problems. Prices start at $16,000. Delivery is six weeks ARO.

John Fluke Mfg Co Inc, Box C9090, Everett, WA 98206. Phone (800) 443-5853.

Circle No 441

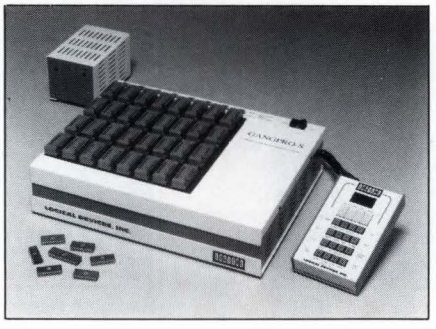
Philips Test and Measurement, Bldg HKF, 5600 MD Eindhoven, The Netherlands. Phone local office.

Circle No 748

Unit simultaneously programs bipolar and MOS PLDs

The Gangpro SP can gang-program both MOS and bipolar PLDs in 20- and 24-pin DIPs. What's more, you can upgrade it to handle EPROMs (32 at a time) and some single-chip μPs. Special configurations of the programmer are available that handle plastic leaded chip carriers and pin-grid packages with as many as 68 pins. The SP can do PLD set programming—that is, it can write different data into each of the individual ICs plugged into it, and it can actually program device sets composed of several types of ICs.

The unit is a stand-alone programmer with 512k bits of program RAM, expandable to 4M bits. You can operate the programmer with a small handheld keypad included in the base price (or you can connect an ASCII terminal to the RS-232C port). Battery backup for the RAM is optional. You use an IBM PC to update the library of programming algorithms stored in EEPROMs inside the unit; the vendor distributes library updates on PC-formatted disks.



The programmer can store the times at which you modify the RAM contents; a label-printing program running on a PC can then print out labels indicating the program version residing in the IC. The Gangpro-SP8 (with eight 20- and 24-pin PLD programming stations) sells for $7995. The EPROM-μP upgrade costs $600/station.

Logical Devices Inc, 1201 NW 65th Pl, Fort Lauderdale, FL 33309. Phone (800) 331-7766; in FL, (305) 974-0975. TLX 383142.

Circle No 749

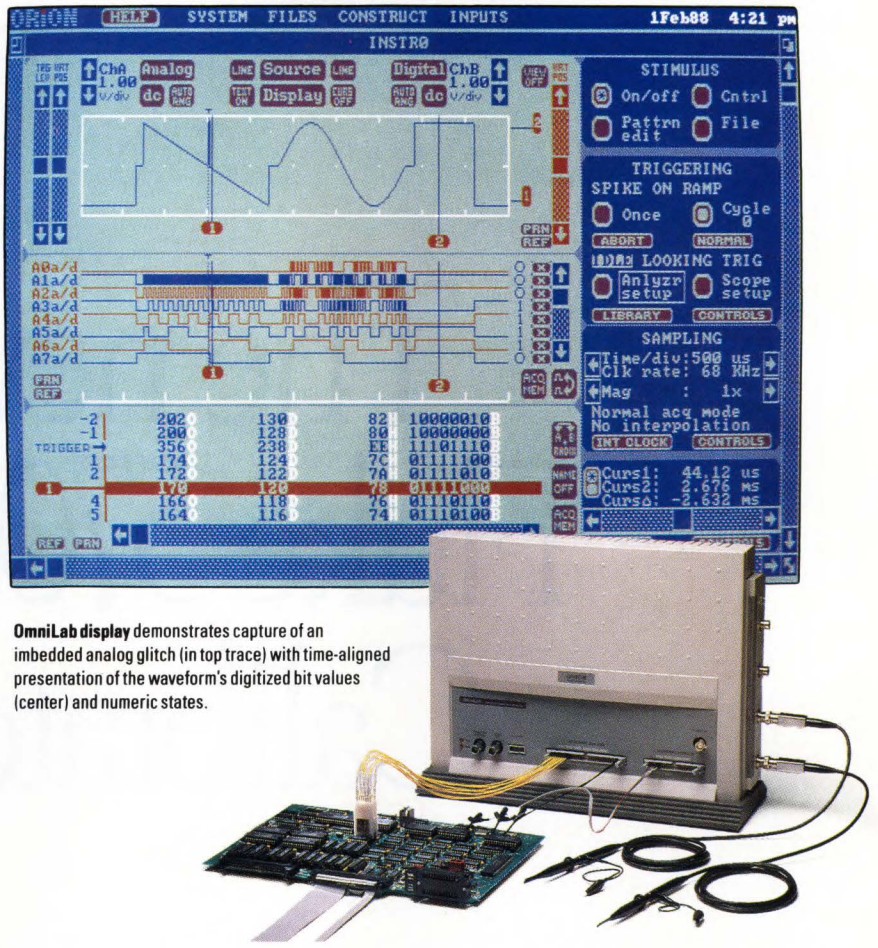
Introducing OmniLab 9240. Totally Integrated Scope-Analyzer-Stimulus.

■ Combine a 100 MHz digital oscilloscope with a time-aligned, 200 MS/s 48-channel logic analyzer. Next add synchronized analog **and** digital stimulus generators. Then a remarkable new triggering system. What you have is the 9240 — a whole **new class** of instrumentation. Expressly designed to speed challenging analog and digital analysis. And get you from concept to product faster.

■ The 9240 is based on an innovative new instrument architecture that merges high-speed universal hardware and seamlessly-integrated software to create high-performance capabilities not available in separate instruments. Analog and digital traces are always time-correlated in a unique, single screen display. SELECT™ triggering bridges scope and analyzer techniques. And OmniLab's stimulus generators can playback captured or edited signals.

■ At the heart of the 9240 is SELECT triggering, the most straightforward and complete solution **ever** to triggering dilemmas. It's one system, operating with synchronized analog and digital views of your data. By combining conventional oscilloscope and analyzer triggering with powerful RAM truth tables — plus min/max time qualification as needed — SELECT triggering helps you analyze hardware, debug software, and integrate systems more easily.

■ OmniLab™ is a generation ahead of conventional digital scopes that often hide rarely occurring faults because they only show you a few cycles out of millions. With its continuous monitoring, you can use SELECT triggering to quickly catch every occurrence of rare events like metastable states, bus contentions, missing pulses, and buried noise glitches.



OmniLab display demonstrates capture of an imbedded analog glitch (in top trace) with time-aligned presentation of the waveform's digitized bit values (center) and numeric states.

■ The 9240 is like having a complete benchtop of instruments integrated with your PC/AT or compatible. Which you can easily customize for digital development, analog development, or a combination of both.

■ With OmniLab, your productivity will soar. Because you achieve results with fewer instruments. And in fewer steps than ever before. By no means least, the 9240 delivers the best price/performance you'll find anywhere, costing just $8900 fully outfitted. And most importantly, without compromising a single high-performance spec. Not a one.

NO-COMPROMISE 9240 SPECIFICATIONS			
DIGITAL OSCILLOSCOPE		**LOGIC ANALYZER**	
Digitizers:	Two, 8 bit	Inputs:	48, timing and state
Bandwidth:	100 MHz	Asynchronous Clocking:	34 MS/s on 48 inputs; 204 MS/s on 8 inputs
Single-Shot Digitizing:	34 S/s to 204 MS/s	Repetitive Sampling:	680 MS/s on 48 inputs
Repetitive Sampling:	680 MS/s	Synchronous Clocking:	0 to 34 MS/s
Scale Factor:	5 mV/div to 10V/div in 1-2-5 sequence	Acquisition Memory:	4K samples (16K, 64K optional)
Record Length:	4K (16K, 64K optional)	Disassembly Options:	Over 150 microprocessors
ANALOG STIMULUS		**DIGITAL STIMULUS**	
Output:	8mV to 8 V peak-to-peak, 8 bit	Outputs:	24, 74F tri-state drivers
Cycle Length:	4 to 4K samples (16K optional)	Cycle Length:	4 to 4K samples (16K optional)
Clocking:	34 S/s to 34 MS/s	Timing:	34S/s to 34MS/s
Functions:	Record, edit and playback	Functions:	Record, edit and playback

■ For more information, call **toll free 800/245-8500.** In CA: 415/361-8883. Or write for complete literature.

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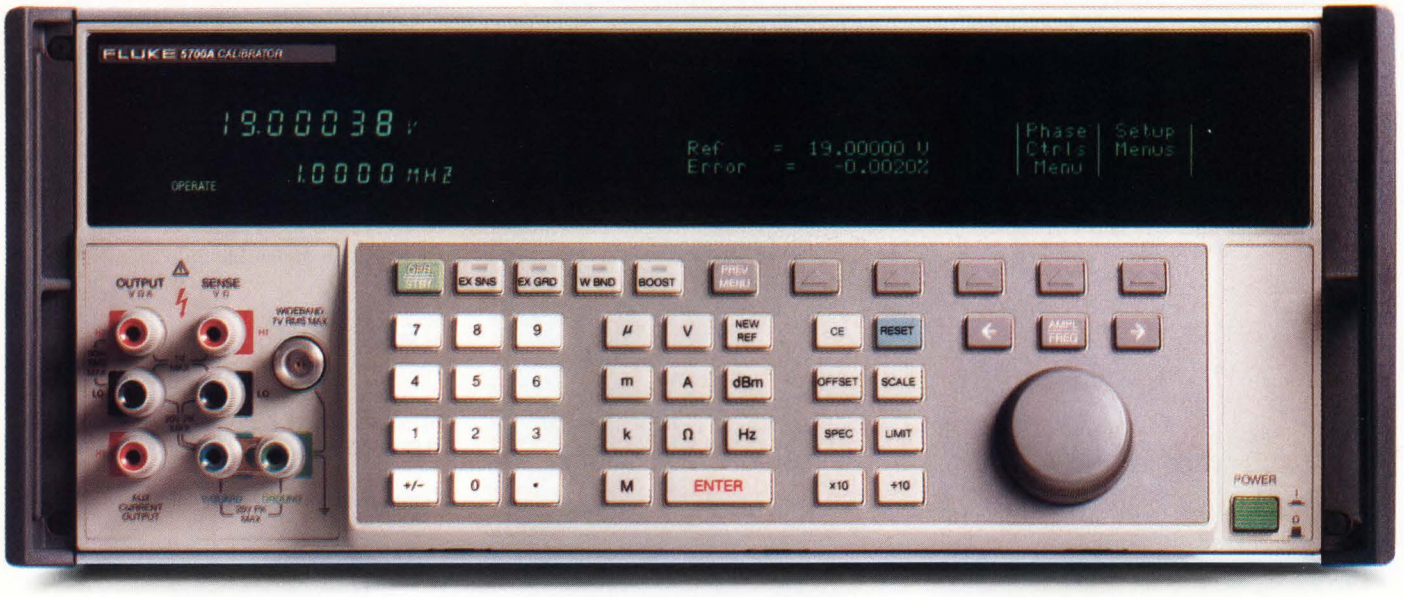
FLUKE

The new Fluke 5700A Calibrator.



PHILIPS

Before it could exceed your expectations, it had to exceed ours.

The most complete multifunction calibrator ever made.

You've always expected more from Fluke calibrators. More features. More performance. More innovation. You expect a lot. And here it is: the all-new 5700A Calibrator.

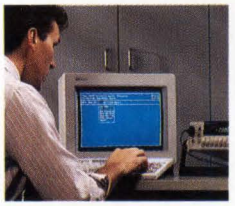
Precision performance that is easy to use.

You will find the 5700A surprisingly easy to use. Enter the desired values on the calculator-style keyboard. View menu selections and interpret status and error messages quickly through plain language displays. Use one of the many convenience features to perform tedious functions automatically.

Simplified support with Artifact Calibration.

You might expect an instrument with the accuracy of the 5700A to be difficult to support. But it's not. You need only three Artifact Standards — a 10V direct voltage standard, and 1Ω and 10kΩ resistance standards — to calibrate all ranges and functions of the calibrator. Front panel messages prompt you through the process. And it all takes just over an hour, compared to the eight hours or more you'd expect for such a calibrator. Internal Check Standards and the Cal Check feature enhance your confidence in the 5700A's performance between calibrations. External verification may be extended to two years.

Covers your complete DMM workload.



The 5700A will calibrate virtually every DMM in your workload. It outputs direct voltage to 1100V. Alternating voltage from 220μV to 1100V (10 Hz to 1.2 MHz). Cardinal resistances from 1Ω to 100 MΩ in x1 and x1.9 decades, plus a short. And direct and alternating (10 Hz to 10 kHz) current to 2.2A. To calibrate higher current ranges or high ac voltages at high frequencies, select the companion 5725A Amplifier. To extend the 5700A's calibration workload coverage to RF voltmeters, order the Wideband Voltage option.

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The 5700A protects your investment in existing Fluke instruments, systems and procedures. 5220A and 5205A/5215A amplifier ports are standard. So are IEEE-488 and RS-232 capabilities. And 5100B emulation mode allows you to update a system with minimal changes to your existing procedures.

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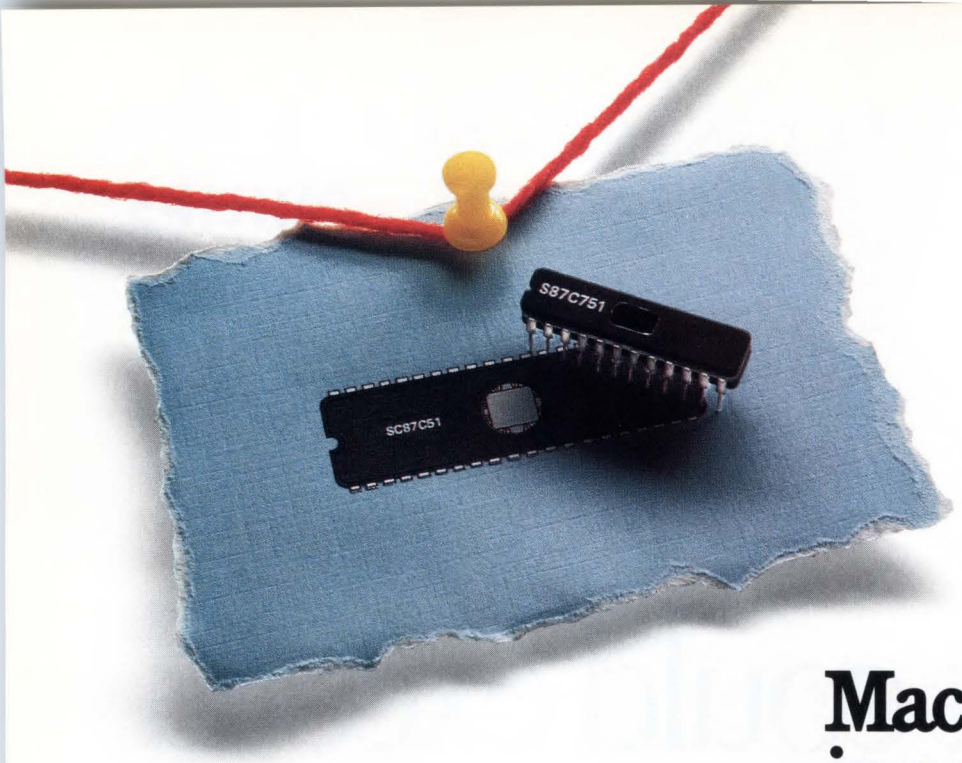
Call 1-800-44-FLUKE today for more information, and ask for a copy of our free 5700A demonstration video. It will give you a closer look at its features and functions in action. The Fluke 5700A Calibrator. It will exceed your expectations.

John Fluke Mfg., Inc. P.O. Box C9090, M/S 250C, Everett, WA 98206. U.S. (206) 356-5400. Canada (416) 890-7600. Other countries: (206) 356-5500. ©1988 John Fluke Mfg. Co., Inc. All rights reserved. Ad no. 0881-F5700.

FLUKE

CIRCLE NO 67



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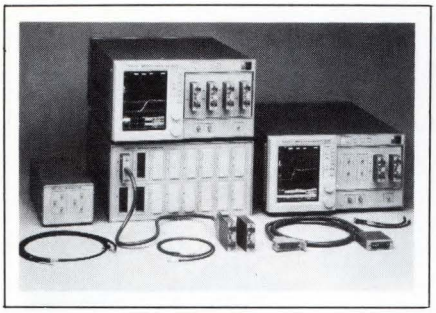
Instruments



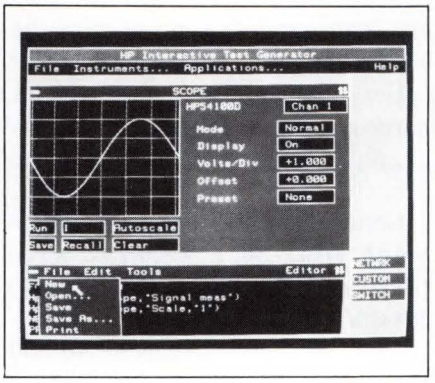
20 GHz SCOPES

The 11800 Series 20-GHz digital sampling oscilloscopes offer as many as 136 channels, 16 automatic measurements, and differential and single-ended time-domain reflectometry (TDR) measurements. Two mainframes are currently available. You can expand the 8-channel 11801 with the SM11 Multi-Channel unit to acquire 136 channels. The 11802 has built-in delay lines that allow you to view the leading edge of the trigger event.

Both models combine ≤17.5-psec rise times with a 200k-sample/sec sample rate and an 8-bit vertical resolution at all vertical sensitivities. They can acquire multiple records of 512 to 5120 points. You can configure the mainframes with the SD-24 dual-channel TDR/sampling head plug-in to execute single-ended and differential multichannel TDR measurements. You can then use the scope to evaluate balanced lines such as twisted pair cables and circuit-board transmission lines. 11801, $23,500; 11802, $22,000; SM11 $10,000 (4 head), $15,000 (16 head); sampling heads, from $3,500.

Tektronix Inc, Box 1700, Beaverton, OR 97077. Phone (800) 835-9433. TLX 151754.

Circle No 555



TEST GENERATOR

The E2000A interactive test generator (ITG) is a mouse-driven software package that runs on specially equipped IBM PC/ATs and compatibles as well as on the vendor's HP 9000 workstations. It lets you create Basic test programs that are independent of the measurement instruments. ITG software drivers, which are tailored to specific instruments, then link the device-independent test program to a particular test system. You can use the same test program for different instruments, and you can change a program to take measurements from different instruments.

The ITG gives you interactive control over the state of an instrument, and its automatic incremental state-programming feature reduces program execution time; the software sends only the minimum number of calculated commands to an instrument. ITG software, $995; 20 drivers for IEEE-488-based instruments, $495; through February 28, 1989, both the ITG software and drivers, $995.

Hewlett-Packard Co, 19310 Pruneridge Ave, Cupertino, CA 95014. Phone local office.

Circle No 556

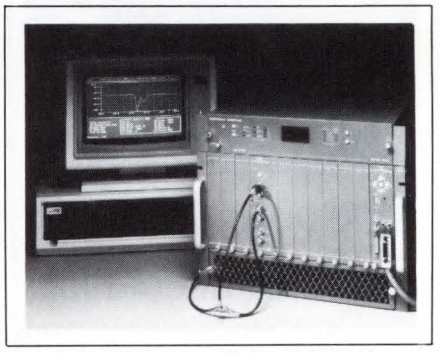
GENERATORS

The 2040 and 2045 arbitrary waveform generators convert data from 8-bit bytes to analog voltages at the rate of 800M points/sec. You can describe the desired waveforms as mathematical equations, graphics sketches, or line segments, or you can download them from a host computer. The units feature 512k points of memory that you can divide into multiple segments and 78k bytes of battery-backed RAM that stores files containing polynomial waveform definitions. You can trigger the output waveforms or you can synchronize them to an external source.

Both generators provide a pair of analog outputs. The 2040's outputs, which are in phase opposition, have internal impedances of 50Ω and supply a 1V p-p signal into a 50Ω load. One output of the 2045 is obtained directly from the main DAC and the other passes through a programmable 63 dB attenuator and Bessel filter. 2040, $13,500; 2045, $14,500. Delivery, within 12 weeks ARO.

Analogic Corp, Centennial Dr, Peabody, MA 01961. Phone (508) 977-3000. FAX 508-531-1266.

Circle No 557



WAVEFORM DIGITIZER

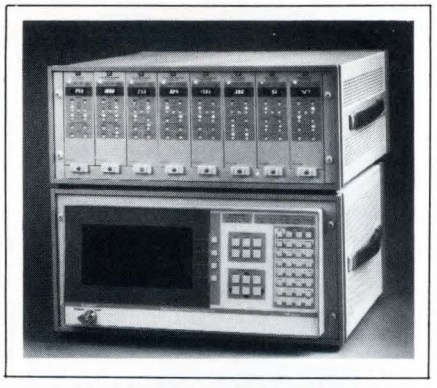
The Model 6880B/6010 waveform-digitizing system has a 1.35 billion-sample/sec digitizing rate and a 500-MHz typ analog bandwidth. Using a charge-coupled-device buffer, the 6880B/6010 captures "snapshots" of the input signal's amplitude every 750 psec and applies them to a flash A/D converter at a slightly lower rate. The unit can store 10,000 digitized samples in its waveform memory. It has 11-bit single-shot resolution—approximately one part in 2000—and provides 9.6 bits of "effective accuracy" in a "sine-fit" test that accounts for differential nonlinearity, noise, aperture uncer-

tainty, and harmonic distortion. You can manually control the digitizer from the front panel or through the IEEE-488 and RS-232C interfaces.

You can create your own digitizing system by combining as many as six 6880B digitizers with one 6010 controller. Prepackaged configurations that include one or two digitizers, a controller, a benchtop chassis, an IEEE-488 cable, and PC-based oscilloscope software are also available. Single-channel version, $20,450; two-channel version, $33,350; 6880B, $14,500.

LeCroy Corp, 700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977. Phone (914) 578-6038. TWX 710-577-2832.

Circle No 558



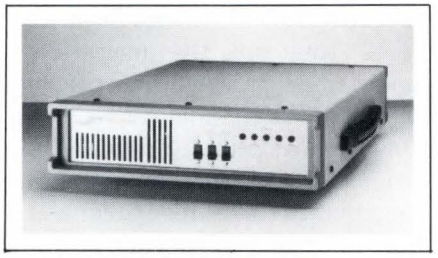
WAVEFORM RECORDER

The 5300 Series programmable waveform recording system allows you to monitor eight analog and eight event data channels at 1M sample/sec/channel with 12-bit resolution. You specify the waveform capture parameters via a software tool called the Event Manager, which has a 21-input, dual-trigger tree system that uses logical AND and OR functions to discriminate among more than one-half million transient events.

The 68000-based 5300 has two independent clock functions: a real-time clock and an interval timer. You can program the 5300 via its RS-232C, IEEE-488 port, or an optional Intelligent Front Panel. Another software tool called the Memory Manager lets you optimize the 5300's memory utilization. Other options include a D/A converter for hardcopy output to standard oscillographic recorders. 5300, from $15,000.

Gould Inc, Test and Measurement Div, 3631 Perkins Ave, Cleveland, OH 44114. Phone (216) 361-3315.

Circle No 559



DATA LOGGER

Although the Step-120 Mobile Incident Logger (MIL) is designed for the automotive industry, it is suitable for use as a 6800 or 68000 family system analyzer. It requires an IBM PC or compatible to act as a host for data transfer and initialization. The unit records processor-bus data, RAM variables, and external events. The data logger has four analog channels and eight event channels. The analog inputs have selectable ranges of 0 to 5V or 0 to 20V, and offer 8-bit A/D resolution. The unit operates from dc power with a 9 to 16V input range and tolerates vibration and mechanical shock. $14,900.

Step Engineering, 661 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 733-7837.

Circle No 560

EMULATOR

The ICE-386 25-MHz emulator allows you to control program execution, modify the contents of memory, control the initial state of registers and flag bits, and directly manipulate memory-resident tables. It is designed for products based on the vendor's 80386 processor. Standard features include 128k bytes of

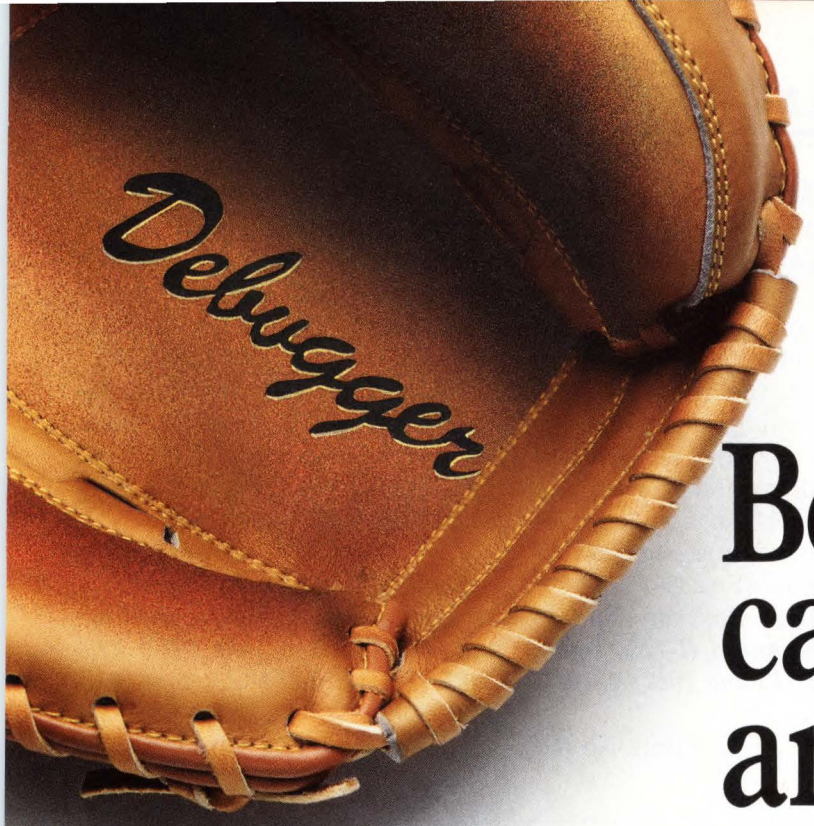
emulator memory, bus trace capture as high as 4k cycles, single-step execution, register and memory access, coprocessor support, and symbolic support for programs written in Intel-supported 86/286/386 languages. You can define a breakpoint as an execution address, a task switch, an external input, a trace-buffer-full signal, a bus event, a series of events, or a counter signal. To connect your host system to the emulator, you can use an RS-232C or a GPIB interface. The emulator provides external I/O lines so you can coordinate events between the emulator and external tools such as logic analyzers. $19,995.

Intel Corp, Garrett 1, 3535 Garrett Dr, Box 58119, Santa Clara, CA 95052. Phone (408) 765-8080.

Circle No 561

MULTIMETERS

The 80 Series comprises three models of hand-held A/D multimeters that offer frequency, duty-cycle, and capacitance functions. You can conduct frequency measurements from 0.5 Hz to 200 kHz, duty-cycle measurements from 0.1 to 99.9% of cycle, and capacitance measurements from 10 pF to 5 μF. A min-max-average feature lets you simultaneously store the highest, lowest,



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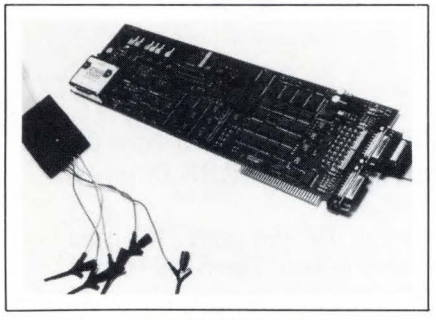
CIRCLE NO 70

and average of all readings over a period of seconds or days. A touch-hold feature captures the measurement until you are ready to view it, and a relative-hold mode shows the difference between the current and subsequent measurement.

All three models have both an analog and a digital display, which update 40 and 4 times/sec, respectively. The 87 version features a high-resolution analog pointer; the 83 and 85 models use an analog bar graph. 83, $189; 85, $219; 87, $259.

John Fluke Mfg Co, Box C9090, Everett, WA 98206. Phone (206) 347-6100. TWX 910-445-2943.

Circle No 562



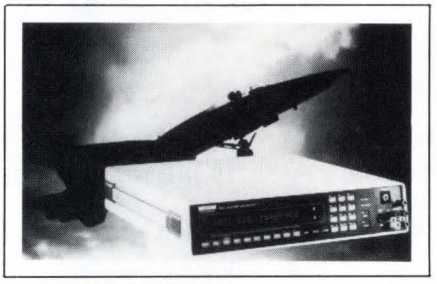
LOGIC ANALYZER

The TA208 is an add-in board that converts an IBM PC/AT, PC/XT, or compatible into a 200-MHz logic-timing analyzer. Each board has eight input channels, and you can install as many as four boards into a single PC to produce a 32-channel analyzer. A coaxial connection beztween the boards synchronizes their operation and enables a 32-channel setup to meet the single-board specification. The variable-threshold input pods present a circuit load of 1 mΩ in parallel with 3 pF. Trace memory depth is 8k bit/channel, and the internal clock period is selectable in a 1-2-5 sequence from 5 nsec to 5 msec. Alternatively, you can externally clock the analyzer at frequencies as high as 50 MHz.

A single trigger word, in which you can specify logic 0, 1, or don't-care states, triggers the analyzer. There is also a trigger filter, which you can set between 1- and 15-clock periods. You can position the trigger point on any 512-sample boundary in the trace memory. The TA208 lets you display and annotate any 16 input channels, smooth scroll through the trace memory, and make timing measurements with screen cursors. You can also store trace data on disk or dump it to a printer. The analyzer also has trace-search and trace-compare facilities. Around SFr 2800.

Fast Digital Systems SA, 48 route de Divonne, CH-1260 Nyon, Switzerland. Phone (022) 621021. TLX 419851.

Circle No 584



DMM OPTION

The 70615A option adds MATE (modular automatic test equipment) compatibility to the vendor's 7061 systems DMM. In addition to providing the DVM with the CIIL (control interface intermediate language) remote programming instruction set, the option also implements other systems-oriented features. For example, after a power failure, the instrument reinstates the instrument setup that existed before the power failure. It also allows you to capture external events in its 8000-reading nonvolatile memory.

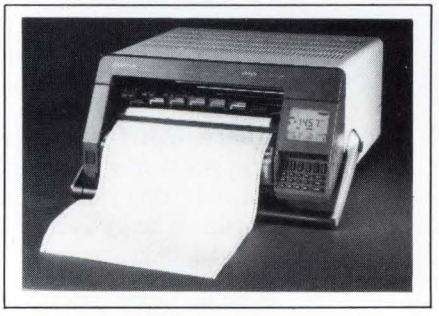
If you have the MATE option, you can also install the 70616A hardware self-test and 70616B status-monitoring relay options; both meet USAF MATE requirements. The self-test option checks the analog functions of the DMM with a simple pass/fail confidence test, a full diagnostic check, and a board-level check. The status-monitoring relay option provides fail-safe operation by activating a hardware or system alarm if the DMM's internal μP fails or if the instrument overheats. Option 70615A, $995; 70616A, $395; 70616B, $145.

Schlumberger Technologies, Instruments Div, Victoria Rd, Farnborough, Hampshire GU14 7PW, UK. Phone (0252) 544433. TLX 858245. FAX 0252-543854.

Circle No 585

Schlumberger Technologies, Instruments Div, 20 N Ave, Burlington, MA 01803. Phone (617) 229-4825. TLX 910-250-745. FAX 617-229-4885.

Circle No 586



RECORDER

The Model 520 data-acquisition and -recording system accepts a range of plug-in, front-end instruments and produces digital or pen-recorder trace outputs. The front-end instruments, which digitize input signals at 30 reading/sec, include a 15-bit dc measurement module, a 15-bit DVM module, a 13-bit DMM module, a thermocouple-linearization module, and a 100Ω platinum-resistance-thermometer module.

The recorder can preprocess measured data and produce output in digital form over optional IEEE-488 or RS-232C interfaces. In addition, you can plot the data on the unit's integral 10-in., 2- to 8-pen chart recorder. The chart recorder has 0.1% nonlinearity, a frequency response of ±0.2 dB 1.5 Hz, and a step response of 200 msec for a 10 to 90% full-scale deflection. It features trace-annotation, trace-overlap, retrace, and external-synchro-

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Simpson Electric Company 853 Dundee Ave., Elgin, Illinois 60120-3090 312/697-2260 FAX: 312/697-2272

nization facilities.

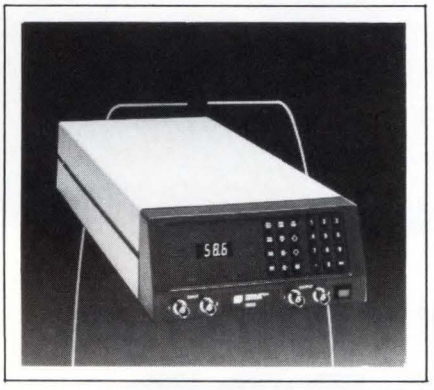
The Model 520 is portable and operates from 110V or 220V ac line supplies or from a 10V to 32V dc supply. Options include an alarm module that detects and flags out-of-limit input signals. From around £3500.

Kontron Elektronik, Freisinger Strasse 21, 8057 Eching, West Germany. Phone (08165) 707103. TLX 526791. FAX 08165-707113.

Circle No 587

Kontron Electronics Inc, 630 Clyde Ave, Mountain View, CA 94039. Phone (415) 965-7020. TWX 910-378-5207. FAX 415-965-3505.

Circle No 588

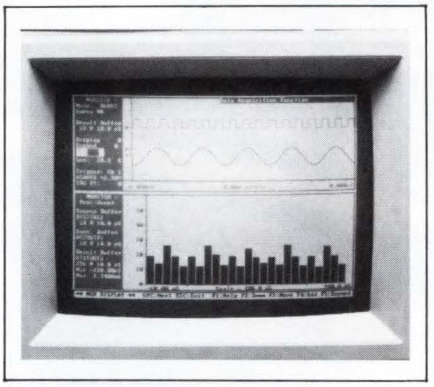


PROGRAMMABLE FILTER

The 9002 programmable filter is a 3½-in.-high, half-rack-width unit with a frequency range from 0.1 Hz to 102.4 kHz. You can program it via an IEEE-488 port or the front panel. Because the filter has battery-backed RAM, you can store eight complete, 6-parameter setups on each of the two channels for five years. You specify the unit to contain two filters with any combination of the following characteristics: 8-pole Butterworth lowpass or highpass, 8-pole/6-zero elliptic lowpass or highpass, 8-pole Bessel lowpass, or 8-pole/6-zero constant-delay lowpass. $2495. Delivery, six to nine weeks ARO.

Frequency Devices Inc, 25 Locust St, Haverhill, MA 01830. Phone (508) 374-0761. TWX 710-347-0314.

Circle No 563



ANALYZER

The Enhanced Graphics Acquisition and Analysis (EGAA) System records and digitizes analog signals while performing preselected signal analyses with high-resolution color graphics. Designed for use with an IBM PC/XT, PC/AT, or Compaq 386 personal computers, the EGAA system consists of a 16-channel A/D plug-in board, a BNC termination box, and EGAA software. The aggregate 16-channel sampling rate is 1 MHz; resolution is 12 bits.

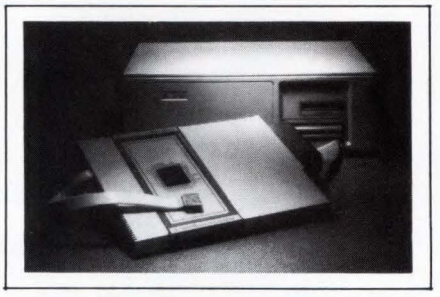
In the scope mode, EGAA functions as a high-resolution, digital-storage oscilloscope and includes individual channel time bases, digital readouts, automatic transducer calibration, and X-Y function display. A mass-storage mode is optional and allows real-time monitoring while continuously storing data to the hard disk. Data-conditioning, averaging, histogram, spreadsheet, and FFT programs are also optional. $2495; with analysis options, from $795 to $1495.

RC Electronics Inc, 5386-D Hollister Ave, Santa Barbara, CA 93111. Phone (805) 964-6708. TLX 295281.

Circle No 564

EMULATOR

The ES 1800 in-circuit emulator for Intel's 80C186/80C188 microprocessor runs with zero wait states at 16 MHz. The unit supports the 80C186/80C188's enhanced-mode feature set, which includes DRAM refresh, direct coprocessor support, power down, and system-testing



modes. The emulator also includes target-system interrupt servicing in pause mode and I/O overlay capability, which allows the emulator to exercise I/O service routines without target hardware in place. Like other ES 1800 emulators, the 80C186/80C188 includes the Event Monitor System, which provides triggering, breakpoint, and emulation-control capabilities. From $11,000; upgrade for existing ES 1800, $8,645.

Applied Microsystems Corp, Box 97002, Redmond, WA 98073. Phone (206) 882-2000.

Circle No 565

ASIC TEST SYSTEM

The 6000 ASIC analysis system is a verification tool for system designers and is priced from $38,000 for 64 pins to $129,000 for 352 pins. The unit is based on the Cadic 5200 Series digital VLSI test system and includes some of the same features—25-MHz system speed and per-pin architecture. System 6000 provides a streamlined vector memory system and enhanced system software. A custom, high-speed interface allows you to connect the ASIC analysis system to an 80386-based workstation. With the 386 workstation, you can control test signals for devices that have as many as 352 pins.

Cadic Inc, 1725 SW 167th Pl, Beaverton, OR 97006. Phone (503) 645-2222.

Circle No 570

Gould Inc, 19050 Pruneridge Ave, Cupertino, CA 95014. Phone (800) 538-9320.

Circle No 571

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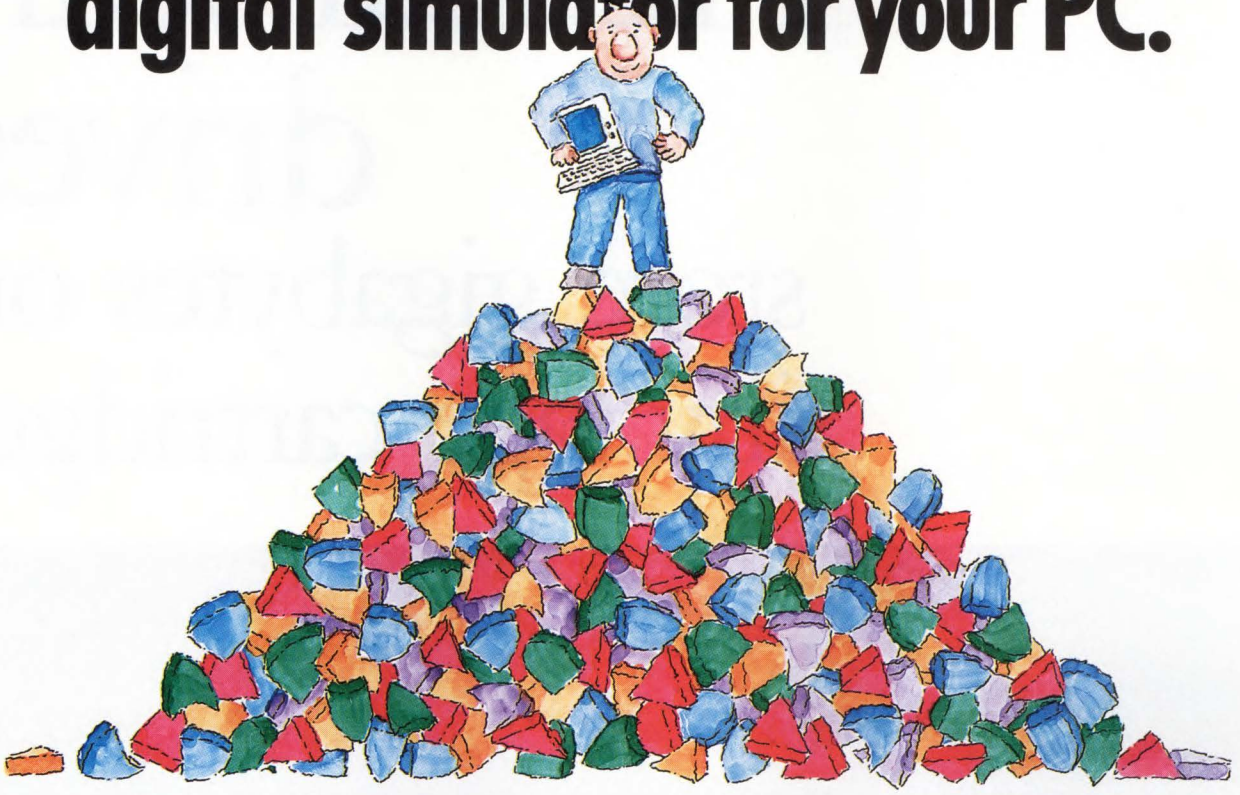

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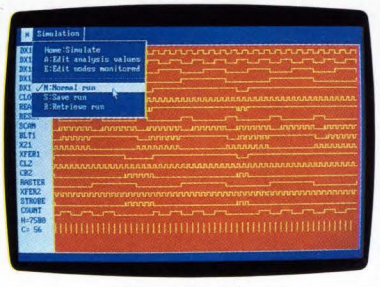
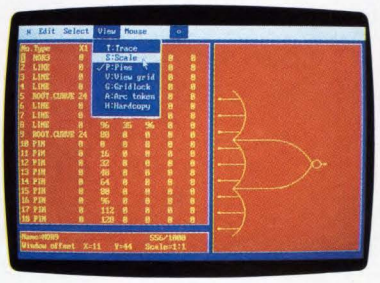


Timing Simulator

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.

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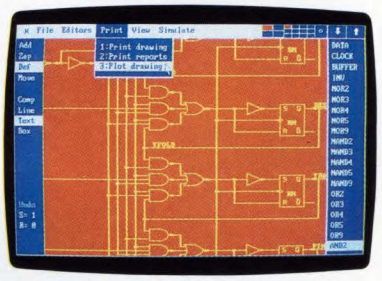

Schematic Editor

spectrum

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CIRCLE NO 49

Helical-scan drives store gigabytes on tiny tape cartridges

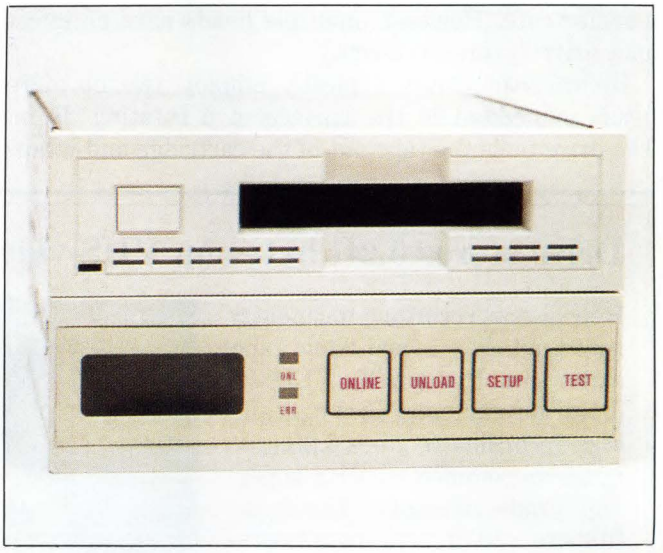
DAT drive compatible with the DDS Manufacturers Group's format (Wangtek Inc)

Tape drives that use helical-scan recording technology can store more than a gigabyte of data on 4-mm digital audio tape (DAT) or 8-mm videotape cartridges. At present, however, issues such as data-format standards, alternate sources, and cost may prove more important than the typical drive specs.

