

EDN

SPECIAL ISSUE—Part 1
Product Showcase No. 32

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

Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

PRODUCT SHOWCASE



BUT YOU MAY SEE IT DIFFERENTLY.



Look at it this way.

The first thing you'll see is a flat-out screaming data mover. Namely, Motorola's 68340

Integrated Processor with DMA. The first and only processor with the performance to meet the high speed data handling needs of next generation applications.

Applications like future Compact Disc-Interactive multimedia machines. Or applications like yours. Say, for instance, optical drives, laser printers, hand-held computers, telecommunication switches and line cards, workstation I/O processors, servers, terminals, robotics or that hot new project only you know about.

A closer look at the 68340 will reveal a 32-bit integrated processor built on a 68020 foundation with a host of pertinent peripherals on-chip. Foremost among these is a two channel DMA (direct memory access) controller that delivers a sustained data transfer rate of

33 megabytes per second. Imagine for a moment what you could do with that.

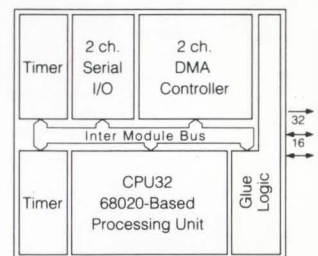
Also on the chip are a pair of serial I/O channels, a couple of timers and a whole bunch of glue logic you won't have to add elsewhere. And, of course, you get all that power in one tidy little package.

Speaking of power, the 68340 doesn't use much at all. In fact, its low power consumption and standby mode make it perfect for a wide variety of battery-powered applications.

But then again, as the highest performance data mover you'll see anywhere, the 68340 is perfect for a whole lot of applications.

Including yours. So call Motorola at 1-800-441-2447 for a free sample.* Or contact your Motorola Semiconductor Sales Office.

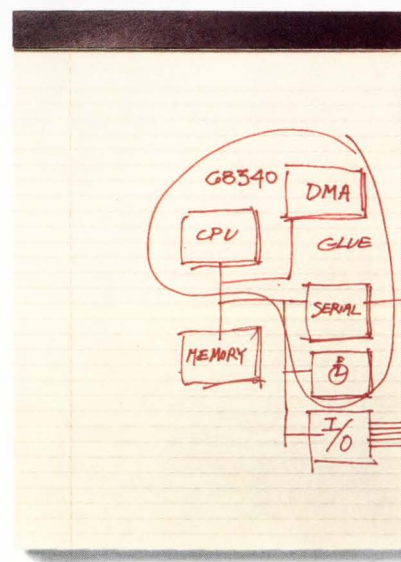
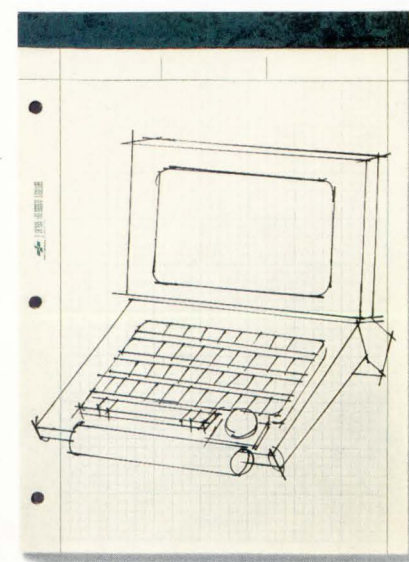
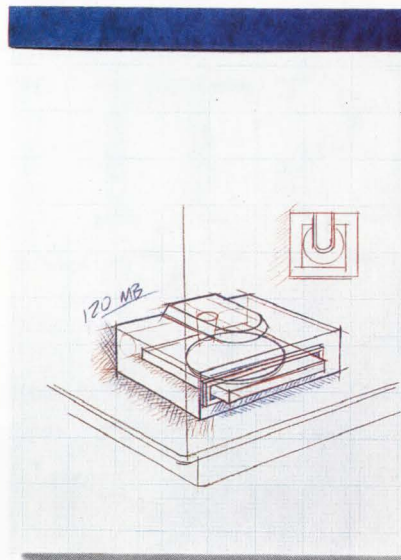
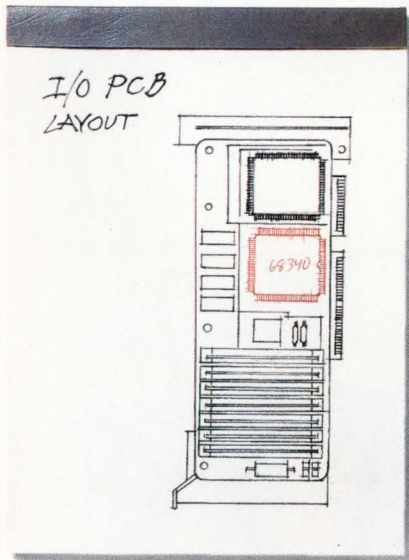
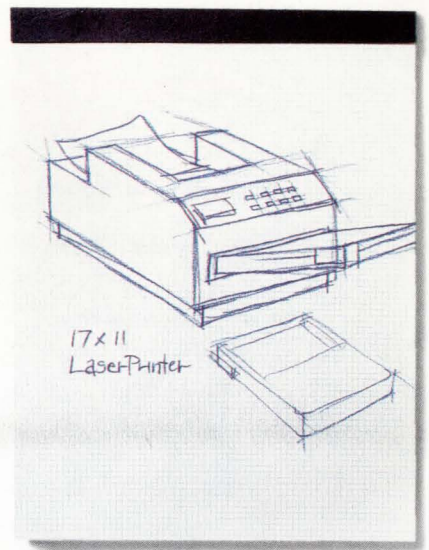
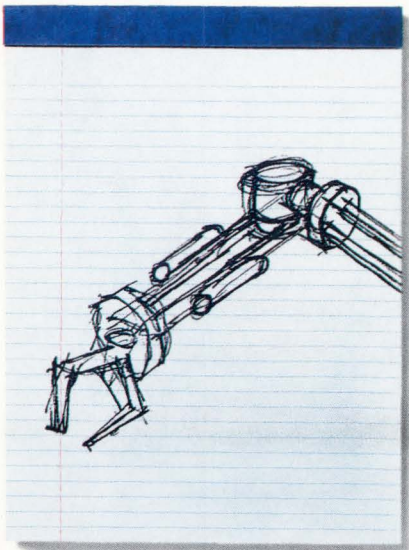
You'll like what you see.



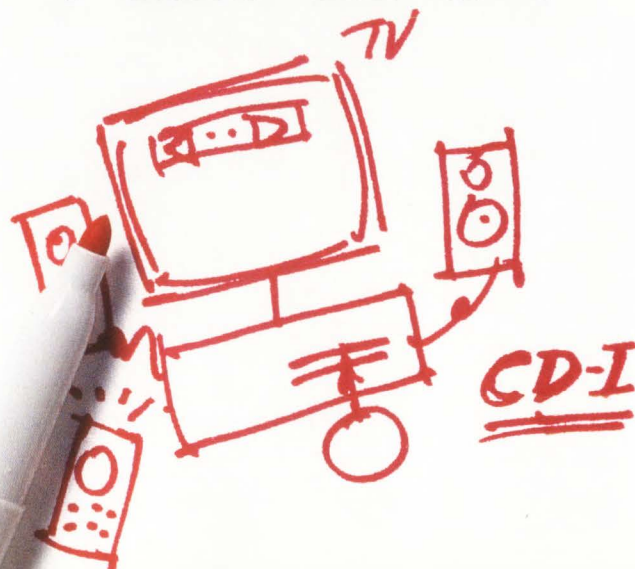
68340 Integrated Processor with DMA

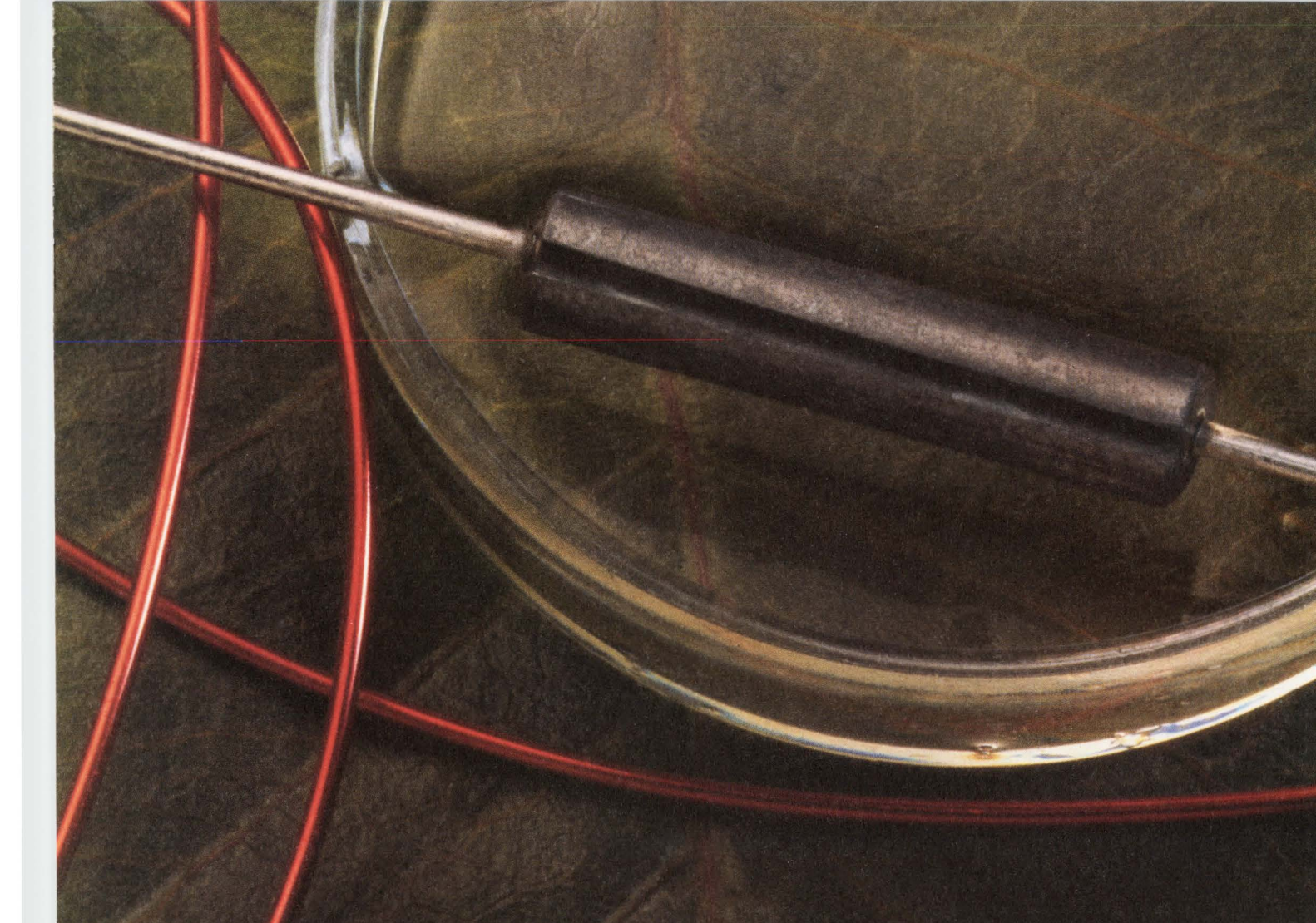


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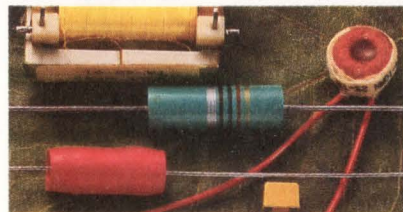
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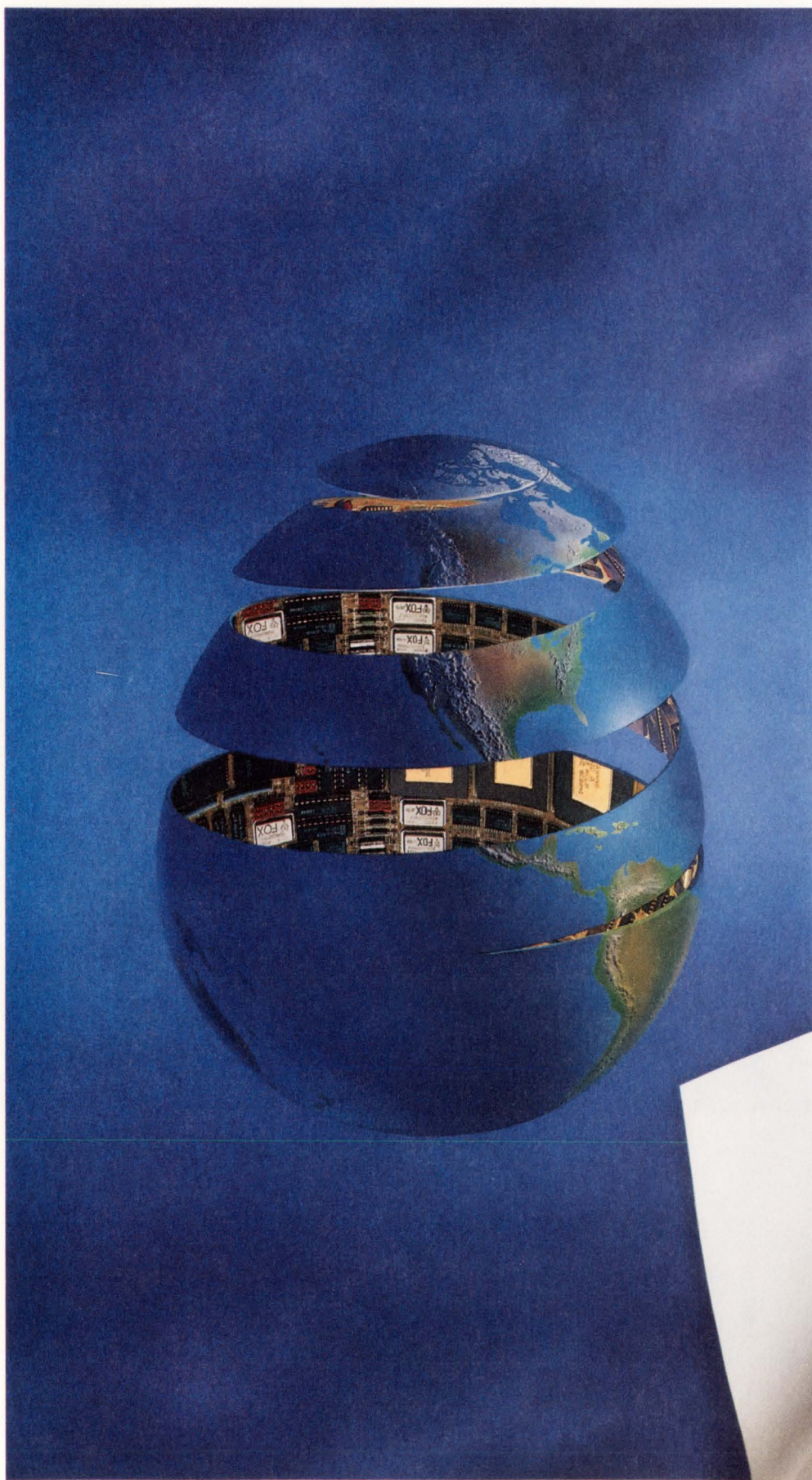
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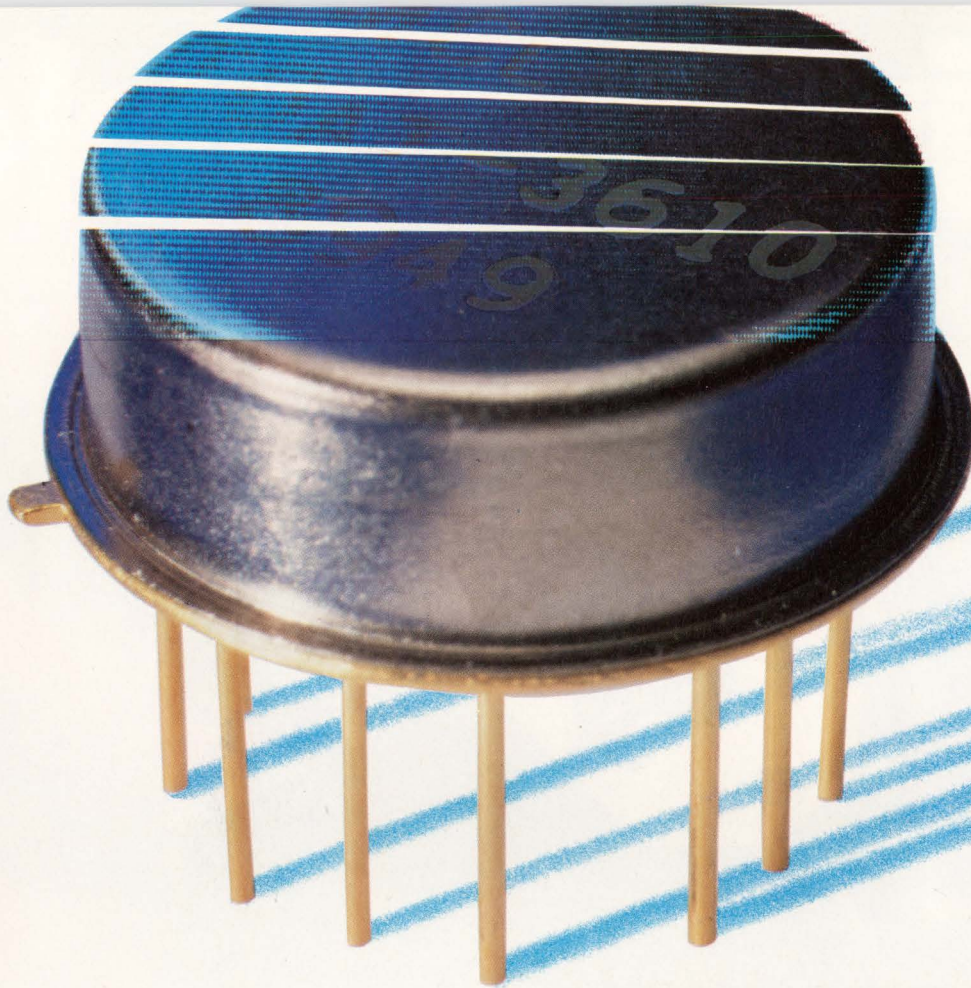
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1.0	0.2	2.0	0.2	6.0	0.3	10.0	0.3
1.5	0.32	3.0	0.4	9.0	0.6	15.0	0.6
2.0	0.2	4.0	0.3	10.0	0.3	20.0	0.4
2.5	0.32	5.0	0.5	13.0	0.6	25.0	0.7
3.0	0.4	6.0	0.5	16.0	0.6	30.0	0.7
3.5	0.52	7.0	0.7	19.0	0.9	35.0	1.0

bold faced values are individual elements in the units

Now...precision TTL-controlled attenuators accurate over 10 to 1000MHz and -55 to +100°C. Four models are available in the new TOAT-series, each with 3 discrete attenuators switchable to provide 7 discrete and accurate attenuation levels (see chart). Cascade all four models for up to 64.5dB control in 0.5dB steps. Custom values available on request. The 50-ohm TOAT-series performs with 6μsec switching speed and can handle power levels up to 0dBm. Units are housed in a rugged hermetically-sealed TO-8 package to withstand the shock, vibration, and temperature stresses of MIL-STD-883. Connector versions are available. Take advantage of the \$59.95 (1-9 qty) price breakthrough to stimulate new applications as you implement present designs and plan future systems.



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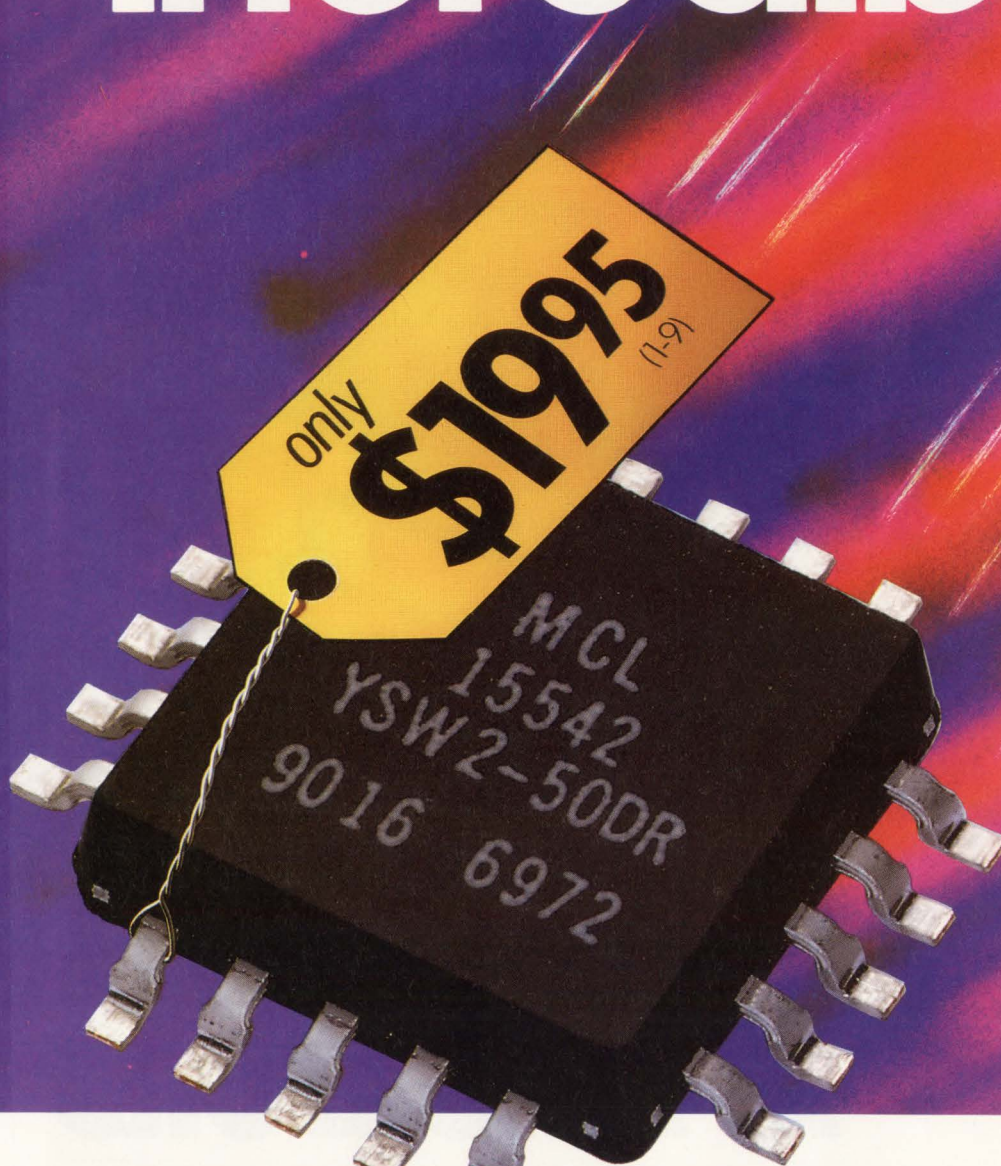
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CIRCLE NO. 90

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SPECIFICATIONS YSW-2-50DR

	dc- 500MHz	500- 2000MHz	2000- 5000MHz
Insertion loss, typ (dB)	0.9	1.3	1.4
Isolation, typ(dB)*	50	40	28
1dB compression, typ (dBm @ in port)	20	20	24
RF input, max dBm (no damage)	22	22	26
VSWR (on), typ	_____	1.4	_____
Video breakthrough to RF, typ (mV p-p)	_____	30	_____
Rise/Fall time, typ (nsec)	_____	3.0	_____



*typ isolation at 5MHz is 80dB and decreases 5dB/octave from 5-1000 MHz

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On the cover: Part 1 of EDN's Product Showcase No. 32 describes offerings from manufacturers of integrated circuits, power sources, hardware and interconnect devices, and software. Staff-written analyses introduce each product category and focus on innovative and unusual applications for ICs (pg 90), simplified system design with distributed power schemes (pg 132), cooling off fast and dense circuits (pg 162), and applying DSP software (pg 194). (Cover illustration by Karen Watson; art direction by Cathy Madigan)

DESIGN FEATURES

Integrated Circuits

ICs move into a variety of new applications 90

Do you ever wonder where all those little, black plastic-and-silicon ICs end up after they roll off the assembly line? The answer is, in some pretty innovative and unusual places.

—Charles H Small, Senior Editor

Power Sources

Distributed power schemes simplify system design tasks 132

DC/DC converters are the key element in distributed power schemes. These units let you use a single voltage bus throughout the overall system and then convert this voltage to the specific levels needed for each subsystem. In most cases, the converters can mount right on the board for which they are supplying power.

—Tom Ormond, Senior Editor

Hardware and Interconnect Devices

Methods converge to cool fast and dense circuits 162

High component densities and operating speeds continue to back circuit designers into a thermal corner. Using familiar tools with a design philosophy that considers both electrical and thermal characteristics helps them fight their way out.

—Anne Watson Swager, Regional Editor

Software

DSP software handles a broad spectrum of applications 194

Today's powerful chips, boards, and software development tools for digital signal processing make the technology readily available. The challenge is in recognizing how your projects can benefit from it.—Richard A Quinnell, Regional Editor

Continued on page 7

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- Plug-in Boards
- VXI
- RS-232

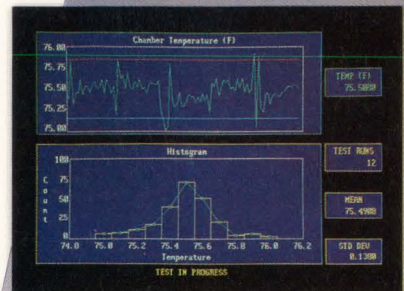
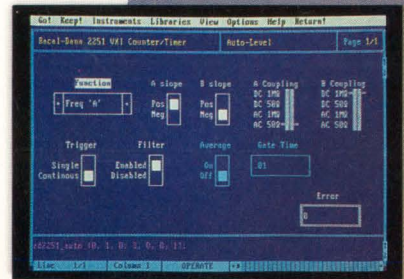
Data Analysis

- Digital Signal Processing
- Statistics
- Curve Fitting
- Array Operations

Data Presentation

- File I/O
- 2D Plots
- Real Time Strip Charts
- Printer and Plotter Output

- True False
- Industry standard Microsoft C, QuickC, and QuickBASIC development tools for data acquisition and instrument control.
- Instrument drivers for over 100 GPIB, VXI, and RS-232 instruments.
- Integrated support for plug-in data acquisition boards.
- Powerful analysis library for real-time data processing.
- Extensive graphics library for creating full-color displays on printers and plotters.
- Code generation and debugging tools for faster program development.
- Software development tools for production test and ATE systems.

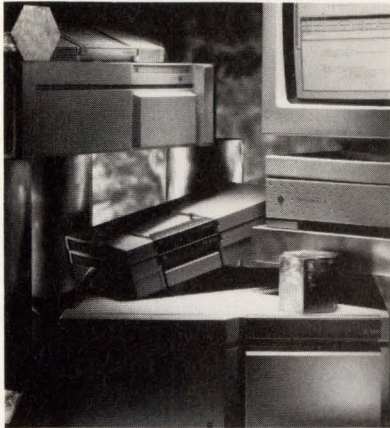


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EDN's semiannual Product Showcase highlights the cream of the crop in four technology areas: ICs (pg 97), power sources (pg 141), hardware and interconnect devices (pg 173), and software (pg 201).

EDN magazine now offers Express Request, a convenient way to retrieve product information by phone. See the Reader Service Card in the front for details on how to use this free service.



EDITORS' CHOICE

Power-supply IC 57

PRODUCT UPDATES

8088- and 80386-based PCs 58
 Layout-rules checker 60
 FPGA family 62
 IC layout tools 66
 Video chip set 72
 Two-chip LAN node 76
 Logic simulator 80

PRODUCT REVIEWS

Integrated Circuits 97

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

Power Sources 141

All types of power supplies, including batteries.

Hardware and Interconnect Devices 173

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

Software 201

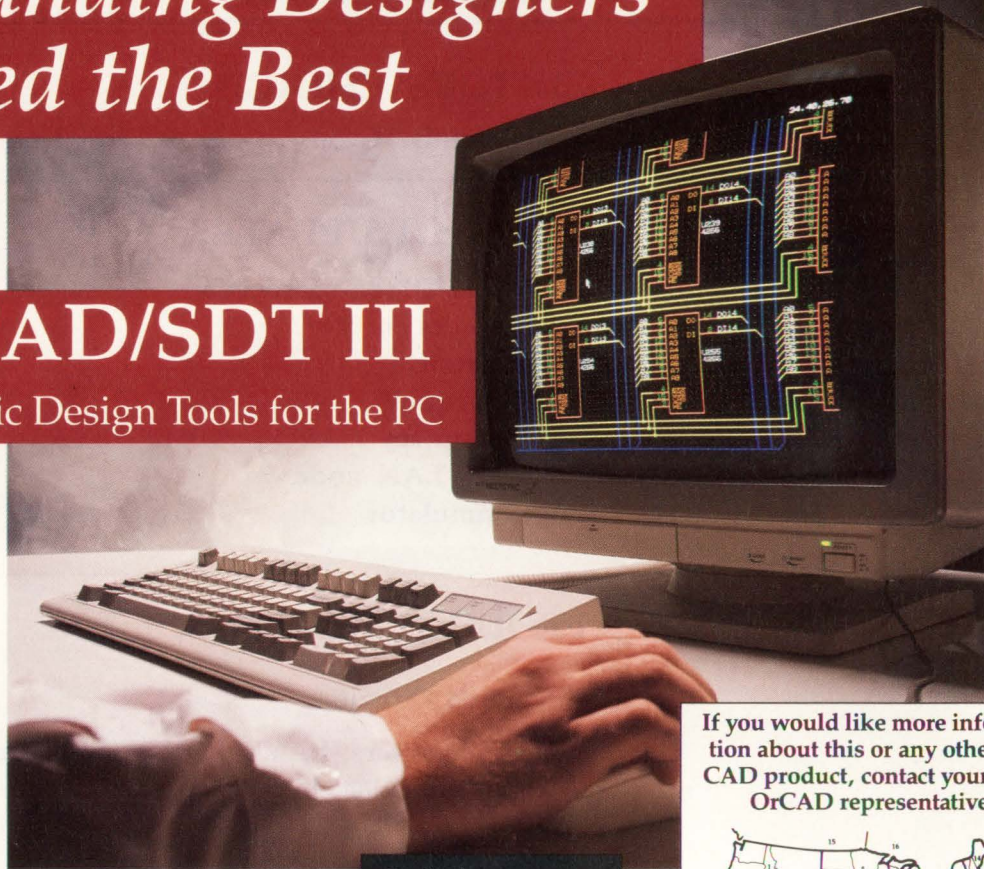
Many types of software, from system packages to application packages.

Continued on page 9

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DESIGN IDEAS

Detector ensures safe Christmas	217
Tube amp isolates high voltages	218
Programmable resistor shifts phase	220
Loop-through amp rejects common-mode noise	222
Analog voltage tracks camera images	224
FET-input amplifier settles fast	226
Conditional skip manipulates clock	228
Sensor and logic form digital compass	228
C++ "class" generates bit manipulators	232

LITERATURE

Instruments	234
Components	237
Computers & Peripherals	238

EDITORIAL

51

The shattered dreams of others offer a touch of reality for new ventures.

PROFESSIONAL ISSUES

251

Judge rules software's look and feel can be copyrighted

Lotus Development Corp vs Paperback Software International.
—Joseph S Iandiorio, *Attorney at Law*

DEPARTMENTS

News Breaks	21
Signals & Noise	35
Ask EDN	41
Calendar	42
Business/Corporate Staff	249
Career Opportunities	258
EDN's International Advertisers Index	265



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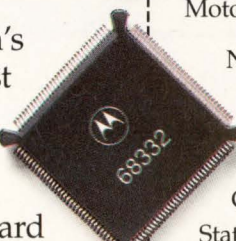
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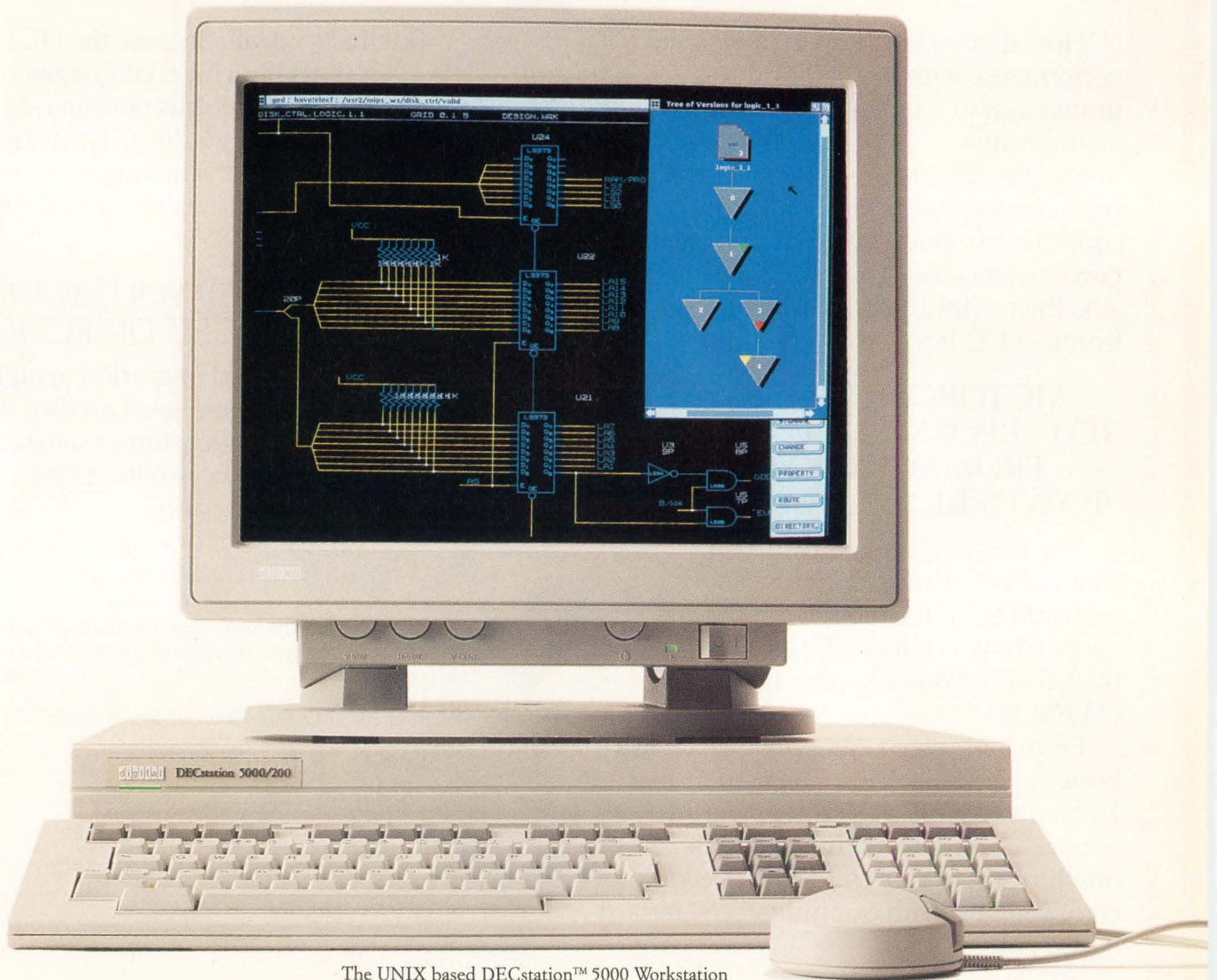
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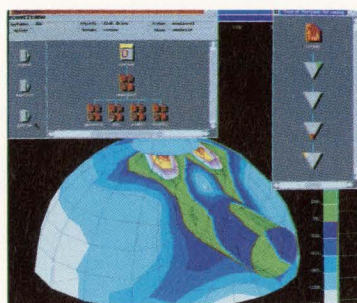


The UNIX based DECstation™ 5000 Workstation

leads by example.

Example #1: Performance

No matter how you measure it, Digital's DECstation 5000 workstation leads all others in performance. Whether it's raw CPU performance, 2D or 3D graphics speed, or price/performance, the DECstation 5000 workstation comes out ahead. In fact, for overall performance, nothing else is close. And we've got the numbers to prove it.

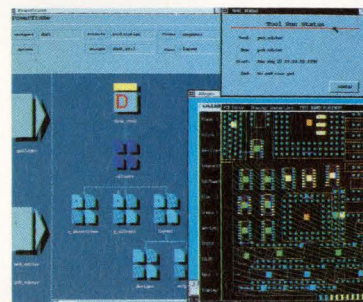


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PERFORMANCE COMPARISON CHART (1)	SUN SPARCstation 1+	IBM 320/520	DECstation 5000 cx
Graphics & Windowing (2)	0.24	0.71	1.59
Integer	1.04 (3)	1.34	1.61
Floating Point	1.10 (3)	2.6	1.7
Overall Performance	0.65	1.35	1.63

(1) All data normalized to DECstation 3100. Comparable configurations tested. Geometric mean used to combine results. Performance will vary depending on applications and environment. (2) Graphics and windowing data measured using X11perf benchmark. CPU Integer and Floating Point performance measured from running SPEC V1.0 workload. (3) SPEC performance estimate based on SUN 4/330 results published by Sun Microsystems, Inc.

Example #2:

UNIX based Applications

When you run with the leader, you know you're in good company. The DECstation 5000 workstation runs more than 1,500

used framework for heterogeneous design management.

And, of course, as the leader in integrated multi-vendor

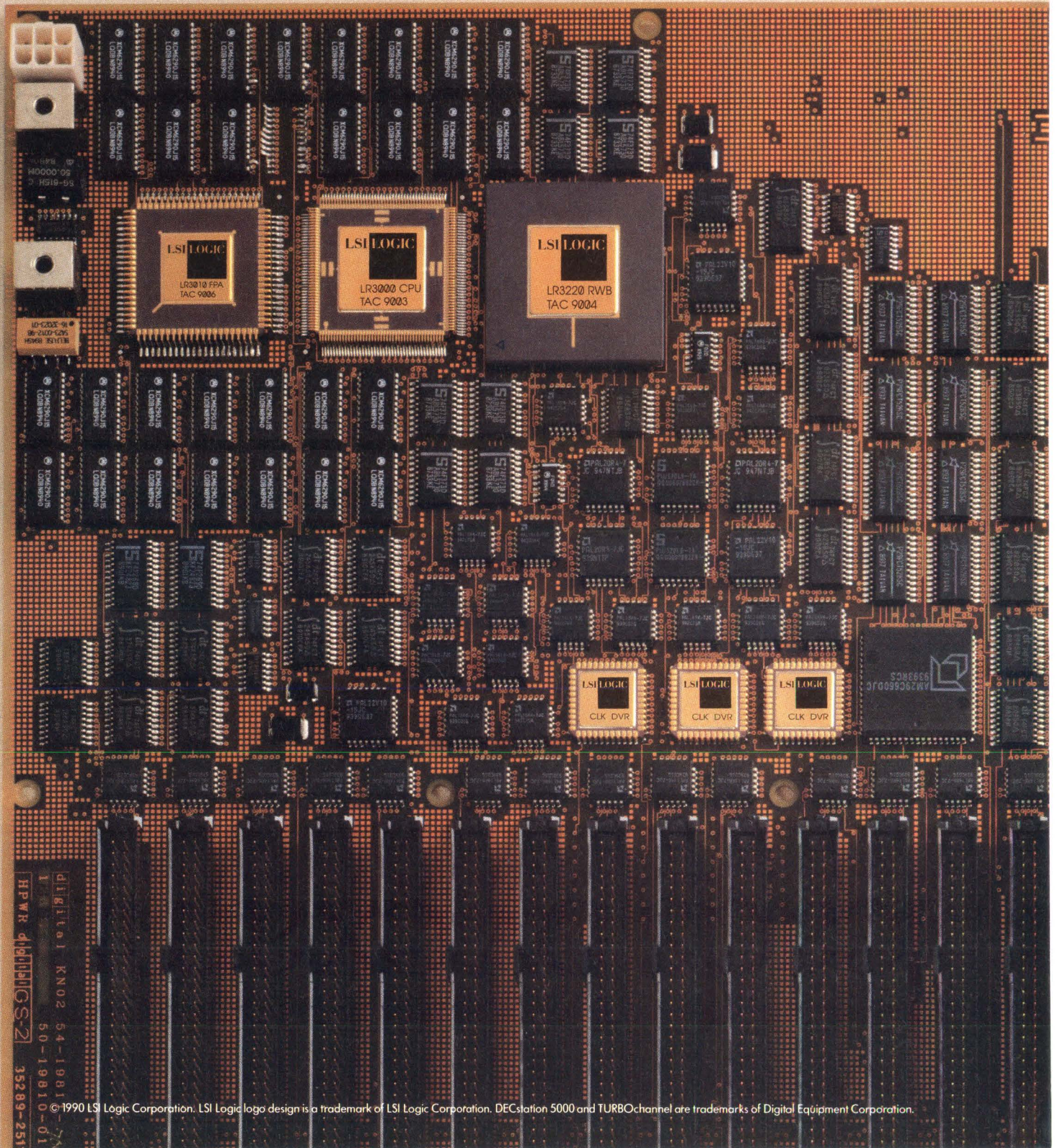
Digital
has
it
now.

HOW A STRATEGIC
PARTNERSHIP WROTE
A NEW CHAPTER ON
SYSTEM PERFORMANCE:

DECstation 5000 AND LSI LOGIC.

Achieving 24.2 MIPS at 25 MHz was no small task. Even for Digital.

So they designed-in LSI Logic's unique read-write buffer and MIPS-based chipset that optimized the processing power of the LR3000 CPU. And consolidated the read-write buffer functions of 17 chips into a single chip. Putting far more performance into far less real estate. And making the new DECstation 5000 workstation a



reality. In less than 11 months.

LSI's proprietary LR3220 read-write buffer performs memory write operations at the CPU clock rate, practically eliminating the bottleneck between the CPU and main memory. Boosting the processing power of the DECstation 5000 workstation to the limits of the price performance curve. A novel idea that delivers 120 Mbytes of main memory, dazzling high-end graphics and

the new TURBOchannel I/O interconnect to the desktop, for under \$15,000.

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LSI LOGIC

ACROSS THE BOARD



According to Tom Furlong, Manager of Digital Equipment Corporation's RISC Workstation Group, "The level of performance achieved on the DECstation 5000 workstation simply wouldn't have been possible without LSI's ASIC methodology and their MIPS microprocessor expertise."

For the whole story call 408.433.7556, or write for a free white paper, "Writing a new chapter in workstation performance: DECstation 5000," LSI Logic, 1551 McCarthy Blvd, MS D102, Milpitas, CA 95035.

CIRCLE NO. 96

SAMSUNG
NOW

LIVING COLOR.

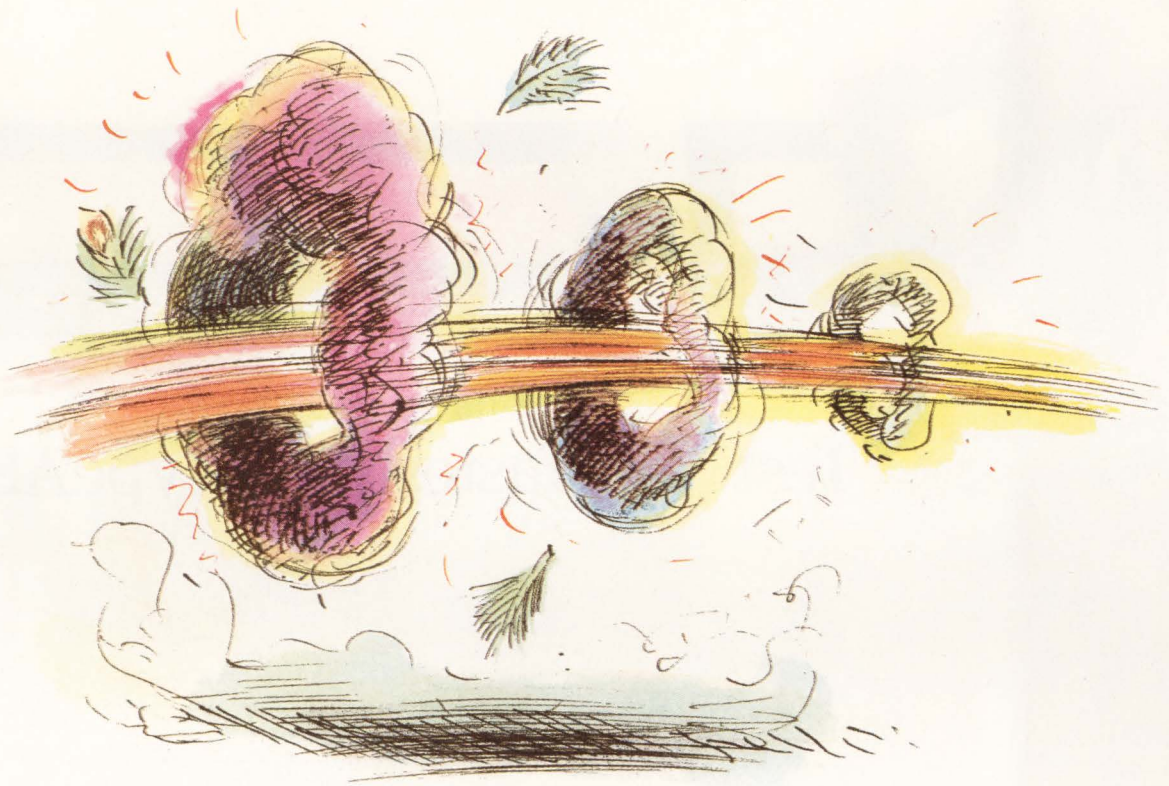


HIGH-END GRAPHICS FROM A 478 RAM DAC?

The cost-effectiveness of the 478 RAM DAC makes it very attractive. But of course you can't use it for high-end graphics. Or at least you couldn't until the new Samsung part, rated at 120 Mhz, came on the market.

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BLINDING SPEED.



THAT'S RIGHT: IT'S THE FASTEST EVER MADE.

Its blinding 120 Mhz speed makes our 478 RAM DAC the fastest such part ever made. Which means that besides cost-effectiveness in high-end graphics applications, it offers a migration path to higher resolution in products already using 478 RAM DACs. All three of our speedy RAM DACs are available now. For information on any of them, write to RAM DAC Marketing, Samsung Semiconductor, 3725 No. First St., San Jose, CA 95134. Or call 1-800-669-5400, or 408-954-7229.

CIRCLE NO. 97





Test your fastest prototype ASICs for

Finally, a 400 MHz IC Evaluation System.

Before you send those fast ASIC designs off to production, make sure they'll handle the stress of real-world operating conditions.

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a 400 MHz vector rate on all channels and up to 512 pin capacity. Finally, you can verify and characterize complex prototype ASICs to their limits. Which means you'll send fast ICs to production with the confidence that they won't return for time-consuming and expensive redesign.

You can even go a step further. Its high-throughput software lets you efficiently test small



failures at speed before production.

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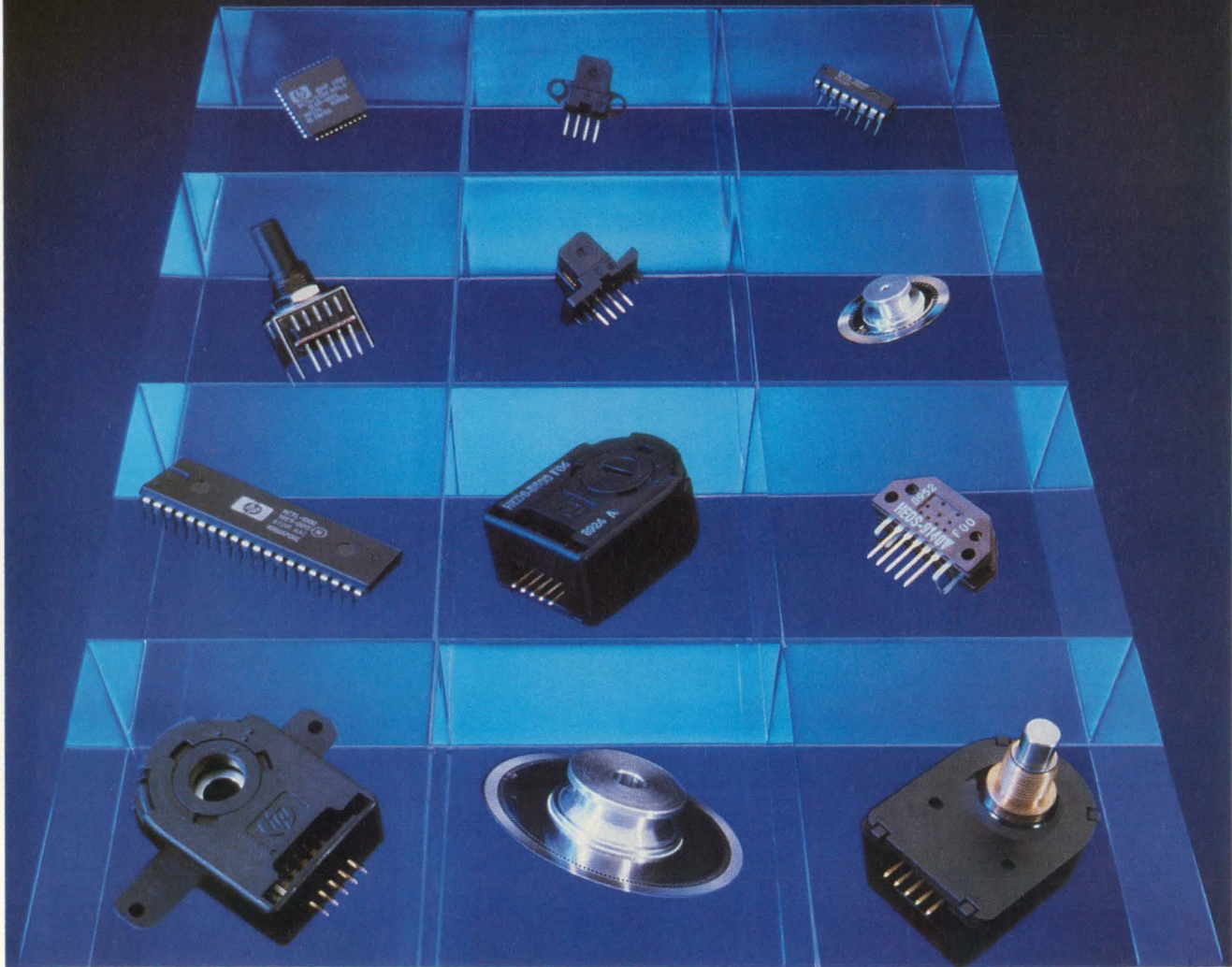
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NEWS BREAKS

EDITED BY SUSAN ROSE

DSP FAMILY USES SIBLINGS' ARCHITECTURE

The 56100 family of 16-bit DSPs from Motorola's Microprocessor Products Group (Austin, TX, (512) 891-2030) is architecturally compatible with the 24-bit 56001 and 32-bit 96002 DSPs. Sharing architectures lets the 16-bit chip use an instruction subset of its more powerful siblings' instruction set. In addition, the family members can share development tools. The 56100 family will initially contain the 56116 and 56156, both of which have 8k bytes of RAM, two serial ports, a parallel port, a timer, a host interface, an on-chip emulator, and a 5616 DSP core. The 56156 adds a 14-bit sigma-delta codec and a PLL. The 5616 core handles fast autoreturn interrupts and has a single-cycle 16×16-bit parallel multiply accumulator that can handle 40 million multiply and accumulates per second. An on-chip emulator provides access to internal registers and tracks the last five executed instructions for debugging. The 5616 is sampling now and costs \$120. The 56156 will be sampling in early 1991 and will cost \$145.—Michael C Markowitz

LOCAL OPERATING NETWORKS SUPPORT DISTRIBUTED CONTROL

Echelon (Palo Alto, CA, (415) 855-7400) has developed a complete set of ICs, development tools, and an operating system for creating a low-cost distributed control system. The local operating network consists of a collection of local control nodes that intercommunicate. Thus one node can read a sensor and another can use that reading to control a motor. The core of each node is a neuron IC that has three separate processors to handle local I/O functions, message processing, and communications hardware. The neuron ICs are preprogrammed with firmware implementing a complete 7-layer OSI model.

You treat nodes in the local operating network as objects when programming. Each node controls a local function and shares network variables with other objects. Communication between nodes is handled automatically by the neuron's firmware; all you add is the local control software. Because the nodes are all objects, the resulting network is flexible. For example, you can extend the network without reprogramming existing nodes.

The Lonbuilder starter kit costs \$14,965 and contains a development station, a neuron emulator, software development and debugging tools, and a network analyzer. Motorola and Toshiba supply the neuron ICs, which cost less than \$10.—Richard A Quinnell

IBM PC/AT-COMPATIBLE VGA BOARDS HAVE TIGA INTERFACE

You no longer have to choose between Texas Instruments' TIGA and IBM's 8514/A graphics for your computer's graphics subsystem. The Volante Series VMEbus and IBM PC/AT-compatible VGA boards from National Design (Austin, TX, (512) 343-5055) include a TI34020 graphics processor, TIGA-340 graphics interface, driver for Microsoft Windows, and both Super VGA and 8514/A emulation. The \$995 AT1000 has a maximum bandwidth of 64 MHz and Super VGA resolution of 1024×768 pixels. The \$2495 AT1200 has a bandwidth of 125 MHz and pixel resolution as high as 1280×1024. A VMEbus version of the AT1200 sells for \$3495. Options include the TI34082 floating-point processor (\$1395) and an AutoCAD optimizing driver with pop-up menus and garbage collection (\$95).—J D Mosley

NEWS BREAKS

FOURTH-GENERATION CD ROM DRIVE HAS 40,000-HOUR MTBF

Two CD ROM disk drives from Laser Magnetic Storage International Co (Colorado Springs, CO, (719) 593-7900) provide average access times of 350 msec with reliability ratings of 40,000 hours MTBF. The CM 202 drive has a serial interface, and the CM 214 drive incorporates a SCSI port coupled with 64k bytes of cache RAM. Both drives also provide CD audio capabilities in addition to their digital data functions. In OEM quantities, the drives cost less than \$350.—Steven H Leibson

BiCMOS BUS INTERFACE CHIPS ARE 16 BITS WIDE

Signetics Co (Sunnyvale, CA, (408) 991-2000) has announced a family of advanced BiCMOS bus-interface chips that feature 16-bit data paths. The Multibyte family provides 64 mA of drive current per output, a 4.6-nsec propagation delay, and zero static-power dissipation. The chips are available in 52-pin JEDEC-registered quad flatpacks that require 174 mm² of board space. Two equivalent 8-bit devices using small-outline surface-mount packages would occupy 310 mm². The first members of the family are the MB2244 16-bit line driver and the MB2245 16-bit transceiver. These parts are functionally equivalent to the '244 and '245 bus-interface devices, respectively. The company plans to introduce 20 family members over the next 18 months, including 18- and 20-bit parts to accommodate parity bits. Prices range from \$1.80 to \$3.70 (1000).—John Gallant

PC PLUG-IN CARDS SUIT INDUSTRIAL SYSTEMS

A range of IBM PC and compatible plug-in cards from Arcom Control Systems Ltd (Cambridge, UK, (223) 411200) lets you control and monitor industrial systems. The range includes digital I/O, counter/timers, serial communications, and ADC and DAC functions. Model PCIB40 contains 40 bidirectional I/O channels and costs £124. A buffer in each channel can sink 24 mA. Also onboard is a 1-MHz clock and three 16-bit counter/timers. The £148 model PICIC is a multifunction counter/timer, which provides nine 16-bit channels operating as high as 5 MHz. Both models link to another range of remotely sited signal-conditioning modules via a rear-panel connector.

The connector's pinout conforms to an internal standard, which 20 other vendors currently use for STEbus and VMEbus products. This arrangement provides compatibility with approximately 200 existing signal-conditioning modules. Other plug-in cards include model PCI24 and PCO24, which provide optoisolation on 24 channels of digital input and output, respectively. Each model costs £185. Model PCSER4 contains four independent channels of serial asynchronous or synchronous communication with as much as 115k baud or 2M baud, respectively. PCSER4 costs £195. ADC and DAC cards are due the first quarter of 1991.—Brian Kerridge

FFT PROCESSOR PERFORMS 1024-POINT TRANSFORM IN 96 μSEC

The PDSP16510 FFT processor from Plessey Semiconductors (Scotts Valley, CA, (408) 438-2900) can perform a 1024-point transform in 96 μsec. The \$1195 processor operates at 40 MHz and accepts real or complex data. It outputs both real and complex frequency components, which can be converted to magnitude and phase by the company's PDSP16330A Pythagoras processor, a \$149 companion IC.—Steven H Leibson



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NEWS BREAKS

ONE CHIP INTEGRATES PROGRAMMABLE PALETTE AND VIDEO

The TLC34075 programmable video interface from Texas Instruments (Houston, TX, (800) 336-5236, ext 700) provides functions that otherwise require as many as 30 chips to implement. The chip has pixel control logic, video overlay, high-speed timing logic, and an interface to video RAM; it allows VGA pass-through mode. You can program the chip for 1, 2, 4, or 8 bits/pixel. A 32-bit/pixel program level yields 24-bit true color with an 8-bit color overlay for photo-realistic images. This \$20 (OEM) chip's register-programmable dot rate lets you select from 640×480, 800×600, and 1024×768 noninterlaced display resolutions. A \$30 (OEM) European version, the TLC34075-85, provides the same selection of display resolutions at European refresh rates.—J D Mosley

PATTERN-RECOGNITION SOFTWARE FINDS RULES IN RAW DATA

If you can't seem to find clear patterns in your data, you may want to give Plogic a shot at it. This pattern-recognition software from Plogic Knowledge Systems Inc (Torrance, CA, (213) 378-3760) accepts data points, formulates rules based on trends in the data, and can make predictions based on those rules. The IBM PC version of the package can analyze problems with as many as 50 variables and 3000 data points. Based on the trends it finds in your data, the software can predict additional data points and even give you a confidence factor for that prediction. You can also use the package to make decisions based on your historical data. The product accepts data stored in ASCII, binary, Lotus 1-2-3, and Dbase III data files. It sells for \$995, but you can buy it for \$495 until December 31.—Steven H Leibson

HIGH-RESOLUTION, COLOR-DISPLAY BOARD SUITS CAD

The Nth Engine/150 noninterlaced 256-color display board from Nth Graphics (Austin, TX, (800) 624-7552) has four times the resolution of standard VGA displays. At \$1995, it is currently the least expensive board of its type available. The 1280×1024-pixel board comes with display-list processing software for AutoCAD 386 Release 10 and 11 and uses AutoCAD 386's protected-mode for 32-bit processing and automatic memory management for the display list. You can use this board with graphics applications that have an IBM 8514/A driver, including Microsoft Windows 3.0 and Presentation Manager. You can also buy a lower-resolution, but still noninterlaced, version of this board that displays 1024×768 pixels in 16 colors for \$1495.—J D Mosley

FULL-FEATURED PLD SOFTWARE PACKAGE COSTS \$795

In an update to its existing PLD design package, Philips Components/Signetics (Sunnyvale, CA, (408) 991-2000) will compete with third-party software vendors that currently offer packages costing several thousand dollars. Snap 1.6 costs \$795 and includes gate-level and fault simulators, a logic optimizer, and a Boolean equation extractor. However, Snap supports only the company's line of PLDs. The package can create a PLD design by merging descriptions made with waveforms, equations, and schematics. It can also reverse-engineer parts with an extractor that creates equations from existing JEDEC fuse maps. You can use this feature to consolidate several smaller PLD designs into one device. The package runs on IBM PCs and compatible machines. If you already own earlier versions of the package, you can get the updated product free.—Steven H Leibson

The FS700 LORAN-C frequency standard

10 MHz cesium stability

\$4950

Cesium long term stability at a fraction of the cost

Better long-term stability than rubidium

Not dependent on ionosphere position changes, unlike WWV

Complete northern hemisphere coverage, unlike GPS.

The FS700 LORAN-C frequency standard provides the optimum, cost-effective solution for frequency management and calibration applications. Four 10 MHz outputs from built-in distribution amplifiers provide cesium standard long-term stability of 10^{-12} , with short-term stability of 10^{-10} (10^{-11} optional). Reception is guaranteed in North America, Europe and Asia.

Since the FS700 receives the ground wave from the LORAN transmitter, reception is unaffected by atmospheric changes, with no possibility of missing cycles, a common occurrence with WWV due to discontinuous changes in the position of the ionosphere layer. Cesium and rubidium standards, in addition to being expensive initially, require periodic refurbishment, another costly item.

The FS700 system includes a remote active 8-foot whip antenna, capable of driving up to 1000 feet of cable. The receiver contains six adjustable notch filters and a frequency output which may be set from 0.01 Hz to 10 MHz in a 1-2-5 sequence. A Phase detector is used to measure the phase shift between this output and another front panel input, allowing quick calibration of other timebases. An analog output with a range of ± 360 degrees, provides a voltage proportional to this phase difference for driving strip chart recorders, thus permitting continuous monitoring of long-term frequency stability or phase locking of other sources.



FS700: The optimum frequency management system



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FILTERS



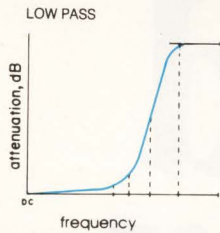
dc to 3GHz from \$1145

lowpass, highpass, bandpass, narrowband IF

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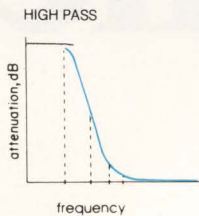
low pass dc to 1200MHz

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



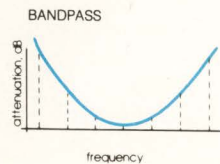
high pass dc to 2500MHz

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



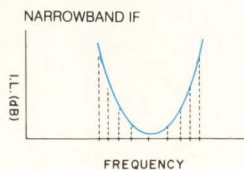
bandpass 20 to 70MHz

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



narrowband IF

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



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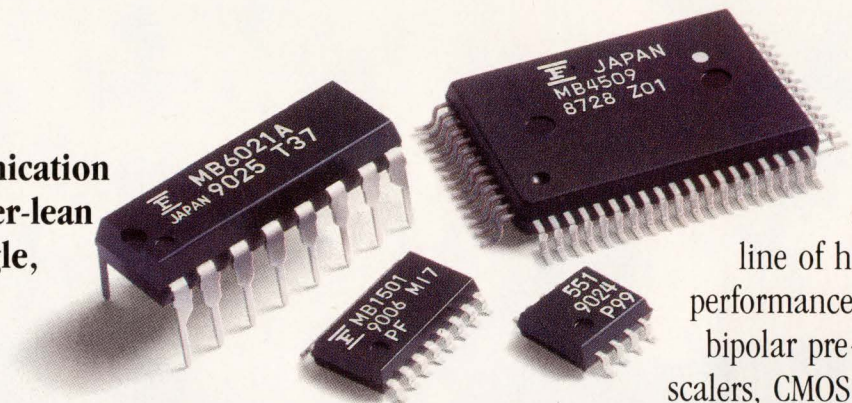
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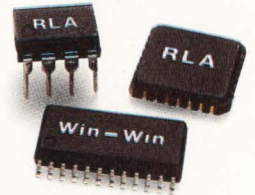
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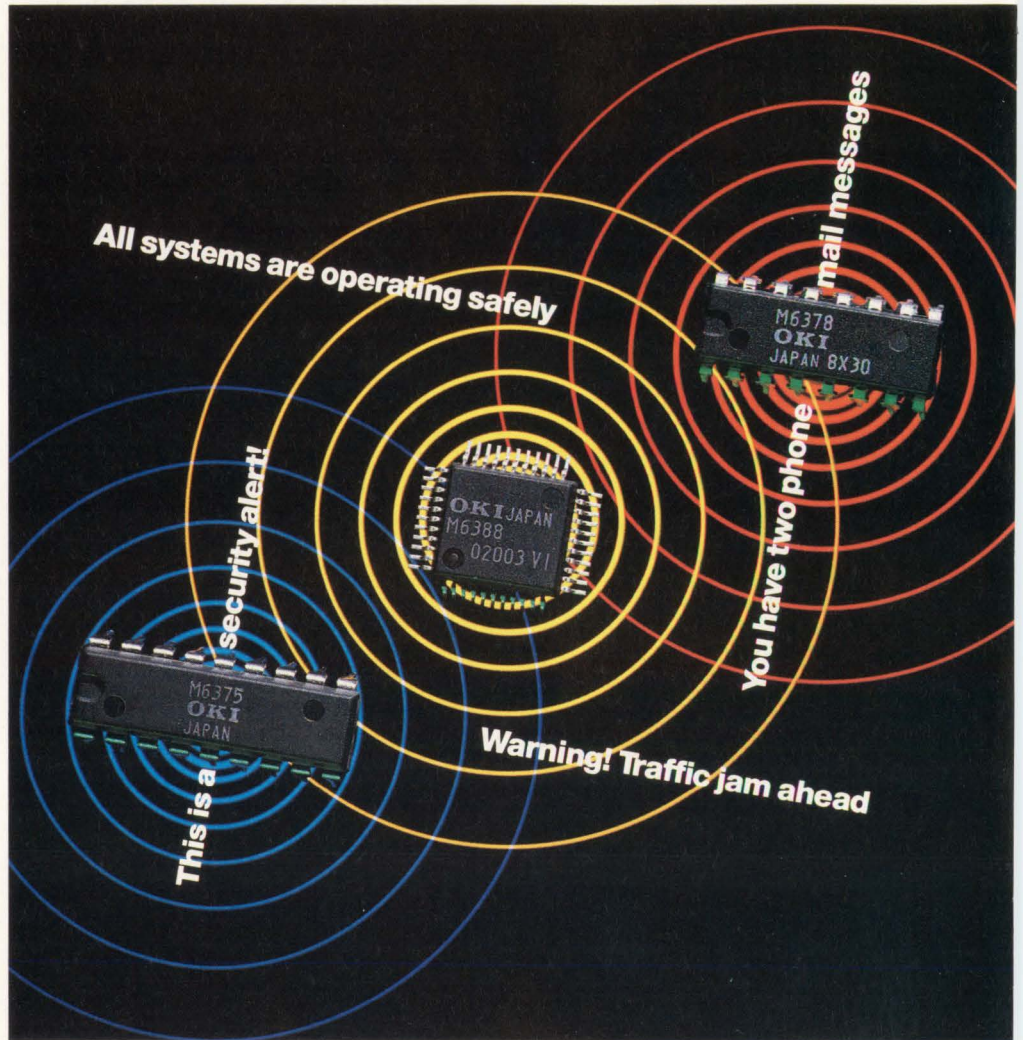
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SIGNALS & NOISE

Thoughts on "Communicate or perish" editorial

Jon Titus's editorial (EDN, June 21, 1990, pg 69) is a great article, but there is an even better way to communicate. Have you seen a company *tell* people the relative costs? Don't turn the plebs into anarchists—give them the chance to become responsible citizens.