Maury Wright, *Regional Editor*

Helical-scan tape drives offer system designers state-of-the-art data-capacity and performance specs for secondary-storage applications. The drives store more than 1G byte on 4-mm DAT (digital audio tape) cartridges and more than 2G bytes on 8-mm videotape cartridges. Currently available drives can fit into the standard 5¼-in. form factor, and manufacturers plan to offer the 4-mm drives in the 3½-in. form factor. Furthermore, the tape cartridges are small enough to fit into a typical shirt pocket. The drives currently cost from $3000 to $7000 in single quantities, but you can expect their prices to drop by more than half in the next year.

Although you can easily compare the technical specs of helical-scan drives, issues such as data formats and alternate sources may be more important considerations at present. Currently, only Exabyte offers 8-mm drives in the US, although the company has licensed other vendors to produce the drives. Meanwhile, a dozen or more companies have either introduced 4-mm drive products or announced the intention to introduce such products in the first half of 1989. But the companies in the 4-mm market have split into two industry groups, the DDS Manufacturers Group and the Data/DAT committee, and they're promoting incompatible physical data formats (see **box**, "Who's who in data-storage DAT").



Full-height 5¼-in., 1.2G-byte, 4-mm cartridge drive *(Gigatrend Inc)*

Helical scan boosts capacity and data rate

Helical-scan recording technology offers advantages in recording density and data-transfer rate over traditional linear recording techniques. Traditional tape drives employ a stationary head to read or write data on parallel linear tracks, which typically run the entire

Helical-scan-recording tape drives achieve higher effective head-to-tape speeds than do traditional linear-recording drives.

length of the tape. The head moves up or down to access any track on the tape, but it reads or writes data linearly as the tape moves by.

For a given set of read/write electronics and type of tape medium, the speed at which the tape moves by the head (head-to-tape speed) determines the number of flux transitions per inch the drive can record on the tape (the drive's flux density). The drive's flux density and its data-encoding scheme (MFM, GCR, etc) determine its recording density (bpi) and ultimately its data-transfer rate. The combination of tape length, number of tracks (and therefore track density), and recording density determine the tape drive's storage capacity. Some traditional drives employ multiple heads that operate in parallel, effectively boosting the transfer rate. However, multiple heads have no effect on a drive's storage capacity.

Helical-scan drives typically employ two or more heads embedded in the surface of a rotating drum. The drive pulls the tape out of the cartridge and wraps it partially around the drum's circumference. In a 2-head drive, the heads are mounted directly opposite (180° apart) each other on the drum's circumference. Each head can read or write data during the time that it's in contact with the tape.

Rotating drum increases tape speed

The drum is slightly tilted in relation to the tape so that the heads read and write stripes or tracks diagonally across the tape. Together, the horizontal tape movement and the rotating drum cause a higher effective head-to-tape speed, but a lower actual tape speed than drives using linear recording can produce. For example, the Exabyte EXB-8200 drive achieves an effective head-to-tape speed of 150 ips, although the tape actually moves at only 0.429 ips. The drive's drum assembly rotates at 1800 rpm. By contrast, drives based on the linear-recording HI-TC standard for ½-in. IBM 3480 tape cartridges have both an actual and an effective tape speed of 79 ips.

Drive stores 5.2G bytes on VHS videotape

Helical-scan recording technology isn't limited to 4- and 8-mm tape cartridges. Honeywell's VLDS drive, for example, uses helical-scan recording to store 5.2G bytes on commercial VHS super high-grade videotape. The drive fits into a 19-in. rack-mount package and offers performance specs that make it suitable for use with mainframe computers.

VHS-based, 5.2G-byte helical-scan drive *(Honeywell Inc)*

The VLDS drive employs a 2-head scanner assembly that rotates at 60 rps and achieves a head-to-tape speed of 454 ips. Operating at a 50,000-bpi recording density, the drive stores 16k bytes of user data on each 4-in. stripe, which is recorded diagonally on the tape.

The drive features a corrected error rate of 10^{11} bits between errors. Each of its two data channels can transfer data at 2M bytes/sec, so the drive can sustain a 4M-byte/sec transfer rate. Recording 5.2G bytes at 4M bytes/sec on a T-120 tape takes 22 min. You can also operate the drive as slowly as 1M byte/sec. To slow the transfer rate, the drive simply decreases the rotational speed of the scanner assembly.

You can purchase the VLDS drive with an embedded SCSI controller or with a Honeywell proprietary interface. The SCSI controller operates in asynchronous or synchronous mode, and it can perform synchronous burst transfers as fast as 5M bytes sec. A 2-channel drive with an embedded SCSI controller costs $39,900.

Both the Exabyte drive and an HI-TC drive transfer data at around 250k bytes/sec, but the Exabyte drive achieves that transfer rate with only one read-write head and a single data channel, while the HI-TC drive employs parallel heads with two data channels. Further, the Exabyte drive stores far more data in the same tape space. The Exabyte drive features a recording density of 43,200 bpi; HI-TC drives record data at only 12,700 bpi. The slow tape speed of helical-scan drives also allows for higher track densities, because it simplifies tape handling and makes the tape alignment more exact. The Exabyte drive operates with a track density of 819 tpi; an HI-TC drive writes only 24 tracks on a ½-in. tape.

Helical-scan recording has been used extensively in the video-recording industry, but only in the past couple of years has it been available for computer-data storage. Helical-scan technology is certainly not limited to 4- and 8-mm cartridge drives (see **box**, "Drive stores 5.2G bytes on VHS videotape"), but those two sizes are the form factors of choice because they fit the mechanical requirements of the computer industry. As with most new-technology products, helical-scan tape drives currently have relatively high unit prices in comparison with those of linear-recording tape drives. Helical-scan drives based on the 4-mm DAT and 8-mm videotape cartridges, however, will benefit from the economies of scale provided by the 4- and 8-mm consumer audio and video products.

Economies of scale benefit DAT drives

Manufacturers of DAT drives, for example, estimate that the electromechanical subsystem common to both the audio products and the data-storage products makes up 25% of the cost of a data-storage DAT drive. As DAT gains widespread acceptance among consumers of audio products, manufacturing volumes will go up, and the price of one key component of data-storage DAT drives—the electromechanical subsystem—will go down.

The other key to lower prices for 4- and 8-mm data-storage drives depends directly on the computer industry's acceptance of the drives. Manufacturers of the drives must employ custom and semicustom VLSI ICs in order to fit the drives into the small form factors required by the industry. When those custom and semicustom ICs go into volume production, the cost of the end product will drop substantially.

DAT drives can cost more than $5000 in small quantities. When you consider the price of a helical-scan product, however, be sure you're making a fair comparison. The Exabyte EXB-8200, for example, stores 2.3G bytes and costs $3850 (1) or $2225 (1000). State-of-the-art ¼-in.-cartridge drives cost much less than $1000 in quantity, but store only 150M bytes. The ¼-in.-cartridge products also offer a substantially slower data-transfer rate than does the Exabyte drive. Manufacturers plan to ship ¼-in.-cartridge products that have a 300M-byte capacity in the first half of next year, but the prices will be higher.

SCSI-based, 2.3G-byte, 8-mm cartridge drive *(Exabyte Corp)*

Drives use low-cost 4- and 8-mm media

Don't forget to compare the prices of the media as well. DAT cartridges sell for about $10 (retail) in Japan, where the audio product is already popular. You can buy 8-mm video cartridges in the US for $15. The 4-mm and 8-mm data-storage drives use exactly the same cartridges that the consumer audio and video products use, and cartridge prices are sure to drop. Data-storage-drive manufacturers plan to offer prilvate-label certified cartridges for a small premium.

Exabyte currently sells 8-mm cartridges to its OEM drive customers for $11 (1000) as a way of ensuring the customers that they're using the highest quality media available. This service is an important one, because as 8-mm data-storage tape drives become popular, and more companies start manufacturing the cartridges, the possibility arises that some lower-quality media will appear on the market. Drive manufacturers will probably test the tape media they sell you.

DC-2000 cartridges for 40M-byte, ¼-in.-cartridge drives sell for $30 and more. The DC600 cartridges used in 60M-byte drives cost about the same amount.

DAT-drive prices for data-storage applications will drop as audio DAT products gain widespread acceptance among consumers.

But premium DC600-style cartridges for higher-capacity drives can cost $60 or more. So even though 4- and 8-mm drives are relatively pricey now, they're actually still a good choice on a cost-per-megabyte basis, because they can store a large amount of data on lower-cost media.

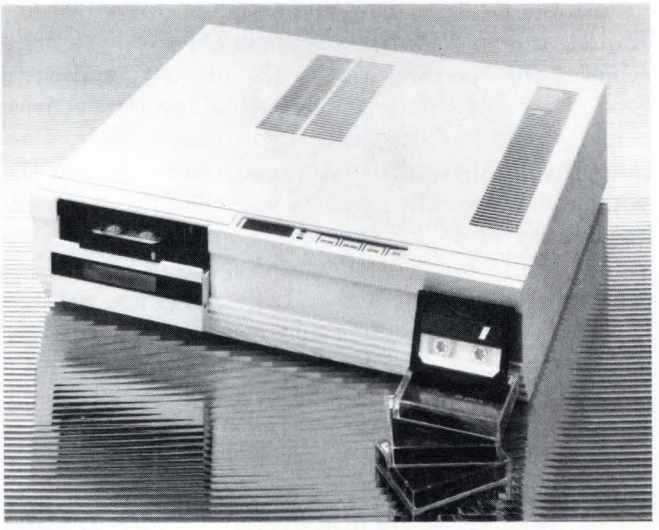
Applications range to minicomputers

Both the 4- and the 8-mm drives target system applications ranging from file servers on personal-computer networks, to workstations, to minicomputers. The Exabyte EXB-8200 8-mm drive offers a 240k-byte/sec transfer rate; according to Marty McCoy, the company's director of marketing and sales, few submainframe applications currently require higher transfer rates. The EXB-8200 has a read head, a write head, and a servo head. The drive performs a read-after-write verify operation as a first level of error correction. On each drum rotation, the drive stores eight 1k-byte data blocks in a stripe or track. The data format that Exabyte employs also stores 400 bytes of ECC data with each 1k-byte block. The drive specs an error rate of 1 bad bit in 10^{13}.

The EXB-8200 does not support update-in-place operations (rewriting a section in the middle of the tape), but it will append information either to the logical end of the tape or to any location you choose. Note, however, that when you append information to any part of the tape before the logical end, you invalidate any data past that point. The 5¼-in., full-height drive includes an embedded SCSI controller and a 256k-byte buffer. The drive can burst data asynchronously across the SCSI bus at 1.5M bytes/sec.

As mentioned, only Exabyte currently offers an 8-mm tape-cartridge product (the EXB-8200) in the US. The drive is based on a mechanism from Sony. According to Exabyte's McCoy, two unnamed US companies have licensed the format, and Exabyte continues to offer licenses. Kubota Ltd (Japan) has licensed manufacturing rights to the drive and is marketing the product in Japan. Exabyte intends to establish the format as a standard so that the 8-mm drives can serve applications requiring multiple sources and data interchange between drives from various vendors.

Meanwhile, manufacturers of 4-mm-cartridge drives face the exact opposite problem. A dozen or more companies want to produce data-storage DAT drives, but there's still no standard; the formats adopted by the DDS Manufacturers Group and the Data/DAT committee are vastly different. The manufacturers all agree



Stand-alone, 1.2G-byte desktop DAT drive *(Gigatrend Inc)*

that only one format can succeed in the long run. Furthermore, the ¼-in. cartridge marketplace has shown that to gain widespread market acceptance, tape-cartridge drives must be capable of data interchange, and, preferably, must have compatible logical file formats.

The DDS Manufacturers Group and Data/DAT formats differ in such key areas as error-correction scheme and operating mode. The Data/DAT group's format will allow the drive to update files in place. The format defined by the DDS Manufacturers Group requires that a file be appended to the end of the tape; if you place it in the middle of the tape, you lose the rest of the file unless you rewrite it. Both formats allow random searches for data. The drives employ a high-speed search mode that examines location data written at the beginning and end of each track and can typically access any file on the tape in less than 20 sec.

Formats affect performance and capacity

The different formats also have ramifications for performance and capacity. Drives compatible with the DDS Manufacturers Group format store 1.3G bytes of data and transfer data at 182k bytes/sec. Because of data overhead associated with the update-in-place feature, Data/DAT drives store 1G byte of data and have a 133k-byte/sec transfer rate. The Data/DAT committee may add a sequential write mode to its format; if it does, the format would provide performance specs similar to those quoted by the DDS Manufacturers Group. Note, however, that a dual-format drive would

require intelligence to handle both formats, so it would cost more. Furthermore, a manufacturer that chose to support only one operating mode could create incompatibility within the standard.

Drives designed for either format are based on the same mechanism—that used for audio products. The standard DAT mechanism handles the C1 and C2 track and frame format and error-correction schemes. A frame consists of two consecutive tracks or stripes, and a frame can store 5824 bytes of protected data. Both formats also specify a read-after-write operation to detect bad frames. However, the two camps have different methods of adding the C3 level of format and error correction.

The DDS Manufacturers Group format handles errors on a group basis. A group consists of 22 consecutive frames that store 126,632 bytes of data. The DDS Manufacturers Group's C3 ECC scheme will correct any two tracks within a group. The Data/DAT format employs a C3 ECC scheme that operates on 32 frames (128k bytes of useful data, not counting the overhead for the update-and-replace operation) and can correct burst errors of as many as five consecutive tracks in length.

There's currently no information on what types of errors will occur during real-world operation of the drives. The Data/DAT group claims that tape defects will cause errors that are undetected by read-after-write checks to propagate through more than two consecutive tracks. The DDS Manufacturers Group be-

Who's who in data-storage DAT

Tape drives based on 4-mm digital-audio-tape (DAT) cartridges promise to become a major contender in the secondary-storage market for computer systems. At present, however, two industry groups are promoting incompatible physical formats for DAT drives. The DDS (Digital Data Storage) Manufacturers Group champions a format that was initially developed by Hewlett-Packard and Sony, then fine-tuned by other members of the group. The Data/DAT committee has adopted a format that Hitachi originally developed.

Companies that wish to join the DDS Manufacturers Group and build compatible tape drives must purchase a license from Hewlett-Packard and Sony. For the license, you pay a one-time fee of $10,000 and a royalty payment of $2 per drive. Hewlett-Packard and Sony initially maintained strict control over the technical aspects of the format; recently, however, members of the DDS Manufacturers Group have all had a voice in decisions regarding the format. So far, Aiwa (Japan), Archive, Exabyte, Laser Magnetic Storage International, Mitsumi, Wangdat, and Wangtek have licensed the format.

The Data/DAT committee is an industry trade group working on open DAT standards for the computer industry. Anyone can attend Data/DAT meetings and build compatible tape drives. Michael Peterson, president of the market-research firm Peripheral Strategies, acts as facilitator of the Data/DAT committee. Archival Storage Devices, Distributed Storage Technology, Gigatape, Gigatrend, Hitachi, JVC (Elmwood Park, NJ), Mitsumi, and Sharp (Mahwah, NJ) have all announced that they plan to build Data/DAT drives or are interested in doing so.

The contacts for the DDS Manufacturers Group in the US, Europe, and Japan are as follows:

Jim Jonez
Hewlett-Packard Co
Greeley Storage Div
700 71st Ave
Greeley, CO 80634
(303) 350-4000
FAX (303) 352-3350

Celia Watts
Hewlett-Packard Ltd
Computer Peripherals
Bristol Div
Filton Rd
Stoke Gifford
Bristol BS12 6QZ, UK
Phone 44 272 799910
FAX 44 272 790076

Kimio Uchida
Sony Corp
10-18 Takanawa, 4-chome
Minato-ku
Tokyo 108, Japan
FAX 81 3 447 5998

The contact for the Data/DAT group is:

Michael Peterson
Peripheral Strategies Inc
351 S Hitchcock Way, B200
Santa Barbara, CA 93105
Phone (805) 569-5610

The DDS Manufacturers Group and the Data/DAT committee support incompatible formats for 4-mm DAT drives.

lieves it has a superior ECC scheme for correcting random 1-track errors.

The DDS Manufacturers Group has also added some further safeguards that the Data/DAT committee could choose to implement as well. For example, the DDS Manufacturers Group format employs a data randomizer to increase data integrity. Certain ASCII code sequences are more prone to causing errors than others, and the randomizer minimizes the probability that those sequences will occur. The format also includes a provision for error monitoring and reporting on the tape. Every error that occurs is logged on the tape, and an intelligent drive can prompt a system to warn users when the condition of a particular cartridge becomes degraded. Finally, the format supports multiple-group writing, or writing data to the same cartridge more than once to ensure that a good copy of the data exists.

Both industry groups plan to submit their formats to ANSI in February, and neither group expects ANSI to publish two such similar formats. Most industry observers do expect to see products from both groups emerge, however. Market acceptance by computer-system OEMs will set the standard.

You can't yet buy a tape drive that's compatible with either the Data/DAT format or the DDS Manufacturers Group format. Several companies do offer data-storage DAT drives, but those products employ proprietary formats. The manufacturers chose to bring out those proprietary drives before the two industry groups completed the format standards. The drives serve some niche markets and provide system designers with products they can use now for evaluation and for proving system concepts.

Gigatape, a West German company, and its US marketing arm, Gigatrend, have led the way by offering 4-mm tape drives for several months. The GIGA-1200 stores 1.2G bytes of data and transfers data at 192k bytes/sec. Like all the DAT drives that are currently available, the GIGA-1200 has only two read/write heads, so it can't perform read-after-write error checking because it has no heads dedicated to that function.

For more information . . .

For more information on the helical-scan tape drives described in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Archival Storage Devices Inc
333 Cobalt Way, Suite 107
Sunnyvale, CA 94086
(408) 730-2346
Circle No 447

Archive Corp
1650 Sunflower Ave
Costa Mesa, CA 92626
(714) 641-0279
TLX 4722063
Circle No 448

Distributed Storage Technology Ltd
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Beedon Newbury
Berkshire RG16 8RY, UK
(635) 248191
Circle No 449

Exabyte Corp
1745 38th St
Boulder, CO 80301
(303) 442-4333
FAX (303) 442-4269
TLX 361740
Circle No 450

Gigatape
Systeme fur Datensicherung GmbH
Benzstrasse 28
8039 Puchheim, Munich
West Germany
(089) 807002
FAX 011-49-89-802592
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Gigatrend Inc
5650 El Camino Real
Carlsbad, CA 92008
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FAX (619) 931-9959
Circle No 452

Hewlett-Packard Ltd
Filton Rd
Stoke Gifford
Bristol BS12 6QZ, UK
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New Media Div
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Torrance, CA 90503
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Box 5227
Denver, CO 80217
(303) 773-4700
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Colorado Springs, CO 80907
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Mitsumi Electronics Corp
35 Pinelawn Rd
Melville, NY 11747
(516) 752-7730
Circle No 457

Sony Corp
Components Marketing Group
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Minato-ku
Tokyo 108, Japan
FAX 81 3 447 5998
Circle No 458

Wangdat Inc
3001 Redhill Ave, Suite 4-222
Costa Mesa, CA 92626
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The storage capacities and data rates of 4- and 8-mm cartridge drives will very likely double over the next year or two.

Despite that fact, the product specs an error rate of 1 bit in 10^{15}, and the drive records data at 61,000 bpi and features a track density of 1869 tpi. (Incidentally, both the DDS Manufacturers Group and the Data/DAT formats specify a 4-head drive that does perform read-after-write error checking.)

Choose from stand-alone or 5¼-in. drives

You can purchase the GIGA-1200 with SCSI, QIC-02, or Pertec 9-track interfaces. The drive comes mounted in a stand-alone desktop box and costs $6700 with a host interface. The companies also began shipping the $2585 (1000) GIGA-1230 in November. The GIGA-1230 comes in the standard 5¼-in. form factor; it includes an embedded controller and maintains format compatibility with the GIGA-1200. Gigatape and Gigatrend plan to introduce a Data/DAT product next year.

Archival Storage Devices (in the US) and Distributed Storage Technology Ltd (in Europe) sell the Sphinx DDT-1000 stand-alone DAT drive. The 2-head drive stores 1G byte of data and transfers data at 192k bytes/sec. The drive employs an update-and-replace format and costs $5000 with a SCSI controller. The companies plan to ship a 5¼-in. product with four heads in the first quarter and a Data/DAT product later in the year.

Hitachi, originator of the Data/DAT format, has shown sample drives at several trade shows but has not announced plans to sell the products. Likewise, Sharp (Mahwah, NJ) has demonstrated a drive but hasn't yet followed up with a publicly available product. Both companies plan to build Data/DAT drives. JVC (Elmwood Park, NJ) will supply mechanisms to a number of drive makers, but it may also enter the drive market with a Data/DAT product.

Company will support both formats

Mitsumi also offers samples of a 5¼-in. prototype drive for less than $3000. The drive employs two heads and an update-and-replace format; it specs a 133k-byte/sec transfer rate, and an error rate of 1 bit in 10^{12}. Marketing manager John Antonchick believes customers want a 4-head device; the company plans to ship one before next summer. Antonchick also claims Mitsumi can adapt its present mechanism to a half-height 5¼-in. package.

Mitsumi is the only manufacturer thus far that has licensed the DDS Manufacturers Group format, yet also tentatively plans to produce Data/DAT products. According to Antonchick, Mitsumi targets only large OEM customers, and will build both types of DAT drives if customers ask for them.

Sony will be the first company to ship a product that's compatible with one of the two proposed 4-mm standards. The company plans to begin sample shipments of its SDT-1000 drive in January. Thus far, Sony has announced the product only in Japan; it sells for ¥600,000 (about $4500). Compatible with the DDS Manufacturers Group format, the SDT-1000 fits the full-height 5¼-in. form factor. The DDS Manufacturers Group produced a workable standard long before Data/DAT did, so the members of the DDS Manufacturers Group had a head start. In fact, Sony helped to develop the original DDS Manufacturers Group format spec.

OEM DAT prices reach $1500

You can also expect Wangtek to ship a DDS Manufacturers Group format drive in the first half of 1989. Wangtek demonstrated the Model 6130F drive at Comdex Fall and promises to ship the product in May 1989. Based on a JVC mechanism, the full-height 5¼-in. drive will cost $1800. Wangdat and Archive will probably also introduce products compatible with the DDS Manufacturers Group format in about mid-1989.

Activity in the helical-scan tape-drive market will very likely continue at a hectic pace for the next couple of years. Exabyte's McCoy predicts that his company will double the capacity and transfer rate of its 8-mm products in the next year. And once the 4-mm standards issues are settled, you can expect to see rapid growth in all segments of the market. Lee Elizer, executive vice president of marketing and sales at Gigatrend, believes that DAT drives will offer twice the present capacity and four times the present transfer rate in a couple of years. As for the low end, market researchers predict the advent of scaled-down, 2-head DAT drives that use schemes such as multiple-group writing. Within three years, they estimate, these drives will be inexpensive enough to suit personal-computer systems. EDN

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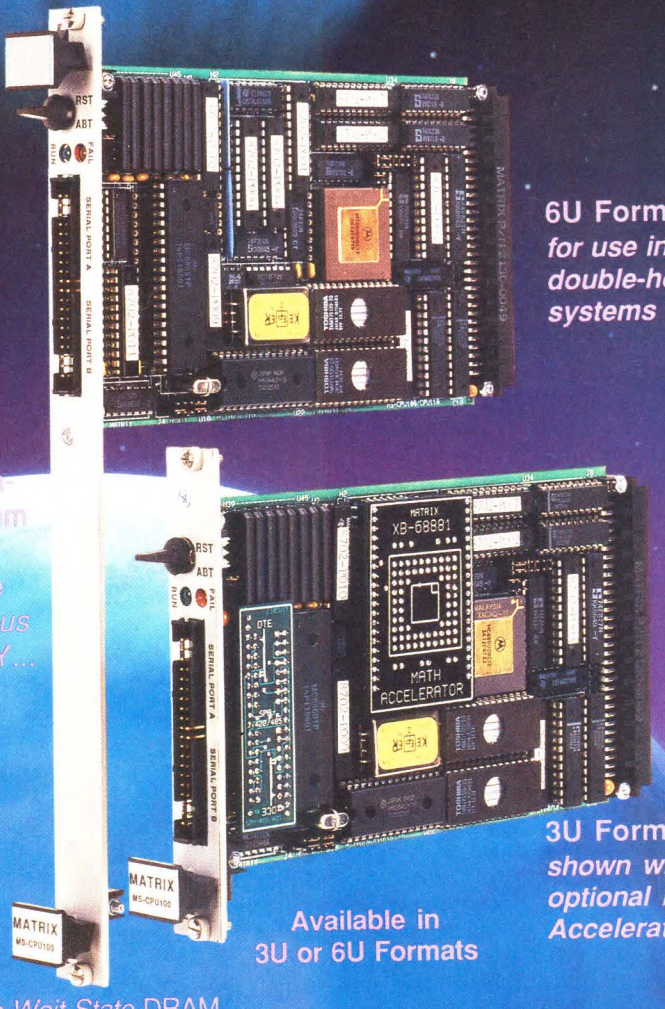

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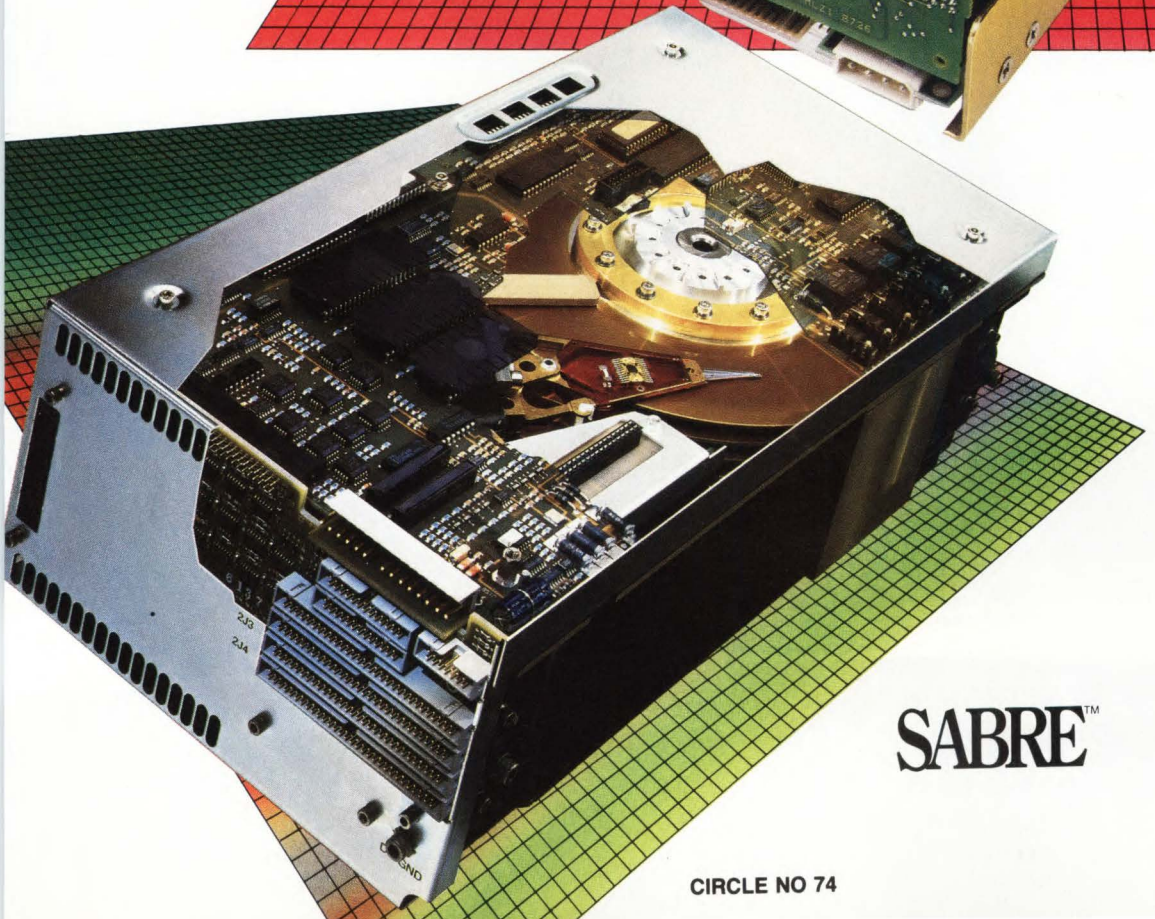

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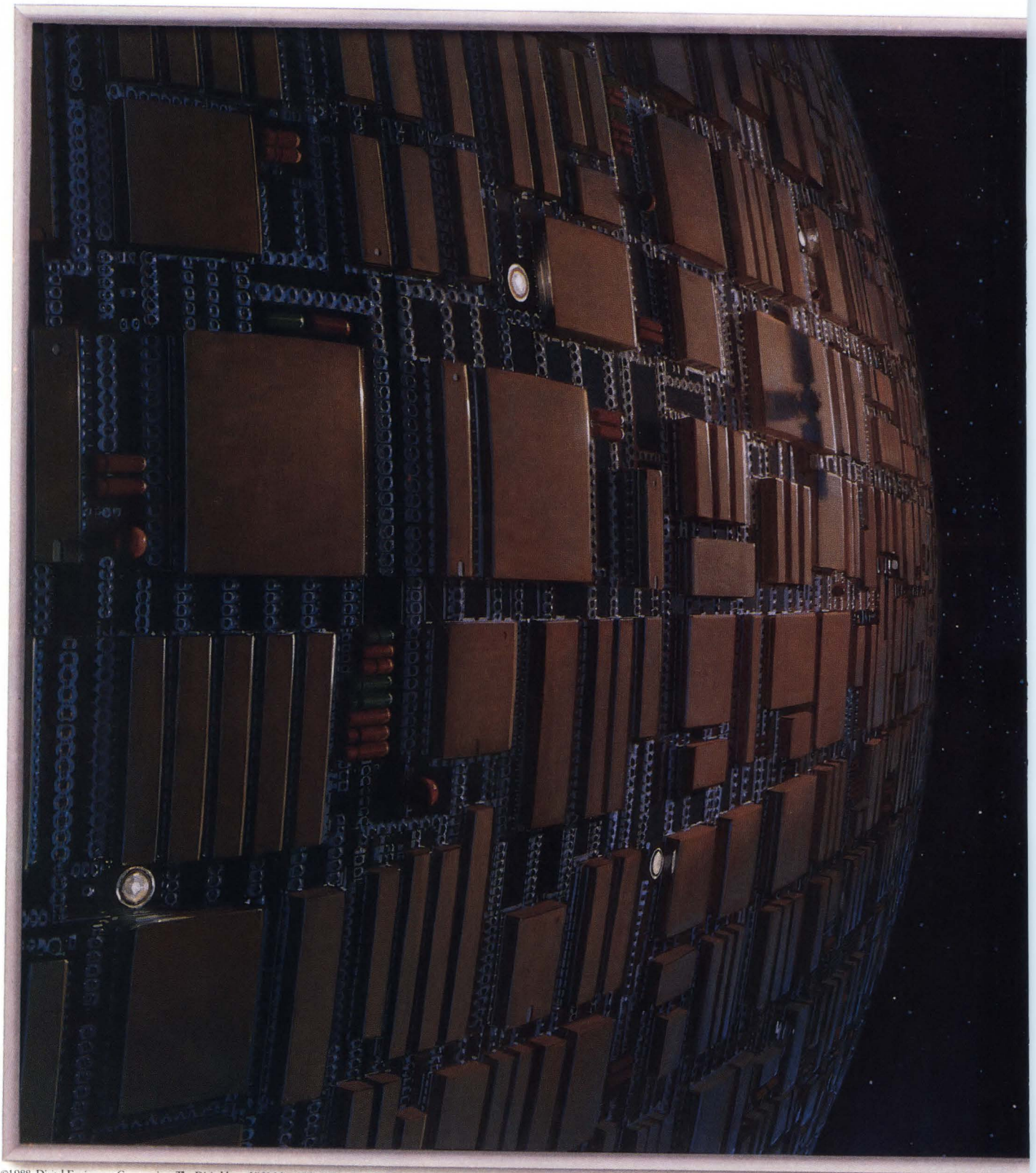

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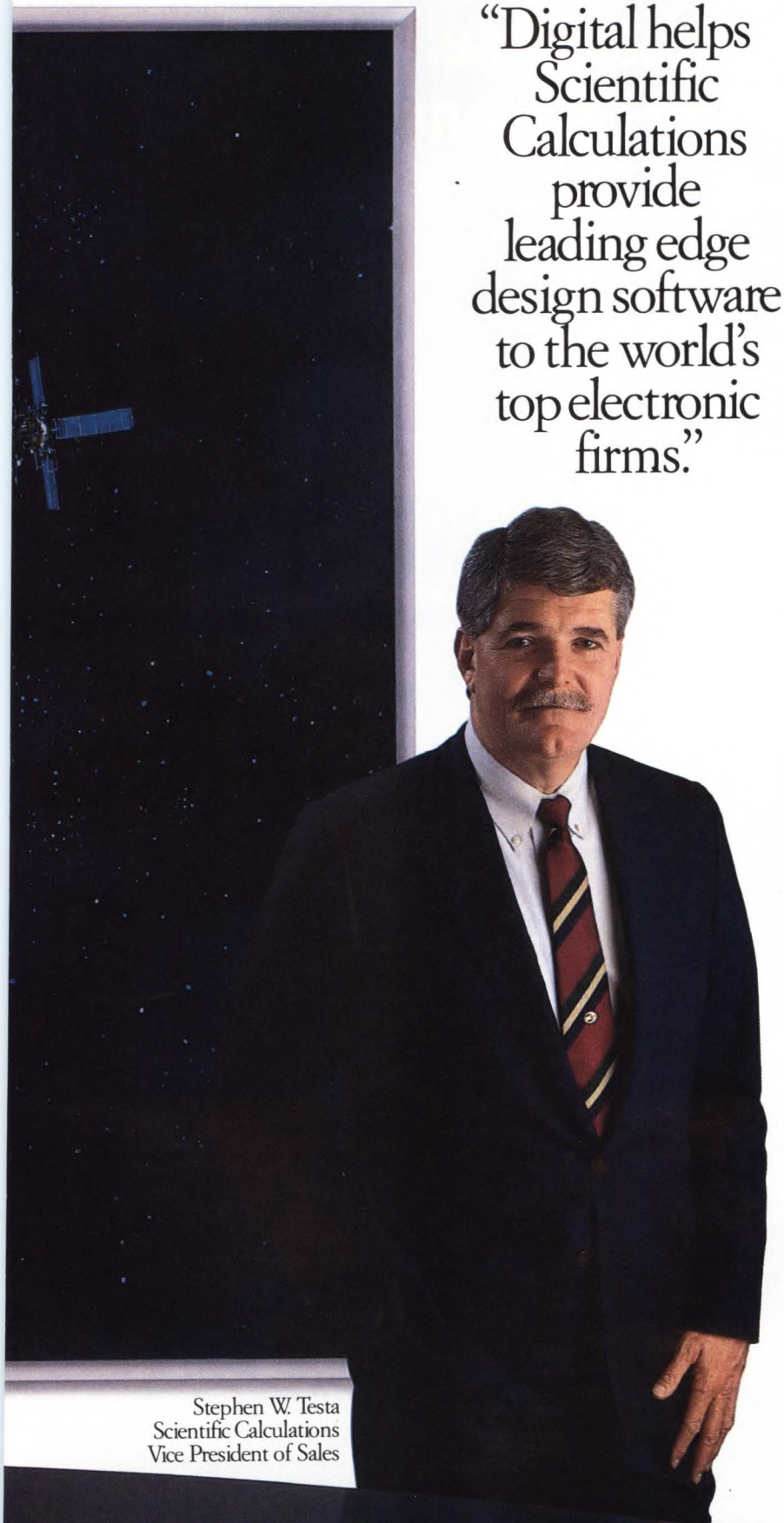

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In Europe, call United Kingdom: 0628 476 741, West Germany: 02162-3798-0, France: (03) 956-8142, Italy: (02) 688-2141.

ZAX

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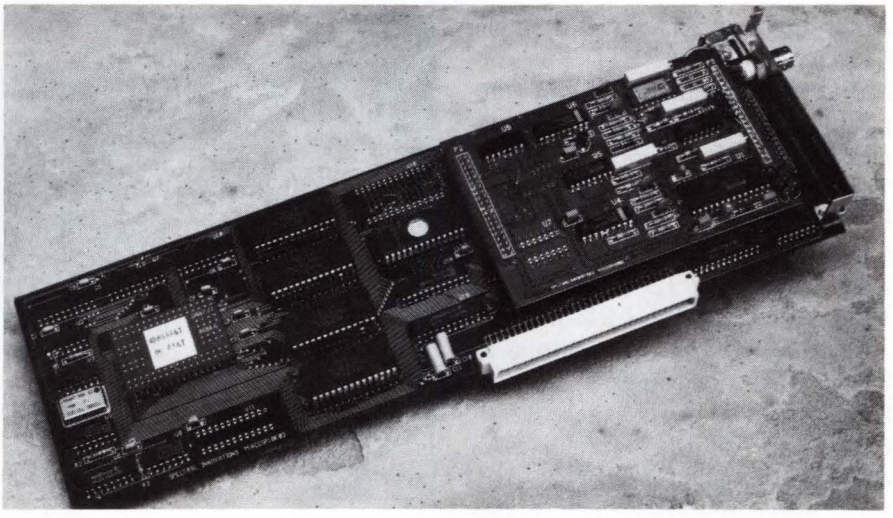
CIRCLE NO 56

DSP board and software tools perform signal analysis on a Macintosh II

Using the MacDSP add-in card and accompanying software tools, Macintosh II owners can develop an interactive menu-driven signal-analysis system. When operating in conjunction with a data-acquisition daughter card, the DSP card acquires data at a 125-kHz rate and processes and displays it in real time. The DSP board is available in a 8M-, 12.5M-, or 25M-flops version. The daughter card has a 16-bit ADC and a 16-bit DAC. The DSP card uses AT&T's DSP32 DSP chip, which performs multiply-accumulate operations in a single instruction cycle. The card acts as a rasterizing coprocessor, thereby allowing it to produce real-time video displays.



The board comes with menu-driven, icon-based software for manipulating a Macintosh mouse. A signal-analysis application package performs FFTs, spectral averaging, Hilbert transforms, and FIR and IIR filters in real time.

An 8M-flops version with 64k bytes of memory and software costs $2249; a 12M-flops version with the same amount of memory and software sells for $2745. The acquisition daughter card costs $486.

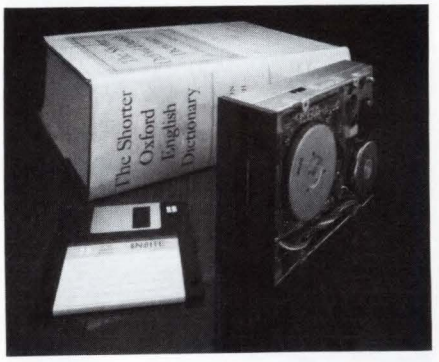
Spectral Innovations Inc, 292 Gibraltar Dr, Suite A-4, Sunnyvale, CA 94089. Phone (408) 734-1314.

Circle No 538

Removable-disk storage system offers 25M bytes of unformatted data

The Model I325 Floptical disk drive, a removable-disk storage system in a 3½-in. format, provides 25M bytes of unformatted disk capacity and 20.8M bytes of formatted memory. The disk drive combines magnetic recording with the high track densities of an optical servomechanism. By combining the two technologies, the system reaps the benefits of a removable, flexible medium and achieves the low cost of a 20M-byte drive. In OEM quantities, Model I325 costs less than $250.

The disk drive accepts double-sided, high-density disks. The



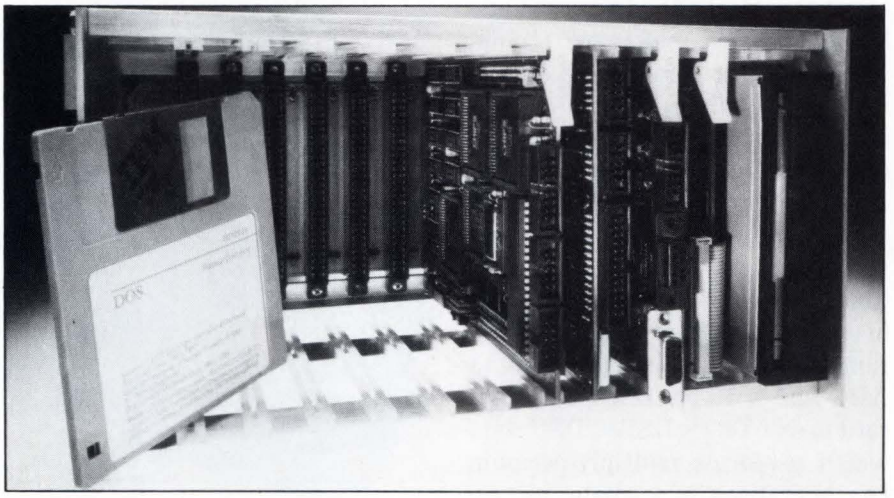
manufacturer optically inscribes 1250 concentric grooves spaced 20 μm apart, which provides 1250 tpi. Track densities of conventional magnetic floppy-disk drives range from 48 to 135 tpi; pure optical-disk drives specify over 15,000 tpi.

The servo uses LEDs similar to those in compact disks and provides an average seek time of 65 msec. The disk drive comes with an embedded disk controller and a common-command-set SCSI interface. If you have an IBM PC, PC/XT, PC/AT (or compatible) without a SCSI host adapter, the company will provide a host adapter.

Insite Peripherals, 2363 Calle del Mundo, Santa Clara, CA 95054. Phone (408) 727-8484. FAX 408-727-7917.

Circle No 544

STD Bus boards provide IBM PC/AT compatibility for industrial applications



According to its manufacturer, the STD-AT is the first STD Bus controller to offer full IBM PC/AT compatibility and 18 times the performance speed of a standard PC/XT. The STD-AT includes three plug-in boards that meet the standard 4.5×6.5-in. STD Bus card-cage form factor: the LPM-286AT, the LPM-Video, and the LPM-Disk.

The LPM-286AT card contains an 80286 CPU. It comes with 512k bytes of zero-wait-state RAM, Chips and Technologies' NEAT chip set, two RS-232C ports, a battery-backed real-time clock, a keyboard controller, an 80287 coprocessor socket, three 16-bit timer/controllers, BIOS ROM, and a speaker.

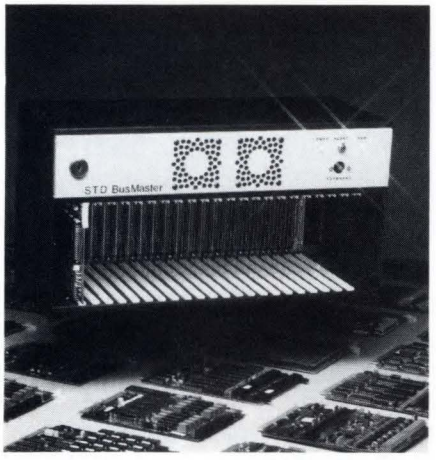
If you add the LPM-Video card to your system, you get 256-color VGA compatibility and 800×600-pixel resolution. The card supports various monitors and meets the EGA, CGA, and Hercules standards.

The LPM-Disk card lets your system control mass-storage devices having as much as 100M bytes of capacity (including 3½- and 5¼-in. floppy-disk drives). LPM-286AT, $1495; LPM-Video, $525; LPM-Disk, $295.

Winsystems Inc, Box 121361, Arlington, TX 76012. Phone (817) 274-7553. FAX 817-548-1358.

Circle No 543

Industrial IBM PC/AT-compatible system employs an 80386 μP and 23 STD Bus slots



The STD Busmaster-386 system couples a 16-, 20-, or 25-MHz 80386 μP to the STD Bus and targets industrial-control applications. The system is partitioned into two functional and physical sections.

One PC/AT-compatible card hosts as much as 16M bytes of 32-bit dynamic RAM and includes a socket for an optional 80387 math coprocessor. The 80386 μP resides on this card. This card plugs into a passive 3-slot PC/AT-compatible mother board positioned in the upper portion of the card cage.

A second PC/AT-compatible board includes a video controller that is EGA, CGA, and Hercules compatible. This multifunction card also includes two serial ports, a parallel port, a dual floppy-disk-drive controller, and a SCSI host adapter. The lower portion of the card cage houses 23 STD Bus slots and a 24th slot that interfaces the PC/AT bus to the STD Bus. A plug-in board acts as the interface between the 2 buses.

The 80386 can address 128k bytes of 8-bit STD Bus memory and 504 contiguous 8-bit I/O locations. A 16-MHz STD Busmaster (without any dynamic RAM installed) and MS-DOS costs $3995. Delivery, stock to 90 days ARO.

Computer Dynamics Sales, 107 S Main St, Greer, SC 29651. Phone (803) 877-8700.

Circle No 545

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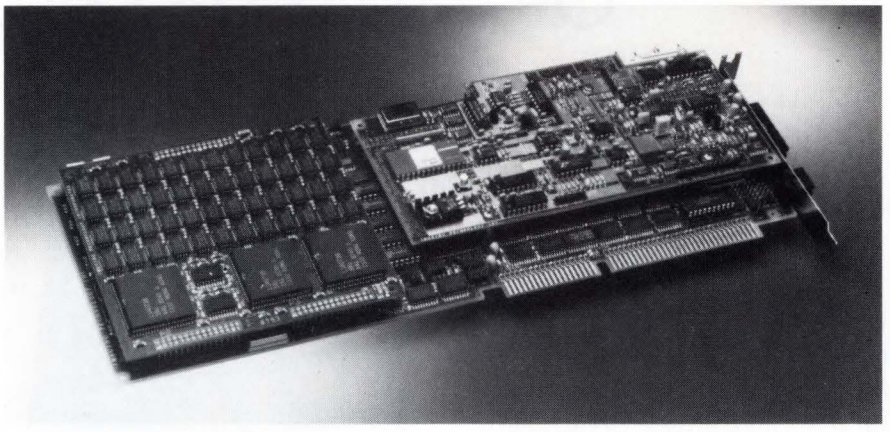
UT Salt Lake City (801) 485-1551*
WA Seattle (206) 486-5747*
WI Wisconsin (414) 797-8400*

CIRCLE NO 75

PC/AT-compatible frame-grabber board interfaces with nonstandard video sensors



The VS-100-AT is a single-board frame grabber for the IBM PC/AT and acquires images as large as 1024×1024 pixels. In addition to being able to acquire images from standard RS-170 and CCIR video cameras, the board interfaces with many of the newer CCD sensors that do not conform to industry standards. Examples include fast-frame-rate area-scan sensors, x-ray sensors, line-scan cameras, and high-resolution cameras.

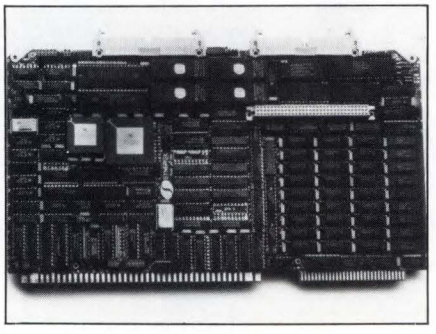
The frame grabber also includes an external part-in-place trigger that allows the board to be synchronized with external events. This feature permits the board to capture images such as parts on a conveyor belt when they pass under a camera for inspection. When the board works with CCIR cameras, a 768×512-pixel image-capture mode provides square-pixel acquisition and display. Capturing square, rather than rectangular, pixels eliminates the need for geometric corrections in gauging applications. The board also has a 640×480-pixel square-pixel capture mode for RS-170 cameras.

Programmable-gain and level-adjust capabilities let you match the video signal to its maximum digitization range and accuracy. A digital input port bypasses the digitization step if the video sensor is outputting digital data. $4495.

Imaging Technology Inc, 600 W Cummings Park, Woburn, MA 01801. Phone (617) 938-8444. TLX 948263.

Circle No 551

32-bit CPU card for Multibus I systems hosts a 68030 μP and a math coprocessor



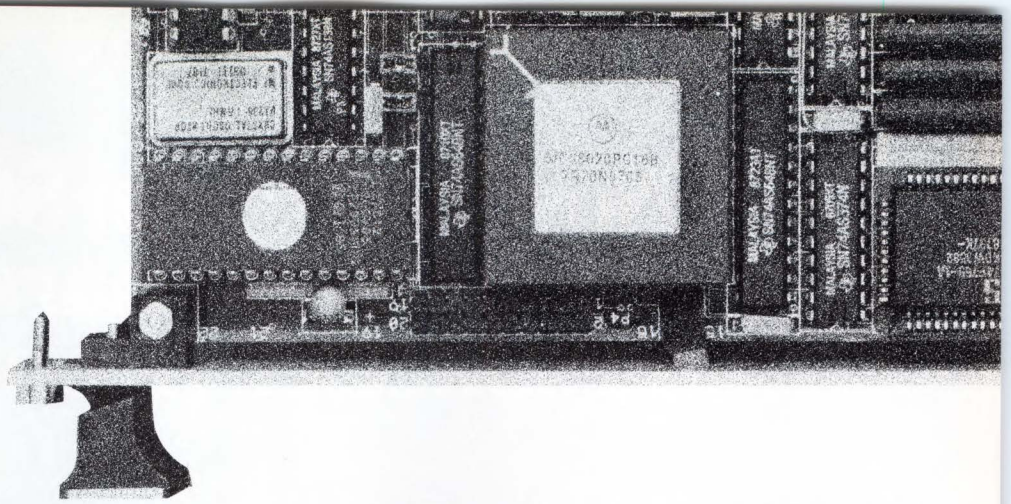
With the introduction of the SM31 board, users of Multibus I systems can upgrade their systems to use the 68030 μP. The card includes either a 20-or 33-MHz CPU and a 68882 math coprocessor. It features a 32-bit extension to the Multibus I standard, called Multiplus, which it implements on unassigned P2 connector contacts. Another salient feature is a SCSI port capable of synchronous operation at 4M bytes/sec.

The card has 4M bytes of dynamic RAM; you can expand it to 40M bytes via a local bus. The SM31 also includes 2M bytes of EPROM and five 16-bit timers. Although the 68030 has an on-chip MMU based on a descriptor cache, the board includes a custom MMU compatible with the Stanford University Network (SUN) MMU. The SUN MMU features a 256M-byte address range and 64,000 descriptors and is suitable for applications that require frequent switching between a large number of tasks.

You can add a variety of functions by adding daughter-card modules. Available modules include a 20M-flops coprocessor, a 1660×1280-pixel video controller, and an Ethernet interface. Configured with a 20-MHz processor and 4M bytes of RAM, the SM31 costs $4575 (100).

Synergy Microsystems, 179 Calle-Magdalena, Encinitas, CA 92024. Phone (619) 753-2191.

Circle No 541



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CIRCLE NO 76

Now there's an 80C86 built specially for harsh military and space environments!

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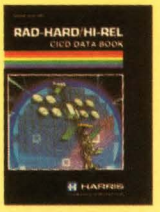
You can prototype with standard 80C86 parts then retrofit with our new rad-hard compatibles — after systems are tested and working.

Want to outshine the competition? Then give your systems a flare for the dramatic...design-in our rad-hard 80C86 family.

Contact Harris Semiconductor for details and a data book. Call 1-800-4-HARRIS, Ext. 1902 (in Canada, 1-800-344-2444, Ext. 1902).

New rad-hard 16-bit CMOS peripherals	
82C85RH	Static Clock Controller/Generator
82C37ARH	DMA Controller
82C54RH	Interval Timer
82C55ARH	Programmable Peripheral Interface
82C52RH	Serial Controller Interface (Q1, '89)
82C59ARH	Programmable Interrupt Controller (Q1, '89)



"A rad-hard 16-bit μP family now. A 64K rad-hard SRAM on SOI soon..."

"Both made for space survival...what a brilliant idea."

IN RAD-HARD CMOS ICs, THE NAME IS HARRIS

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS

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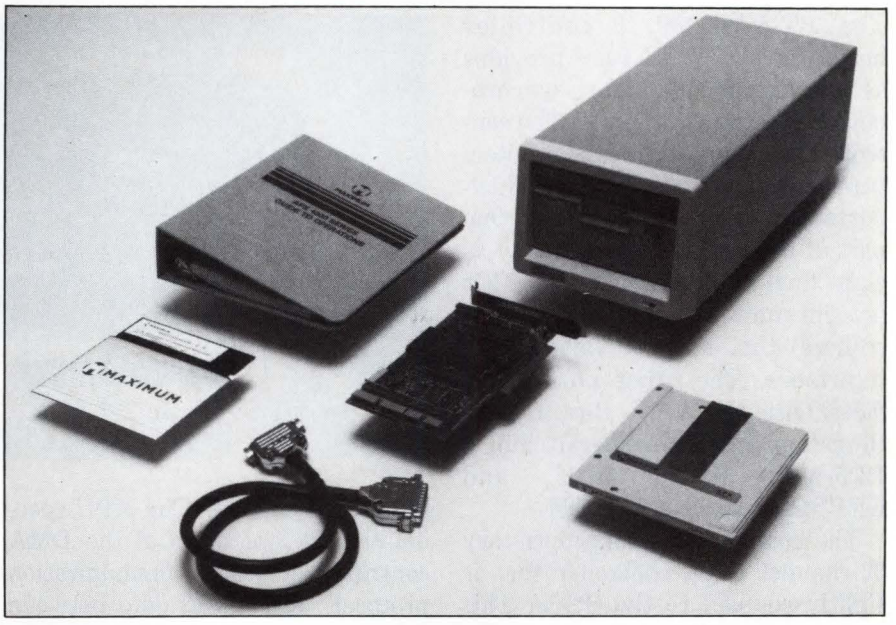
Subsystems based on optical WORM drive store 488M bytes, rival hard-disk drives

Two storage subsystems for the IBM PC bus, the APX-4100 and the APX-4200, are available based on the APX-4000 5¼-in., optical WORM (write once, read many) disk drive. The $4250 APX-4100 mounts inside a PC, and the $4450 APX-4200 includes a case and a power supply so that the WORM drive can operate outside the PC.

The full-height APX-4000 stores 244M bytes on each side of a 2-sided disk, providing a total storage capacity of 488M bytes. The disk drive can also read from and write to optical-disk cartridges in a half-density format compatible with the company's older APX-3000 disk drive.

The subsystems accept single-sided APX-3300 and double-sided APX-3600 disk cartridges, which cost $125 and $175, respectively. Both subsystems include the drive itself, cables, a controller board that adapts the drive's modified ESDI port to the IBM PC bus, Maxsys file-system software, and utility programs for file-version control and deleted-file recovery.



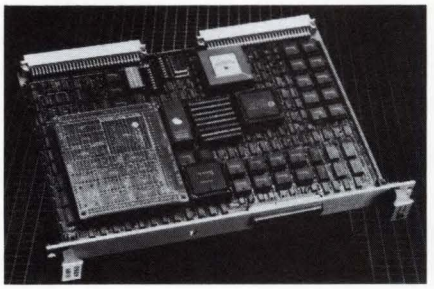
Maximum Storage Inc, 5025 Centennial Blvd, Colorado Springs, CO 80919. Phone (719) 531-6888.

Circle No 540

IPI controller for VME systems provides 36M-byte/sec transfers

If you need faster data I/O between your VME Bus system and your IPI (Intelligent Peripheral Interface) disk drives, the V/IPI 4260 Cougar controller lets you meet the ANSI performance specs required to meet IPI level 2.

Today's IPI disk drives provide 3M-byte/sec transfer rates; the next generation of IPI level 2 drives is expected to offer transfer rates as high as 6M bytes/sec. Because the Cougar board has a 36M-byte data-transfer rate and uses a 1:1 interleaving scheme, it can control as many as eight drives.



The board is based on a 16-MHz 68020 and comes with a 256k-byte data buffer, which you can expand to 512k bytes. Using internal logic, the board segregates the processor-to-memory data path from its IPI-to-VME bus data path. The board's bus path is 32 bits wide for 8-, 16-, or 32-bit addressing and transfers.

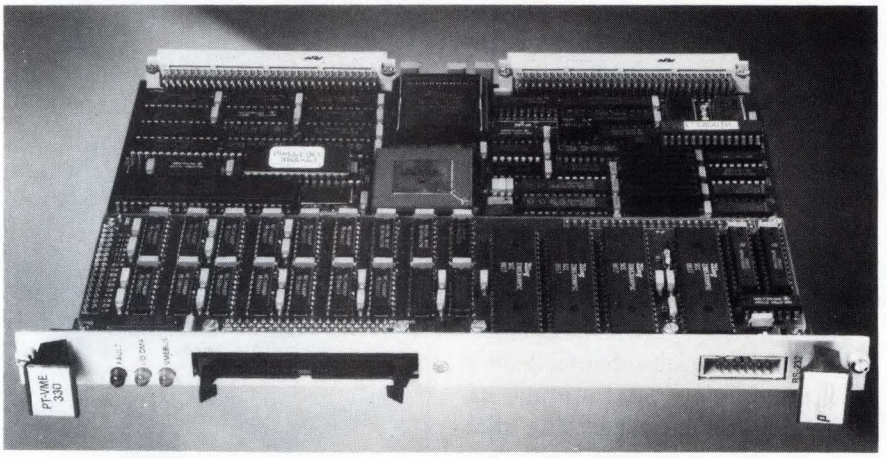
The Cougar accommodates VME Bus sequential-mode transfers. Hardware switches let you select from four bus-priority levels. A proprietary software interface creates individual work queues for each of the IPI devices that the board controls. The V/IPI 4260 Cougar costs $4995.

Interphase Corp, 2925 Merrell Rd, Dallas, TX 75229. Phone (214) 350-9000.

Circle No 539

Synchronous-communication controller for the VME Bus provides 16 serial ports

The PT-VME330, a controller board for the VME Bus, provides as many as 16 full-duplex synchronous-communication ports. The controller has a split-data-bus architecture built around a 1M-byte, dual-ported, dynamic-RAM buffer. One port of the buffer feeds as many as eight dual-channel Z8530 (H) SCCs (synchronous communication controllers) that support various line interfaces. The other port interfaces with the VME Bus, a multifunction 68901 peripheral chip, a 12.5-MHz 68020 MPU, and EEPROM and boot EPROM.



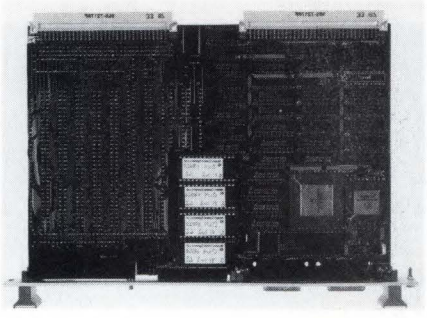
The board also uses a proprietary 32-channel DMA controller that is tightly coupled to the SCCs. This arrangement allows the controller to support data rates to 137k bps for 16 full-duplex serial-I/O channels and to 1.35M bps for one full-duplex I/O channel. The MPU coordinates the operation of the DMA controller, executes communication protocols, and moves data between the dual-ported memory and the VME Bus at rates approaching 12.5M bytes/sec. The controller includes the company's PT-VSI ASIC chip, which permits the user to configure the board using software. $2475 (100).

Performance Technologies Inc, 435 W Commercial St, East Rochester, NY 14445. Phone (716) 586-6727.

Circle No 546

STE Bus card economically adds I/O channels to VME Bus system

The VSC020 CPU card features both VME Bus and STE Bus interfaces, allowing you to use STE Bus boards to implement low-cost industrial I/O ports in VME Bus systems. An I/O subsystem based on STE Bus cards reduces I/O costs by as much as 50% compared to a system using VME Bus I/O cards. Alternatively, you can use the CPU card simply to add 32-bit processing power to an STE Bus system. Because both VME and STE Bus cards are based on Eurocard footprint boards with DIN-41612 connectors, it's easy to integrate buses into the same packaging.



The CPU card includes a 12.5-, 16-, or a 20-MHz 68020 μP; 1M or 4M bytes of dynamic RAM; two serial-I/O channels; and a 16-bit counter/timer. The 32-bit VME Bus interface, which occcupies the card's P1 connector, allows the CPU to operate in a multiprocessor VME Bus environment. The STE Bus interface occupies the two outer rows of pins on the card's P2 connector. An onboard bus arbiter allows you to add extra bus masters to the STE Bus. The company supports the CPU card with the OS-9/68k operating system. The VSC020 sells for £1380.

Arcom Control Systems Ltd, Unit 8, Clifton Rd, Cambridge CB1 4WH, UK. Phone (0223) 411200. FAX 022-341-0457.

Circle No 542

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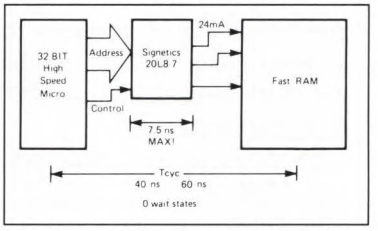
Vroom! Now you can get the zero wait state performance that will allow memory to keep pace with the new ultra-fast microprocessors. And you won't have to pay top price for your memory to do it!



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7.5ns 20-pin		7.5ns 24-pin	
PLUS16L8-7	PLUS16R6-7	PLUS20L8-7	PLUS20R6-7
PLUS16R4-7	PLUS16R8-7	PLUS20R4-7	PLUS20R8-7

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One standard. 0 defects.

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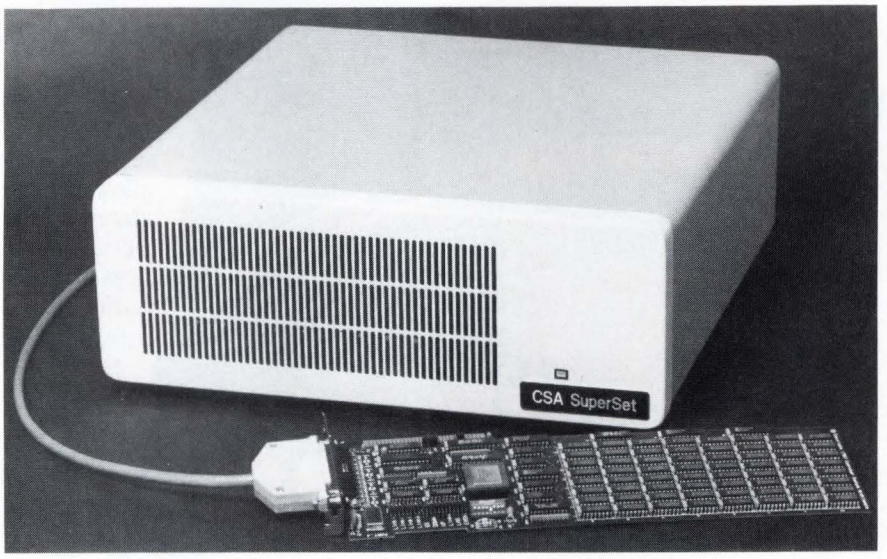
CIRCLE NO 37

Parallel-computing add-on consists of sixteen 32-bit transputers

The SuperSet.16 is a parallel-computing add-on that operates in conjunction with a workstation host. It consists of a host-interface card and a desktop or rack-mountable cabinet that houses sixteen 32-bit Inmos transputers.

Each transputer node includes local RAM and is arranged as a 4-dimensional hypercube. A seventeenth node connects to the hypercube via a communication-link switch and acts a system node that passes messages to and from the host interface. The host system can be an IBM PC, PC/XT, or PC/AT (or compatible), or it can be a VME Bus host.

You can program the subsystem in C, Fortran-77, Occam, or a combination of the three. The C and Fortran compilers come with concurrency libraries and network loaders to facilitate parallel implementation.



An IBM PC model using T414 integer processors and having 256k bytes of memory per node costs $18,000. The same configuration for the VME Bus costs $20,000. An IBM PC model using T800 floating-point processors and having 1M bytes of memory per node costs $36,000; a VME Bus version costs $38,000.

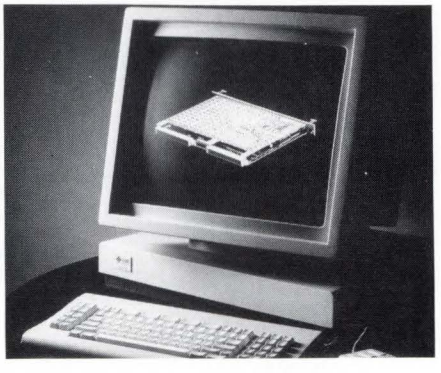
Computer System Architects, 950 N University Ave, Provo, UT 84604. Phone (801) 374-2300.

Circle No 548

Coprocessor board for Sun 3 workstation executes neural networks quickly

The Anza Plus/VME is a single-board coprocessor that you can install in any VME Bus slot in the Sun 3 workstation. It enables developers to run neural networks at speeds over 500 times greater than software-only implementations, and it comes with software that facilitates the integration of neurocomputing into C programs.

The board is equipped with 10M bytes of RAM and performs all neurocomputing functions without imposing any overhead on the host workstation. It is capable of implementing neural networks with any combination of 2,500,000 processing elements and interconnections. The coprocessor board can update a network at a peak rate of 10,000,000 interconnects/sec or at a sustained rate of 6,000,000 interconnects/sec (feed-forward mode) or 1,500,000 (back propagation). The Anza Plus/VME includes Release 2.1 of the vendor's neural-network software system (operating under the Sun Unix operating system) and costs $25,000.



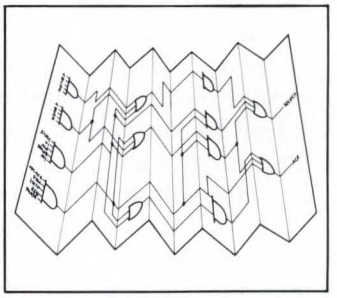
HNC Inc, 5501 Oberlin Dr, San Diego, CA 92121. Phone (619) 546-8877. FAX 619-452-6524.

Circle No 549

"Thwap!"

When you're tired of hitting the wall—Signetics Programmable Logic Arrays offer those additional product terms you're aching for.

Thwap! The 12ns Signetics PLUS173D (24-pin) and PLUS153D (20-pin) have a proven architecture with programmable AND and OR arrays that eliminate "product term depletion." In fact, when you require more than eight product terms per output these devices will outperform the fastest PAL® parts available in a fraction of the board space.



Design flexibility and efficiency with shared product terms.

Thwap! More design flexibility and efficiency. All product terms (up to 48) can be shared among all individually controlled outputs. The result—no speed penalty, improved design flexibility (active high or active low), no redundancy and enough product terms to keep you from hitting the wall. And that's not all! These PLAs, like all Signetics PLDs, are supported by ABEL, CUPL or our powerful AMAZE design software that makes designing easy.

Thwap! We've got the guts! That's right, we have those essential PLDs you need to improve total system performance. Programmable Macro Logic, Logic Sequencers, PAL-type devices and our new PLAs that reduce part count and improve system reliability.

Get the product terms you need! Call Signetics at (800) 227-1817, ext. 986D, for a PLD Data Manual. For surface mount and military product availability, contact your local Signetics sales office.

One standard. 0 defects.

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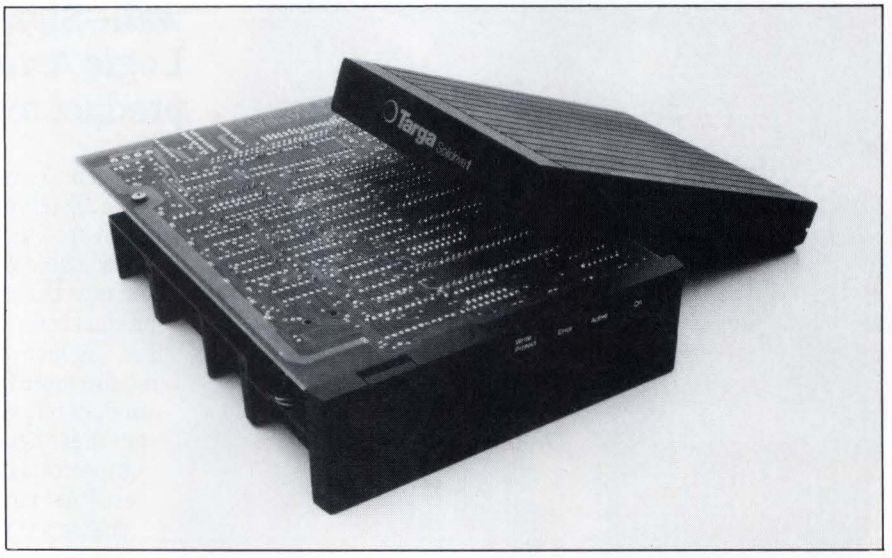
CIRCLE NO 38

Cartridge drive has nonvolatile RAM, replaces conventional disk drives

The FD4500A is a removable-cartridge drive that is a direct replacement for a standard 5¼-in. half-height disk drive. The nonvolatile CMOS RAM cartridge comes in varying capacities: 360k, 720k, 1.2M, and 1.44M bytes.

Lithium batteries having an average lifetime of 10 years maintain the cartridge memory. According to the vendor, the low-insertion-force cartridge connectors underwent more than 100,000 insertion and removal cycles without any deterioration. The cartridge holder includes a floppy-disk interface that connects directly to a floppy-disk controller.

For a 500k-bps data-transfer rate, the FD4500A has an average random-seek time of 83.3 msec; for a 250k-bps rate, it has a spec of 10 msec. It withstands shocks of 10g and vibrations of 5g.



The FD4500B, a fixed nonremovable version, offers the same capacities and battery lifetime as the FD4500A. With a 720k-byte cartridge, the FD4500A costs $895; the FD4500B costs $845. Delivery, four to six weeks ARO.

Targa Electronics Systems Inc, Box 8485, Ottawa, Ontario, Canada K1G 3H9. Phone (613) 731-9941; in US, (800) 267-9793. FAX 613-731-0342.

Circle No 547

Color thermal-transfer printers achieve 300-dot/in. resolution

The CH-5504 and the CH-5514 are color thermal-transfer printers offering 300-dot/in. resolution for A-size (8½×11-in.) and A- or B-size (11×17-in.) pages, respectively. They feature a 1-piece, injection-molded chassis and an integrated proprietary Direct-Drive-Media-Transport system for accurate media control. The integrated design permits 3- or 4-color pass printing without sacrificing print quality. The CH-5504 prints a page in 55 sec; the CH-5514 prints a page in 65 sec. Both units print on both paper and transparent film.

Three video interfaces are available. The VM1 accepts 4096 colors, the VM3 handles 270,000 colors, and VM5 accommodates 16 million. The interfaces all have a 130-MHz bandwidth and a 0.5-sec capture time.

Two Centronics interfaces are also available that accept print data in the following formats: yellow, magenta, and cyan (YMC); YMCK (a separate pass for black); 8- or 24-bit RGB; or a hybrid that combines all three. The printers sell for $5995 to $12,995, depending on the interface option. Delivery, four months ARO.

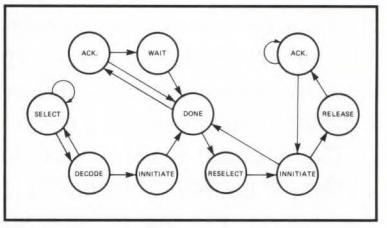
Seiko Instruments USA Inc, 1130 Ringwood Ct, San Jose, CA 95131. Phone (408) 943-9100.

Circle No 550

"Clak!"

IF-THEN-ELSE. Programmable Sequencers for advanced state machine design. From Signetics—who else!

Clak! At last, advanced state machine design is easy. Signetics Programmable Logic Sequencers (PLSs), including the new 50MHz PLUS405, have a unique architecture that employs buried registers to store intermediate values. The result—greater silicon and pin utilization with increased system functionality.



Advanced state machine designs become easy with Signetics sequencers.

Clak! IF-THEN-ELSE functionality. Signetics unique architecture makes complex IF-THEN-ELSE states possible. Connecting any AND term to any OR term (product term sharing) eliminates redundant state transition terms. And JK or SR type registers optimize the logic used in generating state transitions.

In addition, all our PLDs are supported by ABEL, CUPL or our powerful AMAZE software with auto test vector generation to make your job easier.

Clak! We've got the guts! That's right, we have those essential PLDs you need to improve total system performance. PAL®-type devices, Programmable Macro Logic, Logic Arrays and our high-speed PLSs with buried registers that make advanced state machine design easier.

Make your state machines state-of-the-art! Call Signetics at (800) 227-1817, ext. 987D for a PLD Data Manual. For surface mount and military product availability, contact your local Signetics sales office.

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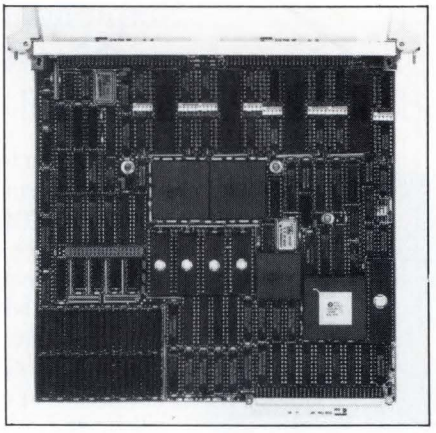
80386-based Multibus II card handles eight serial-I/O channels

The M-CC386/008 is an intelligent communications controller for Multibus II systems and has an onboard 16-MHz 80386 μP. The board controls eight serial-I/O channels. The onboard μP, 1M- or 4M-byte RAM, 82380 DMA controller, and optional 80387 math coprocessor suit the M-CC386/008 for use in high-performance systems running standard operating systems such as Unix.

The onboard RAM is dual ported to the μP and the Multibus II iPSB. Each serial-I/O channel operates at 50- to 19.2k-baud rates (asynchronous mode) or at 1.5M-bps bit rates (synchronous mode). All baud rates are software programmable, and all the serial channels provide full modem control. The board supports bit- and byte-synchronous modes for protocols such as HDLC, SDLC, X.25, and IBM Bisync.



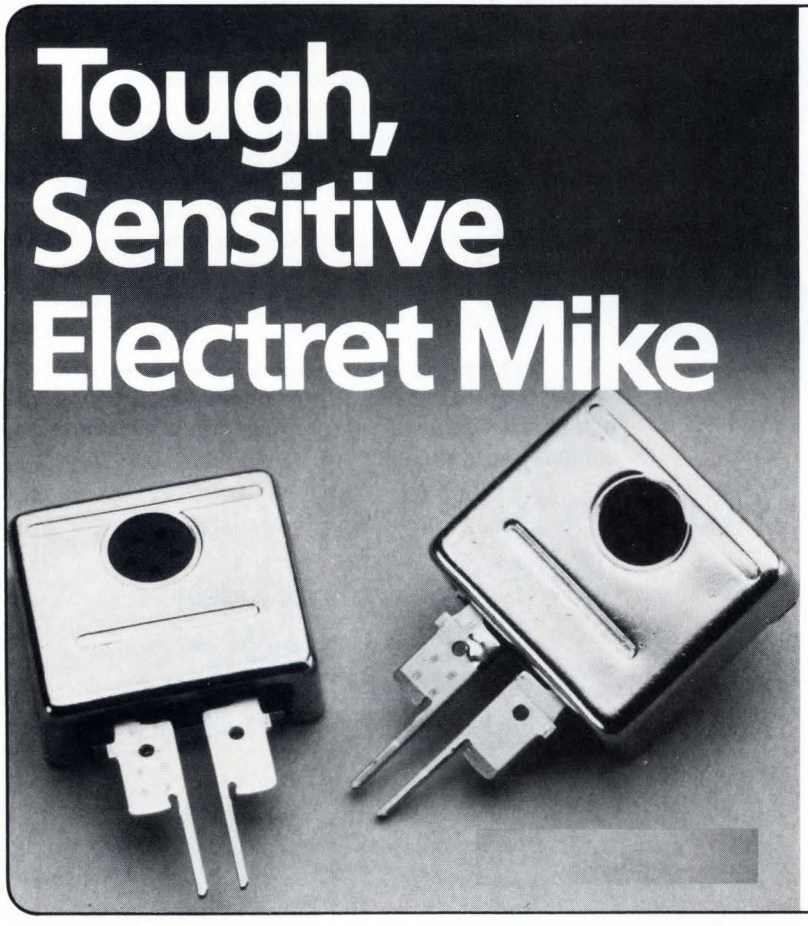
Other features include four 32-pin JEDEC EPROM sockets and an iSBX expansion interface. The iPSB interface supports Multibus II message passing, built-in self test, and interconnect space functions. $5495 to $6450.

Concurrent Technologies Ltd, Fairfax House, Causton Rd, Colchester, Essex CO1 1RJ, UK. Phone (0206) 42996. FAX 0206-67333.

Circle No 552

Concurrent Technologies Inc, 25401 Cabot Rd, Suite 206, Laguna Hills, CA 92653. Phone (714) 768-3332. FAX 714-951-8902.

Circle No 553



The electret microphone RLC 104 can withstand the toughest environment while still performing better than any other.

Between arctic —40°C and tropical +70° C you'll always get super-sensitive performance, about 10 dB better than from the best competitor. The low-mass diaphragm renders the mike insensitive to mechanical vibrations. The signal-noise ratio can't be beaten. A built-in IC handles impedance conversion and a capacitor handles RF-interference.

The microphone can be used both for handsets and loud-speaking telephones. With only two terminal contacts it is designed for fast, automatic or manual assembly without soldering. Terminals can be supplied bent at 90° to adapt to your specific design.

With our mike, you get the best.

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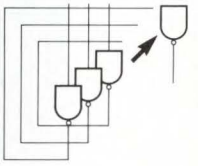
CIRCLE NO 41

"Click!"

Complete your design within hours with Signetics Programmable Macro Logic "instant" gate arrays.

Click! A programmable "instant" gate array. The PLHS501, the first of our Programmable Macro Logic (PML) products, provides up to 1300 equivalent gates—a complete solution in a 52-pin PLCC package. And its wide NAND input capability makes it ideal for high-speed address decoding and bus interface applications.



Third generation single NAND array architecture with NAND foldback paths.

It's also the easiest way to reduce your NRE costs, inventory problems and quality concerns. It's easy to use because it's supported by our powerful AMAZE software which gives you a complete system in an instant.

Click! AND/OR design constraints vanish in an instant. Signetics folded NAND array architecture provides 100% interconnectibility to eliminate routing restrictions. And 100% gate selectability to build flip-flops, multiplexers and decoders resulting in total silicon utilization.

Click! We've got the guts! That's right, we have those essential PLDs you need to improve total system performance. PAL®-type devices, Programmable Logic Arrays and Logic Sequencers plus our new PML products such as the PLHS501, that simplify complex design problems by eliminating interconnect restrictions.

Conquer complexity—instantly! Call Signetics at (800) 227-1817, ext. 988D, for a PML Design and Applications Manual. For military product availability, contact your local Signetics sales office.

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First is a comprehensive new guide to all of Keithley's hardware, software, and systems for data acquisition and control. In its 80 pages, you'll find the proven performers as well as the latest innovations. Like the rugged new 500A acquisition system and rack-mount mechanical package. The new AMM2 analog card with higher speed and resolution — 50kHz and 16 bits. And expanded dynamic range — from a high of 10 volts to a low of 30 microvolts. A new portable DC system. And new software to make it all play.

Second is a comprehensive new corps of highly specialized and objective experts called the "PC TEAM" (That's T-for-Test, E-for-Equipment, A-for-Analysis, and M-for-Measurement. PC means PC.)

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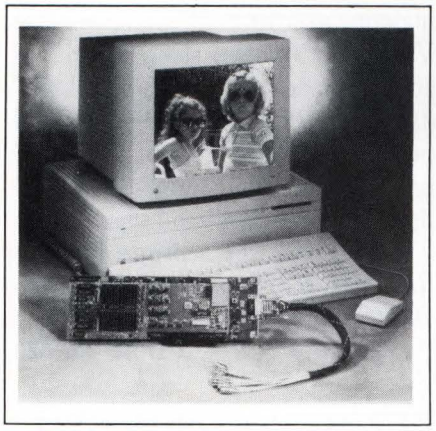
To get our book or talk with the Team, just call 1-800-552-1115. The value is excellent.

Data Acquisition & Control Division, Keithley Instruments, Inc.

KEITHLEY



MAC FRAME GRABBER

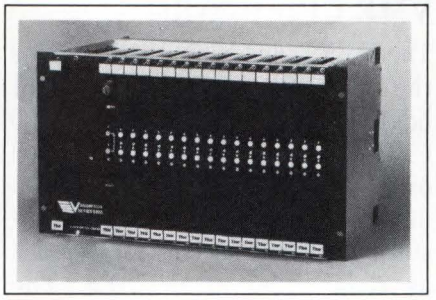
The Colorcapture is a plug-in color frame-grabber board for the Macintosh II computer. The board captures color images from video cameras, VCRs, or still-video equipment, and reproduces them within 1/30 sec (real-time) on a video monitor. It captures 640×480-square-pixel images and can display them with 32,768 different colors. In addition, the board can edit images, add text or graphics to the color video, sharpen or soften edges, adjust brightness and contrast, add and subtract multiple images, and perform animations. Two versions of the board are available: One is compatible with the 60-Hz NTSC (National Television System Committee) video format in North America and Japan; the other is compatible with the 50-Hz PAL format in Western Europe and Japan. An external trigger feature lets you synchronize the capture of a color image from phenomena like a photographer's strobe lights. $2995.

Data Translation Inc, 100 Locke Dr, Marlboro, MA 01752. Phone (617) 481-3700. TLX 951646.

Circle No 524

TRANSFER SWITCHES

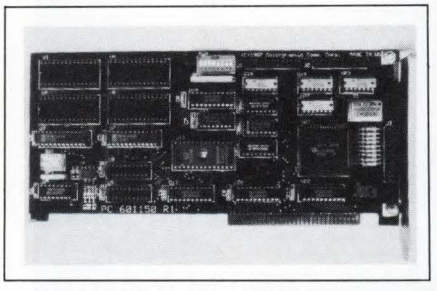
The Variswitch T-1 Master Frame holds a set of A/B transfer switches for T-1 data networks. In the event that an on-line T-1 communication link or T-1 multiplexer becomes inoperative, the transfer switch can switch the data traffic to a backup route. The unit consists of a 19-in.



master frame, which houses 16 A/B switch modules; a master-control module; and a power-supply module. The power supply can provide power for as many as 3 additional frames, each containing 20 A/B modules. This arrangement expands the capacity to 76 A/B transfer switches. You can control each switch via a pushbutton located on the front panel of each switch module. Or, using menu-driven software, you can control each module remotely from a CRT terminal. From $4640 to $5490. Delivery, six weeks ARO.

T-Bar Inc, 1 Enterprise Dr, Shelton, CT 06484. Phone (203) 926-1801. FAX (203) 929-6408.

Circle No 468

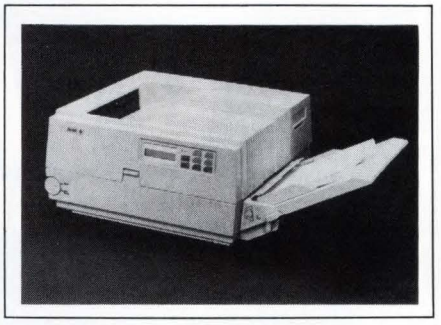


PC/AT I/O BOARD

The I/O Terminal Emulation Board is a single plug-in board for the IBM PC, PC/XT, PC/AT, and compatible computers. It provides 2 RS-232C serial ports that handle data rates as high as 38.4k baud with data structures of 5, 6, 7, and 8 data bits and 1 or 2 stop bits. It also provides a Centronics parallel port and as much as 64k×8 bits of EPROM for customized booting software. An onboard socket can hold either an 8k×8-bit or 32k×8-bit static RAM. The board can emulate a variety of terminals, including a DEC VT 220/100/52; an Intecolor 8001G/8810, 8001R/8820; and the Tektronix 4010. The I/O terminal card comes with a 122-key IBM PC-style keyboard and sells for $700.

Colorgraphic Communications Corp, Box 80448, Atlanta, GA 30366. Phone (404) 455-3921. FAX (404) 458-0616.