*John Washington
Woking, Surrey, UK*

Latch on to your children's natural curiosity

Several recent letters have addressed things we parents should do to educate our children. All of the suggestions are worthwhile, but don't forget that one of the greatest gifts we can pass on is the love of learning. Encourage a sense of wonder in your children. Let them marvel at the intricacy of a cell or the glory of the Milky Way. Avoid denigrating their ideas, no matter how absurd. "Let's think about it" is a much better response than "No, that's not right."

Parenting is hard. We all get worn down by a 2 year old's machine-gun-speed "Whys?" Make the effort to use this natural curiosity to shape your children into thoughtful, well-rounded individuals.

*Jack G Ganssle, President
Softaid Inc
Columbia, MD*

Compromise between copy "right" and "left"

In the Professional Issues section (EDN, October 1, 1990, pg 174), Jay Fraser very competently profiles Richard Stallman, a man we might describe as basically a "computer nut," and more formally, as a professional computer programmer. Although I don't consider "computer nut" in the derogatory sense, this perception is common among those who are not computer enthusiasts. I do, however, consider some

of Richard's logic and interpretations of law and common-law practices to be a little strange and inherently dishonest, and dangerous to the development of American industry, science, technology, and intellectual incentive, development, and property.

I agree with Richard's argument that some of the copyright practices may be wrong and even illegal. But he is clearly wrong in his contention that we have an inherent right to copy from each other freely and without legal repercussions. I believe that Richard doesn't understand the realities of the business world and, particularly, the enormous problems of starting up a high-technology company on the basis of a new and complex database.

As the CEO of my company, I must establish policy, develop corporate and financial structure, work out personnel procedures, maintain a working relationship with everyone, and keep everyone working with each other. As Chief Scientist, I am responsible for the development of the mathematical and engineering database that supports the product line.

Model 1, which I am presently trying to put into full production with a supporting database of more than 500 pages, has caused enormous problems. At least four separate attempts have been made to steal the supporting database.

Three months ago I hired an electronics-design engineer to design the prototype. Almost immediately I ran into serious problems with him. He wanted more data, demanded access to the full database, and began to criticize the program. He also criticized the use of a particular computer language, some of its logical lines of instructions, and its scientific and mathematical notations.

My immediate reaction was to be honest with him. Without understanding his vague criticisms, I admitted that I might be wrong and

to the possibility of making some mistakes in both the development of the database and its subsequent computer program. Although he didn't need to gain access to the database of the computer program, I allowed him partial access nonetheless.

After further incidents, he finally admitted that he couldn't understand the theory and the mathematical relationships. He had difficulty in grasping the process of intuitively "jumping" over gaps of incomplete data to derive the relationships of the phenomena and to work them out mathematically.

Again, I was intellectually fair and honest with him. Of course I was not unaware of his possible ulterior motives. I just lacked the physical evidence to prove he was trying either to steal the database and technology or to take credit for some of its development.

Finally, he made a provable mistake. In the computer program for Model 1, under my name—representing a nonprintable comment in the statement for copyright protection—was "(and modified by)" followed by his name.

I studied the program carefully, but found no other modification other than his name under my name. The conclusion was obvious. He was trying to steal some credit for the development of the database when the computer goes before the US government for copyright protection. If I had not been intuitively suspicious of his ulterior motives and demands for data he did not need, I would have run into serious technical and legal problems within a few years.

And if it were not for the copyright-protection statutory provisions under the law, he could actually have manipulated himself into a legal declaration that he was partially responsible for the development of the database. Then he could demand monetary compensation.

I recognize Richard Stallman's le-

SIGNALS & NOISE

gal concerns for intellectual freedom and certain rights to copy from each other. However, he must accept the responsibility for being competent in his position and for recognizing the need of American industry to protect itself from abuses, fraud, and criminal scams and conspiracies. Without this protection, we simply could not grow.

I suggest that Richard rethink his position and try to work out an intelligent compromise between our right to copy from each other and our right to protection from abuse and theft. I recognize our right to access more information than we need to know, and dislike the common practice of allowing people access to information and databases on a "need-to-know-only basis," except under certain critical security conditions.

I like the idea of a consortium of engineers, scientists, and computer

programmers for the explicit purpose of working out complex and expensive solutions in a "copyleft" protection provision. Richard should introduce legislation to make "copyleft" a legal entity with the help of his local congressman.

*Alvah Buckmore Jr
CEO and Chief Scientist
Buckmore Enterprise
Westfield, MA*

Where to contact Richard Stallman

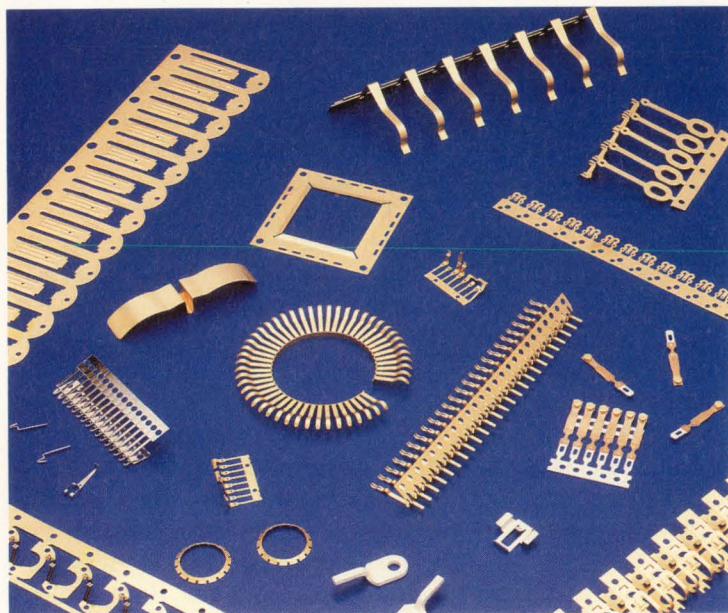
The Professional Issues article, "Keeper of the Faith" (EDN, October 1, 1990, pg 174), has elicited a great deal of reader response. Anyone who wants to contact Richard Stallman can reach him at:
Free Software Foundation Inc
675 Massachusetts Ave
Cambridge, MA 02139
Phone (617) 876-3296.

IT'S EASY TO HAVE YOUR SAY

EDN's Signals & Noise column provides a forum for readers to express their opinions on issues raised in the magazine's articles or on any topic that affects the engineering industry. You can use one of several easy ways to reach us. First, there's always the mail. Send your letters to Signals & Noise Editor, EDN Magazine, 275 Washington St, Newton, MA 02158. Or, send us a message via MCI mail at EDNBOS. Finally, EDN's bulletin-board system is ready for use—and it's free (except for the phone call). You can reach us at (617) 558-4241 and leave a letter in the EDITORS Special Interest Group. You'll need a 2400-bps or less modem and a communications program that is set for eight data bits, no parity, and one stop bit, or 2400, 8N1 in shorthand.

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	System					Serial U A R T	C / S	Timers		Parallel	
	C P U	O S C	M C U	R A M	D M A			C T C	C / T	P I A	P I O
Z84C01	✓	✓		✓				✓		✓	✓
Z84C50	✓	✓				✓				✓	
Z84C90			✓				✓	✓		✓	
Z80180	✓	✓	✓	✓	✓		✓			✓	
Z80280	✓	✓	✓	✓	✓		✓			✓	✓
Z84013/C13	✓	✓				✓		✓		✓	
Z84015/C15	✓	✓				✓		✓		✓	
Z84011/C11	✓	✓				✓		✓		✓	
Z80181	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The Z80181™ SAC™ Controller is the Smart Access Controller™ that combines two powerful standards. You get Zilog's industry standard SCC™ controller for datacom connectivity together with the popular Z180 CMOS controller. And all that utility comes with the user-friendly Z80® code CPU compatible software.

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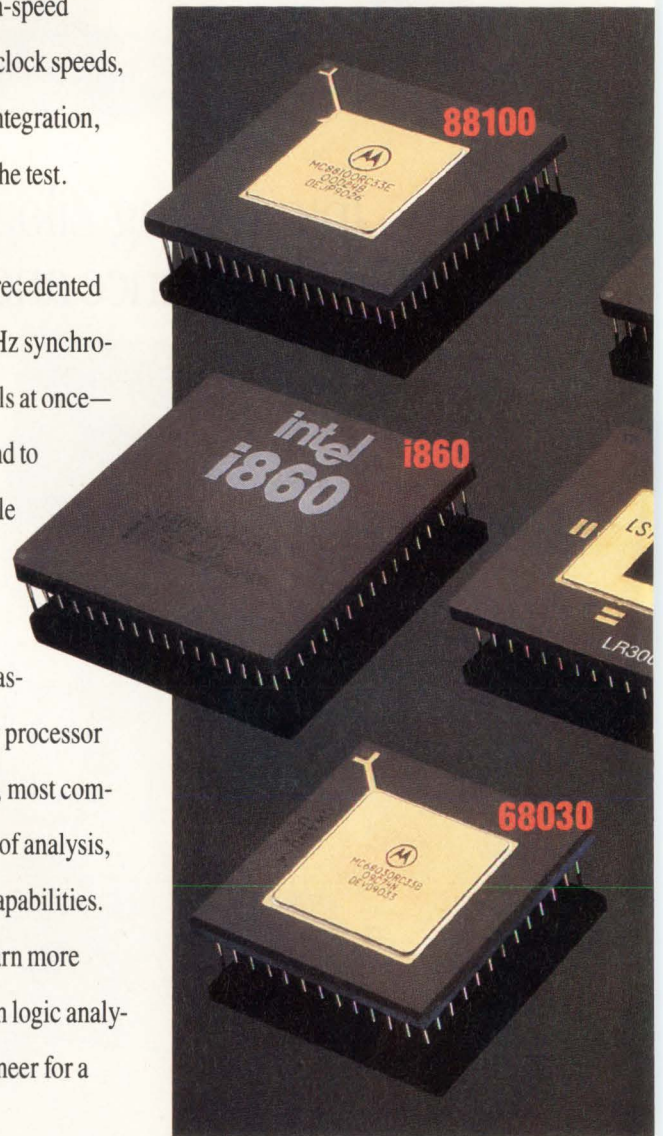
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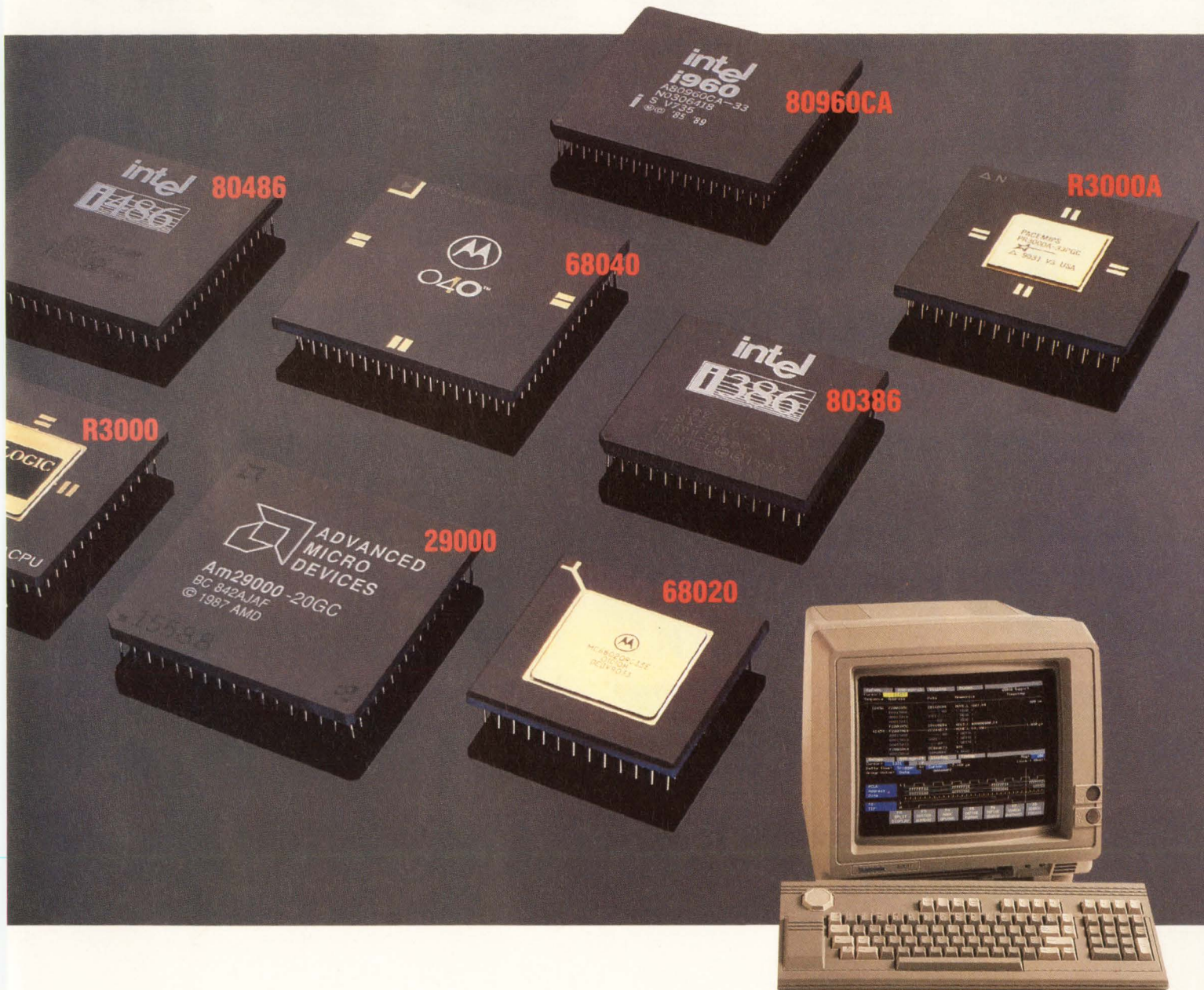
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ASK EDN

EDITED BY JULIE ANNE SCHOFIELD

Have you been stumped by a design problem so long that you don't know who to turn to? Are you having trouble locating parts? Finding companies? Can't interpret a spec sheet? Ask EDN.

This department will serve as a forum to solve nagging problems and answer difficult questions. EDN's editors will provide the solutions. If we can't solve a problem, we'll find an expert who can, or we'll print your letter and ask your peers for help. We can't answer every question, but we'll try to publish the ones that will help you most in your job.

Address your letters to Ask EDN, 275 Washington St, Newton, MA 02158. FAX (617) 558-4470; MCI: EDNBOS. Or, send us a letter on EDN's bulletin-board system. You can reach us at (617) 558-4241 and leave a letter in the /ask_edn Special Interest Group.

Vacuum tubes still in demand

I collect and repair antique radios. I need to purchase old vacuum tubes from Unity Electronics (Elizabeth, NJ, (201) 351-4200), but they either sold out or went out of business. They had a stock of more than two million radio tubes—too many to merely trash. Can you find out who bought them out and who has old vacuum tubes for sale today? Thanks.

Henry Ewald
Livonia, MI

Efforts to contact this company and to find out who now has its two million tubes were fruitless. However, both Editor Jon Titus and Associate Editor Mike Markowitz are radio buffs, and they dug up some alternate sources of radio parts:

Antique Electronic Supply
Box 1810
Tempe, AZ 85281
(602) 894-9503
FAX (602) 894-0124

Fair Radio Sales
Box 1105
Lima, OH 45802

Fala Electronics
Box 1376-1
Milwaukee, WI 53201
Send SASE for tube listings.

Southern Radio Supply
1909 Tulane Ave
New Orleans, LA 70112
(504) 524-2343
FAX (504) 523-1000.

Two antique-radio publications are

Antique Radio Classifieds
Box 802-B7
Carlisle, MA 01741
\$24 per year

Antique Wireless Association
Newsletter
Route 3
Holcomb, NY 14469
\$10 per year.

If you're interested in antique radio restoration but don't know where to start,

Classic Radio Service
Box 764
Woodacre, CA 94973

sells radio restoration kits that contain schematics; detailed restoration instructions for cleaning, alignment, and tuning; and replacement parts. Mike Markowitz would like to hear from readers who are also radio buffs. You can contact him via EDN bulletin-board system; his User-ID is EDNMarko.

RF-transceiver sources come forward

In the October 1, 1990, issue of EDN, Joe Thomas asked for a source of RF transmitter/receiver building blocks or modules. He wanted the devices for digitally transferring data over 100 ft under the control of Motorola's 146805E2 microcontroller. Among the companies that replied that they offer such devices are

Magnavox Electronics Systems Co
1313 Production Rd
Fort Wayne, IN 46808
(219) 429-6000
FAX (219) 429-6598

Metscan Inc
1450 Rochester St
Lima, NY 14485
(716) 624-9384
FAX (716) 624-5619

Toko America Inc
1250 Feehanville Dr
Mt Prospect, IL 60056
(708) 297-0070
FAX (708) 699-7864.

All replies are being forwarded to Mr Thomas.

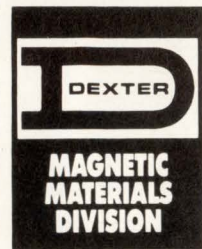
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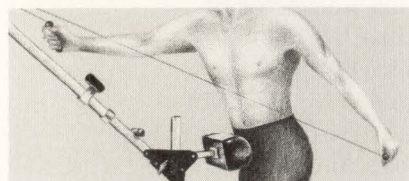
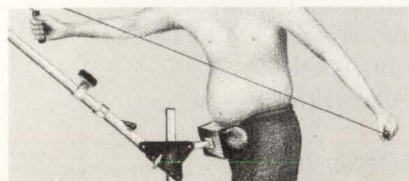
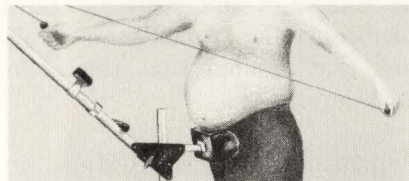
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CALENDAR

Database World, Boston, MA. Digital Consulting Inc, 204 Andover St, Andover, MA 01810. (508) 470-3880. FAX (508) 470-0526. December 11 to 13.

Systems Engineering (short course), Vancouver, BC. Learning Tree International, Box 45974, Los Angeles, CA 90045. (800) 421-8166; in Canada (800) 267-1824; in CA, (213) 645-4762. December 18 to 21.

Troubleshooting & Maintaining IBM & PS2, Raleigh, NC. Center for Advanced Professional Development, 1820 E Garry St, Suite 110, Santa Ana, CA 92705. (714) 261-0240. December 19 to 20.

Expert Systems Design & Development (short course), Los Angeles, CA. Learning Tree International, Box 45028, Los Angeles, CA 90045. (800) 421-8166; in Canada, (800) 267-1824; in CA, (213) 417-9700. January 8 to 11.

1991 Mathematica Conference, San Francisco, CA. Maury Kendall, Wolfram Research Inc, 100 Trade Center Dr, Champaign, IL 61820. (217) 398-0700. FAX (217) 398-0747. January 12 to 15.

ATE & Instrumentation Conference, Anaheim, CA. Leslie Tolworthy, Miller Freeman Expositions, 1050 Commonwealth Ave, Boston, MA 02215. (800) 223-7126; in MA, (617) 232-3976. FAX (617) 232-0854. January 14 to 17.

Applications of Unix Utilities (short course), Seattle, WA. Specialized Systems Consultants Inc, Box 55549, Seattle, WA 98155. (206) 527-3385. FAX (206) 527-2806. January 15.

Winter 1991 UNIX Technical Conference, Dallas, TX. Usenix Association, 22672 Lambert St, Suite 613, El Toro, CA 92630. (714) 588-

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CXK581000M*	128K x 8	100/120	SOP 525 mil	L, LL
CXK581100TM*	128K x 8	100/120	TSOP	L, LL
CXK581100YM*	128K x 8	100/120	TSOP (reverse)	L, LL
CXK581001P	128K x 8	70/85	DIP 600 mil	L
CXK581001M	128K x 8	70/85	SOP 525 mil	L
CXK581020SP	128K x 8	35/45/55	SDIP 400 mil	
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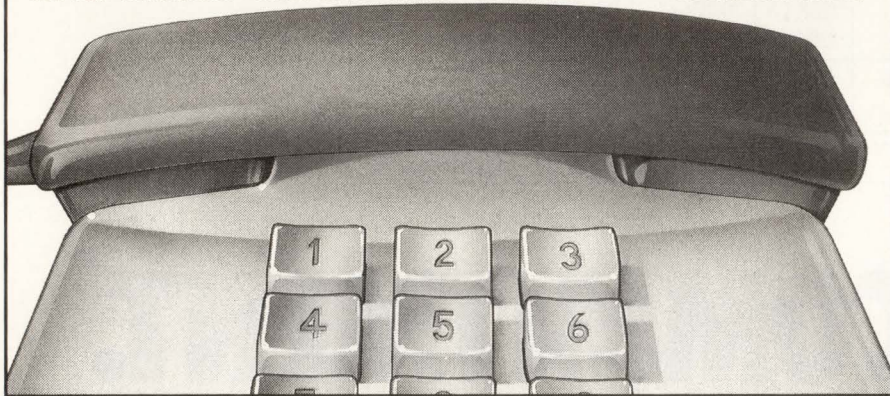
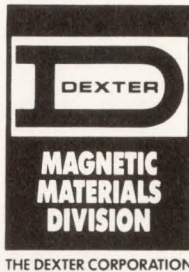
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CIRCLE NO. 20

CALENDAR

8649. FAX (714) 588-9706. January 21 to 25.

1991 Reliability and Maintainability Symposium and Exhibits, Orlando, FL. F Peter, Dayton T Brown Inc, Church St, Bohemia, NY 11716. (516) 589-6204. January 29 to 31.

TAB Symposium, San Jose, CA. Semiconductor Technology Center, 1501 N Cedar Crest Blvd, Suite 107, Allentown, PA 18104. (215) 435-4128. February 11 to 13.

The OEM Computer Technology Conference and Expo for Systems Design and Integration, Anaheim, CA. American Electronics Association, 5201 Great America Pkwy, Santa Clara, CA 95054. (503) 359-5873. FAX (503) 357-3839. February 11 to 13.

7th Annual IEEE Semiconductor Temperature and Thermal Management Symposium, Phoenix, AZ. Paul Wesling, IEEE, 12250 Saraglen Dr, Saratoga, CA 95070. February 12 to 14.

International Conference on Artificial Intelligence, Miami Beach, FL. CAIA '91, IEEE Computer Society, 1730 Massachusetts Ave NW, Washington, DC 20036. (202) 371-1013. February 24 to 28.

NEPCON West '91, National Electronic Packaging and Production Conference, Anaheim, CA. Cahners Exposition Group, 1350 E Touhy Ave, Des Plaines, IL 60018. (708) 299-9311. FAX (708) 635-1571. February 24 to 28.

European Design Automation Conference, Amsterdam, The Netherlands. Professor Jochen Jess, Eindhoven University Technology, Box 513, 5600 MB Eindhoven, The Netherlands. (Phone) 31-40-47-3353. February 25 to 28.

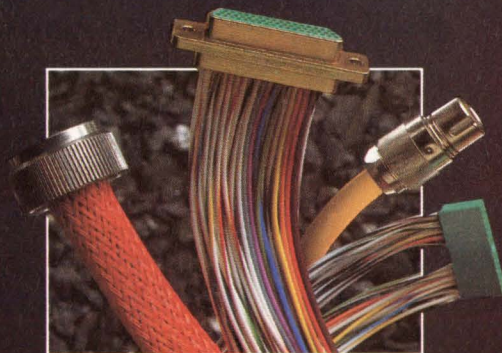
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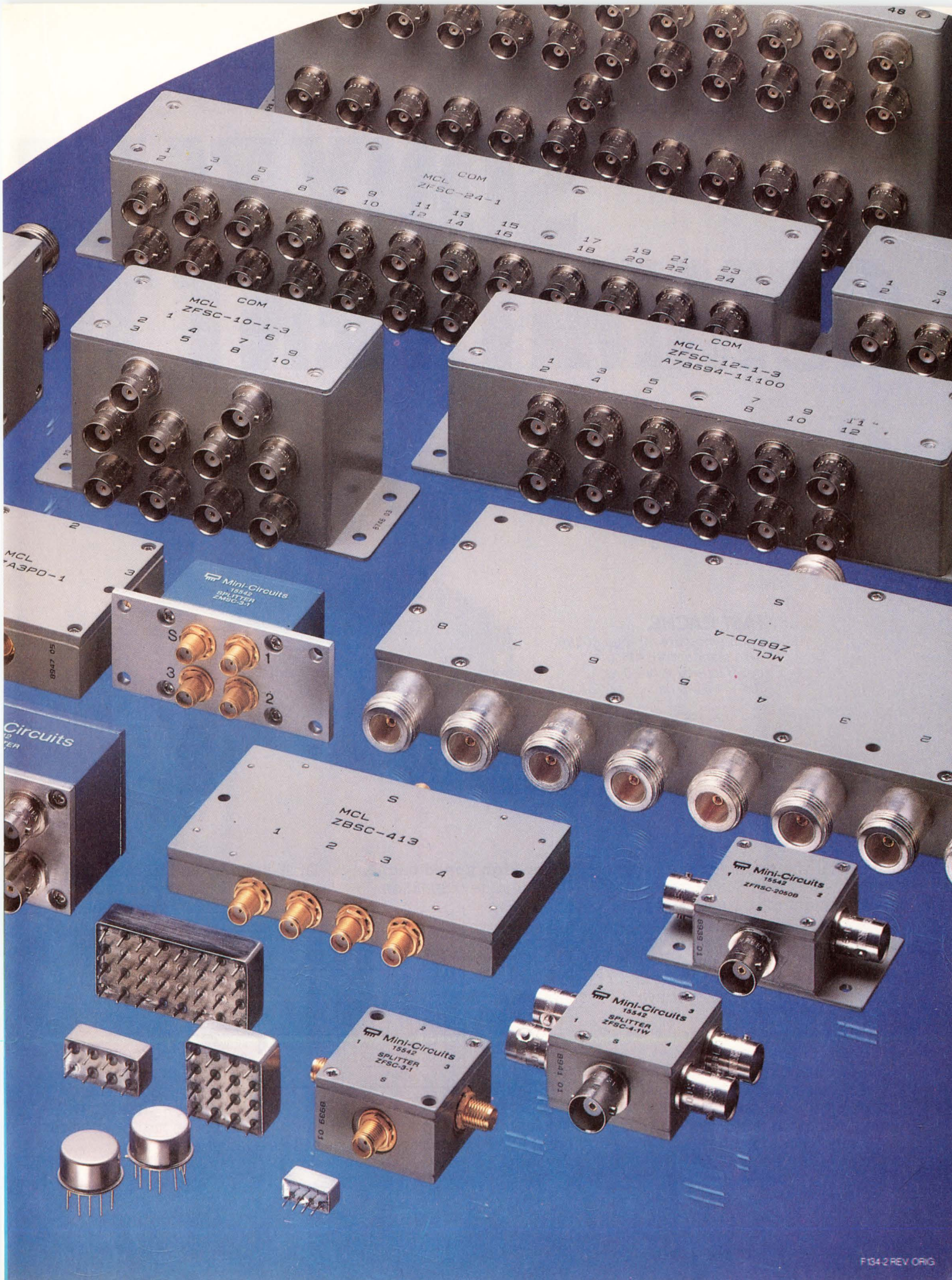


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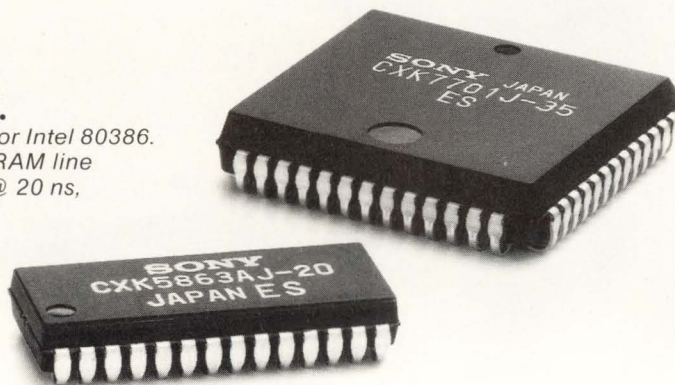
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down to 8K x 8 @ 20 ns,
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This application-specific memory (ASM) combines address

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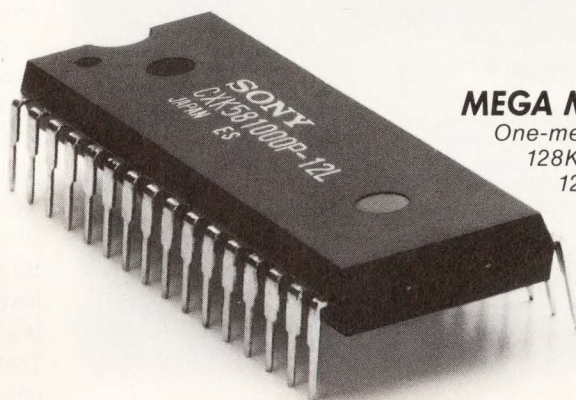
Second, consider our new ultra-high speed SRAM capabilities.

As you scan the chart above, keep in mind even higher speeds will be available soon.

ULTRA-HIGH SPEED CACHE SRAMS			
MODEL	CONFIG.	SPEED (ns)	PACKAGE
CXX7701J*	8K x 16	30/35/45/55	PLCC
CXK5863AP	8K x 8	20/25/35	DIP 300 mil
CXK5863AJ	8K x 8	20/25/35	SOJ 300 mil
CXK5466P	16K x 4	15/20	DIP 300 mil
CXK5466J	16K x 4	15/20	SOJ 300 mil
CXK5467P**	16K x 4	15/20	DIP 300 mil
CXK5467J**	16K x 4	15/20	SOJ 300 mil

*For Intel 80386. **0/E

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128K x 8 @ 70/85 ns,
128K x 8 @ 35/45/55 ns.

Ultra-high density.

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Each is based on our 0.8-micron CMOS technology. Configured as 128K x 8 bits. And available in 32-pin DIP and surface-mount plastic packages.

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Nowhere else will you find a greater choice: 100/120/150-ns, 70/85-ns and 35/45/55-ns speed figures.

HIGH-DENSITY SRAMS			
MODEL	CONFIG.	SPEED (ns)	PACKAGE
CXK581000P CXK581000M	128K x 8 128K x 8	100/120/150 100/120/150	DIP 600 mil SOP 525 mil
CXK581001P CXK581001M	128K x 8 128K x 8	70/85 70/85	DIP 600 mil SOP 525 mil
CXK581020SP CXK581020J	128K x 8 128K x 8	35/45/55 35/45/55	DIP 400 mil SOJ 400 mil

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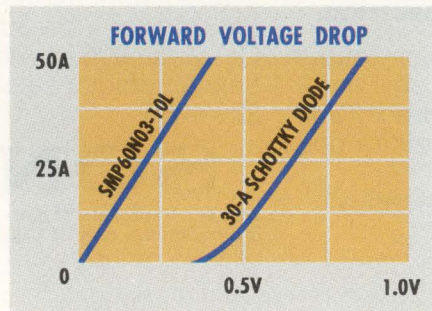
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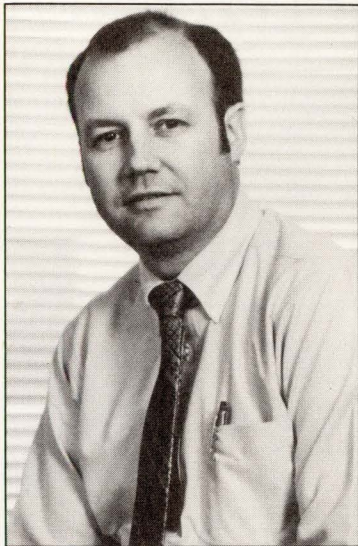
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EDITORIAL

Shattered dreams



The Sunday *Boston Globe* has a section that announces auctions of homes, real estate, personal property, and businesses. It's a sad commentary on the times that this section is expanding weekly. It's particularly sad that so many small, technical businesses are going bust. It would be good if every high-tech venture capitalist took the time to attend a few auctions, at which they'd see the life, soul, and dreams of entrepreneurs sold for 10 cents on the dollar. Often it's the venture capitalists who, expecting a quick profit, force these small businesses into insolvency. Dumping companies overboard happens more often when venture capitalists see the companies they back face a stormy market or an economic squall.

But auctions may not be the best place to see the broken dreams of entrepreneurs, engineers, and business people because they move quickly from lot to lot. The equipment gets scooped up and whisked away before the enormity of a loss of an entire business and the fate of its employees can sink in. For a better exposure to reality, stop in at the Weird Stuff Warehouse, 715 Sycamore Dr, Milpitas, CA 95035 ((408) 434-0168). Every venture capitalist should visit this warehouse before signing their next high-tech business deal. The warehouse displays stacks of products that companies have declared obsolete or surplus to their needs, along with the inventory of businesses that died. The warehouse floor is an open classroom—for those who are willing to sift through its piles—on what can go wrong with products and companies.

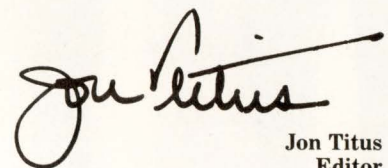
Brand-new chassis, unstuffed circuit boards, reels of components, tubes of ASICs, and stacks of disk drives attest to designs and products that died. Perhaps those products found no market or came to the market too late. In any case, here they lie, scattered remnants of an engineer's best efforts at a new product that was going to storm into the market and make a fortune.

The lessons are many: strive for quality; get your product to market on time; plan your strategy; have clear and meaningful goals; let customers—not engineers—develop products; have enough working capital; and on and on. Venture capitalists aren't the only ones who should go to an auction or stop at an electronic-surplus outlet. Would-be entrepreneurs should visit them, too. Viewing the bits and pieces of products that would have been is a sobering experience. Some will take the lessons to heart, and others will come away with false confidence in their own plans and ideas.

All of this may sound morbid and pessimistic, but I'm very optimistic about the electronics industry and the many innovative entrepreneurs, venture capitalists, and engineers who will help direct it and harness its capabilities. However, every new venture needs a realistic outlook. Looking at others' failures can provide it.



Jesse H Neal
Editorial Achievement Awards
1987, 1981 (2), 1978 (2),
1977, 1976, 1975
American Society of
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Jon Titus
Editor

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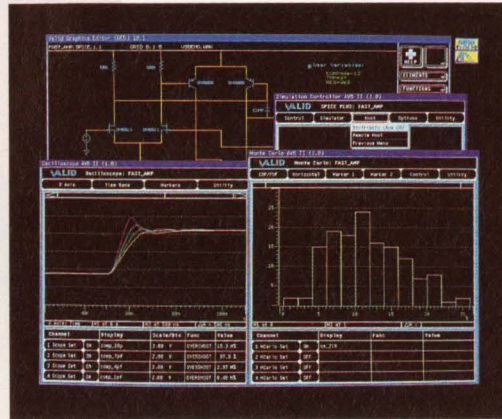
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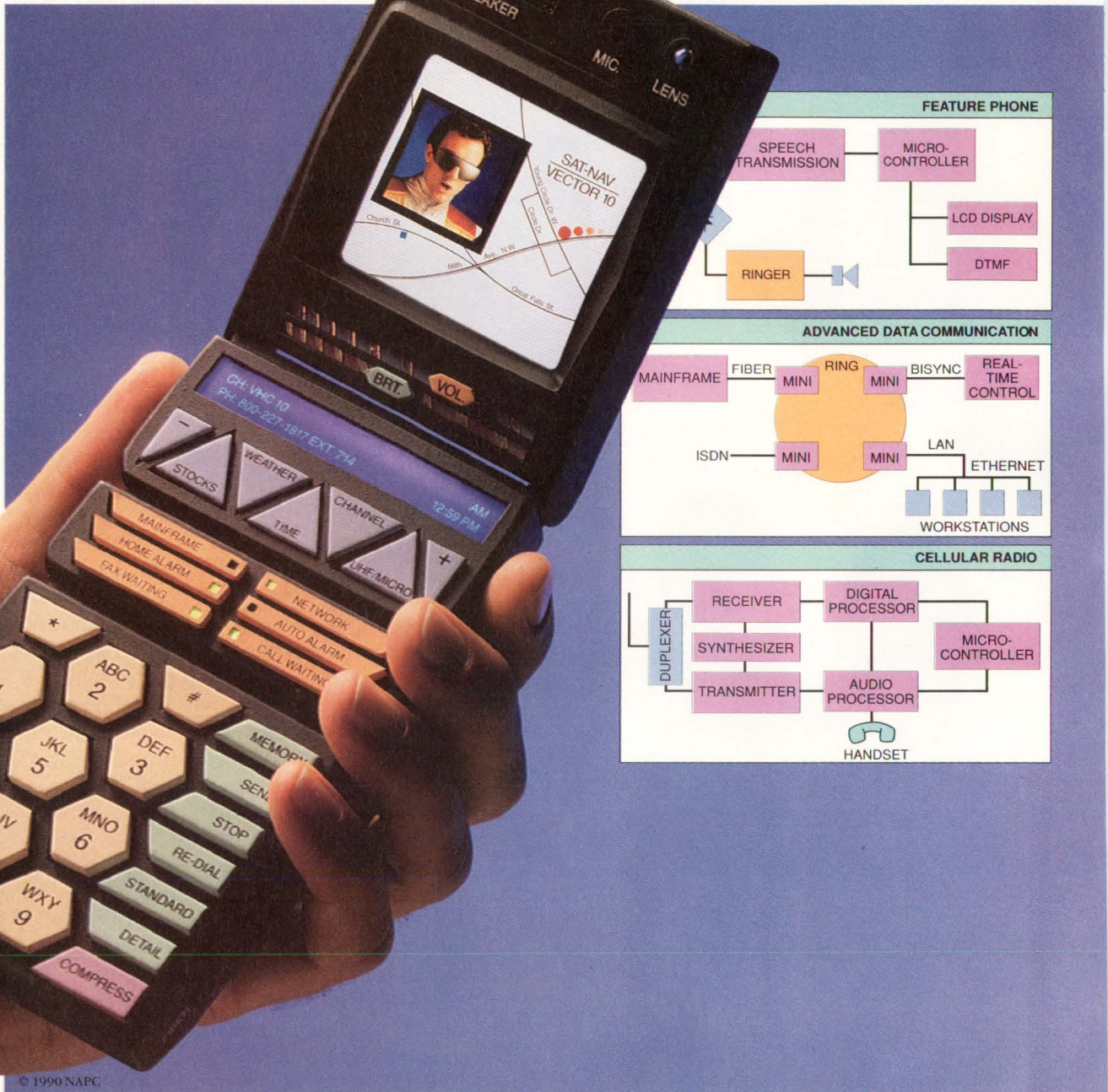
It's all part of Valid's Process Integration Architecture, the industry's most practical and comprehensive approach to concurrent engineering.

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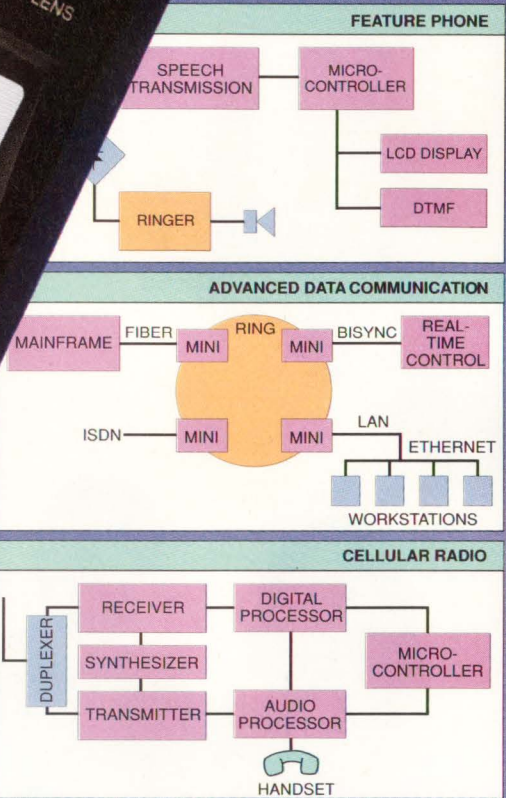
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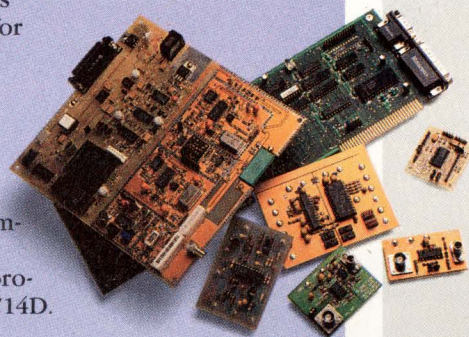
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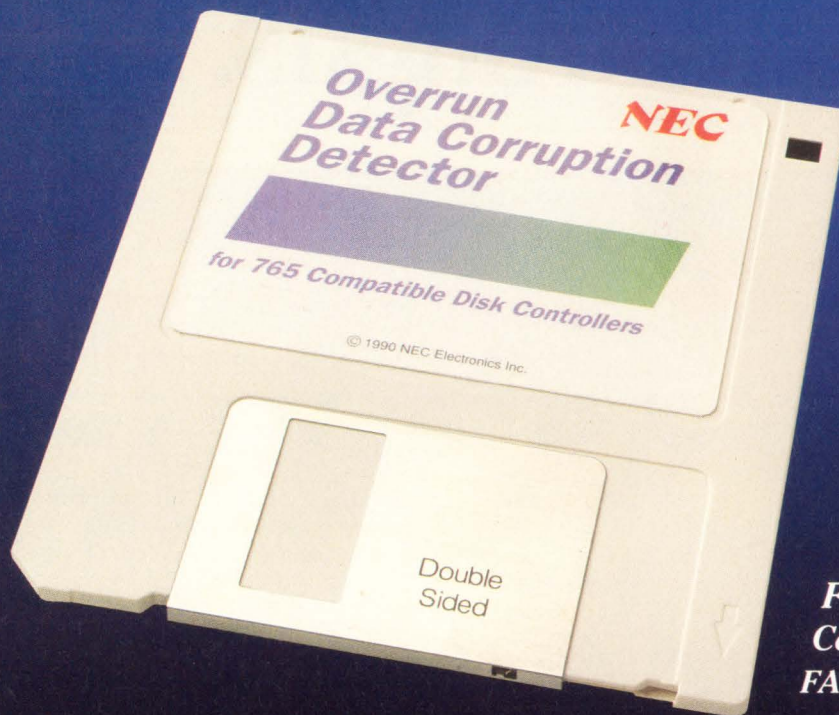
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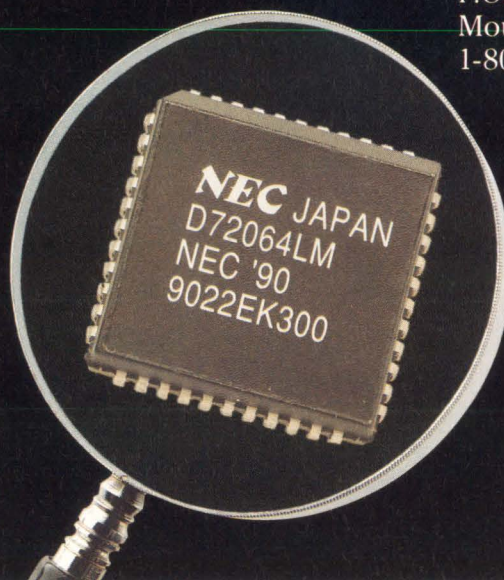
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CIRCLE NO. 86



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NEC

Power-supply IC controls both PWM and power-factor correction

Limited energy supplies, the nature of today's office electrical loads, and new standards are forcing power-supply designers to pay more attention to power-factor correction. The ML4819 makes implementing power-factor correction easier and cheaper by combining both PWM and power-factor-correction control in one IC.

The input capacitor of an uncorrected power supply only charges—draws current from the ac line—during the peaks of the ac line's cycle. Thus, the input current looks like a series of peaks rather than a sinusoidal waveform. This input-current waveform contains unwanted harmonics of the line frequency and contributes to heating in the distribution wires. The goal of power-factor correction is to make the current drawn from the ac line more sinusoidal and in phase with the voltage waveform. Uncorrected power supplies exhibit power factors around 0.65. Using

this controller, you can build a supply with an input range of 90 to 260V ac, which exhibits a power factor between 0.994 and 0.996.

A continuous inductor boost topology is a common implementation of power-factor correction. This device includes a boost-mode control circuit based on a patented current-sensing technique. The boost inductor acts as an extra storage element. The IC controls the current that flows into the inductor; the inductor in turn delivers energy to the supply's capacitor. This boost topology consumes continuous line current, generates low input noise, and imposes low peak current in the power-supply switch.

Although discrete and IC implementations of this correction scheme exist, combining the power-factor control and PWM control reduces the size of the supply's control section by eliminating many passive components. Because the PWM and correction circuits share the same oscillator, synchronization

of the two stages is inherent. Without synchronizing the two stages, the correction circuit's switching frequency could interfere with the converter's chopping frequency and create beat frequencies.

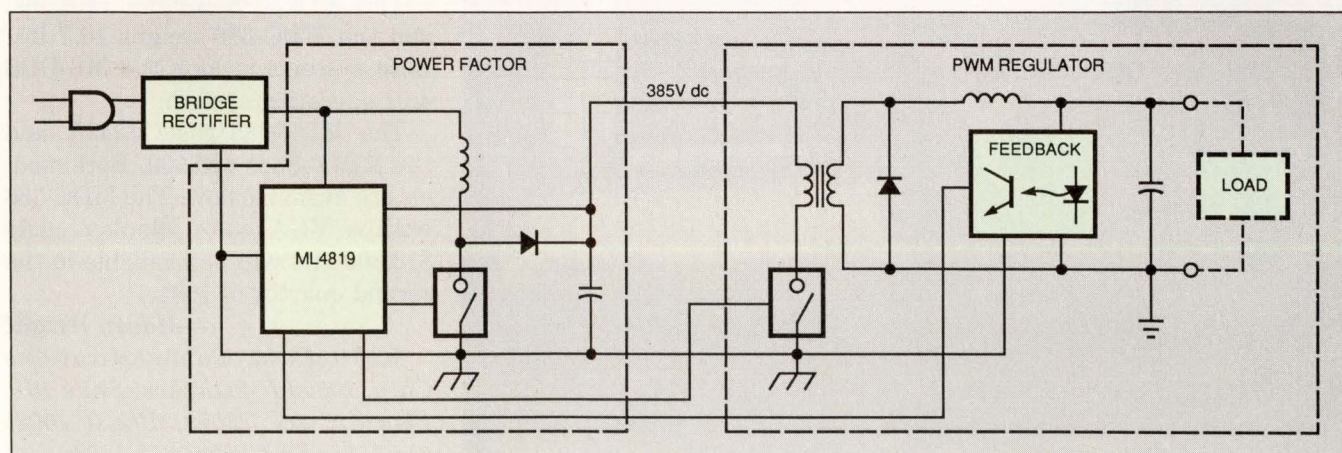
The PWM controller section of the IC is a conventional current-mode PWM circuit with additional features such as a maximum duty-cycle clamp. The controller's output drivers supply 1A peak current and are internally clamped to 15V. During undervoltage lockout, the IC consumes 1 mA. During active operation, it typically consumes 25 mA.

The ML4819 is available in 20-pin DIPs for \$3.95 (100). Typical applications for the IC include power supplies for PCs in the 150 to 400W range, instruments, computer peripherals, plotters, printers, and other off-line power supplies.

—Anne Watson Swager

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

Circle No. 734



By combining PWM and power-factor controls, this IC helps to increase a supply's power factor with fewer components than other implementations.

PRODUCT UPDATE

Ruggedized 8088- and 80386-based PCs withstand automotive and factory applications

The MDC family of ruggedized IBM PC-compatible computers targets applications in harsh environments such as factories, remote locations, and inside vehicles. You can operate the systems in environments with temperatures ranging from -40 to $+85^{\circ}\text{C}$. The company offers 8088- and 80386-based models with a choice of monochrome or color flat-panel displays.

The MDC family comprises three modular components—the display, the keyboard, and processor/storage-unit modules. You can locate the keyboard and display modules as far as 15 ft from the processor/storage modules. For example, you can mount the processor/storage module in the trunk of a car for automotive applications. The display module includes a numeric keypad and a set of function keys that

can eliminate the need for a keyboard in embedded applications.

The display modules also allow direct viewing in sunlight and feature backlighting for use in low light. As a standard feature, the company offers a choice of a 9.125×5.75 -in. display module that supports 600×400 -pixel resolution or an 8.75×3.75 -in. display module that has 600×200 -pixel resolution. You can set up the standard displays to operate in CGA, MDA, or Hercules monochrome modes. A VGA color display is available as an option.

Both the MDC-088 and MDC-386 models include one parallel and two serial ports, a connector for an external floppy-disk drive, and support for an internal modem. The 8088-based MDC-088 includes 640k bytes of RAM, and the 80386-based MDC-386 hosts 4M to 8M bytes of

RAM. You can add standard IBM PC-compatible boards to either system with an optional expansion module.

The company conformally coats the pc boards used in the systems to increase resistance to humidity and liquid spills. The systems can withstand a 20g shock for 11 msec while operating. The systems exceed the EIA RS-374A specification for vibration. You can also operate the systems at altitudes ranging from 10,000 ft to 200 ft below mean sea level.

The systems include two 512k-byte RAM disk cartridges for storage. The 80386 model also includes a standard 40M-byte hard disk, and you can power down the disk drive via software during periods of extreme vibration. The company also offers optional 20M- and 40M-byte drives for the MDC-088.

The systems operate from a dc power source that ranges from 7 to 26V. You can also power the systems with an ac adapter. The company's battery pack powers the systems; it also can function as an uninterruptible power source.

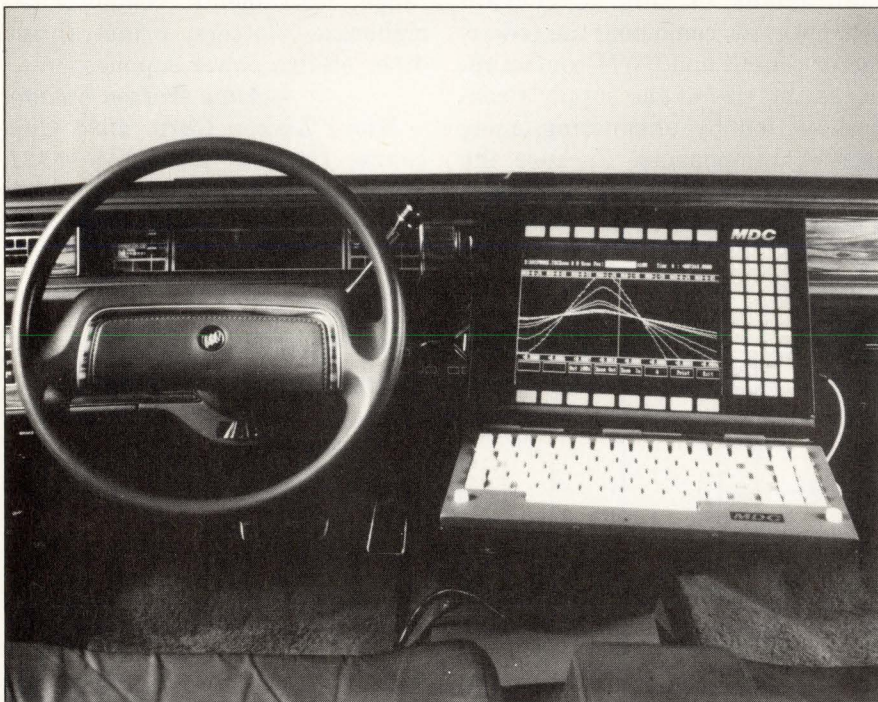
The MDC-088 weighs 14.8 lbs, and the MDC-386 weighs 16.7 lbs. Both systems include the MS-DOS 4.01 operating system.

The MDC-088 costs \$7425, and the MDC-386 is \$10,500. Both models are available now. The MDC-386 with a VGA color display costs \$12,300 and will be available in the second quarter of 1991.

—Maury Wright

MobileData Communications Corp, 10850 N 24th Ave, Suite 101, Phoenix, AZ 85029. Phone (602) 678-3788. FAX (602) 678-4471.

Circle No. 732



Conformally coated pc boards and a modular design make the MDC family of IBM PC-compatible systems suitable for use in rugged environments such as inside vehicles.

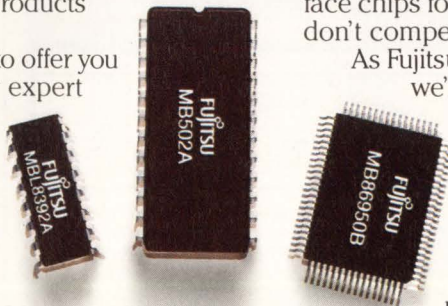


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Parallel processing pushes performance of layout-rules checker

To improve software runtimes, LRC-2000 layout-rules-checking software lets you partition the evaluation on multiple workstations. The software also performs dynamic load balancing, which optimizes CPU usage. You control CPU options via the software's graphical user interface.

In addition to parallel processing, the layout-rules checker utilizes the hierarchy of your layout to build its database and shorten runtimes. Hierarchical analysis eliminates redundant evaluation of identical components. The software's error identifiers, resizers, and Boolean operators all work within the database hierarchy, so you can locate rule violations and operate on the layout without compromising the design.

The layout-rules checker includes

standard operators such as area, internal, external, enclose, intersect, and length. The vendor claims that the two database operators, Contain and Minmax, are unique because they perform oversizing and undersizing on the hierarchical data. The software lets you mask structures, evaluate data in multiple windows, set the number of hierarchical levels to check, and flag non-45° elements. To eliminate redundant checks and false-error reports, an option allows you to assign different distance values for orthogonal, angle, and corner checks in the same run.

For simplicity, you can combine layers and data types and specify each layout-rules check in a single line. Alternatively, a translation utility converts run sets from

the popular Dracula design-rules checking software to the LRC-2000 format.

The software accepts LTL, GDSII Stream, CIF, and Applicon 860 format data and creates LTL or GDSII Stream data. You can run the software on workstations from Sun, Apollo, and Sony, and on some high-end 80386/486 IBM PCs. The software costs \$20,000 and doesn't include layout vs schematic (LVS) or electrical-rules checkers (ERC). The company expects to announce both LVS and ERC packages near the end of this year.

—Michael C Markowitz

Integrated Silicon Systems Inc,
Box 13665, Research Triangle
Park, NC 27709. Phone (919) 361-
5814. FAX (919) 361-2019.

Circle No. 735

Integrated Silicon Systems Inc. - LRC-2000 Parallel Processing Hierarchical Layout Rules Checker

Pending Checks			
Type=X clayspad met1 val<25	(55;171)	{ pad spacing to met1 25.0	55;171
Type=X clayspad met2 val<25	(55;172)	{ pad spacing to met2 25.0	55;172
Type=X clayspad poly val<25	(55;173)	{ pad spacing to poly 25.0	55;173
Type=X clayspad tow val<25	(55;174)	{ pad spacing to tow 25.0	55;174
Type=X clayspad well val<25	(55;175)	{ pad spacing to well 25.0	55;175
Type=E claysmet1 pad val<4	(55;176)	{ metal 1 overlap pad 4.0	55;176
Type=E claysmet2 pad val<8	(55;177)	{ metal 2 overlap pad 8.0	55;177
Type=E clayspad via val<4	(55;178)	{ metal 2 overlap pad 4.0	55;178
Type=S claysmet1 val=-1 output=zuzmet(108)			

Suspend CPU: happy Status: Type=X clayspoly tow val<2 (55;133)

Suspend CPU: iss-rtj Status: Type=[U] clayspoly tow val<2 (55;132)

Suspend CPU: doc Status: Type=X clayspoly val<4 (55;131)

Pending: 28 Complete: 29 Clock Time: Elapsed time = 0:03:44.00

Messages: Host doc has been Restarted.

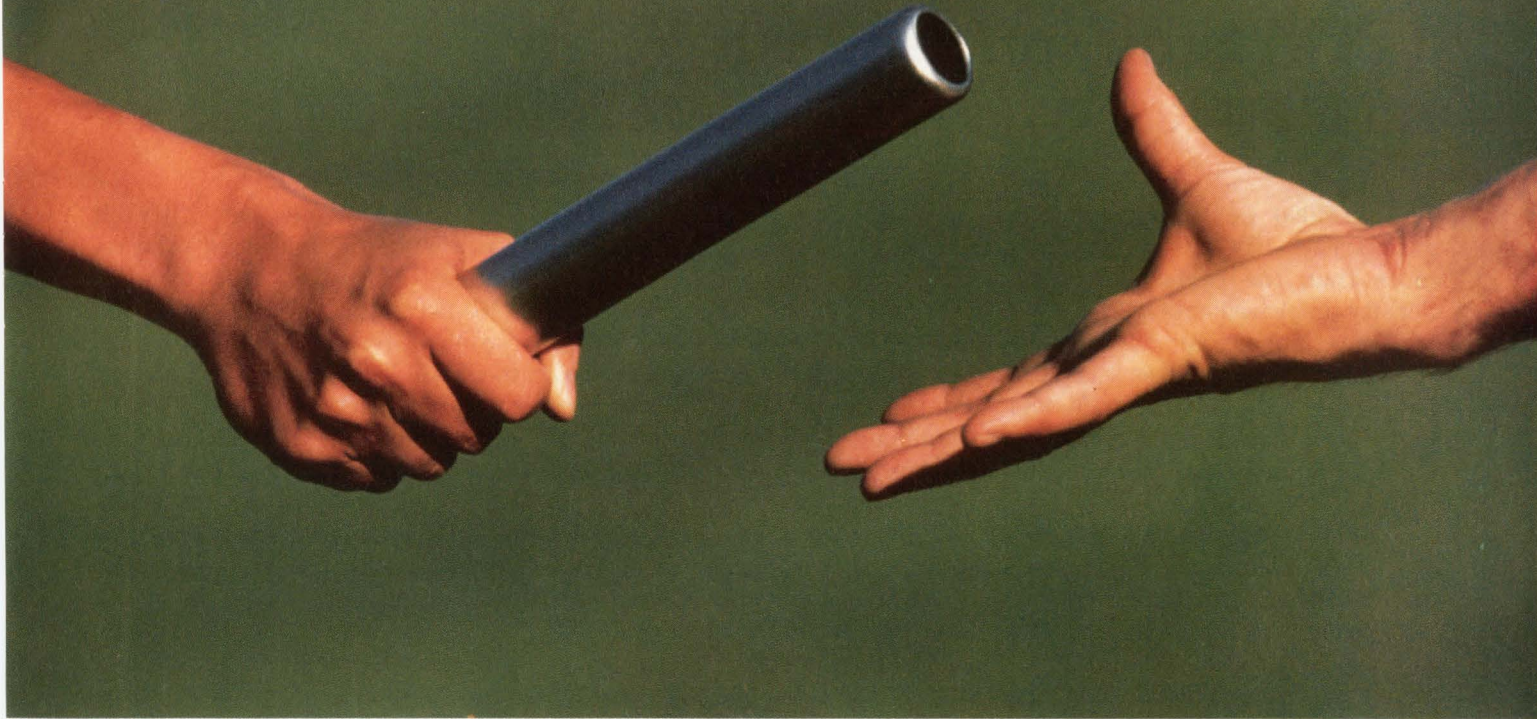
Completed Checks			
Type=I claystox val<4	(55;120)	{ min tox width 4.0	55;120
Type=X claystox val<4	(55;121)	{ tox spacing same poten 4.0	55;121
Type=X clayspdev ndev val<8	(55;122)	{ tox spacing opp poten 8.0	55;122
Type=E clayspsel ptow val<2	(55;123)	{ psel overlap of ptow 2.0	55;123
Type=E clayswell1 tow val<2	(55;124)	{ well1 overlap tox 2.0	55;124
Type=I clayspoly val<4	(55;130)	{ min poly width 4.0	55;130

uzmet_MAXCONT 5616
Total Library Byte Count =
CMD: rd
Window movement can cause screen areas
Window movement can cause screen areas
INTERRUPT
CMD: rd
CMD: *

x: 351.000 | Lib: rich.db Layer: SN: 13 Command: *
y: 755.500 Struct: CHTP DType: 0 DMode: 4 45 Buttons: MENU MENU MENU

Partitioning a design-rules-checking run across multiple workstations, as the LRC-2000 does, greatly improves design efficiency and throughput.

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FPGA family offers speed, density, on-chip RAM, and wide-decode logic

The XC4000 field-programmable gate array (FPGA) family offers more than the performance and density improvements you expect of a next-generation device. The ICs incorporate features that will help you sweep up the RAM and high-speed decode logic you may have previously left outside the FPGA.

Similar to the earlier generations, the 4000-series FPGAs are arrays of programmable logic blocks with programmable I/O blocks and interconnect matrix. All of the programming is RAM based, allowing you to reconfigure the part at any time.

Each logic block has dual D-type flip flops and 4-input Boolean function generators for implementing

your logic design. A third function generator in each block combines the output signals of the first two generators with an additional signal line, allowing each block to handle as many as nine input signals. You can preset the flip flops during programming.