Circle No 469

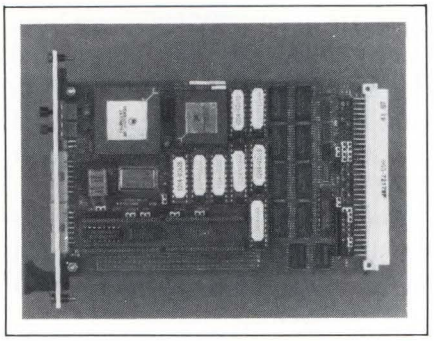


LASER PRINTER

The LP-76 is a laser printer that is fully compatible with the Hewlett-Packard Laserjet Series II. The printer can print at 6 pg/minute, download fonts larger than 30 points, and print fonts with as many as 655 points. The standard version contains 512k bytes of memory, expandable to 4.5M bytes. The printer can print with a resolution of 300 dots/in. It comes with nine resident fonts for printing in other European languages as well as in English. Twenty-one optional cartridges contain font packages written for the Laserjet family (the printer has two font-cartridge slots). The control panel has a liquid-crystal alphanumeric and graphics display for monitoring the printer's operation. A 150-pg output bin is standard, and the printer accepts input cartridges with legal, half-letter, A4, B5, and A5 paper sizes. The unit weighs 37.5 lbs and has a footprint of 16×16-in. It operates below a noise level of 55 db. $1995.

Acer Technologies Corp, 401 Charcot Ave, San Jose, CA 95131. Phone (408) 922-0333. FAX (408) 922-0176.

Circle No 521

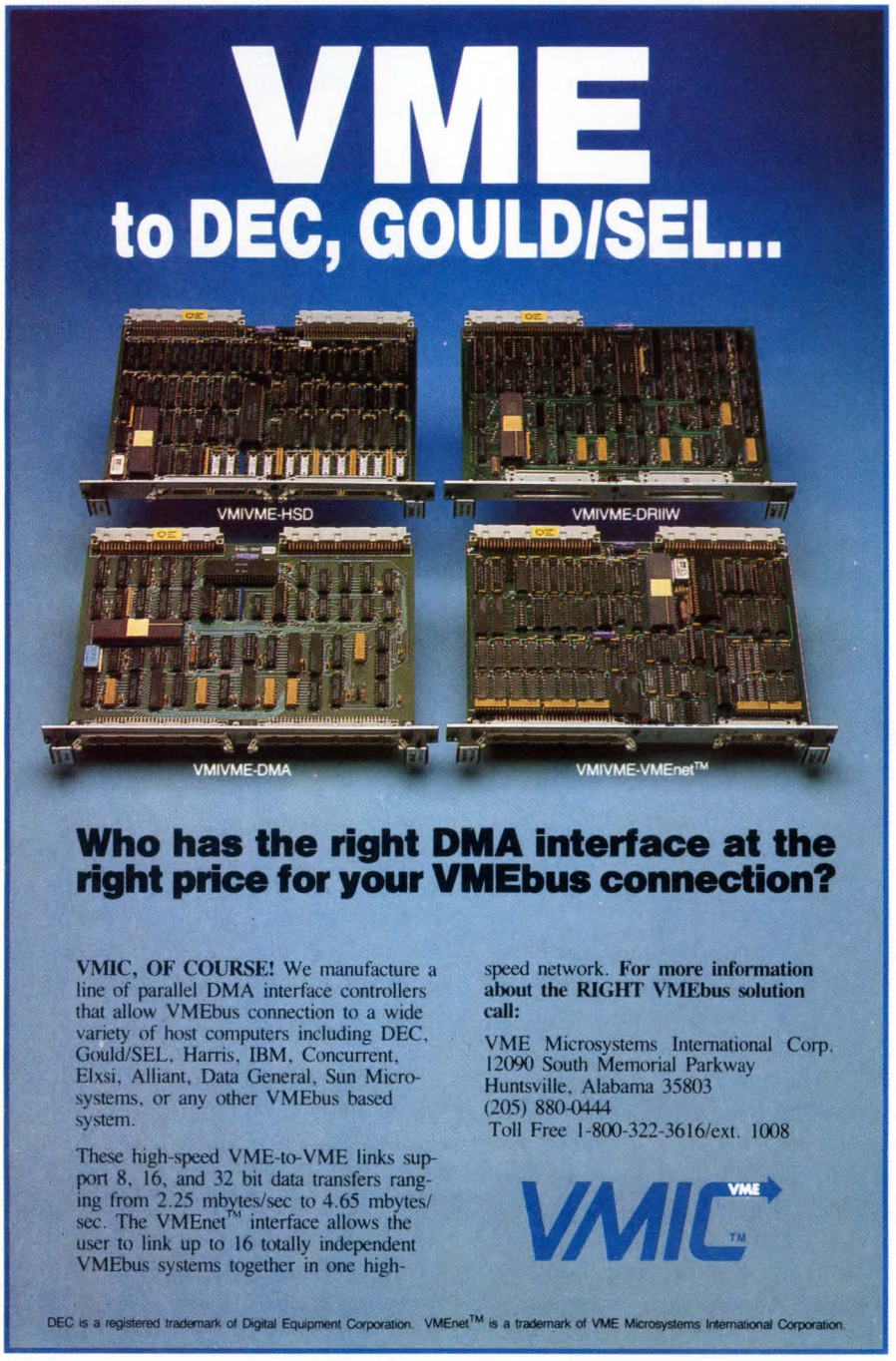


VME CPU BOARD

The XVME-602 is a CPU board for the VME Bus. The single-height board contains a 16-MHz 68020 CPU and a socket for an optional 68881 math coprocessor. The standard version has 256k bytes of static RAM and sockets for as much as 256k bytes of EPROM. The board can access 32 bits of onboard memory at a time; it can access the VME Bus by using the A24 or A16 address space. A 68681 dual UART drives 2 RS-232C serial ports and provides a 16-bit timer. The board has an expansion connector for configuring prototype modules. $1650.

Xycom Inc, 750 N Maple Rd, Saline, MI 48176. Phone (313) 429-4971.

Circle No 523



CIRCLE NO 15

FEEDTHROUGH MODEM

The XE2400FT is a 2400-, 1200-, or 300-bps modem that operates with the industry-standard AT command set. The unit has two RJ-11 connectors—one for the phone and one for the phone line. In addition, it has two RS-232C connectors; one plugs directly into an RS-232C port on a computer, and the other is a feed-through connector for any serial peripheral device. The modem conforms to the CCITT V.22 bis, V.22, and Bell 212A and 103 specifications. The unit contains an FCC-approved Data Access Arrangement (DAA).

The modem automatically sets the baud rate, and features auto-answer, and autodial and redial capabilities. It can also perform remote and local loopback tests as recommended in CCITT V.54. You can switch the modem to transmit or receive data over the phone lines or to provide a feed-through connection to a peripheral. You don't need an A/B switch to use it. A packaged unit consists of the modem, an RJ-11 cable, an RS-232C cable, an adapter connector (DB-25 pin to DB-9 pin), data-communication software, a manual, and a warranty card. From $399.

Xecom Inc, 374 Turquoise St, Milpitas, CA 95035. Phone (408) 945-6640. FAX (408) 942-1346. TLX 325672.

Circle No 531

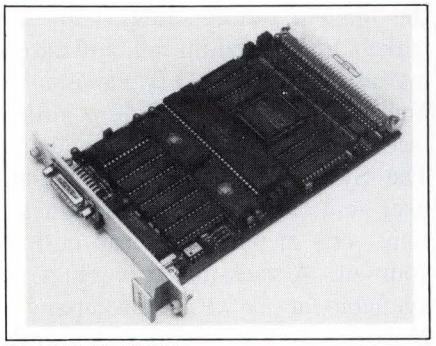
CPU CARD

The RAUT286/10 CPU card for Multibus II computer systems runs

a 10-MHz 80286 μP and an optional 10-MHz 80287 math coprocessor. The CPU card has 256k bytes of onboard, zero-wait-state, battery-backed RAM; space for 256k bytes of EPROM; an 80258 4-channel DMA controller that can transfer data at 8M bytes/sec; an RS-422A (optionally RS-232C) serial interface; and a watchdog timer. In addition to its Multibus II iPSB interface, the board also has a P2 connector interface to the G96 Bus, allowing you to access 16M bytes of local memory, and system I/O. The Multibus II interface supports the iPSB interconnect space and built-in self-test (BIST) functions. Around Fr 14,000.

Geomelec SA, 1 chemin du Bulloz, PAE Les Glaisins, 74000 Annecy-le-Vieux, France. Phone 502-32812. TLX 385350. FAX 50235624.

Circle No 656



LAN CARD

The VLAN is a single-height, single-slot VME Bus board that provides an IEEE 802.3 (Ethernet) LAN interface. The board is based on an AMD 7990 LAN controller, and includes a 68000 μP. The 68000, which runs the Vioxrom real-time multitasking operating system kernel, handles TCP/IP protocols locally. Two 64k-byte dual-port RAMs, one between the μP and the LAN controller and the other between the μP and the board's VME Bus interface, maximize the board's throughput.

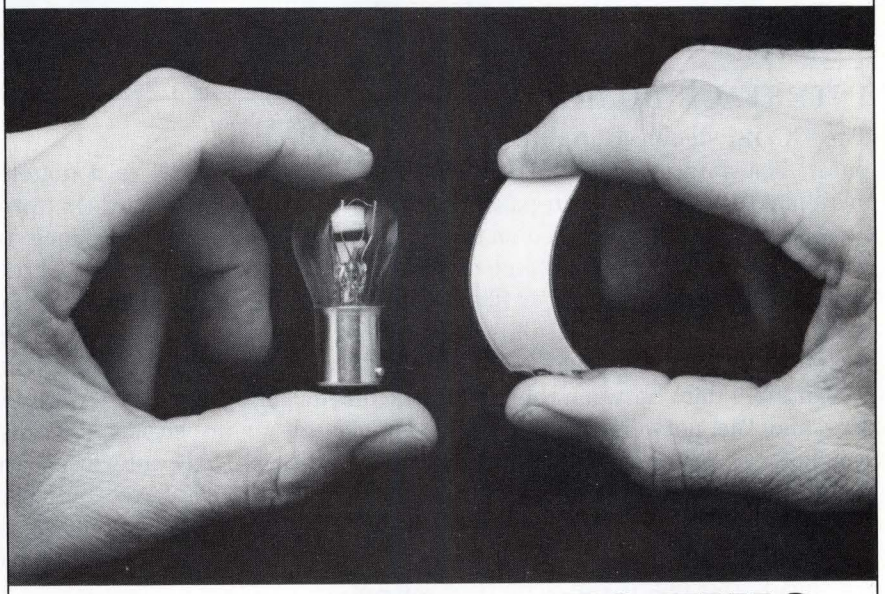
Data transfers to or from host CPUs on the VME Bus go through a mailbox facility in the μP's and VME Bus's dual-port RAM. Mailbox interface software drivers are currently available for the OS-9/68000 and PDOS 3.3 operating systems. Link-level access, Telnet, and file-transfer protocol (FTP) are available as an option. The board has a 15-pin attachment unit interface (AUI) for connection to the LAN. You can add a media attachment unit (MAU) for Ethernet or Cheapernet networks. DM 4500 (OEM qty).

Pep Modular Computers GmbH, Am Klosterwald 4, 8950 Kaufbeuren, West Germany. Phone (08341) 81001. TLX 541233. FAX (08341) 40422.

Circle No 654

Pep Modular Computers Inc,

PULL A LIGHT SWITCH.



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Durel™ Electroluminescent (EL) lighting eliminates the wasted space, energy, and heat of incandescent bulbs.

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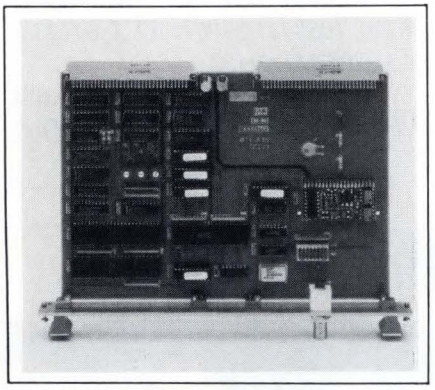
645 WEST 24TH ST. • TEMPE, AZ 85282 • 602-731-6200

CIRCLE NO 16

Carnegie Office Park, 600 N Bell Ave, Pittsburgh, PA 15106. Phone (412) 279-6661. TLX 6711521.

Circle No 655



INTERFACE BOARD

The CC-121 double-Eurocard computer board interfaces VME Bus systems to Arcnet token-passing networks. The board is based on the COM9026 Arcnet controller and can operate with either coaxial or fiber-optic network cabling. It has 2k bytes of onboard dual-port RAM that buffers data between the VME Bus and the network. This buffer can hold as many as four network data packets with a maximum length of 508 bytes per message. Including host-system software overhead, the board can achieve a throughput of 1.5M bps on the network. Data is transferred between the dual-port RAM and the VME Bus in 10M-byte bursts.

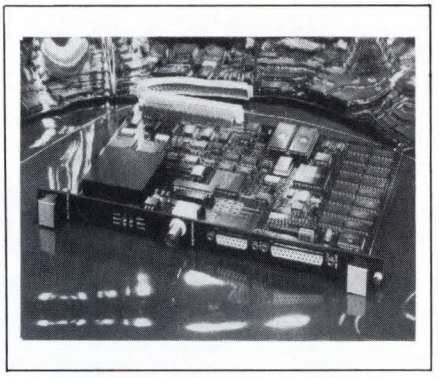
The board operates as a VME Bus slave with 8-bit access to the controller chip and onboard registers and 8- or 16-bit access to the dual-port RAM. The VME Bus also has a 7-level interrupt requester with a software-programmable interrupt vector. Software drivers are available for the OS-9/Net operating system. The company will develop other drivers on request. The CC-121 typically consumes 1A of 5V supply current. $825 (100).

CompControl bv, Stratumsedijk 31, 5600 AD Eindhoven, The Netherlands. Phone (040) 124955. TLX 51603.

Circle No 658

CompControl Inc, 15466 Los Gatos Blvd, Suite 109-365, Los Gatos, CA 95032. Phone (408) 356-3817. TWX 510-601-2895.

Circle No 659



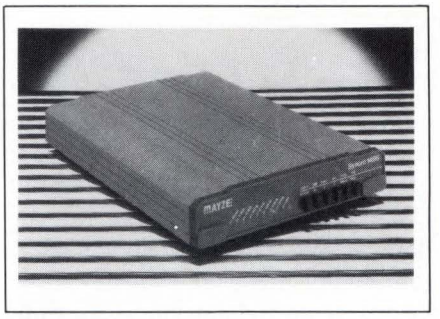
LAN BOARD

The VME68570-LAN is a double-Eurocard VME Bus board that provides an intelligent interface to IEEE 802.3 networks. The board's LAN interface has a transceiver for direct connection to a Cheapernet LAN, and a 15-pin D-connector attachment unit interface (AUI) for connection to an Ethernet transceiver. These LAN interfaces are controlled by a 7990 LAN controller that transfers data using DMA to or from 512k bytes of onboard RAM.

An onboard 12.5-MHz 68HC000 μP allows you to process the data locally before passing it to the VME Bus host system. The board operates as a VME Bus slave, communicating with the VME Bus host via 2k bytes of onboard dual-port RAM and interrupts or semaphores. Alternatively, you can install as much as 128k bytes of EPROM and use the board as a stand-alone system. Software drivers to implement TCP/IP protocol are available for the OS-9 operating system. DM 2650, including 128k bytes of local RAM.

EKF-Elektronik GmbH, Weidekampstrasse 1a, 4700 Hamm 1, West Germany. Phone (02381) 12630. TLX 828621. FAX 02381-15067.

Circle No 657



MODEM

The Syncro-1496 is a multistandard modem that can transmit and receive data over a variety of data links ranging from simple dial-up lines to sophisticated point-to-point data links. The modem is a V.32 9600-bps modem that uses trellis coding and local and remote echo-cancellation techniques, but it also includes V.33, V.29, and V22 bis operating modes. As a result, it can transmit at speeds ranging from 14,400 to 1200 bps.

If the modem is operating on a leased line and the leased line fails, the modem can reconfigure itself, make a PSTN dial-up call, and automatically restore data transmission. You can also use the dial-up interface to configure remote modems. The Syncro-1496 stores 12 preset user-selectable modem configurations, one of which you can define yourself. A rack-mount version is available for use with the company's Network-16 data-communications management system. Stand-alone version, £1995; rack-mount version, £1945.

Mayze Systems Ltd, Delta 900, Great Western Way, Swindon, Wiltshire SN5 7XQ, UK. Phone (0793) 511789. TLX 445707. FAX (0793) 511683.

Circle No 660

GRAPHICS CARD

The TT786 add-in graphics card for IBM PCs and compatible computers provides both digital and analog outputs, allowing you to drive standard monitors at resolutions as high as 800×560 pixels. In its analog mode, the card allows you to simul-

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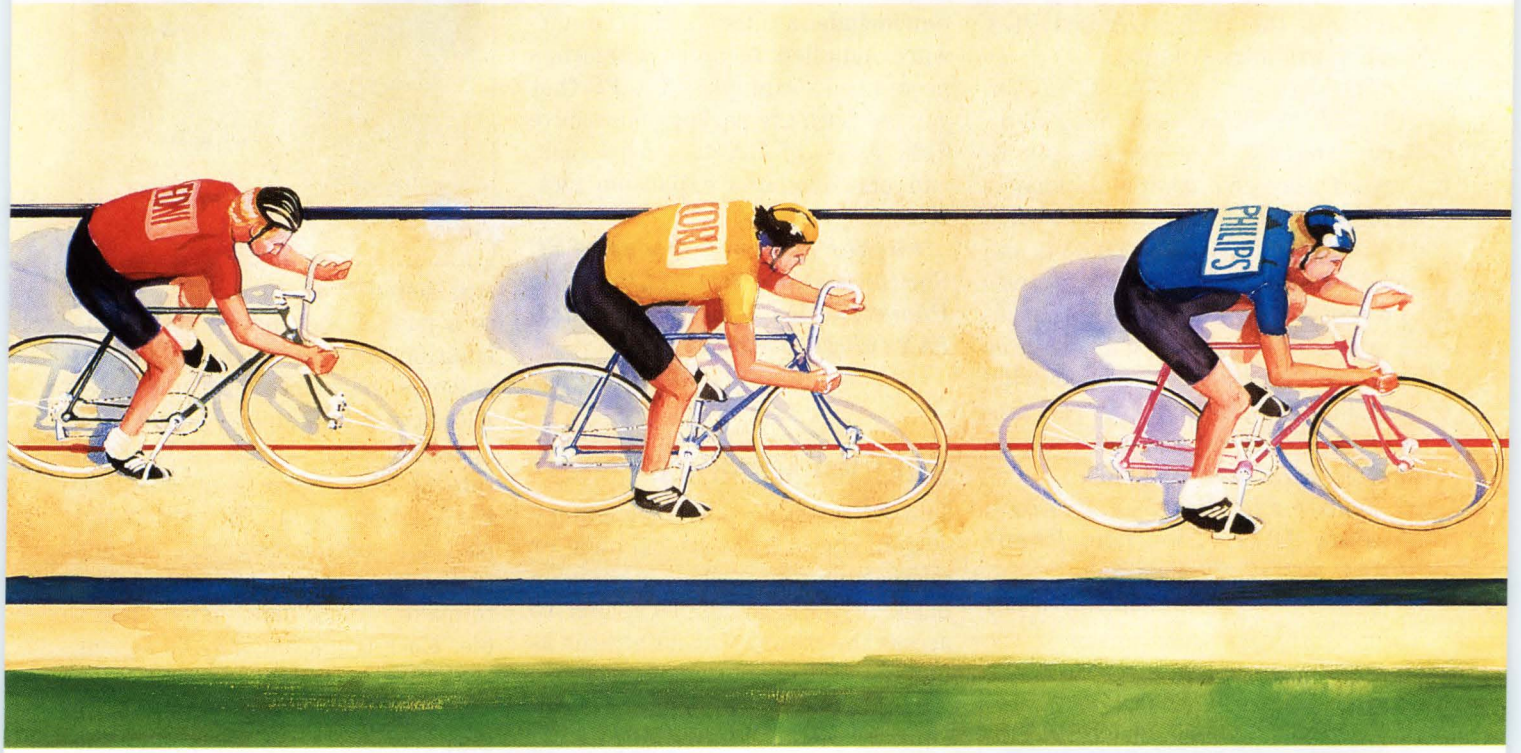

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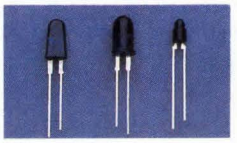

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In Canada: Philips Electronics Ltd., 601 Milner Ave., Scarborough, Ontario M1B 1M8, (416) 292-5161

taneously display as many as 256 colors from a palette of 262,144 colors. It's compatible with IBM CGA and EGA digital graphics adapters, and with the IBM VGA and PGA analog graphics systems.

The card is available with 512k, 1M, 2M, or 4M bytes of video memory. The 4M-byte version allows you to store and manipulate images containing as many as 8000 × 4000 1-bit pixels, or 2000 × 2000 8-bit pixels. An Intel 20-MHz 82786 graphics processor provides features that include a drawing speed of 35 nsec per pixel, and hardware windowing capabilities. The company can provide a library of graphics routines for the card. £395 to £1400.

Tektite Ltd, Box 5, Felixstowe, Suffolk IP11 7LW, UK. Phone (0394) 672117. TLX 987458.

Circle No 661

TRANSPUTER KIT

This fully integrated Transputer training package operates with an IBM PC or compatible computer to provide an educational introduction to the operation of the Inmos T414 Transputer. The package comprises a Transputer module, an interface card for the IBM PC, development software that includes an Occam compiler, and full documentation. The Transputer module includes 256k bytes of RAM, 4 Transputer links, I/O ports, and system-status LEDs. The status LEDs indicate communication to and from the PC, Transputer activity, external-memory access, errors, and event outputs.

The I/O ports are available on a 40-way connector so that you can link the Transputer module to application boards. Training documentation includes a tutorial, and the software supplied includes numerous programs as examples. The PC that you use with the package must have 640k bytes of RAM, a hard disk, and one available expansion slot. £995.

Flight Electronics, Ascupart St, Southampton SO1 1LU, UK. Phone (0703) 227721. TLX 477389. FAX (0703) 330039.

Circle No 662

SHARED MEMORY

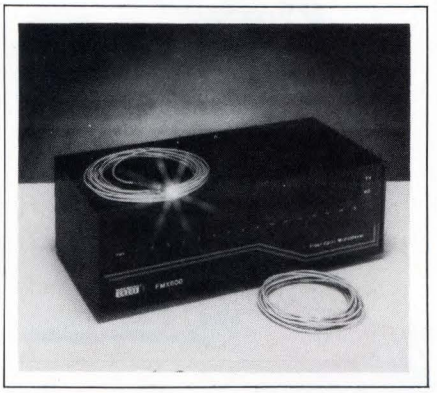
The SNAP-SMS shared-memory system allows conventional mini- or microcomputers to share a common block of physical memory, and to access the memory at data rates as high as 88M bytes/sec. You can use it with a variety of computers, including MicroVax, IBM PC/AT, VME Bus-based computers, and the company's SN-series computing engines. The memory system is suited for use in high-performance real-time applications—for example, flight simulators—where tasks are distributed among several processors that need to share a common database or to exchange data at high speed. The shared memory appears to each attached processor as local memory and thus minimizes operating-system overhead for shared memory access. From around £11,000.

FFT Systems Ltd, 2 Venture Rd, Chilworth Research Centre, Southampton SO1 7NP, UK. Phone (0703) 760611. FAX (0703) 766679.

Circle No 663

FIBER-OPTIC MUX

The FMX800 is a family of fiber-optic multiplexers that provides a high-data-rate link between separate buildings and computer clusters. A single chassis can multiplex



and demultiplex 16 RS-232C ports to a pair of fiber-optic cables. The addition of three expansion chassis expands the number of ports to 64. All of these full-duplex channels can operate at the maximum RS-232C rate of 19.2k baud as specified by the V.24 standard. The control signals are continuously scanned and transmitted through the trunk line to make remote handshaking possible. Each trunk line may be as long as 3.5 km.

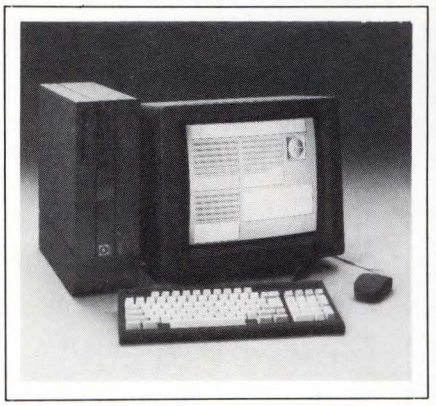
The unit consists of an enclosure that contains a power supply, and a mother board that accepts modular plug-in cards. The plug-in cards include a fiber-optic module, from 1 to 16 RS-232C channel cards, and an expansion card. The FMX800 transmits data at 3M baud over the fiber-optic link. The unit measures 16.8 × 5.3 × 8-in. It costs $800 for two channels, and just under $5700 for each end of a full 64-channel system.

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111. TLX 666491.

Circle No 525

PARALLEL COMPUTER

The XTM is a modular parallel-processing supercomputer. The basic desktop system contains two 20-MHz Inmos T800 Transputers that can provide 5 MIPS and 1.5M flops of performance each. You can order the system with as many as 400 processors. A 30-processor system, for example, delivers 45M flops and 150 MIPS (as measured in DEC's



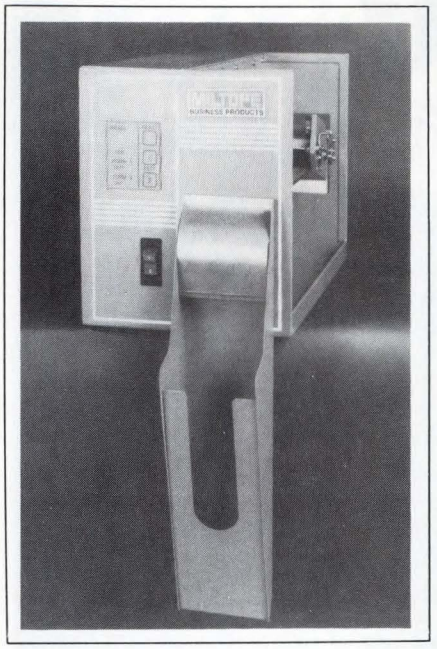
VAX 780's MIPS). The architecture contains a parallel bus and an intelligent switch, which can dynamically reconfigure the Transputers' communication links. The computer runs the Linda software environment developed at Yale. You can invoke Linda by adding four statements to familiar progamming languages, such as Lisp, Ada, C, or Fortran. The system can have a 90M- or 190M-byte, internal SCSI hard-disk drive; an 800k-byte, double-sided 3½-in. floppy-disk drive is standard. Prices depend on the configuration. A 2-processor system costs $19,800; a 30-processor system costs $225,300.

Cogent Research Inc, 1100 NW Compton Dr, Beaverton, OR 97006. Phone (503) 690-1450. FAX (503) 690-1344. TLX 990986.

Circle No 526

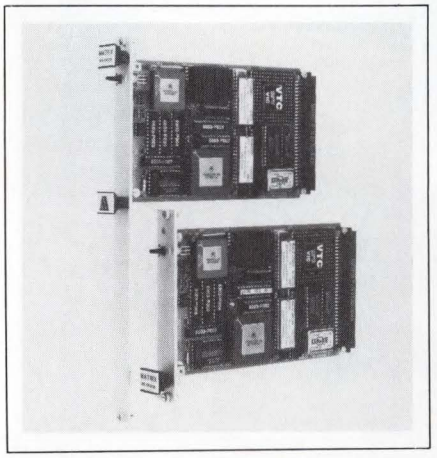
TICKET PRINTER

The Series 4550 is a ticket, boarding-pass, and baggage-tag printer that can print alphanumeric characters and bit-mapped graphics on 3¼-in. wide, 100-lb fan-fold stock. The direct-thermal printer has dual stock feeds, which means you can set the unit up so it can print two types of documents on demand. You can format the data on a host computer and download it to the printer via an RS-232C or RS-422 port (or a 20-mA link) at data rates ranging from 300 to 19.2k baud. Both horizontal and vertical printing resolutions are 4 dots/mm (approximately 100 dots/in.). The standard character size is 0.07×0.107-in. (other character sizes are also available). The unit can print logos, bar codes, and machine-readable OCR characters. It has a self-contained power supply that can operate from 115V ac at 60 Hz or 220/240V ac at 50 Hz. $4500.



Miltope Business Products Inc, 1770 Walt Whitman Rd, Melville, NY 11747. Phone (516) 420-0200. TWX 510-221-1803.

Circle No 527



NETWORK SERVER

Designed for use on VME Bus systems, the MS-CPU220 has all the basic computing power, memory, and control necessary for acting as a universal server on a network. The system contains a VIC (VME Interface Controller) chip, a 16-MHz 68020 MPU, 1M byte of dual-ported dynamic RAM, two 32-pin ROM or EPROM sockets, and board-control and -status registers. A 68881 coprocessor is optional.

The board has a 60-pin personality-module connector for customizing applications. That connector provides a 16-bit data path and a 22-bit address for installing personality modules. The modules can configure the board as a network server, a file server, or the network's processing unit. An optional time-of-day module has a lithium battery that offers backup for more than 10 years. Software support includes OS-9, VxWorks, and a Unix-compatible operating system with TCP/IP protocols. From $1695.

Matrix Corp, 1203 New Hope Rd, Raleigh, NC 27610. Phone (919) 833-2000. FAX (919) 833-2550.

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VME CURRENT DRIVER

The VMIVME-2130 is a 64-channel high-current source-driver board for the VME Bus. The board can source 500 mA of continuous current and as much as 3.5A for a 10% duty cycle on all channels simultaneously. Each of the 64 output drivers incorporates thermal shutdown protection and output-transient suppression diodes. Each output has a high-voltage breakdown rating of 35V min. The outputs are provided on dual 64-pin DIN 41612 connectors. A built-in test feature detects and isolates faults off line or in real time. A front-panel LED lights up at power-up or at reset, and goes off after successful completion of board-level diagnostics. $995. Delivery, 45 days ARO.

VME Microsystems International Corp, 12090 S Memorial Parkway, Huntsville, AL 35803. Phone (800) 322-3616; in AL, (205) 880-0444.

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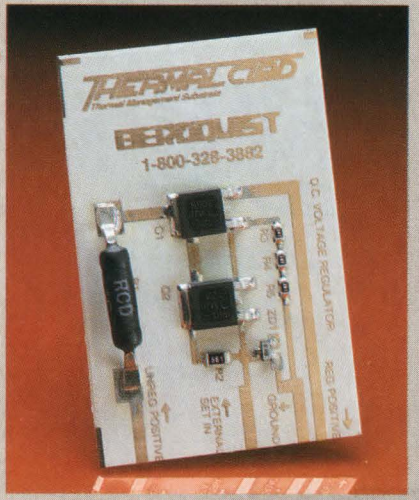

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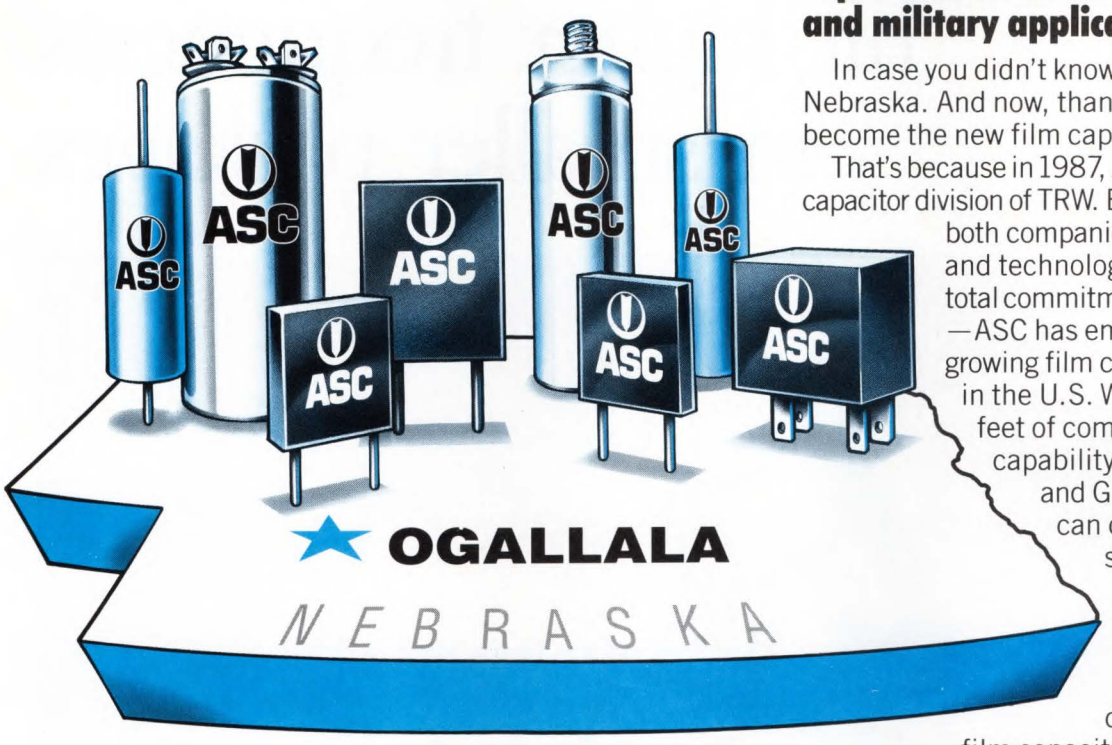

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Crystal oscillators

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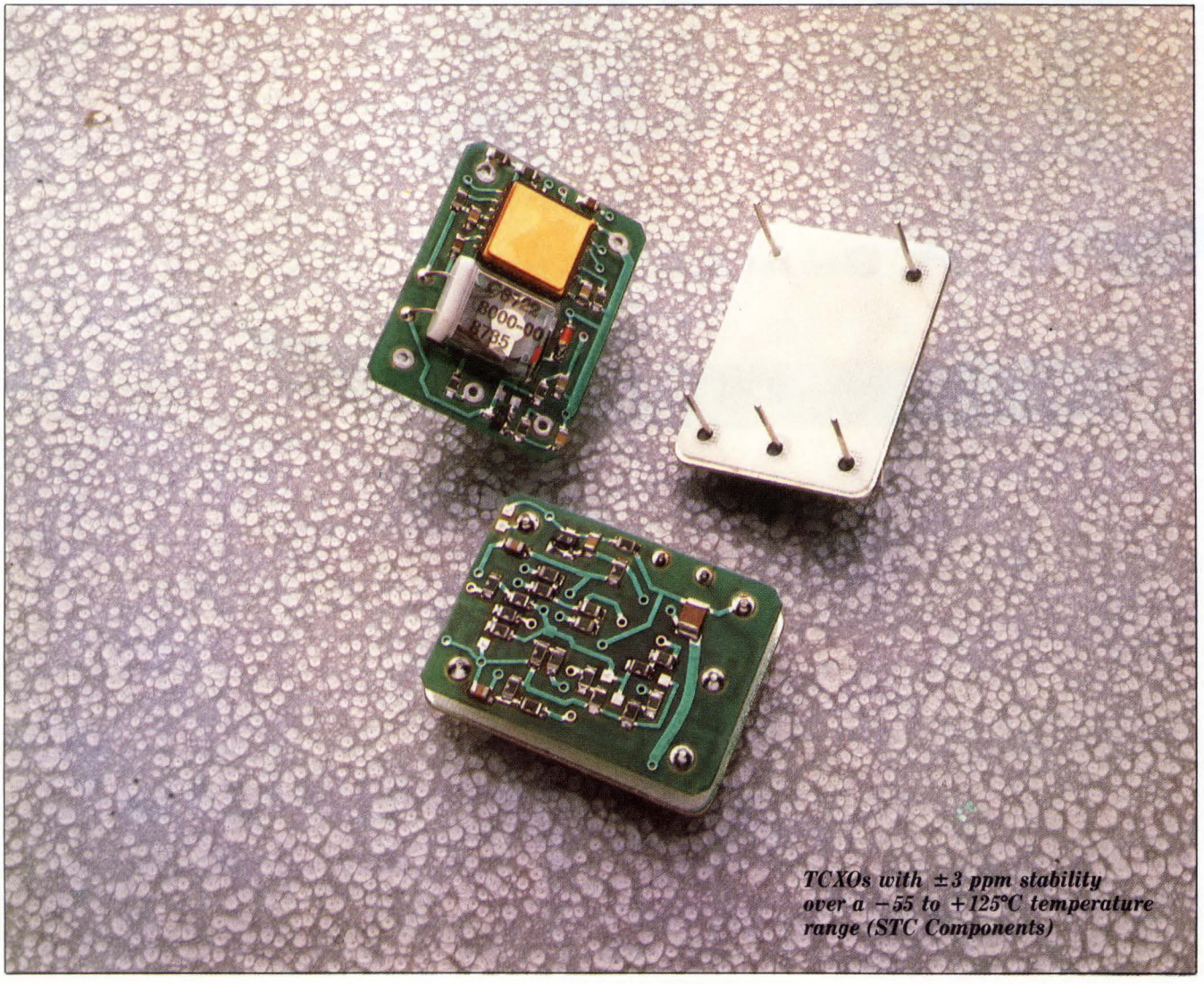


TCXOs with ±3 ppm stability over a −55 to +125°C temperature range (STC Components)

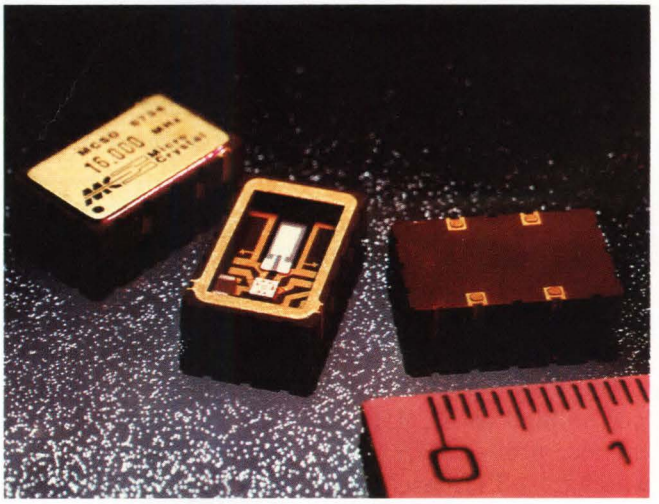
Like other components, TTL- and CMOS-compatible pc-board crystal oscillators are moving into true SMD packages. And although ECL-compatible devices still come in standard metal cans, they now provide clock frequencies as high as 400 MHz to handle high-speed logic families.

Peter Harold, *European Editor*

Manufacturers of low-cost pc-board crystal oscillators, devices that sell in high volumes to the computer industry, have had to keep pace with advances in automated pc-board assembly methods. As a result, you can now obtain a range of crystal oscillators in SMD packages for use with pick-and-place equipment, or in packages for automatic-insertion equipment. The ability of surface-mount technology to reduce the weight and increase the packing density of pc boards has also spurred manufacturers to offer military-grade devices in SMD form. Various pc-board oscillators introduced during the last year illustrate these developments.

The movement toward SMD packaging is most apparent at the low end of the pc-board oscillator market, where SMDs satisfy the needs of low-cost automated manufacturing methods. Most of these devices are general-purpose clock oscillators designed to drive CMOS or TTL circuitry at clock frequencies as high as 50 or 60 MHz. Consequently, they operate from a single 5V supply and offer moderate levels of stability—typically between ±1000 and ±100 ppm over the commercial temperature range (0 to 70°C). They can drive 10 standard TTL loads (ie, they can sink 16 mA and source at least 0.4 mA at TTL levels); they can drive CMOS inputs as well. Their typical output mark-to-space ratio is between 2:3 and 3:2 so you'll need to operate at twice the required frequency and divide the oscillator's output frequency by two with a flip-flop if you require a mark:space ratio of exactly 1:1.

Fox Electronics recently introduced its FSO Series crystal clock oscillators; they're pin compatible with Motorola's MSO Series devices and come in 4-pin J-lead surface-mounting plastic DIPs that measure



CMOS/TTL-compatible crystal oscillators in hermetically sealed SMD packages
(Micro Crystal)

General-purpose crystal oscillators no longer need special handling—standard SMD and plastic DIP packaging make things easier.

TTL-compatible military-grade SMD crystal oscillators *(Xsis Electronics Inc)*

0.550×0.385×0.185 in. These oscillators cover the frequency range from 1.5 to 55 MHz, and have a frequency stability of ±100 ppm over a −10 to +70°C range. Over the oscillator's full operating range of −40 to +85°C, that stability figure worsens to ±200 ppm.

The FSO Series oscillators that operate at frequencies as high as 36 MHz can drive 10 TTL loads, and can also drive CMOS loads. They are optionally available with a TTL-level enable input. The highest group of oscillators in this line, operating between 30 and 55 MHz, can sink or source 4 mA at TTL- and CMOS-compatible levels. You can obtain any of the FSO oscillators on tape and reel for use on automatic-placement equipment. They can withstand vapor-phase and other high-temperature soldering methods. A typical 20-MHz part sells for around $4 (1000).

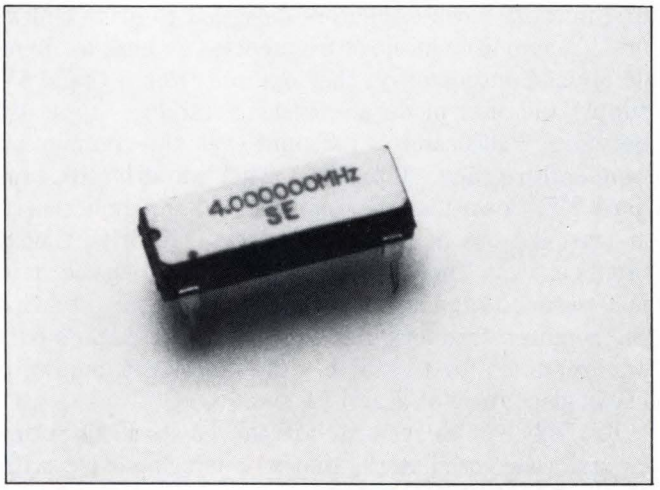
Micro Crystal's MCSO Series crystal clock oscillators, which are also pin-compatible with the Motorola MSO Series, are packaged in 0.55×0.35×0.11-in. ceramic leadless chip carriers. This design adds the advantage of hermetic sealing to a small-outline surface-mount package that's suitable for vapor-phase and wave soldering. Ranging in frequency from 0.1 to 35 MHz, these oscillators are available with stability ratings of ±5000, ±500, or ±100 ppm over a 0 to 70°C operating range. You can also order these devices for the −40 to +85°C operating range. Their outputs can each drive 10 TTL loads at logic levels that are also suitable for CMOS loads. Typical current consumption is 8 mA for a 1-MHz oscillator and 20 mA for a 30-MHz version. Priced at around $6 (1000), the MCSO clock oscillators are supplied in tray carriers, on 24-mm tape, or in sticks for use on automatic-placement equipment.