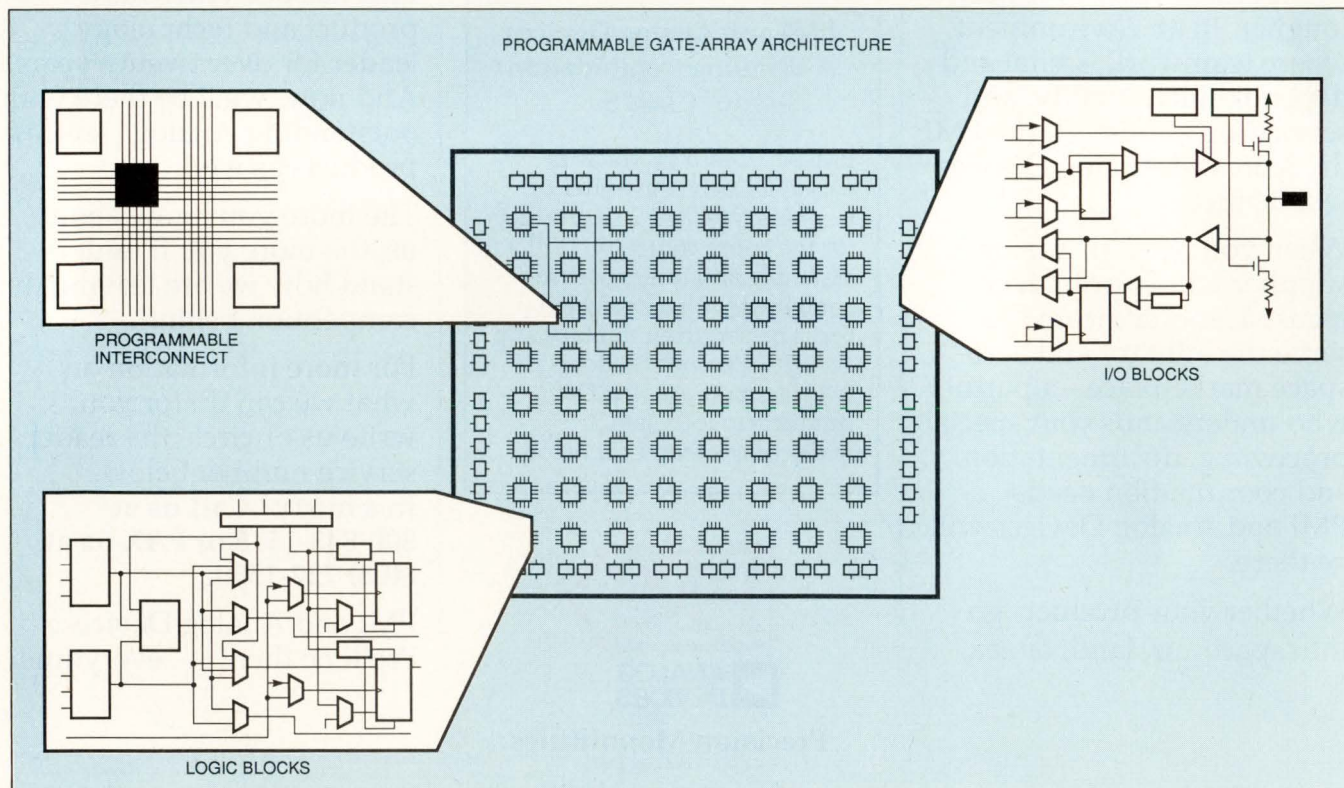
Logic blocks are great for logic designs, but terribly inefficient for implementing RAM. If designers using earlier FPGAs needed a bit of RAM in their circuit, they usually used an external device. The 4000-series, however, allows you to convert the RAM normally used for programming a logic block into RAM accessible by your circuit.

You can trade half of a logic block for 16×1 bits of RAM when programming the IC. You can combine

logic blocks to increase either bit width or depth as needed. The resulting RAM has a 5-nsec read- and a 10-nsec write-access time. You can also preset the data values of the RAM, allowing you to use the memory as ROM.

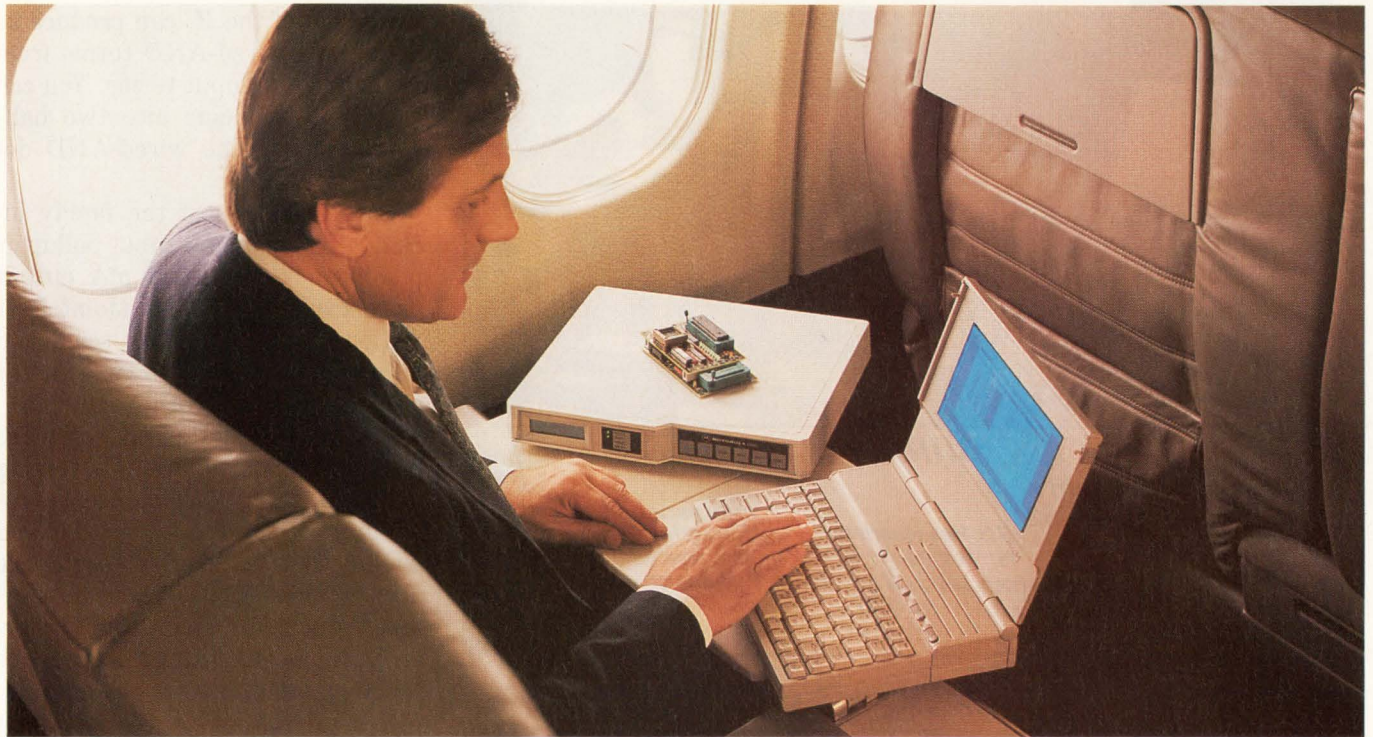
One drawback of FPGAs has been the limited width of their logic-block input lines. For example, with a 4-input logic block you would have to use 11 blocks, 8 in parallel and 3 to combine the output signals, in order to decode a 32-bit address. The resulting 3-level logic delay may be too slow for some applications, forcing you to use an external high-speed decoder in your design.

The 4000-series provides a wide-input logic function at its I/O pins,



On-chip RAM and wide-decode logic are some of the added features of the XC4000 next-generation FPGA.

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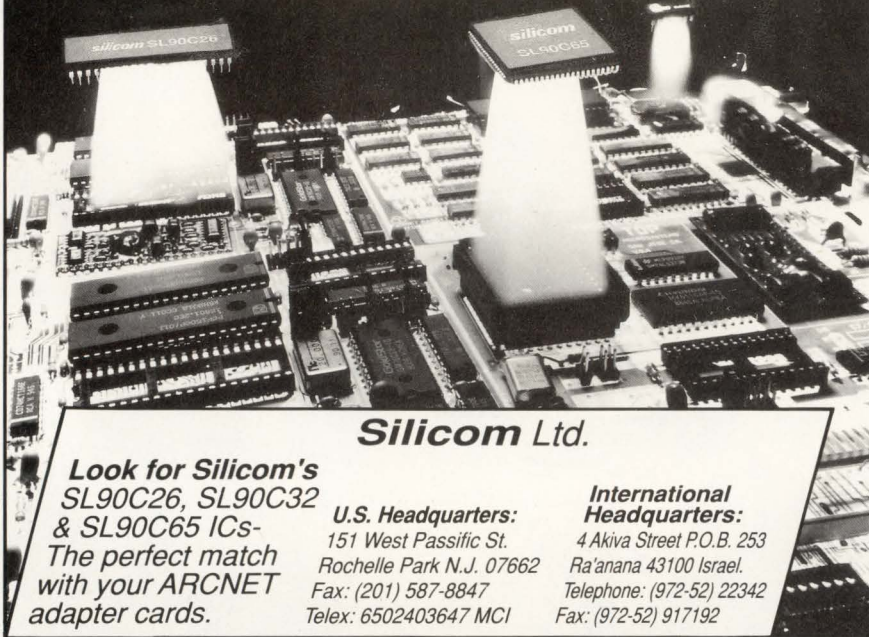
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UPDATE



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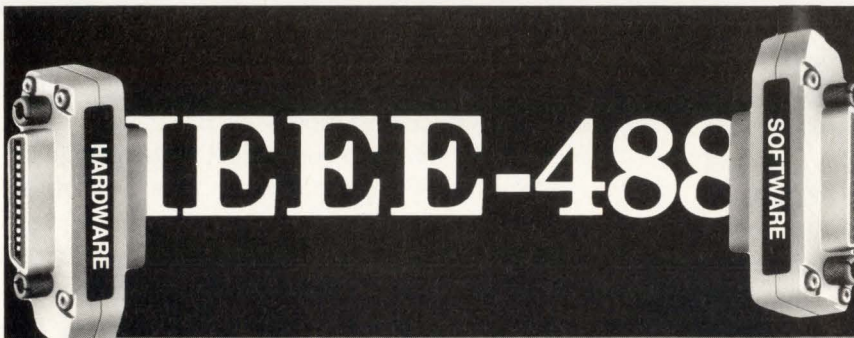
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CIRCLE NO. 26

independent of the logic blocks. Each side of the IC can produce as many as 4 wired-AND terms from as many as 40 input terms. You can also split the logic into two half-wide groups. The wired-AND decodes in 10 nsec.

Other features of the family include programmable input pullup or pulldown resistors, 12 mA output drive capability, JTAG (Joint Test Action Group) boundary scan, and 8 low-skew global networks for clock distribution within the chip.

An upgraded design software package supports the ICs, giving you automatic place-and-route capability with access to the RAM and wide-decode features. The software also provides 276 soft and 50 hard macros for implementing higher-level functions. Soft macros are functions that the software maps into available logic blocks using logic synthesis. Hard macros are functions with guaranteed performance characteristics, for which the software has a prepartitioned, fixed-routing blueprint.

The ICs handle system speeds of 60 MHz and will come in sizes from 5000 to 10,000 gates. The first family member, the XC4005, has 5000 gates, costs \$192.50 in sample quantities, and is available immediately. The XC4010, with 10,000 gates, will be available in the first quarter of 1991 for \$686.50. ICs with 6000 and 8000 gates will follow.

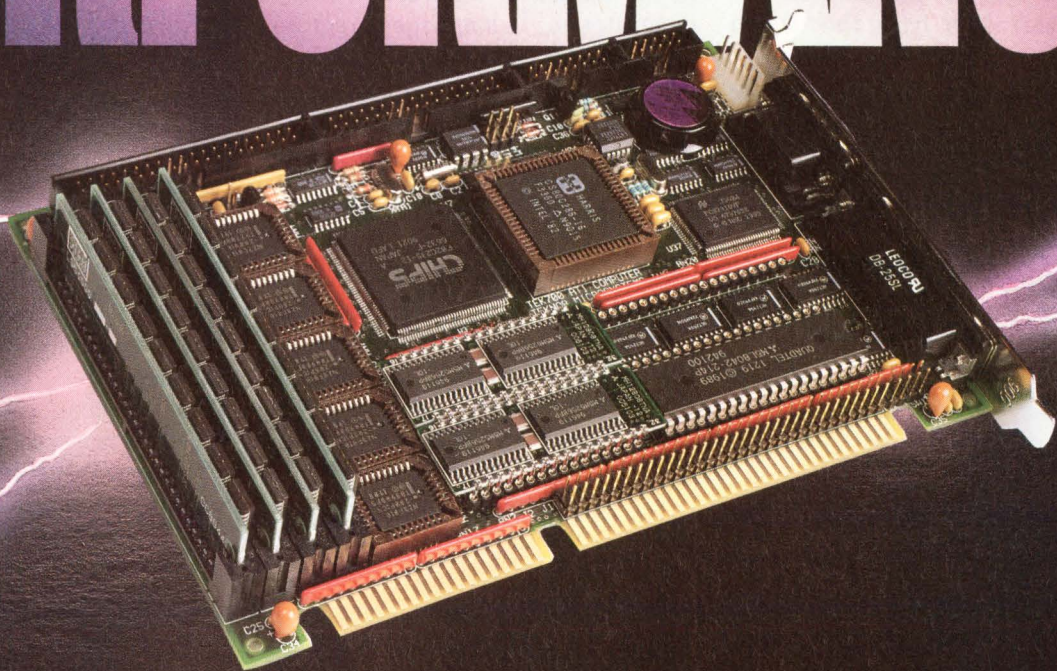
The development system with design software costs \$7840 for PC-based systems and \$15,950 for workstations. Current users can upgrade their PC-based systems for \$1750, \$3300 for workstations.

—Richard A Quinell

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IC layout tools ensure integrity and maintain flexibility

Construct PI is not a TV series about a detective going undercover on a hard-hat job. Compose Architect won't calm an irate building designer. Construct PI and Compose Architect are IC design and layout tools that provide process independence (hence the PI) and layout flexibility.

Construct PI uses a process-technology database to store design rules and process information. Removing this data from the design allows the design—or portions of it—to migrate among various processes. You can redo or reuse a design by editing the database and issuing an update command.

The tool's all-layer device-com-

paction feature causes the layout widths and spacings to shrink or expand to meet the database's design rules. The graphical-device-generation feature lets you sketch a layout, paying attention only to the layers on which you place polygons and paths and their relative relationships. The software then correctly sizes and spaces the layout based on the information you've got in the database. The software also generates a C-language program that you can use as a parametrized cell. You can define or edit constraints in either the layout or in the C program. You may need to assign constraints to certain structures before the software can gen-

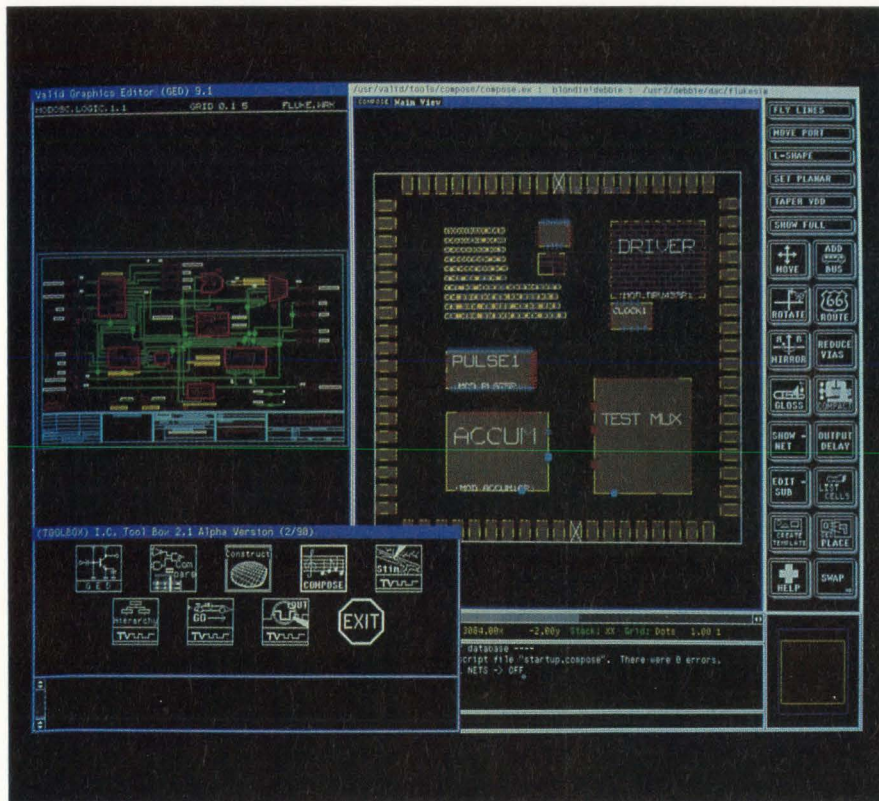
erate a properly sized, design-rule-correct layout.

Construct PI uses the schematic and net list to ensure a correct-by-construction layout. Among the information the software reads from the design files are gate sizes, wire widths, and device groupings. With the schematic and layout in side-by-side windows on your workstation, you can select a gate in the schematic window, drag it into the layout window, and place it in the layout. For bookkeeping, placed components appear in your schematic in a different color than unplaced components.

Compose Architect is a floor-planning and analysis tool that works with hard- and soft-function blocks. Soft-function blocks, which don't have associated layout data, need port assignments and area definition. You define area via a manual estimation or by entering a gate-size area estimate that the software extrapolates to the whole function block. Soft blocks aren't limited to rectangular shapes. With area and port information, you can modify aspect ratios and swap port assignments to optimize the layout.

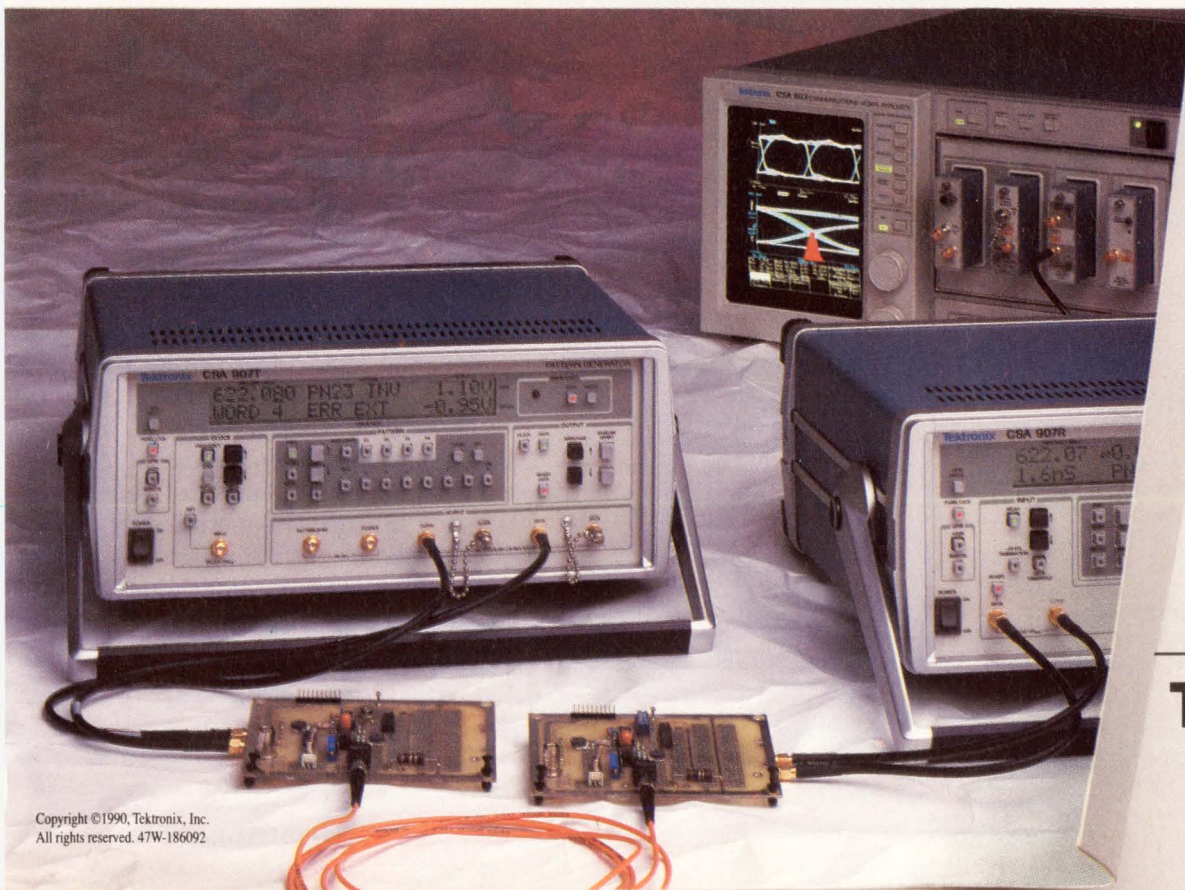
Power-, delay-, and path-analysis tools contained in Compose Architect let you correctly size, taper, and place power buses and clock signals. The software calculates pin-to-pin delays and creates the files necessary to use the delay information in logic simulation. Obviously, the software works best with the vendor's own simulator and the static timing analyzer that the company resells.

The Compose Architect software communicates with the Construct PI software to track the progress of each of its components through



Architectural analysis gives you the flexibility to evaluate many design alternatives. Compose Architect works with soft blocks (red bricks), which don't have layout data, and hard blocks (tan), which do.

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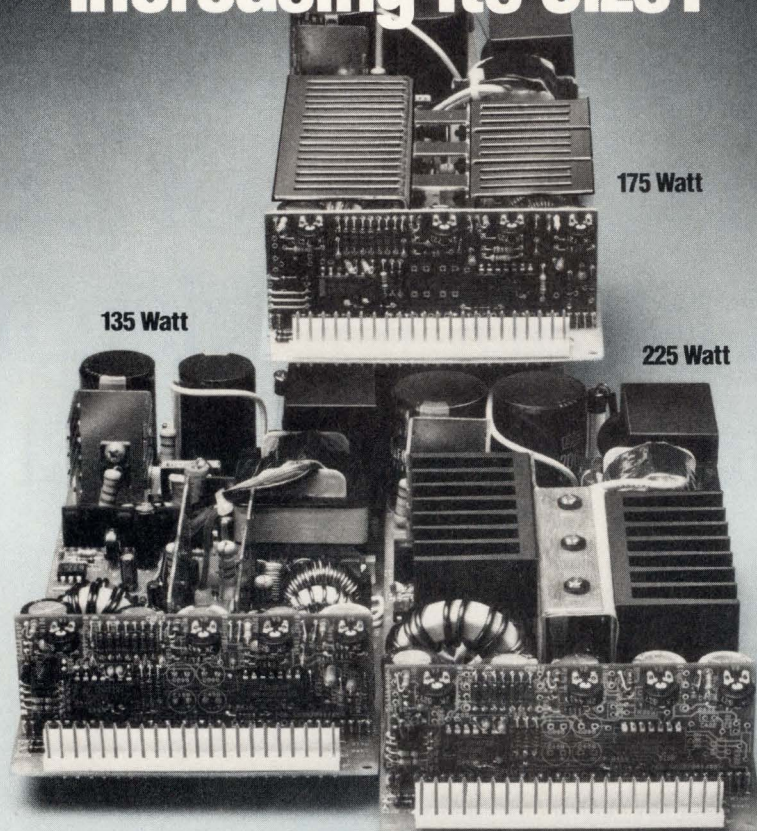
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UPDATE

the layout. For example, the software represents soft-function blocks as a brick wall (under construction). When you finish the soft block's layout—that is, when you make it a hard block—the representation turns to a solid wall.

Current Construct users can upgrade to process independence by purchasing the device-level compacter, which starts at \$15,000. Construct PI, including the compacter, starts at \$50,000. A stand-alone version of Compose Architect starts at \$30,000, and it is available bundled with Compose chip assembly-tool routers that start at \$65,000. The initial release of the software, due late in 1990, will run on Sun-3 and -4 workstations. Software versions for Digital and IBM workstations are scheduled for early 1991.—**Michael C Markowitz**

Valid Logic Systems, 2820 Orchard Pkwy, San Jose, CA 95134. Phone (408) 432-9400. FAX (408) 432-9430.

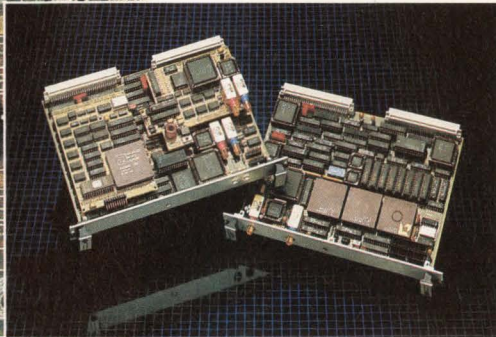
Circle No. 737

WHAT'S COMING IN EDN

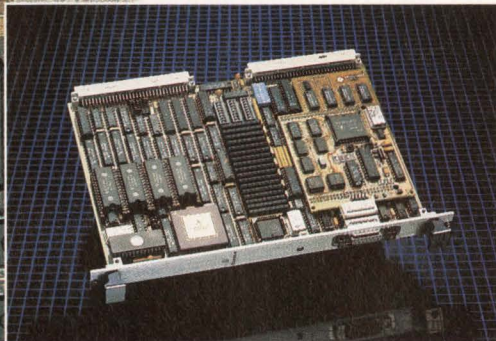
EDN Magazine's December 20, 1990, issue will conclude Product Showcase No. 32. The issue will feature staff-written reports on VHDL tools, capacitors for high-density circuit applications, bar codes, and logic analyzers for debugging 32-bit CISC systems. Special product coverage will focus on computer-aided engineering, components, computers and peripherals, and test and measurement instruments.

In January look for special reports on nonvolatile and FIFO memories.

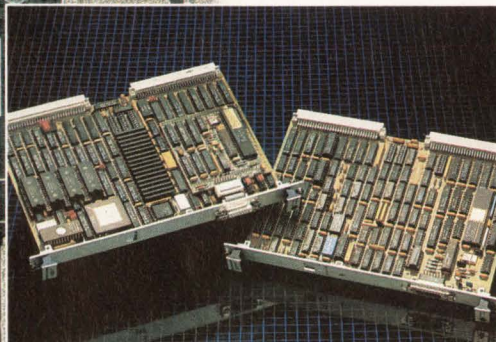
NETWORKING SOLUTIONS



V/FDDI 4211 Peregrine
V/FDDI 3211 Falcon



V/Token-Ring 4212 Owl



V/Ethernet 4207 Eagle
V/Ethernet 3207 Hawk

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Interphase's FDDI 100 Mb/s offerings are a logical choice for the industry. The V/FDDI 3211 Falcon received *UnixWorld* magazine's Product of the Year designation and was the industry's first 6U VMEbus FDDI solution. Interphase's newest FDDI product is the V/FDDI 4211 Peregrine, a RISC-based high-performance node controller capable of link level operation or on-board protocol processing. The Peregrine provides single or dual attach configurations, with SMT (Station Management Software) running on-board, all in one 6U VME slot.

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CIRCLE NO. 67

PRODUCT UPDATE

Video chip set handles decompression, special effects, and mixing in many formats

The i750 video processor chip set helps you mix text, graphics, and video images in your computer-display application. The 2-chip set comprises a microprogrammable pixel processor for manipulating image data and a display processor for handling the video interface.

The 82750PB pixel processor chip handles image decompression, windowing, and video mixing at the pixel level. It uses a 48-bit-wide instruction word and can manipulate 16-bit data on 2 independent internal buses simultaneously. Its ALU uses 16-bit data but is configurable to provide an 8-bit dual-add-with-saturate operation for handling pixel arithmetic.

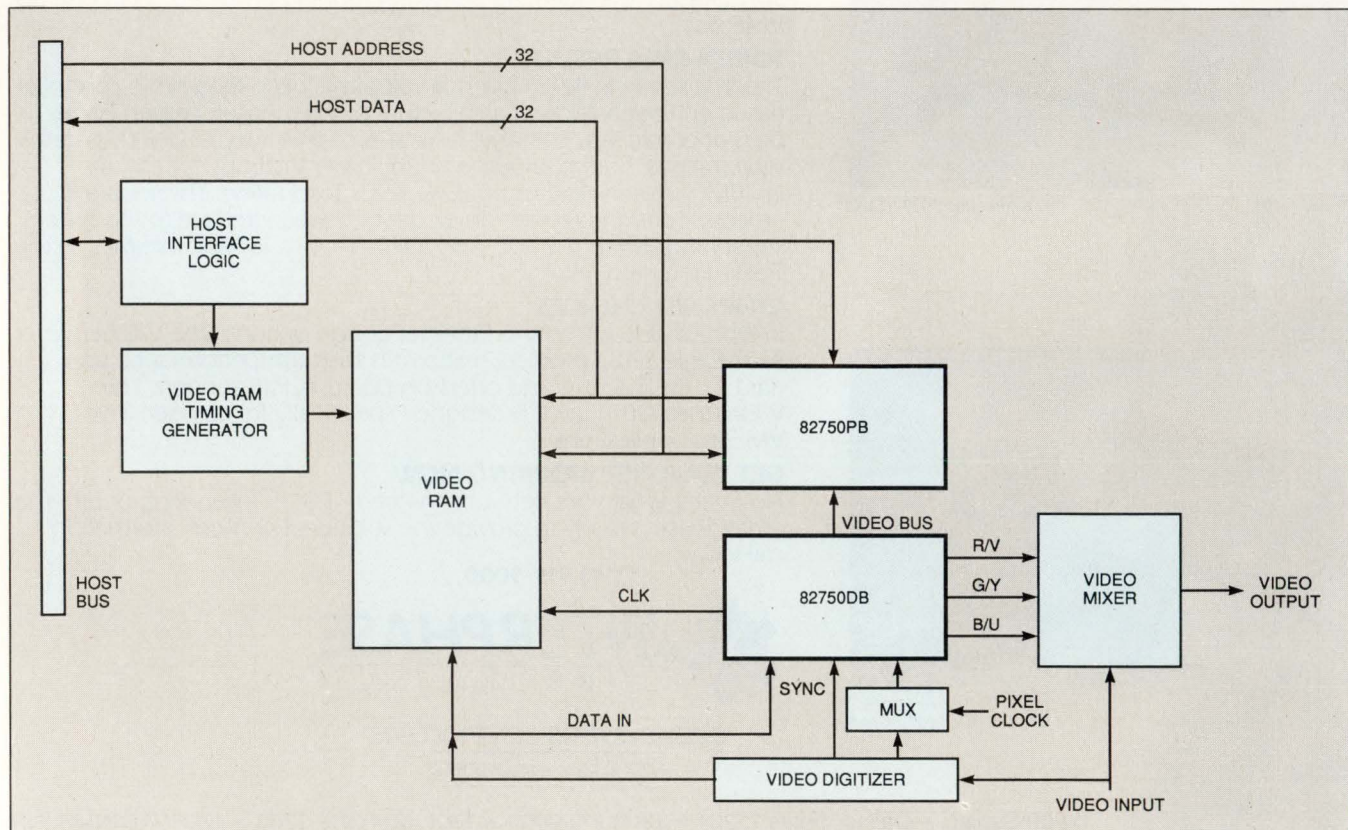
The chip has an onboard 512-word \times 48-bit instruction memory and a 512-word \times 16-bit data RAM, as well as 16 general-purpose registers. The ALU can reload its instruction memory from external memory for programs longer than 512 words. The chip offers 32-bit address and data buses to external memory and uses a FIFO input/output buffer.

To speed up processing, the pixel processor has several common image-handling functions in hardware. These functions include a built-in Huffman decoder, a single-cycle n -bit barrel shifter, and a pixel interpolator with $1/16$ -bit resolution. The processor also offers two loop count-

ers to save instructions during software loops; automatic addressing of external video memory by the I/O FIFO buffer; and a horizontal line counter to keep track of the display's use of memory.

The pixel processor's companion piece, the 82750DB display processor, handles the timing and control of image data. The chip has fully programmable horizontal and vertical display parameters, permitting it to handle many display formats, including NTSC, PAL, SECAM, and VGA. You can also synchronize the chip to an external video source.

You can use the data display to display data from the pixel processor or to mix that data with an ex-



You can create the core of a multiple-format video subsystem with just two chips. The i750 chip set handles image decompression, mixing, and special effects with a programmable display format.

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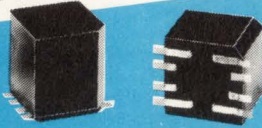
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CIRCLE NO. 28

UPDATE

ternal video source. To drive the display, the chip has three 8-bit D/A converters, each of which has an associated 256 x 8-bit color look-up table. The chip supports both the RGB (red-green-blue) and YUV (chrominance-luminance) color maps.

The display processor provides several hardwired functions to ease the handling of multiple display formats. The features include a 2-line horizontal interpolator for mixing video and graphics, a hardwired YUV-to-RGB converter, and automatic line doubling for displaying video on noninterlaced monitors.

The pixel processor operates at 25 MHz and the display processor at 28 MHz. These clock rates are fast enough to provide real-time image processing and display, including handling JPEG (Joint Photographic Experts Group) image decompression at 30 images/sec. The chips will not handle MPEG (Motion Picture Experts Group) motion video, but they will handle other real-time video decompression algorithms.

The chips come in 132-pin plastic quad flatpacks. Samples are available now, though production quantities won't be available until the first quarter of 1991. The display processor costs \$46, and the pixel processor sells for \$39 (10,000). Enabling software is available, including compression algorithms, host-system software, and a micro-code developer's kit.

—Richard A Quinnell

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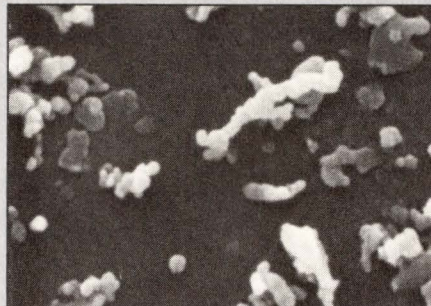
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EDN December 6, 1990

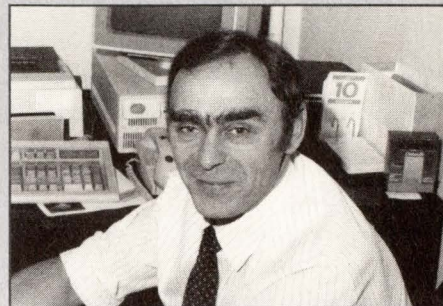
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Victor Ettel, Director of Battery Powder Research, Sheridan Park, Mississauga, Ontario, Canada. His job is to find new uses for carbonyl technology.



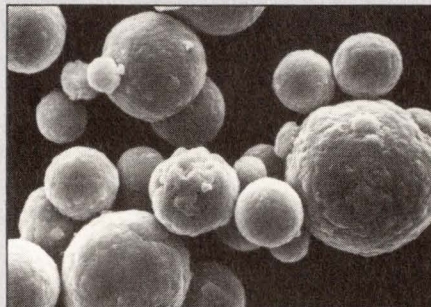
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Arcnet controller IC and μ C make up a complete 2-chip LAN node

The COM20020 Arcnet IC combines controller and transceiver functions in a single chip and targets low-cost embedded applications such as process control, factory automation, medical equipment, and automobile LANs. In effect, the IC and a microcontroller compose a complete Arcnet node. Available in both 24-pin DIPs and 28-pin plastic leaded chip carriers, the IC includes a $2k \times 8$ -bit dual-port static-RAM buffer, provides a glue-free interface to most microcontrollers, and includes a variety of hardware diagnostics capabilities.

On-chip buffers allow the Arcnet IC to support zero-wait-state accesses for both itself and the attendant microcontroller (including ar-

bitration). Incorporating the buffers on chip also eliminates cumbersome memory interface and related control circuitry—a feature that helps reduce the number of devices required to implement an Arcnet node by a factor of five. With the addition of a microcontroller, the IC provides a complete 2-chip Arcnet node solution.

The IC implements the Arcnet token-passing protocol. Featuring a 2.5M-bit/sec data rate, the device supports as many as 256 nodes in a wide variety of network topologies, including rings, stars, buses, and trees. The device also includes a self reconfiguration protocol with software programmable node IDs that enables the protocol to auto-

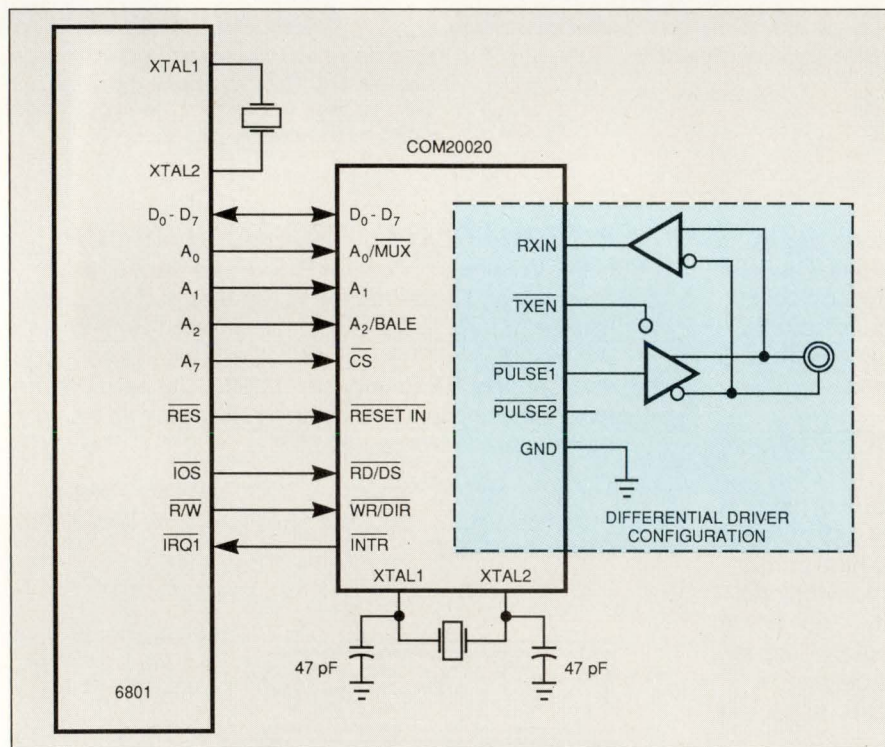
matically reconfigure the network when nodes are added or deleted, or when certain timeout conditions aren't met.

The IC includes a command-chaining feature that speeds packet processing and enables it to support consecutive transmissions without host intervention. A dual 2-level FIFO buffer handles command transmission and reception, and status bits in a pipeline manner. Therefore, the chip can receive new packets before the interrupt for the previous packet has been acknowledged and serviced. When the IC is used with a microcontroller whose interrupt latency is less than 100 μ sec, it can process packets indefinitely without host intervention.

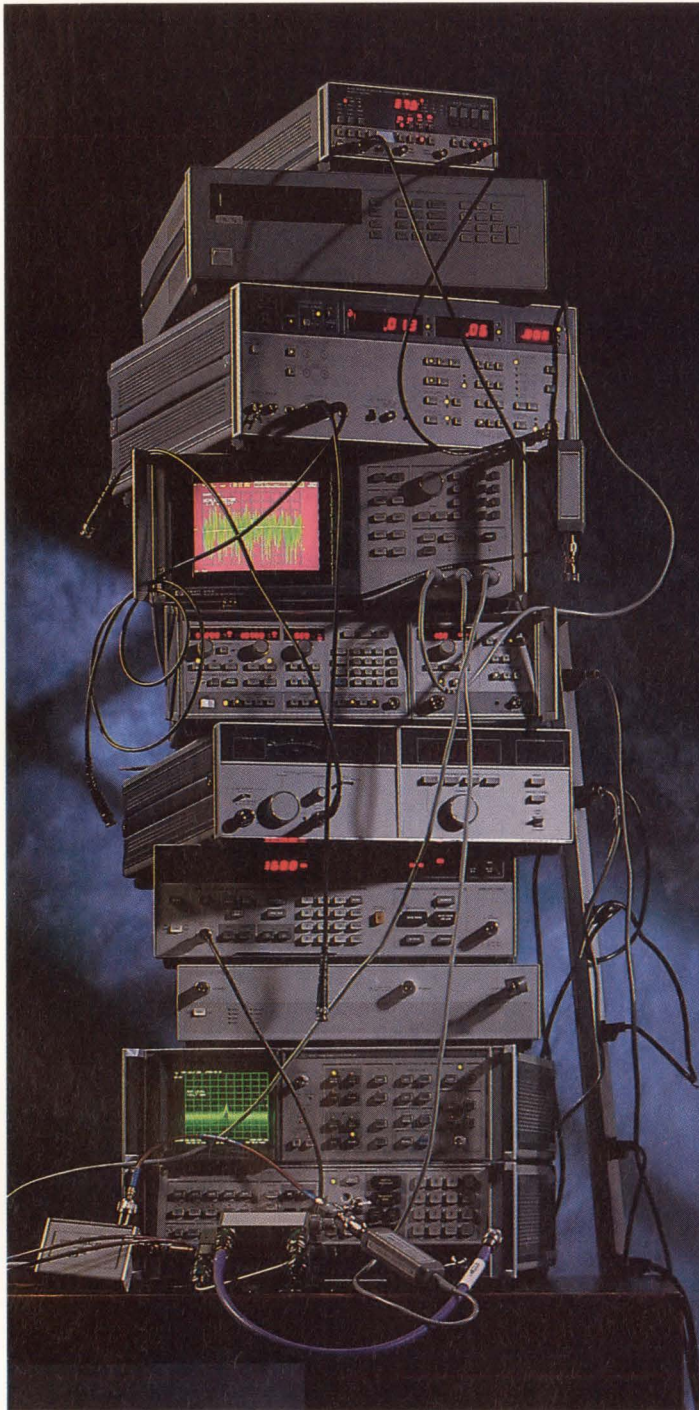
You can interface the controller IC to a variety of popular microcontrollers, including Zilog's Z-80, Motorola's 68XX family, Intel's 80XX family, and NEC's V Series, with no glue logic. The device automatically detects microcontroller features such as a nonmultiplexed or a multiplexed bus and configures itself accordingly.

The IC also provides a flexible media interface. The chip supports a traditional transformer hybrid interface for applications that require long transmission distances. The IC includes an RS-485 differential interface for low power and for low-cost applications. Finally, you can use an open-collector mode for short-distance applications that require a direct-line interface.

On-chip hardware diagnostics improve network adaptability and facilitate fault prevention and isolation. Before joining a network, the device first checks to see if there is any activity. Next, the device



Support for an RS-485 differential interface, a transformer hybrid interface, or a simple open-collector bus makes the COM20020 suitable for a wide range of applications. The IC also directly supports connections to microcontrollers with multiplexed buses or nonmultiplexed ICs such as the 6801.



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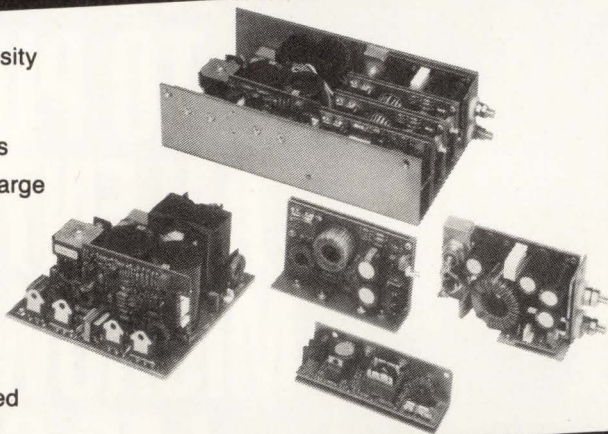
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CIRCLE NO. 30

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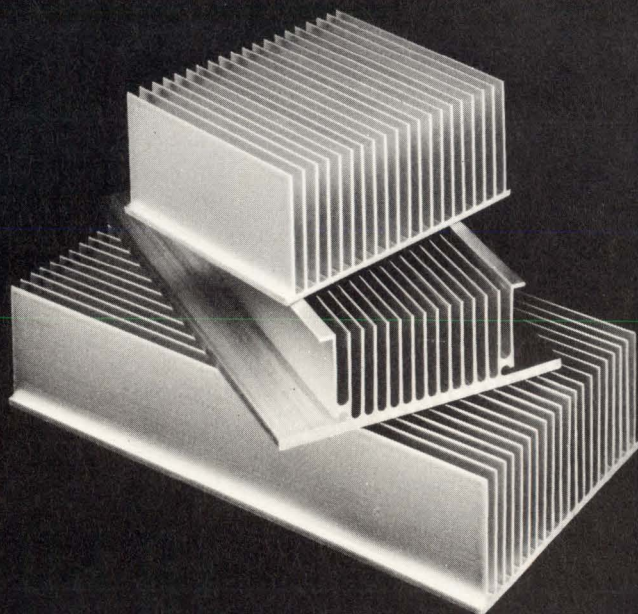
checks to see if a token is circulating. Finally, it determines if its tentative node ID is the same as that of any other node on the network. If it is, then the device changes its ID prior to entering the network. The IC can also determine whether its node is responsible for the last network reconfiguration.

The CMOS IC operates from a single 5V supply and has an operating temperature range of -40 to +85°C. The COM20020 costs \$16.23 (1000) and is available immediately.—*Maury Wright*

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Extended modeling capabilities increase simulator accuracy

A simulation is only as good as your models. And your models can only be as good as the underlying simulator will allow. You can build models for the Hilo 4 simulator using a number of new capabilities.

Models have often been built using either inertial or transport delays. Inertial delays limit the propagation of a pulse through a gate to some minimum pulse width. Transport delays propagate all pulses with a gate-dependent delay. Hilo 4 uses a 3-band paradigm that lets you build your models to reject too-short pulses, pass long-enough pulses, and propagate ambiguous pulses as unknowns.

The simulator also allows you to build models using precise functions for delay characteristics. These functions can contain, but are not limited to, such variables as temperature, voltage, process, and cell loading. You can also build your models to incorporate pin-to-pin dependencies. The models can also emulate point-to-point variations through the use of resistor-capacitor (RC), inductor-capacitor (LC), and resistor-inductor-capacitor (RLC) functions.

There are more than 12,000 device models for the software. Among these models are standard components, hardware modeling

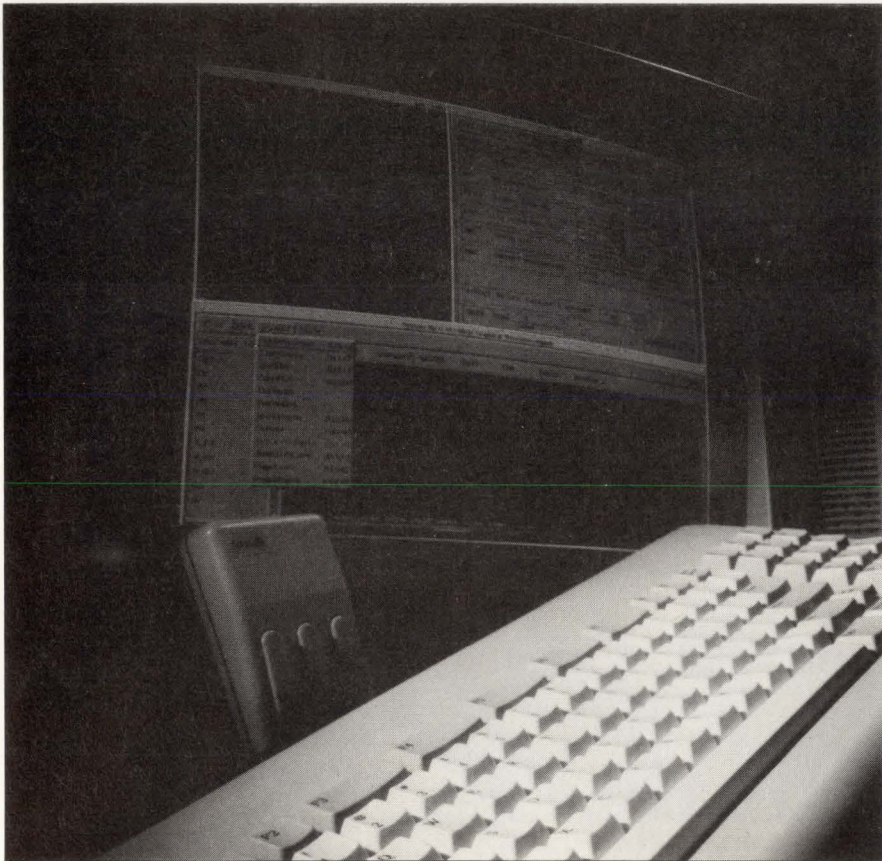
shells for the Logic Modeling (Milpitas, CA) LM-1000, third-party models, C models, Altera and Xilinx PLD models, and foundry supported ASIC libraries. The company also offers a modeling service.

The simulator runs behavioral and structural models built using the company's own proprietary Genrad Hardware-Description Language (GHDL) models. The simulator uses the CAD Language Systems (Rockville, MD) VHSIC Hardware-Description Language (VHDL) front-end to compile VHDL models to an intermediate format. Internal software translates the intermediate models into GHDL. The simulator accepts VHDL models that conform to a superset of the VHDL models you can synthesize, using the Synopsys (Mountain View, CA) synthesis software.

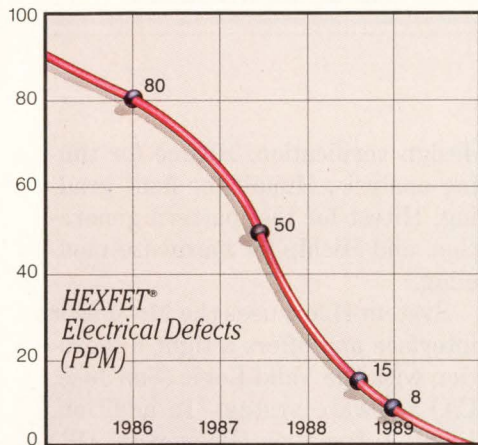
You can debug GHDL and VHDL models using a source-level debug capability. This debugger lets you use breakpoints, single-stepping, variable examinations, and variable modification. By changing variables during a simulation, you can experiment with your design.

To describe stimuli and response, the Design Waveform Language (DWL) also incorporates behavioral features such as procedures, processes, and functions. If you know the behavioral circuit is correct, you can write behavioral stimuli and use a learn capability within the DWL to capture the response. You can then use these learned patterns to verify synthesized structural implementations.

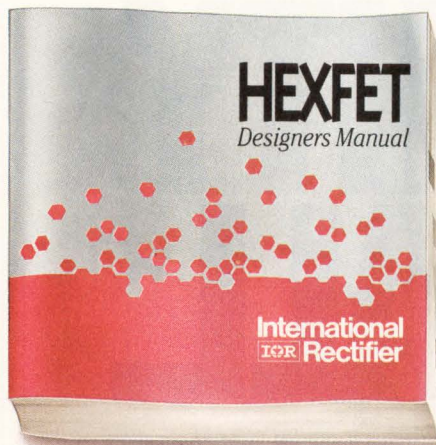
System Hilo 4 contains a range suite of design tools. The suite comprises the Hisim logic simulator for



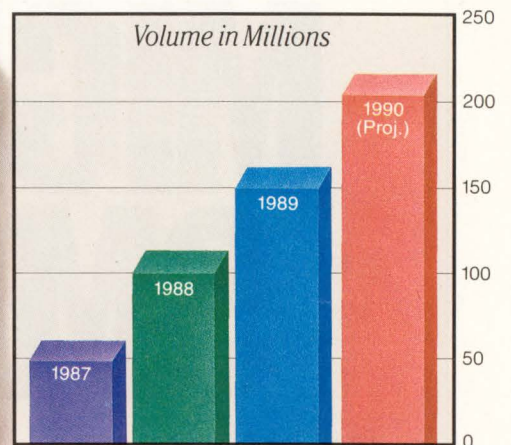
Three-band delay models and function equations give System Hilo 4 the ability to simulate small feature-width ICs accurately.



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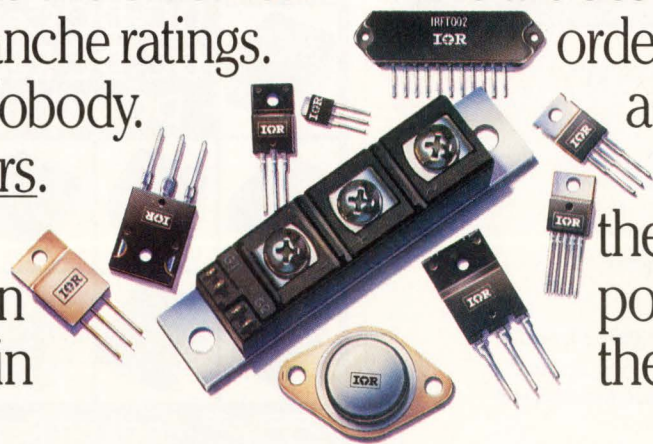
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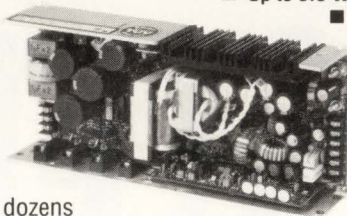
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design verification; Hitime for timing analysis; Hifault for fault grading; Hitest for test pattern generation; and Hichip for hardware modeling.

System Hilo 4 uses the Motif user interface and offers a tight integration with the Valid Logic (San Jose, CA) software system. In addition, Logic Automation (Beaverton, OR) models work with the simulator.

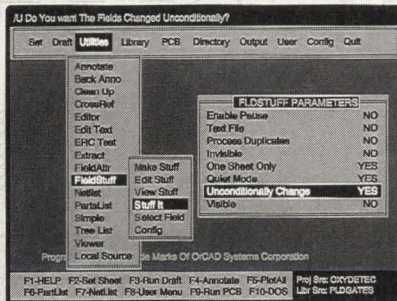
The software runs on workstations from DEC, HP/Apollo, IBM, Intergraph, NEC, and Sun. The software costs about \$18,000 and will be available in the first quarter of 1991.—**Michael C Markowitz**

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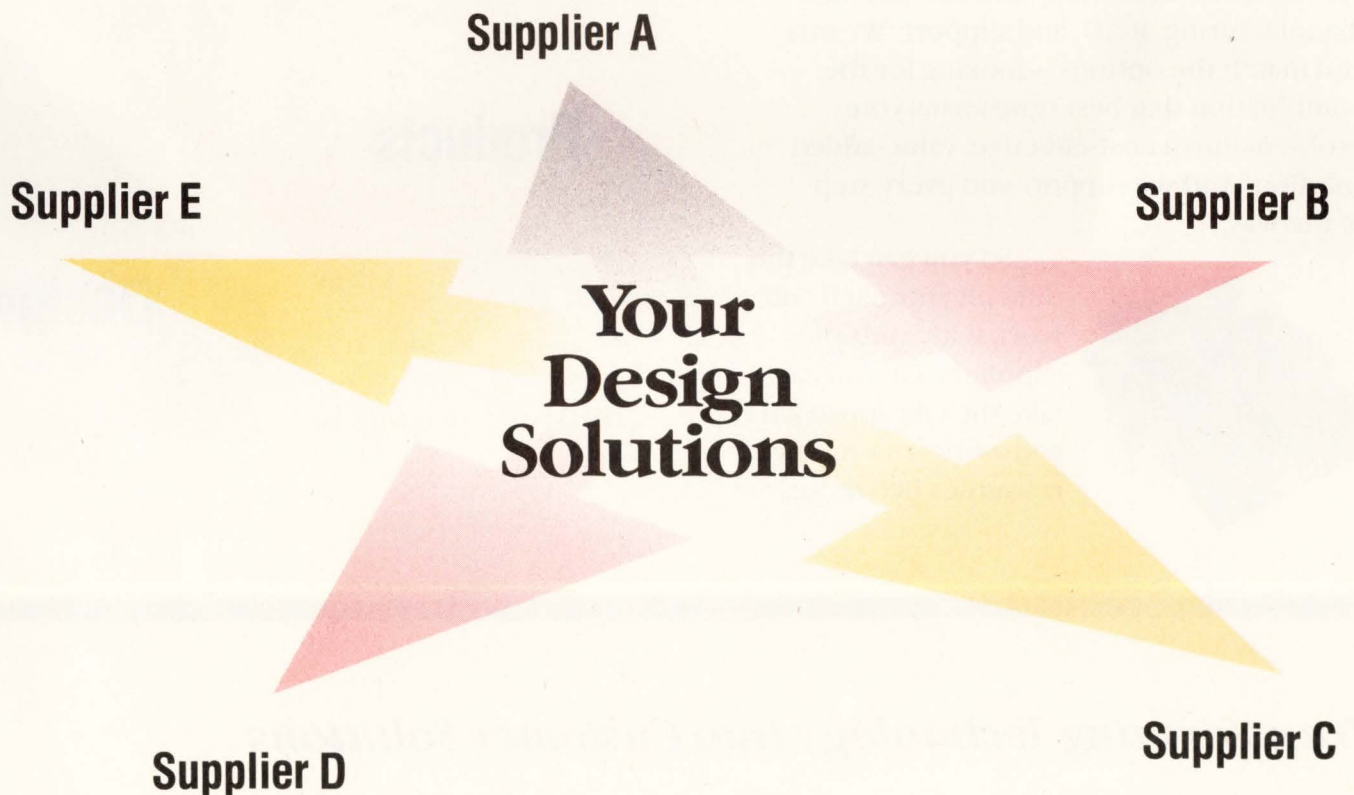
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The difficult approach.

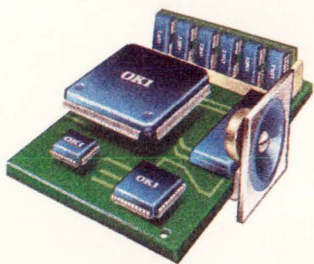
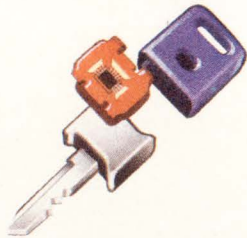


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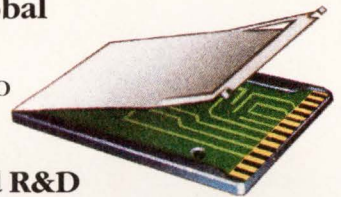
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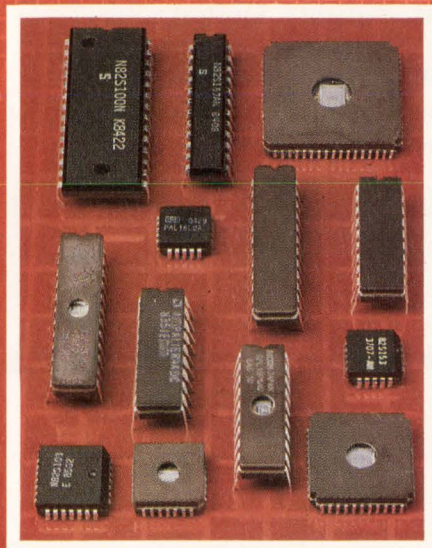
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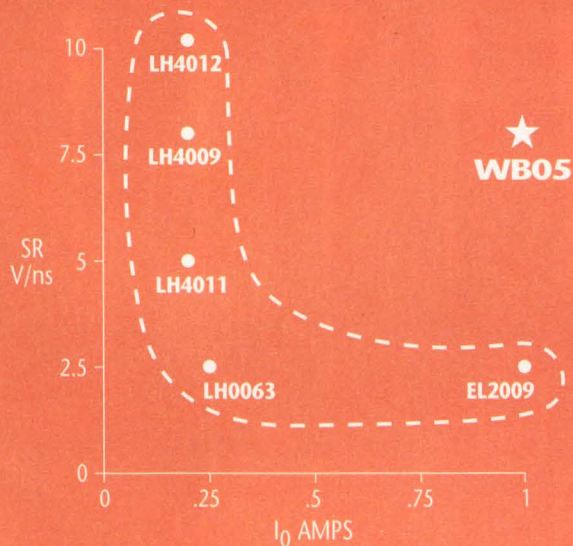
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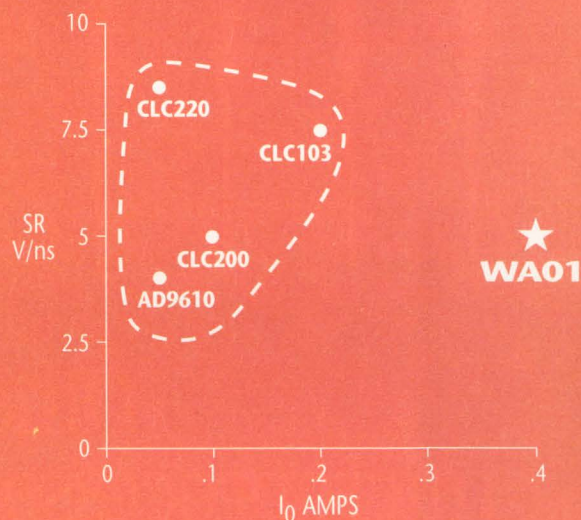
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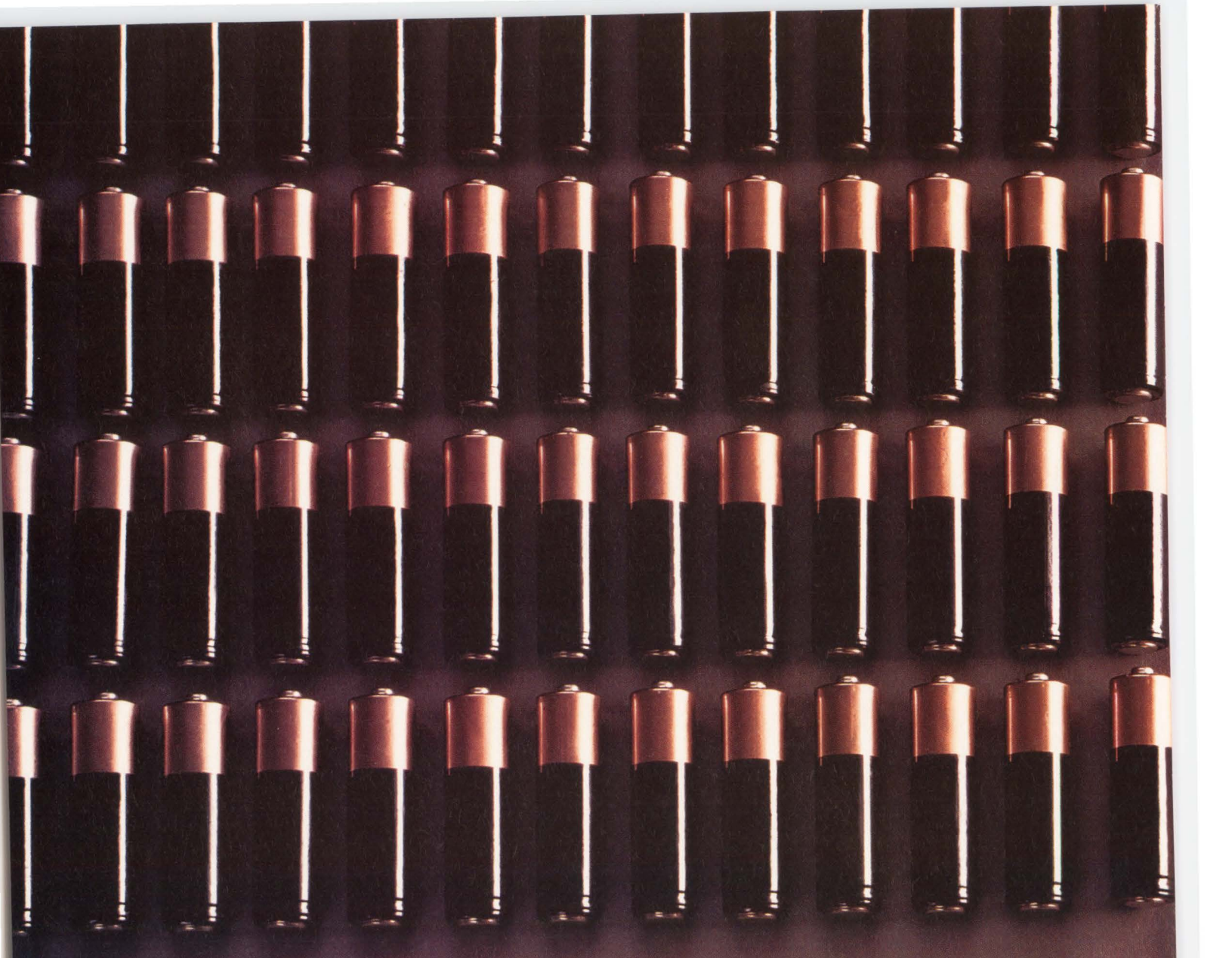
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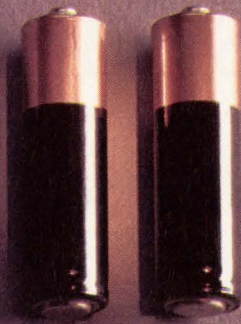
In fact, the 80C186EB provides the lowest power consumption of any 16-bit integrated microprocessor.

Intel achieved this feat in three ways. First, the 80C186EB is designed to run on as little as 3 volts. Next, its power management capabilities allow the processor and peripherals to be placed in various degrees

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INTEGRATED CIRCUITS

ICs move into a variety of new applications

Charles H Small, *Senior Editor*

Do you ever wonder where all those little, black plastic-and-silicon ICs end up after they roll off the assembly line? The answer is, in some pretty innovative and unusual places.

Everybody knows ICs are everywhere, but some of their applications might surprise you. For example, new driver ICs are at the heart of the remarkable recent advances in LCDs. These displays allow manufacturers to squeeze a full-function personal computer into a briefcase.

Masterminding Grid System's (Fremont, CA) 1810 notebook-sized computer's 10-in. LCD is Cirrus Logic's CL-GD6/620 LCD-driver IC. The LCD driver, in conjunction with a 10-MHz NEC V₂₀ μ P, gives the \$2895 diminutive computer a complete IBM EGA display.

Recently introduced ICs are lurking inside some futuristic-looking products for engineers, too. For example, the Ramtek (Santa Clara, CA) Millennium image processor uses a Texas Instruments 34020 DSP μ P to perform imaging functions, such as FFTs and convolutions, as well as graphics. The DSP μ P combines specialized signal-processing instructions, and internal hardware, with general-purpose data-processing μ P facilities. Thus, the μ P can perform DSP and conventional processing. For example, the processor also mates with MIT's

X-Window System—a graphical user interface for networked Unix computers.

We all knew that eventually semiconductor companies would pack a supercomputer into a chip, giving engineers awesome power right on their desks. Now Texas Instruments claims to have done just that for engineering workstations. Three-D graphics workstations, like the Silicon Graphics' (Mountain View, CA) Iris II, use a 320C20 to perform graphics operations as fast as a supercomputer does.

ICs have also benefited consumer products. They're included in products people use everyday. For example, they run automobile fuel-injection systems, antilock brakes, and automatic transmissions. In addition to these glamorous tasks, ICs are performing more mundane, but nonetheless important, jobs in modern automobiles.

BMW (Munich, Germany) and Analog Devices have jointly developed the AD22001 filament-sensing IC. This 5-channel device monitors as many as five lamp filaments to ensure that the lamps work. The IC checks lamps that are either on or off. Thus, drivers can be sure



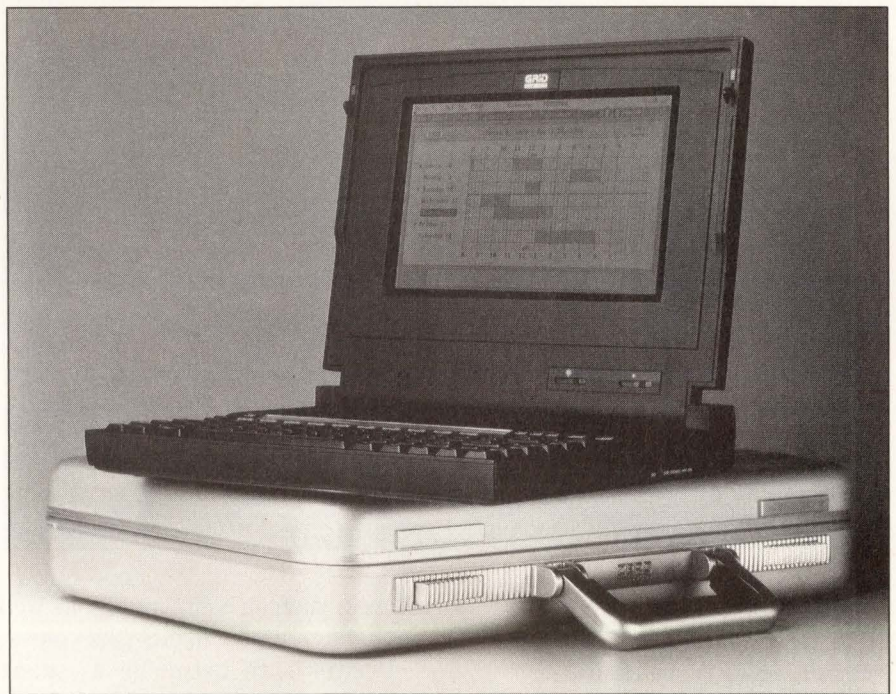
To make sense of the complicated color files, they need lots of smarts. This color printer has an internal RISC μ P processing files.

that an unilluminated trouble light is out because there is no trouble, not because the lamp is burned out.

Meanwhile, anyone who has used a cellular car phone while driving knows that interference frequently obscures the voice reception. A Texas Instruments fixed-point DSP μ P in the Ericsson GE (Bohemia, NY) Hotline carphone works in real time to clean up transmissions. The μ P handles all of the functions that the Electronic Industries Association stipulates for bandpass filtering, syllabic companding, pre-emphasis, de-emphasis, limiting, and post-limiting filtering. The chip also generates and decodes DTMF signals. Further, the chip provides echo suppression and a total loop attenuation of at least -40 dB in its ADC/DAC path, allowing you to make phone calls hands free.

The talk of the town

The videophone is finally here—but not quite in the form science-fiction writers envisioned. Overcoming the phone lines' limited



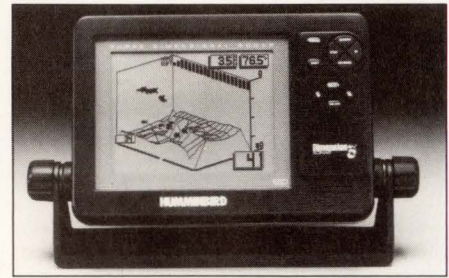
bandwidth to transmit a wide-bandwidth video signal is no mean feat. A Texas Instruments 320C25 DSP μ P compresses video images in real time so that the Videotelecom Co (Riverside, CA) Conference

Squeezing a full-function PC into a notebook-sized case, the Grid Systems' 1810 uses a 10-in. LCD.

The pressure to squeeze a full-function PC into a briefcase has prompted remarkable advancements in LCDs and LCD-driver ICs.

System 300 can give conferees a visual link over conventional phone lines. The system can send both live TV "snapshots" and graphical material bidirectionally between conferees. However, live, 30-frame/sec video over conventional phone lines is still a dream.

Further, the scourge of the 80s has become the darling of the 90s. Answering machines are like opinions: everybody has one. Having wormed their way into our affection, answering machines are acquiring new responsibilities. Now they can handle digital communications, such as fax transmissions or FSK data, as well as voice. For example, the Phonemate (Torrance, CA) Adam is an all-digital answering machine that uses its Texas Instrument's TMS320C17 DSP μ P to perform audio signal-processing



A chip, originally designed as an FM demodulator, detects fishes' electric fields and allows this fish finder to display their location, along with a profile of the bottom, on its screen.

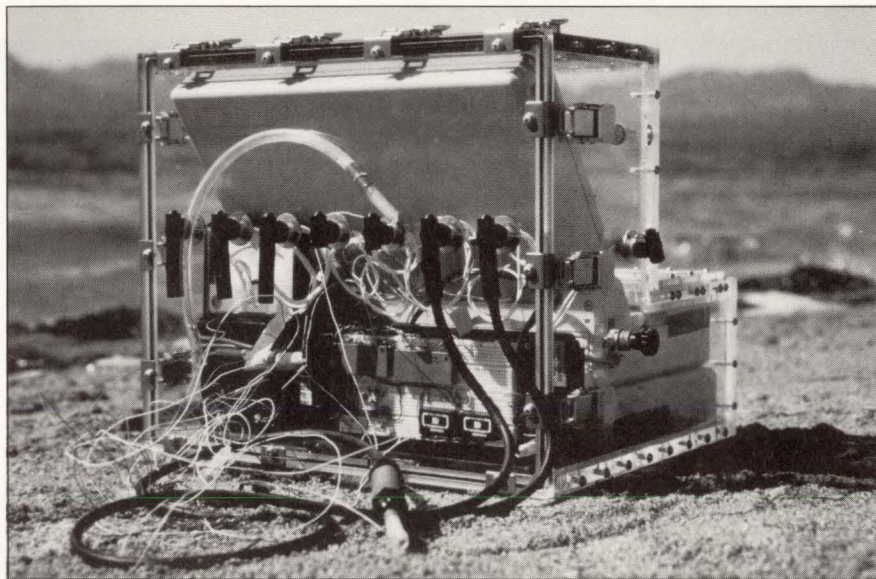
desktop color printers uses an Intel 80960 reduced instruction-set computer (RISC) μ P to execute Phoenix Technology's (Norwood, MA) Phoenixpage conversion program internally.

The printers have 300-dpi resolution, and various models produce the usual A- or B-size images (\$6999 and \$9999, respectively). There are also "super-A" and "super-B" sized drawings that are as large as standard magazine pages. Because the printers can convert Postscript files internally, you can connect them to virtually any computer.

The security industry is also becoming more intelligent. Polaroid (Cambridge, MA) is doing its bit to help mankind in its never-ending search for identity. Using an electronic medium instead of film, Polaroid's ID-2000 digital security and identification system electronically processes individual portraits, personnel information, and signatures to produce tamper-resistant ID cards instantly. The device uses a Texas Instruments TMS320C25 DSP μ P for image and data compression.

What you see is what you get

ICs are in the eyes of NASA's proposed space station. General Dynamics Convair Div (San Diego, CA) will soon flight-test an advanced image processor for the space station. The image processor



Sensitive isolation amplifiers and a D/A converter, mounted in a waterproof box, allow scientists to snoop on the electric fields that stingrays generate when mating.

chores, such as companding, as well as manage a pair of RS-232C ports.

Printers are becoming as smart as answering machines. Transforming complex images, such as Postscript files, into something that a color printer can actually print requires considerable processing. Consequently, Seiko's (Torrance, CA) latest Colorpoint PS Series of

is a 22- μ P system. It uses Immos Transputers and a distributed Ada runtime software system to achieve 200M-flops, 200-MIPS performance.

If you want to monitor fish activity, you have to be able to find them. Find them, that is, if you were careless enough to lose your fish in the first place. The Techsonics's (Eufaula, AL) Hummingbird Dimension 3 Sonar Fish Finder locates fish and places them in three categories; small, medium, and large. It also displays a map of the bottom of the body of water. Unlike other fish finders, it can do this either obliquely or straight on. The fish finder uses a Signetics NE604A low-power, FM-IF demodulator that detects the RF signals which indicate the presence of fish. (See **box** "Animal magnetism and other electronic wonders" for more fun fish facts.)

On a more serious note, steady advances in rugged, low-power analog ICs are improving established industrial devices as well as scien-

For more information . . .

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

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tific instruments. A common position-sensing device for industrial electronics is the linear variable differential transformer (LVDT). The Lucas Schaevitz (Pennsauken, NJ) Accu/Sens series of LVDTs measures ranges from as wide as ± 10 in. to as narrow as ± 0.050 in. to an accuracy of 0.125% of full scale. As well as being rugged, the units are temperature and shock resistant.

Unlike older units, this series

produces a simple $\pm 10V$ output signal that is proportional to measured displacement. Older units developed complex ac-waveform outputs. The key component for the new units' performance is an Analog Devices AD598 LVDT signal conditioner. **EDN**

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Animal magnetism and other electronic wonders

Some alarmists are concerned that modern electronics allows snooping into our most intimate secrets. If stingrays could talk, they'd agree. Researchers have discovered that stingrays, sharks, and related animals possess a "sixth sense." These animals can perceive electric fields with organs called Ampula of Lorenzini. Discovering if elasmobranchae use animal magnetism to detect potential mates meant that researchers had to simulate precisely the tiny nV/m field these animals generate underwater.

It turns out that female stingrays, lying buried in the sea bottom during mating season and otherwise invisible, produce a characteristic electric field associated with their breathing. One theory postulates that male rays in the area sense this field and, their ardor sparked, come like a flash to the buried female.

Testing this theory involved first making a system that could record and then play back the stingrays' signals. The stingrays generate a very weak, 500

nV/m dc electric field modulated at less than 1 Hz. (For comparison, the mean field intensity of the earth at sea level varies between 100 and 300 nV/m.)

Researcher Timothy Tricas of the Washington University School of Medicine coupled a Compaq (Houston, TX) laptop computer with an Analog Devices AD7845 12-bit DAC and AD210 isolation amplifiers. He enclosed the resultant system in a waterproof plastic housing. He tested various frequencies and found that the male rays did indeed respond. When they came within a few meters of the buried electrodes, they dug in vain looking for the elusive female. Female rays were also attracted by the signals, burying themselves nearby.

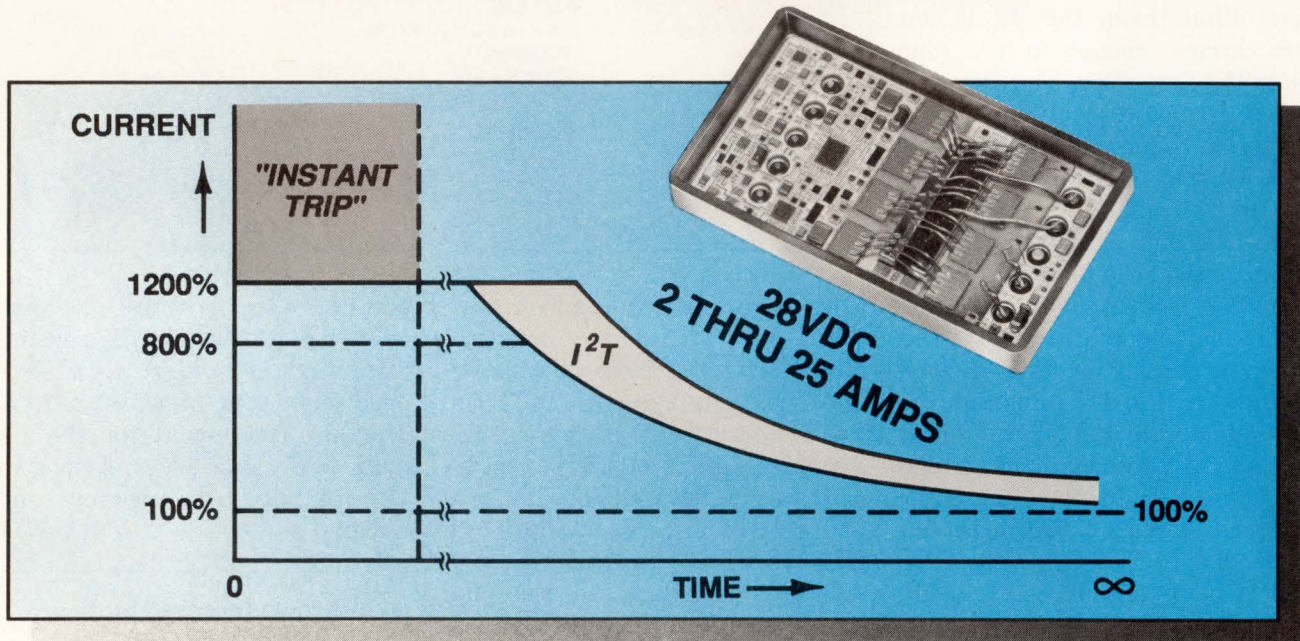
The findings of this "sixth-sense" experiment may have more timely uses for humankind. For example, electric fields in the earth change before an earthquake and some animals and fish are able to detect this.

NEWS

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Utilizing power MOSFET switches, these power controllers offer low "ON" resistance, low voltage drop, high "OFF" impedance, and low power dissipation. Built with power MOSFETs and custom monolithics many options such as I^2T trip curve tailoring, output rise and

- True I^2T
- CPU Control and Status
- Built-In-Test (BIT)

fall times, and a variety of custom current ranges are possible. They offer small size, low power, and high reliability, since there are no mechanical parts.

Built-In-Test (BIT) has been provided to monitor, in real time, the status of the internal circuitry as well as circuitry external to the SSPC. This BIT monitors reverse current flow, MOSFET failure or degradation, unit overtemperature, and control circuit

failure. The status outputs also provide BIT and an indication of light and heavy overloads as well as minimum load current. The status lines are TTL/CMOS compatible in order to support microprocessor or logic integration of a consolidated electrical load management center (ELMC) of control.

The SSP-21110 series will operate over the full military temperature range from -55°C to $+125^{\circ}\text{C}$. Military screening and optional packaging are available upon request. The SSP-21116, 270 Vdc, series, will be available before the end of the year.

Please contact Steve Friedman at (516) 567-5600 extension 381 for further information concerning the SSPC products. □

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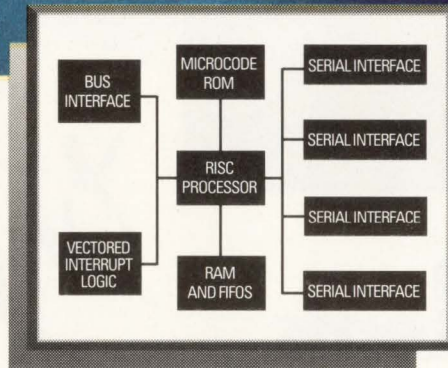
For high line count, cost-effective applications, there's the CL-CD180. It offers performance gains similar to the CL-CD1400, plus the advantage of 8 channels in a single 84-pin package.

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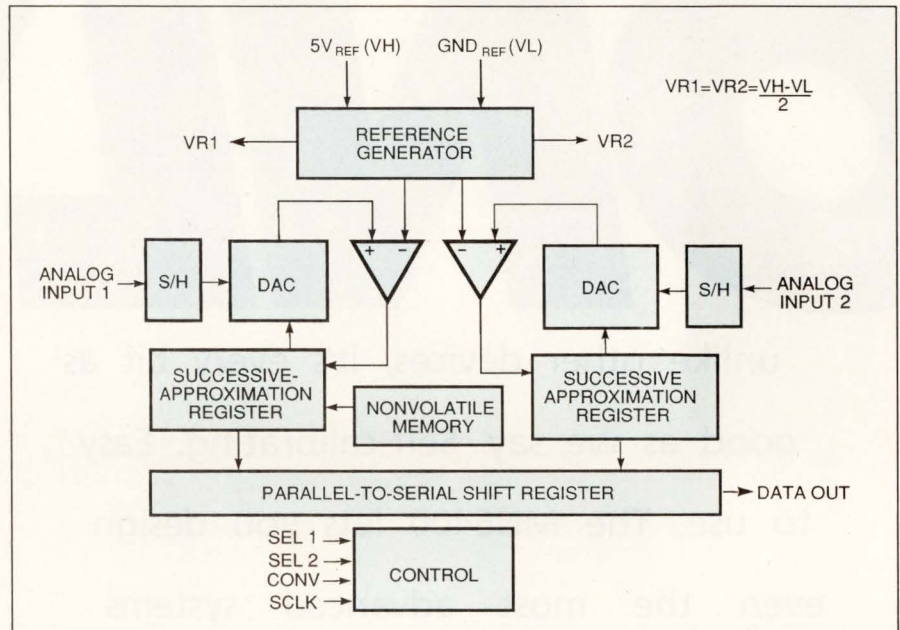
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Integrated Circuits

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Operating from a 5V supply, the AT76C120 18-bit A/D converter can convert 96k samples/sec on each of its two channels. The ADC includes dual sample-and-hold circuits that sample both channels simultaneously. Using a successive-approximation method, the chip converts and then outputs the data serially in a 2's-complement format on a single-output port. Nonvolatile on-chip memory lets the manufacturer trim any linearity errors by adding correction factors to the digital values.

The converter requires a stable 5V reference and two clocks for operation. The conversion clock controls the S/H function and initiates the output of data after conversion. The system clock controls the conversion and synchronizes the output of the individual data bits at the output port. Select pins let you specify which channel is output first at the serial output port, and

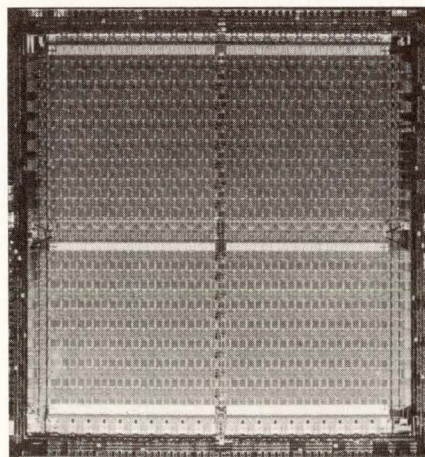


whether the converter outputs 16 or 18 bits. The ADC is available in 13- and 15-bit linearity grades for \$23.50 and \$25 (1000).

Atmel Corp, 2125 O'Nel Dr, San Jose, CA 95131. Phone (408) 441-0311. Circle No. 691

FPGA family boosts circuit density to handle 8000-gate designs

A member of the Act 2 family of field-programmable gate arrays (FPGAs), the A1200 runs at 60 MHz and has as much circuit capacity as an 8000-gate gate array. The device contains an array of logic modules, separated by channels of 32 parallel conductors. Overlaying the array are sets of 29 additional conductors running at right angles to the channels. At each intersection lies an antifuse. When you apply a programming voltage across the conductors, the antifuse changes state to become a permanent connection. Three antifuses are sufficient to connect any two logic elements. The impedance of a programmed anti-



fuse can be as low as 200 Ω , allowing a fast rise time.

In addition to combinatorial mod-

ules, which let you implement an 8-input logic function, the Act 2 family offers sequential modules, which allow 7-input logic with a flip-flop. The A1280, which is 4 \times the size of its predecessors, offers 1232 logic modules and 140 user I/O pins in a 176-pin pin-grid array. The circuits have a standby current of <300 μ A, and an I/O drive capability of 8 mA. The A1280 costs \$440 in sample quantities. A programming station with software costs \$11,950.

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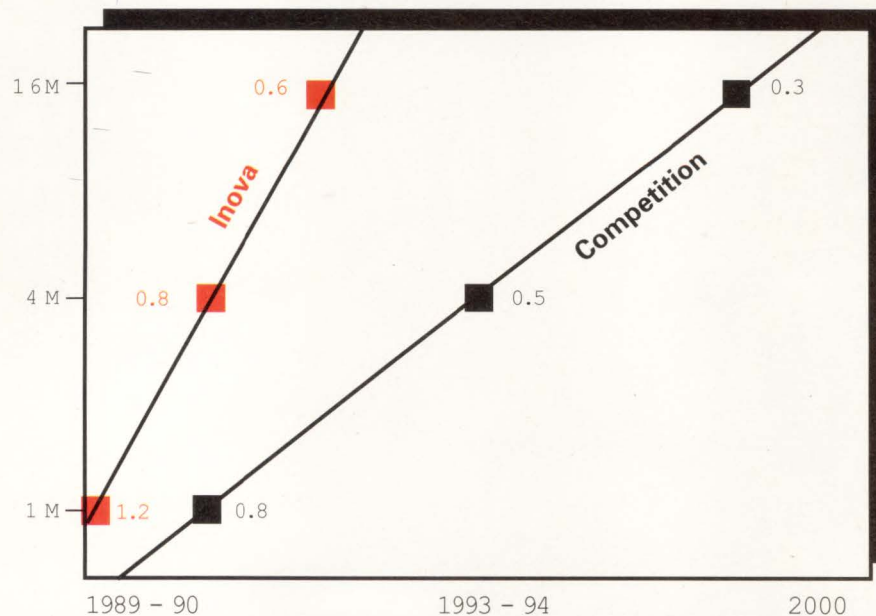
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MT5C2565	64K x 4 OE	20ns	PDIP, CDIP, SOJ, LCC	NOW	MT5C1601	16K x 1	12ns	PDIP, CDIP, SOJ	NOW
MT5C2568	32K x 8	20ns	PDIP, CDIP, SOJ, LCC, ZIP, Flatpack	NOW	MT5C1604	4K x 4	12ns	PDIP, CDIP, SOJ	NOW
					MT5C1605	4K x 4 OE	12ns	PDIP, CDIP, SOJ	NOW
					MT5C1606/7	4K x 4 S. I/O	12ns	PDIP, CDIP, SOJ	NOW
					MT5C1608	2K x 8	12ns	PDIP, CDIP, SOJ	NOW

* Slower speeds also available.

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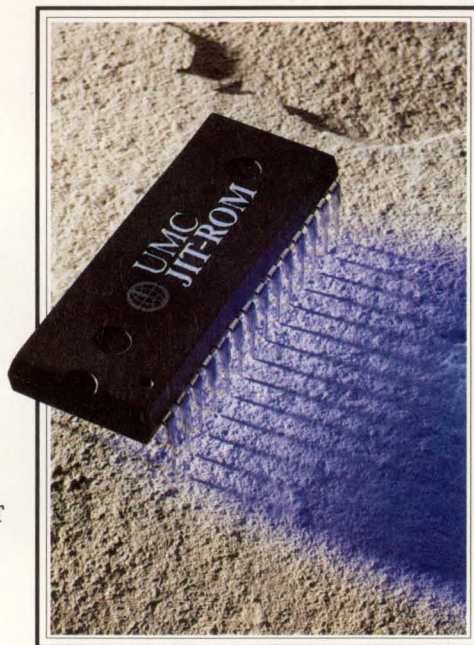
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Capacity	Part Number	Organization	Speed(ns)
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256K	UM23C256	32K x 8	150
512K	UM23C512	64K x 8	150
1Mb	UM23C1024/5	128K x 8	120/150/200
2Mb	UM23C2001	256K x 8	120/150/200
4Mb	UM23C4000/1	256K x 16/512K x 8	200/250
8Mb	UM23C8001	1M x 8	200/250
16Mb	UM23C16000	2M x 8	200/250

JIT-ROMs include DIPs and SOs. 16 Mb available 2nd quarter 1991.



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Integrated Circuits

Low-Skew Clock Buffer

The GA1110 multiphase clock buffer provides six clock signals that are phase locked to an external clock. The typical output skew is ± 100 psec with a maximum of ± 250 psec. A 500-MHz oscillator in the phase-locked loop uses one of the six output clocks for feedback. The IC forces the feedback signal to the same phase as the input clock, with no more than a 500-psec delay from input to output.

Two control pins let you select one of four patterns of output clocks. Using a zero-phase clock for feedback, you can obtain combinations of inverted signals and phase shifts of ± 2 and -4 nsec on the other output lines. By using one of the modified clocks for the feedback signal, you can extend the phase shifts to ± 6 nsec. Altogether, there are 14 possible combinations. The IC comes in speed grades of 25, 33, or 40 MHz. In a 16-pin DIP, \$35 in sample quantities.

Gazelle Microcircuits Inc, 2300 Owen St, Santa Clara, CA 95054. Phone (408) 982-0900.

Circle No. 351

Controller

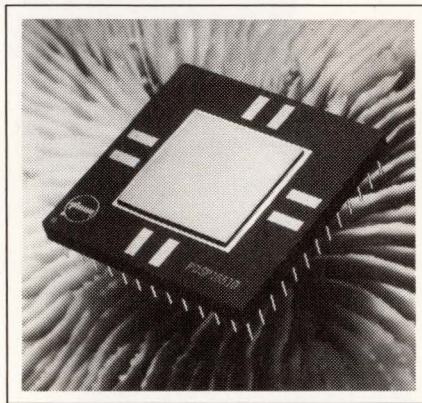
The Z80181 Smart Access Controller (SAC) combines the features of three ICs with additional I/O ports. The device contains a 10-MHz Z180 μ P, a Z84C30 quad counter/timer, and one channel of a Z85C30 serial communications controller. Also included are two 8-bit parallel ports, two software-controlled chip-select signals, and a clock oscillator. Built into the Z180 μ P are two UARTs, a clocked serial I/O port, two 16-bit timers, two DMA channels, and a programmable dynamic-RAM refresh circuit. An on-chip memory-management unit extends the Z180's address space to 1M byte, and a programmable wait-state generator accommodates slow memory.

The Z84C30 counter/timer section offers four 8-bit timers with 8-

bit prescalers to extend the timer's count resolution. The timers share I/O pins with one of the parallel ports. The parallel ports are bidirectional, and each I/O pin's direction is individually programmable. The Z85C30 communications controller handles both synchronous and asynchronous protocols. In a 100-pin quad flatpack, \$22 (1000).

Zilog Inc, 210 Hacienda Ave, Campbell, CA 95008. Phone (408) 370-8000.

Circle No. 352



Self-Contained FFT Processor

A completely self-contained FFT processor, the PDSP16510 performs forward or inverse FFTs on both real or complex data sets. The device features 16-bit data and coefficients, with block floating-point arithmetic for increased dynamic range. An internal 32k-bit RAM can hold as many as 1024 complex data points. In the continuous mode, the processor uses three internal control units, which overlap new data, present data, and previous results.

The user can choose to overlap data blocks by zero, 50, or 75%. Inputs and outputs are asynchronous to the 40-MHz system clock used for internal operations. The processor can complete a complex transform with 1024 points in 96 μ sec. You can apply either a Hamming or a Blackman-Harris window operator to the incoming data. These operator values are calculated internally and do not require an ex-

ternal ROM. Samples in 84-pin pin-grid-array package, \$1195.

Plessey Semiconductors Corp, 1500 Green Hills Rd, Scotts Valley, CA 95066. Phone (408) 438-2900. FAX (408) 438-5576. TLX 4940840.

Circle No. 353

Single-Chip Controllers

The 10/20-MHz PC87120 SuperAT and the 16/20-MHz PC87130 SuperAT/SX controllers integrate all of the peripheral support needed in 80286- or 80386SX-based IBM PC/ATs, respectively. As a result, it is possible to design a complete mother board with just the PC87120 or PC87130, the CPU, memory devices, and from five to ten TTL devices. Each single-chip device has 8- and 16-bit BIOS ROM selectability, 512k- to 8M-byte dynamic-RAM support, shadow RAM support for system BIOS, video ROM and video RAM, software-configurable conventional or page-mode-interleaved memory, and software-configurable wait states and command delays.

On-chip peripherals include two 8237 DMA controllers, two 8259 interrupt controllers, and one 8254 timer/counter. The PC87120 SuperAT and PC87130 SuperAT/SX cost \$40 and \$47 (100), respectively.

National Semiconductor, Box 58090, M/S 16-300, Santa Clara, CA 95052. Phone (408) 721-5000.

Circle No. 354

Closed-Loop Buffer

The EL2012 high-speed buffer amplifier features a wide bandwidth, accurate gain, and high output current. With a 50 Ω load, the buffer has a bandwidth of 80 MHz, gain is 0.999, and output-current capability is 250 mA. The device, which needs only 17 mA of quiescent current, operates from ± 15 V supplies and provides an output swing of ± 12 V. The device uses a process

Text continued on pg 106



The Phone.

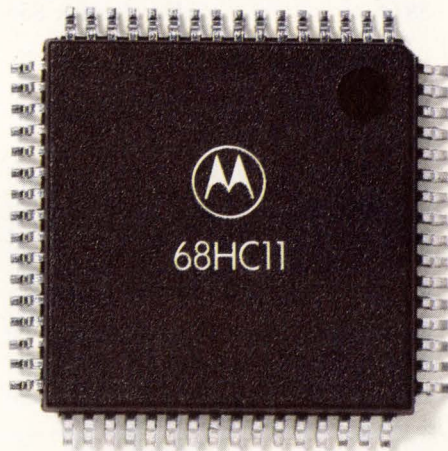


Motorola's Micro T•A•C™ cellular telephone was the winner of both the Fortune Magazine and Nikkei Electronics Product of the Year Awards, which isn't surprising. It's so small and lightweight, it can be carried in a shirt pocket. And it carries the most technically advanced cellular phone features on the market today.

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The Operator.



The 68HC11 is the powerful microcontroller Motorola called on to operate the Micro T•A•C. It's highly integrated, yet compact—ideally suited to the advanced capabilities of this phone.

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that insulates the metal heat-sink tab on the 5-lead TO-220 package from all supply voltages. \$8.07 (100).

Elantec, 1996 Tarob Ct, Milpitas, CA 95035. Phone (408) 945-1323, ext 303. Circle No. 355

Transceiver Chip

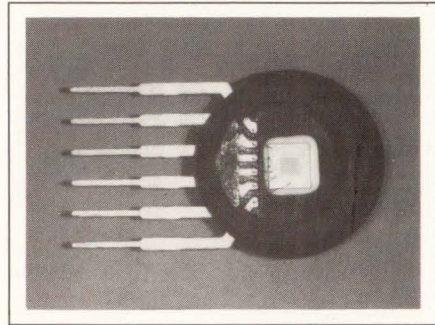
Interfacing with DS-3 lines, the SSI 78P236 transceiver operates at a multiplex rate of 44.736M bps. The chip can also operate at the Synchronous Optical Network (SONET) STS-1 data rate of 51.84M bps, and the CEPT E-3 data rate of 34.368M bps. The receiver section of the transceiver accepts B3ZS-encoded alternate-mark-inversion (AMI) inputs and implements a low-level input signal indication. The transmitter section converts clock and data input signals into AMI pulses of the appropriate shape for transmission.

A line-buildout circuit lets you attenuate the outgoing pulses for various line lengths. The transceiver also eliminates the need for crystals or tuned components. The 78P236 is fully compliant with AT&T Compatibility Bulletin 119 and Bellcore Technical Reference 000009. \$25 (10,000).

Silicon Systems, 14351 Myford Rd, Tustin, CA 92680. Phone (714) 731-7110, ext 3575. FAX (714) 669-8814. Circle No. 356

Monolithic Rail-To-Rail Silicon Pressure Sensor

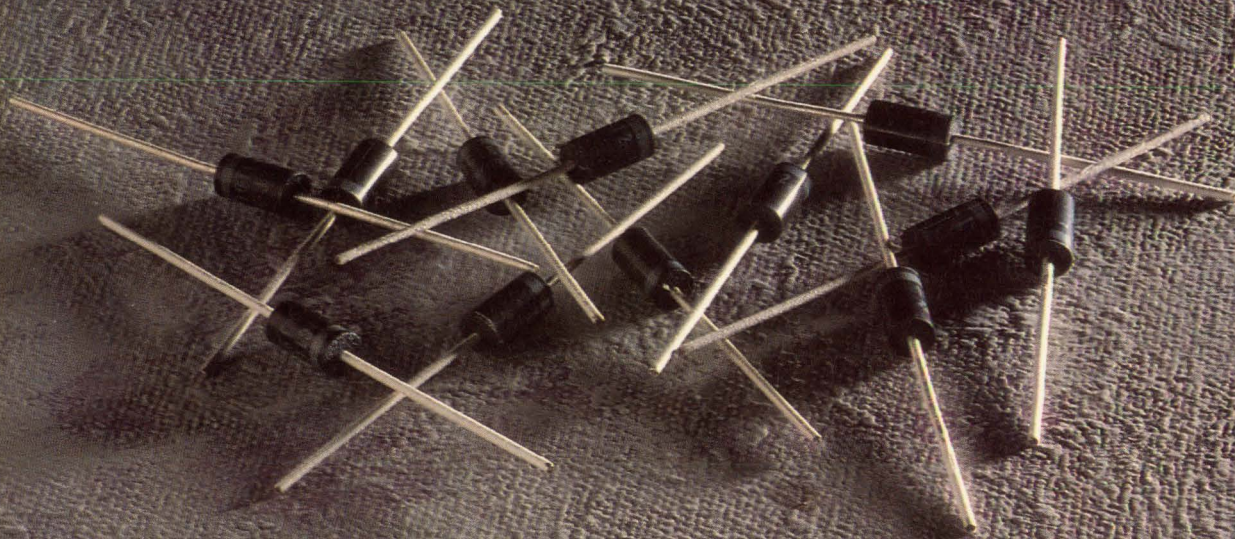
The MPX5100D 0-to-15 psi, signal-conditioned pressure sensor integrates the sensing element, offset calibration, temperature-compensation circuitry, and signal amplification on a monolithic silicon chip. The sensor's output scale is calibrated from 0.5 to 4.5V, which makes the



device suitable for μ P-based systems having analog-to-digital inputs. The device, which uses a patented silicon shear-stress strain gauge, is temperature compensated over the range of 0 to 85°C. The sensor is available in the basic-element package, single- and dual-ported versions, and with customized outputs. From \$45 (100).

Motorola Inc, MD Z201, 5005 E McDowell Rd, Phoenix, AZ 85008. Phone (800) 752-3621; in AZ, (602) 244-4556. Circle No. 357

Once it took this to protect
12 lines from surges.



Integrated Circuits

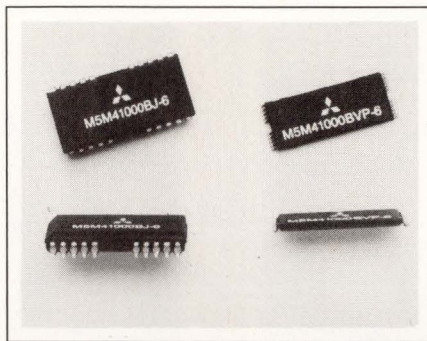
Single-Chip Fax Modem

The R144EFX is a member of the company's line of single-device Monofax facsimile modems. The synchronous, half-duplex (2-wire) modem operates at a speed of 14.4k-bps over the public telephone network. According to the company, an R144EFX-based fax machine operates 50% faster than a Group 3 9600-bps V.29 machine during the actual page transmission.

Additional benefits include the use of trellis-coded modulation to achieve 14.4, 12, 9.6, and 7.2k-bps operating modes and boost modem performance under poor line conditions. The modem's architecture also incorporates the function of a serial I/O device to assist in the implementation of error detection and correction. Samples are available now, with OEM quantities expected for the first quarter of 1991. The device is housed in a 64-pin quad

in-line package or a 68-pin plastic leaded chip carrier. \$68 (10,000).

Rockwell International Corp,
Digital Communications Div, Box C,
Newport Beach, CA 92658.
Phone (800) 854-8099; in CA, (800) 422-4230. Circle No. 358



1M-Bit Dynamic RAMs

Featuring an access time of 60 nsec, these 1M-bit dynamic RAMs are available in two organizations. The M5M41000B is a 1M \times 1-bit device;

the M5M44256B is a 256k \times 4-bit device. Both devices have a maximum standby current of 500 μ A. Low-power versions are available with a maximum standby current of 200 μ A.

The DRAMs are available in 20- and 24-pin, 300-mil wide, thin small-outline packages, which offer the industry's smallest profile surface-mount packages. You have a choice of both standard and reverse pin-out versions, which allow placement on both sides of a pc board, sharing a single metal trace for added density. Other package options include 18- and 20-pin DIPs, a 20-pin ZIP, and a 26-pin SOJ package. \$7.75 (100).

Mitsubishi Electronics America Inc, Semiconductor Div, 1050 E Arques Ave, Sunnyvale, CA 94086.
Phone (408) 730-5900. FAX (408) 730-4972. Circle No. 359

Text continued on pg 112

Now it takes this.

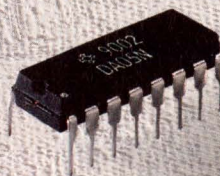
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For more information on these products, call or write us at General Semiconductor Industries, Inc., 2001 West Tenth Place, Tempe, AZ 85281, (602) 968-3101.



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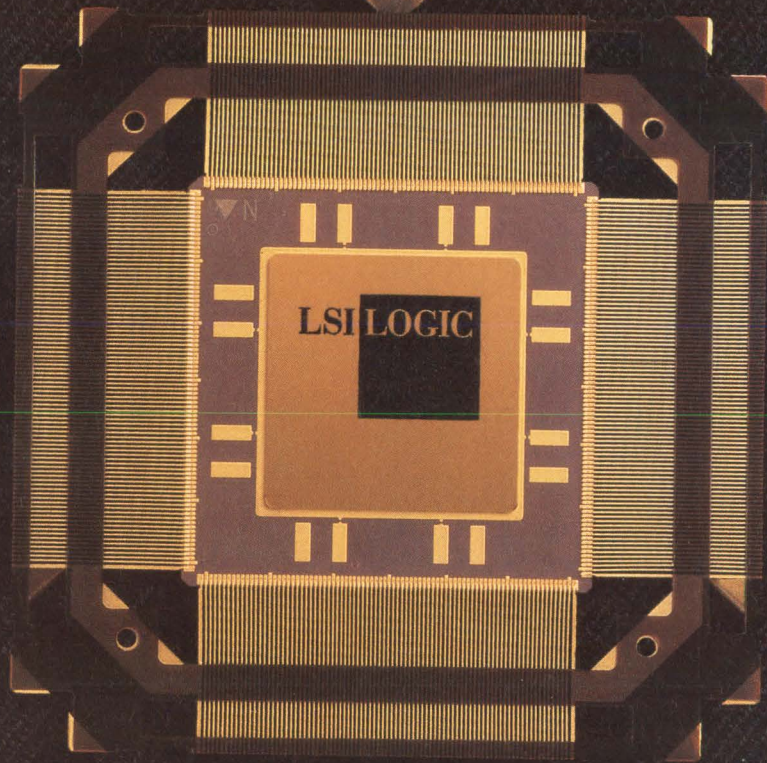
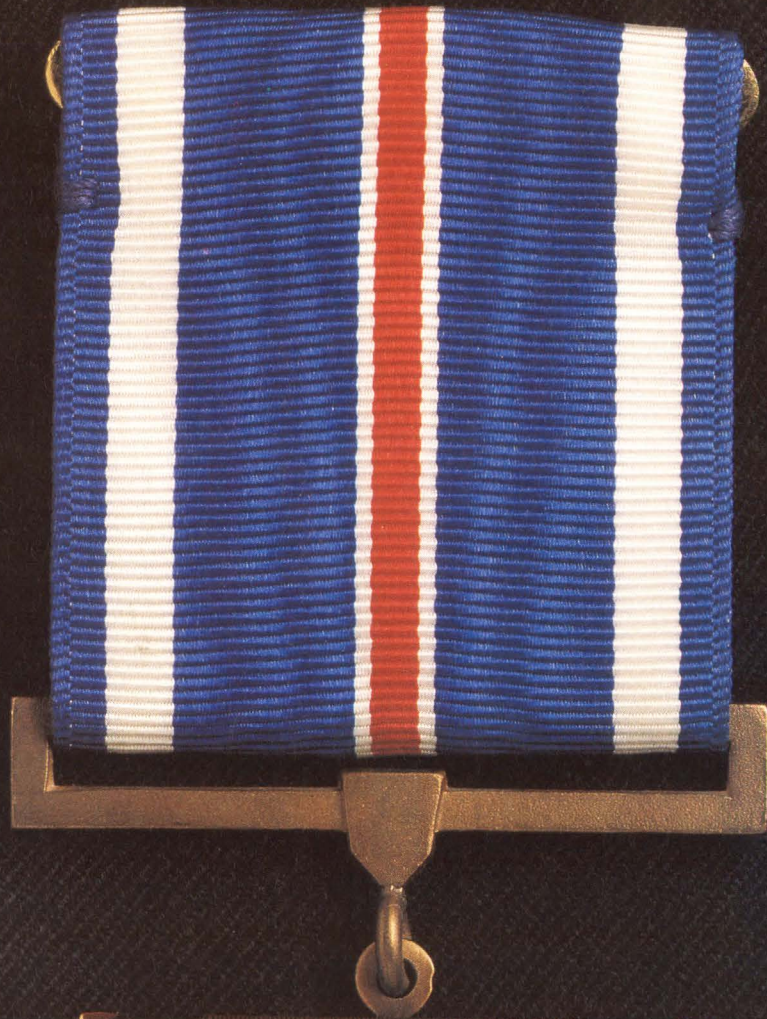
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ACROSS THE BOARD

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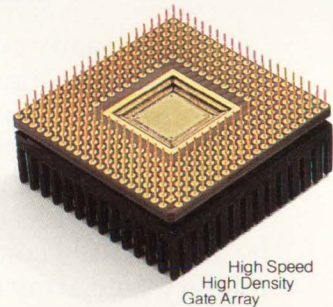
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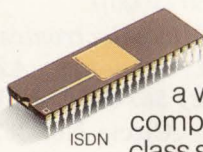


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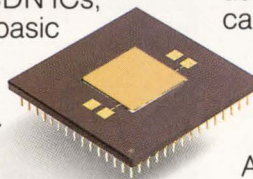


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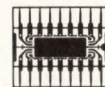
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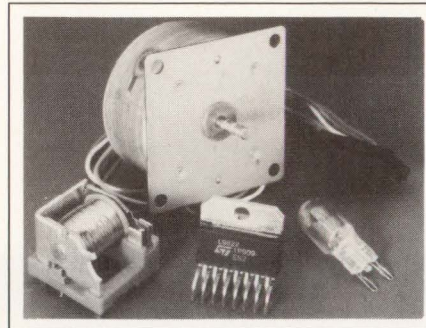
Integrated Circuits

4M-Bit EPROM

Organized as 512k×8 bits, the Am27C040 is a 4M-bit ultraviolet EPROM with an access time of 140 nsec. The device operates from a single 5V supply and features fast single-address-location programming. In the standby mode, current drain is 20 μA typ. The EPROMs

are available in windowed ceramic DIPs and LCC packages as well as one-time programmable DIPs and plastic leaded-chip-carrier packages. In a 32-pin windowed ceramic DIP, \$57.20 (100).

Advanced Micro Devices, Box 3453, Sunnyvale, CA 94088. Phone (408) 732-2400. Circle No. 360



Smart-Power Chip

Featuring eight low-side drivers in a single 15-lead multiwatt package, the L9822 smart-power chip can deliver 750 mA continuously from each driver. All eight drivers can operate simultaneously. The device is controlled through a 4-wire serial bus, which is used both to load a control byte and read a status byte. This diagnostic feature allows a microcontroller to detect fault conditions due to overloads or open-circuit outputs. When an overload is detected, the device turns off the faulty driver to prevent damage. The chip's outputs are also protected by internal 34V zeners that suppress overvoltages caused by inductive loads. \$3.50 (1000).

SGS-Thomson Microelectronics, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. FAX (602) 867-6290. Circle No. 361

D/A Converters

The single-channel DSP201 and dual-channel DSP202 D/A converters are designed for ease of use with modern DSP ICs. Complete with internal glue logic, both parts feature sampling rates to 500 kHz and provide a single-chip interface to standard DSP chips, such as those from Analog Devices, AT&T, Motorola, and Texas Instruments. By eliminating the need for external logic and design time, the devices provide an easy analog signal-processing output for DSP circuit designers. Running full-speed on a DSP IC serial port, both devices are faster than most of the bit clocks

8051 & 68HC11

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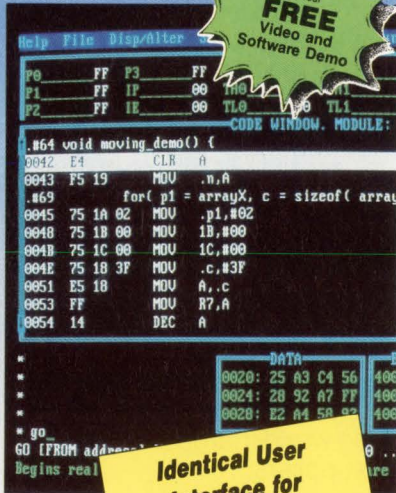
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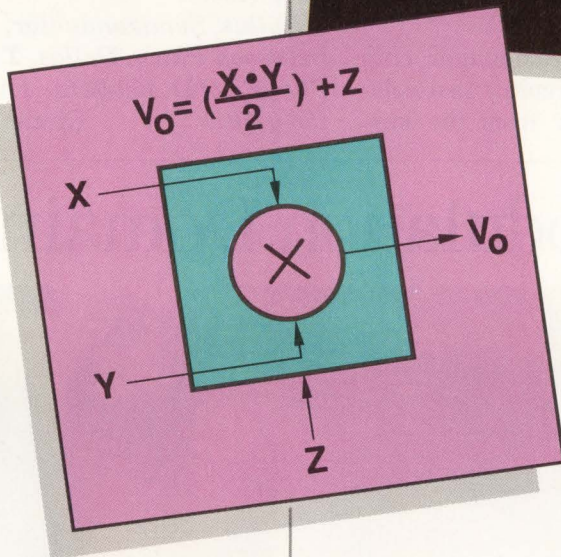
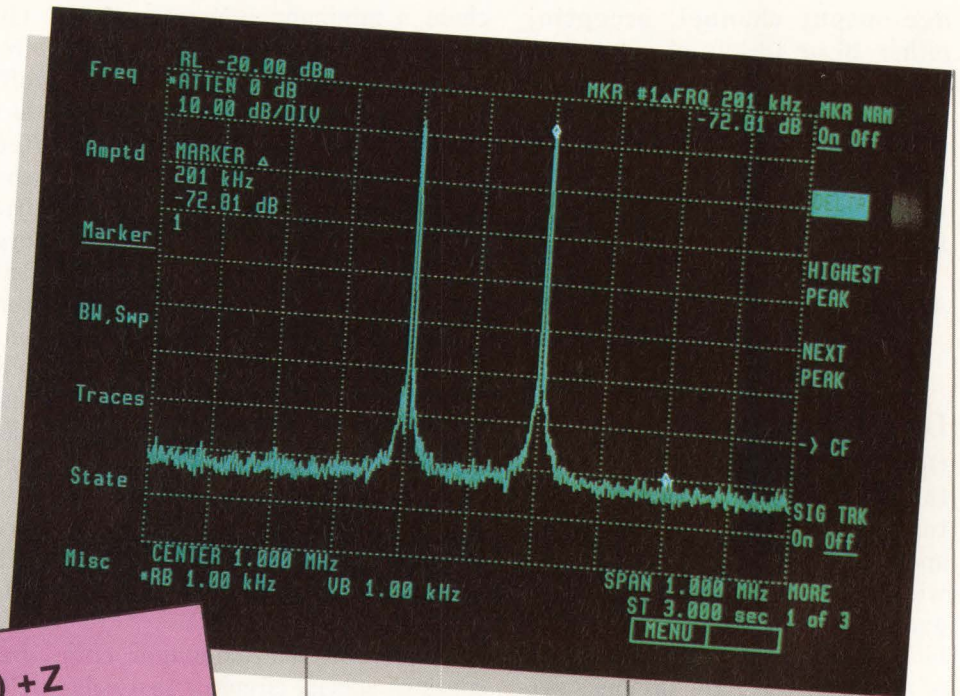


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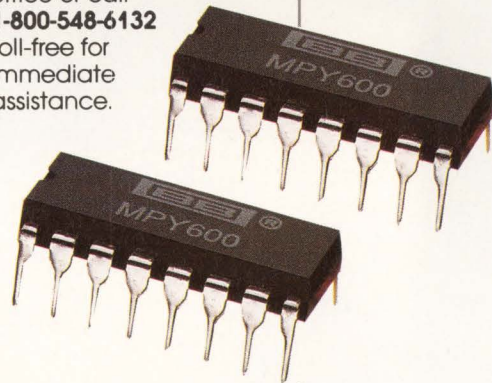


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that DSP ICs can currently handle.

The DSP201 offers a single voltage-output channel, accepting either 16 or 18 bits of input data; the DSP202 has two voltage-output channels with either two separate input ports or a mode to drive both output channels from a single 32-bit word. The DSP201 costs \$19.95; the DSP202 costs \$24.95 (1000).

Burr-Brown, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111.

Circle No. 362

Dual-Channel 18-Bit ADC

Operating from a single 5V supply, the AT76C120 A/D converter features 18-bit resolution, a conversion speed of 10 μ sec, and an input bandwidth of 50 kHz. The device has a guaranteed linearity accuracy of 15 bits and can resolve input signals of $<10 \mu$ V. The ADC provides system designers with 96,000 18-bit

conversion samples/sec on each of its two channels. Other features include a minimum S/N ratio of 86 dB and a 2's-complement format for the device's digital-output code. In a 24-pin plastic DIP, \$25 (1000).

Atmel, 2125 O'Nel Dr, San Jose, CA 95131. Phone (408) 441-0311.

Circle No. 363



"Kickstarter" Chip

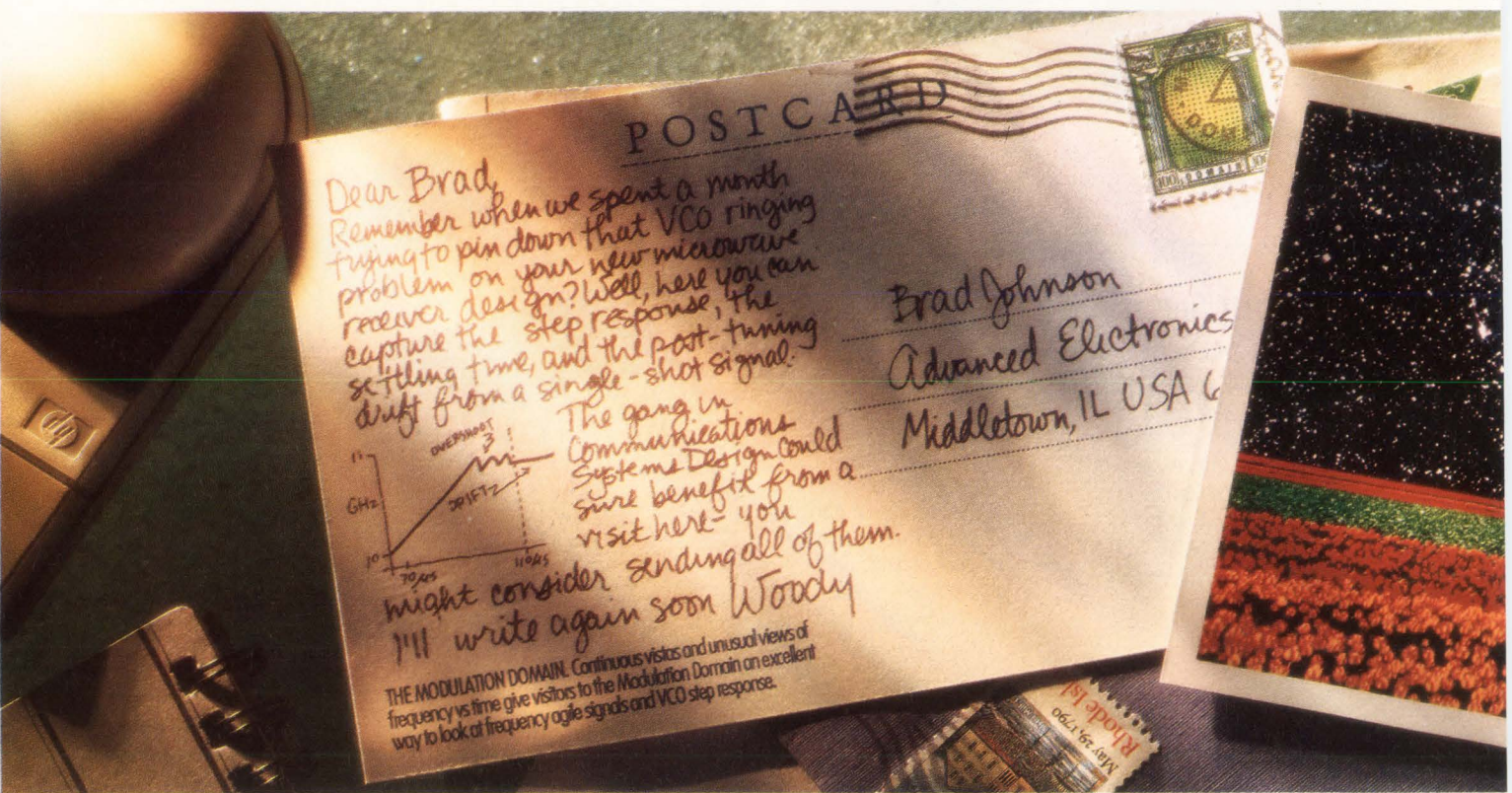
The DS1239 MicroManager chip contains special circuitry that cold-starts a computer from the key-

board. In addition to convenience, the chip enhances safety by keeping 110/220V ac power cabling distant from the person activating the on/off switch. When equipment power is off, a pushbutton closure is detected by the chip, which then sources a small amount of energy from a 3V lithium battery. This energy lights an optoisolator to kick on a triac, which powers up the system. The chip also monitors a second pushbutton to reset a processor when the operator wants to intervene. The DS1239 also has provisions to monitor power. If the 5V power supply dips out of tolerance, a warning signal interrupts the processor, allowing for storage of information in nonvolatile RAM. \$3.50 (1000).

Dallas Semiconductor, 4350 S Beltwood Pkwy, Dallas, TX 75244. Phone (214) 450-0448. FAX (214) 450-0470.

Circle No. 364

Venture into the Modulation Domain and



Integrated Circuits

4-Channel, 12-Bit ADC

The ADC7802 4-channel, 12-bit A/D converter is optimized for accurate multiplexing of dc signals. The ADC is self-calibrating and needs no offset or gain adjustments. Operating from a single 5V supply and dissipating only 10 mW, the device accepts unipolar inputs from 0 to 5V. Total conversion time is 17 μ sec, and conversion results are available in two bytes with "no missing codes" guaranteed. Channel separation is typically 92 dB and channel-to-channel mismatch is $\frac{1}{4}$ LSB max. The IC contains a monolithic capacitor-array with an on-chip S/H device, a 4-channel multiplexer, autocalibration circuitry, and an 8-bit μ P interface port. A special register permits full control over the converter through the μ P bus, eliminating the need for hard-wired control lines. The ADC7802 is available in a 28-pin DIP or a

28-lead plastic leaded chip carrier. \$19.95 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. FAX (602) 889-1510. TWX 910-889-1510.

Circle No. 365

20-Bit Audio DAC

Designed specifically for high-performance digital audio applications, the AD1862 20-bit DAC features a typical S/N ratio of 119 dB, THD + N of -96 dB, and a dynamic range of 102 dB. Gain linearity is ± 1 dB at a -90-dB amplitude. The monolithic converter uses proprietary digital-offset circuitry to enhance low-level signal linearity and eliminate the need for deglitching circuitry.

An external midscale trim pin lets you adjust the DAC for the lowest possible distortion for signals

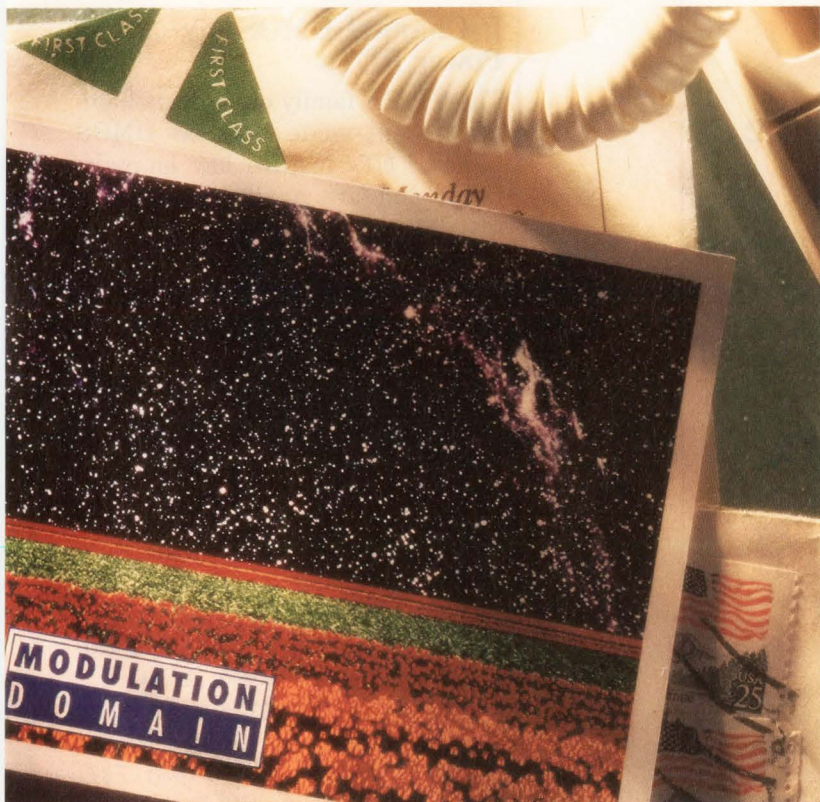
<60 dB in amplitude. The DAC can perform $16 \times$ oversampling and has a digital interface that accepts 2's-complement 20-bit serial words. The DAC operates from ± 12 V supplies and comes in two performance grades. The device is available in 16-pin plastic DIPs. From \$17.20 (100).

Analog Devices, 804 Woburn St, Wilmington, MA 01887. Phone (617) 937-1428. Circle No. 366

High-Speed PLD

According to the company, a maximum propagation delay of 7 nsec makes the GAL16V8B-7 the fastest E²CMOS PLD available and the only low-power device in this speed range. The 20-pin device, which can operate to 100 MHz, typically draws only 100 mA of current. The PLD emulates all standard 20-pin PAL devices with full functional,

improve your powers of observation.



When characterizing VCO responses and frequency agile signals, most designers depend on their powers of deductive reasoning. The Modulation Domain offers a more direct approach. It brings changes in frequency vs. time clearly into view. So you can see the transient response and post-tuning drift of a single-shot VCO step, or the chirp linearity and staggered PRI of a frequency agile signal. On a single display. In seconds.

Find out how looking at frequency vs. time in the Modulation Domain can make you a better designer, call Hewlett-Packard at 1-800-752-0900*. Ask for Ext. 1827, and we'll send you a *Visitor's Guide to the Modulation Domain* on floppy disk, complete with a list of sights and excursions you won't want to miss.

There is a better way.



*In Canada, call 1-800-387-3867, Dept. 419. Any similarity to existing persons or companies is purely coincidental. ©1990, Hewlett-Packard Co. TMSCD054A/EDN

CIRCLE NO. 36

Integrated Circuits

fuse-map, and parametric capability. The device is available in sample quantities. 20-pin DIPs, \$15; plastic leaded chip carriers, \$13.80 (100).

Lattice Semiconductor, 5555 Northeast Moore Ct, Hillsboro, OR 97124. Phone (503) 681-0118. FAX (503) 681-0347. Circle No. 367

Octal S/H Chip

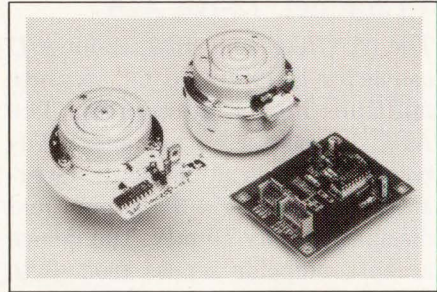
The SMP-08 combines eight independent S/H channels on a single chip. The device incorporates internal capacitors that hold the input signal and output amps for buffering the signal held on each of the hold capacitors. A TTL/CMOS-compatible, one-of-eight decoder controls a series of eight internal switches that connect the analog input to the selected S/H channel. Through the multiplexer, each channel can be addressed to program a

different output voltage. The chip operates from single supplies of 5 to 15V or dual supplies of ± 3 to ± 7 V. It provides make-before-break channel addressing and TTL compatibility over the full supply range. Acquisition time is only 7 μ sec; the droop rate, the device's hold storage capability, is <1 mV/sec typ. The chip is available in 16-pin plastic DIPs, ceramic DIPs, and SO packages. From \$6.25 (100).

Precision Monolithics Inc, Box 58020, Santa Clara, CA 95052. Phone (408) 562-7181. FAX (408) 727-1550. Circle No. 368

Motor Drive Chip

The TDA 5140 drives a 3-phase brushless dc motor in either a star or delta configuration. The chip contains commutation and delay circuits that detect zero crossing points in the motor's back EMF.



These signals control the timing of the 3-phase push-pull output drive and produce a tachometer output. The TDA 5140/A has a 0.6A drive capability. The supply voltage is 4 to 18V, and power consumption is 4 mA. It is available in sample quantities. Other chips include the TDA 5141 with 1.8A drive capacity and the TDA 5142 for higher outputs using external power transistors. The TDA 5140 comes in an 18-pin DIP, SO-20, or SO-24 package and costs Gld 3.7 (10,000).

Philips Components, Box 218, 5600 MD Eindhoven, The Netherlands. Phone (40) 724324. FAX (40) 724825. Circle No. 369

P-Channel DMOS Power FETs

The VP22A family of p-channel, enhancement-mode vertical DMOS power FETs feature low on-resistance and are available in three breakdown-voltage ratings. The VP2210N3, VP2206N3 and VP2204N3 have respective drain-to-source voltage ratings of 100, 60, and 40V. The on-resistance of these devices is 0.9Ω at $V_{GS}=10V$, $I_D=3.5A$ and 1.5Ω at 5V and 1A. The drain-to-source on-state current is a minimum of 4A. Available in low-cost, space-saving TO-92 packages, the devices have a power-handling capability of 1W. VP2210N3, \$0.91; VP2206N3, \$0.90; VP2204N3, \$0.89 (1000). Delivery, four to six weeks ARO.