If you're looking for a very inexpensive crystal clock oscillator for conventional through-hole or socket mounting, and you want to be able to handle those devices easily with automatic-insertion equipment, consider using one of Savoy Electronics Inc's S2150 or S2650 Series oscillators. Unlike metal-can oscillator packages, which overhang the pins on all sides by approximately 0.1 in., S2150 and S2650 Series oscillators come in standard 14-pin plastic DIPs, thus adding real-estate savings into the bargain. They sell for around $2 (1000). The S2150 Series, which covers the frequency range 62.5 kHz to 20 MHz, has a TTL- and CMOS-compatible output that can drive 1 LSTTL load or 15 pF. The S2150s' maximum 5V supply current is 6 mA.

The higher-speed S2650 Series oscillators cover the frequency range from 15.625 kHz to 20 MHz. They have rise and fall times of 15 nsec max for CMOS loads with total capacitance values as high as 50 pF, and 5 nsec for a load that has 10 LSTTL gates. Maximum supply current for S2650 Series oscillators is 12 mA with a 50-pF load.

Both series have a stability rating of ±100 ppm over their 0 to 70°C operating range—a rating that includes a calibration accuracy at 25°C as well as the effects of supply-voltage variation, load changes, aging, shock, and vibration.

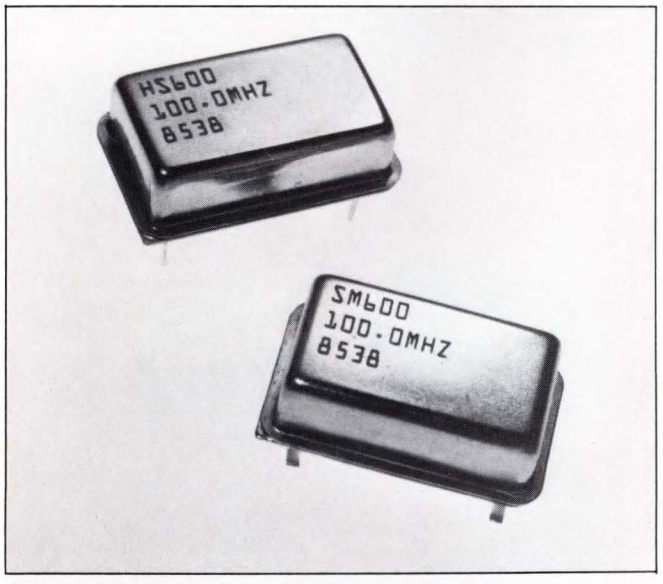
Xsis Electronics is typical of the companies that have



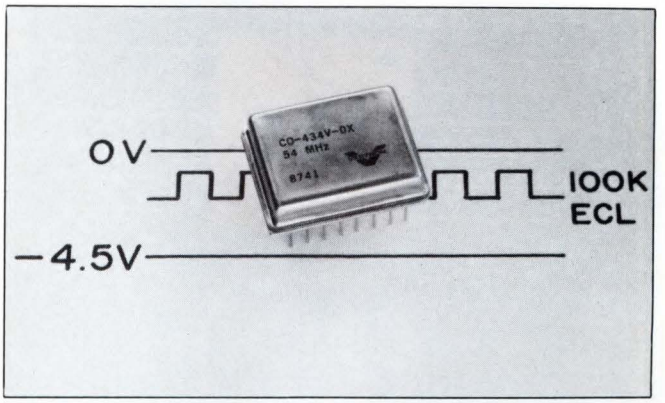
A low-cost crystal oscillator in IC-style plastic DIP *(Savoy Electronics Inc)*

turned to SMD packaging to meet the requirements of high-reliability and military applications. The company has introduced a high-performance crystal oscillator in a $0.48 \times 0.48 \times 0.085$-in., 40-pin ceramic leadless chip carrier. Designated the XE10 Series and covering the frequency range 500 kHz to 25 MHz, these oscillators offer an initial accuracy at 25°C of ±15 ppm and an aging rate of 5 ppm/year. The stability rating is as low as ±20 ppm for a device that operates in the range from −30 to +85°C, and ±50 ppm for a device with an operating range of −55 to +125°C. The hermetic sealing provided by the XE10's welded package is essential to maintain these levels of stability. Xsis plans to extend the frequency range of these oscillators to 60 MHz in the near future. The company manufactures most XE10 oscillators to specific customer requirements and price them from approximately $50 to $70 (100).

In the UK, Salford Electrical Instruments Ltd has also chosen a 40-pin ceramic chip carrier to house its recently introduced QC-6111 and -6112 Series crystal oscillators. These two series are TTL- and CMOS-compatible and TTL-compatible respectively, and are available with output frequencies in the range of 875 kHz to 28 MHz. Targeted for use in military and avionics equipment, they offer the full military temperature range, over which their specified stability is ±100 ppm. Standard versions sell for around £40 (100), although the company admits that devices screened to mil-



ECL-compatible crystal oscillators in through-hole or surface-mounting metal cans *(NEL Frequency Controls Inc)*



An ECL-compatible crystal oscillator with ±5 ppm stability over 0 to 50°C *(Vectron Laboratories Inc)*

standard requirements, or customized parts, will cost considerably more. For use under space or battlefield conditions, the oscillators will be available in a rad-hard form, constructed from high-purity quartz crystals and silicon-on-sapphire ICs.

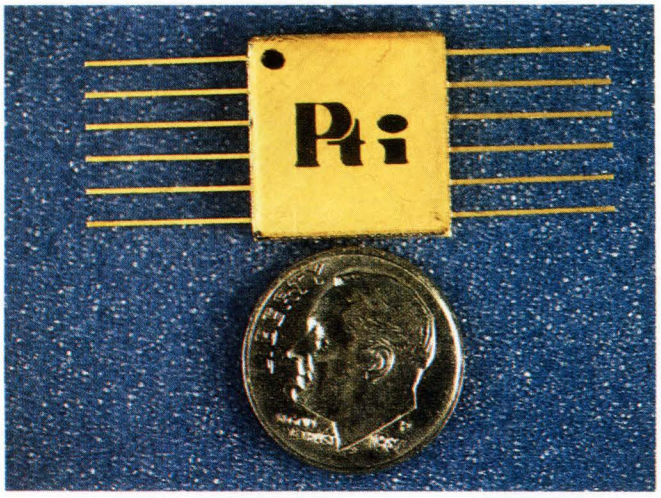
Piezo Technology Inc's latest introduction also targets the military market with a surface-mount oscillator packaged in a $0.625 \times 0.625 \times 0.110$-in. 12-lead flat pack. Piezo also manufactures their devices for specific customer requirements. These oscillators cover the frequency range from 488 Hz to 60 MHz, and have an aging specification of 5 ppm/year max and a stability of ±30 ppm over a temperature range of 0 to 70°C (±50 ppm over their full operating range of −55 to +125°C). The output rise and fall times for these oscillators are 5 nsec max; and the output swings to within 0.2V of the supply rails. Unlike most oscillator modules, which require a supply of 5V ±0.5V or ±0.25V, these oscillators operate from a supply in the range 3 to 6V. The unit price is around $300 for an oscillator at the low end of the frequency range—a price that buys you a part fully screened to the relevant MIL-STD requirements.

Metal-can packages remain popular

Most of the other pc-board oscillator modules introduced over the last year still use conventional metal-can packaging. Not only does this package style have the advantage of excellent RFI shielding; it also guarantees a highly reliable hermetic seal provided it's resistance welded rather than soldered. Although most of these devices are suited only for conventional through-hole mounting, some have modified leads that allow you to surface-mount them.

NEL Frequency Controls Inc's SA100 and SA350

Temperature-compensated crystal oscillators, targeted at industrial and military applications, are now available in SMD packages.



A military-grade CMOS-compatible clock oscillator in a 12-lead flat pack *(Piezo Technology Inc)*

Series crystal clock oscillators, for example, cover the frequency range 0.5 to 63 MHz and are packaged in $0.515 \times 0.515 \times 0.2$-in. hermetically sealed metal cans with leads that are bent and cropped to provide a gull-wing SMD. These oscillators, which sell for between \$4 and \$6.50 (1000), are aimed at the general-purpose clock oscillator market. The SA100 Series includes clock oscillators with frequencies between 0.5 and 25 MHz, which are specified for driving TTL loads, and 25- to 63-MHz oscillators, which are specified for driving Schottky TTL loads. The SA350 Series oscillators' outputs can drive a range of NMOS or CMOS loads.

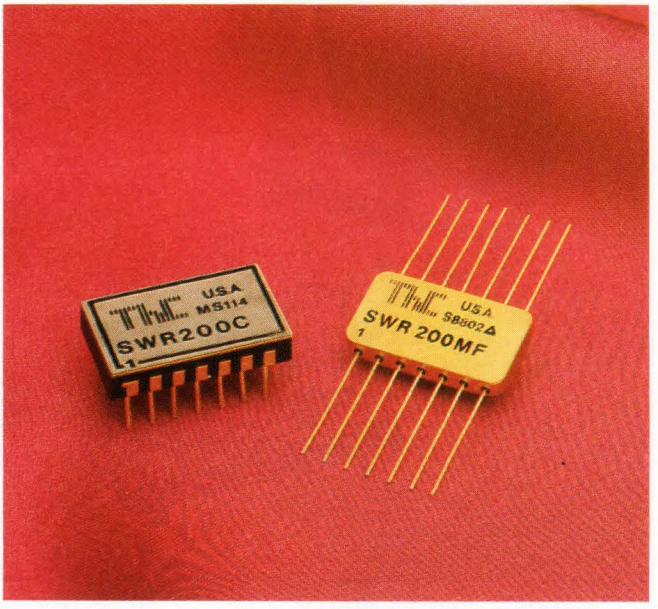
Choose TCXOs or OCXOs for improved stability

If you need an oscillator with a frequency stability over its temperature range that you can't achieve with standard crystal oscillators, you'll have to use a temperature-compensated crystal oscillator (TCXO) or oven-controlled crystal oscillator (OCXO) **Ref 1**. Within the last year, both Savoy Electronics and STC Components have introduced new TXCOs. The S5100 Series TCXOs from Savoy Electronics, which sell for between \$8 and \$50 (1000), cover the frequency range from 4 to 30 MHz and provide a stability of ± 3 ppm max over their operating range of -20 to $+70$°C. Their aging rate is ± 1 ppm/year max; and their frequency variation over their operating supply voltage range of 5V ± 0.25V is ± 0.5 ppm max. The oscillators produce a 2V p-p min output, and consume 15 mA max.

STC Components' SQO3500 oscillators are targeted at both the industrial and the military markets. Covering the frequency range from 2.5 to 20 MHz, they have a stability of ± 0.3 ppm over a temperature range of -20 to $+70$ °C; the stability rating increases to ± 3 ppm over the full military range. These oscillators operate from any supply in the range from 5 to 15V. They're available with output options that drive 1 CMOS logic input, 1 HCMOS logic input in parallel with 10 pF, or 5 LSTTL inputs. In addition, you can obtain them with ac-coupled output options that produce a clipped sine-wave output capable of driving a 1-kΩ load in parallel with 10 pF, or a 50Ω load at a 0-dBm drive level.

You can also obtain the SQO3500 oscillators with one of two frequency adjustments: The first option allows you to trim the frequency using an external potentiometer, thereby maintaining the hermetic seal of the 2×2-in. metal-can package; the second option has an onboard potentiometer with a screwdriver head that's accessible from the side of the package. Typical prices for SQO3500 oscillators range from \$150 to \$400.

Piezo Technology Inc has introduced a pc-board oven-controlled, crystal oscillator, designated the XO1119, that's packaged in a $1.5 \times 1.5 \times 0.5$-in. hermetically sealed metal can. The unit offers ± 3 ppm stability at a frequency of 10 MHz, and operates over a temperature range from -55 to $+85$°C. Although the standard part is a 10-MHz oscillator, the manufacturer can modify the design to operate at a particular frequency in the range 8 to 20 MHz. Because of the small thermal



A precision sine-wave reference *(Thaler Corp)*

mass involved in the package, the oven has a relatively short warm-up period—a maximum of four minutes. Prices for the XO1119 start at $550.

EDN's October 17, 1985, Special Report on pc-board crystal clock oscillators only listed one device that could hit 100 MHz (**Ref 1**). During just this past year, however, several manufacturers have pushed that limit to 200 MHz, and at least one manufacturer has introduced 400-MHz parts.

NEL Frequency Controls Inc's HS600 and HS2600 Series of ECL-compatible crystal clock oscillators cover the frequency range from 30 to 200 MHz. The HS600 series offers ECL-10K, -10KH, or -100K compatibility. The HS2600 Series generates complementary outputs suitable for driving the ECL-10K or -10KH logic families that have complementary inputs. Their output rise and fall times are around 3 nsec max. All of these oscillators have an initial accuracy at 25°C of ±50 ppm, and a stability over their 0 to 75°C operating range of ±100 ppm. They are housed in 0.815×0.515-in., hermetically sealed, 4-pin metal-can packages, which are the industry-standard metal enclosures for crystal oscillators. The devices cost between $15.50 and $22 (1000). Standard Crystal Corp has introduced a similar line in the same size package that covers the frequency range 20 to 200 MHz; the price is approximately $12 (1000).

Standard units in Oscillatek's EM1100 Series of ECL-compatible oscillators, introduced in April of this year, cover the frequency range from 150 to 350 MHz. The company will consider designing custom parts at frequencies as high as 500 MHz. The outputs are suitable for driving 10KH ECL; the output rise and fall times are 2 nsec max. These oscillators are available with stability ratings between ±1000 ppm and ±50 ppm over their operating range of 0 to 70°C. In addition to the standard single-output units, versions are available with complementary outputs or with an enable

For more information . . .

For more information on the pc-board oscillators discussed in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

ETA Industries Inc
35 E 21st St
New York, NY 10010
(212) 505-5340
Circle No 375

Fox Electronics
5842 Corporation Circle
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FAX 813-693-1554
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Div of ETA SA/Fabriques d'Ebauches
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Piezo Technology Inc
Box 7859
Orlando, FL 32854
(407) 298-2000
TWX 810-850-4136
FAX 407-293-2979
Circle No 380

Q-Tech Corp
10150 W Jefferson Blvd
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(213) 836-7900
TLX 696140
FAX 213-836-2157
Circle No 381

Salford Electrical Instruments Ltd
Times Mill
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TLX 635106
FAX 0706-64394
Circle No 382

Savoy Electronics Inc
Box 5727
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TWX 510-955-9766
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Standard Crystal Corp
9940 E Baldwin Place
El Monte, CA 91734
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STC Components
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TLX 818746
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STC Components Inc
636 Remington Rd
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TWX 910-291-1280
FAX 312-490-9707
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Thaler Corp
10940 N Stallard Place
Tuscon, AZ 85737
(602) 742-5572
TLX 825193
FAX 602-742-9826
Circle No 387

Vectron Laboratories Inc
166 Glover Ave
Norwalk, CT 06850
(203) 853-4433
TWX 710-468-3796
FAX 203-849-1423
Circle No 388

Xsis Electronics Inc
12620 W 63rd St
Shawnee, KS 66216
(913) 631-0448
TLX 437227
FAX 913-631-1170
Circle No 389

An oven-controlled crystal oscillator in a pc-board metal can has a fast warm-up period.

input. You can order the version with the enable input so that the output remains either in a logic 1 or in logic 0 state when disabled. Prices for EM1100 series oscillators range from $50 to $100 (100).

The highest-frequency standard ECL oscillators recently introduced come from Vectron Laboratories. This company's CO450 Series covers the frequency range 5 to 400 MHz. The standard stability rating for a part with a 0 to 70°C operating range is ±25 ppm. The oscillators provide complementary 100K ECL-compatible outputs, and operate from a supply voltage of −4.5V or −5.2V. The company also offers devices with a 0 to 50°C stability rating as low as ±5 ppm; extended temperature ranges are also available. Prices start at $114 (10). You can also obtain VCXO versions of these oscillators that operate at frequencies as high as 200 MHz.

Savoy Electronics and Q-Tech Corp have each recently introduced a new line of voltage-controlled crystal oscillators (VCXOs) that are useful when you need to pull the frequency over a narrow range—for example, in phase-lock loops. Savoy's S4100 Series VCXOs are available with center frequencies between 4 and 30 MHz. They have a ±25 ppm stability rating, a figure that takes into account the effects of temperature changes between 0 and 70°C, of 1 year of aging, and of variations in load and supply voltage. By applying a ±1.5V dc control signal, you can shift the oscillator frequency by as much as ±75 ppm with a maximum nonlinearity of 5%. These devices can drive 10 TTL loads and consume a 5V supply current of 30 mA max.

Q-Tech's VCXOs cover the frequency range from 1 kHz to 55 MHz, providing ±25 ppm stability over a −20 to +70°C operating range. The company can also supply those oscillators for the military range. Standard parts allow you to pull the oscillator frequency by ±100 ppm with the use of a 0 to 5V control input; the oscillators have a modulation bandwidth of 10 kHz. They are available with square-wave outputs that can drive TTL or HCMOS logic inputs, or with a sine-wave output. The typical price for a military-grade part in the frequency range from 8 to 27 MHz is around $42 (100).

Analog's not forgotten

Finally, if your interest is analog rather than digital, and you want a pc-board sine-wave source that has excellent amplitude stability, consider using Thaler Corp's SWR200 oscillator. The unit contains a phase-shift oscillator, the frequency of which is set with two external capacitors. You can set the frequency anywhere in the range from 400 Hz to 10 kHz. The oscillator produces a 7.071V rms output with an initial amplitude accuracy of ±0.05% and a temperature coefficient of 2 ppm/°C max for a version with a temperature range of −25 to +85°C (±3 ppm/°C for a military-grade version). To achieve this level of amplitude stability, the oscillator has an AGC circuit that monitors the output amplitude and compares it to a reference voltage that is generated by an internal zener diode. The resulting error signal provides feedback to alter the gain of the phase-shift oscillator.

To improve stability at the extremes of the device's operating temperature range, the temperature coefficient of the amplitude monitoring circuitry is arranged to compensate for that of the zener-diode reference. You can operate the oscillator at lower frequencies by adding external components to alter the time constant of the error amplifier. Using this technique, you can use the oscillator as, for example, a precision 60-Hz source. The SWR200 is available in either a 14-pin ceramic DIP or in a 14-lead flat pack. The devices sell for between $86 and $126 (100), depending on package type and temperature range. EDN

References

1. Ormond, Tom, "Crystal oscillators," *EDN*, October 17, 1985, pg 99.

Article Interest Quotient (Circle One)
High 491 Medium 492 Low 493

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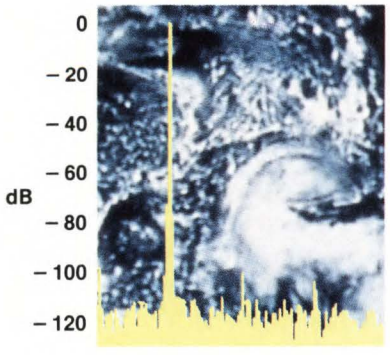

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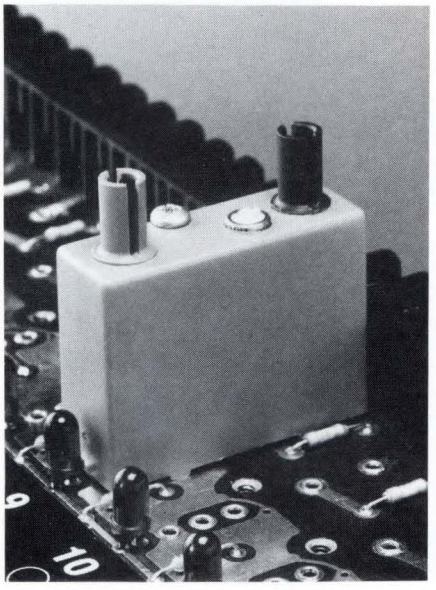
CIRCLE NO 79

Board-mounted fiber-optic sensor brings a PC's power to the factory floor

FiberPak is a fiber-optic-based sensor system for equipment manufacturers using μP-based control systems. The modular sensors are packaged in a case that is plug compatible with single-channel I/O modules that interface with standard computer-bus mounting racks. Sensing options include four modes: through-beam, proximity, true reflex, and polarized reflex.

The system's plastic fibers extend as far as 75 feet and allow FiberPak to interface with a number of the manufacturer's accessories. Lenses are available in a variety of shapes and sizes to increase the sensing range in the through-beam mode. Flexible fiber-optic tips allow the sensors to accommodate proximity-sensing applications in confined spaces. A reflex lens and a polarized reflex lens simplify alignment and reduce interference from reflections. These accessories allow the FiberPak modules to operate anywhere a standard photoelectric control can be used.



FiberPak also features improved sensing speed and noise immunity compared with traditional photoelectric controls. Three FiberPak models are available: a high-sensitivity model with a 15-msec response time; a standard version with a 1-msec response time; and a high-speed version with a 100-μsec response time. Over a 6-ft length of fiber, appropriate lenses extend sensing capabilities in the through-beam units to 160, 46, and 16 ft, respectively. Because all three models operate from 4.75 to 30V dc supplies, you can use a single module in 5, 15, and 24V systems. FiberPak modules have a 3-year warranty against mechanical and electrical defects and are priced at $90 each.

Opcon Inc, 720 80th St SW, Everett, WA 98203. Phone (206) 353-0900.

Circle No 426

Moderate-resolution incremental encoders handle high-density applications

The Model 84C incremental encoder is a 4 oz, housed incremental encoder that functions in mild environments where small size and moderate resolutions are the critical design requirements. The encoder comes in a 2.2-in. diameter by 1.18-in. length housing and costs $73 in quantities of 100.

The 84C provides resolutions up to 1800 cycles with quadrature outputs and an index marker pulse with an operating frequency to 100 kHz. The encoder can withstand a slewing speed of 5000 rpm. The outputs of the 84C are TTL-CMOS compatible. Options include a differential line driver at 5V, voltages to 24V, and a square mounting plate. The cover of the encoder meets UL94-VO requirements, and the unit's cable is UL/CSA approved.

Litton Encoder, 20745 Nordhoff St, Chatsworth, CA 91311. Phone (818) 341-6161. TWX 910-494-1229.

Circle No 423

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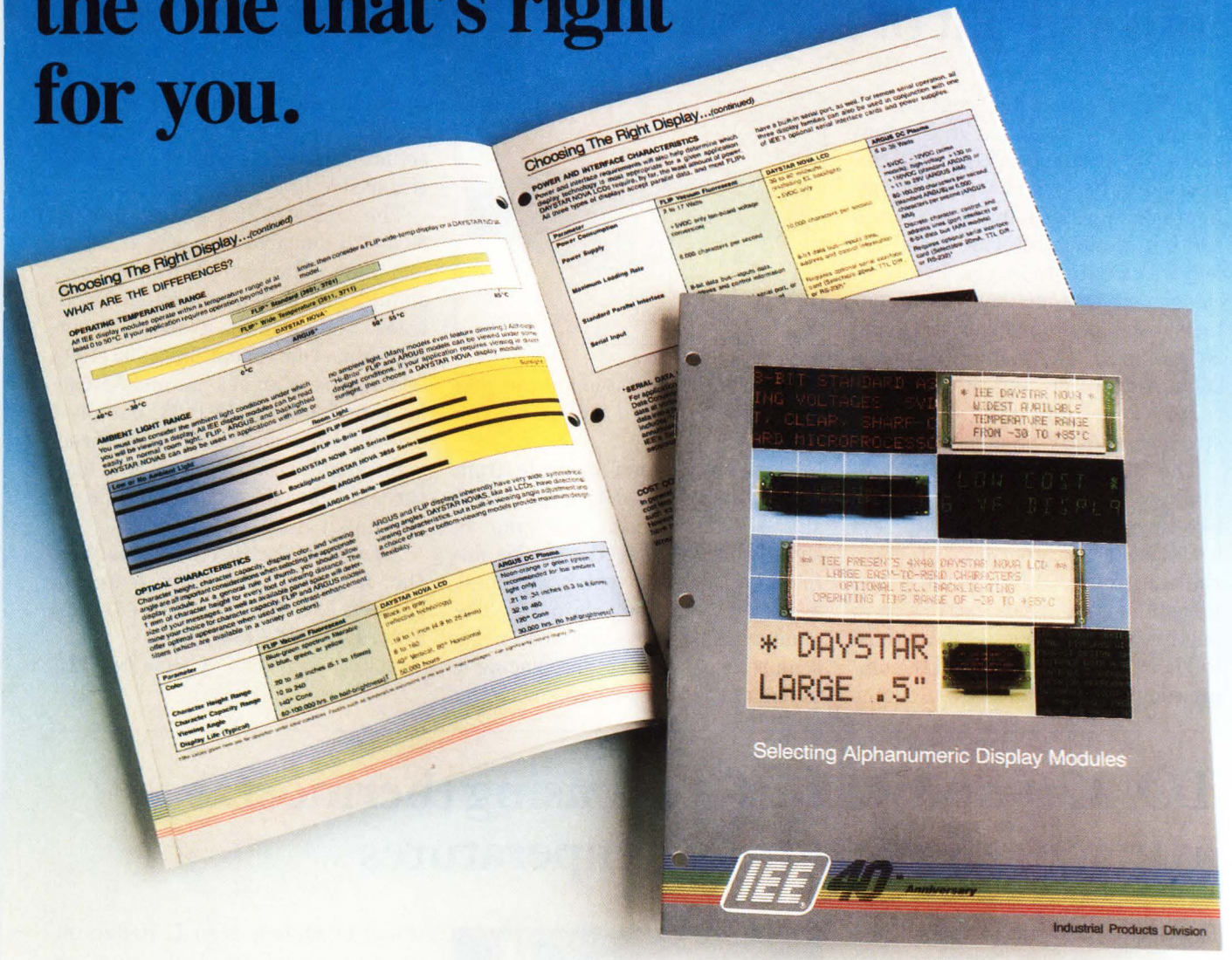

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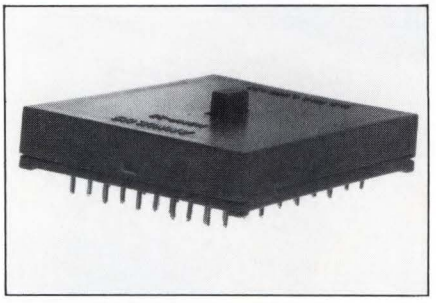
CIRCLE NO 35

Conductive rings act to switch devices into and out of a circuit

The HDMP-25 switch contains 25 double-throw switches in a miniature low-profile package and can be used to perform a system reconfiguration by swapping devices into and out of a circuit. The HDMP-25 features a patented stressed elliptical-contact system that has a contact resistance of 20 mΩ typ and 50 mΩ max. The contact rating is 250 mA at 5V dc, and the manufacturer specifies the dielectric strength at 500V ac min.

The stressed elliptical-contact system features movable conductive rings, which are made from cylindrical cross sections of thin-walled tubing. After proprietary processing, the rings become conductive circular springs that return to their original shapes after compression. A nonconductive actuator



finger shifts the position of the ring between the two poles of the switch.

The switch itself is made from four posts arranged in an elliptical shape. The conductive ring is slightly larger than the circles defined by the one major axis post and the two minor axis posts. The vendor assembles the switch by compressing the ring and placing it in one of the two positions with the actuator finger inside the ring. You operate the switch by shifting the actuator, which snaps the ring to either side of the 4-post array.

The HDMP-25 switch has a 39.4×33-mm footprint and is 10.2-mm high. For insertion ease, you should use 1-mm plated-through holes. The switch is available as an individual component for $9.95 (100) and as part of an evaluation kit. The kit contains an HDMP-25, one predrilled and etched pc board, three right-angle DB25 connectors, and three 24-pin IC sockets. The cost for the kit is $34.95.

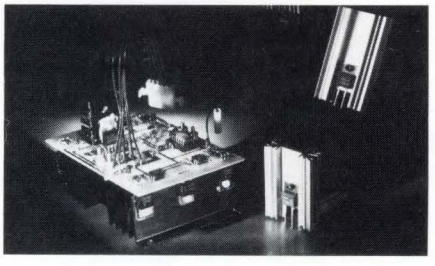
Annulus Technical Industries Inc, Box 7407, Ancaster, Ontario, Canada L9G 4G4. Phone (416) 648-8102. FAX 416-648-8102.

Circle No 421

TO-220-housed surface-sensing thermostat manages power supply temperatures

The Series 6700 surface-sensing bimetallic thermostat features a completely redesigned bimetallic disk. The thermostat is rated for a 100,000-cycle lifetime at 5V dc at 20 mA; its mechanical life exceeds 10^6 operations. Gold-plated silver crossbar contacts are standard in both the normally open and normally closed versions. The contacts are rated for 1A at 48V dc. The contacts of the normally open version close with rising temperatures; the contacts of the normally closed version open with rising temperatures. The closed contact resistance equals 50 mΩ max. The operating sense range extends from 40 to 120°C in 5°C increments.

The thermostat's nickel-plated

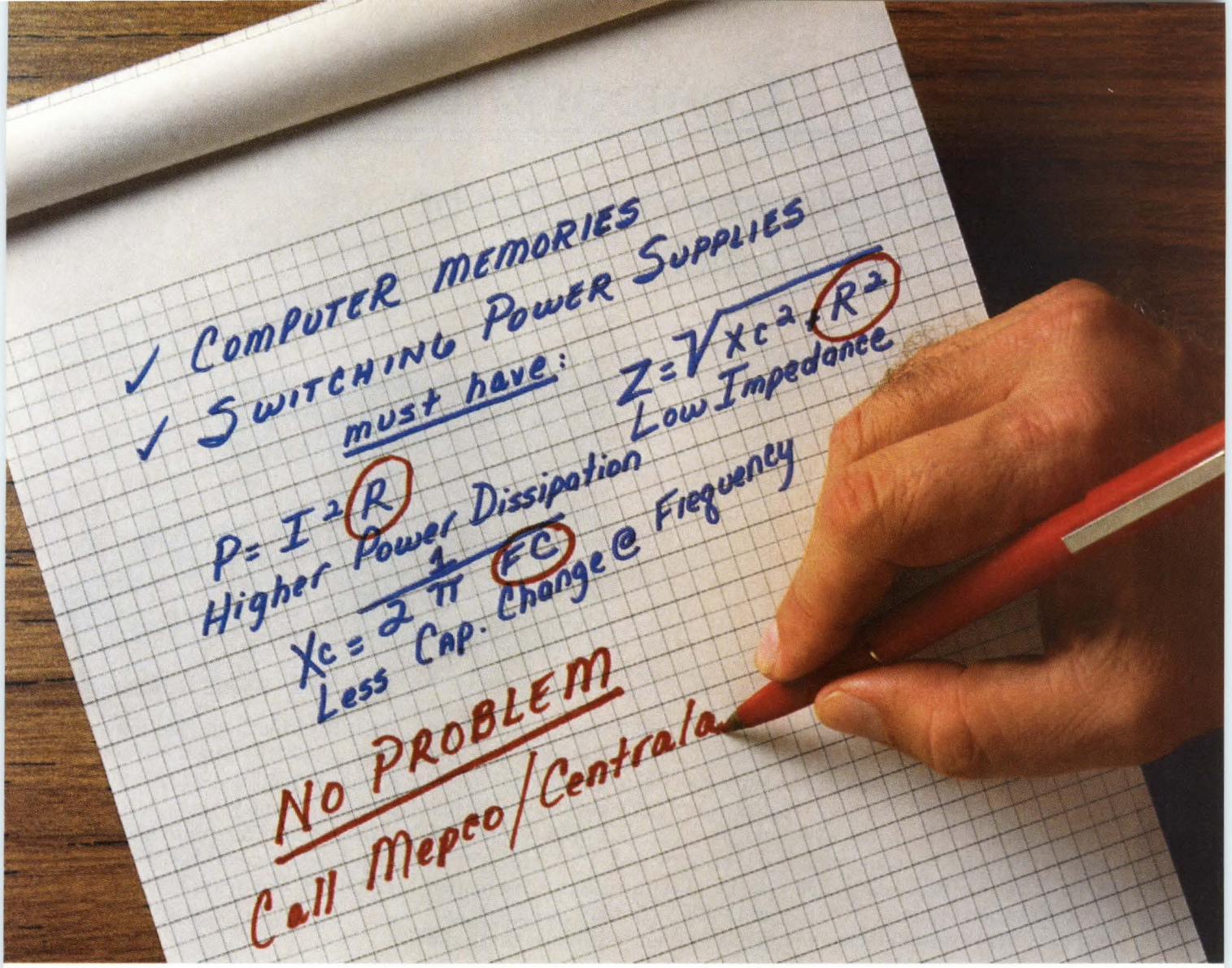


copper mounting bracket, which is isolated from the operating contacts, lets you connect the Series 6700 thermostat directly to a heat sink. The thermostat's surface-sensing ability allows it to detect any over-temperature condition generated by other components that are mounted directly on or close to the heat sink. You can configure the thermostat to turn on a visual or audible signal, switch on or change the speed of a fan, or completely shut down the system when it detects an over-temperature condition.

The Series 6700 thermostat dimensionally conforms to the international Y220/TO-220 product package standard, making it compatible with automatic-placement equipment. Using high-speed equipment, you can also solder the thermostats onto pc boards. The thermostat sells for $5 and is shipped in a plastic tube that's compatible with automatic-placement equipment.

Airpax, Box 868, Cheshire, CT 06410. Phone (301) 663-5141. FAX 301-698-0901.

Circle No 425



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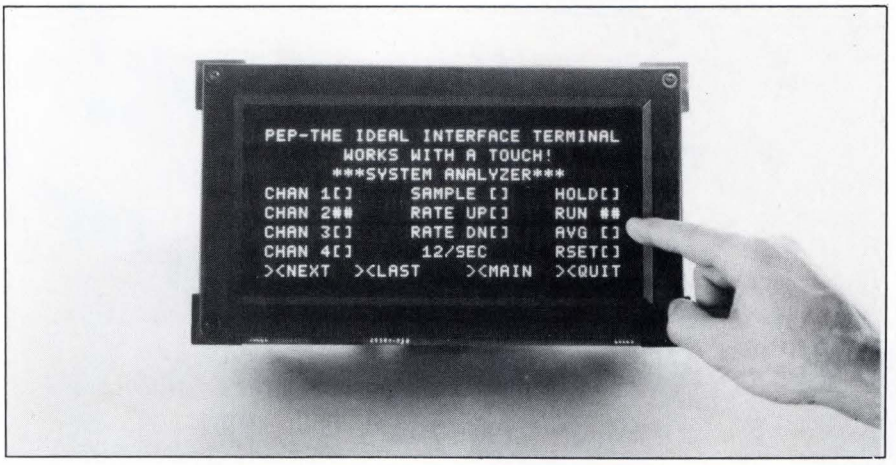
Store and display messages can be answered with a touch

The PEP Model 4285-XX canned-message memory module combines an 8-line × 32-character dc gas-plasma display with an infrared touchscreen. The module sports 16k bytes of RAM, which can store as many as 127 canned messages and is backed by an onboard lithium battery for use in interactive environments. The touch-input infrared switch matrix provides 128 switch locations using optical technology, which allows a high quality display. Proprietary techniques minimize the effects of ambient light.



The alphanumeric display provides a 64-character U.S. ASCII character set as well as several European character sets in a 5 × 7 dot-matrix format. The 0.18 × 0.26-in. characters come in neon-orange or green and are software dimmable to three brightness levels.

The 12.2 × 7.14 × 3.915-in. module accepts RS-232 or RS-422 serial data at 1200 or 9600 baud. The unit supports CTS and DTR and can detect parity and rate errors in transmission. The PEP 4285 requires 5V dc at 0.5A and 150V dc at 9 to 55mA. Typical power consumption is 4 to 11W. Options include mounting subpanels, drip-proofing, and EMI/RFI shielding. The base unit price is $1089 (100) for the neon-orange display and $1242 (100) for the green display.

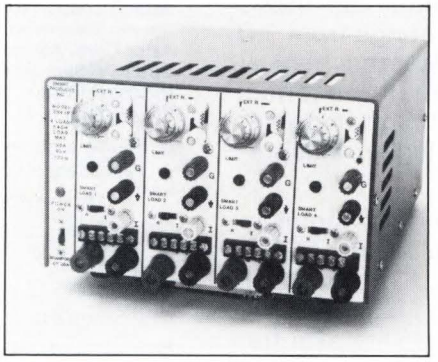
Industrial Electronic Engineers Inc, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311.

Circle No 422

Variable active resistors can function in constant current sources

The Smart Resistor family of power supply loads incorporates variable active resistors. You can also use the SR Models as resistance simulators, 500W potentiometers, precision 4-wire resistors, and for other applications where you need a constant resistance or current.

The units can supply an adjustable load of 0.03 to 1000Ω and can dissipate as much as 500W over a range of 0 to 90V. The maximum current is 160A. In addition, they have fail-safe protection against excessive current and temperature, and they provide electronic gating of the load. You can operate the



Smart Resistors in parallel and control them via a computer using a IEEE-488 bus.

The Smart Resistors come in four versions: a basic OEM unit and three units that share the same cabinet but have different numbers of loads. The SR-01 is the basic model. It dissipates 10W alone and 50W with a heat sink, has a maximum current of 20A, and sells for $121. The other three units all dissipate a total of 500W. The SR-11P single-load unit sells for $890; the SR-21P dual-load, 80A/load unit sells for $990; and the SR-41P 4-load, 30A/load unit sells for $1190.

Smart Products Inc, Box 930, Branford, CT 06405. Phone (203) 453-9606.

Circle No 424

KEMET: More than a surface solution surface mount.

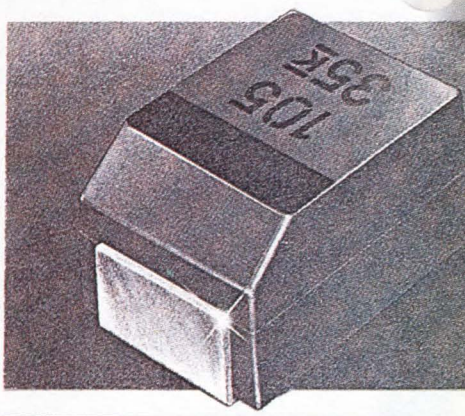
Look beyond the surface in surface-mount capacitors and you'll find nobody matches KEMET's availability and selection. They're all produced in dedicated plants using the tightest controls — with special attention to solderability.

Our T491 tantalums' symmetrical terminals eliminate "wheelies" and "tombstones"; they're compatible with all soldering techniques — up to 260°C for 10 seconds.

Nickel-barrier terminations on all our MLC chips withstand reflow temperatures and assure high-integrity connections.

Need a military/space chip? KEMET MIL-spec chips offer a failure-rate qualification level that is unsurpassed.

See for yourself. Ask your KEMET distributor for our engineering kits — a surface-mount kit for tantalums and ceramics in a range of values. With drawings and ordering information, too.



Sales Offices and Distributors Worldwide
In U.S.A.: (803) 963-6348; Telex 57-0496.
In Europe: 22-396500; Telex 412-901 KESA CH.
In Asia: 852-3-770-5633; Telex 780-44093 KEMET HX.

and Distributors Worldwide
3) 963-6348; Telex 57-0496.
2-396500; Telex 412-901 KESA CH.
-3-770-5633; Telex 780-44093 KEMET HX.

KEMET Electronics Corporation
P.O. Box 5928 • Greenville, SC 29606 • 803/963-6300

CIRCLE NO 81

TEXAS INSTRUMENTS REPORTS ON

THE VALUE OF COM

IN THE ERA OF MEGACHIP™ TECHNOLOGIES

If you think all PALs and their suppliers are pretty much alike, we'll send you up to 100 PALs free to change your mind.

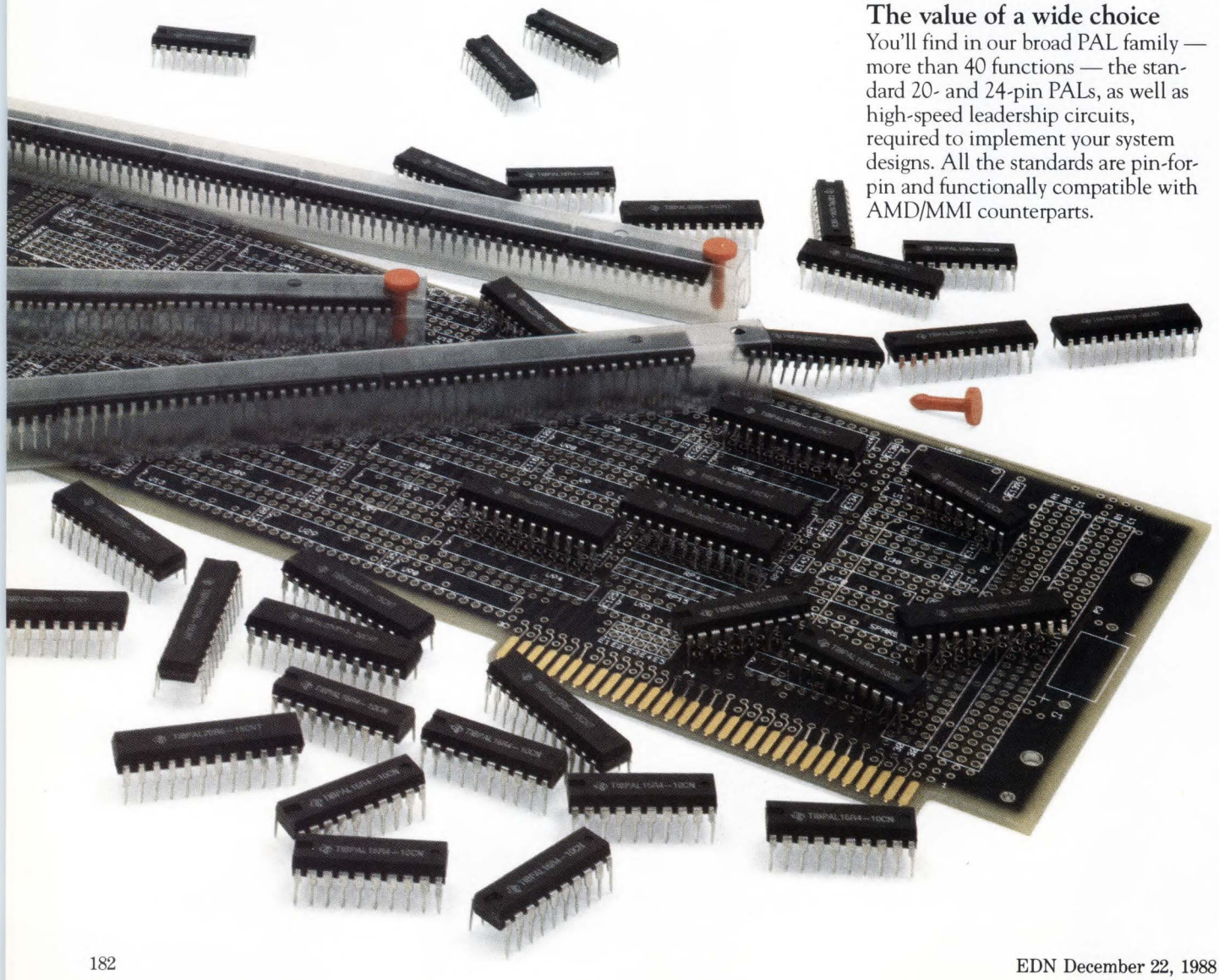
Using is believing.