Supertex Inc, 1225 Bordeaux Dr, Sunnyvale, CA 94088. Phone (408) 744-0100. FAX (408) 734-5247. Circle No. 370

RAF

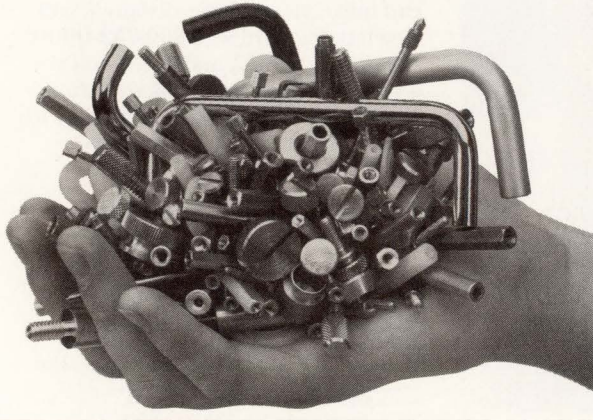
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CIRCLE NO. 42

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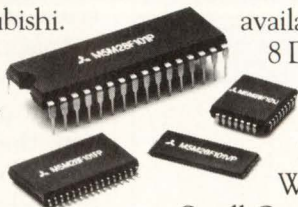
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Lower the cost of your system upgrades with Flash EEPROMs' on-board reprogramming. In workstations, office automation equipment and telecommunication systems, our 10K erase/write

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Mitsubishi Flash EEPROMs are available in 1 Mb, 128K x 8 DIP packages, as fast as 100ns. Flash will also be available in 64K x 16, and higher densities. Watch for TSOP (Thin-Small-Outline-Package), SOP and PLCC versions in the future.

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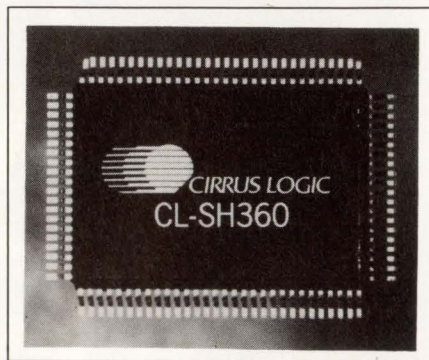
 **MITSUBISHI**
ELECTRONIC DEVICE GROUP

Integrated Circuits

Disk-Drive Controller

The CL-SH360 disk-drive controller implements Reed-Solomon error-correction code (ECC) while transferring data at a continuous 24M-bps rate. Using this correction, the chip can double the density of a single-platter 3½-in. drive from 40M to 80M bytes with no change in

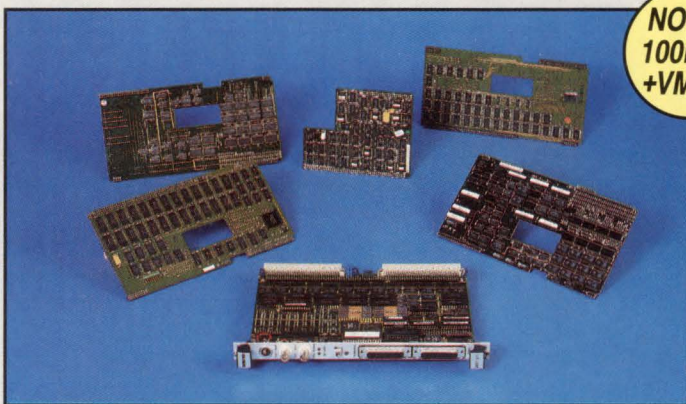
heads or media. The chip automatically performs correction of data errors during disk read operations without any local μ P intervention. The controller can also continue data transfer from the disk to the buffer while correcting previously read data. The CL-SH360 features an 88-bit Reed-Solomon ECC with



on-the-fly hardware correction. Other features are a power-down and an automatic wake-up mode that reduce power consumption by about 75% when the drive is not in use. A proprietary split-data field allows skipping defects within a sector. The CL-SH360 is packaged in a 100-lead quad flatpack. \$24 (1000). Samples are available now, with production scheduled before the end of 1990.

Cirrus Logic, 1463 Centre Pointe Dr, Milpitas, CA 95035. Phone (408) 945-8300. FAX (408) 263-5682. Circle No. 371

The Ultimate VMEbus Tool Set

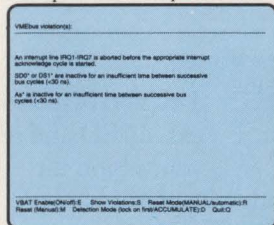


Based on the VBT-321 Advanced VMEbus Analyzer, VMETRO's Modular VMEbus Analyzer System offers piggyback modules for all kinds of VMEbus development, verification and tuning purposes.

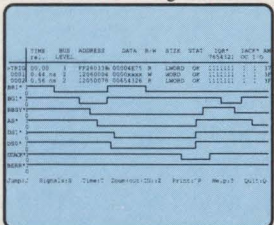
VMETRO's Modular VMEbus Analyzer System gives you unrivalled measurement capability in a single VMEbus slot. Pick the right piggyback module to the VBT-321 VMEbus Analyzer and obtain:

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- * VSB State Analysis
- * VME Cycle Generator
- * 100MHz VME Timing Analysis
- * P2 General Purpose Analysis
- * 256K Trace w/SCSI dump

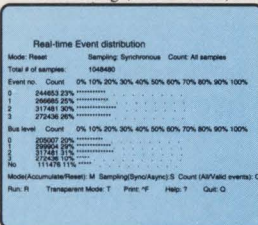
VMEbus Anomaly Trigger reveals incompatibilities and spec. violations.



Combined VMEbus State trace and 100MHz Timing Waveform.



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Single-Chip PC/AT Controllers

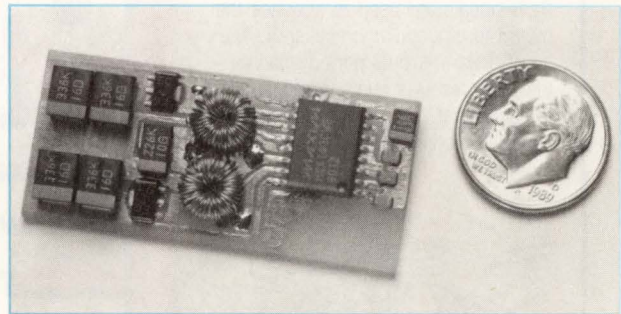
The VL82C310 laptop and VL82C311 desktop controllers are single-chip devices for use in IBM PC/AT applications. The devices operate in 80286 and 80386SX microprocessor-based systems with clock speeds from 10 to 20 MHz. Both chips meet complete PC/AT system standards and require only six inexpensive TTL devices for PC/AT bus buffering. The controllers contain the standard mother-board peripheral functions, and the required memory, CPU, and expansion bus controls in a single 160-lead quad flatpack. The VL82C311 includes advanced features such as interleaved page-mode memory control, and the VL82C310 adds power-down modes for laptop operation that are normally found only in high-performance chips such as the company's Topcat 286/386SX and

+5V TO $\pm 15V$ DC-DC CONVERTERS POWER UP TO 30W LOADS

No Design Required — Just Drop In

Maxim's MAX742 and MAX743 dual-output DC-DC converters provide the simplest solutions for generating $\pm 15V$ or $\pm 12V$ analog supplies from low input voltages, such as +5V digital supplies. To make designing with the parts as simple and reliable as plugging in modules, we not only specify all critical components, we also provide them.*

- Generates $\pm 15V$ or $\pm 12V$
- 82-92% Typical Efficiency
- Uses Inductors, Not Transformers
- 0.3% Typical Noise and Ripple
- Current-Mode Control
- 200kHz Switching Frequency
- Two PWM Controllers Per Package



Using surface mount components, the MAX743 DC-DC converter delivers 3W in less than half the board space of the smallest modules. Power density is a healthy 18W per cubic inch.

	MAX742	MAX743
Input Voltage	4.2V - 10	4.2V - 6.5V
Output Voltage	$\pm 12V$ or $\pm 15V \pm 4\%$	$\pm 12V$ or $\pm 15V \pm 4\%$
Output Power	30W	3W
Power Switch	External	Internal
Price	\$5.82**	\$5.82**

** MAX742 and MAX743, 1000-up, FOB USA

Evaluation Board Simplifies Prototyping

A MAX743 (through-hole) evaluation board containing a MAX743 and all the components required to build a 3 Watt DC-DC converter is available from Maxim for only \$20. To order your evaluation board, send check or money order to Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086. For applications assistance or information on other Maxim products call (408) 737-7600, ext. 4000 or FAX (408) 737-7194.

* MAXL001 - 100 μ H Low-Loss Toroid Inductors (\$1.47, 1000-up) and MAXC001 - 150 μ F Low-ESR Capacitors (\$0.29, 1000-up)

MAX743CPE Production Kit (\$8.18, 1000-up) includes:

- 1 - MAX743CPE
- 2 - 100 μ H Low-Loss Toroid Inductors
- 3 - 150 μ F Low-ESR Capacitors
- 2 - Schottky Rectifiers



Distributed by Arrow, Bell/Graham, Hall-Mark, Nu Horizons, Pioneer, and Wyle. Authorized Maxim Representatives: Alabama, (205) 830-0498; Arizona, (602) 730-8093; California, (408) 248-5300, (619) 278-8021; (714) 261-2123; (818) 704-1655; Colorado, (303) 799-3435; Connecticut, (203) 384-1112; Delaware, (609) 778-5353; Florida, (305) 426-4601, (407) 682-4800; Georgia, (404) 447-6124; Illinois, (312) 577-9222; Indiana, (317) 921-3450; Iowa, (319) 393-2232; Kansas, (816) 436-6445; Louisiana, (214) 238-7500; Maryland, (301) 644-5700; Massachusetts, (617) 329-3454; Michigan, (313) 583-1500; Minnesota, (612) 944-8545; Mississippi, (205) 830-0498; Missouri, (314) 839-0033; Montana, (503) 292-8840; Nebraska, (816) 436-6445; Nevada, (408) 248-5300; New Hampshire, (617) 329-3454; New Jersey, (609) 778-5353; New Mexico, (505) 268-4232; New York, (201) 428-0600, (607) 754-2171; North Carolina, (919) 846-6888; Ohio, (216) 659-9224, (513) 278-0714, (614) 895-1447; Oklahoma, (214) 238-7500; Oregon, (503) 292-8840; E. Pennsylvania, (609) 778-5353; W. Pennsylvania, (919) 851-0010; South Carolina, (919) 851-0010; Tennessee, (404) 447-6124; Texas, (214) 238-7500, (512) 835-5822, (713) 789-2426; Utah, (801) 561-5099; Virginia, (801) 644-5700; Washington, (206) 823-9535; Wisconsin, (414) 792-0920; Canada, (416) 238-0366, (613) 225-5161, (604) 439-1373, (514) 337-7540.

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(516) 981-2400

NHI-1553RT

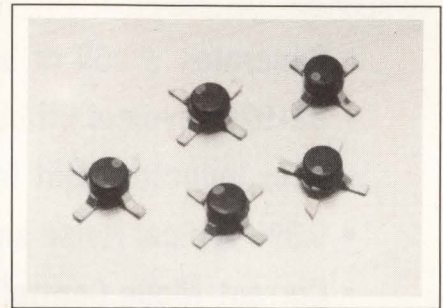
+5V

ONLY

Integrated Circuits

386DX chip sets. Both the 82C10 and 82C11 chips use a standard AT BIOS and provide LIM EMS 4.0 hardware support. VL82C10, \$75; VL82C311, \$65.

VLSI Technology, 8375 South River Pkwy, Tempe, AZ 85284. Phone (602) 752-8574. FAX (602) 752-6000. Circle No. 372



Silicon MMIC

Designated INA-02184 in the 85-mil plastic "pill" package and INA-02186 in the 85-mil surface-mount plastic package, this monolithic-microwave integrated circuit has a 3-dB bandwidth from dc to 800 MHz. At 500 MHz, the amplifier has a gain of 31 dB, a noise figure of 2 dB, and output power of 11 dBm at 1-dB gain compression. At 1.5 GHz, the amplifier's gain is typically 26 dB. Either version is available in tape-and-reel packaging, with 1000 units in a 7-in. reel or 4000 units in a 13-in. reel. \$3.40 each (100).

Avantek, M/S M82, 481 Cottonwood Dr, Milpitas, CA 95035. Phone (408) 943-3038.

Circle No. 373

Math Coprocessor For Software Programs

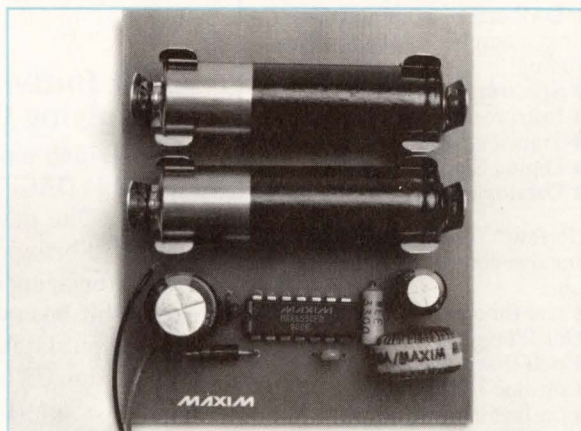
Using a 1- μ m process, the latest version of the industry-standard 387-DX math coprocessor runs as much as 20% faster than previous versions. The device is available in 16-, 20-, 25- and 33-MHz versions. Software programs such as Borland's Quattro Pro, Autodesk's

2 AA CELL TO 5V CONVERTER EXTENDS BATTERY LIFE

The MAX654-658 Family of regulated DC-DC converters provide the simplest and most compact solution available for efficiently generating 3V or 5V from a 1.5V or 3V battery input. An auxiliary, low-power, +12V converter guarantees start-up under load even when your battery is almost completely discharged. This +12V supply also provides a simple means of turning on and off intermittent loads via an external N-Channel MOSFET — further extending battery life.

MAX655 EVALUATION KIT AVAILABLE

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- **85% Conversion Efficiency**
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- **Starts Up Under Load**
- **Auxiliary 12V/100 μ A Supply**
- **Low Battery Indicator**
- **14-Pin SO and DIP Packages**



An evaluation board containing a MAX655 and all the components necessary for building a 2 AA cell to +5V converter is available from Maxim for only \$20.

Battery Input	Part	V _{OUT}	I _{OUT}	Price**
1 Cell: 1.15V - 1.6V	MAX654	5V	45 - 80mA	\$ 3.34
	MAX656*	5V	190 - 380mA	\$ 3.34
	MAX657	3V	50 - 110mA	\$ 3.34
2 Cells: 1.5V - 3.2V	MAX655	5V	60 - 170mA	\$ 3.34
	MAX658*	5V	205 - 450mA	\$ 3.34
	MAX655EVKIT	EVALUATION BOARD		\$20.00

* Plus IRF541 MOSFET

** MAX654-658CPD, 1000-up, MAX655EVKIT, 1-up, FOB USA

To order your evaluation board, send check or money order to Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086. For applications assistance or information on other Maxim products call (408) 737-7600, ext. 4000 or FAX (408) 737-7194.

WARNING: The Typical Operating Circuit and Figures 1 thru 4 shown in the MAX654-658 data sheet published 1/90 and in our 1990 New Releases Data Book ARE IN ERROR. Contact factory for a corrected data sheet, published 11/90.

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CIRCLE NO. 117

System Solutions For Data Acquisition

Onboard Intelligence for IBM PC/XT/AT/386

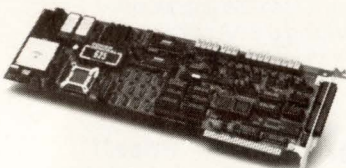
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- C language custom commands
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CIRCLE NO. 40

Integrated Circuits

AutoCAD, and Lotus's Freelance Plus, which use floating-point mathematical operations, can benefit by the faster speeds of the latest devices. 16-MHz version, \$570; 20-MHz version, \$647; 25-MHz version, \$814; 33-MHz version, \$994.

Intel Corp, Box 58065, Santa Clara, CA 95052. Phone (800) 538-3373; in CA, (916) 351-2747.

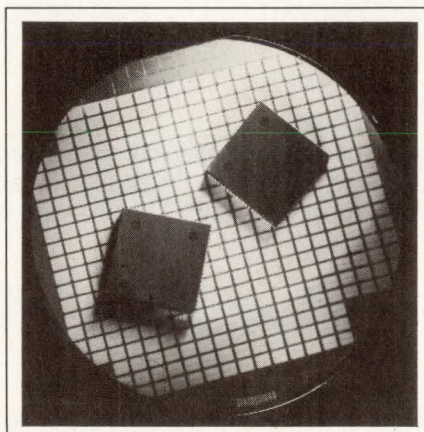
Circle No. 374

12-Bit Buffered Multiplying CMOS DAC

The AD7545 monolithic 12-bit multiplying DAC has on-chip data latches. The device loads data in a single 12-bit-wide word, which allows interfacing directly to most 12- and 16-bit bus systems. The loading of the input latches is under the control of the \overline{CS} and \overline{WR} inputs. A logic low on these control inputs makes the input latches transparent, allowing direct unbuffered operation of the DAC. The device, which comes in a 20-pin DIP, operates from a single 5 to 15V supply and is available in commercial, industrial, and military grades. From \$6.25 (100).

Harris Semiconductor, Box 883, Melbourne, FL 32902. Phone (407) 724-3800.

Circle No. 375



Field-Programmable Gate Arrays

The ATT3000 series of field-programmable gate arrays (FPGA)s of-

fer compatibility with similar parts from Xilinx Corp. The basic architecture includes five input-variable core logic blocks (CLB), two flip-flops per CLB, enhanced routing resources, and 3-state drivers for wide ANDs.

The ATT3020, the first device in the series, contains an 8x8 CLB matrix and 2000 equivalent gates. It comes with toggle rates of 70 and 100 MHz, allowing its use in systems with operating speeds to 50 MHz and higher. The ATT3000 series will consist of five basic devices with sizes ranging to 9000 equivalent gates. The parts will be available by the first quarter of 1991. ATT3020 in 84-pin, 100-MHz plastic leaded chip carriers, \$36.70; 70-MHz versions, \$28.50; in 68-pin plastic leaded chip carriers, 100-MHz version, \$35.60; 70-MHz version, \$27.30 (100).

AT&T Microelectronics, Dept 52AL300240, 555 Union Blvd, Allentown, PA 18103. Phone (800) 372-2447; in Canada, (800) 553-2448.

Circle No. 376

Microwave Power Transistor

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Philips Components, Discrete Products Div, 45 George Washington Hwy, Smithfield, RI 02917. Phone (401) 232-0500.

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- Input Voltage Range Includes Neg Supply Rail
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MAX406 VS. ALTERNATIVES				
Device (T _A = 25°C)	I _Q μ A max	V _{OS} mV max	I _B pA typ	Rail-to-Rail Output
MAX406	1.2	0.5	< 0.1	YES
ICL7611	20	2	1	YES
TLC271	23	2	0.1	NO
OP90	20	0.15	4000	NO

Rail-to-Rail Output Sources 2,000X Supply Current

The MAX406 maintains linearity under heavy load conditions and is capable of sourcing as much as 2mA from a 9V battery. The output swings rail-to-rail while the input voltage range extends to the negative supply rail. The new device operates from voltages as low as 2.4V while maintaining widest input and output voltage ranges.

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Call your Maxim representative today for applications information, data sheets and samples. Or, write Maxim Integrated Products, 120 San Gabriel Dr., Sunnyvale, CA 94086, (408) 737-7600, FAX (408) 737-7194.

* From 3V supplies

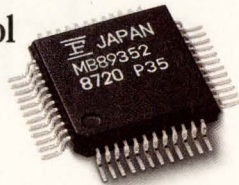


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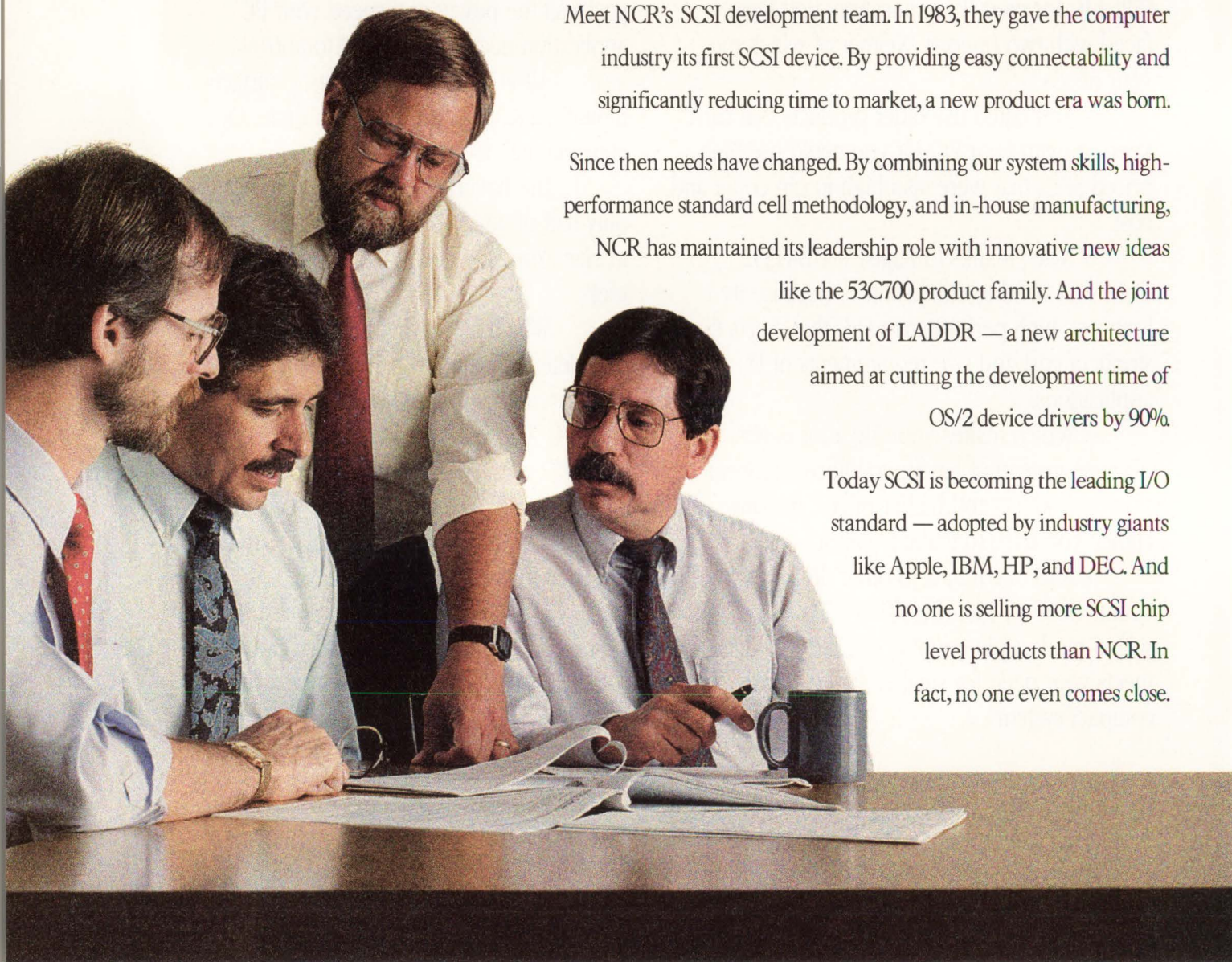
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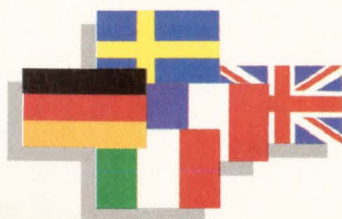
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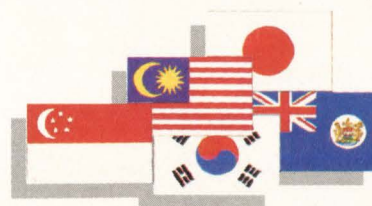
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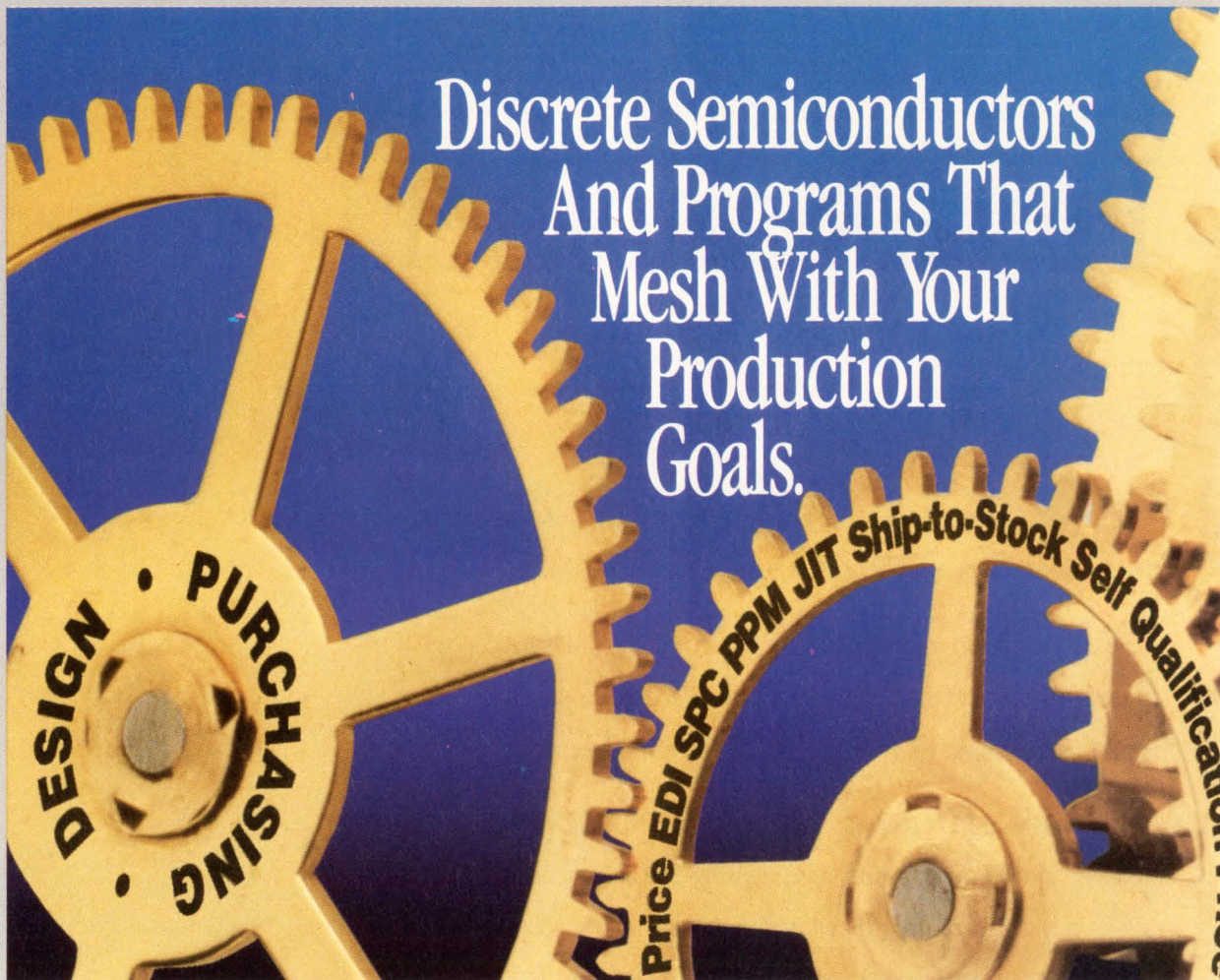
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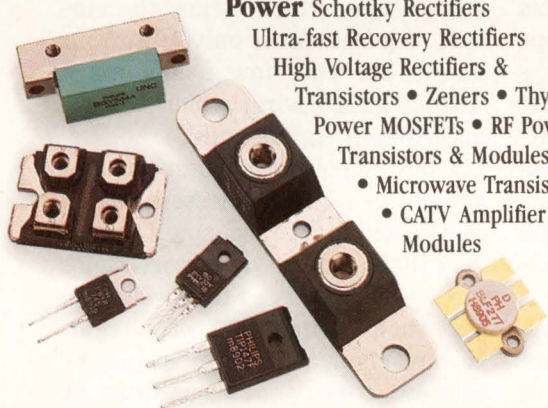


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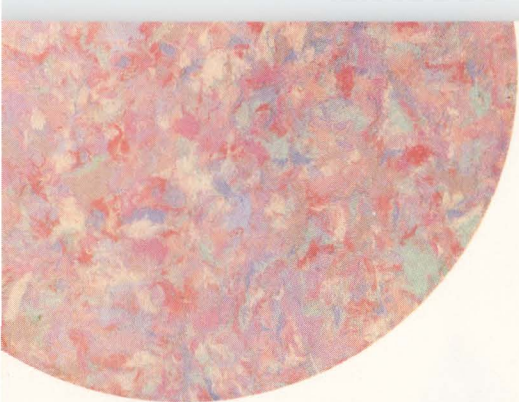
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POWER SOURCES

Distributed power schemes simplify system design tasks

Tom Ormond, *Senior Editor*

DC/DC converters are the key element in distributed power schemes. These units let you use a single voltage bus throughout the overall system and then convert this voltage to the specific levels needed for each subsystem.

When it comes to designing a system power network, you essentially have two ways to go: you can use a centralized power scheme or a distributed power scheme. In a centralized scheme, the bulk power supply (or supplies) develops the specific voltages and currents needed throughout the system. In the distributed power scheme, you again have a bulk supply. In this case, however, the supply develops an arbitrary voltage level, which is bused throughout the system. At appropriate points, dc/dc converters change this voltage to the levels needed for the circuitry involved.

While neither option will be the best choice in all cases, the distributed power scheme does offer a number of advantages in many applications. Such schemes can save space and lower weight, improve reliability, reduce the amount of redundant equipment, and ease the design of independent subsystems. Distributed power schemes can also improve the quality of the generated power.

One of the primary advantages of distributed power schemes is simplified power busing. Consider the following scenario: You must

provide 500W of power for a system that involves 5V logic circuitry. In the centralized power scheme, your bulk supply must develop a 5V/100A output. Busing 100A throughout a system will require some pretty heavy gauge wire.

If you are using a distributed power scheme, your bulk supply can arbitrarily develop a 50V output voltage, which means the current requirement is only 10A. Your power bus can now use a much smaller gauge wire, which will reduce weight significantly.

There's another point to consider in this scenario—IR losses. In the centralized power scheme, there's very little you can do to correct for the significant losses that would occur when busing 100A of current. However, in a distributed power scheme, regulators residing at points of need won't have trouble with IR losses in the bus wiring. Each dc/dc converter will accept the reduced input voltage on the bus and still provide the specified output needed for the circuitry it is powering.

In the centralized vs distributed power debate, there is more to the cost- and weight-saving considera-

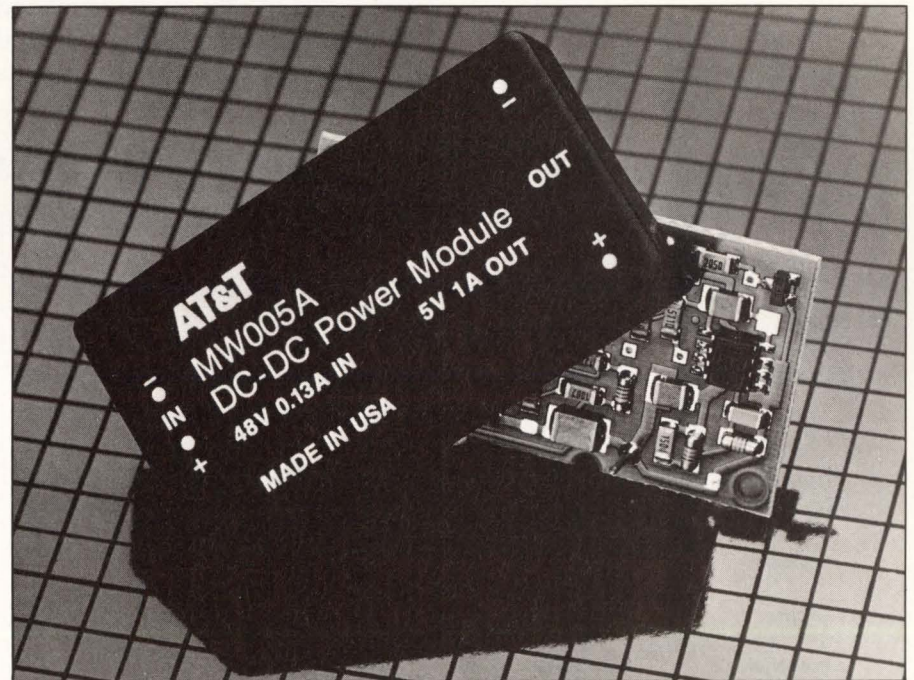


Fully compliant with MIL-STD-883C, Method 5008, Interpoint's MHF/883 Series converters have output ratings ranging to 12W. The units have a 0.365-in.-high profile to support standard board-to-board spacing requirements. They are packaged in all-metal, hermetically sealed cases that require only 1.7 in.² of board area.

tions. A distributed power scheme partitions the system load into failure groups wherein each group has its own power source. As a result, the failure of one converter will affect only that portion of the system and, therefore, have a limited impact on overall system performance. Such is not the case in a centralized powering scheme, where the loss of a single supply output will be felt throughout the entire system.

To avoid such problems, you would have to go with a redundant power scheme. For a centralized power design this could be very costly and exact significant weight penalties. In the case of distributed power, you need only provide redundant power sources for the most critical system functions—not the entire system. The result is that the distributed power concept develops into a compact, fault-tolerant system without the need to employ total redundancy.

In the centralized power scheme, the bulk supply must be capable of



regulating its output (or outputs) to meet the needs of all system circuitry. Depending on how stringent these requirements are, you could be looking at a very expensive power supply. And even then, system performance is not going to be

Operating with 36 to 72V inputs, MW005 Series converters from AT&T develop single outputs of 5, 12, or 15V. The units operate over a -40 to $+85^{\circ}\text{C}$ range and feature current limiting, overvoltage, and short-circuit protection.

The remote dc/dc converter provides all the necessary voltage regulation in a distributed power scheme.

very reliable when you have fast changes in load requirements occurring at the end of a long power bus. In fact, the bulk supply in a centralized power scheme might not even see the rapid load change. In a distributed power scheme, the point-of-need dc/dc converters supply all the regulation, and each converter can handle very fast load changes without degrading system performance.

There's another point to consider when it comes to reliability—system protection. **Table 1** lists some representative specifications for a number of dc/dc converters. As the numbers illustrate, today's converters perform quite well, operating efficiently and providing good power output capability. From the reliability standpoint, however, **Table 1** doesn't tell the whole story. In just about every case, the converters listed offer short-circuit and overvoltage protection as standard features. In some cases, the units



For applications destined for the British Telecomm system, NFC25 Series converters from Computer Products meet BTR2511 inrush current specifications. They feature a $\pm 1\%$ accuracy on the 5V output and include short-circuit and overvoltage protection.

also offer thermal shutdown protection. Such features can lead to only one thing—better overall system reliability.

Satisfying system expansion needs is another area where distributed power schemes offer advantages over centralized power tech-

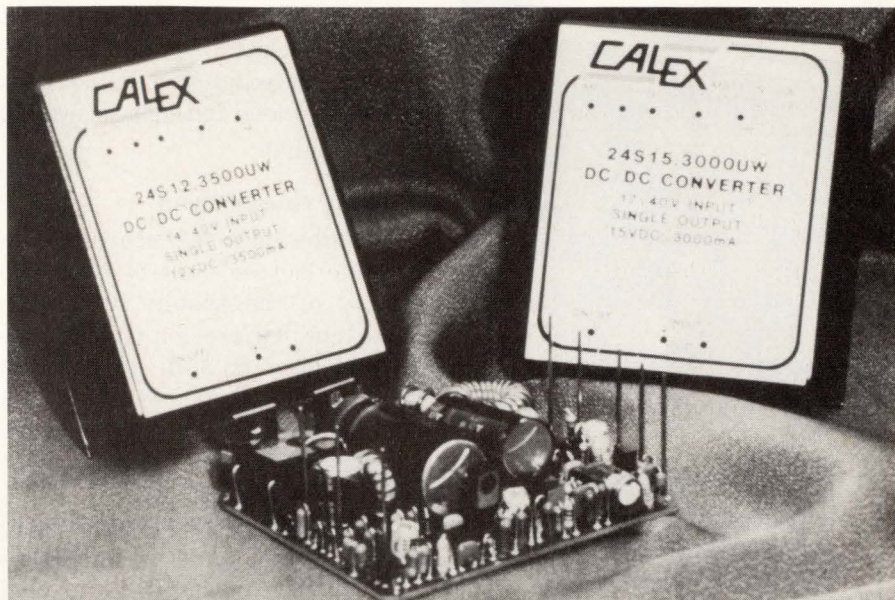
Table 1—Representative dc/dc converter specifications

Manufacturer	Series	Output power (W)	Outputs	Output voltage (V)	Input voltage (V)	Efficiency (%)	Operating range (°C)	Price
AT&T	MW005	5	1	5, 12, 15	36 to 72	82	-40 to +85	\$85.20
Abbott	MIL/PAC	20, 35, 50	1, 2	5 to 28, ± 12 , ± 15	14 to 31	70 to 80	-55 to +100	from \$850
Astec America	AA 9030	43	4	5, 12, -12, -26	11 to 17	80	NS	\$114 to \$129
Burr-Brown	PWR59XX	0.5 to 1.3	1, 2	5, 9, 12, 15, ± 5 , ± 12 , ± 15	5, 12, 15, 24	42 to 60	-25 to +85	\$20.75 (100)
Calex	24S12.3500UW 24S15.3000UW	45	1	12, 15	14 to 40	90	-25 to +80	\$130
Computer Products	NFC25	25	3	5, ± 12	36 to 72	82	-25 to +70	\$77 (50)
Datel	wide range	15 to 30	1, 2, 3	± 5 , ± 12 , ± 15	9 to 18, 18 to 36	75 to 84	-25 to +71	from \$107
Interpoint	MHF/883	12	1, 2	5, 12, 15, ± 12 , ± 15	16 to 40	NS	-55 to +125	from \$780 (100)
Lambda	UHD	210 to 233	1	5, 12, 15, 24, 28	38 to 72, 200 to 370	75 to 80	0 to 85	from \$139 (250)
Powercube	28DC 515-150	150	3	5, ± 15	22 to 34	80	-55 to +85	from \$1283 (100)
Power General	DCU1-5-WR	5 to 7.5	1	5, 12, 15	7 to 32	75	-25 to +70	\$82
Reliability Inc	15A	15	2	± 12 , ± 15	9 to 32	80	-25 to +71	\$40 to \$50
Shindengen	HDA/HDB	½	1, 2	5, ± 12 , ± 15	5, 12, 24	NS	-10 to +70	\$5.59 to \$7.06 (1000) \$7.66 to \$8.75 (1000)
Vicor	Minimod	25 to 100	1	5 to 48	12 to 300	80 to 90	-20 to +100 -40 to +100 -55 to +100	\$134 (75W model)

Note: NS=not specified

niques. In the latter case, the bare-bones version of the system must include the power capability to accommodate any and all add-on features that users might employ. This power need is a must even if users never expand system capability beyond that afforded by the basic system. While the centralized power scheme works, it is certainly not a cost-effective way to satisfy expansion needs.

Distributed power techniques readily accommodate system expansion needs. Since each add-on subsystem card can have its own power source on board, there's no problem when it comes to users increasing system capability. Best of all, you only have to provide the basic system design with enough power to satisfy its needs. Even in those cases where real estate restrictions make it impossible to mount the dc/dc converter right on the add-on card, distributed power



schemes have minimal problems accommodating system expansion needs. You can simply design the basic system with a slot (or slots) that accepts a card containing multiple dc/dc converters. These con-

To accommodate ATE applications, CALEX's UW Series 45W converters feature an output that can be digitally programmed over a $\pm 10\%$ range using a simple D/A converter. They include thermal shutdown circuitry for temperature protection and are housed in a 6-sided shielded case to minimize RFI.

For more information . . .

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

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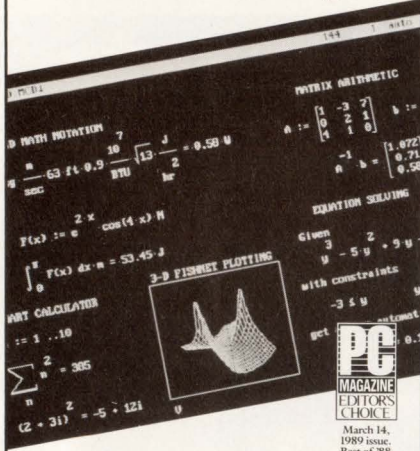
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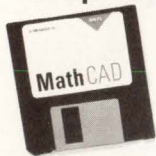


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CIRCLE NO. 41

POWER SOURCES

verters will provide the output needed to satisfy power requirements as expansion subsystem cards are added to the basic system configuration.

Keeping things clean

Distributed power schemes also provide better control over the quality of the system power—an important feature for many sensitive electronic applications. As noted earlier, dc/dc converters can maintain output at a constant voltage regardless of variations in input current and output load.

The dc/dc converters also isolate the subsystem by providing electrically separate power and ground planes. This scheme protects both the subsystem and the entire system from malfunction or damage due to failures or fluctuations in one part of a circuit. Single-chip power ICs can perform many of the conversion and regulation tasks provided by dc/dc converters, but they cannot provide the isolation. Even with the advances in recent power-IC device performance, dc/dc converters are still the devices that best satisfy the needs of distributed power schemes.

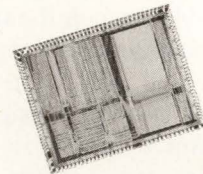
So what's in the future? With the distributed power concept growing in popularity, many vendors see a strong market for dc/dc converters. Some also feel that the industrial and commercial markets will follow the aerospace/military demand for higher reliability, more durability, and smaller size. As they extend distributed power schemes to more industrial control, medical, and instrumentation applications, such benefits become inherent. **EDN**

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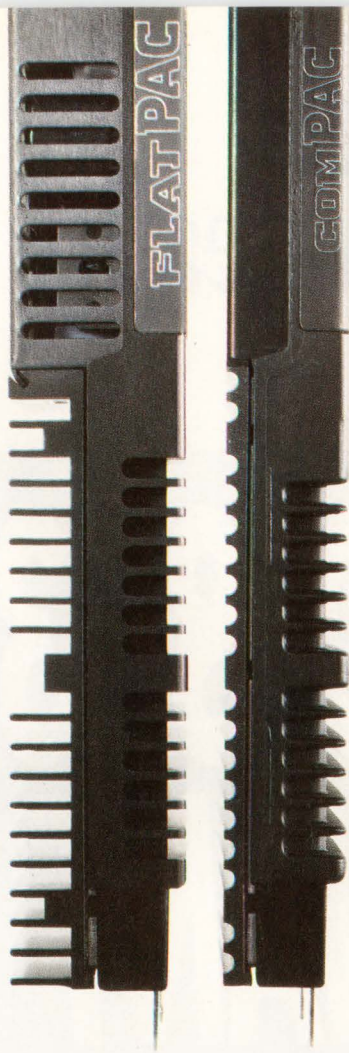
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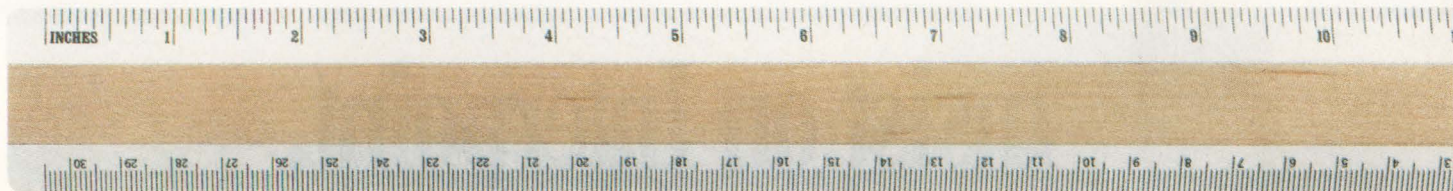
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110/220 VAC	Voltage Inputs	24, 28, 48, 270, 300 VDC
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2 to 95 VDC	Output Voltages	2 to 95 VDC
Up to 600 Watts	Output Power	Up to 600 Watts
1.37"	Height	1"
FCC Part 15, Class A VDE 0871, Class A IEEE Std 587-1980	Applicable Specifications	Bellcore (24/48 V) British Telecom (24/48 V) FCC/VDE, Class A (300 V) MIL-STD-461 C (28/270 V) MIL-STD-704A



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CIRCLE NO. 130

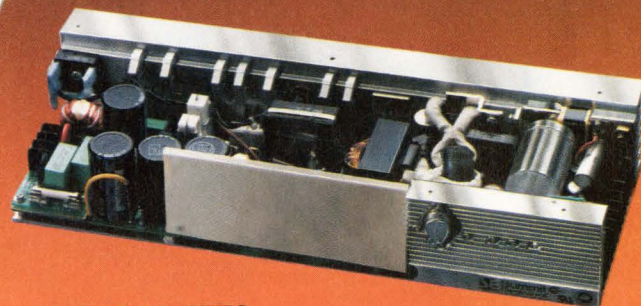
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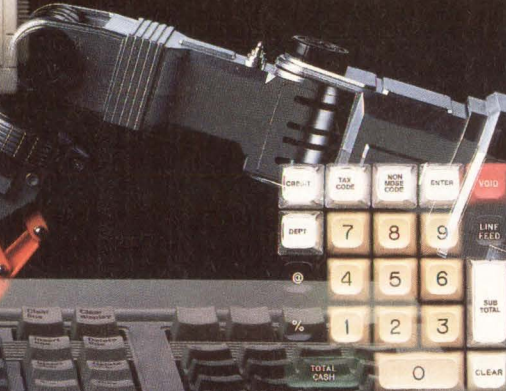
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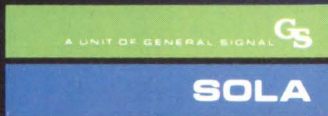
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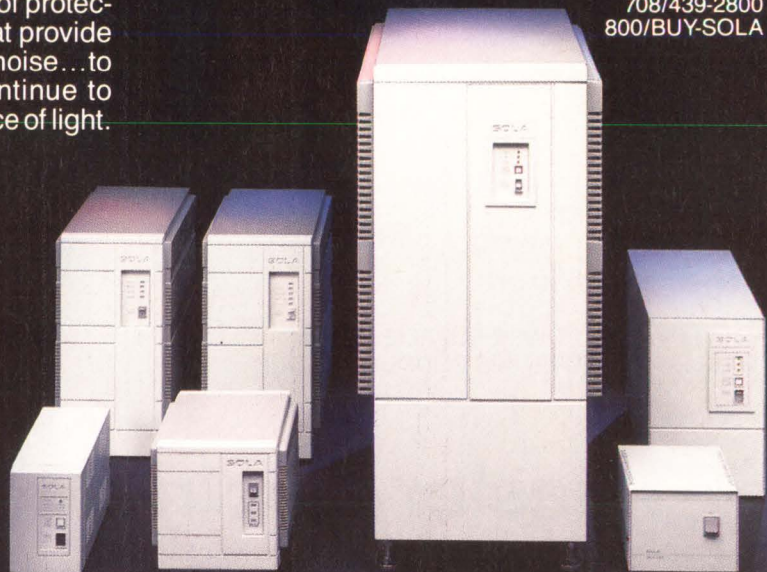
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Power Sources

Rechargeable, nickel-cadmium cells offer high capacity and high peak current

The Ultramax series of rechargeable nickel-cadmium batteries have ratings from 800 to 5000 mAh. The six sizes and their minimum capacities at a 5-hour discharge rate are: AA (800 mAh), $\frac{1}{4}$ Af (1000 mAh), $\frac{7}{8}$ Af (1700 mAh), sub-C (2000 mAh), C (2800 mAh), and D (5000 mAh). (Af refers to a "fat" A cell with a maximum diameter of 16.5 mm versus 14.2 mm for a AA cell.) All have capacities at least equal to the highest in their size; some sizes' capacities exceed by 50% to 70% the highest available in competitive units.

All batteries have a 1.2V nominal output voltage. Maximum output currents range from 18A for the AA cell to 110A for the D cell (1-sec ratings). Maximum internal resistance ranges from 38 m Ω for the AA cell to 13 m Ω for the D cell. With correct charge-termination techniques, you can fast-charge any



of the batteries in as little as one hour.

Single-unit pricing for large OEM orders is as follows: AA, \$1.25; $\frac{1}{4}$ Af, \$1.56; $\frac{7}{8}$ Af, \$1.95; sub-C, \$2.95; C, \$3.50; and D, \$6.

Gates Energy Products Inc, Box 667850, Charlotte, NC 28266. Phone (904) 462-3911.

Circle No. 697

20 to 50W MIL-spec dc/dc converters offer MTBF to 1.4 million hours

The MIL/Pac line of dc/dc converters includes units that produce 20, 35, and 50W. Minimum efficiency is 65%. Input voltage range is 14 to 31V dc. You can get units that produce a single output of 5, 12, 15, 24, or 28V dc as well as triple-output units that furnish 5 and ± 12 or ± 15 V. All units meet MIL-STD-810C for altitude, shock, acceleration, and vibration, and MIL-STD-901C for high-impact shock. Hermetically sealed units are available. At high line and full load, the

MTBF of the converters comply with MIL-STD-2000, which is approximately 1.4×10^6 hours in a ground-benign environment and has a 50°C baseplate temperature.

Line regulation is the greater of 0.1% or 10 mV for an input change from 14 to 31V. No-load-to-full-load regulation is the greater of 0.1% or 10 mV. A 50% change in load current causes transient overshoot of no more than 0.5V; the units recover within regulation limits in less than 0.5 msec. Ripple and noise

are less than 100 mV p-p in a 25-MHz bandwidth over the full -55 to +100°C temperature range. The units meet MIL-STD-461C for electromagnetic interference for class A1, A2, and A3 equipment. The converters start at \$850 in small quantities. Delivery is 12 to 14 weeks ARO.

Abbott Transistor Labs Inc, 2727 S La Cienega Blvd, Los Angeles, CA 90034. Phone (213) 202-8820. FAX (213) 836-1027.

Circle No. 700

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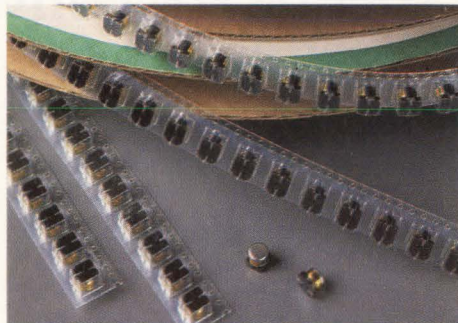
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UZ	5,000 hr. life/6mm ht./4~50V -55~+105°C/0.1~200 μF
WX	2,000 hr. life/5.5mm max. ht. -40~85°C/0.1~220, μF/4~50V
UT	2,000 hr. life/6mm ht. -55~105°C/0.1~100, μF/4~50V
UP	1,000 hr./6mm ht./Non-polarized -40~+105°C/0.1~47 μF 6.3~50V
UK Muse	2,000 hr./6mm ht./For audio -40~+85°C/0.1~220 μF 4~50V

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CIRCLE NO. 133

Power Sources

DC/DC Converters With 750V Isolation

The HPR1XX series of dc/dc converters have a power density of 10W per in.³ with efficiencies as high as 80% and a continuous input-to-output isolation rating of 750V dc. The converters' load regulation is $\pm 10\%$ from a minimum load of 1 mA to full load. They do not provide line regulation.

The line includes single- and dual-output models; both produce 750 mW. All converters are packaged in single-in-line cases that occupy 0.78 x 0.25 in. on a pc board and are 0.41 in. high. Input voltages are 5, 12, 15, and 24V dc. The 5V-input models include a unit with a single 5V output rated at 150 mA and a $\pm 5V$ -output unit with 75-mA outputs. At all input voltages, there are units with $\pm 15V$, 25-mA outputs and at all input voltages, except 24V, there are units with $\pm 12V$, 30-mA outputs. All, except 24V units, have a reflected ripple current of 5 mA p-p at their inputs. \$6.85 (1000).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (800) 548-6132; in AZ, (602) 741-3978. FAX (602) 889-1510.

Circle No. 378



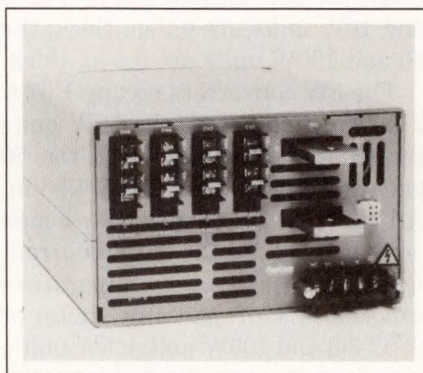
Miniature DC/DC Converter

The NMH series of dc/dc converters produces dual outputs of ± 5 , ± 9 , ± 12 , or $\pm 15V$ from an input of 5 or 12V. The devices deliver 1.8W

over its 0 to 70°C operating range without heat sinks. Input-to-output isolation voltage is 500V dc. A choice of 5-pin packaging for pc boards exists; an SIP requires 0.23 in.², and the DIP requires 0.32 in.². £7 (100).

Newport Components Ltd, Tanners Dr, Blakelands N, Milton Keynes MK14 5NA, UK. Phone (908) 615232. FAX (908) 617545.

Circle No. 379

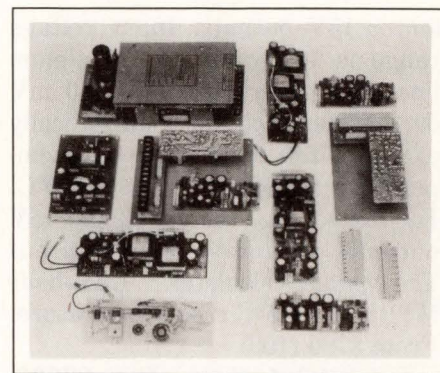


Power-Factor-Corrected 1000W Supplies

Series 31 supplies have from one to nine outputs. You can obtain them with integral power-factor correction. A power-factor-corrected unit with a 1000W output can operate from a 15A, 120V (nominal) ac line. A similarly rated supply without power-factor correction draws so much current at full load that it needs higher-current ac service.

The 120V-input models operate from 90 to 264V lines with no jumper change. The series also includes 2-kW, single-output and 1.5-kW, multiple-output models with a 240V (nominal) ac input as well as 48V dc input units. Without power-factor correction, the supplies are in the industry-standard 5 x 8 x 11-in. fan-cooled package; power-factor-corrected units measure 5 x 8 x 12.5 in. From \$743. Delivery, 8 to 10 weeks ARO.

Qualidyne Systems Inc, 3055 Del Sol Blvd, San Diego, CA 92154. Phone (619) 575-1100. FAX (619) 429-1011. Circle No. 380



Modules For Building Custom Switching Supplies

The MIM and MOP Series modules allow users to quickly assemble custom switching-regulated power supplies using single, dual, or triple outputs that produce a total power of 50, 100, or 200W. The supplies can derive their inputs from 115/230V ac or from any dc source having a voltage from 12 to 130V.

You can specify any output voltage from 5 to 130V. The supplies meet their full specifications from 0 to 50°C. Interference meets the requirements of VDE 0871 class B. Units with ac inputs withstand 4250V dc from input to outputs. Outputs withstand a continuous short circuit. Regulated outputs exhibit a maximum of 1% variation due to line and load changes. 50W unit, \$75; 100W unit, \$125; 200W unit, \$165.

Absopulse Electronics Ltd, 110 Walgreen Rd, W Carleton Industrial Park, Carp, Ontario K0A 1L0, Canada. Phone (613) 836-3511. FAX (613) 836-7488. TLX 0533859. Circle No. 381

12W, Single- And Dual- Output DC/DC Converters

The MHF/883 series of single- and dual-output dc/dc converters produce as much as 12W. They comply with MIL-STD-883C, method 5008. The 0.365-in.-high units occupy 1.7 in.² on a pc board. They meet the requirements of MIL-STD-461 for reflected ripple current.

The units provide 5, 12, ± 12 , 15,

Power Sources

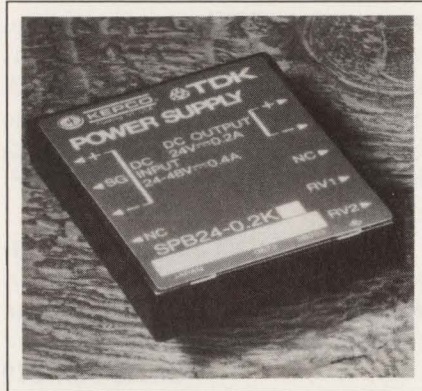
and $\pm 15V$ outputs. Input voltage range is 16 to 40V dc. Maximum line and load regulation is 50 mV dc. Efficiency at full load typically exceeds 75%. Operating case-temperature range is -55 to $+125^{\circ}C$. For units that produce 12 and 15V outputs, no derating is required. The vendor calculates a 1.3M-hour MTBF at a $45^{\circ}C$ case temperature. From \$780 (100).

Interpoint Corp, Box 97005, Redmond, WA 98073. Phone (206) 882-3100. FAX (206) 882-1990.

Circle No. 382

Low-Profile DC/DC Converters

The FPD series of low-profile dc/dc converters includes units that produce 5, 10, 50, and 100W. The 5 and 10W units accept inputs from 12 to 24V. For the 50 and 100W models, input voltages are nomi-



nally 12, 24, 48, and 150V. The 5 and 10W units are 0.3 in. thick; the 50 and 100W units are 0.5 in. thick.

The 5W converters occupy 1.57×2 in. on a pc board; the 10W units require 2×2 in.; and both the 50 and 100W units take 2.28×4.53 in. All operate from 0 to $71^{\circ}C$, though you must reduce the output current when the baseplate temperature exceeds $50^{\circ}C$ (5 and 10W units) or $85^{\circ}C$ (50 and 100W units). 5W units,

\$45; 50W units, \$120; 100W models, \$175.

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

Circle No. 383

5¼-In.-High 75-kV, 1-kW Supplies

The WX Series of high-voltage supplies rack-mount in a $5\frac{1}{4}$ -in.-high space and produce as much as 1 kW at voltages as great as 75 kV. The front panels have analog voltage and current meters. As an alternative, you can specify digital meters or a blank panel. The supplies use switching-regulator technology to achieve 83% efficiency. They automatically switch from constant-voltage to constant-current operation. Line regulation is 0.005% for input variations from 198 to 242V. Output resistance is $<1\Omega$. At full

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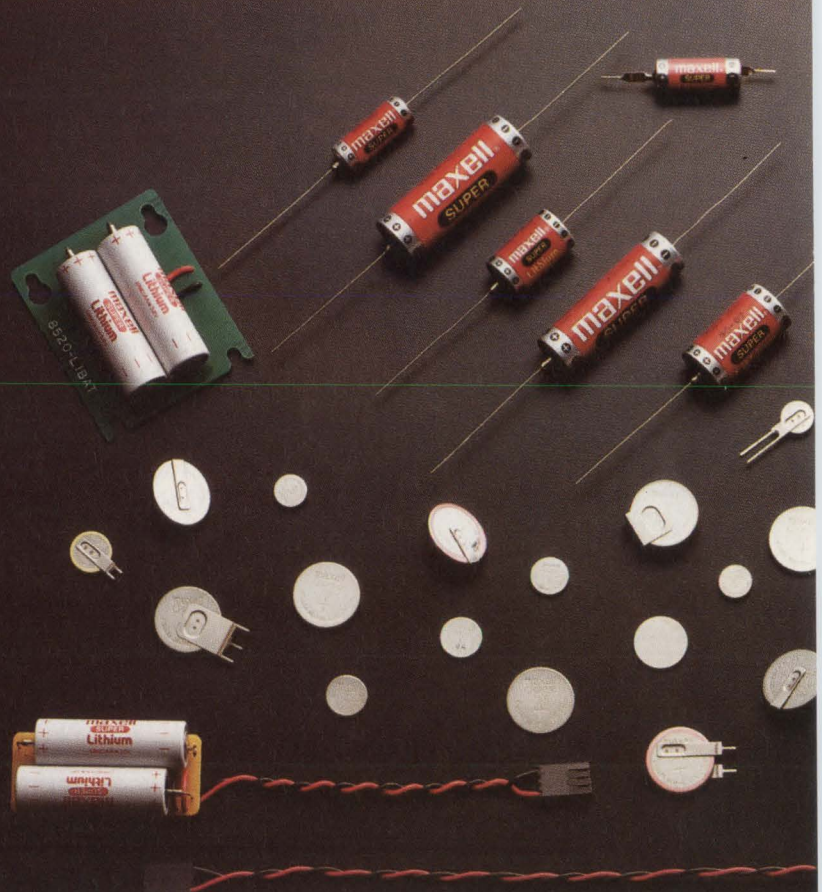
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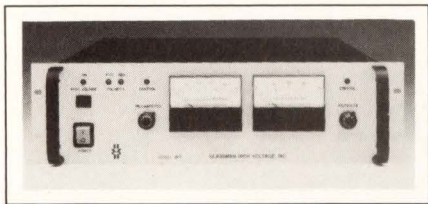
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Power Sources



load, ripple is $<0.05\%$ of rated output. You can program and monitor the output voltage and current. A TTL level enables and disables the output. \$3900 to \$7100. Delivery, six weeks ARO.

Glassman High Voltage Inc,
Box 551, Whitehouse Station, NJ
08889. Phone (201) 534-9007. FAX
(201) 534-5672. TWX 710-480-2839.

Circle No. 384

2.8V Lithium-Iodine Cells For CMOS Backup

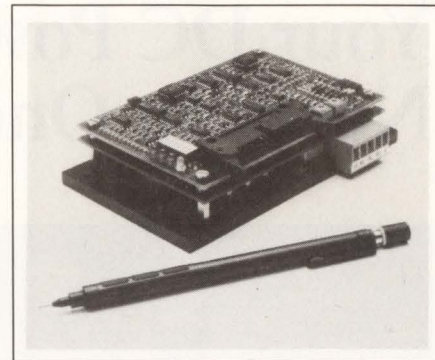
The B-35 μ Powercell rechargeable lithium-iodine cell comes in a variety of shapes and sizes and provides

continuous 2.8V power to CMOS circuits. The cell has true glass-to-metal hermetic seals. At temperatures below 37°C, the operational or shelf life is more than 20 years. The cell inherently limits its output current under short-circuit conditions, minimizing the likelihood of catastrophic failure.

Although operation of CMOS devices at voltages higher than 2.8V is common, CMOS RAMs retain data with a 2V supply. The vendor points out that because circuits use less power at lower voltages, a 2.8V battery will power a given set of ICs longer than a battery with the same capacity but a higher voltage. Axial-lead cell, \$3; \$1 (OEM qty).

Catalyst Research, 3706 Cromdall Lane, Owings Mills, MD 21117. Phone (301) 356-2400, ext 545. FAX (301) 581-0346.