We're betting that hands-on experience with TI's PAL® ICs will prove to you that, by comparison, they can easily deliver the performance, reliability, and value you need. We're backing our bet with an Evaluation Kit that offers up to 100* free TI PALs programmed to your specs.

Return the card to get your kit. It will, we're confident, make a few points:

The value of a wide choice

You'll find in our broad PAL family — more than 40 functions — the standard 20- and 24-pin PALs, as well as high-speed leadership circuits, required to implement your system designs. All the standards are pin-for-pin and functionally compatible with AMD/MMI counterparts.



PARISON IN PAL ICs

TI's 16XX 20-pin series offers four standard architectures in five speed/power ratios to provide flexibility, speed, and power conservation. In this series are PALs with a 10-ns propagation delay, plus the recently announced TIBPAL16XX-7 PALs that decode logic in a scant 7.5 ns.

TI's 20XX 24-pin series offers four standard architectures in two speed/power ratios. High-performance TIBPAL20XX-15 members deliver a 15-ns propagation delay, while TIBPAL20XX-25 devices satisfy lower power requirements with a low 105-mA I_{CC} at a 25-ns propagation delay.

Our 24-pin selection also includes exclusive-OR, registered-input, and latched-input devices.

TI's TIBPAL22V10/V10A and TIBPAL22VP10-20 provide flexibility beyond that of standard PAL architectures. They feature programmable output logic macrocells and variable product-term distribution. The '22VP10-20 allows two extra, exclusive output configurations, for a total of six. Its 20-ns delay is a 20% improvement over the competition's "A" version.

TI PALs are fabricated using exclusive IMPACT™ or IMPACT-X™ technologies that produce very dense circuitries and superior speed/power characteristics.

Most TI PALs are characterized for operation over the -55°C to 125°C military temperature range. Packaging options include plastic and ceramic chip carriers as well as plastic and ceramic DIPs.

The value of programming support that moves you along

Programming of TI PALs has been structured with one objective in mind, to help you get to market — fast.

Substantial third-party support allows you to program TI PALs yourself. The necessary equipment and software are readily available from a growing number of third-party sources, including Data I/O, Logical Devices, Stag, INLAB, and Advin.

Or, if you prefer, regional IMPACT Centers have been established, equipped, and staffed to provide design, programming, and testing services for TI PALs at selected authorized TI distributors. Such local, individualized support helps you save programming time and costs.

The value of inherent reliability

A strict philosophy at TI is that quality and reliability must be designed in and built in from the start. Then before a new design is released, we program it to worst-case codes to test that it will perform as specified.

To make sure our PALs will last over time, they are subjected to a battery of operating-life tests. At present, TI PALs are demonstrating a 10 FIT rate.

Bias humidity and autoclave testing probe packaging integrity, while temperature cycling determines how well TI PALs stand up to operating temperatures.

As a result, you can be confident of long, reliable operation.

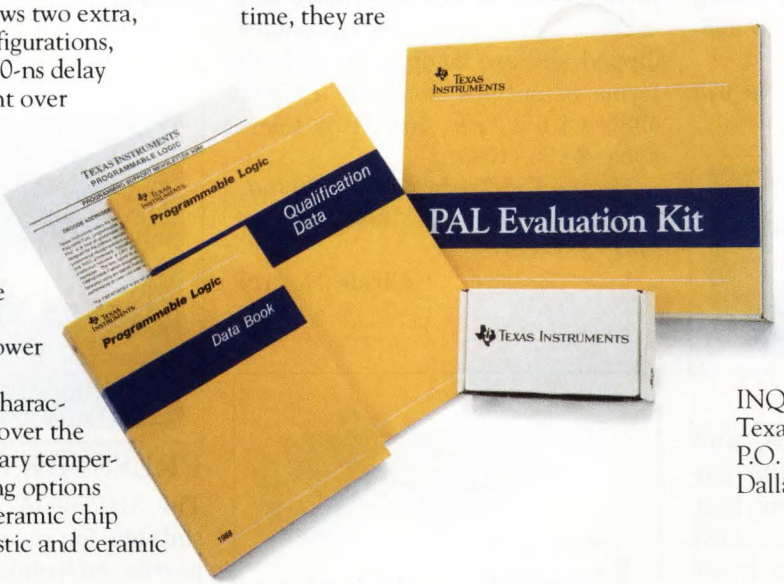
Now, about those free PALs...

Send us your completed return card, and we'll ship your TI PAL Evaluation Kit. In it, you'll find copies of TI's product-support literature: (1) a 472-page design and specification data book with applications notes; (2) a 192-page qualification data book containing the information you need to qualify your TI PALs, as well as reliability data by quarter; and (3) the latest issue of our quarterly programming guide, which also lists third-party support.

In the kit, you'll find a container for shipping your programmed master device(s) so that up to 100 free PALs can be programmed for you.

Within 30 days, you'll receive your free TI PALs. Then it's up to you — just plug 'em in and make your own comparisons.

Mail your return card today; if it's missing, call 1-800-232-3200 (ask for INQ3204), or write Texas Instruments Incorporated, P.O. Box 809064, Dallas, Texas 75380-9064.



* Offer limited to 100 units total per customer, not to exceed ten (10) military PALs or ten (10) commercial 7.5-ns TIBPAL16XX-7 PALs and up to 90 devices from TI's other commercial PAL series. Offer subject to availability. Void where prohibited. Offer expires March 31, 1989.

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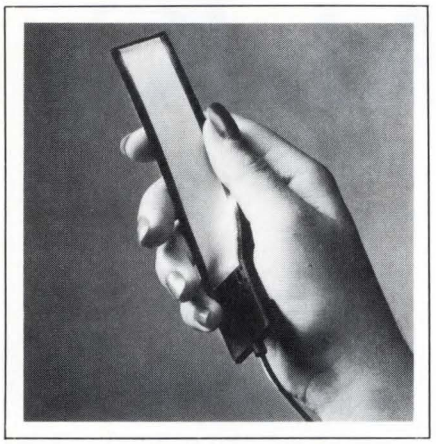
TEXAS INSTRUMENTS

Components

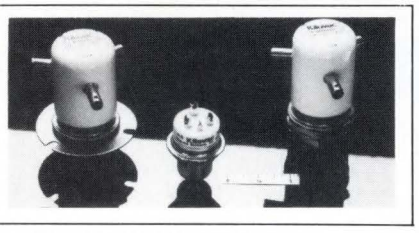


VIBRATION SENSOR

The SDT1-028K fully shielded, low-mass, surface-mount vibration sensor consists of a piezo film and a shielded cable and housing. The sensor measures $1.75 \times 0.775 \times 0.125$ in., and the sensing element measures $1.125 \times 0.440 \times 0.005$ in. The unit has an 18-in. wire and weighs 2.1g. The SDT1-028K responds to operating forces greater than 2g with an output voltage of 20 mV/g. Using a 1 MΩ load, the frequency response is basically flat above 125 Hz; however, roll-off exists and extends the low frequency range by about a decade. $40 (sample qty).

Pennwalt Corporation, Kynar Piezo Film Dept, Box 799, Valley Forge, PA 19482. Phone (215) 666-3500.

Circle No 677

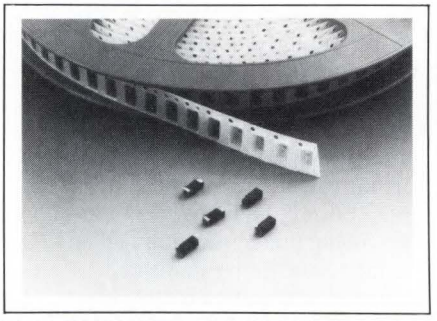


POWER RELAYS

The HC-5, KC-15, KC-16, and K60C relays are available for power-switching applications that cause severe contact erosion, such as capacitive discharge of a heart defibrillator and electrostatic discharge simulation. The vendor fills these relays with an electronegative gas and offers arc-quenching characteristics to extend component life. These four relays operate at voltages ranging from 3.5 to 30 kV dc and continuous currents as high as 12A dc. From $108.

Kilovac, Box 4422, Santa Barbara, CA 93140. Phone (805) 684-4560. TWX 910-336-1141.

Circle No 678

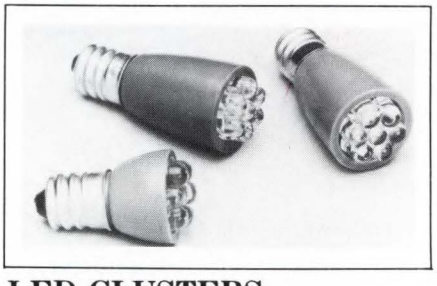


TANTALUM CAPACITORS

The 49SC Star Chip tantalum capacitor yields a low ESR (equivalent series resistance) at high frequencies. For example, a 4.7-μF 10V capacitor has an ESR of <100 mΩ at 100 kHz. The 49SC capacitors are available in capacitances ranging from 0.1 to 100 μF and from 4 to 50V. You can purchase the devices in 5 case sizes conforming to EIA specification IS-28, and in tolerances of ±5%, ±10%, and ±20%. Terminations are hot-solder dipped and are compatible with all forms of surface bonding. Typical 49SC with 47 μF, 10V, 10% tolerance, $0.95 (1000).

Mepco/Centralab, Box 10330, Riviera Beach, FL 33404. Phone (407) 881-3257.

Circle No 679



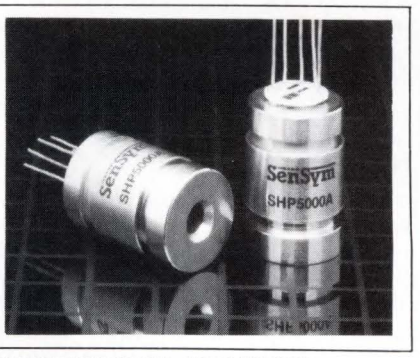
LED CLUSTERS

The Series SL467 and S467 consist of seven LED clusters in an industry-standard candelabra S6 screw-base lamp that mounts directly in the S6 screw-base sockets or lamp holders. Because the series contains all the necessary limiting resistors and rectifiers within its packages, you don't need to modify your circuit to convert from S6 type filament incandescents to the cluster LEDs. The advantages of the LEDs are lifetimes exceeding 10 years, low power, low turn-on surge currents, equal intensity light output, and high shock and vibration tolerance.

The clusters are available from stock in 5V/6V, 12V/14V, 24V/28V, 36V, 48V, 60V, 110V dc, 120V ac, and 130V dc, and can be made to order for other voltages. They are available in either polarized dc types or nonpolarized dual-polarity ac/dc types. The brightness of the clear illuminator LEDs approaches that of a 1 to 3W incandescent bulb; seven other colors are in production. Standard high-efficiency SL467 in 120V ac, $7.22 (1000). Delivery, stock to six weeks ARO.

Ledtronics Inc, 4009 Pacific Coast Hwy, Torrance, CA 90505. Phone (213) 676-7996. TLX 4945454.

Circle No 680



PRESSURE SENSOR

The SHP5000A pressure sensor is suitable for measuring media in a hostile environment. The sensors feature internal temperature compensation for accurate operation over 0 to 50°C. Factory laser trimming sets the initial offset calibration to within 0 to 10 mV, and

SEE HOW YOUR CONNECTOR MEASURES UP TO OURS.

If your present I/O connector can completely cover the new Fujitsu Series 230 pictured on this page, you've got a large problem.

You're wasting valuable board space.

Space you could use to cram in a few extra components. Or space you could eliminate entirely to reduce manufacturing costs.

Fact is, the Series 230's remarkably compact 1.27mm (.50″) pitch and remarkably efficient 4-row, zig-zag terminal layout pack provides all the pinout you're used to in 40% less real estate.

More than that, the cable mount plug and board mount socket, in 50 and 68 positions, conforms to the SCSI II and III standards adopted by ANSI.

And, every Series 230 connector also includes features like a standard "D" shape polarization header, EMI shield, plug/socket lock and minimum-pressure insertion/withdrawal fitting. All with no extra size.

So, before you run out of space on your next compact or portable system design, call us at **(408) 562-1000** or see the EEM Catalog. For a complete list of local distributors and representatives write to Fujitsu Component of America, Inc., 3330 Scott Boulevard, Santa Clara, California 95054-3197.

We'll keep you from coming up short.

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CIRCLE NO 108

PHOTO SHOWN ACTUAL SIZE

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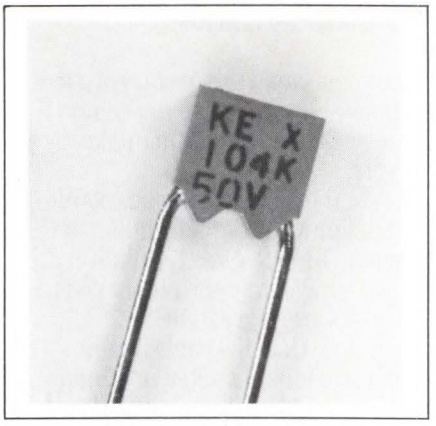
linearity errors are <0.5% FSO typ. A high-impedance 5-kΩ bridge makes the SHP5000A suitable for battery and low-power applications. A 316 stainless-steel casing isolates the sensor from corrosive media. You can use the sensor to measure from 0 to 5000 psia with a sensitivity of 30 to 50 μV/psi. $20 (OEM qty).

SenSym, 1255 Reamwood Ave, Sunnyvale, CA 94089. Phone (408) 744-1500.

Circle No 681

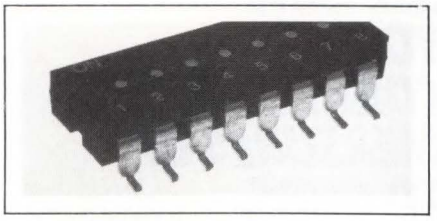
CERAMIC CAPACITORS

The C056 and C066 Series radial-molded ceramic capacitors feature a permanent 2-legged standoff between the leads. The standoff improves solderability and eases flux removal. The standoff also makes visual inspection of solder joints easier and eliminates the need for external spacers, as well as minimizing tilting and flush mounting. The series meets all performance requirements and physical characteristics of MIL-C-39014 and MIL-C-20. The devices are available in a wide range of values and tolerances. CKR05-style 0.1 μF, 10%, 50V capacitor, $0.28. Delivery, stock to 10 weeks.



Kemet Electronics Corp, Box 5928, Greenville, SC 29606. Phone (803) 963-6300.

Circle No 682



DIP SWITCH

The K40 surface-mount DIP switch features two separate slides for each contact point to improve the switch's reliability. The switch is also flush with the cover to eliminate accidental on-off movement. The slides are made of beryllium copper plated in a 100-μin. nickel bath and then spot gold-plated 30 μin. deep at all the contact points. The size of the K40 switch corresponds to the size of a DIP with the same pin count. The K40 switch is available in 4- to 16-pin, surface-mount packages—either gull-wing or J-bend; each package can have 2 to 8 switches. From $0.65 to $1.30.

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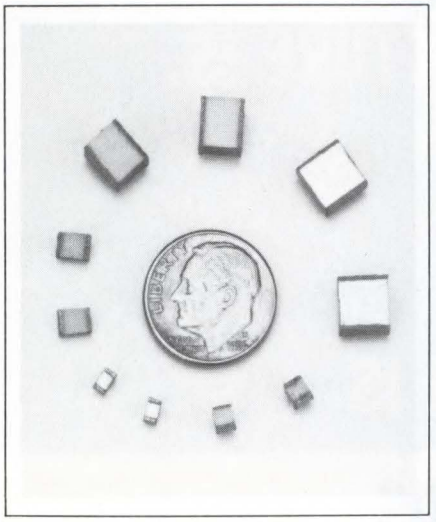
American Research and Engineering, 1500 Executive Dr, Elgin, IL 60123. Phone (312) 888-7245. FAX 312-888-7094.

Circle No 683



FILM CAPACITORS

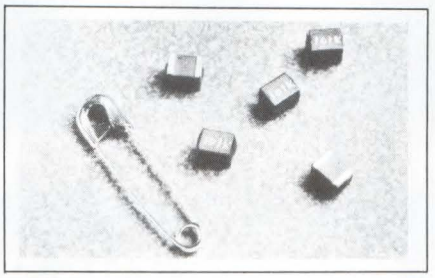
The Surfilm ST multilayer surface-mount-chip film capacitors have the same footprint as ceramic chip capacitors. Available in capacitance values from 0.01 through 2.2 μF in ±5%, ±10%, and ±20% tolerances at 50V dc, the capacitors come in chip sizes 1210, 1812, 2225, 2824, and 3827. The parts can withstand IR or vapor-phase soldering at 225°C for one minute and are available on 12- and 16-mm plastic tape and reel. The capacitors' dielectric absorption of 0.25% is suitable for S/H circuit applications. A 0.1-μF ST 1812, $0.29; a 1.0-μF ST 2225, $0.90 (1000). Delivery, six weeks ARO.

ITW Paktron, 1205 McConville Rd, Lynchburg, VA 24502. Phone (804) 239-6941. FAX 804-239-4730.

Circle No 684

CHIP INDUCTORS

The CS 2014 series shielded-chip inductors are available in values from 1 to 1000 μH. The Q minimum is 50 for parts below 68 μH, 40 for parts between 68 and 470 μH inclusive, and 30 for both the 680- and 1000-μH parts. These devices come



with tolerances of ±10% from 10 to 1000 μH and ±20% below 10 μH, although you can special order ±10% parts below 10 μH. The chip inductors measure 0.199×0.144×0.125 in., and you can use them with either flow or reflow soldering. The shield on the CS 2014 is 100% ferrite, thereby providing better protection against induction interference than more traditional shields made with a combination of ferrite

Our electroluminescent (EL) lamps give you light that's easy to work with.

Instead of juggling grains of wheat, we give you a single field of light, perfectly uniform and balanced the moment you plug it in.

Instead of bulk, we give you a lamp so thin, it's barely three-dimensional – lighted almost edge to edge. We can make our lamps in all kinds of sizes and shapes – with cutouts and holes to fit protruding knobs and switches.

Instead of resistance-based technology that's hot, we give you capacitance-based technology that's very cool. Instead of a limited color range, we can make a lamp in almost any color – even multicolor. Instead of sudden death, we give you lamps with useful lives exceeding 10,000 hours in extreme environments. We can give you a variety of connectors, including IC leads. And we can supply front or back adhesives, for easy mounting.

OUR DESIGN GUIDE CAN LIGHT YOUR WAY.

And with our lamps, we give you solid-state-of-the-art construction backed with our Loctite applications know-how. So for solutions to any problem, we're here. To learn more, send for our DESIGN GUIDE, the definitive reference on electroluminescence. Because the solution to your lighting problem may be as simple as seeing it in a new light.

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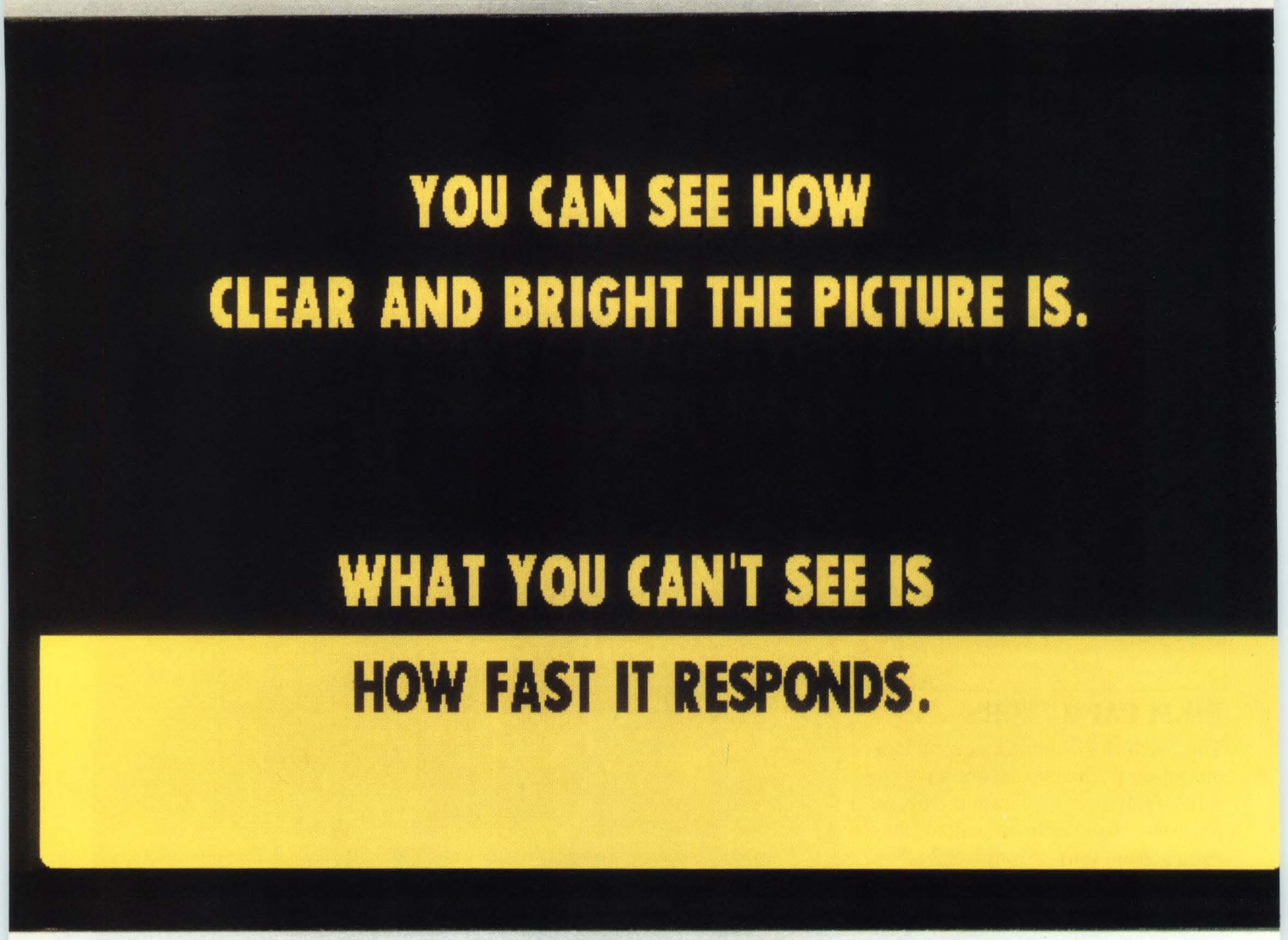
SETTING THE STANDARD
A SUBSIDIARY OF LOCTITE CORPORATION

tel (603) 448-3444
FAX (603) 448-3452, TWX 710-366-0607
Etna Rd., Lebanon, NH 03766

CIRCLE NO 21



Fast response time, less than 5 ms, gives Finlux Electroluminescent displays video capability. In laptop PCs, the cursor is visible during all rapid movements or data changes.

As for picture quality, you can see for yourself: it's worth a thousand words. Here are just a few: Crisp. Stable. Bright. Wide-angle viewing. Finlux EL is easy on the eyes, even during a long workday.

The big little EL display

The display above is shown as large as life. Just 18 mm thin and weighing less than 500 grammes, this Finlux EL shows as much text as an 11" CRT: 25 lines of 80 characters, or full graphics. Finlux EL displays are available in a range of 320 x 256 to 640 x 400 pixels.

Wherever your customers need compact clarity

Finlux EL displays are easily interfaced for high-resolution graphics, word processing, medical and industrial applications. The fully solid-state flat EL panel and electronics are assembled into a sturdy, compact package ready for mounting in even the most demanding environments.

Lohja Finlux is the only European manufacturer of flat panel Electroluminescent displays.

To see more, get in touch with:

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FINLUX Display Electronics
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Telecopy (+358-0) 422 143
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In the USA:
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20395 Pacifica Drive
Suite 109
Cupertino, CA 95014, USA
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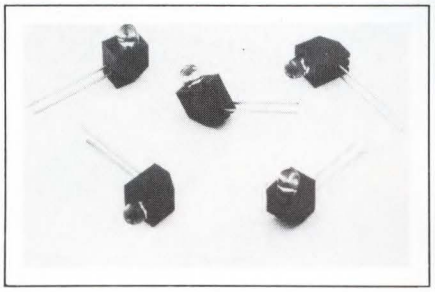
Telecopy (408) 996-7547

and ceramic. The ferrite shield yields a coupling rate of 3%. You can order the CS 2014 either in bulk or tape and reel. From $0.50.

ICS Manufacturing Inc, 11661-F Martens River Circle, Fountain Valley, CA 92708. Phone (800) 642-2645; in CA (800) 247-7864. FAX 714-540-8326.

Circle No 685



PCB MOUNT LED

The PCL201-200 right-angle, pc-board-mount status indicator is available in several color choices including red, green, and amber. The luminous intensity is a function of the color you select; however, at a forward current of 20 mA, the luminous intensity is 50 mcd, minimum for green. The 45° angle of the LED makes the device well suited for elevated viewing. The PCL201-200 package includes a protective, flame-retardant black nylon housing, which meets UL94VO approval. From $0.30 (1000). Delivery, stock to six weeks ARO.

Data Display Products, Box 91072, Los Angeles, CA 90009. Phone (800) 421-6815; in CA, (213) 640-0442

Circle No 686

DISPLAY MODULE

The Model 3601-95-040 displays the full 96 ASCII character set of upper- and lower-case letters, numbers, and symbols in a low-cost, 5 × 7-in. dot-matrix, 2-line × 20-character display. The vacuum-fluorescent display module measures 5 × 2.25 × 0.98 in. and features legible 0.2-in.-tall characters in a bright blue-green color. Color filters are also available. An onboard microprocessor controller handles all scan, refresh, and data I/O tasks, permitting easy interface to an 8-bit ASCII parallel data bus. The module requires a 5V supply for operation. $92 (100). Delivery, four to six weeks ARO.

IEE Inc, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311.

Circle No 688

CIRCLE NO 22

Finally! An economical keylock that stands up to just about anything.

Introducing Oak's SURE LOCK keylock switch. Its metal construction makes it rugged and durable. Yet it costs no more than plastic versions. So you get all the strength and security you need without settling for less.

The SURE LOCK's attractive design and solid, consistent feel make it the ideal keylock for your CRT terminals, bank teller systems, test instruments, you name it! There are versions to meet virtually all of your design needs.

For complete specifications on Oak's full keylock line, call or write us today.

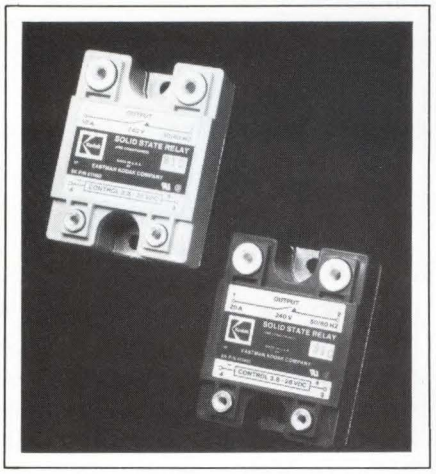
OAK Switch Systems Inc.
P.O. Box 517, Crystal Lake, IL 60014
Phone 815/459-5000,
FAX 815/459-5000 Ext. 2218

NEW SERIES 500 Digital switching
TYPE A & F Versatile switching
APPLIANCE High current capacity
ANTI-STATIC 20 Kv protection

OAK *Your Partner in Excellence*

CIRCLE NO 34

Components



SOLID-STATE RELAYS

Two high-reliability solid-state relays, the 10A and 20A, can switch loads up to 240V ac at a power factor of 0.3. The 10A and 20A have a reliabilty of 0.05 failures per million hours so you can use the relays in high-reliability, low power factor applications. The relays mount directly on your pc board with four screws. Both the 10A and 20A are UL recognized, CSA certified, and conform with VDE specifications. Both units carry a 10-year warranty. 10A relay, $20; 20A relay, $21.50 (100).

Eastman Kodak Co, Solid State Relay Group, 901 Elmgrove Rd, Rochester, NY 14653. Phone (716) 726-4538.

Circle No 687

FLAT-PANEL DISPLAY

The manufacturer claims that this electronically addressed smectic liquid-crystal (EASL) screen provides a high-resolution flicker-free display that's readable in bright ambient light and has a viewing angle equivalent to that of ink-on-paper printed material. It has a contrast ratio greater than 20:1, and a line resolution of 200 dpi max. Once updated, the display doesn't require any refreshing, thereby eliminating the requirement for high-speed drive circuitry and providing a high degree of data security. You can update the entire screen of a 640×480-pixel display in <300 msec.

Power dissipation during erasure of the image is $0.1 W/cm^2$, and the display requires zero power for image retention. The operating temperature range is 15 to 55 °C. The display is initially being manufactured in 4-, 8-, and 14-in. diagonal versions. The 14-in. version can display a full-size A4 page. The initial

CIRCLE NO 23

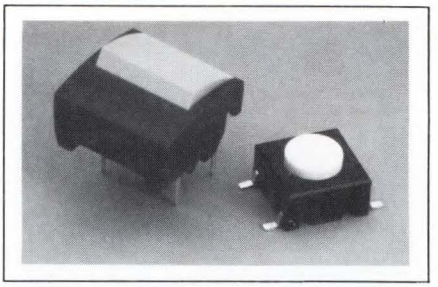
display is black and white, but color versions are under development. Samples of the 640×480-pixel display complete with interface circuitry and a power supply, £600. In high volume, the display competes in price with supertwist LCD technologies.

Image Displays Ltd, The Astra Centre, Edinburgh Way, Harlow, Essex CM20 2BU, UK. Phone (0279) 443344. FAX 0279-31022.

Circle No 717

SMD SWITCHES

These fully sealed miniature keyboard switches are suitable for surface mounting using pick-and-place equipment. They have a 10.1×10.1-mm footprint and a height of 6.4 mm. You can fit them with a range of standard or customized colored keycaps. The keycaps can incorporate a medium-intensity LED indicator, or high-intensity illumination. The keyswitches have an operating force of 150g and provide 1 mm of switch travel with tactile feedback. $0.65.



Mec A/S, Box 26, Industriparken 23, 2750 Ballerup, Denmark. Phone (02) 973366. TLX 9125649. FAX 02-681514.

Circle No 718

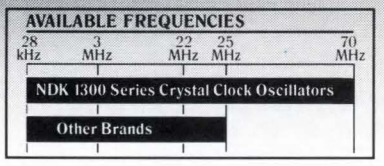
ACTUAL SIZE

NDK 1300 Series Compact Crystal Clock Oscillators

NDK's 1300 Series offers the widest range of CMOS- and TTL-compatible compact oscillators available. Frequencies from 28 kHz to 70 MHz with enable/disable std and dual-frequency output as an option. All in rugged, space-saving, half-size packages that are perfect for high density pc-board applications.

NDK 1300 Series Features

- Broadest range of available frequencies – 28 kHz to 70 MHz
- Low-power/low-heat CMOS technology
- Choice of TTL, CMOS or dual-compatibility
- Compact size (0.52-inch square) – perfect for portables
- Quick rise and fall times (5, 7, 10 ns)
- Excellent fan out (2 or 5 TTL gates)
- Sealed, grounded metal case resists EMI, high temperatures, humidity
- Shock and vibration resistant



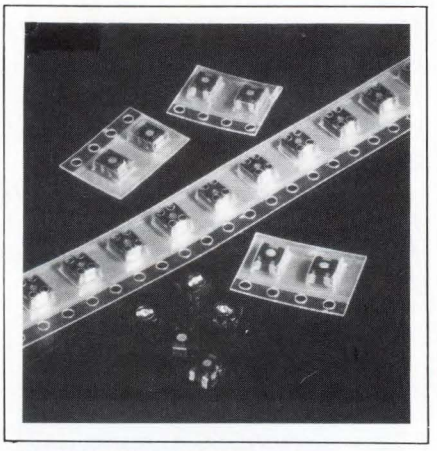
NDK: Your single source.

NDK offers the widest range of compact crystal oscillators, microprocessor quartz crystals, and standard crystal oscillators available. All fully guaranteed to be free from impurities and defects. And all readily available through NDK's nationwide network of stocking distributors.

For a free product catalog, or to order evaluation samples, contact NDK today.

NDK America, Inc.
20300 Stevens Creek Blvd., Suite 400
Cupertino, CA 95014-2210
Telephone: (408) 255-0831
Telex: 352057 NDKCOLTD CPTO
Fax: (408) 725-0369

NDK®

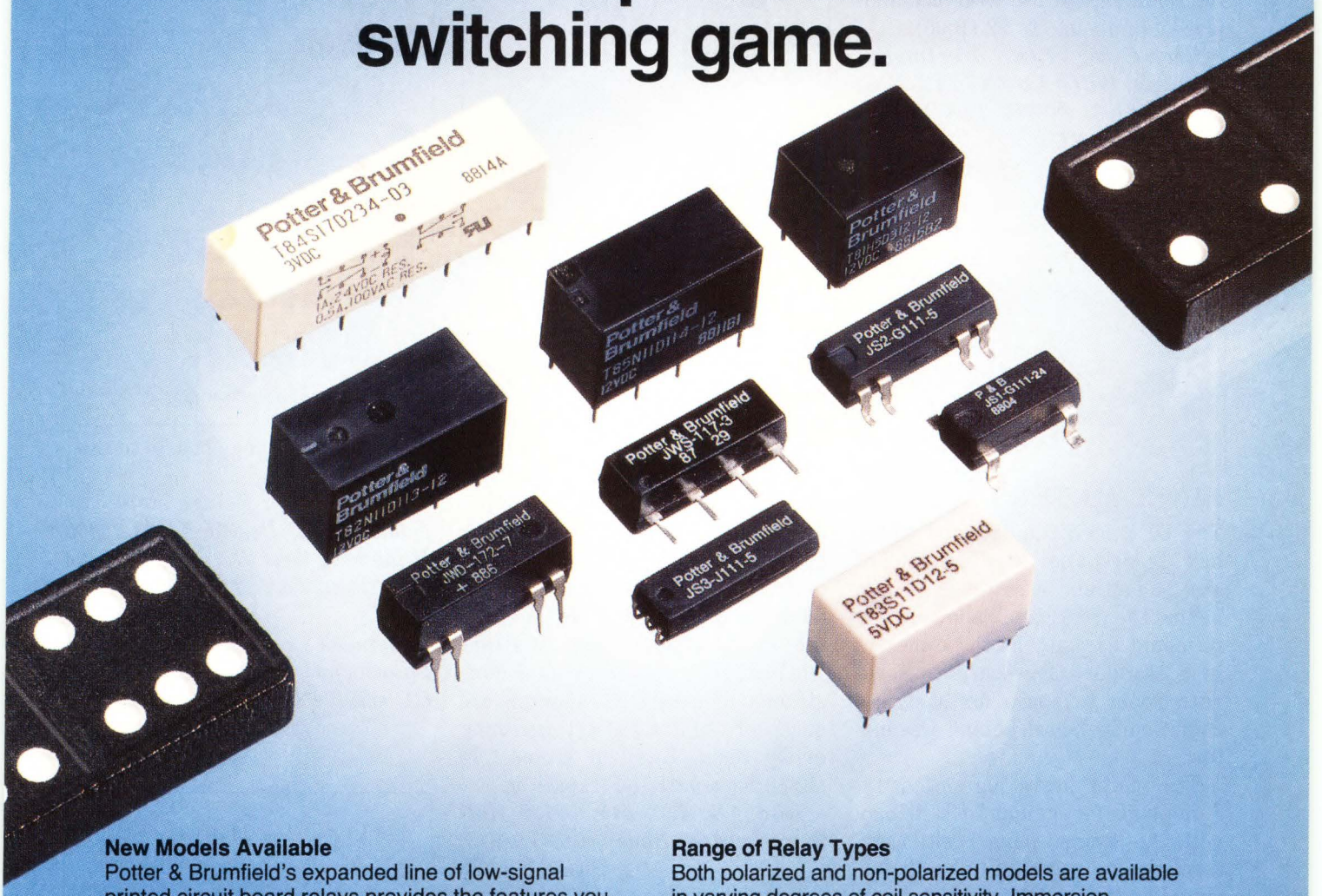


POTENTIOMETERS

Series-3203 surface-mount potentiometers have package dimensions of 3×3×1.7 mm and can withstand dual-wave soldering, and vapor-phase soldering at 250°C for 10 sec or 280°C for 5 sec. The potentiometers are available with resistance values between 200Ω and 1 MΩ, and have a temperature coefficient of resistance of 250 ppm/°C.

You can adjust the potentiometer after soldering by removing its silicone seal, and lock it again by using a rubberized locking paint. The terminal layout of the package is offset

Specify P&B relays for the 2 amp and under switching game.



New Models Available
Potter & Brumfield's expanded line of low-signal printed circuit board relays provides the features you need for your 2A and under switching requirements. New products, traditional P&B quality, stock availability and service through our broad sales network combine to help solve your toughest relay design-in problems in telecommunications, alarm, industrial control and other applications.

SPST to 4PDT, Dry Circuit to 2A
Whether your design demands single or multiple-contacts, dependable dry circuit or 2A switching, one or more of our new models will probably meet your needs. Many are UL recognized and CSA certified.

Range of Relay Types
Both polarized and non-polarized models are available in varying degrees of coil sensitivity. Immersion-cleanable DIP and SIP types are offered, as are surface-mountable reed relays.

Send for Free Information
Contact us today to learn more about our growing line of low-signal relays or our other P.C. board relays for loads through 30A. Potter & Brumfield, A Siemens Company, 200 South Richland Creek Drive, Princeton, Indiana 47671-0001.

Call toll-free 1-800-255-2550 for the P&B authorized distributor, sales representative or regional sales office serving your area.

Series	JS1, 2 & 3	JWD/JWS	T81	T82	T85	T83	T84
Features	Reed relay Surface mount terminals Shielded type available	Reed relay DIP & SIP models Optional diode	Miniature size DIP layout Sensitive coil available	Low profile DIP layout Single or bifurcated contacts	Ultra-sensitive DIP layout Bifurcated contacts	Latching or non-latching Meets FCC Part 68 DIP layout Bifurcated contacts	Latching or non-latching Meets FCC Part 68 DIP layout Bifurcated contacts
Contact Form	1A	1A, 1B, 1C, 2A	1C	2C	2C	2C	4C
Maximum Rating	0.5 Amp	0.5 Amp	1.0 Amp	2.0 Amp	1.25 Amp	2.0 Amp	2.0 Amp
Nom. Coil Power	66-288mW	50-480mW	200-450mW	516-560mW	150-300mW	75-400mW	75-400mW

Potter & Brumfield A Siemens Company

8802A

CIRCLE NO 55

to prevent solder bridging, and the potentiometers are supplied on reels suitable for use with pick-and-place equipment. £0.22 (1000).

Bicc-Citec Ltd, Westmead, Swindon, Wiltshire SN5 7YT, UK. Phone (0793) 487301. TLX 449112. FAX 0793-610217.

Circle No 719

PANEL METER

The DPM-35 3½-digit panel meter has front-panel dimensions of 48×24 mm and a depth of 34 mm behind the front panel, allowing you to mount as many as three meters in a standard Eurocard cassette with room to spare for a signal-conditioning board behind the meters.

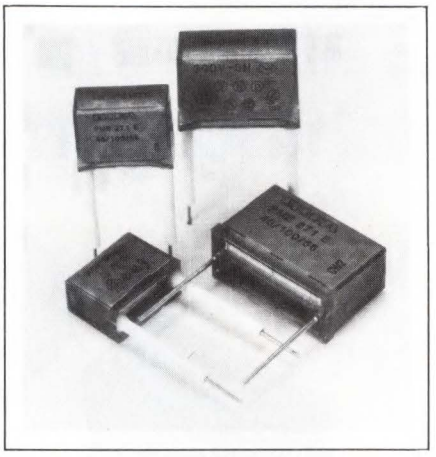
The meter has a high-intensity, 8-mm high, 7-segment LED display with the decimal point position determined by soldered links. It has single-ended or differential input voltage ranges of 200 mV and 2V, and current input ranges of 20 mA and 200 mA. The measurement accuracy is ±1 digit. The DPM-35 draws a maximum of 750 mW from a 5V supply. DM 65 (100).

Emtron Electronic GmbH, Rudolf-Diesel-Strasse 14, 6085 Nauheim, West Germany. Phone (06152) 61081. TLX 4191127. FAX 06152-69347.

Circle No 721

CAPACITOR

The PME-271E range of RFI suppression capacitors meets the X1 category requirements of IEC-384-14, and nine other stringent national standards. The capacitors are suitable for use in high pulse applications such as the suppression of fluorescent lamps and other line operated household equipment. They are available with capacitance values between 0.01 and 0.22 μF.



Their voltage rating is 300V ac, and they have a dV/dt capability between 400 and 1200 V/μsec. Their operating temperature range is −40 to +100°C, and they meet the 56-day requirement of the IEC humidity tolerance specification. PME-271E capacitors are constructed of metallized paper and are encapsulated in a self-extinguishing epoxy resin. Swedish krona 1.70 (1000) for a 0.047-μF capacitor.

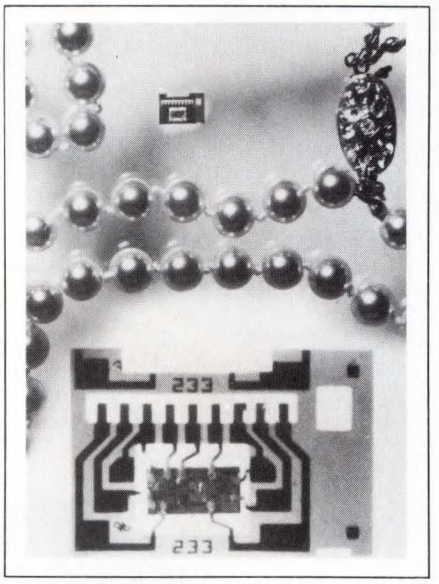
Rifa AB, Box 945, 39129 Kalmar, Sweden. Phone (0480) 61723.

Circle No 720

HALL-EFFECT IC

The TLE4910K Hall-effect IC produces an output voltage that is proportional to the flux density of its surrounding magnetic field, allowing you to convert mechanical motion directly into an analog electrical signal. External resistors allow you to adjust the zero point of the device's linear output characteristic and sensitivity. By adjusting the zero point you can use the device to detect flux reversal of the magnetic field.