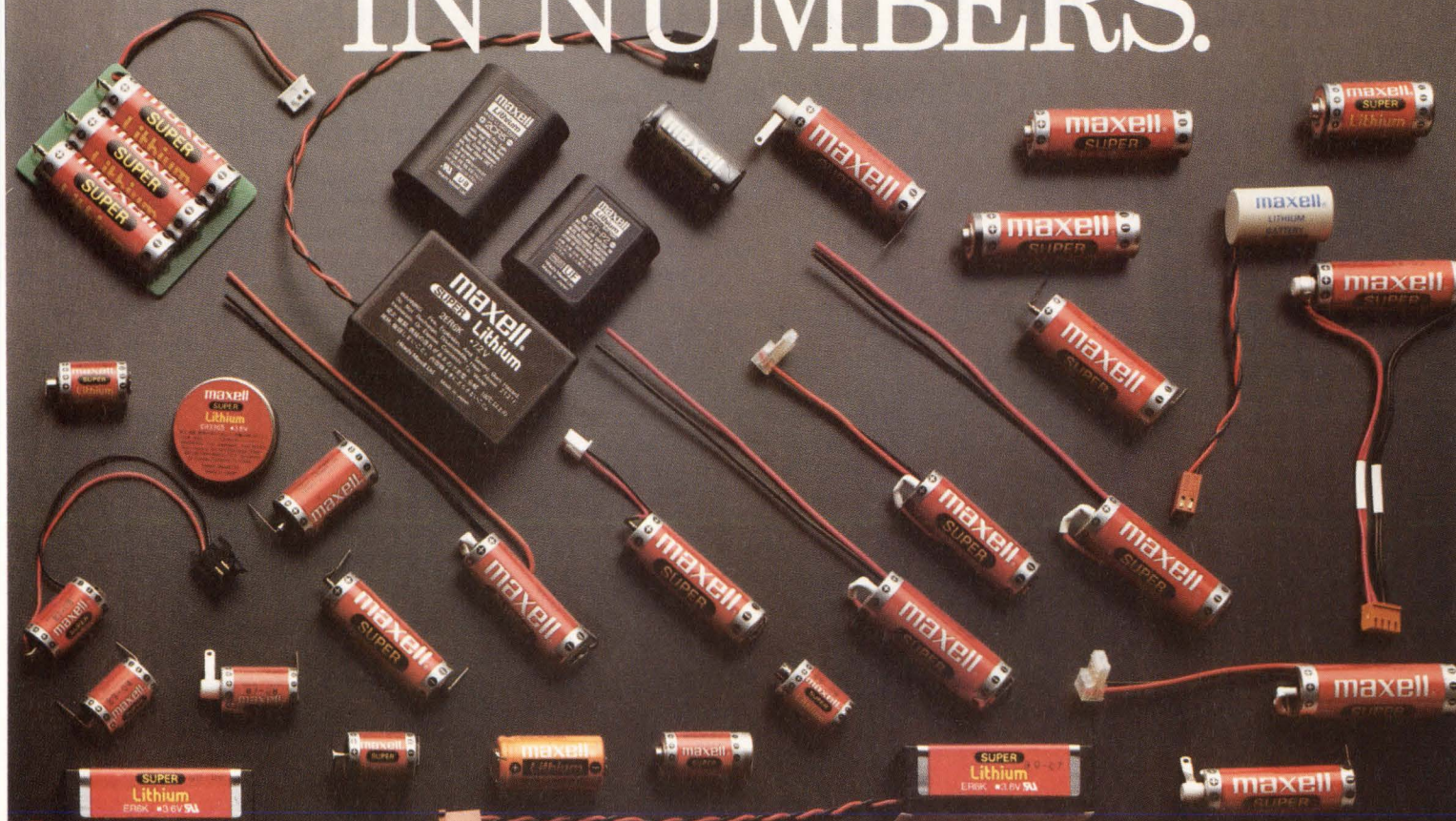
Circle No. 385



2-kW Amplifier For Brushless DC Motors

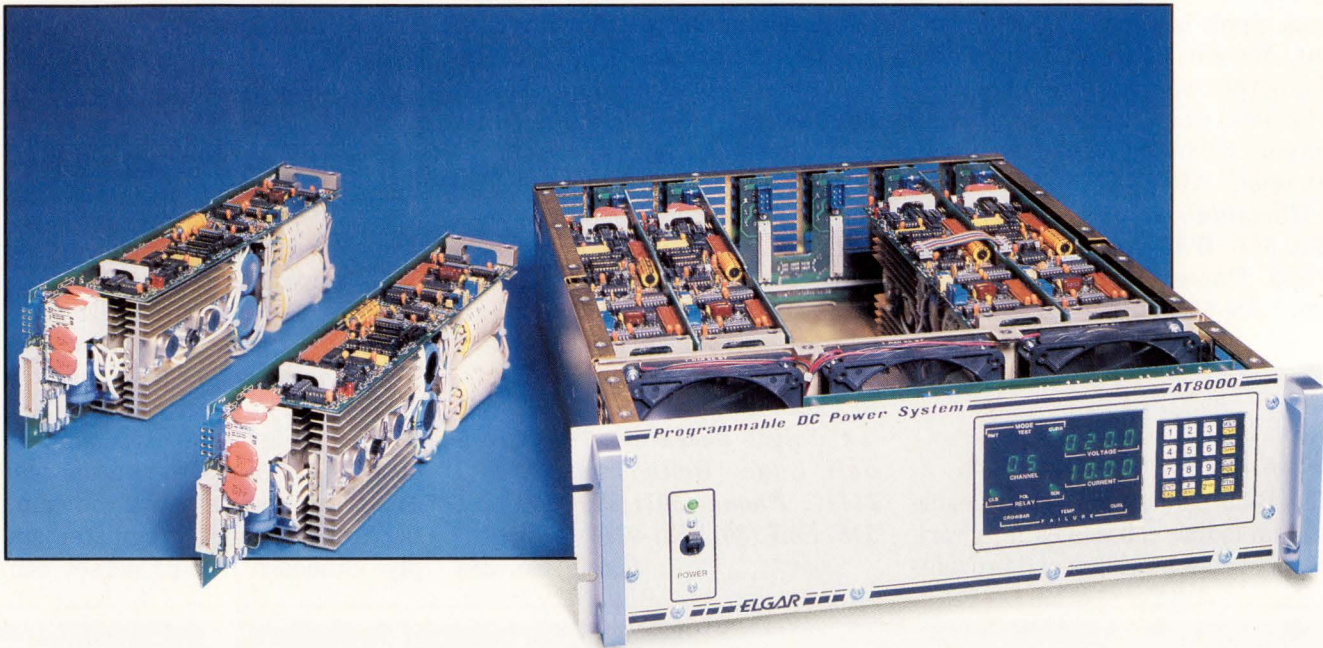
The miniature, pulse-width-modulated amplifier of the SBA Series provides as much as 2 kW to drive 3-phase, brushless servo motors. The amplifier, which measures $5.1 \times 3 \times 1.2$ in., operates from 20 to 330V and furnishes 10A continuously and 20A pk. An internal dc/dc converter lets you power the amplifier from a single unregulated supply. Standard models accept com-

IN NUMBERS.



CIRCLE NO. 43

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For more information about how the AT8000A Power Sources and Loads can help you solve your ATE testing needs, call:

1 (800) 73-ELGAR

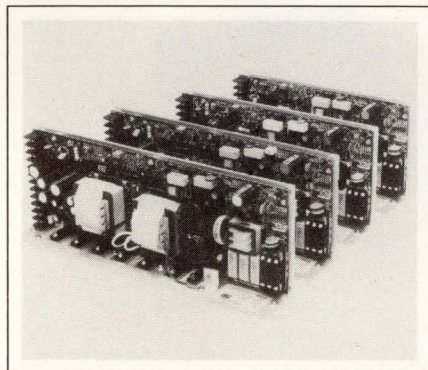
ELGAR



Power Sources

mutation signals directly from Hall-effect transducers, but the vendor can supply units that accept other types of commutation signals. The unit, whose efficiency exceeds 95%, shuts down automatically if it detects loss of commutation, excessive temperature, under- or overvoltage, or short circuits to a power supply or to ground. SBA-10-80 10A-pk, 80V unit, \$495 (100).

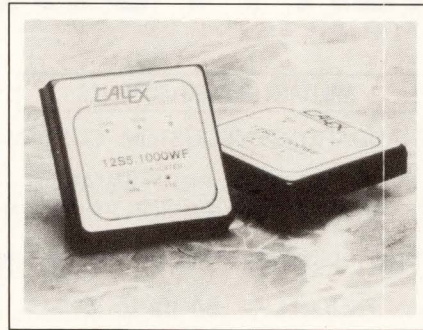
Galil Motion Control Inc, 575 Maude Ct, Sunnyvale, CA 94086. Phone (408) 746-2300. FAX (408) 746-2315. Circle No. 386



5-Output, 350W Open-Frame Supplies

The SMQ355 5-output, open-frame switching supply delivers 350W. The main output produces 5V at 30A. You can choose a first auxiliary output rated for 12 or 24V. You can pick 5, 12, or 24V for each of the other auxiliary outputs. You can strap the ac input to accept 90 to 132V or 180 to 264V from 47 to 440 Hz. The units include line filters that meet FCC level B and VDE 0871 level A requirements. Input-to-output spacing supports 3750V ac; the units conform to the CSA 22.2 and UL 478 standards. Overvoltage protection safeguards your load; overcurrent protection and thermal shutdown protect the supply. \$261 (100).

Switching Systems International, 500 Porter Way, Placentia, CA 92670. Phone (714) 996-0909. FAX (714) 996-2753. Circle No. 387

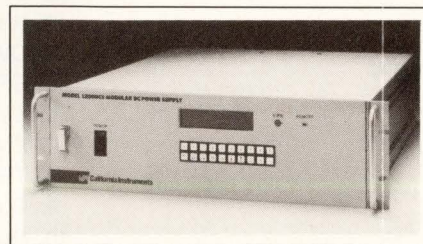


7-To-32V-Input DC/DC Converter

The 12S5.1000WF dc/dc converter provides 5V dc at 1A from a 2x2x0.375-in. package. It can use any input voltage in the range of 7 to 32V. The wide-input range allows the unit to operate from unregulated batteries with 12 or 24V nominal outputs.

The converter uses pot-core transformers to minimize radiation of magnetic fields and is shielded on all six sides as well. It incorporates both overcurrent and overvoltage protection. The overvoltage protection is set for 6.8V, hence it does not interfere with adjustment of the output voltage over a $\pm 10\%$ range. The converter operates from -25 to 80°C . Key specs include 20-mV p-p noise, 0.05% line and load regulation, and 0.3%/1000 hour long-term stability. \$43.40 (100).

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. FAX (415) 932-6017. Circle No. 388

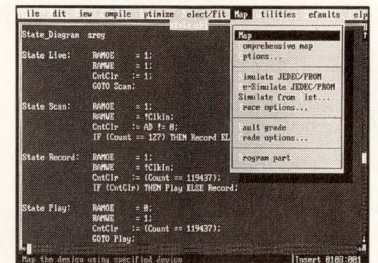


Programmable Supply

The 1200DCS programmable dc power system lets you mount eight modules with a total output of 1200W in a 5 1/4-in.-high, rack-mountable chassis. The chassis in-

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DATA I/O
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*Price valid in U.S.A. only.

HIGH RELIABILITY POWER SUPPLIES

MILITARY POWER SUPPLIES

STANDARD, SEMI-CUSTOM, CUSTOM

FULL MIL-SPEC PERFORMANCE
(FIXED 0.5MHZ CONVERSION FREQUENCY)

HIGHEST OUTPUT POWER PER IN² MOUNTING SURFACE

HEIGHT — .64 up to .81"

INPUT: 18-36 VDC

**SINGLE OUTPUT: UP TO 75W
(20WIN³)**

SIZE: 3.26 x 1.81 x 0.62"

Model	V/A
7009/1	5/10
7009/2	12/6
7009/3	15/5
7009/4	24/3.1
7009/5	28/2.65

INPUT: 18-36 VDC

SINGLE OUTPUT: UP TO 90W

SIZE: 4.24 x 2.13 x 0.67"

Model	V/A
7007/1	5/12
7007/2	12/6.5
7007/3	15/6
7007/4	24/3.75

SINGLE OUTPUT: UP TO 200W

SIZE: 5.91 x 3.54 x 0.81"

7030/1	5/30
7030/2	12/16.5
7030/3	15/13
7030/4	24/8
7030/5	28/7

DUAL OUTPUT: UP TO 120W

SIZE: 5.91 x 2.81 x 0.81"

8001	±5/8
8002	±12/4.5
8003	±15/4
8004	±24/2.5

TRIPLE OUTPUT: UP TO 180W

SIZE: 5.51 x 4.49 x 0.81"

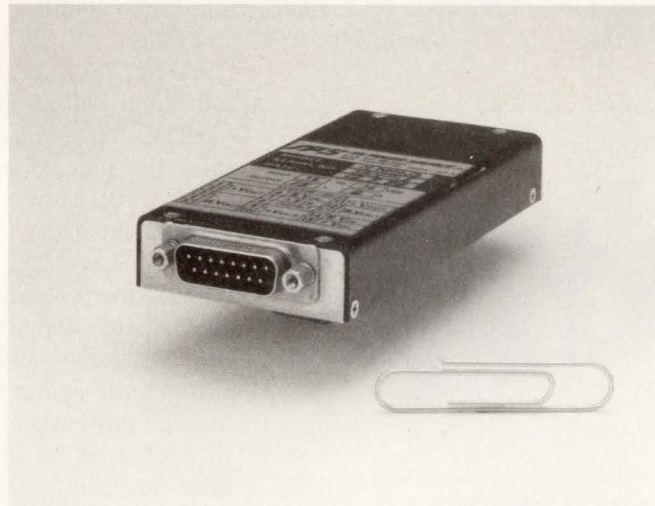
8506	5/12, ±12/4.5
8606	5/12, ±15/4

INPUT: 170-360 VDC

SINGLE OUTPUT: UP TO 150W

SIZE: 5.12 x 2.91 x 0.81"

7701/1	5/20
7701/2	12/12.5
7701/3	15/10
7701/4	24/6
7701/5	28/5.5



NOTES:

1. INPUT PROTECTION: MIL-STD-1275AT, MIL-STD-704A/D
2. LINE LOAD REGULATION: ±1%
3. RIPPLE & NOISE: 30mv p-p TYPICAL
4. OVERVOLTAGE & CURRENT LIMITING
5. EFFICIENCY: 75-85%
6. EMI/RFI: MIL-STD-461/2
7. ENVIRONMENTAL: MIL-STD-810C
8. TEMP: -54°/+90°C BASE PLATE
9. Q.A. SYSTEM MIL-Q-9858A, MIL-I-45208A
10. DESIGN/WORKMANSHIP UP TO MIL-STD-2000

FULL STANDARD LINE AVAILABLE

MPS MILPOWER SOURCE, INC.

BELKNAP INDUSTRIAL PARK
RTE. 106, P.O. BOX 657
BELMONT, NEW HAMPSHIRE 03220, U.S.A.
TEL: (603) 267-8865, FAX: 267-7258

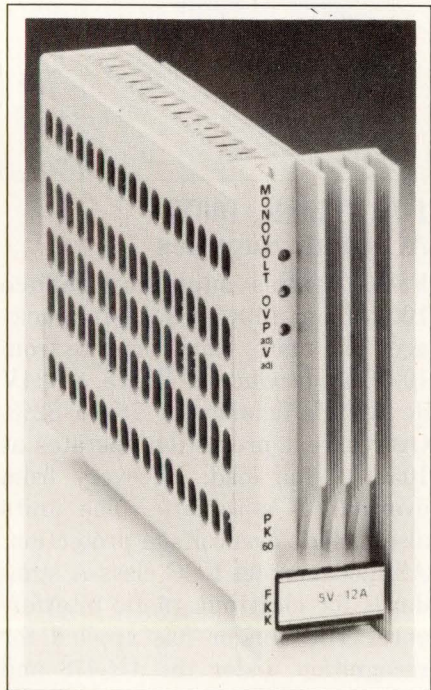
Power Sources

terfaces with the IEEE-488 bus. Data transfers occur as fast as 500k bytes/sec. Sixteen modules, producing as much as 4800W and housed in as many as four chassis, can reside at a single bus address.

The three module types have maximum outputs of 10V at 20A, 20V at 10A, and 40V at 10A. They are programmable from 10 to 100% of the maximum voltage and are more than 80% efficient. The units are electrically isolated from each other, and they include protection against short circuits, overloads, overvoltage, open-sense leads, and excessive temperature. The system runs an automatic self-test of each output at start-up. From \$6340.

California Instruments Corp,
5125 Convoy St, Suite 201, San Diego, CA 92111. Phone (800) 356-2244; in CA, (800) 821-1634; (619) 279-8620. FAX (619) 279-8139.

Circle No. 389

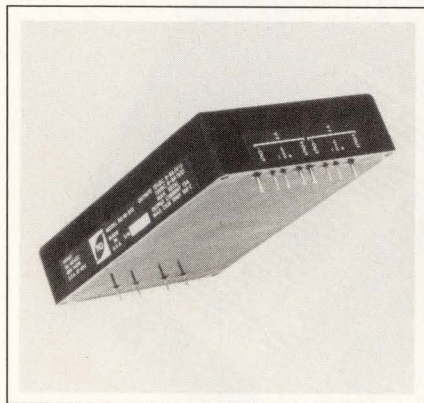


Submodular 60W Supply

You can use PK 60 FKK submodular, 60W switch-mode power supply in 19-in.-wide card cages that comply with DIN 41494, part 5. The units, which are 100 mm high and

160 mm deep, produce their full rated output continuously at 70°C. A heat sink mounted on the front of the units conducts the heat dissipated within the modules outside the card cage. The units offer switch-selectable ac inputs of 110V and 220/240V. \$275.

Bicc-Vero Electronics, 1000 Sherman Ave, Hamden, CT 06514. Phone (203) 288-8001. FAX (203) 287-0062. Circle No. 390



125W, Dual-Output DC/DC Converters

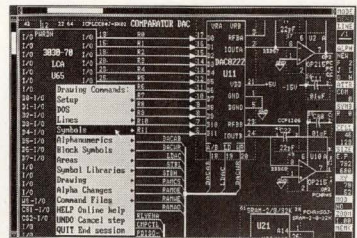
If you maintain its case temperature below 100°C, the 0.98 x 3.4 x 4.85-in. RO48-D512 dc/dc converter can produce 125W. The unit has two floating outputs—5V at 10A max and 12V at 8A max. Input-to-output isolation is 5500V. You must limit the current you draw from one or both outputs to hold the total power to the rated maximum value. For operation without a heat sink, the thermal resistance from the case to ambient air is 2.5°C/W. Efficiency is approximately 80%. The converter can operate in an N+1 redundant configuration with true current sharing (no master and no slaves); it can withstand being plugged into or unplugged from live circuits. The unit complies with MIL-STD-810D as well as with UL, CSA, and IEC requirements. \$325.

RO Associates Inc, Box 61419, Sunnyvale, CA 94088. Phone (408) 744-1450. FAX (408) 744-1521.

Circle No. 391

NEW

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No matter what schematic editor you now use, Data I/O's new FutureNet-5 Schematic Designer Software will give you more power and better results—in less time.

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NEW FutureNet-5, just \$895!** FutureNet-5 will knock your socks off with an enhanced design environment, dialog boxes, symbol browser, and other advanced features. An OrCAD translator is also available to translate OrCAD schematics and symbols into FutureNet-5's easy-to-use format.

We'll even **guarantee** your satisfaction within 30 days, or your money back.

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*Users of previous DASH™ or FutureNet versions from Data I/O may upgrade to FutureNet-5 for only \$595.

**Price valid in U.S.A. only.

The Personal Silicon Experts

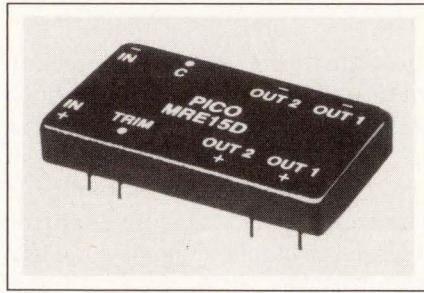
DATA I/O

Corporation

Power Sources

0.3-In.-Thick, Military DC/DC Converters

You can order dc/dc converters from the MR Series with environmental screening conforming to MIL-STD-883. The 36 2.5W-output units provide I/O isolation and have shielding on all six sides, yet they are only 0.3 in. high. You can plug

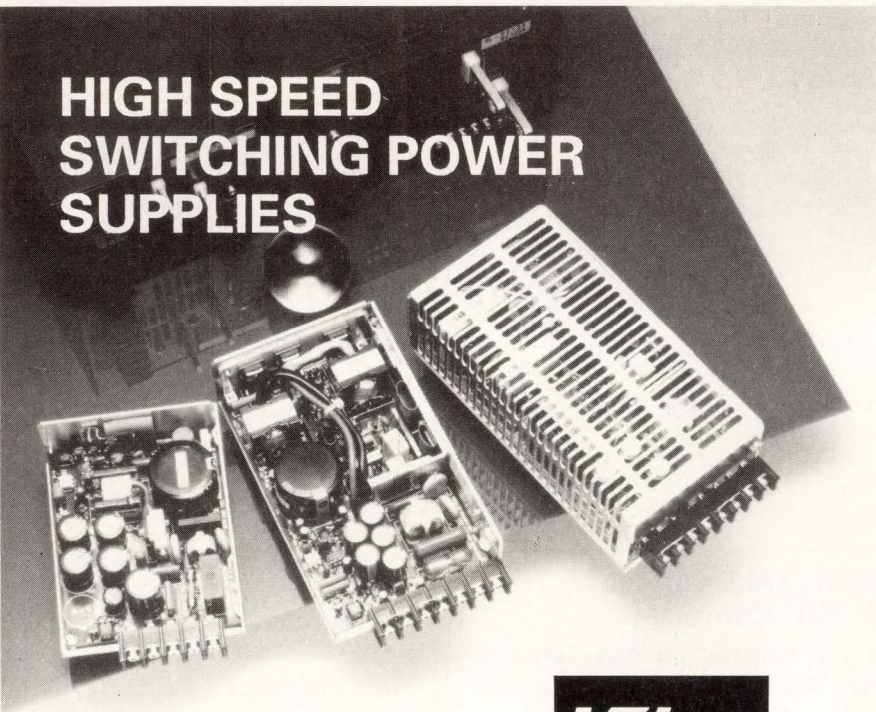


the converters into 32-pin DIP sockets. The units provide full-rated power from -55 to $+85^{\circ}\text{C}$ without need of a heat sink. \$295.

Pico Electronics Inc, 453 N MacQuesten Pkwy, Mount Vernon, NY 10552. Phone (800) 431-1064; in NY, (914) 699-5514.

Circle No. 392

HIGH SPEED SWITCHING POWER SUPPLIES



THREE NEW LINES HIGH QUALITY COMPETITELY PRICED



QUALITY FIRST

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- In-Line Input/Output Terminals
- Universal Input AC85-264V
- 15, 30, 50, 70W Triple Output
- Safety: UL1950, CSA 950, EN 60-950
- EMI: FCC/VDE 0871 Class "B"
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PRK Series

- Switches at 60 to 300 KHz
- Input Range AC 85-132V
- 15, 30, 50 70W Dual & Tripe Output
- Safety: UL, CSA
- EMI: FCC Class "B"

MRE Series

- Switches at 300 KHz
- Universal Input AC85-264V
- Miniature Size
- 15 and 30W Single Output
- Safety: UL, CSA, TUV
- EMI: FCC/VDE 0871 Class "B"

— 2 YEAR WARRANTY —

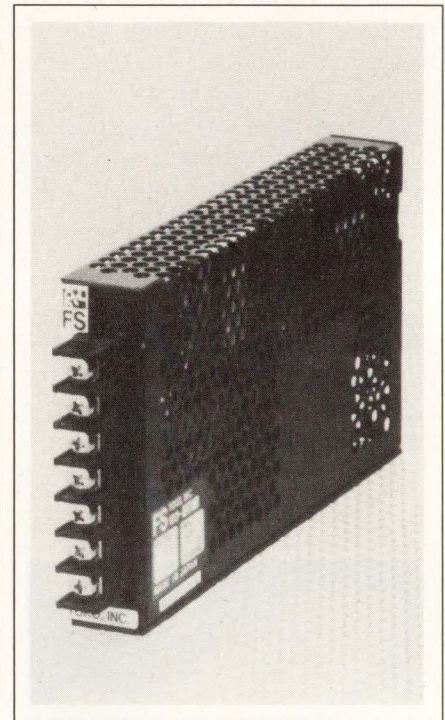
Volgen also features top quality custom services and standard unit modifications. Check out our New VME Bus & 2W Board Level DC/DC'S.

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(408) 945-9100

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(708) 981-5655

Volgen America Inc. 39650 Liberty Street, #325, Fremont, CA 94538
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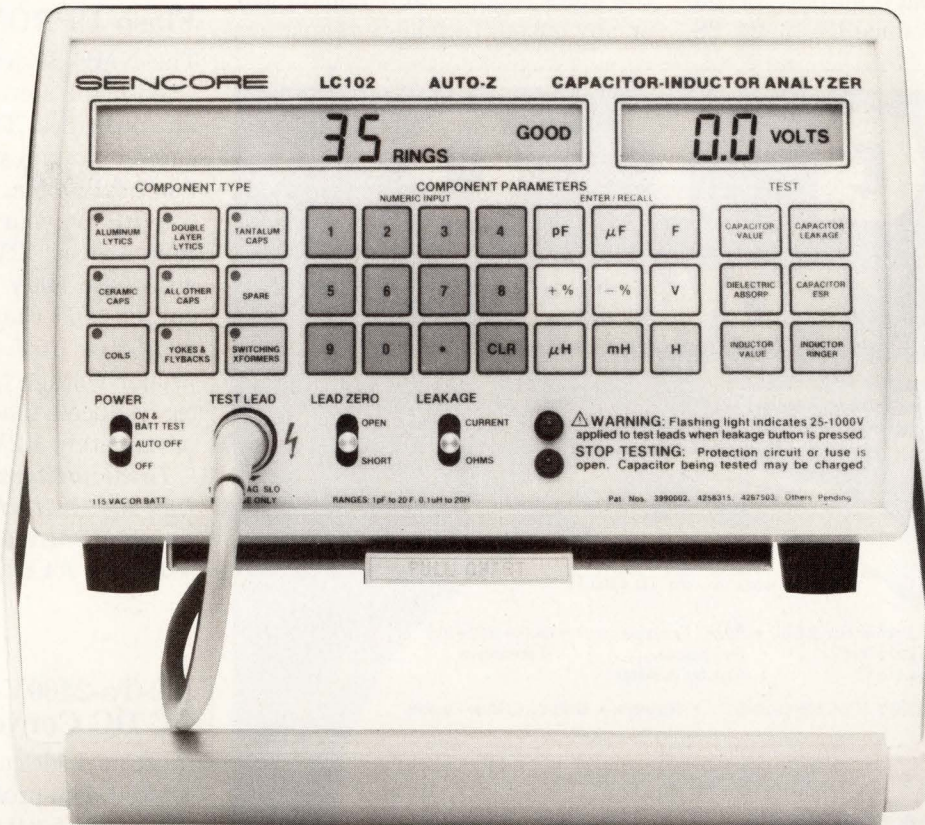


1-In.-Thick, 100W AC-Input Supplies

FS100 series supplies produce 100W from a $1 \times 3.8 \times 6.7$ -in. package. The units, which operate from 100V ac, produce 5, 12, 15, or 24V dc with efficiency of 78 to 82%. Overcurrent protection operates at 105% of full load. Recovery from overload is automatic. The units also include overvoltage protection. All models meet FCC class-A standards for electromagnetic interference. The vendor has applied for recognition under the UL478 and CSA A22.2 safety standards. From \$228. Delivery, eight weeks ARO.

Toko America Inc, 1250 Feehanville Dr, Mount Prospect, IL 60056. Phone (708) 297-0070. FAX (708) 699-7864. Circle No. 393

For Switched Mode Power Supplies— There's Only One True Dynamic Component Analyzer!



Capacitors:

A switching power supply can easily use 35 or more capacitors. Any one can cause the circuit to fail or even avalanche. Only the Auto-Z allows you to dynamically catch all 4 failure modes eliminating your need to ask, "Is the cap good or bad!"

- Capacitor Value
- Dielectric Leakage (up to 1 kV applied)
- Dielectric Absorption, patented
- Equivalent Series Resistance, patented

Switching Transformers:

A defective switching transformer can easily take out switching transistors and other valuable components. Only the **patented** Auto-Z provides a guaranteed 100% reliable "Ringer" test to catch even a single shorted turn, an open winding, or a completely shorted transformer. The Auto-Z eliminates the need to stock parts inventory for all the brands of switching supplies.

Transistors/Diodes:

Many switched mode power supply failures occur only at full operating voltage. Only the Auto-Z tests components for breakdown at full operating voltage, catching defects that static testers miss. Never order a component again just because you couldn't fully test it.

The Auto-Z is also great for analyzing inductors, SCRs, Triacs, transmission lines, and high voltage components.

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Call 1-800-SENCORE Ext.500!

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Power Sources

2- And 3-Output, UL 544-Compliant Supplies

The MDU2-40 and MDU3-40 Series are double- and triple-output, 40W supplies that conform to the UL 544 safety standard for medical and dental equipment. All models have a 5V, 5A primary output. Secondary outputs produce 12, 15, 24, 28,

and -5V. The units, which measure 3×5×1.5 in., have a universal, 85-to-265V input (100-to-380V optional) and incorporate a line filter that meets FCC class-B interference requirements. Unlike many multiple-output switching supplies, the units require no minimum load on any output to achieve regulation.

The vendor claims that the supplies' MTBF exceeds 205,000 hours. \$70 to \$74 (100).

Power General, Box 189, Canton, MA 02021. Phone (617) 828-6216. Circle No. 394

Flash EPROM Supply

The NMF Series is a group of isolated dc/dc converters in single in-line packages. The modules provide supply voltages for programming flash EPROMs. The units occupy 0.18 in.² on your pc board. They accept a 5 or 12V input. The units withstand 500V between input and output, and they produce 5, 9, 12, 12.75, or 15V. By applying the proper voltage to a control pin, you can reduce a module's output to approximately 1.2V. \$12 (OEM qty).

International Power Sources Inc, 200 Butterfield Dr, Dept 8536, Ashland, MA 01721. Phone (508) 881-7434. FAX (508) 879-8669.

Circle No. 395

100-To-2400V-Output DC/DC Converters

D series dc/dc converters are encapsulated, low-profile units that measure 1.5×1.5×0.63 in. They produce isolated high voltages at low power levels. The standard input is 10V, but the vendor can supply units that operate from supplies of 5 to 28V. Output voltages range from 100V at 250 μA to 2400V at 50 μA. Units rated to produce 500V or less can have regulated outputs. All units are short-circuit proof and have filters and shielding to limit electromagnetic interference. MTBF exceeds 100,000 hours. \$31 (100).

Emco High Voltage Co, 11126 Ridge Rd, Sutter Creek, CA 95685. Phone (209) 223-3626. FAX (209) 223-2779. Circle No. 396

Programmable Supplies

PPS series units are programmable, series-regulated benchtop supplies.

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BROADEST LINE

- Up To 4000A - Up To 6000V

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CIRCLE NO. 45



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More Nickel-Cadmium Power For All Your Portable Power Needs.

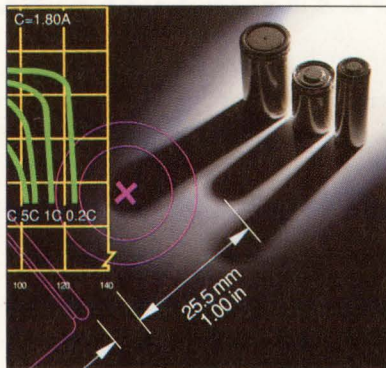
Marathon, a pioneer in nickel-cadmium power systems, introduces its new world class line of sealed, rechargeable cells. With standard, fast charge and high temperature capabilities, Marathon provides the power for all your portable power needs.

New ValuPower cells deliver excellent runtimes and power delivery for all standard applications, plus fast charge capabilities for one-hour recharge. They will provide the power for unmatched performance from portable appliances, consumer electronics, communications equipment, lighting and toys.

XtraPower cells give you maximum power delivery and longer runtimes. They are the ideal power source for portable power tools and hand-held vacuums.

MaxPower cells provide maximum charge acceptance, capac-

ity delivery and long life at high temperatures. They set the standard for rechargeable power in low to moderate discharge applications.



Unmatched Design and Engineering Responsiveness To Meet All Your Power System Needs.

Marathon brings over 35 years of proven design and engineering experience with sophisticated batteries and electronic power and conversion systems for the world's most advanced military and civil aircraft to your portable power needs.

Our in-house design and

engineering capabilities provide the flexibility to tailor innovative solutions to every customer's needs. And we translate highly technical specifications into practical, producible prototypes faster than anyone in the business.

From design to assembly, shipping and service before and after the sale, Marathon sets the standard for customer responsiveness. And always at a competitive price, no matter what the size of your order.

World class sealed, nickel-cadmium rechargeables coupled with unmatched design and engineering responsiveness—that's the power of Marathon. Put it to work for you today.

For more information call Marathon at (817) 776-0650.

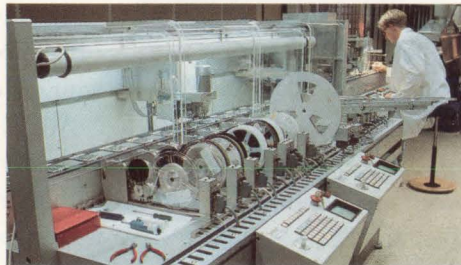
 **Marathon Power Technologies**
Power Technology Worldwide
P.O. Box 8233, Waco, Texas 76714-8233



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

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

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



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

The first product, the PKA 25 to 40 Watt converter, set the standard and is still the market leader by far. Using hybrid construction and 300 kHz

switching it's the world's smallest converter to offer full power operation at 85°C. And with ceramic capacitors for filtering and effective thermal management design, it has a demonstrated MTBF of over 200 years!

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

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

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



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

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



Power Sources

You can control and monitor their outputs either from their front panels or via the IEEE-488 bus. You can also calibrate the supplies without removing their covers. The PPS-10710 has a single 0-to-7V, 10A output; the PPS-1322 has a 0-to-32V, 2A output; the PPS-2322 has two 0-to-32V, 2A outputs; and the PPS-1325 has one dual-range output that produces 0 to 32V at 2A or 0 to 12V at 5A. PPS-10710, \$995; PPS-2322, \$795; PPS-1325, \$695; PPS-1322, \$495.

American Reliance Inc, 9241 E Valley Blvd, Rosemead, CA 91770. Phone (818) 287-8400. FAX (818) 287-8855. Circle No. 397

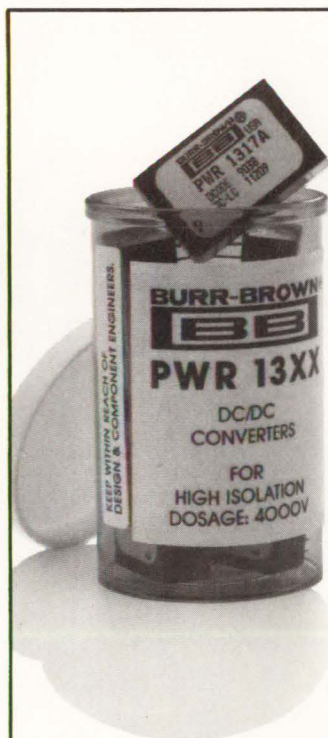
Universal-Input, Open-Frame Supply

Units in the US150 series are miniaturized, low-profile, open-frame, 1-to-4-output, universal-input switch-

ing supplies that measure 6.8×3.8×1.5 in. They deliver 150W with 20 ft³/minute of forced-air cooling. With convection cooling, the supplies deliver 100W. Efficiency is 78 to 82%. The ac input range covers 90 to 264V, and the vendor supplies the units with line filters that conform to FCC and VDE class-A or -B specs.

To achieve regulation, you must draw at least 3A from the primary (5V) output. On units with two or more outputs, you must also draw at least 1A from the second output. Load regulation is ±0.5% on primary outputs and ±5% on secondary outputs. \$142 to \$152 (100); \$0.60/W (OEM qty). Delivery, stock to eight weeks ARO.

Digital Power Corp, 686 E Gish Rd, San Jose, CA 95112. Phone (408) 288-5600. FAX (408) 288-9537. Circle No. 398



For The Health Of Your Monitoring Systems, Burr-Brown Prescribes PWR13XX.

The DIP DC/DC Converter For Ultra High Isolation: 4000V.

Medical grade isolation is yours with a dose of 1.5 watts of unregulated output power from the PWR13XX. Its dual-in-line package uses only 1 inch² of PC Board space and comes in low prices that are easy to swallow.

Use as needed for applications where system integrity and reliability are critical. No external parts required.

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0007: Command /I2(Inquiry) 00 00 00 30 00
0000: Data-In /00 00 01 01 29 00 00 00 43 4F 4E 4E 45 20 20
0010: 43 70 33 34 30 20 28 34 30 60 62 20 33 2E 35 29
0020: 28 30 34 20 42 30 31 33 34 42 20 20 20
0038: Status /00
003C: Message-In /00
003D: Bus free
003F: Arbitration w.ATN /80
0041: Select w.ATN /C0
0044: Message-Out/CO(Identify)
0045: Command /08(Read) 00 00 10 01 00
0048: Message-In /04(Discconnect)
004C: Bus free
004E: Arbitration /40
0050: Select /C0
0052: Message-In /80(Identify)
0053: Data-In /00 00 00 00 12 34 56 79 12 34 56 7E 12 34 56 7F
0063: 12 34 56 7C 12 34 56 70 12 34 56 7E 12 34 56 7F
    
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CIRCLE NO. 47

**Power
tool**



Power tools

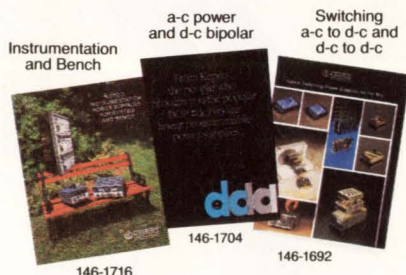
KEPCO TEST/BENCHTOP POWER SUPPLIES

The correct tool makes any job easier. Kepco's Power Supplies for workbench, for burn-in, and float-charging batteries are just some of the tools at your disposal.

For your workbench choose a multi-out array that you configure for the application by plugging-in modules with adjustable outputs. You can combine one, two or three modules in convenient bench-top housings or put six of them together in a rack. Other experimentalist power includes a nice selection of 100W single output instruments (MSK), a triple output logic-analog model (MPS), and burn-in/float chargers (TBC) that range from 300 to 3000 Watts in all the popular voltages.

Custom power assemblies allow you to create your own toolkit with just the selection of voltage and power to fit your need.

Other power tools from Kepco include: *ac power* to 18KVA, precision *programmable dc* for test applications, *high voltage* models and four-quadrant *bipolar power*. For these, and our broad selection of *switching power* models, including *d-c to d-c converters*, please ask for one of the three catalogs illustrated below.

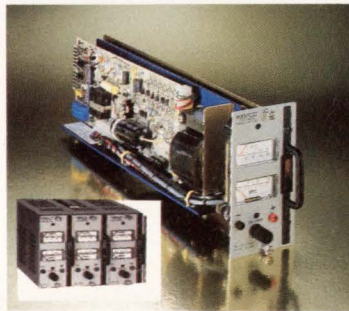


146-1716

146-1704

146-1692

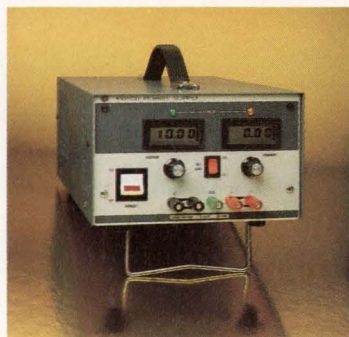
Call/fax/write Dept. LXT-12, Kepco, Inc., 131-38 Sanford Avenue, Flushing, NY 11352 USA (718) 461-7000 • Fax (718) 767-1102 • Easylink (TWX) • 710-582-2631



Plug-in power

- 20 Watt modules, either voltage stabilizers (series PCX-MAT) or current stabilizers (series CC).
- Sized to plug-in six abreast in a 19" rack or in bench-top housings for 1, 2 or 3 units.
- Mix or match.
- Select from six voltage ranges up to 100V.

Kepco Group PCX-MAT and CC Power Supplies



100 Watts of precision benchtop power.

- LCD meters to set the level accurately, a preview feature to check your setting before applying power to your load.
- Linear design for low-noise high stability.
- Ten-turn controls for good resolution.
- Five models offer outputs up to 125 Volts.

Kepco Group MSK Power Supplies



A triple output design for maximum convenience.

- 0-6V at 5A for logic and a tracked \pm 0-20V, 1A for analog.
- Each output current limited, the 0-6V output has an overvoltage protector.

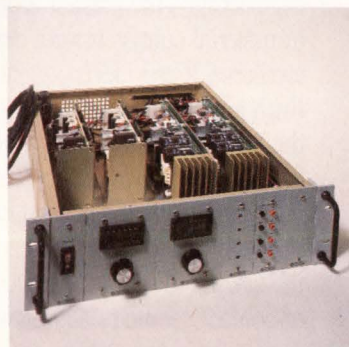
Kepco Group MPS Power Supply



Battery/float-chargers.

- For telecommunications: maintain 12V, 24V and 48V batteries, built-in equalize timer.
- For burn-in: power up to 3000 Watts, current limited, over-voltage protected. Two output settings, remotely selectable for margining.

Kepco Group TBC Float Chargers/Power Supplies



Kepco Custom System Power Assemblies

We will stuff a 19" rack (5 1/4 or 7") full of switchers to your requirement. With modules from 3 Watts to 3000 Watts, in a wide selection of voltage ranges, we can accommodate most needs.

- LCD output meters.
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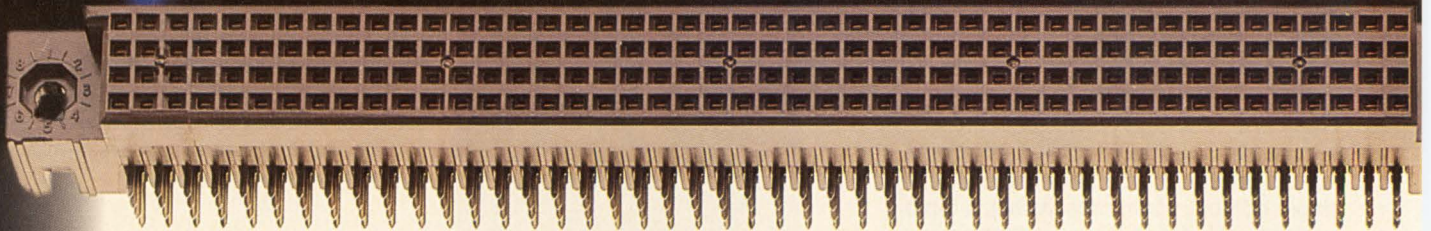
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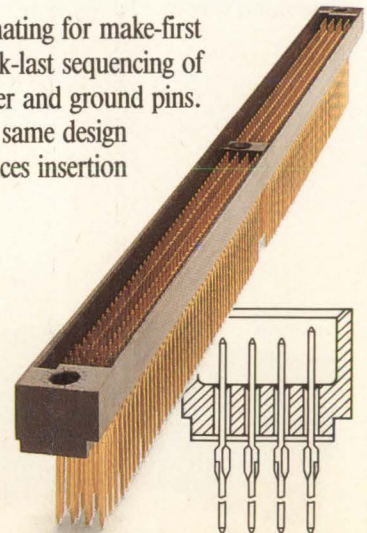
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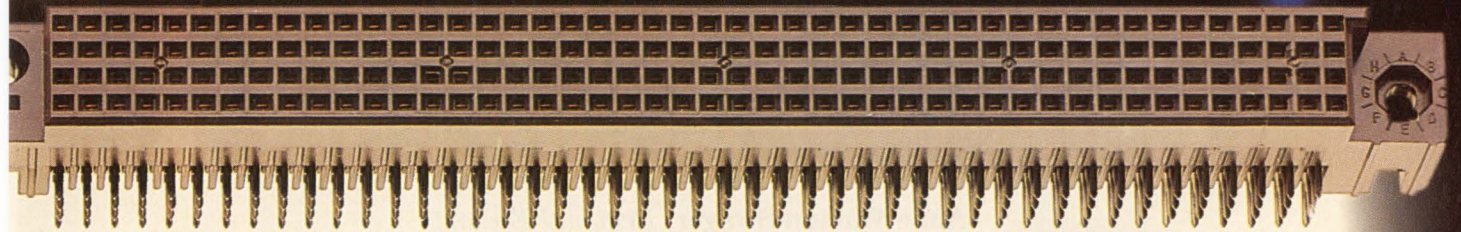
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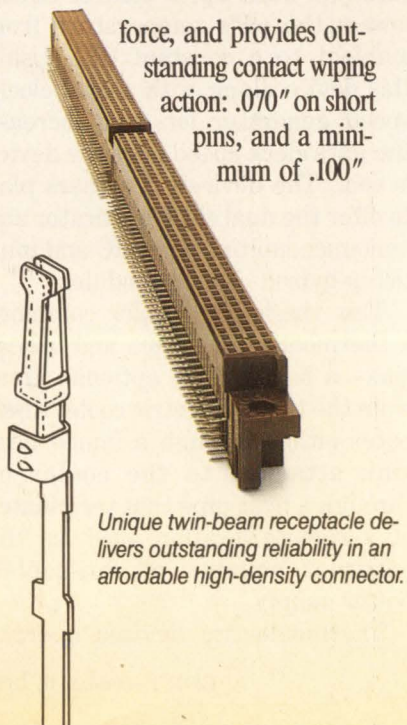
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AMP Interconnecting ideas

Methods converge to cool fast and dense circuits

Anne Watson Swager, *Regional Editor*

High component densities and operating speeds continue to back circuit designers into a thermal corner. Using familiar tools with a design philosophy that considers both electrical and thermal characteristics helps them fight their way out.

Manipulating the thermal characteristics of an IC to achieve optimum performance is a growing design philosophy. The alternative is designing the circuit from a purely electrical standpoint and then dealing with overheating just to maintain acceptable performance. Computer designers have used low-temperature design techniques for years to achieve superfast speeds. But the universally increasing density and speed of what were once low-power-producing ICs and circuits is forcing the philosophy to spread.

Fortunately, the increased recognition of heat-producing problems has led to some innovative uses of passive and forced-air systems as well as heat pipes and thermoelectric devices. Thermal-management companies, component suppliers, and enclosure manufacturers are all working to dissipate the heat today's circuits produce. The tools they're using—heat sinks, fans, heat pipes, thermoelectric devices, and liquid cold plates—are nothing new. What's new is the widespread and innovative application of these devices.

One new product epitomizes the philosophy of teaming thermal con-

trol with circuit performance, and shows what you can achieve by combining cooling techniques. The Icecap 486 (approximately \$150 (OEM qty)), Velox Computer Technology's first product, combines heat-removal and -sensing techniques to cool Intel Corp's 80486 μ P. The device doesn't cool the chip just to keep it from burning up; the cooling increases the chip's speed from 33 to 50 MHz. An integral sensor measures the device's temperature. On start-up, a control circuit lowers the μ P's temperature from ambient to a constant 0°C. Using this device along with a dual clock-speed generator lets you increase the μ P's clock speed once the device is cool. The device's designers plan to offer the dual clock generator and announce multipackage-IC and multichip-hybrid cooling modules.

This single-chip cooler combines a thermoelectric device and a heat sink—a heat pipe is optional. Heat from the thermoelectric cooler dissipates either through a finned heat sink attached to the cooler or through a heat pipe that terminates at a remote location, such as the external housing or fan-cooled power supply.

Thermoelectric devices operate

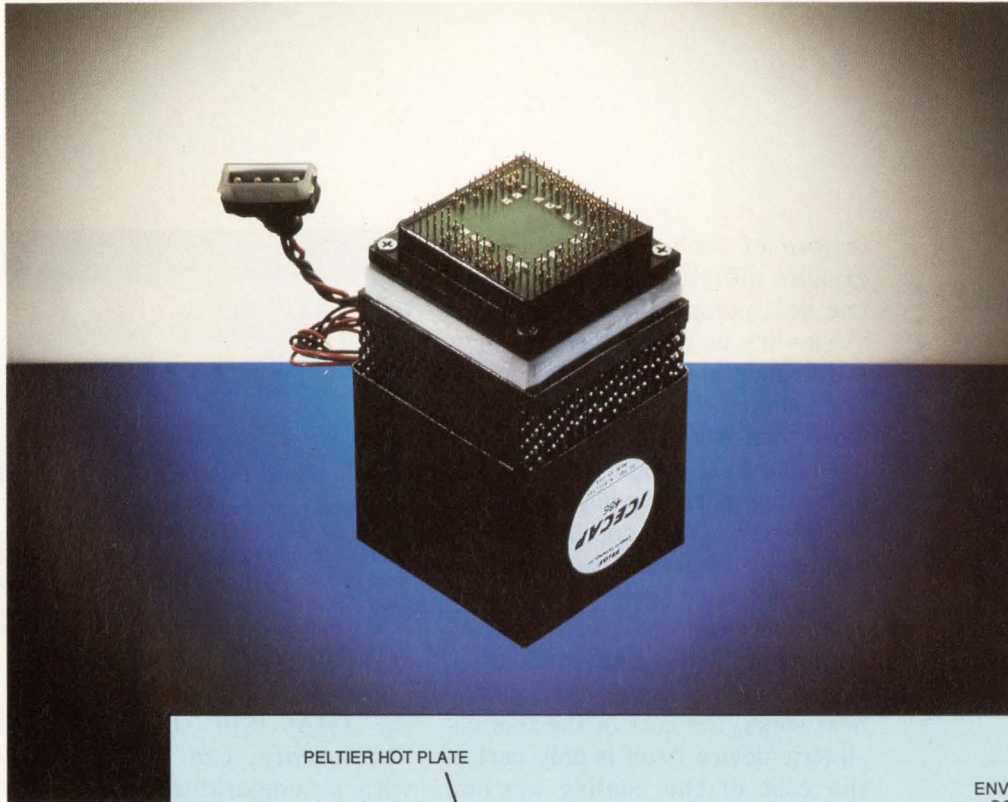
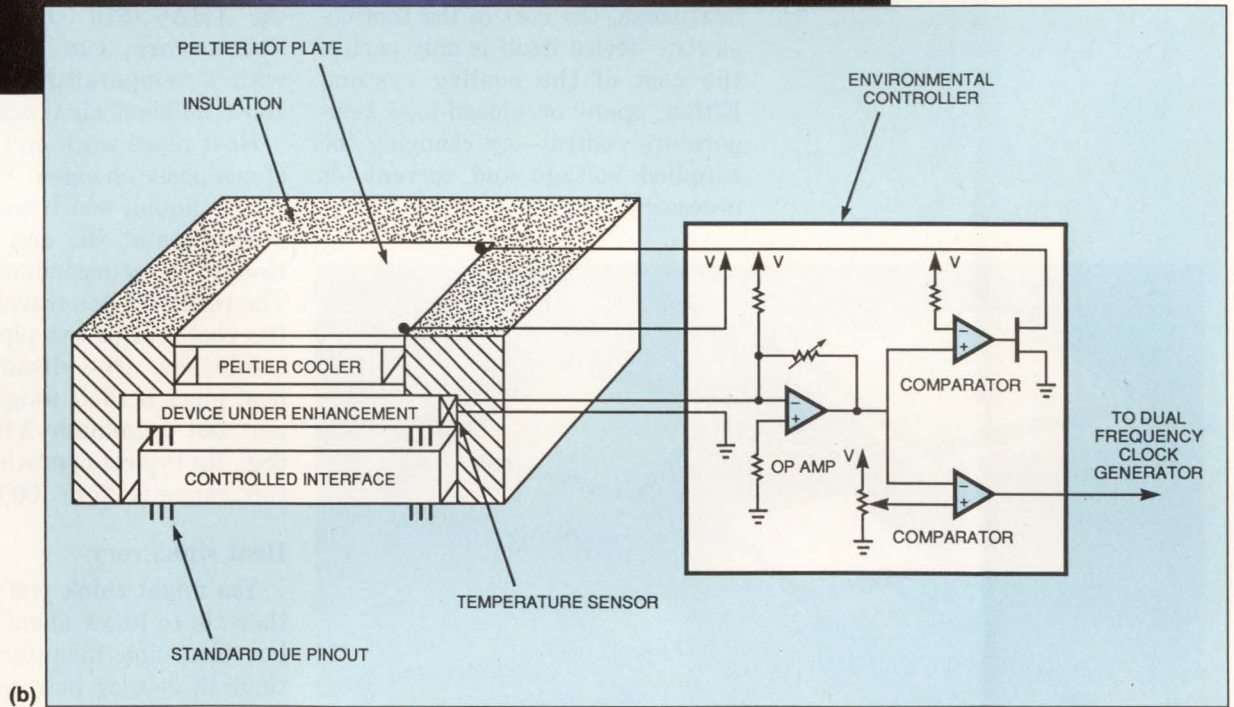


Fig 1—The Icecap active cooling device (a) from Velox Computer Technology has both a thermoelectric heat pump and control circuitry (b). By cooling a 80486 μ P to 0°C, the device increases the processor's operating speed from 33 to 50 MHz.

(a)



(b)

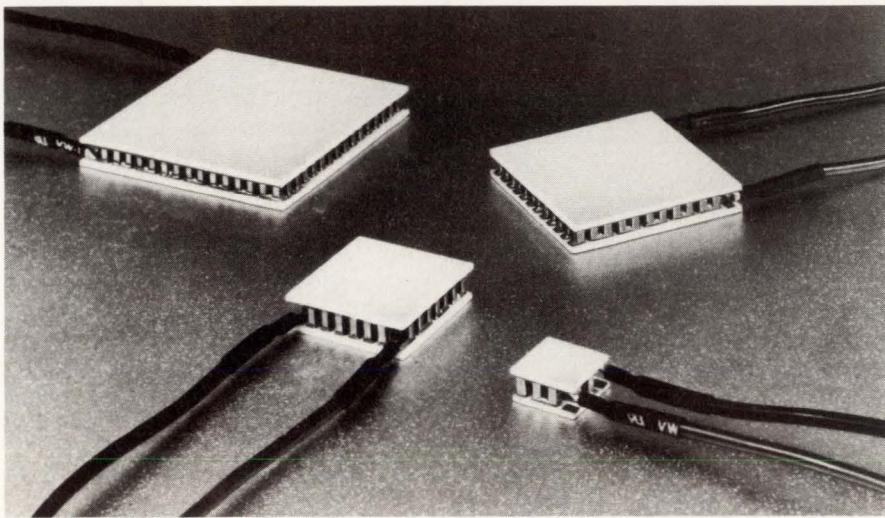
on the same principle—the Peltier effect—as thermocouples, but in reverse. A thermocouple uses the voltage generated at the junction of two dissimilar metals to indicate temperature. A thermoelectric device externally applies a voltage to a pair of metal junctions causing one junction to heat up and the other to cool down. The device pumps the heat absorbed at the cold junction to the hot junction at a rate proportional to the current passing through the circuit.

Thermoelectric modules are available from Melcor and Marlow Industries in a variety of sizes, shapes, operating currents and voltages, and heat-pumping capacities. Melcor's modules cost \$5 to \$70, depending on type and quantity. Sizes vary from approximately 1 to 2 in. square. Most devices have an operating-temperature range of -150 to $+80^{\circ}\text{C}$. Single-stage thermoelectric devices can produce temperature differentials of approximately 65°C . You can stack modules

The increasing density and speed of what were once low-power-producing ICs and circuits are forcing designers to consider heat-removal methods up front.

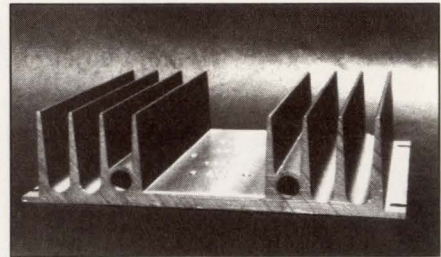
on top of each other to achieve greater differentials. Thermoelectric heat pumps are strictly dc devices—any ac component on the dc is detrimental to the device's operation. Manufacturers recommend no more than 10% ripple.

Unlike heat sinks, these devices are not general purpose. Thermoelectric devices fill specific requirements: an unusual space and size constraint, such as the Icecap's footprint over the 486 μ P, or an environmental constraint, such as operating in a vacuum. Also unlike heat sinks, the cost of the thermoelectric device itself is only part of the cost of the cooling system. Either open- or closed-loop temperature control—by changing the supplied voltage and current—is necessary.



Thermoelectric devices pump heat between two junctions based on the amount of current you supply. Typical units from such vendors as Melcor measure $1 \times 1 \times 0.25$ in.; subminiature devices are as small as $0.16 \times 0.16 \times 0.11$ in.

Heat pipes are simply that: heat conduits. In and of themselves they do not dissipate heat. Instead, they deliver heat away from your circuit to a point where the heat can more easily dissipate. Companies such as Thermacore and Noren Products often attach aluminum fins to the heat pipe. The heat pipe carries the heat to the fins where it dissipates to the air by natural or forced convection. One 1.25×1.25 -in. model,



Equipped with two 0.438-in. diameter holes, the HS11 heat sink from Apex Microtechnology can cool two T0-3 amplifiers in the 100W range by natural convection, natural convection with forced air, or natural convection with water flowing through the pipes.

the XHA6 (\$10 (OEM qty)) from Thermacore, can dissipate 60W with a temperature rise of 60°C above ambient air temperature.

Heat pipes work on the principle of gas-phase changes. The pipe contains a liquid, which heats and then evaporates at the end of the pipe close to the semiconductor junction. The resultant gas travels quickly to the cool end of the pipe, where it condenses. One disadvantage of heat pipes is their weight. The copper and aluminum XHA6 weighs 68g. Its typical operating temperature range is 25 to 100°C .

Heat sinks vary

You might think you've heard all there is to know about heat sinks, but heat-sink manufacturers continue to develop new devices. They continue to design new styles and work with new materials. EG&G Wakefield Engineering recently announced a composite polymer heat sink. The Deltem heat sink is made from thermally conductive plastic and can remove heat from plastic surface-mount and high-lead-count IC packages.

These molded plastic heat sinks are extremely light and cheap. They reduce the thermal-coefficient-of-expansion mismatch that typically occurs when using aluminum heat sinks with plastic IC

packages. When attached with a thermally conductive adhesive to a package dissipating 0.75 to 3W, the heat sinks remove approximately 85 to 90% of the heat removed by same-size aluminum heat sinks at low airflows. However, the plastic Deltem heat sinks weigh 40% less and cost \$0.30 (10,000).

Available from both EG&G Wakefield and Aavid Engineering, folded fin stock is another type of heat sink. A thin sheet of metal—typically an alloy of aluminum, stainless steel, or copper—folds back on itself to create the folded fins. The advantage of this design is the large surface area. The alloys are lightweight and can be folded with various heights and pitches.

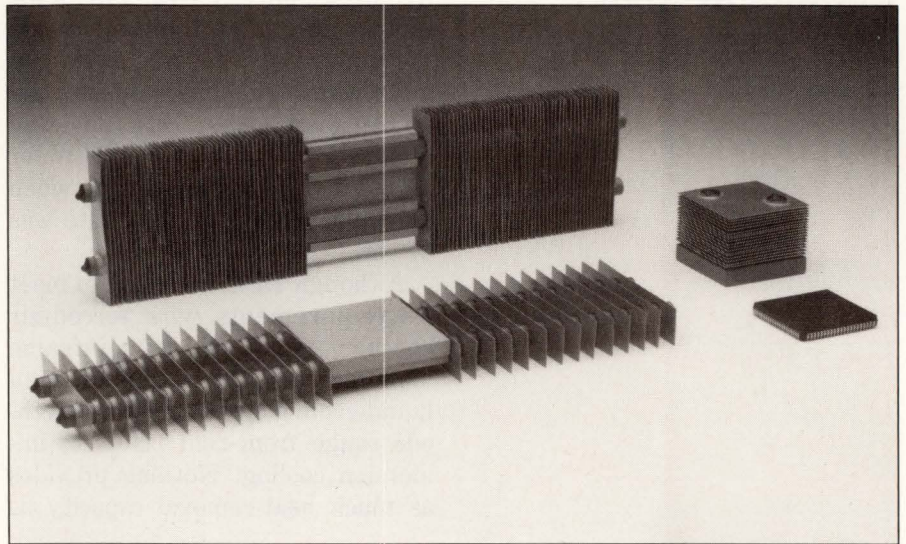
Available for approximately two years (Ref 1), 3M's liquid-filled heat-sink bags are an option for size-constrained systems. The bags contain fluorinert liquid—the same type of liquid used in many immersion-cooled systems. The liquid transports heat from the semiconductor it contacts to a cooler surface. NCR (West Columbia, SC) uses the liquid-filled bags in its Tower 32/200 supercomputer. The company estimates that forced-air methods fell short of the cooling objective by more than a factor of two. The liquid heat sinks reduced the temperature differences between components from 25°C for the forced-air version to about 8°C.

In addition to the advent of new heat-sink materials, more manufacturers of power components have started producing heat sinks for their devices. Apex Microtechnology, a power-amplifier manufacturer, early this year announced the HS11 heat sink (\$48.40 (100)) for high-power amplifiers in TO-3 or PD-12 packages. Intended for power amplifiers in the 50 to 100W range, the heat sink contains pipes through which you can pump either

air or water. You can also rely on natural convection. The heat sink's natural-convection thermal resistance is 0.7°C/W. Using forced air drops this number to 0.2°C/W. The device's water-cooled thermal resistance decreases to 0.1°C/W and

back pressure, and no net increase in air flow.

The company concluded that there are two critical aspects in cooling an enclosure. The first is how directed the air is. The second is the amount of room between the



Heat pipes conduct heat from one place to another. Heat-pipe vendors such as Thermacore often attach aluminum fins to the pipes to dissipate the heat by natural convection.

lower. Two TO-3 packages or one PD-12 can mount on the heat sink.

Enclosure manufacturers are doing more than before to ensure adequate cooling inside their cabinets. Electronic Solutions, a manufacturer of Multibus I- and VMEbus-based system enclosures, recently tested various fan configurations, sizes, and air velocities. By using two sensors to measure temperature and air flow across the surface of a board, the company found some useful results. The tests indicated that pulling air out of the enclosure doesn't work any more efficiently than blowing the air in. The tests also revealed that there was a maximum air flow through a given design space. Once you reach that maximum rate, adding more fans results in very little additional cooling. In fact, adding more fans in the box causes turbulence, more

box's inlet and the outside of the fan—in other words, the amount of back pressure on the fan. As a result, Electronic Solutions implemented a plenum—a gap in front of the fan where air can stabilize and pressurize—to direct the air flow more precisely and to avoid recirculating air inside the box. The gap ensures that the air flow into the card cage or power supply is uniform. The additional metal for the plenums has added a small cost to the Omega line of enclosures.

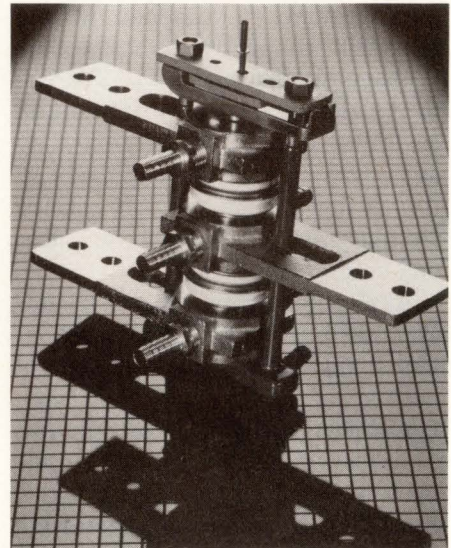
Mupac is also working to solve several heat problems. According to the company, many RISC-based systems are so power hungry that they're exceeding VME specifications. As a result, the company has changed the size and placement of fans in its 539 series of enclosures.

These enclosure manufacturers work almost exclusively with

Not all heat sinks are the same. Composite polymers and folded-fin stock are two examples of new heat-sink materials.

forced-air techniques. Although liquid-cooling techniques are common in high-end mainframe computers, you'd be surprised at what people are still doing with forced-air cooling. Digital Equipment Corp for instance, designed its VAX 9000 family of computers with forced-air cooling only. The company cooled the computers' internal multichip units with high-voltage dc fans and pin-fin heat sinks. DEC achieved thermal resistances of 0.14°C/W for a 4 × 4-in. aluminum heat sink when the impingement air flow rate was 31 cfm.

Although DEC managed to meet its requirements with forced-air cooling, many other mainframe manufacturers have implemented liquid-cooling systems. These methods range from cold plates to immersion cooling. Nothing provides as much heat-removal capacity as



Liquid-cooled systems handle extremely high heat fluxes. The elements to implement such systems include standard cold plates and this standard 4600 series cast bus-bar cooler (\$22 (100)) from Aavid Engineering. Note, however, that most liquid-cooled systems comprise custom parts.

For more information . . .

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

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Thermal-management companies, component suppliers, and enclosure manufacturers are working to dissipate the heat today's circuits produce.

liquid cooling. Estimates from manufacturers vary, but if your power levels exceed 10 to 25 W/in.², forced air won't be adequate. You might also need to consider liquid cooling if your board or system demands extremely uniform temperatures or if you have unique packaging requirements.

One distinct advantage of liquid cooling is the absence of acoustic noise that fans create. However, potential users of liquid cooling are more concerned with what they perceive to be liquid cooling's major disadvantages: cost and reliability. Liquid cooling adds cost, but just how much is difficult to quantify. Chris Soule, a senior engineer with Aavid Engineering, ventured some numbers. The cost of a heat sink

field Engineering, and Lytron Inc for them to quote a price. On the positive side, companies with cold-plate-design experience, such as EG&G Wakefield, offer extensive design help which costs you—if anything—surprisingly little.

The reliability of liquid-cooling systems isn't as easy to quantify as their cost. All cold-plate and heat-exchanger manufacturers can claim no failures of their parts in the field, but elements other than the plates themselves can fail. The joints that connect the piping to the cold plate are one potential problem. Manufacturers recommend you use as few joints, and preferably straight ones, as possible. You have to keep the fluid running through the system at less than 8 ft/sec to avoid eroding the cold-plate material. Also, mixing dissimilar metals throughout a liquid-cooling system might cause problems.

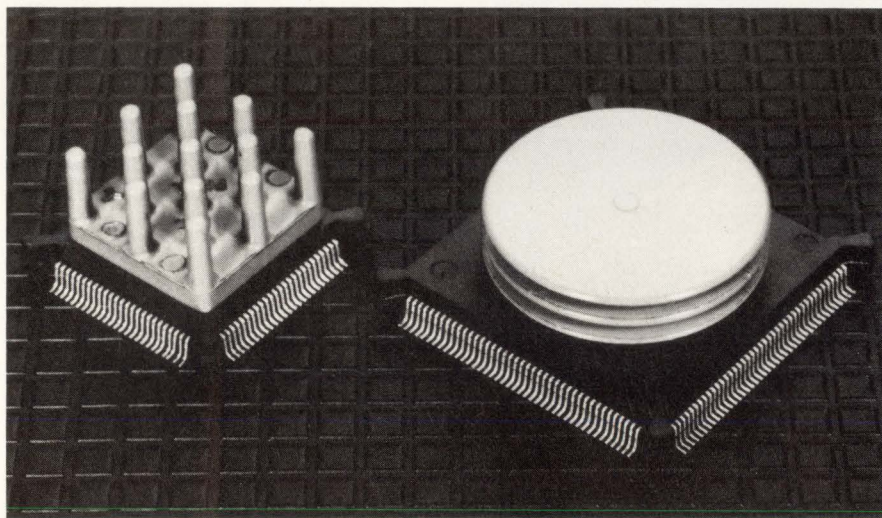
If the extent of designing a liquid system is starting to sound a little beyond your area of expertise—more like that of a thermal or mechanical engineer—you're right. But gaining an appreciation for the potential hardware complexity will push you to do some power-density calculations. If the number starts pushing 10W/in.², start reviewing your options and get a thermal engineer involved—or consult with a thermal-management company or specialist—as early in the design cycle as possible. **EDN**

Reference

1. Swager, Anne Watson, "Circuit design requires thermal expertise," *EDN*, June 22, 1989, pg 93.

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Not all heat sinks are created equal. Using a thermally-conductive polymer material, the light-weight Deltem heat sinks from EG&G Wakefield Engineering can cool plastic IC packages for a low cost (\$0.30 (10,000)).

for a PGA (pin-grid-array) package, including the forced air, is around \$1.25. The average cost of a piece of copper tubing brazed to a copper cold plate, according to Soule, is \$8 to \$10. The cost increases if you need to add heat exchangers, a reservoir, and pumps.

Standard cold plates are available, but 80% of liquid-system designs are custom. You've got to provide drawings and specs to companies such as Aavid, EG&G Wake-



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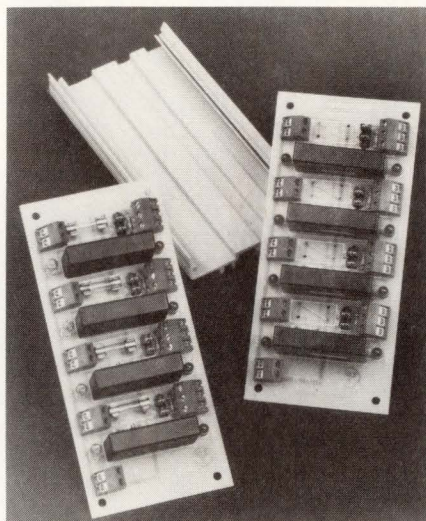
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Hardware and Interconnect Devices

Output boards connect ac or dc loads to control systems

Output boards for connecting ac or dc loads to control systems accept control signals from sensors or computers and drive the loads via on-board relays. The ac output board accepts input signals from 3 to 24V dc and the dc output board accepts input signals from 9 to 30V dc. On-board minijumpers permit the use of sink or source type input signals. Each relay on the ac output board has a 3A cartridge fuse.

LEDs indicate the input status on both boards. Neon lamps display the output status on the ac board and the dc board uses LEDs for the same purpose. The ac relays have



140V ac μ P, 3A max rating, and the dc relays have a 60V ac, 3A max rating. The input and output wiring terminations use the company's pressure-clamp connectors in a 45° wire-entry configuration, which eliminates sharp wire bends. The boards measure 2.7×6.0 in. and have corner holes for screw-mount installation. The dc output board is \$145, and the ac output board is \$95.

**Vernitron Corp, Box 10, Laco-
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Circle No. 705

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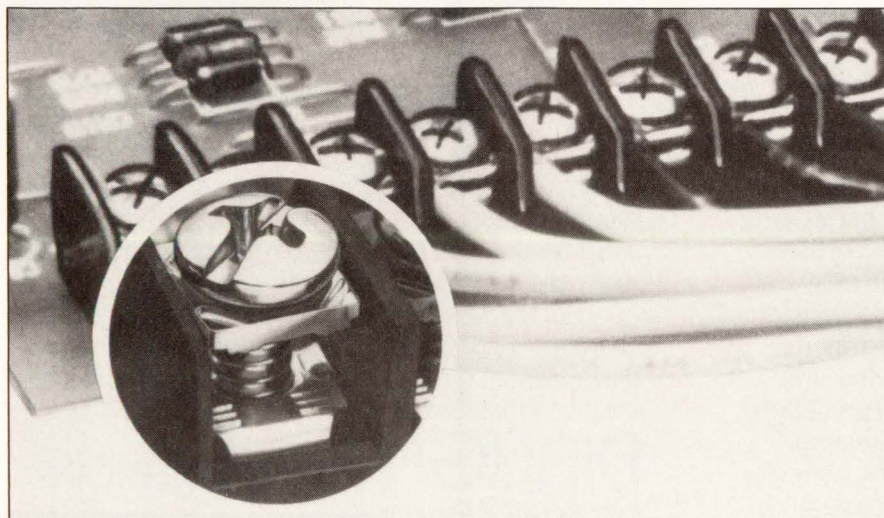
The Series SSB3 are single-screw barrier strips with 0.325-in. center-to-center spacing. The series is

available in strip lengths from 2 to 36 terminals. The units are resistant to wire pull-out and can accom-

modate #14 to #30 AWG wires. Backed-out recessed screws with interrupted threads prevent screws from falling out. Phil-slot screws accept both Phillips and straight screwdrivers. Additional features include elevated flat bases that allow flux and solvents to drain during soldering, polypropylene insulators, and molded-to-size strips that maintain circuit spacing when mounted end-to-end. Prices start at \$0.43 for a 2-terminal strip and \$5.76 for a 36-terminal strip.

**Amerace Corp, Industrial Elec-
trical Products, 530 W Mt Pleas-
ant Ave, Livingston, NJ 07039.
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Circle No. 706



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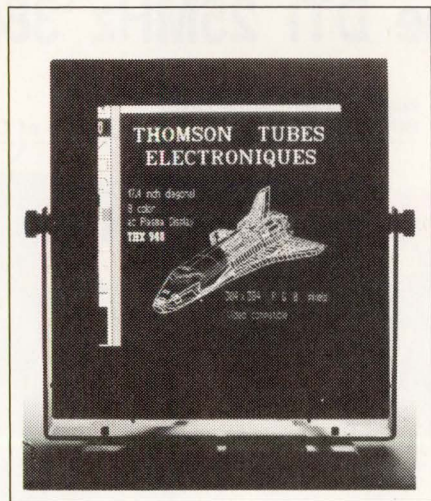
Fiber-Optic Connectors

The MST is a fiber-optic connector compatible with ITT's ST family of connectors. The connectors operate in single or multimode and feature a radial track design for the coupling ring. The radial track reduces the required rotation to mate with the connector.

The connectors accommodate tight and loose tube buffer cables that have jackets with outside dimensions as large as 4.4 mm. The multimode connectors are available with ceramic or polymeric alignment ferrules and have typical losses of 0.2 dB and 0.8 dB, respectively. The single mode connectors have ceramic alignment ferrules with a typical loss of 0.2 dB. Bulkhead and mating adapters and printed-circuit mount receptacles are also available. The plastic ferrule multimode connector is \$6.15, and the ceramic ferrule multimode connector is \$8.40 (100).

Method Electronics Inc, 7444 W Wilson Ave, Chicago, IL 60656. Phone (800) 323-6858; in IL, (708) 867-9600. FAX (708) 867-9130.

Circle No. 418



Color Plasma Display Panel

The 17-in.-diagonal THX 948 flat-screen color plasma display panel features a display area of 12.3 x 12.3 in. and a 384 x 384-pixel density with a resolution of 0.03 in. The de-

vice can display eight colors; the angle is 160°. Typical power consumption is 70W. \$10,000 (100).

Thomson Tubes Electroniques, BP 305, 92102 Boulogne-Billancourt Cedex, France. Phone (1) 49092828. FAX (1) 46045209.

Circle No. 419

DIP Test Clips

A series of six DIP test clips penetrate oxides built up on DIP ICs. The product family operates the same as standard test clips, but feature a stainless-steel surface coating on their serrated contacts, which provides good electrical connections on contaminated surfaces.

The clips provide hands-free testing of standard ICs with 8 to 40 pins. Molded insulating barriers separate the 1.02-mm wide, serrated and rough-coated contacts. The construction allows you to make connections on live boards without accidentally shorting adjacent contacts. The upper contact pins on the clips, which accept wire wraps or miniature test clips, are 0.64 x 0.71 mm. You can use flat-ribbon cables with 8- through 40-pin sockets to connect the clips to an instrument. From \$9.70 to \$31.

ITT Pomona Electronics, 1500 E 9th St, Pomona, CA 91769. Phone (714) 623-3463. FAX (714) 629-3317.

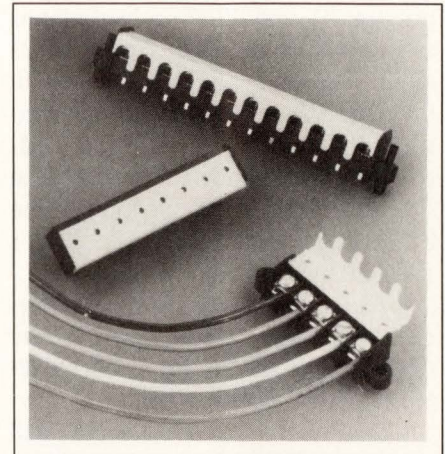
Circle No. 420

Wire-Wrap Panels

Lo-Wrap Panels are low-profile, wire-wrap panels. Though the panels use a low-profile socket, the sockets do permit two full MIL-STD-1130B wraps using #30 AWG wire. Available in 26 configurations, you can structure the panels for VME, Sun, VXI, MBII, Mupac Metric, or custom power commitments. \$305. Delivery, four to six weeks ARO.

Mupac Corp, 10 Mupac Dr, Brockton, MA 02401. Phone (508) 588-6110.

Circle No. 421



Terminal Strip

The Series 75H closed-side terminal strip features a captive, hinged cover. The 1-piece unit simplifies inventory and prevents loss of the cover. The cover features a snap closure to inhibit accidental opening. Probe holes in the cover aid testing. The terminal strips use a hardware-free mount that allows 1-sided mounting. The hinged cover, mounts, and insulating body of the terminal strip are made of a nonconductive, flame-retardant thermoplastic. Captive screw terminals are placed on 0.375-in. centers. The terminals accept a maximum #14 AWG wire and are voltage-rated to 250V rms for UL-recognized Class B equipment. 6-circuit strips, \$1.25 (500).

**Vernitron Corp, Box 10, Laco-
nia, NH 03247. Phone (603) 524-
5101. FAX (603) 524-1627.**

Circle No. 422

10-Layer VME Backplanes

A series of 10-layer VME backplanes handle fast VME signals with minimum distortion and crosstalk. The backplanes feature four signal planes, four power planes, two pads-only planes, an embedded microstrip design, evenly distributed power entry, on-board decoupling capacitors, three types of power connector options, Schottkey-diode clamping of critical signals, and wire-wrap connector

Hardware and Interconnect Devices

pins on J1 and J2. The backplanes are available in sizes from 2 to 21 slots. The backplanes also come in 6U heights, which include J2 connectors with VME extended addressing. Six versions have a choice of power and I/O connections. The 3-slot version costs \$297; the 21-slot version sells for \$1375.

Electronic Solutions, 6790 Flinders Dr, San Diego, CA. Phone (800) 854-7086; in CA, (619) 452-9333. TWX 910-335-1169.

Circle No. 423

Power Supply For The PS/2

The FS200-40 is a 200W power supply for the IBM PS/2 computer. The supply provides 5, 12, -12, and -5V dc at maximum current ratings of 20, 8, 0.5, and 0.5A, respectively. You can switch the supply to operate with an input voltage from 90 to 130V ac or from 180 to

250V ac at input currents of 4.2 and 2.4A, respectively. The input frequency can range from 47 to 63 Hz.

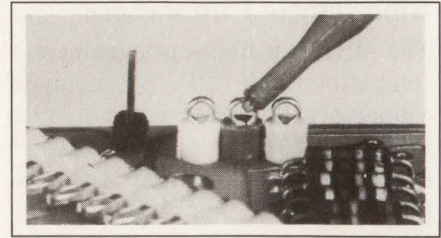
Other specifications include a minimum efficiency of 65% at 200W output; a holdup time of 16 msec; a line regulation of 0.5% max at full load; an inrush current of 50A at 115V ac or 100A at 230V ac at 25°C; operating temperature of 0 to 50°C; and an MTBF of 40,000 hours min. The supply measures 5.9 x 5.5 x 3.4 in. and costs \$34 (100).

Fortune/Source Corp, 6818-G Patterson Pass Rd, Livermore, CA 94550. Phone (415) 373-1008. FAX (415) 373-1168. TLX 559291.

Circle No. 424

Test Points

The TP-105 series are color-coded printed-circuit test points that directly replace header posts. The test points are available in ten col-



ors and offer from one to ten positions with 100 mil spacing. The 0.035-mil-hole-diameter loops provide a positive anchor for probes and spring-loaded test clips. The test-point's collars are made from an Underwriters Lab-recognized, glass-filled nylon insulator. A break-away strip format, similar to header connectors, let you use as many or as few test points as you need. Depending on quantity, \$0.05 to \$0.08 each.

Components Corp, 6 Kinsey Pl, Denville, NJ 07834. Phone (201) 627-0290. FAX (201) 361-5801.

Circle No. 425

Inquire about DTI's Price Reductions on the '386' / '486'™ Single Board Computers

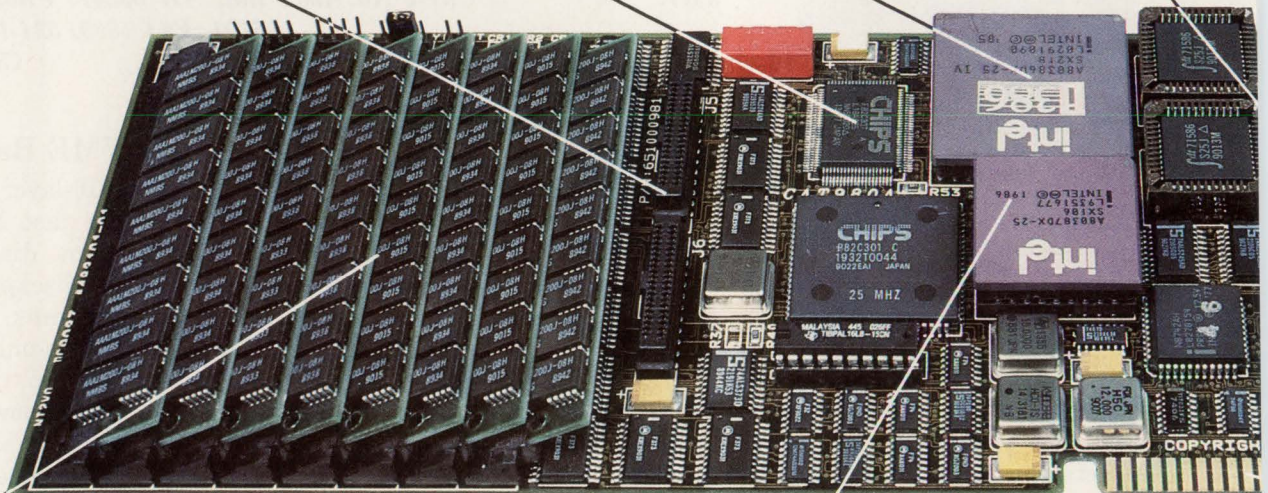
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32Kb of CACHE



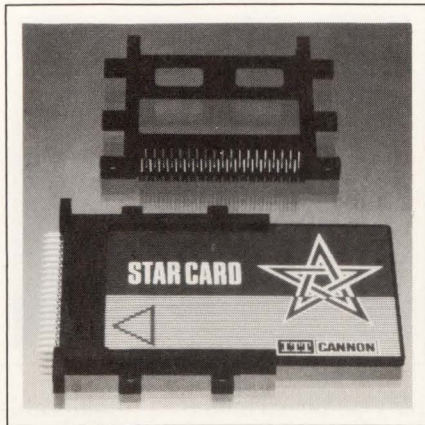
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80387 Math Co-Processor

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SERIES

Hardware and Interconnect Devices



Edge Connectors

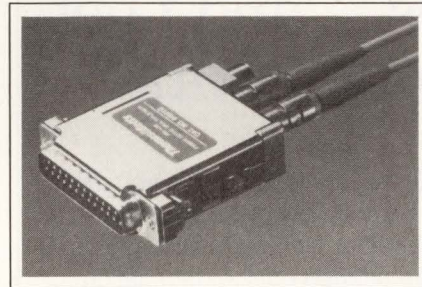
The DICM family is a high-reliability edge connector that is tested to withstand 50,000 mating cycles. Reliability is ensured via a low insertion-force requirement and a protected contact system on both the card and connector. An audible click assists you in achieving constant positive alignment of the connectors. The connectors are available

in either straight- or right-angle versions. \$5.25 (100). Delivery, four to six weeks ARO.

ITT Cannon Components Div,
1851 E Deere Ave, Santa Ana, CA 92705. Phone (714) 757-8337. FAX (714) 757-8301. Circle No. 426

RS-422 Multiplexer

A fiber-optic RS-422 multiplexer connects peripheral equipment to CPUs via fiber-optic cables. The multiplexer eliminates ground loops and attenuates voltage spikes and



EMI/RFI. You can power the multiplexer through a DB25-pin connector or through an optional power supply. The multiplexer, which can be purchased with either male or female contacts, accommodates 125- and 140- μ m glass fibers and handles data rates, low-speed data rates as high as 19.2k baud/sec, and high-speed data rates as high as 1.5M baud/sec. \$90 in low volume. Delivery, six weeks ARO.

Thomas and Betts Corp, 1001 Frontier Rd, Bridgewater, NJ 08807. Phone (201) 685-1600.

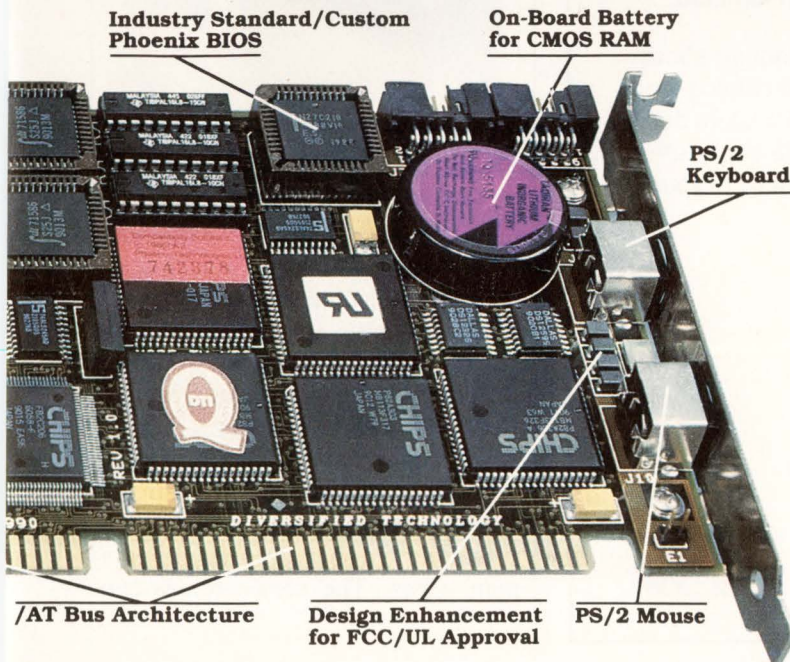
Circle No. 427

AC Outlet Strips

RAC ac outlet strips are available with either five or nine receptacles. Built from heavy-gauge steel in a textured black-enamel finish, the outlet strips feature 15A grounded

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Landmark V1.14 Speed at 25MHz	39.4	Not Determined	Not Determined

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CIRCLE NO. 48

Hardware and Interconnect Devices

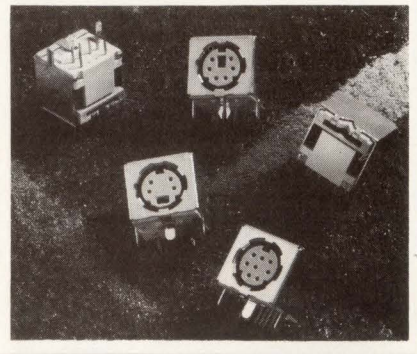
receptacles, and a 6-ft, 3-wire cord. The strips mount to horizontal frame supports of your enclosure housing. 5-receptacle outlet strip, \$61.88; 9-receptacle strip, \$85.63.

Atlas/Soundolier, 1859 Intertech Dr, Fenton, MO 63026. Phone (314) 349-3110. FAX (314) 349-1251.

Circle No. 428

Mini-DIN Sockets

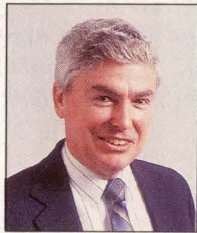
Mini-DIN sockets are available in connector sizes of 3 to 8 positions. These small DIN sockets are 69% smaller than standard DIN sockets. Among the features of the mini-DIN sockets are shielding for protection from EMI, RFI, and ESD. Right-angle solderable tails sim-



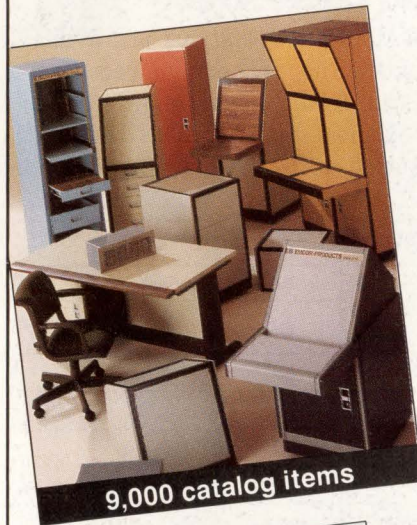
ply pc-board mounting. Solderable grounding tabs help maintain conductivity between the cable shield and the pc board. Boardlocks provide mechanical hold-down during soldering. The mating area uses phosphor-bronze contacts post-plated with gold over nickel. The tail area is tin/lead over nickel. 6-position socket, \$0.60 (10,000).

Cinch Connector Div, 1500 Morse Ave, Elk Grove Village, IL 60007. Phone (708) 981-6000.

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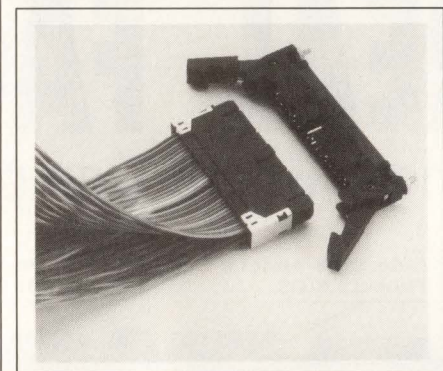
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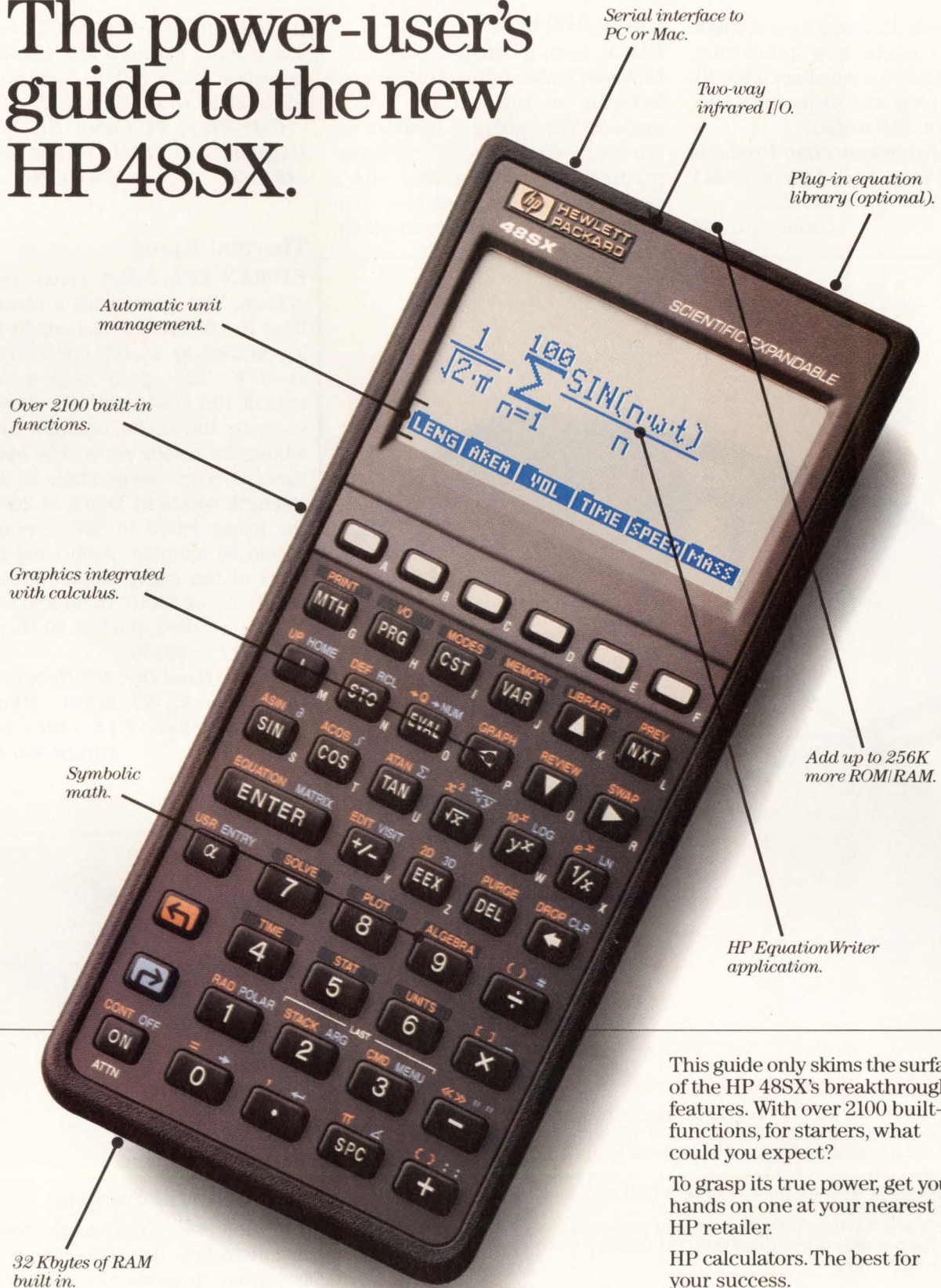
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The Selective Integral Ground (SIG) transmission-line cable/connector series is a mass-terminated, insulation-displacement connector. The connector utilizes a ground-signal-ground configuration to reduce crosstalk via an internal bus bar at rise times faster than 1.5 nsec. The connector, with conductors on .050-in. centers, terminates two flat or twisted-pair ribbon cables. The bus bar grounds all common wires. The series offers con-

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Hardware and Interconnect Devices

nectors with 13 positions in a single row to 64 positions in a dual row. Additional series members offer 40-pin DIP plug and 64-position DIN connectors. \$15 to \$20.

Augat Interconnection Products Div, 33 Perry Ave, Attleboro, MA 02703. Phone (508) 222-2202.

Circle No. 430

Cable Markers

FM321 is an irradiated, polyolefin, heat-shrinkable tubing that accepts lettering so you can use it as a marker. The tubing is mounted on pin-feed carriers to aid computer printing. After customizing with a typewriter, ink-jet printer, or computer printer and heat shrinking,

the lettering is permanent. The yellow FM321 markers are available in reels of 125 or 250. In small quantities, \$0.26 to \$0.95/marker.

Cole-Flex, 91 Cabot St, West Babylon, NY 11704. Phone (516) 249-6150.

Circle No. 431

Thermal Epoxy

EP30AN is a 2-part epoxy resin system. The epoxy uses a ceramic filler to provide thermal conductivity as high as 25 BTU/hr/ft²/°F/in. at 75°F. The epoxy uses a non-critical 10:1 mix ratio and offers a working life of 30 minutes after mixing for a 450g mass. The epoxy cures at room temperature to 90% strength within 24 hours; at 200°F, the epoxy cures to 85% strength within 30 minutes. Additional features of the epoxy include volume resistivity of $7 \times 10^{14} \Omega\text{-cm}$ and a dielectric constant of 6.9 at 60 Hz and 77°F. \$12 to \$20/lb.

Master Bond Inc, 154 Hobart St, Hackensack, NJ 07601. Phone (201) 343-8983. FAX (201) 343-2132.

Circle No. 432

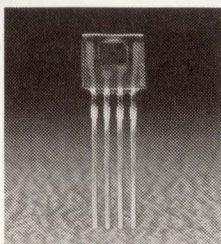


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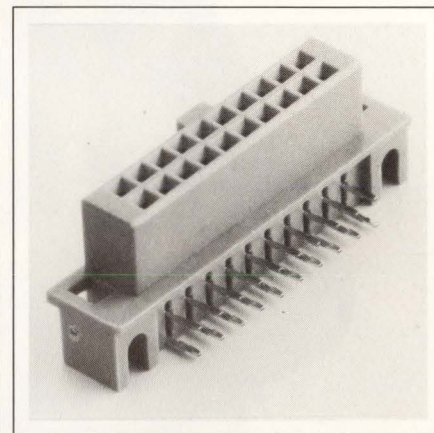
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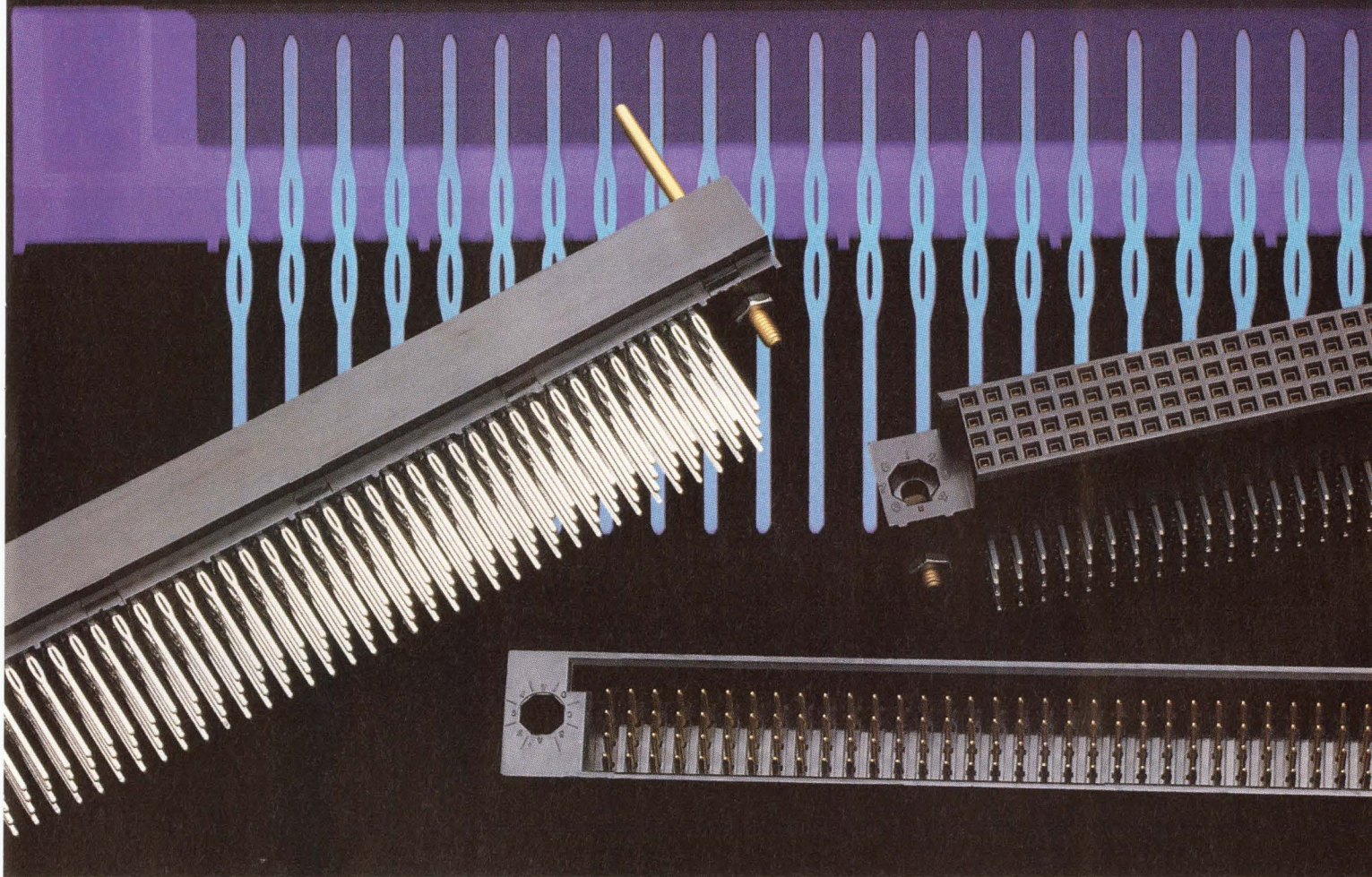
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CIRCLE NO. 50



Board-Mount Sockets

The 5100 Series right-angle board-mount sockets use centerbump polarization to guide the connector, reduce mismatch, and eliminate circuit damage. They use gold-plated wiping contacts to ensure connections. The body of the sockets is



A revealing look at the difference in high density PCB connector systems.

The X-ray of our XD/P™ high density PCB connector emphasizes that what's **inside** a connector makes the difference — in performance, reliability, and installed cost.

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To take a close look at our comprehensive XD/P™ connector line, and for the location of our nearest stocking distributor, call **1-800-344-4744**.

Thomas & Betts Corporation, Electronics Division,
1001 Frontier Road, Bridgewater, NJ 08807, 201-685-1600

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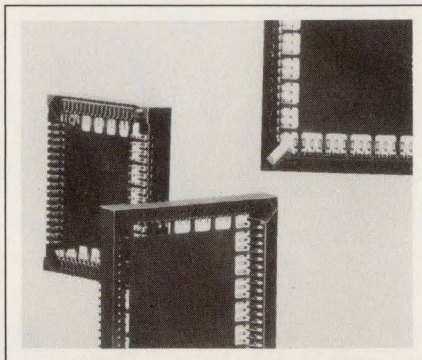
Hardware and Interconnect Devices

made of glass-reinforced polyester; the sockets are available in eight sizes: 20, 26, 30, 34, 40, 50, 60, and 64. The sockets' size is 0.1 x 0.1 in. with standard headers and plug connectors. \$3.59 to \$6.71 (500).

3M Electronic Products Div, Box 2963, Austin, TX 78769. Phone (800) 225-5373. Circle No. 433

PLCC Sockets

A family of PLCC (plastic-leaded-chip-carrier) sockets is available with 28, 32, 44, 52, 68, and 84 leads. The sockets, made from a liquid crystal polymer, withstand high-temperature soldering. Stamped solder tails have a small slot which aids adhesion of the solder paste and provides mechanical strength after reflow. Downward pressure exerted by the contacts on the PLCC ensure that it remains in the socket. The sockets have openings



that allow full visual inspection of the solder fillets. From \$1.50 (1000).

Samtec Inc, Box 1147, New Albany, IN 47151. Phone (812) 944-6733. FAX (812) 948-5047.

Circle No. 434

Connector Series

A series of 13 1-piece, plug-in connectors and headers accept wire from #12 to #30 AWG. Some connector models offer easy access to

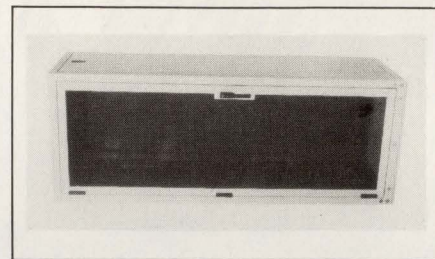
test points. All connectors are UL/CSA certified. 2-circuit connectors, from \$0.67.

Amerace Corp, Industrial Electrical Products, 530 W Mt Pleasant Ave, Livingston, NJ 07039. Phone (201) 992-8400.

Circle No. 435

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Hardware and Interconnect Devices

also come in four depths, ranging from 17 to 36 in.; their three available panel widths are 19, 24, and 30 in. The enclosures are all tested to the Zone 4 seismic test. Gaskets can provide additional protection from dust and moisture. EMI/RFI protection is also available. From \$1000.

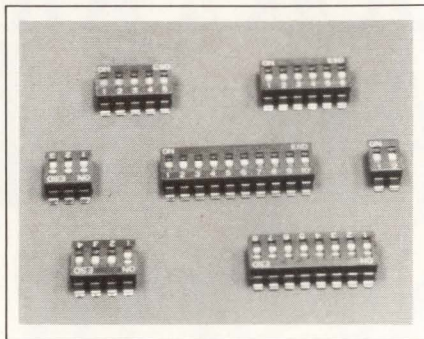
Equipto Electronics Corp, 351 Woodlawn Ave, Aurora, IL 60506. Phone (708) 897-4691. FAX (708) 897-5314. Circle No. 436

Pressert Flush Nuts

Pressert flush nuts are stainless-steel nuts that provide a smooth, flush finish. To install the nuts, you press the nut into a punched or drilled hole. The nuts are available in hex sizes from 3/16 to 7/16 in. and thread sizes from 2-56 to 1/4-28 as well as metric sizes from M2 to M6. You can use the nuts with pan-

els from 0.04 to 0.312 in. thick. Free samples are available. \$0.04/piece.

Precision Metal Products Co, Box 6026, Peabody, MA 01961. Phone (617) 532-5500. Circle No. 437



DIP Switches

You can insert the EAM100 Series of surface-mount DIP switches using automatic equipment. The switches are available with 2 to 10 switches. Switching contact ratings

are 100 mA, 5V dc. Contact resistance is 100 mΩ. The switch's top is tape sealed to withstand wave soldering and board washing. The contacts are gold-plated, and the body is UL 94V-0 rated. 8-position switch, \$1.05 (1000).

Kycon Cable & Connector Inc, 1772 Little Orchard St, San Jose, CA 95125. Phone (408) 295-1110. FAX (408) 295-8054. Circle No. 438

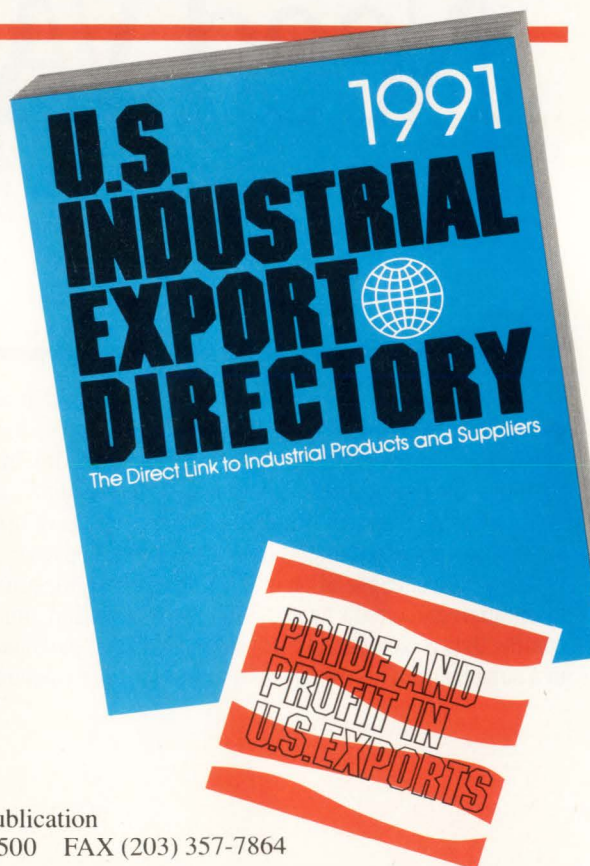
DC Cooling Fan

Smartfan is a dc cooling fan that uses a closed-loop temperature-regulating system to control cooling air flow. The regulating sensor is built into the fan. At full speed, the fan noise level is 45 dB. At idle speed, the fan's noise level is 31 dB. The fan is available in four sizes: 3.1×1.0, 3.6×1.0, 4.7×1.0, and 4.7×1.5 in. 4.7×1.5 in. fan, \$15 (5000).

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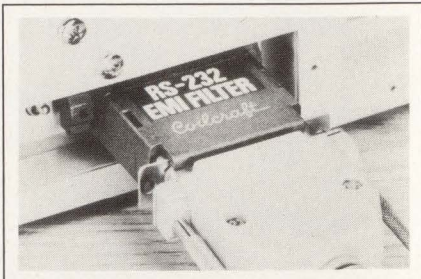
Offices in San Francisco, Boston,
Wilmington and Düsseldorf.

Hardware and Interconnect Devices

NMB Technologies Inc, 9730 Independence Ave, Chatsworth, CA 91311. Phone (818) 341-3355. FAX (818) 341-8207. Circle No. 439

Filter Module

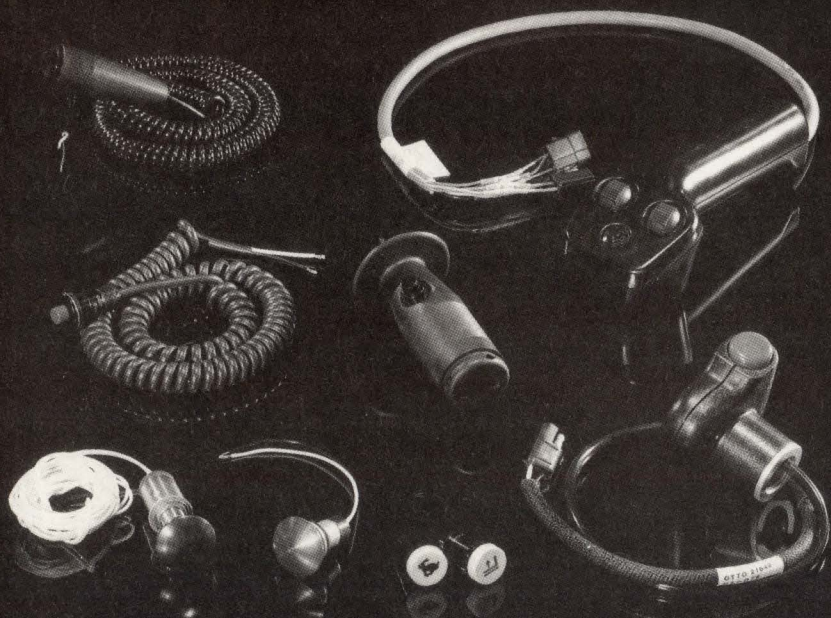
The EMI Filter Module has male and female DB-9-type connectors



and plugs between an RS-232A cable and an input or output port. The module attenuates EMI as much as 19 dB over the 30- to 300-MHz range, using common-mode magnetics. \$25.95.

Coilcraft, 1102 Silver Lake Rd, Cary, IL 60013. Phone (708) 639-6400. Circle No. 440

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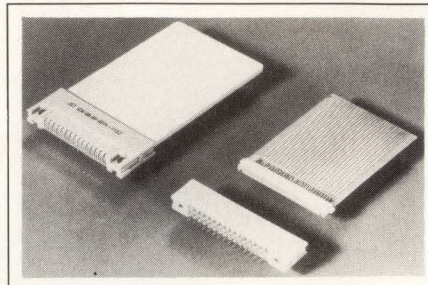


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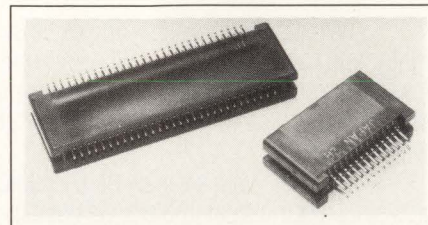
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Memory-Card Connectors

The ICM-B connectors are 0.050-in. pitch, 60-circuit memory-card connectors. Independent split-beam contacts ensure at least 5000 mating cycles. The connectors feature 0.126-in. and 0.157-in. tails for surface mounting. Rated at 0.5A, the connector's contacts are copper alloy with nickel plating overall and selective gold plating. \$0.05/mated position. Delivery, 8 to 10 weeks ARO.

JST Corp, 1200 Business Center Dr, Suite 400, Mount Prospect, IL 60056. Phone (800) 292-4243; in IL, (708) 803-3300. Circle No. 441



Card-Edge Connector

The FCN228 is a card-edge connector for low-profile designs, which is available in 26- and 60-pin configurations. Standing 0.283-in. high, the connector features two rows of gull-wing surface-mount contacts on its back. When mated to a 0.063-in. pc

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Meeting FCC/VDE requirements is quick and simple with Chomerics' low-cost clip-on EMI gaskets. Each combines Chomerics quality and technology with labor-saving attachment mechanisms. All are available off-the-shelf.*

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3. Stainless Steel Clip. Series 302/304 SS clip has sharp tines which bite through paint or oxide for electrical contact. Closure force as low as 1 lb/in. Available mitered.

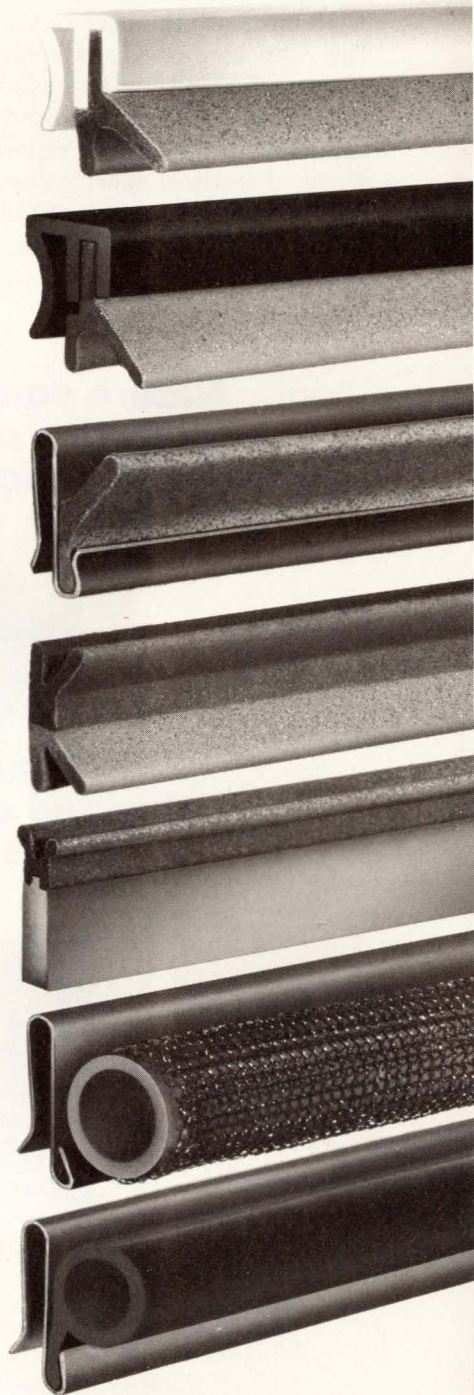
4. Stick-On Shield & Seal. Co-extruded conductive/nonconductive elastomers provide best environmental seal. Permanently mounts with pressure-sensitive adhesive. Closure force as low as 3 lb/in.

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METALKLIP™ Gaskets

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Hardware and Interconnect Devices

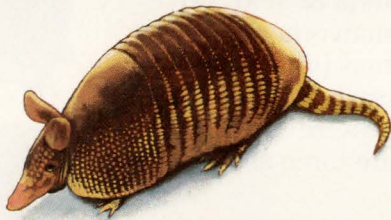
board, the connector extends only 0.110 in. above the board's surface. The connector's body is polyphenylene sulfide plastic to ensure its momentary withstanding the 240°C temperatures of infrared reflow soldering. Electrical specifications include a dc current rating of 24A and a voltage rating of 250V ac. The

connector provides a 0.1A contact resistance, 2 kg maximum insertion force, and 250g minimum withdrawal force. 26-pin connector, \$5.21 (1000).

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

Circle No. 442

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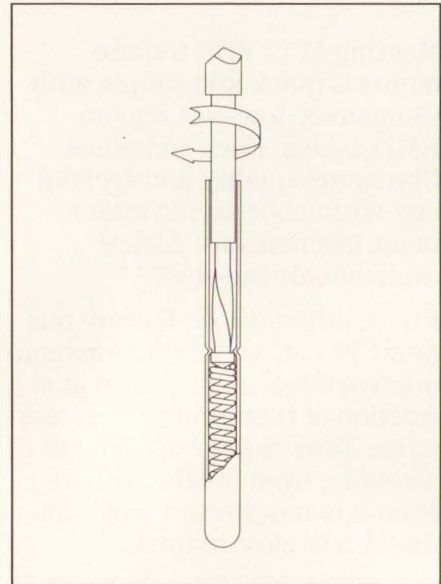
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Call 1-317-897-7009. Or write General Devices Company, Inc., P.O. Box 39100, 1410 S. Post Rd., Indianapolis, IN 46239.



CIRCLE NO. 55



Spring Contact Probe

The Rotator is a 0.1-in. center, 0.25-in. stroke-spring contact probe. The probe, available with springs of 4-, 5.5-, 6.7-, 8-, and 10-oz springs, rotates 90° at 0.167-in. travel. Rated at 3A continuous current, the probe offers a contact resistance of 50 mΩs max. The plunger is beryllium copper, rhodium plated over nickel. The rotation of the contact allows the heads to penetrate fluxes or residues on test pads or plated-through holes. \$1.50 to \$2 (10,000).

Interconnect Devices Inc, 5101 Richland Ave, Kansas City, KS 66106. Phone (913) 342-5544. FAX (913) 342-7043. Circle No. 443

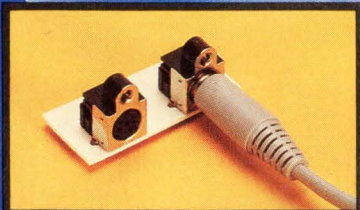
Twisted-Pair Cables

The 1455A, 1456A, 1457A, and 1458A are twisted-pair cables for data transmission. The cables carry data at speeds of 16M to 100M bps. The cables meet or exceed the IEEE 10-Base-T standard and the proposed EIA/TIA SP1907 standard. The cables contain 4-pair, #24 AWG insulated copper wire. Shielded versions use an overall foil shield with a drain wire. 1455A, 1000-ft lengths, from \$140.

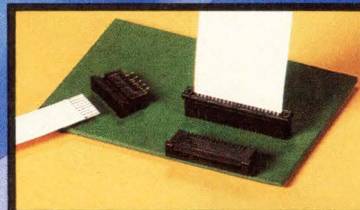
Belden Wire and Cable, Box 1980, Richmond, IN 47375. Phone (800) 235-3364. Circle No. 444



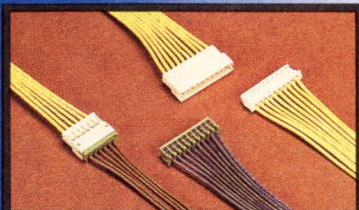
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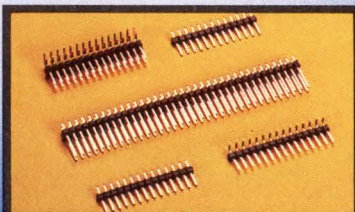
Type MD, miniature, circular DIN connector has EMI shielding. Low profile... only 19.4 mm (H) x 13.0 mm (W). Spring mounting lock prevents movement during PCB soldering.



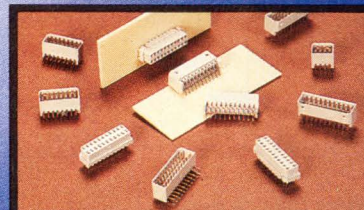
The smallest zero-insertion force connector! Only .165" high in right angle version. This **FMZ**, .039" pitch, connector is ideal for high density applications.



Ultra-compact crimp type wire-to-wire connector, only .059" pitch. **Type ZM** accommodates both crimp style and IDC connector "Z" Series receptacles and is only .142" thick. Fully shrouded polarized header for stability.



These **unshrouded breakaway headers** have .100" pitch, 36 (single row) and 72 (double row) positions, and .025" square pins suitable for wire wrap. Also .200" pitch, 18 (single row) and 36 (double row) position types. Straight & rt. angle styles.

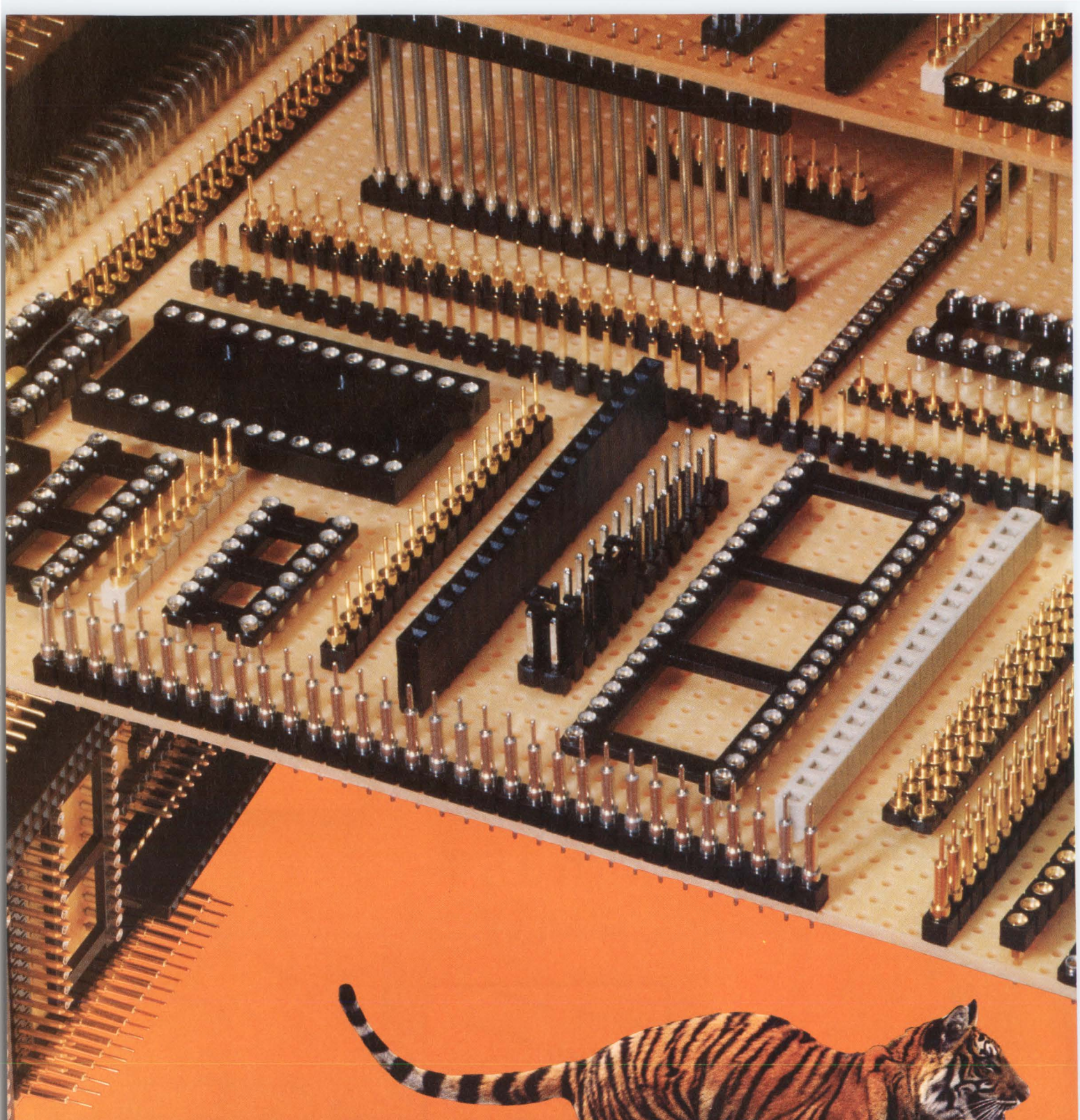


A high density board-to-board connector, the .049" pitch **JED Type** is super-compact, only .181" thick and .276" high when assembled. Solid mating, polarized shrouded header.



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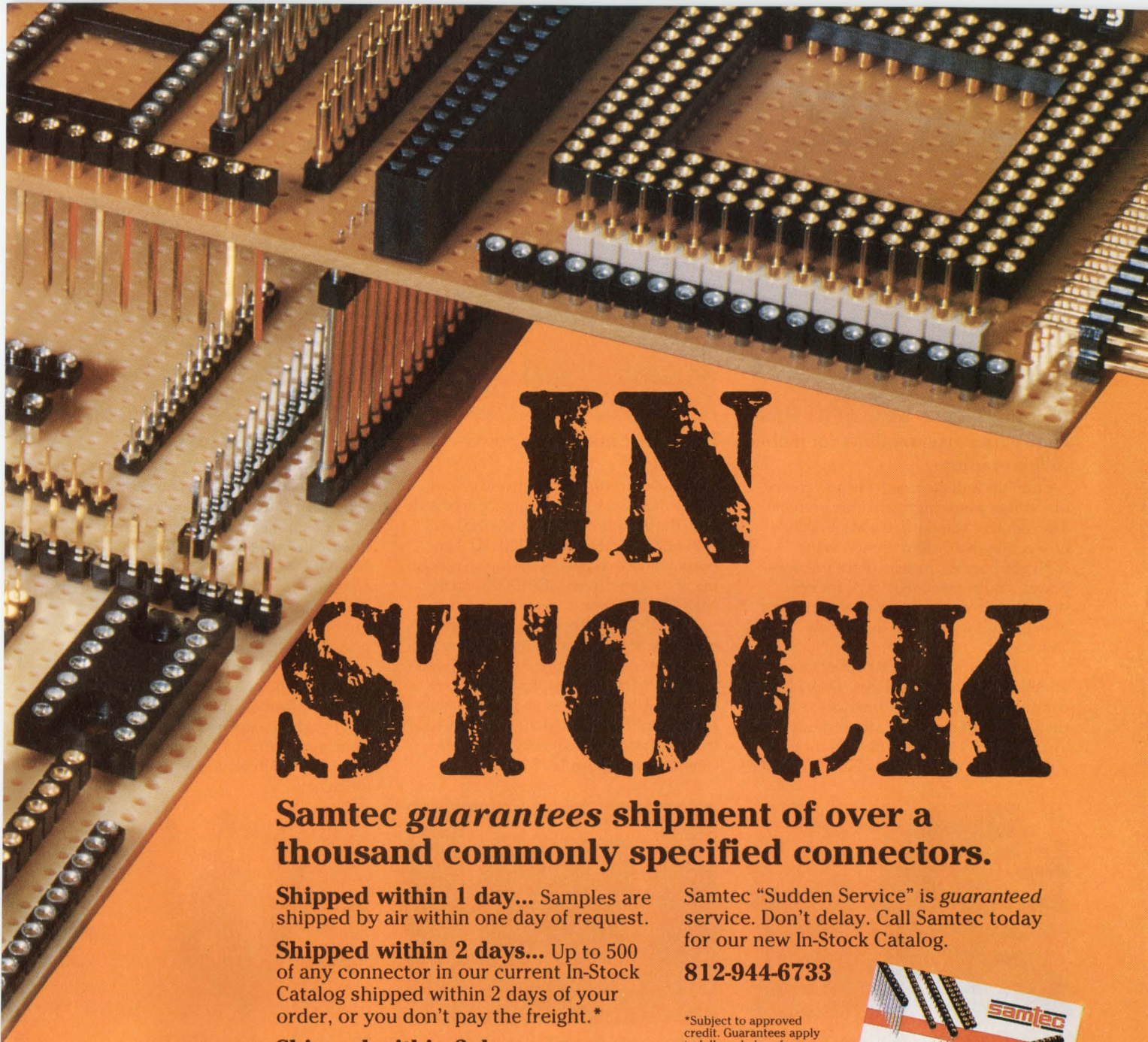


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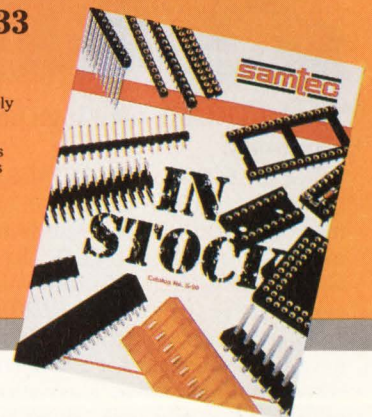
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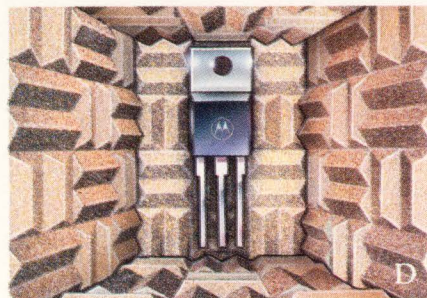
Motorola Discrete



High gain power modules for mobile cellular radios.

From the industry leader in power modules comes a new high gain improvement. The industry standard, the MHW806A, now comes in a 0-dBm version as the MHW807 Series. Instead of the previous power requirement of 30 mW, the new series requires only 1 mW to obtain 6W of output power, thanks to two new gain stages.

The MHW807 Series is perfect for all cellular radio applications. They offer controllable, stable performance over more than the 35 dB range in P_o that's needed. Two different frequency models are available: 820 to 850 MHz and 870 to 905 MHz.

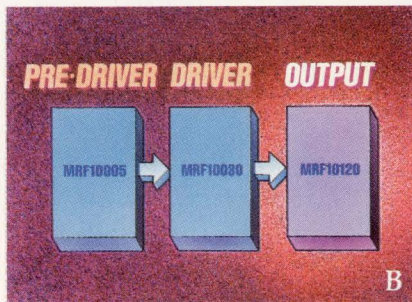


Special TRIACS offer high noise immunity.

The MAC219 series of TRIACS is designed specifically for applications in industrial areas where high noise immunity is required. These TRIACS have voltage ratings from 200 to 800 volts and current ratings of 8, 12, 15 and 20 amps.

All of the devices in the MAC219 series have a noise immunity of 500 volt/microsecond minimum value. This critical rate of rise of off-state voltage is five times that of standard devices with equivalent specifications.

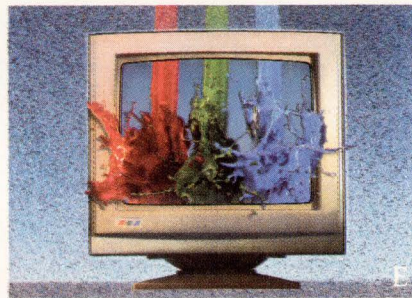
They're perfect for exceptionally demanding applications in AC power control where noise immunity is essential to successful operation of the TRIAC. Use them in appliance controls, industrial controls and AC power circuits involving motors and other inductive loads.