The device can withstand ambient temperatures of −40 to +135°C and includes a temperature sensor that you can use to temperature-compensate measurement circuitry. The TLE4910K has an operating supply voltage range of 4.75 to 18V. $2.29 (1000).

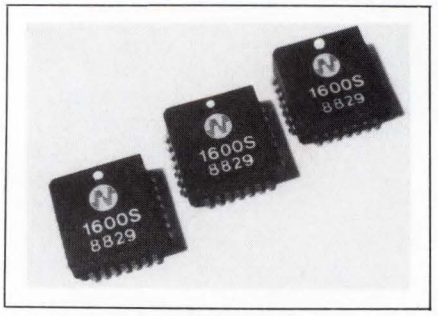


Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 722

Siemens Components Inc, 2191 Laurelwood Road, Santa Clara, CA 95054. Phone (408) 980-4500.

Circle No 723



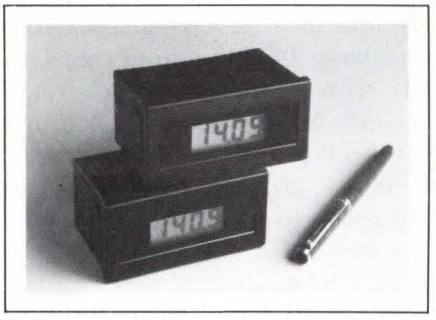
BUS ISOLATORS

Suitable for surface mounting, 1600-series bus isolators for CheaperNet, token-ring, and other networks are packaged in 28-pin J-lead plastic leaded chip carriers. They are available with isolation voltage ratings of 500V or 2000V rms. In conjunction with suitable interface chip sets, you can use the isolators to implement CSMA/CD (carrier sense multiple access/collision detection) and IEEE-802.5 network nodes. The isolators for CSMA/CD networks provide isolation for the

TX and RX data channels and for the CD (collision detect) channel. The isolator for IEEE-802.5 networks is a dual-channel device. In addition, a 4-channel isolator is available for isolating data buses, offering a low-cost alternative to optocouplers. £5 (100).

Newport Components Ltd, Tanners Dr, Blakelands North, Milton Keynes MK14 5NA, UK. Phone (0908) 615232. TLX 825621. FAX 0908-617545.

Circle No 724



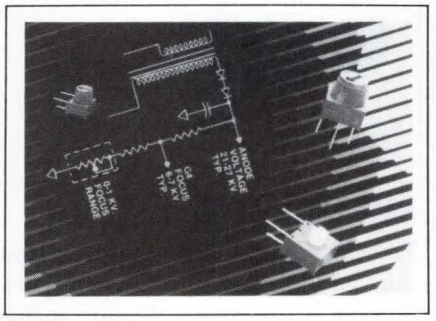
LCD DPMs

The DP-1650 and DP-1654 digital panel meters feature user-selectable decimal-point placement, automatic polarity changeover, and overrange indication of ±1. Both DPMs are completely autozeroing, employ a dual-slope integrating A/D converter, and use fully differential inputs for reliable readings. The DP-1650 has a fixed input of ±2V dc; the DP-1654 covers a full-scale input range of ±20V dc.

Both DPMs have 12.7-mm, 3½-digit LCD displays, a HOLD function for freezing the display, a common-mode rejection ratio to 86 dB, accuracy to ±0.1% full scale (+1 digit), and they draw 17.5 mW typ, 5V dc at 3.5 mA. An external reference that measures between 0.5 to 1.5V dc for ratiometric measurements can replace the internal reference of 1V dc. The input impedance for the DP-1650 is 1000 MΩ with overvoltage protection to ±10V dc; the DP-1654 has an input impedance of 1 MΩ and overvoltage protection to ±100V dc. $79 each; C-14 connector, $4.

Acculex, 440 Myles Standish Blvd, Taunton, MA 02780. Phone (508) 880-3660. TLX 503989.

Circle No 689



TRIMMER

You can perform adjustments to CRTs using this high-voltage focus-control trimmer with an input voltage rating as high as 1 kV dc. The Model 3386-HV1 trimmer has a cermet element with a temperature coefficient of ±150 ppm/°C. The trimmer is a ⅜-in.-square single-turn device, which meets MIL-STD-202, Method 103, for humidity.

Standard resistance values for the 3386-HV1 are 2.5 and 5 MΩ. Contact resistance variation is 1% maximum. Adjustability in the voltage divider mode is ±0.05% and in the rheostat mode is ±0.15%. The rotational life is specified at a minimum of 200 cycles, and the knobs are available in white or blue, with optional red knobs. The vendor requires a 50-piece minimum order. $1.01 (1000). Delivery, stock to eight weeks ARO.

Bourns Inc, 1200 Columbia Ave, Riverside, CA 92507. Phone (714) 781-5500. TWX 910-332-1252.

Circle No 690

PNP DARLINGTON

The PH27001H smart, high-power pnp Darlington provides fast current-foldback overload protection. To protect against short-circuit conditions, the unit monitors the current through an internal 16-mΩ sense resistor. Upon detecting an overload condition, the sense circuitry diverts the input base cur-

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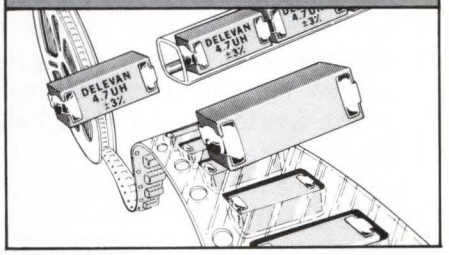
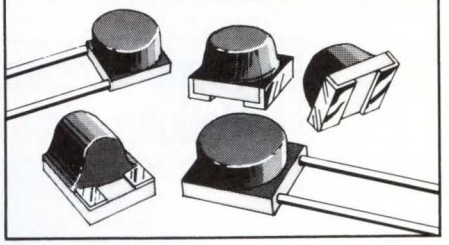
☑ For Custom-Engineered Surface Mountable Coils and Inductors:



- 1%, 3% Tolerance for Unshielded Matched Parts, 0.022μ H to 1000μ H
- 5% Shielded, from 0.1μ H to 560μ H

☑ For MICRO-i® chip inductors for hybrid circuits



- Qualified to MIL-C-83446/4 MS 21367
- Chips, wire bondable ribbon leads or reflow solder pads
- .010μ H to 1000μ H

For the ultimate in engineering capability:

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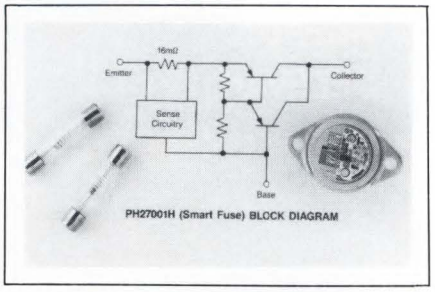
CIRCLE NO 127

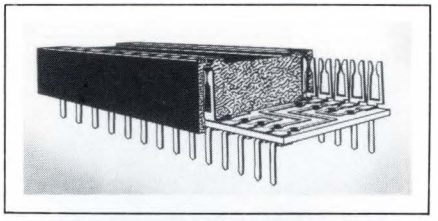


PH27001H (Smart Fuse) BLOCK DIAGRAM

rent to shut off and protect the Darlington. Other features include a 312W power-dissipation rating, a 1.8V max $V_{CE(SAT)}$, an 80V min collector-to-emitter breakdown, a 1500 min dc current gain, a −55 to +125°C operating range, and a 1.2-μsec turn-on time. The unit is housed in a TO-3 hermetically sealed package with a 0.4°C/W thermal impedance. Units are available screened to MIL-STD-883C, Method 5008, Class B. Sample quantities available from stock. $89 (100). Delivery, four to six weeks ARO.

Micro Networks, 324 Clark St, Worcester, MA 01606. Phone (508) 852-5400.

Circle No 693



PROGRAMMED SOCKET

The Correct-A-Chip is a socket that the vendor programs to your specification to reroute circuit paths, either due to unavailability or obsolescence of the ICs you are using in your design. Using a tiny pc board, the Correct-A-Chip can be adapted to any pin count and to any DIP configuration. The contacts are gold plated with tin-plated solder tails and the Correct-A-Chip is available in standard and low-profile versions for 0.300-mil centers in 14-, 16-, 18-, 20-, and 24-pin sizes and 0.600-mil centers in 24-, 28-, and 40-pin sizes. Worksheets are available from the vendor to help you plot your circuitry. The $250/order for each configuration programming fee is reduced to $100 for repeat orders. 14-pin socket, $4.68 (1000).

Aries Electronics Inc, Box 130, Frenchtown, NJ 08825. Phone (201) 996-6841. FAX 201-996-3891.

Circle No 691

CRYSTAL OSCILLATORS

A line of TTL crystal oscillators combines 14 pin, in-line compatibility with a frequency range from 1 to 200 MHz. The frequency drift over a 0 to 70°C operating range is ±0.01%, and rise and fall times are 10 nsec typ. Power consumption is as low as 15 mA. From $1.75 to $2.15 (1000).

Ecliptek Corp, 18310 Ward St, Fountain Valley, CA 92708. Phone (714) 963-7468.

Circle No 694

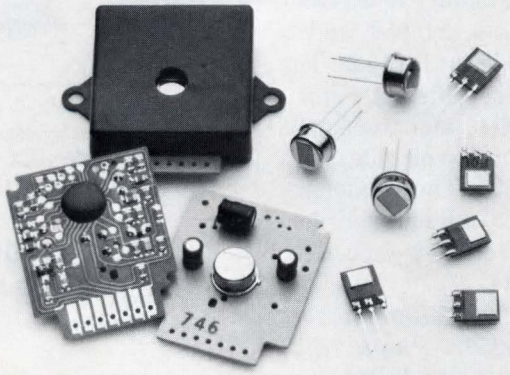
WIREWOUND RESISTORS

Type WSC surface-mount wirewound resistors are available in 1 and 2W models with tape-and-reel packaging suitable for automatic-insertion equipment. The SMD has broad wraparound terminals to provide mounting stability and solderability. You can mount the 1W WSC-1 resistor in the same foot pad as a 1W chip resistor. The 1W WSC-1 resistors come in values ranging from 0.1Ω to 2.38 kΩ, and the 2W WSC-2 resistors are available in 0.005Ω to 10.4 kΩ resistances. You can get tolerances from ±0.05% to ±5%. Standard temperature coefficients are ±20, ±50, and ±90 ppm/°C in values down to 0.1Ω. $0.98 (1000). Delivery, 8 to 10 weeks ARO.

Dale Electronics Inc, 1122 23rd St, Columbus, NE 68601. Phone (402) 563-6228.

Circle No 696

Nippon Ceramic IR Sensors and Modules...from PACE Electronics



Nippon Ceramic IR products, distributed in the US by PACE Electronics, are robot assembled for high reliability.

TO-5 detectors offer high sensitivity with a variety of element configurations and cut-offs. Assembled modules have low current drain, user-specified on-times and choice of operating modes. Low-cost flat packs are ideal for proximity and dispensing applications.

Call PACE for specs, application notes and evaluation samples.

PACE ELECTRONIC PRODUCTS
34 Foley Drive
Sodus, New York 14551-0067
Telephone 800-228-7223
Facsimile 315-483-9480
Telex 200806

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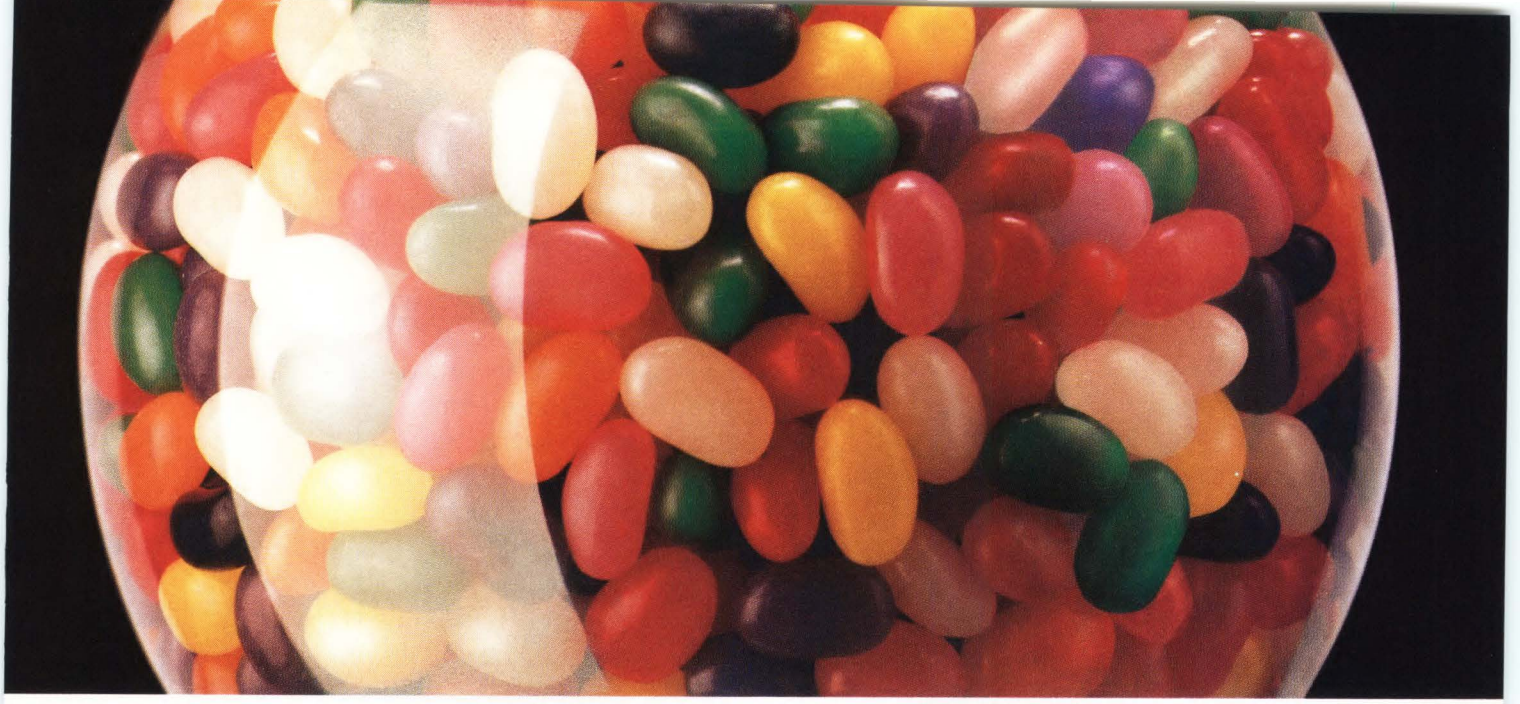
CIRCLE NO 20



If this is how you see LEDs, the ad is over.

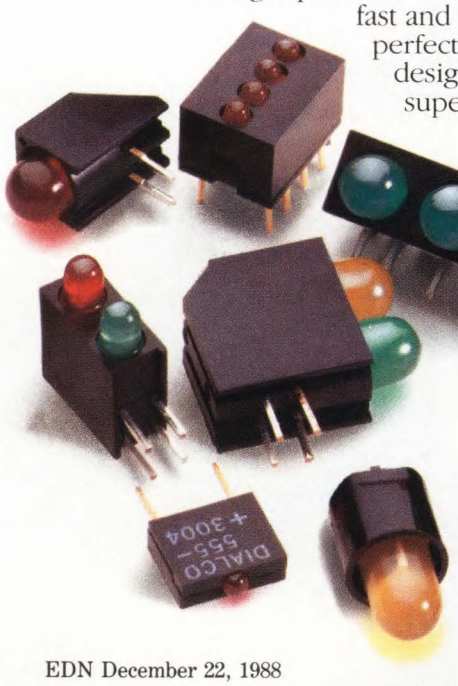
The popular myth goes something like this: "An LED, is an LED, is an LED." Or: "If you've seen one, you've seen them all." And of course: "LEDs? They're commodity products."

Notions we at Dialight, steadfastly reject. And once you're familiar with our products, you'll know why.

Take our Circuit Board Indicators. Single or multiple discretes aligned in a sturdy plastic housing, complete with their own current limiting resistor. The entire assembly polarity-keyed to guarantee correct insertion.

Each unit is 100% tested—ready to insert for wave soldering. No leads to bend, trim, or break. No time wasted fumbling with discretes.

Dialight pioneered the concept more than fifteen years ago to satisfy the OEM need for fast and reliable circuit board installation of LEDs. And we've been perfecting it ever since. Developing hundreds of standard and custom designs. A heritage of technological advance you can see in our new super-bright gallium aluminum arsenide units.



All meticulously engineered with the understanding that the failure of a "jelly bean product" can cost thousands in end-user downtime, and who-knows-what in customer loyalty.

The same understanding might bring you to call 201-223-9400, or write Dialight Corporation, 1913 Atlantic Ave., Manasquan, NJ 08736, and ask for our catalog or a product sample. At the very least, it's brought you to the real end of our ad.

DIALIGHT CORPORATION
A Cambridge Electronic Industries Company

DIALIGHT·KULKA·HHSMITH

Engineering is the only commodity we sell.

CIRCLE NO 46

Hitachi's 3-Chip Graphics System

Off the northeast coast of Australia lies the Great Barrier Reef... a world of striking visual images... its appearance changing effortlessly with the tide. *Now, Hitachi's made it easier than ever for you to create dazzling graphic images.*

Our renowned HD63484 Advanced CRT Controller (ACRTC) has been joined by the HD63485 Graphics Memory Interface Controller (GMIC), and the HD63486 Graphics Video Attributes Controller (GVAC). The ACRTC made graphics software design simple, and now the GMIC and GVAC complete the picture by making your hardware design just as easy.

Glue logic is virtually eliminated. Development time and cost are slashed to the minimum. You end up with a graphics system so cost-effective that you can use it in high-volume, mainstream PC and OA workstation applications. High-performance graphics no longer has to be an option on your products.

A trio of devices gives unbeatable performance in every key area. The ACRTC embodies Hitachi's 2-micron CMOS technology to integrate all CRT and graphics control functions on one chip. This all-CMOS device has three on-board processors to relieve the system's CPU of many time-consuming processing tasks. The ACRTC executes 38 high-level commands—including 23 graphic drawing commands. You don't have to compute command parameters, and address translation is done in *hardware*.

The GMIC acts as an interface between the ACRTC and your frame buffer. This 64MHz Hi-BiCMOS™ device generates every control and refresh signal required by the DRAM frame buffer, including all timing signals, row-and-column addresses, and write strobes.

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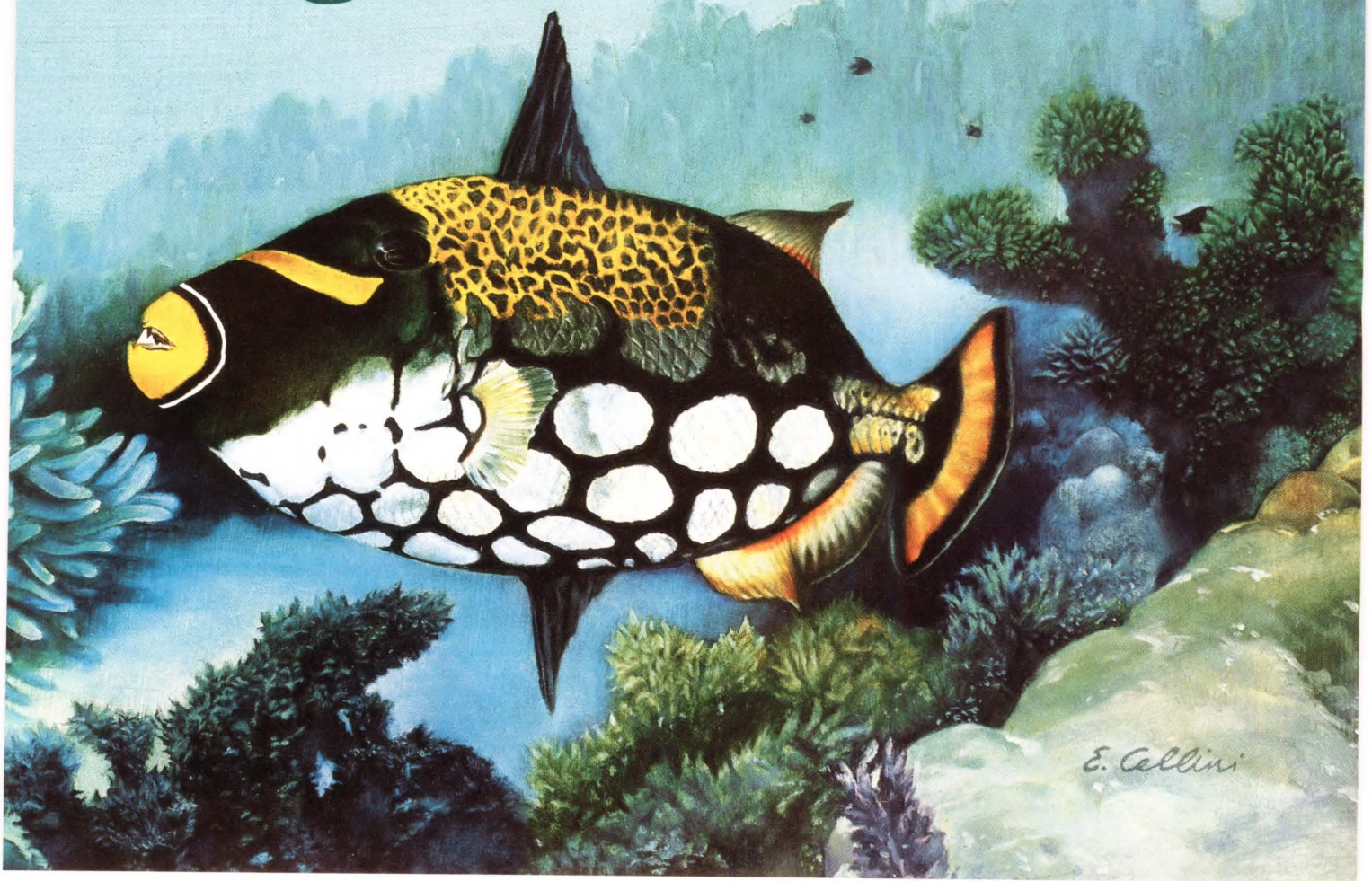

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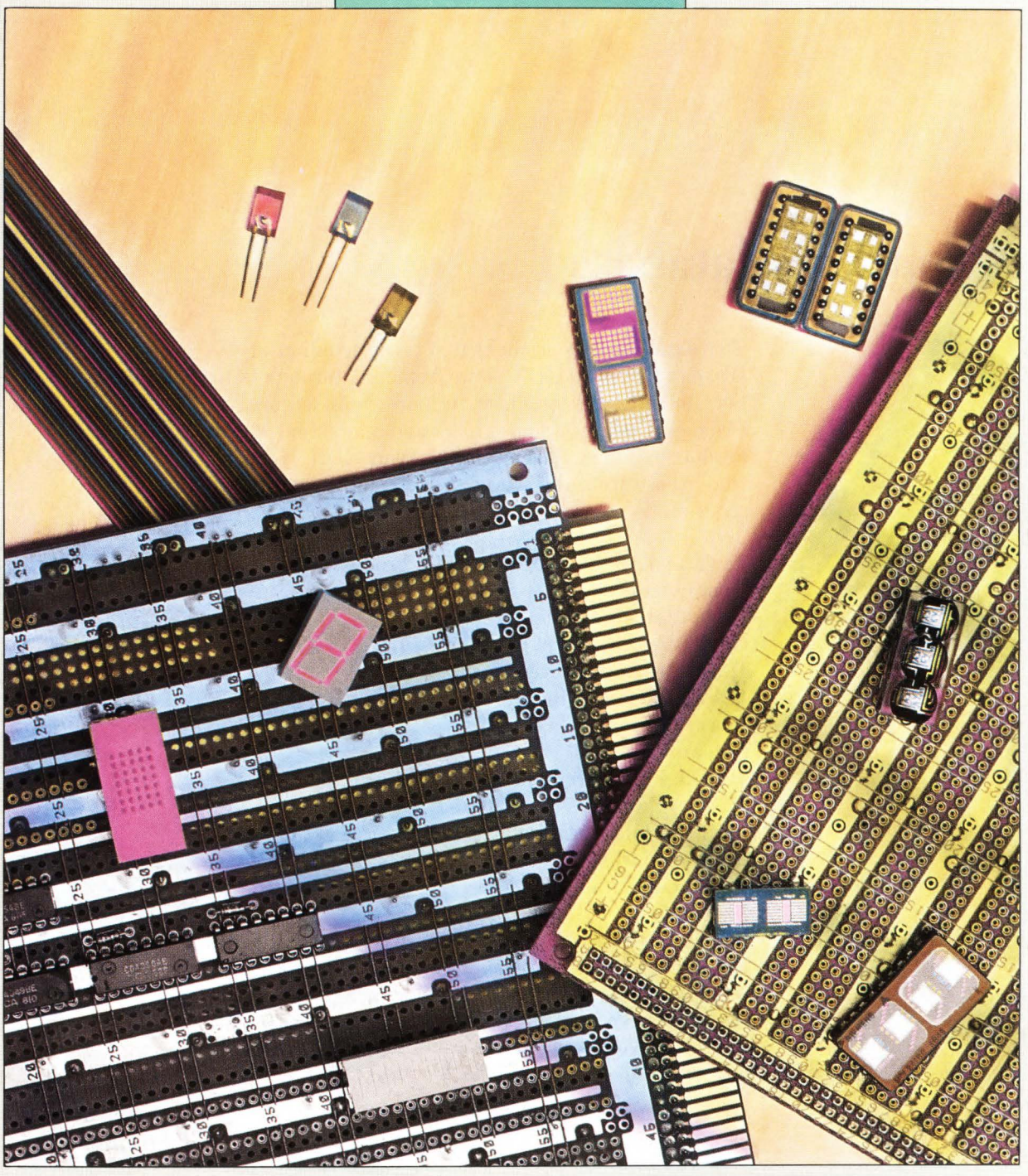

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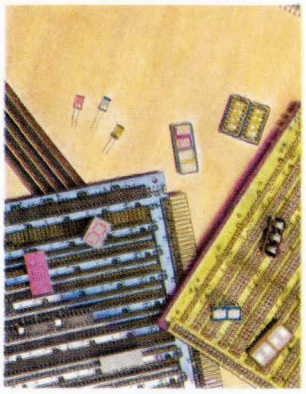

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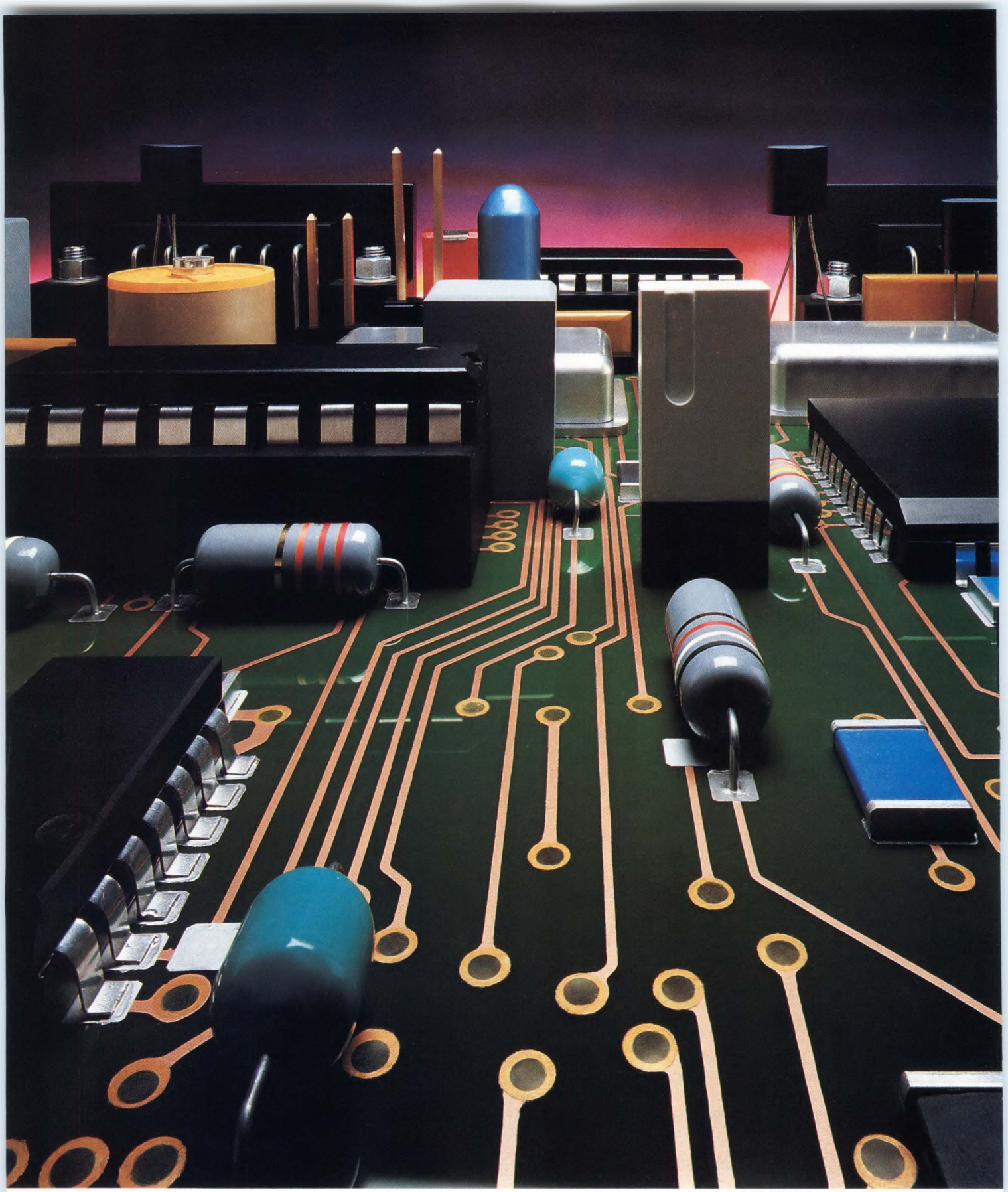

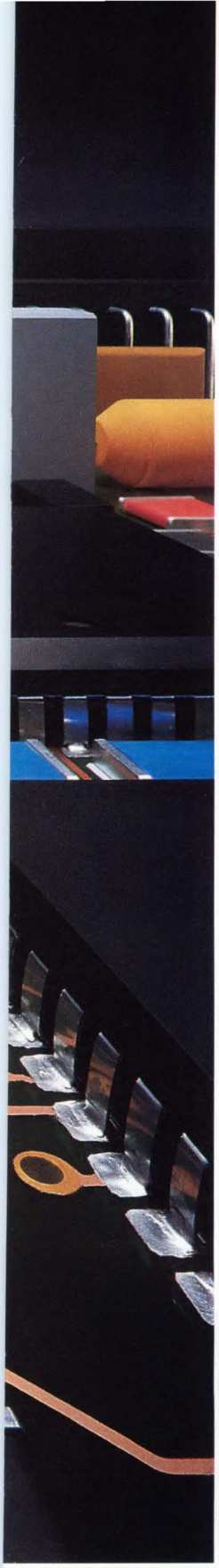

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General Resistance Co, *RTD-700*, EDN, 7/21/88, pg 226

Recorder
John Fluke Mfg Co Inc, *PM 8238*, EDN, 10/27/88, pg 407
John Fluke Mfg Co Inc, *PM-8238*, EDN, 9/29/88, pg 84
Kontron Electronics Inc, *Model 520*, EDN, 10/27/88, pg 405

Resistance calibrator
Electronic Development Corp, *Model 620A*, EDN, 9/29/88, pg 101

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Tektronix, *K501,K217S,K318,K212,K501*, EDN, 9/15/88, pg 287

Signal analyzer
Hewlett-Packard Co, *HP 35660A*, EDN, 8/18/88, pg 279

Signal conditioner
Data Translation, *DT760*, EDN, 5/26/88, pg 260

Signal converter
National Instruments, *GPIB-232CV, GPIB-422CV*, EDN, 7/21/88, pg 206

Signal generator
B&K Precision, *3017*, EDN, 10/13/88, pg 307
Kron-Hite Corp, *2100A*, EDN, 6/23/88, pg 260

Simulator
Processing Telecom Tech Inc, *5721*, EDN NEWS, 5/01/88, pg 68

Spectrum analyzer
Marconi Instruments, *2383*, EDN, 7/21/88, pg 213
Rohde & Schwarz, *Model FSA*, EDN, 7/21/88, pg 232

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Venable Industries Inc, *Model 350*, EDN, 9/15/88, pg 292

Supply evaluator
Vicor Corp, *VI-MEB-AC*, EDN, 9/15/88, pg 294

Sweep generator
Marconi Instruments, *Model 6311*, EDN, 7/21/88, pg 208

Synthesizer
Comstron Corp, *FS-2000A-18*, EDN, 10/13/88, pg 306

Temperature indicator
Beckman Industrial Corp, *500T*, EDN, 5/26/88, pg 249

Temperature meter
Simpson Electric Co, *2871, 2872*, EDN, 5/12/88, pg 261

Test software
Hewlett-Packard Co, *Interactive Test Generator*, EDN NEWS, 9/01/88, pg 79

Test subsystem
BitWise Designs Inc, *(TSD) modules*, EDN NEWS, 5/01/88, pg 12

Thermometer
Extech Instruments Corp, *Oyster*, EDN, 6/09/88, pg 295

Thickness tester
CMI International, *Beta-Min 1800*, EDN, 9/29/88, pg 98

Time-stamp module
Applied Microsystems Corp, —, EDN, 6/09/88, pg 318

Timing analyzer
Rohde & Schwarz, *LAL*, EDN, 7/21/88, pg 200

Timing instrument
Outlook Technology Inc, *T-132*, EDN, 7/21/88, pg 227

Transient recorder
Rapid Systems Inc, *R1240*, EDN, 10/13/88, pg 302

Troubleshooter
Huntron Instruments Inc, *Tracker 5100DS*, EDN, 8/18/88, pg 270

VXI bus hardware
Hewlett-Packard Co, *HP E1400*, EDN, 9/15/88, pg 292

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Hewlett-Packard Co, —, EDN NEWS, 8/01/88, pg 74

Vibration controller
GenRad Inc, *GR2530*, EDN, 6/23/88, pg 254

Video photometer
Photo Research, *PR-900*, EDN, 6/23/88, pg 252

Voltage standard
Ballantine Laboratories Inc, *Model 6400A*, EDN, 7/21/88, pg 200

Wafer-probe card
Tektronix, *P6521*, EDN NEWS, 9/01/88, pg 75

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Sencore, *SC61*, EDN, 9/29/88, pg 234

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Rapid Systems Inc, *R2088*, EDN, 10/27/88, pg 416

Waveform recorder
Soltec Corp, *SDA2000*, EDN, 6/09/88, pg 321

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Analogic/Data Precision, *660-1*, EDN, 10/13/88, pg 303

Word recognizer
Tektronix, *P6408*, EDN, 10/13/88, pg 302

μP emulator
Huntsville Microsystems Inc, *200 Series*, EDN, 6/23/88, pg 252

High Performance Triacs That Need No Snubber.

The Brighter Solution.

When it comes to advanced smart power integrated circuit technology, SGS-THOMSON Microelectronics is an acknowledged leader. But what about discrete devices? Our latest range of Snubberless Triacs offers design, reliability and cost-saving advantages second to none. Just what you'd expect from The Brighter Power.™

High $(di/dt)_c$ guaranteed without a snubber.

Created specifically to deliver very high switching performance, SGS-THOMSON's Snubberless Triacs have a guaranteed $(di/dt)_c$ and do not require the use of a snubber circuit. With devices covering the 6 to 16 A_{RMS} and 200 to 800 volt ranges Snubberless Triacs can, in fact, replace less efficient triacs in most applications.

Snubberless Triacs save design time and space.

With SGS-THOMSON Snubberless Triacs, you simply specify it, fit it and forget it—even when driving high inductive loads. There's no more over-dimensioning to achieve system reliability. No more wasted time and money designing and fitting costly, space-consuming snubbers.

Winning IC driven triacs, too.

Even for low I_{GT}, IC driven triacs, SGS-THOMSON technology is ahead of the rest. Our Logic Level Triacs offer guaranteed switching characteristics and super high performance. In the 20 to 50V/μs range, SGS-THOMSON's $(dv/dt)_c$ is up to 50 times better than conventional sensitive triacs.

Snubberless and Logic Level Triacs are just two members of a family that also include standard triacs, thyristors and alternistors. Why settle for second best and why design what you don't need when a whole range of brighter triac ideas is just a phone call away?

SNUBBERLESS TRIACS

TYPE/CURRENT/ VOLTAGE	SUFFIX	I_{GT} MAX*	$(di/dt)_c$ Min @ $(dv/dt)_c \leq 100V/\mu s$
BTA/BTB 6A/200-800V	AW	75mA	8.0A/ms
	BW	50mA	5.0A/ms
	CW	35mA	3.5A/ms
BTA/BTB 8A/200-800V	AW	75mA	10.0A/ms
	BW	50mA	7.0A/ms
	CW	35mA	4.5A/ms
BTA/BTB 10A/200-800V	AW	75mA	12.0A/ms
	BW	50mA	9.0A/ms
	CW	35mA	5.5A/ms
BTA/BTB 12A/200-800V	AW	75mA	16.0A/ms
	BW	50mA	12.0A/ms
	CW	35mA	6.5A/ms
BTA/BTB 16A/200-800V	AW	75mA	21.0A/ms
	BW	50mA	14.0A/ms
	CW	35mA	8.5A/ms

LOGIC LEVEL TRIACS

TYPE/CURRENT/ VOLTAGE	SUFFIX	I_{GT} MAX*	$(di/dt)_c$ Min @ $(dv/dt)_c$
BTA/BTB 6A/200-800V	SW	10mA	2.7A/ms 50 V/μs
	TW	5mA	1.3A/ms 20 V/μs
BTA/BTB 8A/200-800V	SW	10mA	3.5A/ms 50 V/μs
	TW	5mA	1.8A/ms 50 V/μs

*1st, 2nd and 3rd Quadrants

SGS-THOMSON Microelectronics
1000 E. Bell Road
Phoenix, AZ 85022
(602) 867-6259

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SGS-THOMSON Microelectronics
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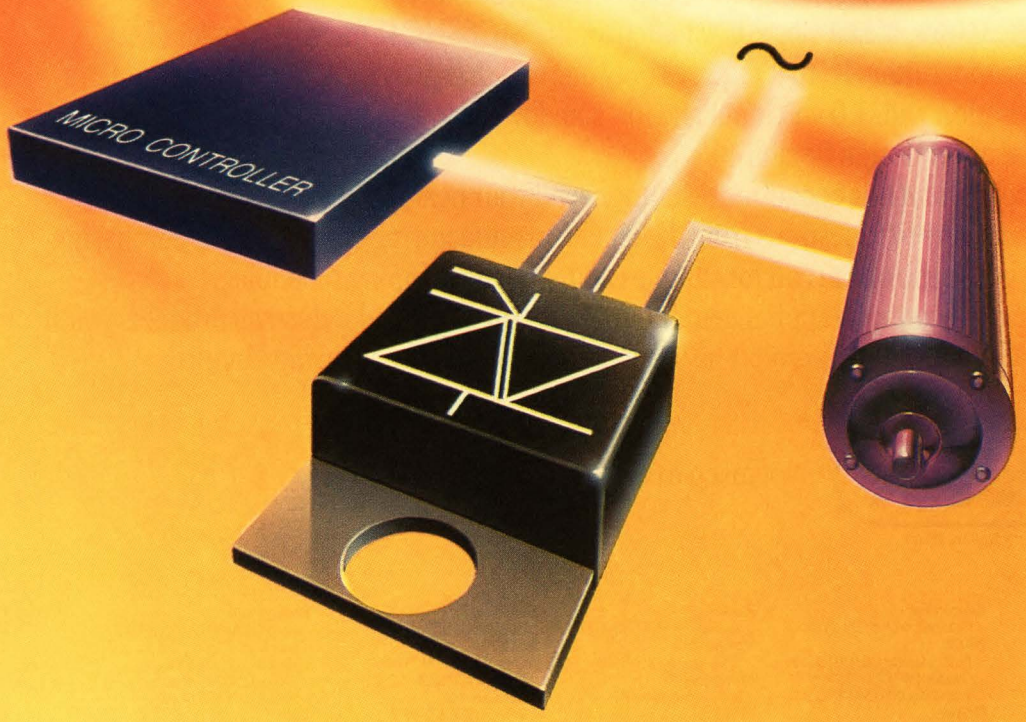
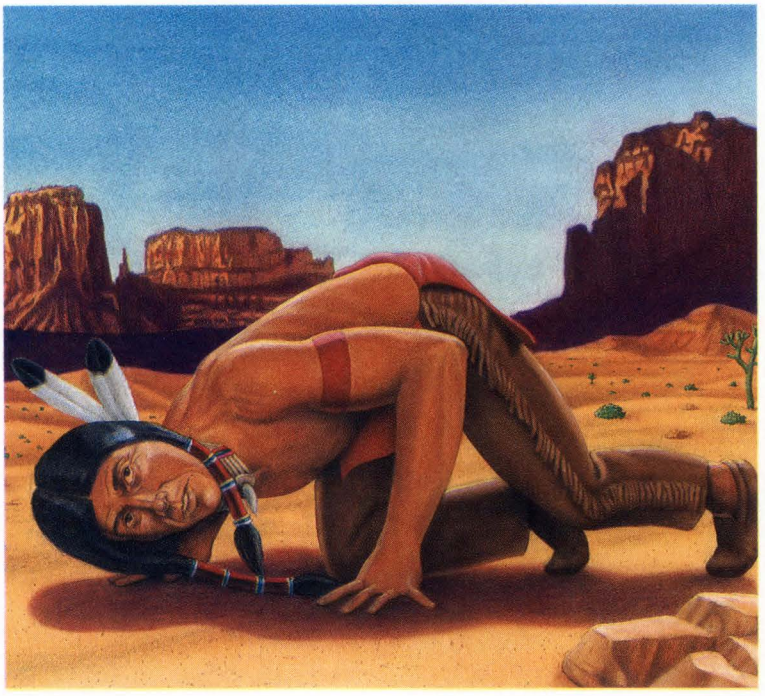


SGS-THOMSON
MICROELECTRONICS

CIRCLE NO 25

Early warning device from Motorola and Hall-Mark.



Call Hall-Mark for the Motorola undervoltage sensing circuit and save your boards from power struggles.

The Motorola undervoltage sensing circuit acts as a single device reset controller in microprocessor-based systems to save your boards and save your customers' headaches.

Called the MC34064, it's an electronic match for the MC68HC11 microcomputer. The MC34064 is a silicon monolithic IC that requires only one external resistor to operate. It features a guaranteed reset operation with 1.0 volt input and low standby current, and it's offered in TO-92 and surface mount packages for design flexibility.

To find out more about this economical solution, call your nearby Hall-Mark sales center. They're ready with answers for questions from designers, manufacturing engineers and purchasing experts. Hall-Mark is also the one to call for samples and accurate shipping schedules.

If you have an application in appliances, automotive, consumer and industrial products you'll want to know more about Motorola's circuit insurance—the undervoltage sensing circuit.

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Wisconsin
Milwaukee (414) 797-7844

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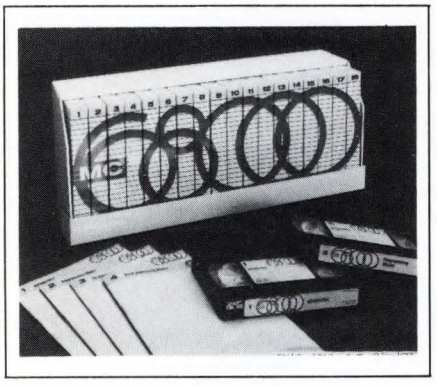
CIRCLE NO 32

Periodical deals with information management

FYI, a magazine for information management, publishes information about the company in a feature-news format that covers developments, trends, and case studies. It aims at an audience of executives in information technology; individuals who use high-technology systems, equipment, and components; and company employees. Articles in a recent issue focused on planning strategic information networks, computerized weather forecasting, a new μP for laptop computers, fail-safe radios for emergency communications, and computerized flight simulation.

FYI, Harris Corp MS-24, 1025 W NASA Blvd, Melbourne, FL 32919.

Circle No 664



Video series teaches use of MC68000 μP

The MC68000 Video Training Series (MTTV2) for the MC68000 microprocessor is organized into 18 modules with one videotape per module. It includes five Student Packs with workbooks and self-evaluation material. An Instructor Pack and MC68000 Educational Computer Board are also available as options. Complete 18-tape Video Training Series with five Student Packs and accompanying material, $9000; Instructor Pack, $175; Educational Computer Board, $495.

Motorola Inc, Training & Technical Operations, 1140 S Priest Dr, Tempe, AZ 85281.

INQUIRE DIRECT

IC data book

This company's 1988 data book presents all of the information found in the 1987 issue, as well as technical specifications and application notes for all the company's products released during 1988. New sections describe electrostatic discharge sensitivity and provide information about the sale of products in die form.

Elantec Inc, 1996 Tarob Ct, Milpitas, CA 95035.

Circle No 665

Brochure covers μP development products

The 12-pg brochure, *Microprocessor Development Environments*, presents an overview of the vendor's in-circuit emulation products and software development tools. It provides development-tool solutions for embedded μP designs, as well as product information. Photographs and charts complete the publication.

Applied Microsystems Corp, Box 97002, Redmond, WA 98073.

Circle No 666

Pamphlet features precision op amps

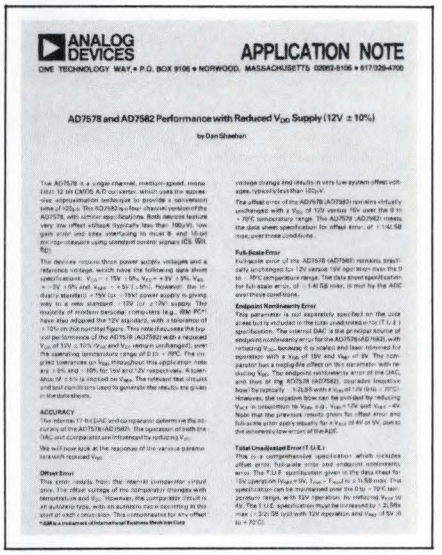
The vendor's 8-pg Precision Operational Amplifier Selection Guide presents more than 50 device types. It summarizes performance specifications, packaging information, and MIL-STD-883B availability of the op amps.

Raytheon Co, Semiconductor Div, 350 Ellis St, Mountain View, CA 94043.

Circle No 668

Summary and comparison of ADC performances

The 2-pg application note, *AD7578 and AD7582 Performance with Reduced V_{DD} Supply (12V ± 10%)*, summarizes typical performance at 12V V_{DD} for 100-μsec, 12-bit ADCs and compares it with the data-sheet


ANALOG DEVICES

APPLICATION NOTE

ONE TECHNOLOGY WAY • P.O. BOX 9106 • NORWOOD, MASSACHUSETTS 02062-9106 • 617/329-4700

AD7578 and AD7582 Performance with Reduced V_{DD} Supply (12V ± 10%)

by Dan Sheehan

specifications for 15V operation. Among the topics included are accuracy, timing, power-supply current, and logic inputs and outputs. Also included are a table showing accuracy results and a diagram illustrating the interfacing of the ADCs to an IBM PC.

Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021.

Circle No 667

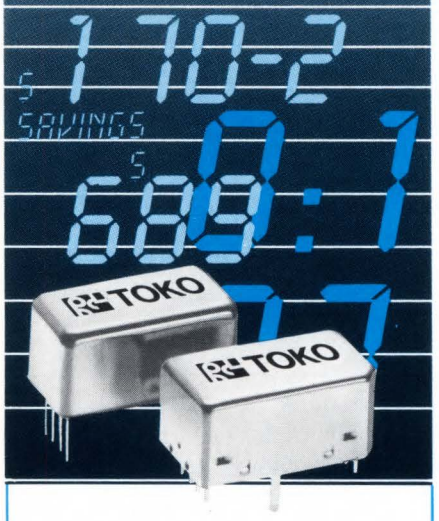
Handbook helps EEPLD users

The 54-pg *Erasic Multi-Level E²PLD TTL Macro Library Handbook* tells you how to implement more than 100 standard 7400 Series TTL building blocks in an EEPLD design using simple macros. The publication proceeds step by step through the fundamentals of installing the TTL Macro Library and shows you how to implement macros in EEPLD design. It also describes the internal make-up of the macro library and how to use its logic-reduction capabilities. Some of the TTL parts described in the handbook include SSI gates, AND-OR inverters, decoders, multiplexers, comparators, and flip-flops.

Exel Microelectronics Inc, Box 49007, San Jose, CA 95161.

Circle No 671

Toko DC-DC Converters: A Bright Idea for Powering Vacuum Fluorescent Displays.



Whether you're using Futaba, ISE or NEC vacuum fluorescent displays, Toko CPS series DC to DC Converters are the power solution to provide grid, anode and filament voltages —with high reliability and cost savings. They also provide stable power for modems, RS-232 interfaces and other subsystems requiring mixed operating voltages, at prices much lower than other power alternatives. Contact us to be sure you're not over specifying your DC to DC Converter needs.

High performance characteristics:

- ☐ Stable output levels for flicker-free displays
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- ☐ Full metallic shielding and matched external filtering prevents EMI problems
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The CPS series is available in power outputs to 2.4 watts, with input voltages of 1.7 to 30 VDC and output voltages ±5 to ±50 VDC or 1 to 10 VRMS AC. For more details and application assistance, contact Toko America today.

TOKO

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Mount Prospect, Illinois 60056
(312) 297-0070, TELEX: 724372
FAX (GIII): (312) 699-7864

CIRCLE NO 82

LITERATURE: COMPUTER-AIDED ENGINEERING

CAD/CAE course comes in four versions

You can obtain this on-site, personalized, customer software training for the company's Modular Design Environment (MDE) CAE/CAD software running on Sun 3 workstations. Four versions of the course accommodate different numbers of students. All versions cover five common elements: three video tapes for MDE engineering, the LSED schematic editor module, and the LWAVE waveform editor; MDE workbooks for individual students; MDE quick-reference cards; a user-support hotline telephone number staffed by trained engineering professionals; and a kit of reference data sheets and brochures. From $795 for TR-S99-K01A evaluation kit to $4995 for the 15-student TR-S99-K01D version.

LSI Logic Corp, MS D102, 1551 McCarthy Blvd, Milpitas, CA 95035.

INQUIRE DIRECT

Applications added to AutoCAD catalog

The new edition of the guide to third-party application development, the *AutoCAD Applications Catalog*, contains hundreds of entries. It covers application categories such as architectural engineering and construction, civil and chemical engineering, computer-aided manufacturing, and desktop publishing.

AutoDesk Inc, 2320 Marinship Way, Sausalito, CA 94965.

Circle No 730

Studies deal with AI in electronics manufacturing

These three case studies discuss the use of artificial intelligence in electronics manufacturing. The 336-pg *Artificial Intelligence Applications in Manufacturing* presents more than 200 commercial expert systems and case studies for specific applications such as CAD/CAM, maintenance, production scheduling, and energy management. The 198-pg *Artificial Intelligence in the Computer/Electronics Industry* explains the aspects of AI used for in-house applications: expert systems, artificial vision, voice recognition, and intelligent robots. Finally, the 176-pg *Artificial Intelligence in the Semiconductor Industry* discusses the research being done by major manufacturers in the design of VLSI circuits. Each publication costs $135.

Lion Publishing, Box 1869, Los Gatos, CA 95031.

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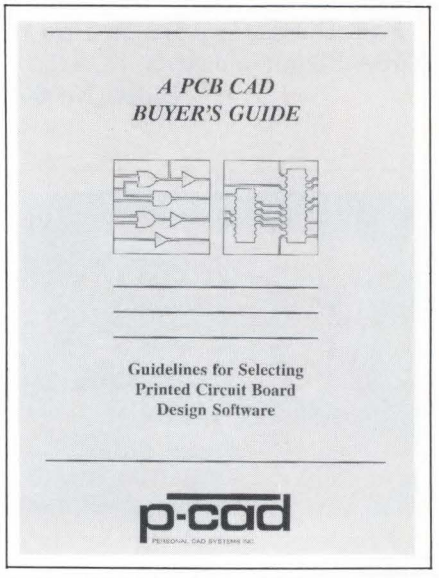

Software buying guide

The 24-pg booklet, *A PCB CAD Buyer's Guide*, helps you evaluate your needs and provides a checklist for reviewing CAD system features. The guide also includes payback calculations and criteria for a system life-cycle analysis.

Personal CAD Systems Inc, 1290 Parkmoor Ave, San Jose, CA 95126.

Circle No 732

How to select electronic CAD for personal computers

The vendor's guide to buying electronic CAD for personal computers lists more than 150 items and pro-

vides worksheets for making comparisons. According to the vendor, the book saves time for first-time buyers by helping them evaluate their needs for electronic CAD. For experienced workstation CAD users, the guide points out where PC-based products can have problems in relation to workstations. $25.

Design Solutions, 2912 Daubenbiss Ave, Suite 32, Soquel, CA 95073.

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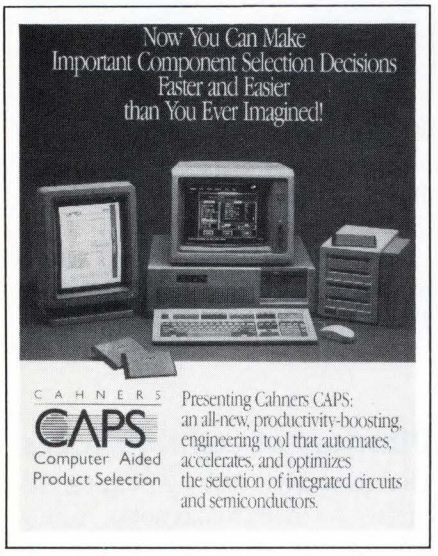


Publication helps you select CAD products

This 6-pg brochure describes the CAPS (computer-aided product selection) system. A series of photographs illustrates how the PC-based CAPS system optimizes the search and selection process for integrated-circuit and semiconductor devices. The pamphlet also details the configuration of the system.

Cahners CAPS, 275 Washington St, Newton, MA 02158.

Circle No 731

Information service for engineering managers

Targeted at engineering managers, the *Computer Aided Design Report* is based on data gathered by an independent group of engineering and computer professionals. This monthly report provides information such as user reports on software function and reliability, results of hands-on benchmark tests, and comparisons of workstation and PC performance. Another helpful feature is its organization and summary of CAD/CAM and CAE information. Finally, all reports are fully indexed twice per year. The indexes help you find the software and peripherals you need by function, vendor, or computing platform. A 12-month subscription on a trial basis, $154.

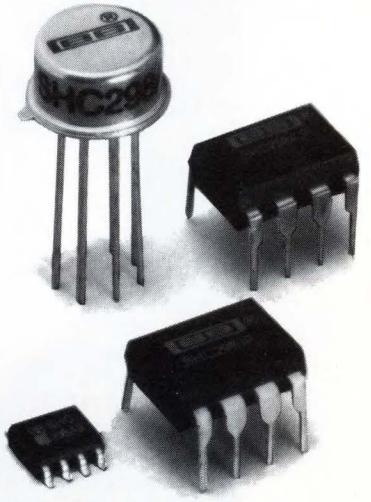
Computer Aided Design Report, 841 Turquoise St, Suite D, San Diego, CA 92109.

INQUIRE DIRECT

LOW COST SAMPLE HOLD AMP GUARANTEES 12-BIT ACCURACY, 6μs ACQUISITION TIME

Burr-Brown's popular SHC298 sample/hold amplifier is specified for 12-bit accuracy and is available in 8-pin TO-99, plastic DIP, and SOIC packages. SHC298 provides fast, precision performance over a wide ±5V to ±18V supply range and is an excellent choice for data acquisition and distribution system applications. Features include:

- 12-bit throughput accuracy;
- 6μs acquisition time (to ±0.01%, 10V step);
- 30μV/ms droop rate;
- 10μVrms noise;
- 10nA bias current;
- Reliable monolithic construction;
- 160 hour "burn-in" option;



$2.85 SHC298JP

*U.S. price in 100s.

Contact your Burr-Brown representative or Applications Engineering, 602/746-1111, for complete technical literature, samples, and assistance. Burr-Brown Corp., P.O. Box 11400, Tucson, AZ 85734.

BURR-BROWN®

CIRCLE NO 25

Booklet presents UPSs

This 28-pg illustrated brochure depicts the vendor's complete line of FerrUPS and microFerrUPS uninterruptible power systems. It provides application examples, technical and engineering specifications, information about performance and pricing, and available services and options.

Best Power Technology Inc, Box 280, Necedah, WI 54646.

Circle No 725

Document examines dc/dc converters and amplifiers

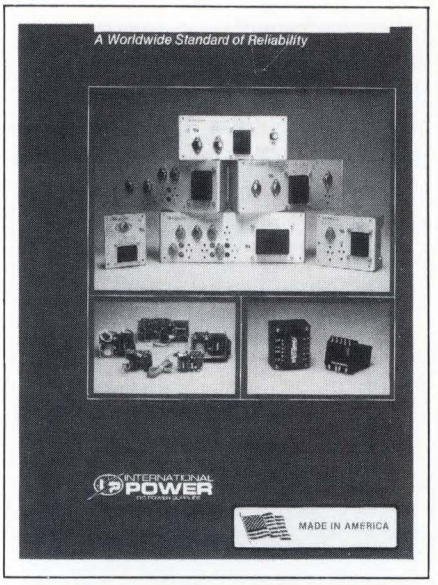
This 32-pg booklet of application notes defines technical terms for dc/dc converters. It includes a user's guide that tells you how to make accurate measurements; and about the effects of regulation, input noise, common-mode noise, and load-induced noise. Notes on *input ripple rejection* provide instructions for building a low-power noise test fixture and thermal-design calculations. Other sections, which include illustrations of 25 performance-type curves and 45 diagrams, instruct you in the use of a dc/dc converter as an ATE supply; in the use of a dc/dc converter in parallel for more power; in using instrumentation amplifiers, and in grounding and shielding amplifiers.

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523.

Circle No 726

Catalog features linear power supplies

This 12-pg catalog describes the vendor's open-frame series of power supplies. The brochure begins with a general description of the supplies' features and specifications. Photographs and voltage/current rating charts detail the various models of single-, dual-, triple-



output, and disk-drive linear supplies. Applications data and mounting drawings complete the publication.

International Power DC Power Supplies Inc, 355 N Lantana, Suite 710, Camarillo, CA 93010.

Circle No 727

Directory of control devices

The company's 160-pg catalog discusses its electromagnetic rotary-motion control devices, including clutches, brakes, tensioning systems, clutch couplings, power supplies, and related products for industrial, aerospace, and military applications. The book provides complete technical details, applications, specifications, and features for each product. In addition to sections on the aforementioned products, the book includes sections on fail-safe brakes, solenoids, and timers.

Electroid Co, 45 Fadem Rd, Springfield, NJ 07081.

Circle No 728

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INTERNATIONAL SWITCHER

- VDE, UL, CSA Safety and Emissions
- 5 Outputs
- 400 Watts
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MODEL CV405B

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P.O. Box 1369, Wissahickon Avenue, North Wales, PA 19454.

Deltron inc. / POWER SUPPLIES

CIRCLE NO 24

Disk describes C support tools

This demonstration disk presents the Micro/C programming-language support tools for single-chip microcomputers. It also details MS-DOS-based cross-compilers for the 8051 and the Z8 and Super8 processors. The disk spotlights standard and enhanced features of C. Further, it provides examples of Micro/C support for memory maps, interrupts, and on-chip peripherals; sample C and assembly-code listings are included.

Micro Computer Control, Box 275, Hopewell, NJ 08525.

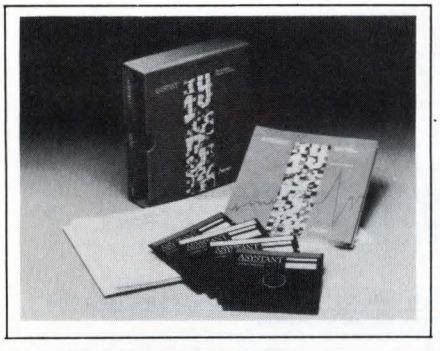
Circle No 733

Guide for designers of embedded systems

The *Guide to Embedded Languages* addresses the tradeoffs involved in embedding a language. This reference for engineers examines the characteristics of ROMable languages, interpreter/compiler tradeoffs, interactive development, and multitasking from within the language. It also contains a discussion of a case study.

Softaid Inc, 8930 Route 108, Columbia, MD 21045.

Circle No 735



Publication features scientific software

This 6-pg brochure, *Asystant, The Scientific Number Cruncher,* discusses the capabilities of the menu-driven scientific software for data analysis and graphics. It describes data file I/O and processing, array and matrix operations, statistics, waveform and signal processing, polynomials and differential equations, curve fitting, built-in utilities, and graphical presentation. The illustrated pamphlet also lists system specifications. Descriptions of the vendor's products and support services complete the brochure.

Asyst Software Technologies Inc, 100 Corporate Woods, Rochester, NY 14623.

Circle No 734

Catalog unveils software for VAB and HP-UX

The vendor's 200-pg Publication 5951-6794 deals with value-added-business (VAB) software and proprietary-software solutions for its HP-UX operating system. The catalog lists more than 400 technical and commercial software packages for the vendor's HP-9000 workstations and servers. Using the market keyword index, you can look for products in specific application areas. A range of application areas are available, from aerospace simulators to water-utilities operation. Business application areas include financial management, sales analysis, and accounting packages. The 200 VAB software packages listed in the publication are part of the HP Plus Program that assists third-party software suppliers with marketing the products.

Hewlett-Packard Co, Customer Information Center, Inquiry Fulfillment Dept, 19310 Pruneridge Ave, Cupertino, CA 95014.

Circle No 737

Video-based courses for database system, software

The two training courses, *Using Informix-SQL* and *Using Oracle SQL*Plus,* are available on 2-hour-long videotapes. The Informix-SQL course, which explains the functions and features of this relational database system, is suitable for three levels of users: managers, who need an overview of the system's capabilities; experienced users, who can reinforce their knowledge of the SQL system; and beginning users, who can learn to read and interpret a variety of RDSQL programs. The Oracle SQL*Plus course outlines the basics of this software package and gives detailed instructions on how to create a data table and insert rows of data in the table. Finally, you learn how to display the data rows in a formatted report on a screen or a printer. Packages for each course include a 2-hour-long videotape, a student guide, and hands-on exercises. Informix-SQL course in VHS format, $595; on ¾-in. tape, $695. Oracle SQL*Plus course in VHS format, $495; on ¾-in. tape, $595.

Computer Technology Group, 310 S Michigan Ave, Chicago, IL 60604.

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Data book delineates applications development

The Guide to 64180 Applications Development gives instructions for programming the 64180 microprocessor. Its inclusion of benchmarks comparing the 64180 with other processors helps you select an appropriate CPU. It tells you how to use the μP's peripherals such as UARTs, timers, and the memory-management unit, and it provides schematics and code segments that are useful in most applications. A description of hardware- and software-development environments and a listing of support products complete the guide. A supplementary guide disk is also available.

Softaid Inc, 8930 Route 108, Columbia, MD 21045.

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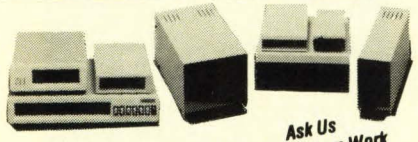

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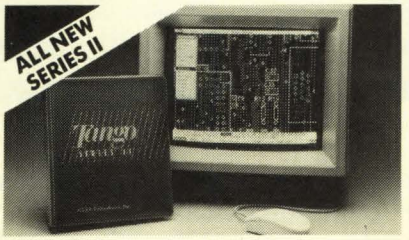

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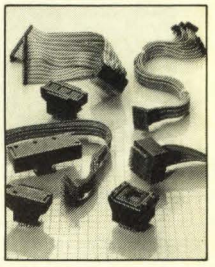

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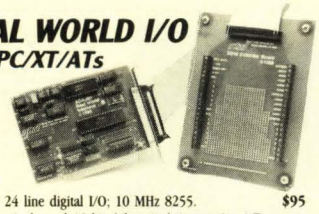

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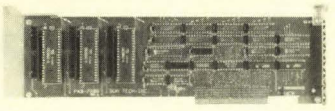

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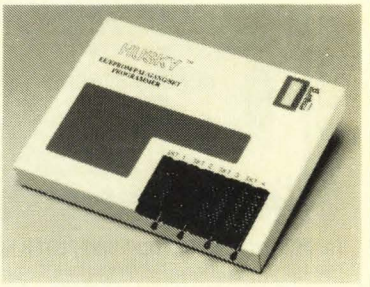

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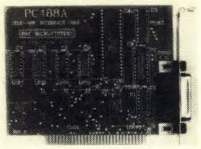

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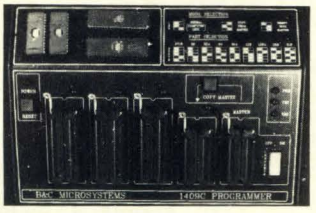

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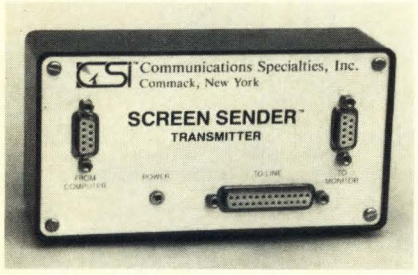

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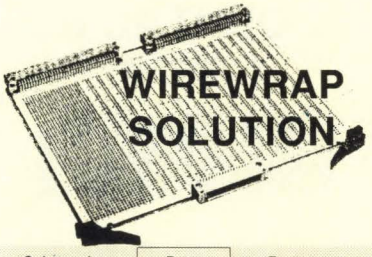

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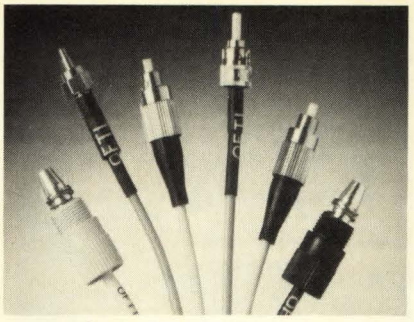

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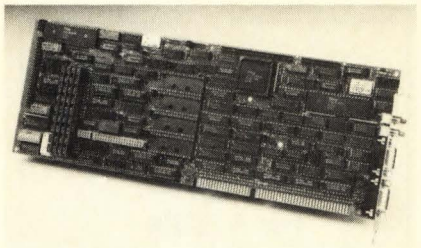

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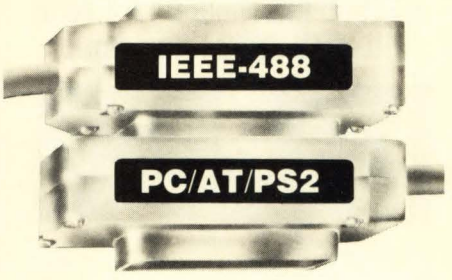

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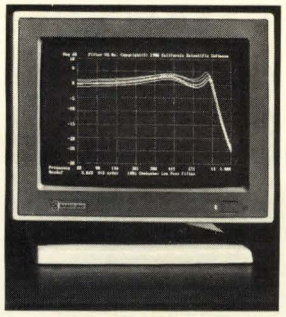

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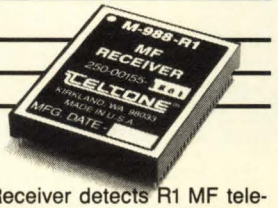

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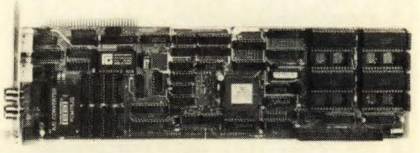

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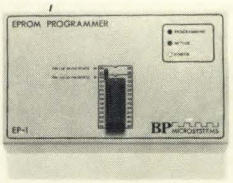

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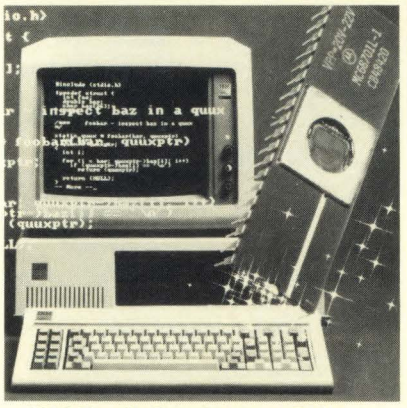

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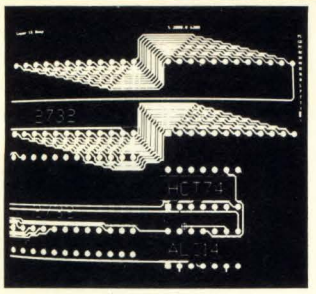

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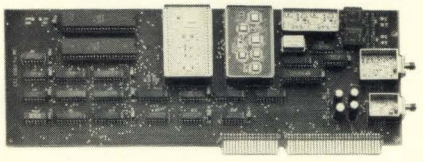

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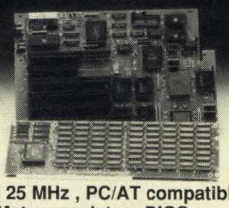

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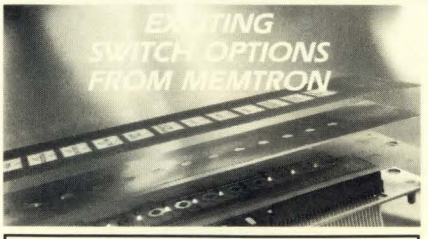

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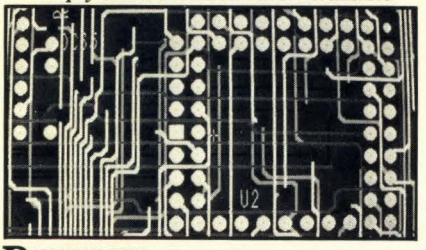

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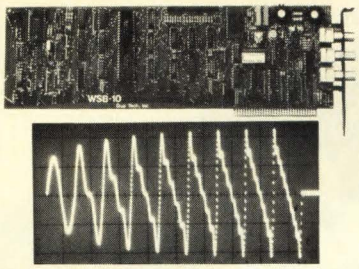

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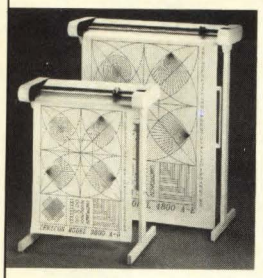

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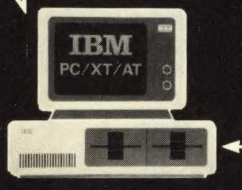

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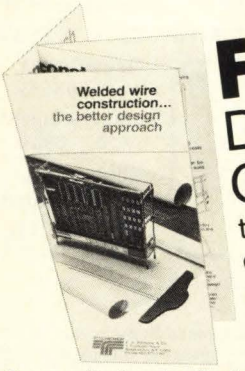

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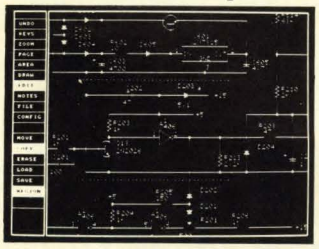

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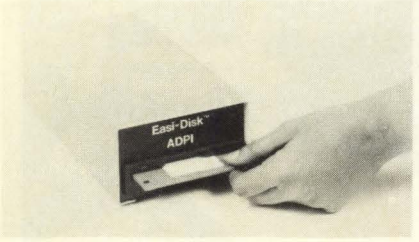

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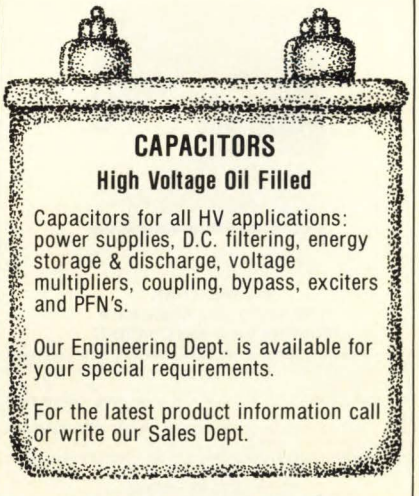

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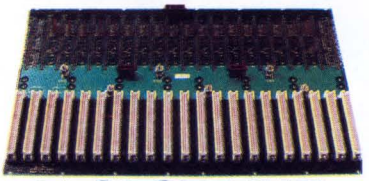

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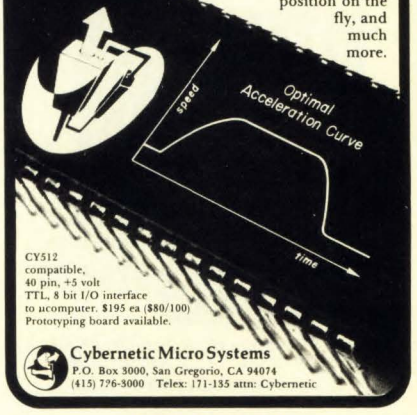

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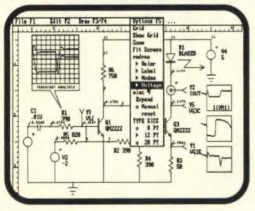

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Issue Date	Recruitment Deadline	EDN Magazine Edition — Editorial Emphasis	EDN News Edition
Jan. 5	Dec. 15	Power Semiconductors, Computer Peripherals, Software	Closing: Dec. 20 Mailing: Jan. 12
Jan. 19	Dec. 29	Computer Boards, Analog ICs	Closing: Jan. 6 Mailing: Jan. 26
Feb. 2	Jan. 12	Semicustom ICs, Computer Boards	Closing: Jan. 20 Mailing: Feb. 9
Feb. 16	Jan. 26	Display, Analog ICs	Closing: Feb. 3 Mailing: Feb. 23
Mar. 2	Feb. 9	Digital ICs, CAE	Closing: Feb. 16 Mailing: Mar. 9
Mar. 16	Feb. 23	CAE, Analog ICs	Closing: Mar. 3 Mailing: Mar. 23
Mar. 30	Mar. 9	Integrated Circuits, Computer Boards	Closing: Mar. 17 Mailing: Apr. 6
Apr. 13	Mar. 23	Test & Measurement, Digital ICs	Closing: Mar. 31 Mailing: Apr. 20
Apr. 27	Apr. 6	Communications Technology, Special Issue Communication ICs	Closing: Apr. 13 Mailing: May 4
May 11	Apr. 20	Analog Technology, Special Issue Computer Peripherals	Closing: Apr. 28 Mailing: May 18
May 25	May 4	Digital ICs, Computer Peripherals	Closing: May 25 Mailing: June 15
June 8	May 18	Components, Digital ICs	
June 22	June 1	Semicustom ICs, Computer Boards	Closing: June 9 Mailing: June 29
July 6	June 15	Product Showcase — Volume I, Power Supplies	Closing: June 22 Mailing: July 13
July 20	June 29	Product Showcase — Volume II, Components	Closing: July 21 Mailing: Aug. 10
Aug. 3	July 13	Integrated Circuits, Computer Boards	
Aug. 17	July 27	Military Electronics, Special Issue Military Software	Closing: Aug. 4 Mailing: Aug. 24
Sept. 1	Aug. 10	Test & Measurement, Integrated Circuits	Closing: Aug. 18 Mailing: Sept. 7
Sept. 14	Aug. 24	Industrial Product Showcase, Digital ICs	Closing: Aug. 30 Mailing: Sept. 21
Sept. 28	Sept. 7	Integrated Circuits, Computer Peripherals	Closing: Sept. 15 Mailing: Oct. 5
Oct. 12	Sept. 21	DSP Chip Directory, Integrated Circuits	Closing: Sept. 28 Mailing: Oct. 19
Oct. 26	Oct. 5	Test & Measurement, Special Issue, Computers & Peripherals	Closing: Oct. 27 Mailing: Nov. 16
Nov. 9	Oct. 19	CAE, Integrated Circuits	
Nov. 23	Nov. 2	16th Annual μP/μC Directory, Integrated Circuits	Closing: Nov. 9 Mailing: Nov. 30
Dec. 7	Nov. 16	Product Showcase — Volume I, Power Supplies	Closing: Nov. 22 Mailing: Dec. 14
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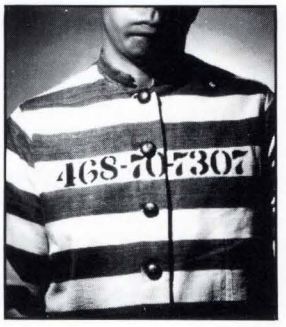

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Duties and Accomplishments: Industry of Current Employer:

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Reason for Change: _____

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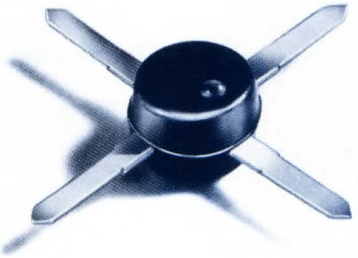

dc to 2000 MHz amplifier series

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.
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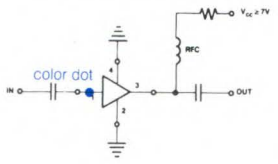

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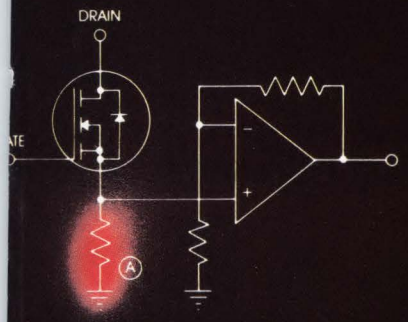
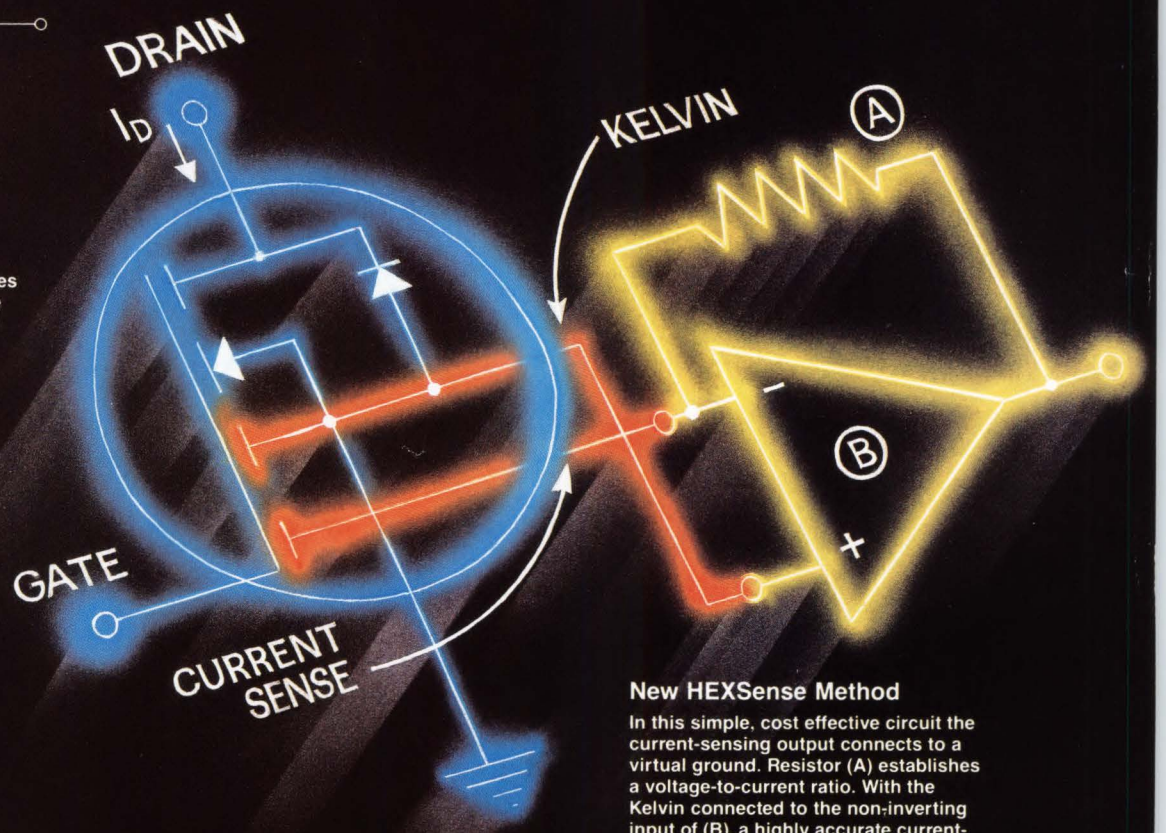


Old Method

This circuit uses a fractional value resistor (A) to measure current, causing a voltage drop which increases power losses. Its parasitic inductance also slows down switching speed. To offset these losses, a lower $R_{DS(ON)}$ power MOSFET may be used, increasing circuit cost.



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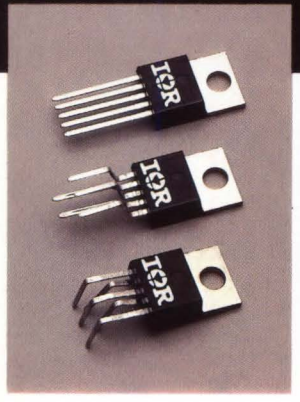

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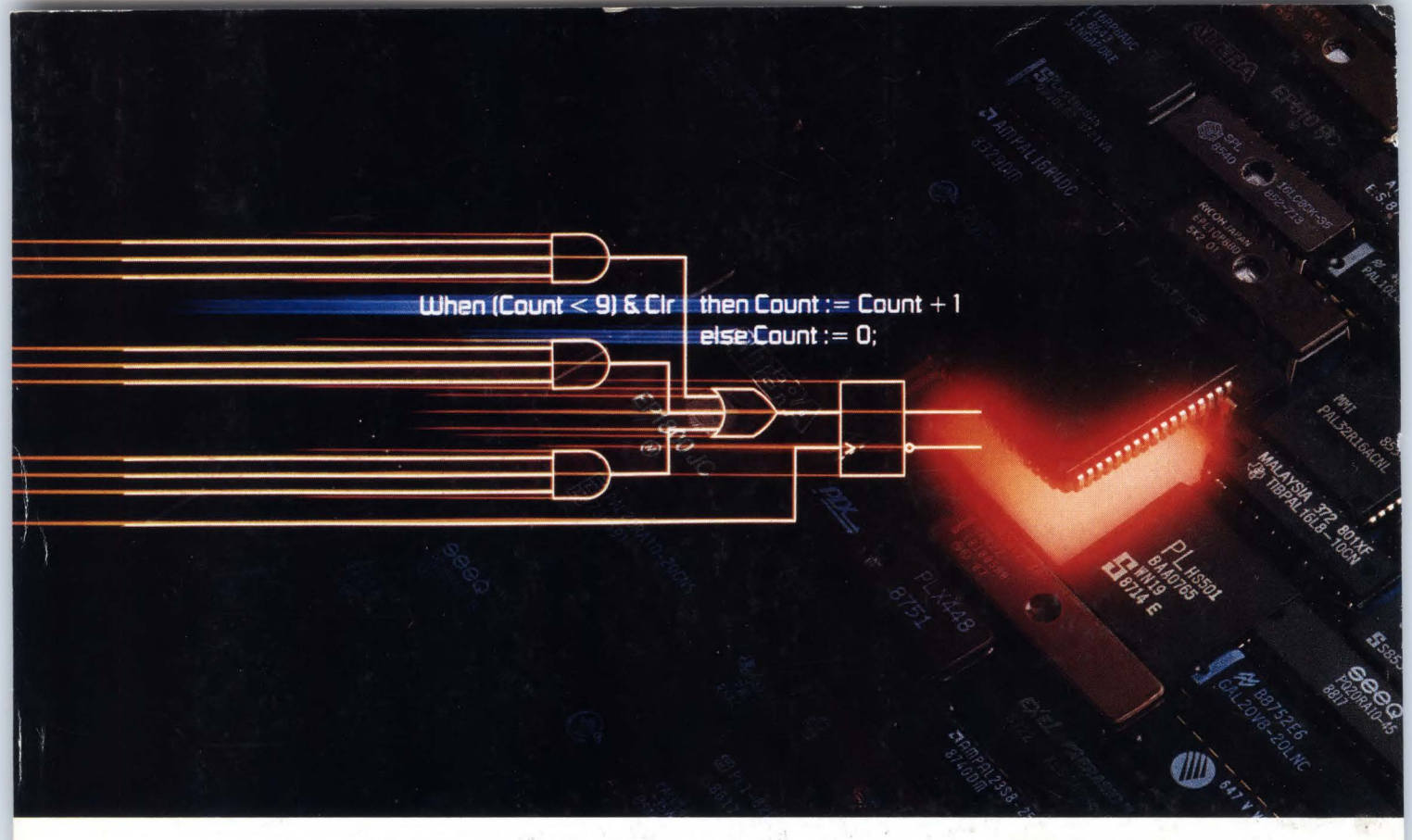

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