Long pulse microwave power transistor.

Motorola continues to expand its long pulse microwave power transistor portfolio with the introduction of its new 120 watt L-Band transistor, the MRF10120. This output device completes the lineup consisting of the pre-driver MRF10005 and the MRF10030 driver.

The MRF10120 operates on a power supply of 36 volts and delivers 120 watts of peak power for typically less than 15 watts of peak RF input power. It's designed for common base amplifier applications such as JTIDS (military) and Mode S (commercial) transmitters. The frequency of operation extends from 960 to 1215 MHz.



Make a splash in high resolution CRTs.

The SCANSWITCH™ family of semiconductors offer simple answers to horizontal deflection and video amplification problems in high resolution and ultra high resolution CRT applications. The SCANSWITCH family consists of application specific horizontal output transistors, damper diodes and video amplifiers.

Single-chip control ICs are also available for personal computer monitors to reduce design complexity and overall system cost.

All the devices are designed to improve performance in monochrome and color CRT monitors with horizontal scan frequencies of 50 kHz or greater. They offer reduced power dissipation and the ability to work over a wide range of frequencies.

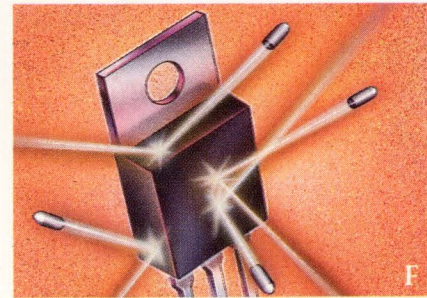
For horizontal output, video amplifiers and multimode horizontal, vertical and video processors, the SCANSWITCH family of semiconductors is the answer.



Satellite microwave power transistors.

Three new microwave power transistors are available for large-signal output and driver amplifier stages for satellite up/down links. The MRA1600-2, MRA1600-13 and MRA1600-30 are designed for Class C, common base amplifiers that operate in the 1600-1660 MHz frequency range. They provide 2.2, 12.7 and 30 watts of minimum power respectively.

These devices offer the highest in reliability and performance. They feature gold metalization, diffused ballast resistors and internal compensation for impedance matching control. All this is offered in a low-cost microwave package for cost efficiency.



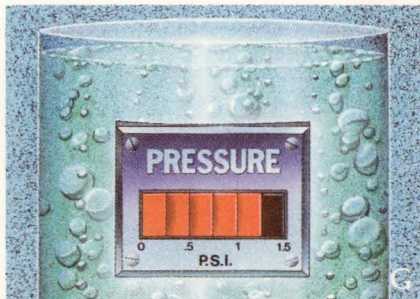
New high-voltage EFETs.

There's some new additions to Motorola's advanced line of Bulletproof™ EFETs. The new devices have gate voltage ratings of 40 volts and have avalanche energy capability specified. These two characteristics make them essentially indestructible from transients on the gate or drain when used within their specified ratings.

These high voltage EFETs offer breakdown ratings from 400 volts to 1000 volts in the industry's standard TO-218 and TO-200 plastic package. They allow the design of line operated circuits such as motor controls, power supplies and lamp ballasts and other high voltage circuits with a higher degree of reliability.

Many other EFETs are available with smaller size die housed in both metal and plastic packages, including isolated Full Paks.™

Design News

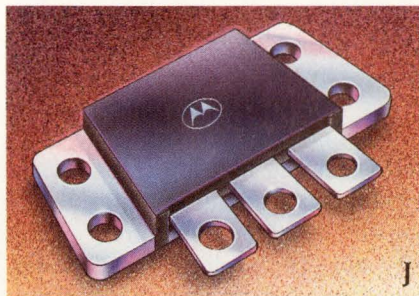


Low pressure transducer for critical applications.

This new low pressure, temperature compensated, fully calibrated sensor provides a very accurate and very linear voltage output directly proportional to pressure differentials. Its accurate range is from 0 to 1.5 PSI.

The MPX2010D pressure sensor is calibrated for a full-scale span of 25 mV, with a linearity error of less than 1.0 percent, due to laser trimming of critical on-chip components. Even with temperature variations from 0 to 85°C, typical span error is only ± 1.0 percent.

A variety of package options make it perfect for applications in automotive, industrial, medical, and many more.

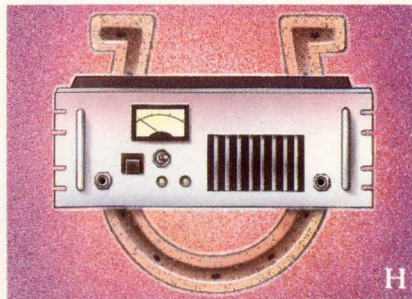


Switchmode power rectifier with dual Schottky barrier.

These new high current, dual Schottky rectifiers are available in an electrically-isolated low profile package. Less hardware and tooling is required for mounting than with conventional stud-mounted rectifiers. Both reverse avalanche energy and dv/dt are specified.

Their low inductive package is of obvious advantage in high frequency switching applications. And the platinum barrier metal technology creates optimum forward voltage drop and low reverse leakage current.

The MBR16035CT, MBR16055CT and MBR16050CT Schottky barrier rectifiers are rated at 160 amps continuous, with a non-repetitive peak surge current of 1200 amps. V_{rrm} is rated at 35, 45 and 50 volts minimum respectively.



A new breed of workhorse.

Now you can have the same rugged workhorse you've enjoyed for your high-power applications in a medium-power, broadband amplifier. The PAA series of broadband amplifiers are bred to outwork and outlast the competition.

They're ruggedly built with the same power components as our high-power PAA Series including MIL-STD capacitors and resistors, gold-plated connectors, MIL-SPEC plating and painting, EMI/RFI input filter, heavy-duty machined housings with stainless steel hardware, and teflon-coated wire.

For high-reliability performance you can depend on in a medium-power amplifier, Motorola's PAA Series is the answer.



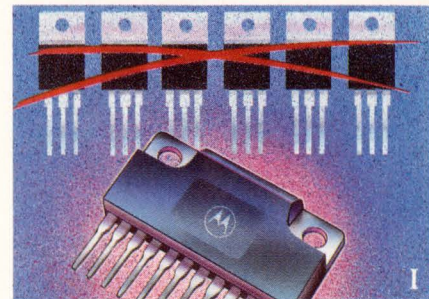
They're here. High volume, small-footed Optoisolators.

There's a new, reliable, UL-recognized optoisolator for designers who need the time and space savings of opto coupling in small outline, surface mount packages—the MOC200 Series.

Motorola supplies all MOC200 devices in the industry-standard SOIC-8, eight pin packages. And, they're available in tape-and-reel option, conforming to EIA standard RS481A. These devices offer a variety of output configurations:

- 30 & 70 volt transistors @ $IF=10mA$
- 30 volt transistors @ $IF=1mA$
- PhotoDarlington detectors

Each of the 12 small-footprint types in the series is packaged with a stable, long-life infrared emitting diode, and features high input-output isolation of 2500 vac(rms), minimum.



ICePAK™ TMOS Power Modules for brushless motor control.

Just one ICePAK™ power module replaces 6 power MOSFETS in brushless motor applications. Motorola's MPM3003 power module can handle high surge of up to 25 amps at motor startup. It's a complete three-phase bridge with three N-channel MOSFETS in the lower legs and P-channel MOSFETS in the three upper legs.

This power module is rated at 60 volts to 100 volts at 8 to 10 amps. It offers high dissipation capability and a mechanically rugged, isolated, space-saving package.

Get more information.

To get more information on any of the Motorola products shown here, contact your local Motorola sales office, complete and return the coupon below to Motorola Semiconductor Products, Literature Distribution Center, P.O. Box 20912, Phoenix, AZ 85036. Or call toll-free any weekday, 8:00 a.m. to 4:30 p.m. (MST) 1-800-521-6274.



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SOFTWARE

DSP software handles varied applications

Richard A Quinnell, *Regional Editor*

Today's powerful chips, boards, and software development tools for digital signal processing make the technology readily available. The challenge is in recognizing how your projects can benefit from it.

If the 80s were the decade of the personal computer, the 90s may well be the decade of digital signal processing (DSP). The proof will lie in how large a range of applications DSP software can service. Examining some of DSP's novel uses may help inspire your own creativity.

Perhaps the first application you think of when considering DSP technology is signal filtering. Most DSP boards and development tools have filter development aids as part of their standard software package. DSP-based filtering is commonplace in telecommunications. Virtually every modem and most cellular telephones use a digital filter to increase their S/N ratios. Almost any electronic system can do the same.

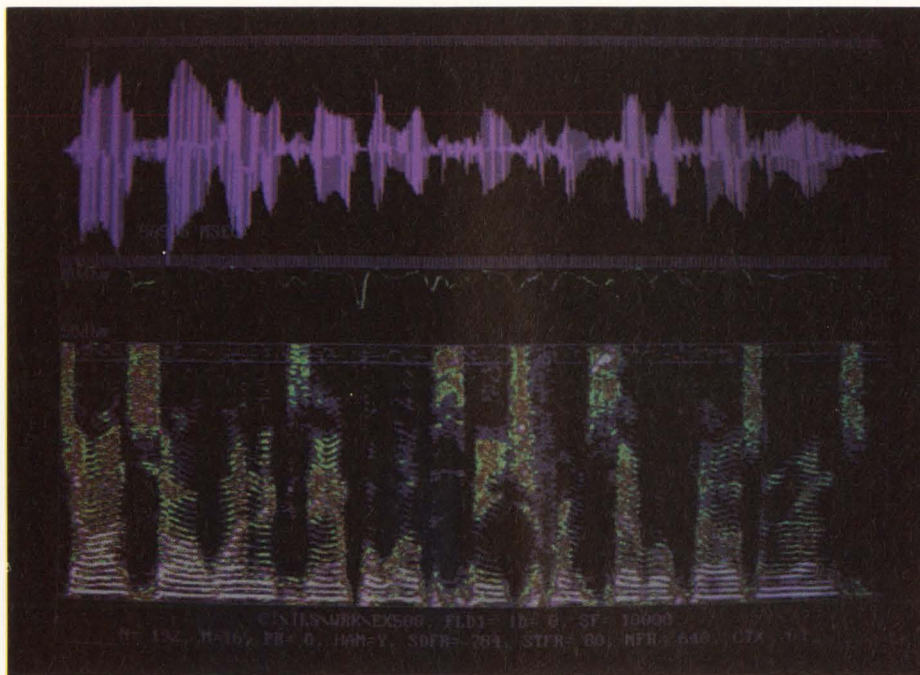
DSP improves S/N ratios

Improving S/N ratios is a major goal of the engineers at Metrologix (Santa Clara, CA). Their design of an electron-beam-based wafer-inspection system is a good example. The system scans the wafer with a narrow high-energy electron beam, then measures the scattered secondary electrons to create an image of the wafer surface. The secondary-electron signal is both noisy

and weak. "We have an S/N ratio of about one to one," says company president Guillermo Toro-Lira. "We only get one and a half electrons per pixel."

To pull their signal out of the noise, the Metrologix engineers turned to DSP technology. Using a National Instruments DSP2300 board running in a Macintosh, they developed proprietary signal-enhancement algorithms in C. They were able to develop their complex algorithms quickly, says Toro-Lira, because of the development tool kit and many useful software routines that came with the board. Once the engineers had developed and tested their algorithms, they compiled the code into machine language for the Texas Instruments 32030 DSP chip. They then optimized the code for speed.

Ironically, one challenge the engineers faced was not a lack of capability but an excess. The wafer-inspection system needed the DSP chip's speed, but didn't always use the chip's 32-bit word width. The word width became a liability when the system needed to use 8-bit arithmetic. Toro-Lira says, "To do the 8-bit operations, we had to use



You can "see" sound with a spectrogram. The display, produced by Signal Technology Inc's Interactive Laboratory System, shows a time-history of the signal's spectral power (color-coded) alongside the original signal. (Photo courtesy Signal Technology Inc)

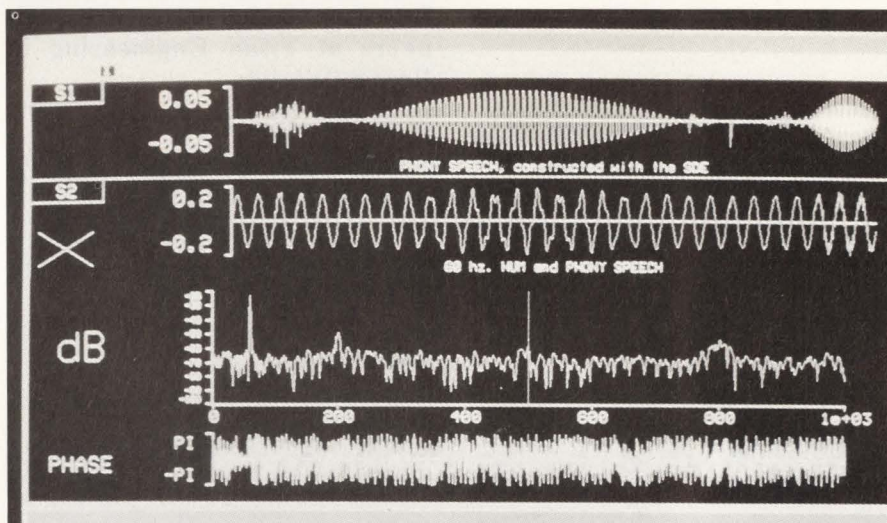
software tricks like shifting and masking."

Improving S/N ratios is only one use of DSP filtering. Filters can also simulate the effect a physical system will have on your signal's propagation. Sam Berkow, an associate with the Joiner-Rose Group (Dallas, TX), uses DSP filtering to check concert-hall acoustics while his design is still on the drawing board.

Berkow uses computer simulation to evaluate the propagation of sound within his planned concert halls. He also employs empirical methods. Because acoustic effects scale linearly, Berkow can build a scale model of a hall and measure its frequency response directly. But simulations and measurements provide only numbers, and the audio community is more concerned with aesthetic quality than numbers. "What looks good on paper," says Berkow, "may not sound right."

What DSP technology allows Berkow to do that a calculation doesn't is check the quality of the sound. By using an Ariel Corp DSP56 analog board, an Ariel Corp TMS320C30 DSP board, and Hyperception software, Berkow can literally listen to his designs.

To ensure the fidelity of his signal, Berkow starts with music digitally recorded in an anechoic cham-



ber. Then he uses the DSP board to convolve the music signal with the measured or calculated impulse response of his design. The result is music as it would sound if he were sitting in the completed hall.

Audio has its own needs

DSP technology has a variety of other uses in audio applications, including music synthesis, soundtrack editors, and virtually noise-free digital recording and playback of music. People using current DSP software products for sound analysis, however, have a problem.

"The way acoustic people represent signals is different from that of the general DSP community," says Berkow. He points out that

Simulating signals to test your system is one application of digital-signal-processing technology. In this example the Comdisco Systems Inc workstation is testing a modem design. (Photo courtesy Comdisco Systems Inc)

Spectral analysis need not be an end in itself. You can embed the analysis in test tools that make simple go/no-go decisions.

acoustic filters are specified in decibels per octave instead of decibels per decade, frequency scales are logarithmic instead of linear, and noise spectrums are measured in one-third- and one-sixth-octave instead of 1-kHz bands.

Spectrum analysis is another well-known application of DSP technology. With the addition of a plug-in board and some software, any personal computer can become a spectrum analyzer. You're not limited to only using that analysis capability as a lab tool, however. You can also use it to create tools for other disciplines, as the engineers at Titan Engineering in Racine, WI did.

Titan's general manager, Greg



Not all signals can be sampled with an A/D converter. For Drs Zeller and Laird of the University of Kansas, the "signal" is the occurrence of nitrates in snowfall.

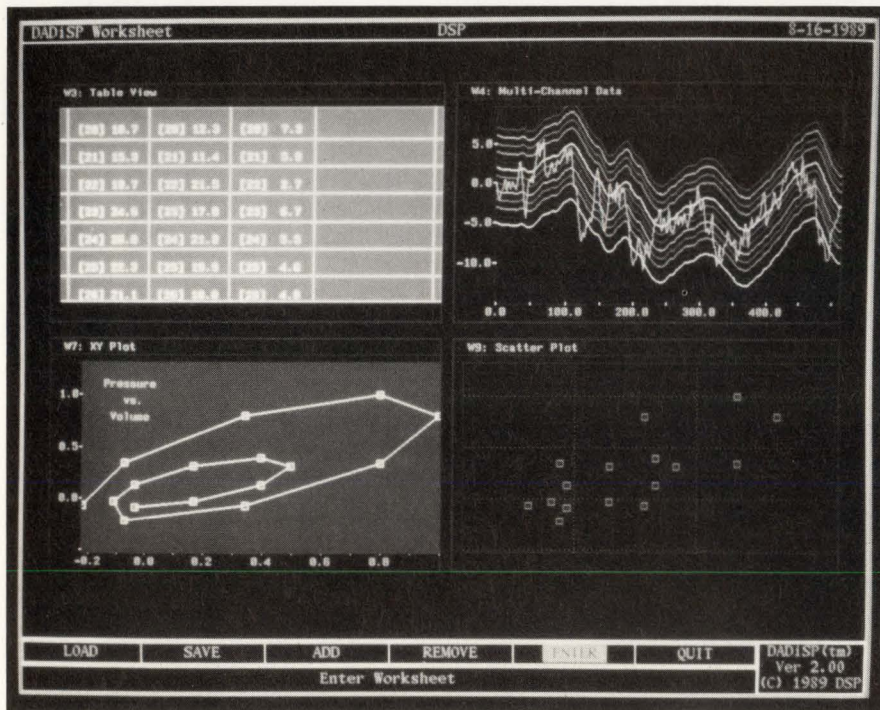
turer's production engineers test 50 transmissions per day. Previously, says Petro, they would have used stand-alone analog filters and a spectrum analyzer, but only for spot testing. Now they can test every transmission they make.

According to the project's systems engineer, Kevin Sholly, Titan's engineers wrote the system software in a high-level language that calls machine-coded DSP routines. The routines came from Burr-Brown's DSP library and were supplied with the board. The system software gives the user a simple go/no-go test that compares the energy in various bands of the spectrum against preset limits.

Order-tracking eases analysis

Because spectrum analysis only provides absolute frequencies, the Titan software does more than merely compute the frequency spectrum of the vibrations. "We can measure the spectrum and get all of these numbers," says Petro, "but what do they mean? The real key to vibration analysis is to make the correlation between the data you've collected and the physical entity you're looking at. We need to know that when we see a given signal it means that the bearing on the third shaft down in the clutch is cracked."

To help make correlating easier, the Titan software provides order



Data for DSP can come in many forms, including tables, waveforms, and plotted curves. Development tools, such as DSP Development Corp's DADISP 2.0 readily handle all forms. (Photo courtesy DSP Development Corp)

Petro, says the tool they created tests the transmissions of motorized agricultural equipment. It comprises an IBM PC/AT with data-acquisition and DSP boards from Burr-Brown. By using DSP techniques to analyze a transmission's vibration at a variety of drive speeds, the tool helps the manufac-

tracking—it normalizes the computed vibration spectrum to the transmission's drive rate. As the drive rate changes, gear meshes shift in frequency. With a conventional spectrum analyzer someone would have to keep track of those shifts manually. Order tracking accounts for them automatically.

Other cross-disciplinary tools that use DSP-based spectral analysis are safety monitors for power generators. If a monitor detects vibration frequencies that herald a mechanical breakdown, power-plant engineers can shut down equipment before any damage occurs.

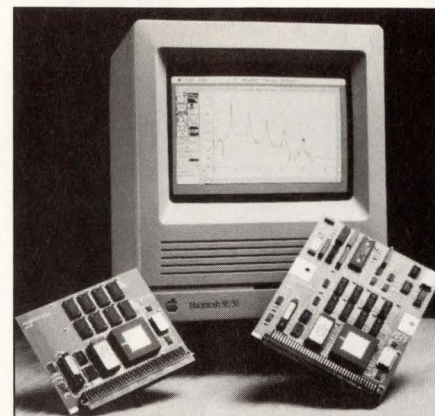
Synthesis: reversing analysis

Spectral analysis and signal filtering aren't the only capabilities that DSP software offers. You can also reverse the analysis process by us-

ing spectral information to regenerate signals. You can even synthesize signals that never existed.

Dr Charles S Henry of the University of Connecticut (Storrs, CT) is combining DSP-based analysis and signal generation in his studies of the family *Chrysopidae*, or green lacewing insects. They are important to biological pest-control programs because, in their larval form, lacewings prey voraciously on aphids, scale, mealybugs, and other insects that damage crops.

Dr Henry is studying the insects' mating songs. Each species of lacewing, even those very closely related, produces a distinctly different mating song. They avoid cross-species mating because they respond only to the song of their species. By introducing controlled variations into the mating songs and observing the insects' reactions,



Virtually any computer can become a spectrum analyzer with a DSP plug-in board and software. The Spectral Innovations Inc Mac DSPSE/30, for example, converts a Macintosh SE into a programmable instrument. (Photo courtesy Spectral Innovations Inc)

Dr Henry can determine which features of the songs are important.

First, Dr Henry records and digitizes an individual lacewing's song using a CED-1401 Intelligent Laboratory Interface board from Cambridge Electronics Design Ltd (Cambridge, England) in an IBM PC/AT. Next, he manipulates the recorded signal with a DADiSP 1.05 signal-processing spreadsheet from DSP Development Corp. He changes such characteristics as amplitude, repetition rate, and frequency content. Then he plays the resulting synthetic signal back through the CED board and observes how it affects other lacewings.

One key to unlocking the power of DSP technology is to expand your concept of what constitutes a signal. Signals don't come from A/D converters alone. A signal can be any series of data points acquired by any means. Consider the solar flare studies being conducted by Dr Ed Zeller, Professor of Physics and Geology at the University of Kansas (Lawrence, KS). His signal is atmospheric nitrates embedded in Antarctic snow.

Nitrates form when a solar flare

For more information . . .

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

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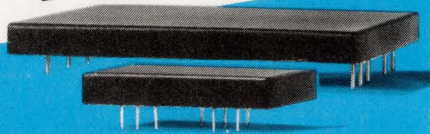
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Filtering not only removes noise, it can also simulate the transmission mechanism's effects on signal propagation.

reaches Earth's upper atmosphere and ionizes oxygen and nitrogen. Precipitation then washes the nitrates out of the air and brings them to earth. In the Antarctic, they remain trapped in snow that never melts.

Dr Zeller acquires his data by first taking a coring from the Antarctic snow mass. Individual snow falls are visible as layers in the coring, much like growth rings in a tree. You can determine the age of a sample by counting the layers above it. It's even possible to determine the season during which the snow fell. Dr Zeller separates the layers in the coring, melts them, and measures their nitrate concentrations.

Dr Zeller uses the DSP Development Corp's DADiSP software to analyze his data. In order to prove he could date his samples accurately, he correlated his data with the snowfall records of nearby weather stations. He then correlated his data with solar-flare records. He proved that the nitrate concentrations in the layers of snow accurately reflected flare activity. For example, spectral analysis showed 11- and 22-year solar-activity cycles, just as he expected. Dr Zeller's long-term goal is to study the occurrence of solar flares over the last 3000 years.

One drawback that Dr Zeller faces in using DSP techniques on his data is that he has to assume a uniform sampling rate. However,

SOFTWARE

because the sampling times depend on the whim of the weather, they are far from uniform. "Nature isn't very convenient," notes Dr Zeller. He uses interpolation routines to generate uniformly spaced data from the randomly spaced samples.

Another example of an unconventional signal comes from ESI Communications (Tallahassee, FL). The signal is a periodic measurement of memory utilization and I/O activity in a mainframe computer. ESI engineers use DSP techniques to study system utilization patterns and trends, which enable them to plan system capacity more effectively.

Performance metrics, chemical concentrations, sound, vibration, and electron voltages are only a few of the possible sources of signals that can be analyzed with DSP software. Regardless of the nature of your signal, there are ICs, boards, and software development tools (Refs 1 to 3) to help you turn it into useful information. The limits on what you can handle with DSP technology will be set only by your imagination. **EDN**

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1. Leibson, Steven H, "DSP development software," *EDN*, November 8, 1990, pg 156.
2. Gallant, John, "Plug-in DSP boards," *EDN*, April 26, 1990, pg 142.
3. Travis, Bill, "Single-chip DSPs advance in speed and versatility," *EDN*, October 12, 1989, pg 125.

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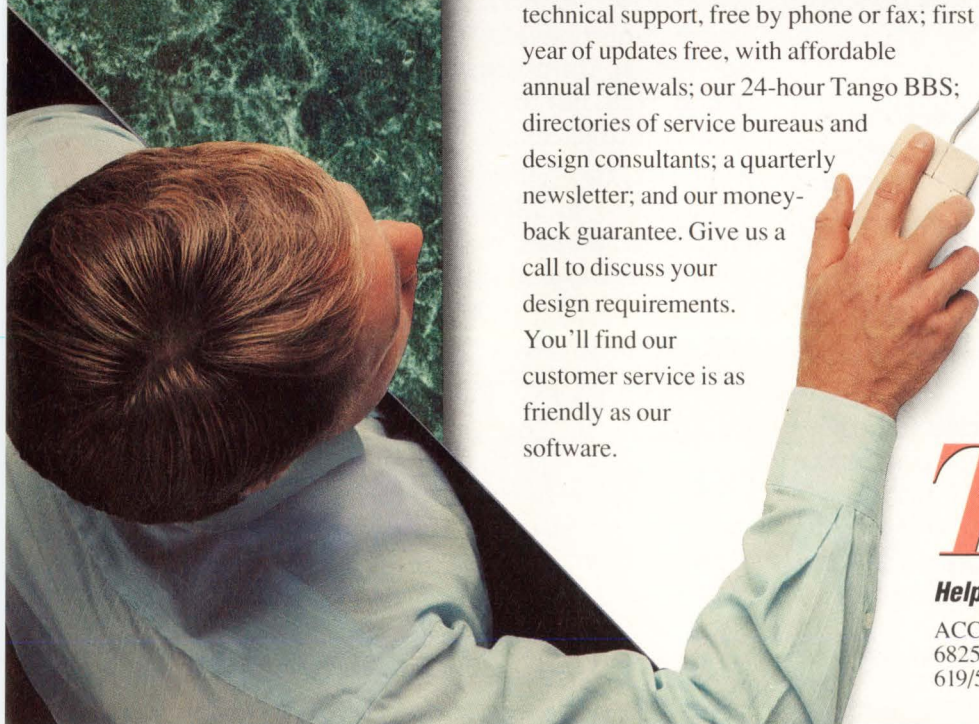
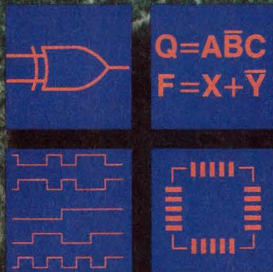
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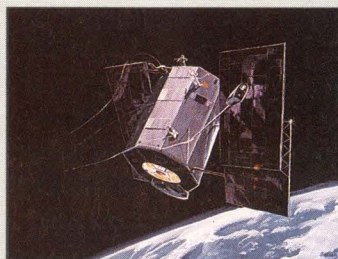
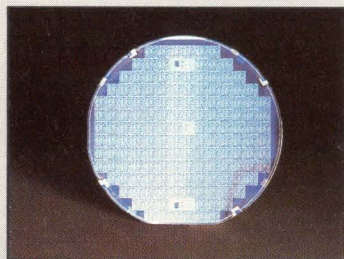
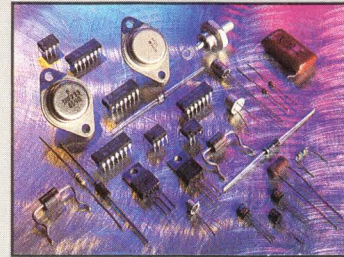
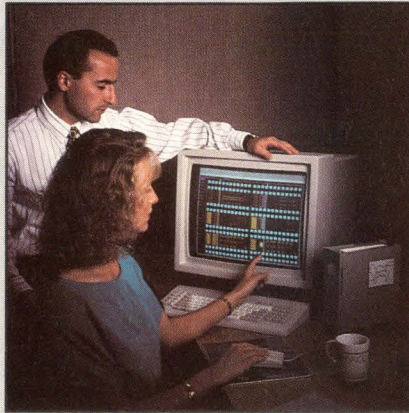
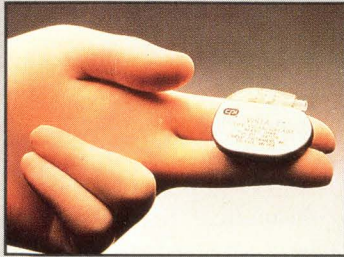
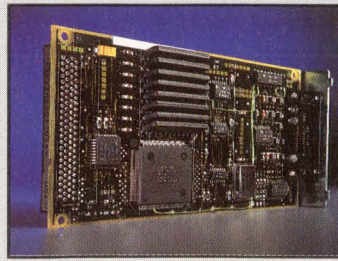
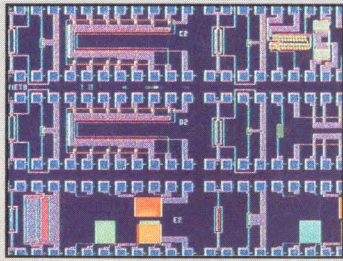
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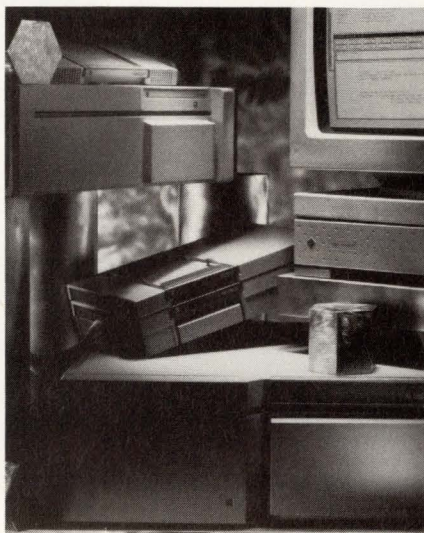
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Emulation and development tools run on Sun-4

Validate/Xel and Validate/Unison are integrated-emulation and software-development tools that work with either the company's EL 3200 or its ES 1800 emulators. These tools are now available for cross-development using a Sun-4 workstation as the host. The EL 3200 emulates Motorola's 68020 and 68030 μ Ps. The Sun-4 host can run as a node on an Ethernet network using TCP/IP protocols so that you can access the emulator from any node on the network.

The ES 1800 can emulate the major Intel, Motorola, and Zilog μ Ps, including Intel's 80C186 and 80C188, and Motorola's 68302. This emulator includes an event monitor that provides hardware triggering. Therefore, you can maintain full control of the software trace and find deeply nested bugs. The ES 1800 comes with a built-in SCSI interface.



Validate/Xel gives you extensive tracing capability, source- and assembly-level debugging features, instruction simulation, a window-oriented display, a command history, and the ability to use macros that make full use of the Sun-4 fea-

tures. The package includes an ANSI-C compiler, an assembler, a disassembler, a simulator, and a source-level debugger. Validate/Unison includes a C source-level cross-debugger, an optimizing cross-compiler, a cross-assembler, and a variety of other debugging tools. The Unison also has a real-time C-level trace, data breakpoints for tracking variables, and simultaneous display of as many as four I/O ports.

Pricing for the EL 3200 with control software starts at \$30,000, and the ES 1600 at \$12,500. Validate/Xel costs \$10,300, and Validate/Unison costs \$7050.

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Currently supporting mixed networks of Sun-3, Sun-4, and Decstations, the system provides multiple levels of caching, clustering, page swapping, and pinning. It also offers local working sets, which you can access with almost no DBMS overhead, and efficient recovery mechanisms. For operations such as locking, version control, recovery,

deletion, and data creation, you can specify the appropriate granularity for each type of operation. This feature lets you lock fine-grained objects to obtain a high level of concurrency. Alternatively, if you want higher performance, you can apply the locks to larger pieces of the design. A development system costs \$30,000.

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Task-Management Tool

Mind's Eye is an application-development tool that lets you interactively create a database relating to almost any system engineering project. Although this tool does not adhere to the strict definition of an object-oriented database management system, it does let you define your project by means of objects and their relationships. An object may, at different levels, be the whole system, a subsystem, a component, a subcomponent, or a piece part. At each level, an object may require values or actions from other objects, and may in turn be the target of requirements from still other objects. Further, each object may be represented by any of three kinds of data: attributes, text, or images.

The proprietary user interface is as easy to use as Windows 3.0, but is faster because it is fully integrated with all of the tool's functions. Color coding helps you identify the status of objects.

To run Mind's Eye you need an IBM PC/AT-class computer with 640k bytes of memory (2M bytes recommended), an expanded memory manager, a VGA graphics card and monitor, a mouse, and DOS 3.3 or later version. A preconfigured version with templates to get you started is \$695; a professional version for large applications is \$3000.

Earle-Briggs Inc/Mind's Eye Inc, 36 Commerce Way, Woburn, MA 01801. Phone (301) 862-1944. FAX (301) 862-2121.

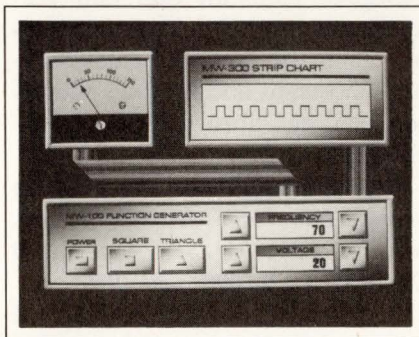
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Source-Level-Language Debug System

The Pathfinder HPC-16 is a source-level-language debugger for use with National Semiconductor's HPC family of microcontrollers. The HPC-16 debugger interfaces directly with Mole-PB1, Mole-PB2, or Summit-PB3 emulator hardware and runs on an IBM PC or compat-

ible computer. You can display source code and associated bus and port signals simultaneously. In the single-step mode, you can evaluate or continuously monitor variables. You can define complex expressions for variables, which include the contents of the processor registers and program counter. You can set breakpoints on source or disassembly code, or on address- or data-bus trace trigger conditions. The real-time trace capacity is 2k x 48 bits. \$1950.

Ashling Microsystems Ltd, Plassey Technological Park, Limerick, Ireland. Phone (61) 334466. FAX (61) 334477. Circle No. 400



Real-Time Multimedia Interface For PCs

RAVE (Real-Time Audio/Video Environment) is a set of tools that helps you build multimedia software for industrial process control, instrumentation, and similar applications. The tools run on 80386/486-based computers under the OS-9000 real-time operating system. The package includes a graphics editor and a library of graphics primitives, with which you can create images of control panels as well as virtual instruments. You can also use a video camera to capture images of actual equipment control panels, and then modify the images with the graphics editor. You can also capture sound from external audio equipment such as microphones or cassettes, or load digitized sound segments from a disk.

The tools work with ATI's VGA

Wonder graphics board, as well as with Vigra's VME-MMI-100 board for the VMEbus. Both boards yield 640 x 480-pixel resolution with 256 colors; thus you can move an application from a PC-based OS-9000 system to a VMEbus OS-9 system (or vice versa) just by recompiling the application on the target system. \$750.

Microware Systems Corp, 1900 NW 114th St, Des Moines, IA 50322. Phone (515) 224-1929. FAX (515) 224-1352. Circle No. 401

Optimizing C Compiler For 80386-Based Computers

Watcom C8.0/386 is an optimizing ANSI-C compiler that generates 32-bit, 80386 or 80486 protected-mode code, and can make use of all the hardware features of the 80386 μ P. The package includes a video debugger (with mouse support), a C runtime library and graphics library, an editor, a linker, an object librarian, a *make* recompilation utility, a disassembler, and a source-level debugger.

Applications compiled with C8.0/386 can make use of a DOS extender. The compiler can generate re-entrant code, and the library contains many re-entrant functions, so that you can generate ROMable code for embedded systems. The compiler has a built-in syntax checker that validates the syntax of your program before attempting to generate code; it produces warnings for type mismatches, uninitialized variables, unreferenced variables, questionable operations, and potentially incorrect statements. The register allocator accommodates user variable declarations as well as the instruction selector's requirements, thereby reducing code size and improving execution speed. \$1295 (US); \$1595 (Canadian).

Watcom, 415 Phillip St, Waterloo, Ontario N2L 3X2, Canada. Phone (519) 886-3700. FAX (519) 747-4971. Circle No. 402

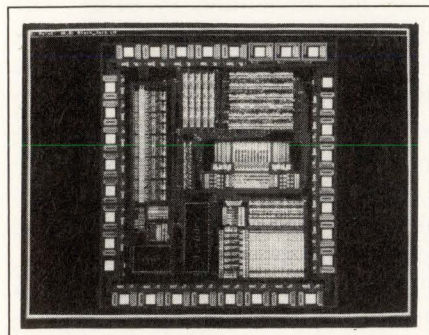
Software

Developer's Kit For CAD/CAM Software

The CAD/CAM Developer's Kit (CCDK) is a toolbox of C functions that can help you write third-party CAD/CAM applications. The tool kit uses object hierarchies and data encapsulation to minimize the number of public routines needed to support all of the operations provided. DXF functions let you read and write ASCII and binary files in AutoCAD's DXF format and create layers, blocks, and exploded inserts. Display functions let you create 3-D images that are adaptable to many popular graphics libraries. Geometric functions let you perform 2-D and 3-D operations such as translation, rotation, scaling, mirroring, intersection, offset, trimming, and selection. List-management functions support list construction, traversal, sorting, and iteration. CCDK is compatible with the AutoCAD Development System and with ANSI-C compilers that run under DOS, Unix, and VAX/VMS, as well as with Metaware and Watcom compilers that provide extended-DOS facilities. \$1295.

Building Block Software, Box 1373, Somerville, MA 02144. Phone (617) 628-5217.

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Tool Set For IC-Library Development

New tools that the vendor added to the GDT Designer module-generation system automatically characterize cell libraries and let you adapt these libraries to different

manufacturing processes. In addition, you can capture handcrafted layouts in a reusable form.

The object-oriented database and a new procedural design interface allow you to access both geometric and connectivity data in chip designs, thereby shortening the time required to adapt libraries to different manufacturing processes. The tool set includes Explorer Lsim, a mixed-signal, multilevel simulator that provides detailed circuit-level simulation of the layouts created by the module generators.

Using the timing data produced by Lsim, you can automatically calibrate gate-level and logic-synthesis models and create data sheets. GDT Designer runs on Sun and HP/Apollo computers and includes tools for schematic capture, rule-checking, placement and routing, simulation, and cell-library development. \$90,000.

Mentor Graphics Corp, Silicon Design Div, 2045 Hamilton Ave, San Jose, CA 95125. Phone (408) 371-2900. FAX (408) 559-4916.

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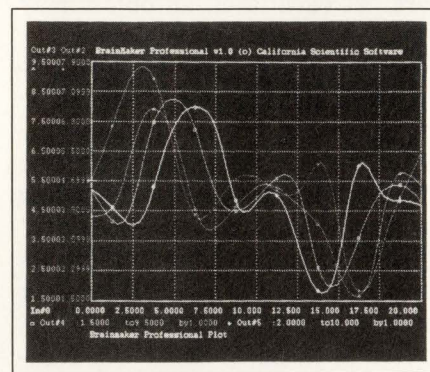
Cross-Debugger For The Motorola 68332 μ P

RMXDB 5.0 is a C source-level debugging system for Motorola's 68332 μ P. The package consists of a ROM-based monitor resident on the target system, and a window-based version of the vendor's XDB debugger hosted on an IBM PC or other computer. You can configure RMXDB for almost any target system that has a serial port; the installation kit includes driver programs and configuration examples for a wide variety of single-board computers and serial-interface boards.

The debugging system is compatible with Motorola's 68332 development system (the 68332 EVS and Business Card Computer), as well as with the vendor's Intertools line of C cross-compilers, cross-assem-

blers, and programming utilities for writing ROMable, reentrant code for the 68332. From \$2500 for RMXDB 5.0 hosted on an IBM PC; a full tool kit of compilers, assemblers, utilities, and RMXDB, \$4250 for a single PC host. The tools for the 8086 and 68000 μ P families are available at the same prices.

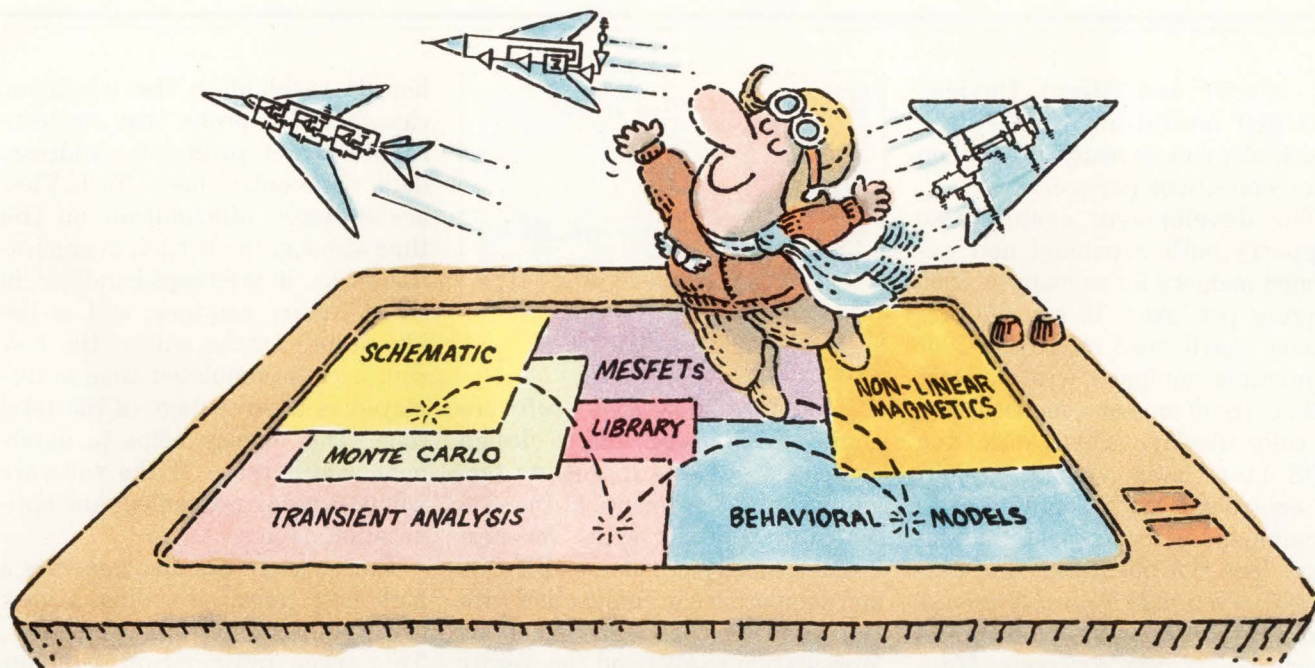
Intermetrics Microsystems Software Inc, 733 Concord Ave, Cambridge, MA 02138. Phone (617) 661-1840. Circle No. 405



Neural-Network Application Development System

Brainmaker Professional version 2.0 is a development tool that lets you simulate in software a neural network that can recognize patterns, analyze trends, and learn from any set of data. Applications include stock, sales, and inventory forecasting; assistance in medical diagnoses; filtering noise from communications links; and accurate conversion of optically scanned printed characters to ASCII codes, regardless of font style and size.

Netmaker Professional, which is the network-generation and data-manipulation program, displays data in spread-sheet style, makes possible complex arithmetic operations on data, and automatically builds network-description and training files. This program optimizes the number of hidden neurons so you can identify the data that has the most influence on your network. The program can handle chaotic systems, and can work with In-



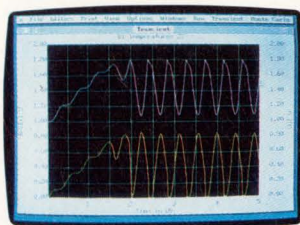
THE NEW MICRO-CAP III.™ SO YOU CAN TEST-FLY EVEN MORE MODELS.

It wasn't easy. But we did it. Made the long-time best-selling IBM® PC-based interactive CAE tool even better.

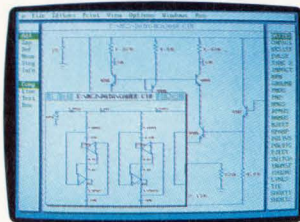
Take modeling power. We've significantly expanded math expression capabilities to permit comprehensive analog behavioral modeling. And, beyond Gummel Poon BJT and Level 3 MOS, you're now ready for nonlinear magnetics modeling. Even MESFET modeling.

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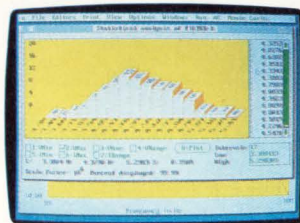
As always, count on fast circuit creation, thanks to window-based operation and a schematic editor. Rapid, right-from-schematics analysis — AC, DC, fourier and transient — via SPICE-like routines. The ability to combine digital/analog circuit simulations using integrated switch



Transient analysis



Schematic editor



Monte Carlo analysis

models and parameterized macros. And stepped component values that streamline multiple-plot generation.

And don't forget MICRO-CAP III's extended routine list — from impedance, Nyquist diagrams and BH plots to Monte Carlo for statistical analysis of production yield. The algebraic formula parsers for plotting virtually any function. The support for Hercules, CGA, MCGA, EGA and VGA displays. Output for plotters and laser printers.

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spectrum

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Sunnyvale, CA 94086
(408) 738-4387

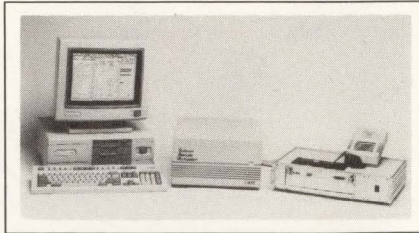
Software

tel i80170 and Micro Devices MD1220 neural-network chips, which can run as many as 2 billion interconnections per sec.

The development system also supports both expanded and extended memory for as many as 8000 neurons per layer. To run the programs, you'll need an IBM PC or compatible equipped with at least 512k bytes of memory, monochrome or color display, a hard disk, and DOS 3.0 or later version. An 8087 or equivalent math coprocessor is recommended but is not mandatory. The documentation includes an *Introduction to Neural Networks* and the *BrainMaker Professional User's Guide and Reference Manual*. \$795.

California Scientific Software, 10141 Evening Star Dr #6, Grass Valley, CA 95945. Phone (916) 477-7481. FAX (916) 477-8656.

Circle No. 406



Software-Analysis Tool For Ada

AC 100 Task View allows software engineers who use Ada to design embedded systems to analyze target-system performance at the system-state and task levels. This performance analyzer runs on IBM PCs and compatibles in conjunction with the vendor's Software Analysis Workstation (SAW) and the Verdix Ada Development System (VADS).

The SAW is a real-time, nonintrusive software measurement tool that monitors the execution of the software under test. It monitors the execution using state-analysis

boards resident in the μ Analyst chassis and a probe that connects to the target processors address, data, and control lines. Task View accumulates information on the time spent in the kernel, in application tasks, in interrupt handlers, in select library routines, and in the idle state. At the end of the test run, each accumulated time is displayed as a percentage of the total time. This display helps to determine which areas of the software will best repay refinement and optimization efforts.

The program can also generate a high-level trace, providing a view of target-system state transitions. This trace information includes identification of each application task entered, identification of interrupt handlers entered and of system calls to the kernel, Ada exception occurrences, memory-allocation routines, and semaphores. In

All you need to know about 5.25" Semicon disk drives, inside

120MB Full-height 5.25"

SCSI Interface

< .35ms Access time

40MB Half-height 5.25"

4.0MB/Second sustained transfer rate

Up to 220,000 hours MTBF



Computers and Communications

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Software

addition, you define specific measurement points in the application code, and you can elect to track specific procedures in detail. Task View, \$4500; SAW, from \$10,500, depending on the target version and the options selected.

Cadre Technologies Inc, 222 Richmond St, Providence, RI 02903. Phone (401) 351-2273.

Circle No. 407

Ada Development System

FirstAda is a development system for Ada software that runs on IBM PC/ATs, PS/2s, and compatibles under DOS 3.0 or later version. The compilation system (officially validated by the Ada Joint Program Office) includes the compiler, with high- and low-level optimizers and binder; multiple library managers; the Ada runtime executive; the Adaworld user interface; and all

standard Ada packages. In addition, you get a source-level symbolic debugger, a cross-reference generator, an automatic recompilation tool, a source-code standardization tool, and an Ada syntax checker. The package is menu driven and includes a full-screen text editor; however, you can add your preferred text editor to the menu.

A set of packages provides an Ada interface to all DOS functions, and interrupt-entry handling makes it easy to create special device drivers. You can generate either 8086 or 80286 code, and you can call existing routines that you've written in assembly language or Microsoft C. Floating-point code that you write will use an 80287 or 80387 math coprocessor if one is present in your system; otherwise, the system will emulate the floating-point instructions in software. The pack-

age incorporates an ISO-standard elementary math function library (this library requires a math coprocessor). Documentation includes a Beginner's Guide, User's Guides, a Project Development Guide that explains the multilibrary features, and the ANSI/ISO standard for the Ada language. \$1815.

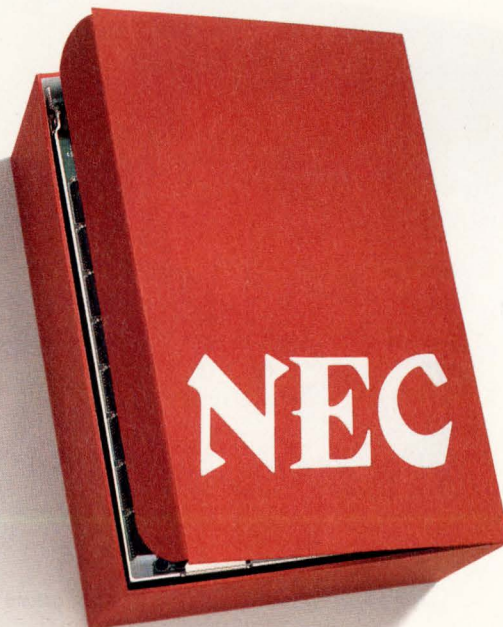
Alsys Inc, 67 S Bedford St, Burlington, MA 01803. Phone (617) 270-0030. FAX (617) 270-6882.

Circle No. 408

Object-Oriented Development System

Objectvision is an integrated development system for creating object-oriented software. The program lets you draw objects on the screen by using the built-in graphics editor. Once you've named an object, you can attach properties to it to specify the information it contains.

and out.



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But all you really need to know is that they're made by NEC, a 24-billion-dollar company, and the fourth largest manufacturer of disk drives in the world. For more information, call 1-800-NEC-INFO.

EDN December 6, 1990

CIRCLE NO. 57

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207

Software

You can also attach procedures to an object to specify how the object works. You can establish the relationships between two or more objects merely by drawing lines between them.

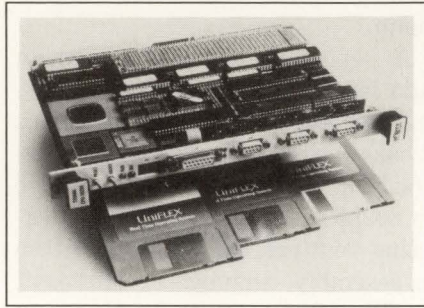
The program supports inheritance. For example, you can specify a "class" object and then attach other objects, which share the same properties and procedures, to it. These objects have additional properties and/or procedures that distinguish them from each other and from the class object.

When you've completed your design, you can run it interactively from within the development system, or ask the system to generate commented and ready-to-compile code in Zortech C++, Glockenspiel C++, Borland's Turbo C++, or Borland's Turbo Pascal 5.5 (you specify the compiler type when you order). To run the program, you'll

need an IBM PC or compatible that has at least 640k bytes of memory, a VGA or EGA monitor, and a mouse. \$399.

Objectvision, 2124 Kittredge St, Suite 118, Berkely, CA 94704. Phone (415) 540-4889.

Circle No. 409



Cross-Development System For VMEbus

Uniflex.wks is a cross-development system for designers of real-time, embedded systems based on Mo-

torola 68000 μ Ps and the VMEbus. The tools run under the real-time Uniflex operating system on Sun 68000-based and SPARC-based workstations. The package includes the GNU ANSI-C compiler and GDB (the GNU symbolic debugger). Other tools provide network services such as TCP/IP and NFS, and file-system creation for the target system. The tools fully support remote procedure calls.

The system provides real-time features such as priority task assignment, interprocess communications, and contiguous files. In addition, you can configure the target system to use standard Uniflex features such as networking, virtual memory, multiprocessing, and X Windows with the Motif user interface.

The output of the cross-development system is a pseudo-disk that you can download to PROM on the

All you need to know about 5.25" Winchester disk drives, inside

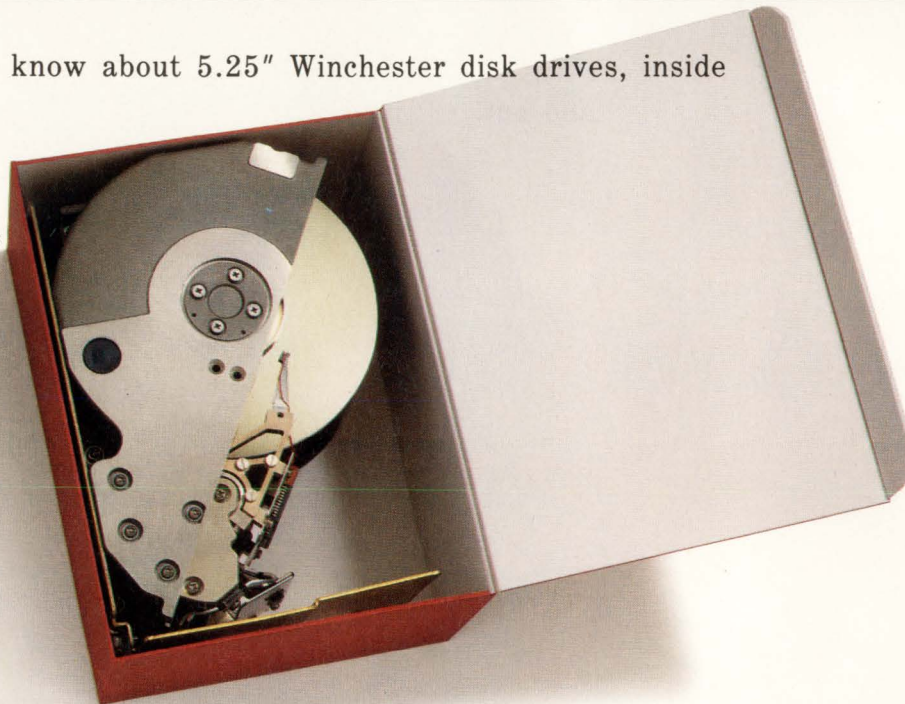
14ms Avg. seek

Variable sector sizes

1.6GB Capacity

SCSI-2 Interface

5MB/Second transfer rate



C&C
Computers and Communications

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Software

target system; this pseudo-disk contains the Uniflex kernel and the application programs. To improve performance, the target system should copy the programs into RAM before executing them. From \$13,600.

UniFLEX Computing Ltd, 111 Providence Rd, Chapel Hill, NC 27514. Phone (919) 493-1451. FAX (919) 490-2903. Circle No. 410

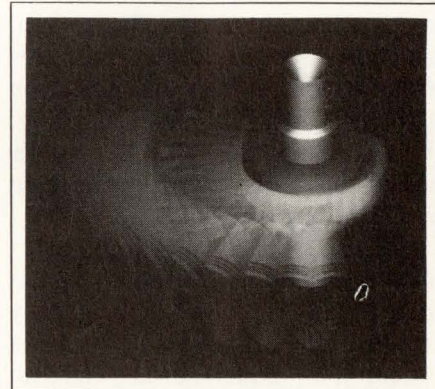
Data-Protection Software

The Immunity software data-protection package runs under PC/MS-DOS 3.2 or higher on IBM PCs, PS/2s, and compatibles. The program requires that the computer be equipped with two identical hard disks; it can work with most standard disk controllers and coding schemes such as MFM, RLL, ESDI, and SCSI. The software intercepts all disk-write operations and writes the data in duplicate to

the same physical sectors on both drives. If the primary drive fails, the program notifies you and automatically switches over to the secondary drive (or vice versa).

Read operations are performed by whichever drive has its heads closer to the required data; the decreased seek time more than compensates for the extra time needed for writing to the second disk. The program sends all details of disk errors to an error log and includes disk-repair utilities to aid in troubleshooting and resynchronizing the disks after an error. Immunity version 2.41 uses only 5k bytes of main memory and is compatible with a number of DOS-based LAN operating systems. \$345.

Unitrol Data Protection Systems Inc, 815 Hornby St, Suite 604, Vancouver, BC V6Z 2E6, Canada. Phone (604) 681-3611. FAX (604) 687-0814. Circle No. 411



Graphics Tool For Double-Buffering On X Windows

Figaro+ is a graphics application builder for personal workstations that run the X Window System. It is an enhanced implementation of the PHIGS (Programmer's Hierarchical Interactive Graphic System) standard, and provides features previously unavailable on X servers. In particular, you can use double buffering to make an image

and out.



But all you really need to know is that they're made by NEC, a 24-billion-dollar company, and the fourth largest manufacturer of disk drives in the world. For more information, call 1-800-NEC-INFO.

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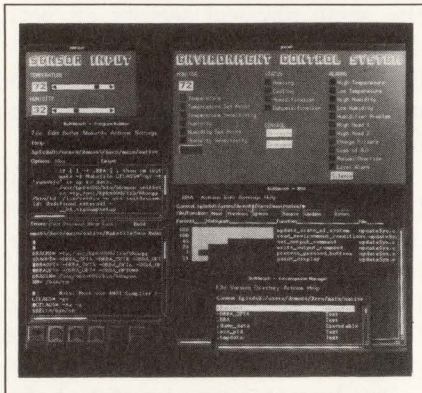
Software

move smoothly across the screen, and you can remove hidden surfaces from an image. The tool gives you two methods of double buffering. Using a hidden pixmap as a buffer allows full color and also works on monochrome displays.

Alternatively, you can use color-map manipulation, which is not limited by the X server's pixmap-copy speed, but does limit the available colors. The hidden-surface-removal feature improves the quality of the image by removing all polygon facets that in real life would be hidden by other surfaces closer to the eye of the viewer. The tool runs on 80386/486-based computers running Unix and the X Window graphics system. \$1595.

Template Graphics Software Inc., 3510 Dunhill St, San Diego, CA 92121. Phone (619) 457-5359. FAX (619) 452-2547.

Circle No. 412



Branch-Analysis Tool

HP Branch Validator simplifies and improves your software-validation testing by providing accurate information about the execution of branches in the program under test. Histogram summary information lets you apply validation criteria to a complete file or to individual functions. You can select branches to be excluded from your test criteria with the aid of a mouse, and you

can insert comments to explain why a branch was ignored.

When you run the tool, its default report provides a global view of program coverage; it can also generate a report that identifies all unexecuted branches. You can then determine what conditions would execute those branches and expand your test file to make sure that those branches are executed during testing. The tool works with the vendor's Softbench suite of debugging tools. Branch Validator and Softbench run on the vendor's HP 9000 Series 300 and Series 800 computers; separate versions are available for HP-UX C (native) and for AxLS C (embedded). Softbench, from \$1500; Branch Validator, from \$2000.

Hewlett-Packard Co, Logic Systems Div, Box 617, Colorado Springs, CO 80901. Phone local office.

Circle No. 413

All you need to know about 3.5" Winchester disk drives, inside

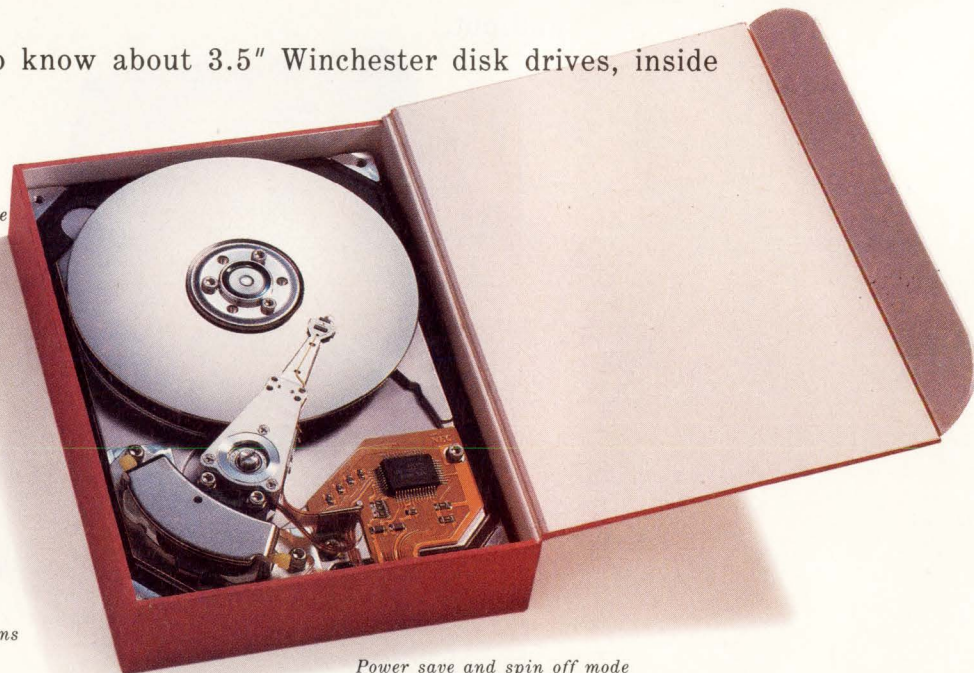
PC/AT and SCSI Interface

1" Height

56/130MB Capacity

Fast head positioning time 25ms

Power save and spin off mode
(wattage as low as 0.5W)

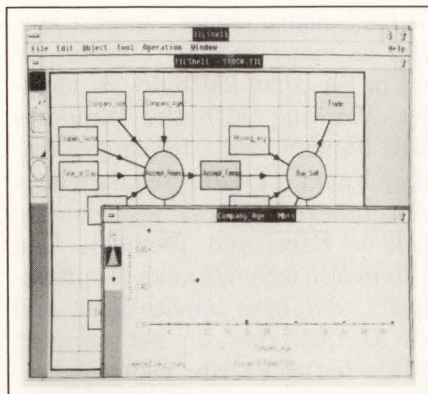


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Computers and Communications

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Software



Fuzzy-Logic Development System

The TILShell is a CASE tool for building expert systems that use fuzzy logic to assign probabilities or weighting to factors that affect a decision, when the available information is imprecise. You can manage complex interrelationships, such as data flow, in graphical form. The system acts in some respects like a spreadsheet; that is, if you

modify the values in one cell, the program automatically updates all algorithms in other cells that use the values. The tool lets you define the structure of an expert system in terms of inputs, outputs, and fuzzy rule bases. When you've completed your design, the tool can pass the design data to one of several code-generating compilers. \$8900, including the vendor's Fuzzy-C Compiler.

Togai InfraLogic Inc, 30 Corporate Park, Suite 107, Irvine, CA 92714. Phone (714) 975-8522. FAX (714) 975-8524. Circle No. 414

Object-Oriented Database

Gemstone 2.0 is an object-oriented database management system (OODBMS) that runs on all major workstations and servers from IBM, DEC, and Sun, and on Apple Macintosh II computers. This new

version supports TCP/IP and DECnet network protocols and will work with heterogeneous networks. The vendor says that improved caching, optimized algorithms, and greater flexibility in retrieving complex objects yield a threefold improvement in performance over the previous version.

Among the other new features are on-line backup, which allows 24-hour continuous up-time; interfaces to Smalltalk/V, Smalltalk-80, and C; and a C++ 2.0 interface that provides persistent storage to C++ applications. This feature allows C++ objects stored in Gemstone to exist independent of the application that creates them; the same or other applications can then recall and use the objects. The C++ interface also includes a class library that gives the programmer a standard set of definitions for commonly used data structures; you can ex-

and out.



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NEC

Software

tend these classes to create more complex data structures. A 4-user license on entry-level workstations, from \$12,000.

Servio Corp, 1420 Harbor Bay Pkwy, Suite 100, Alameda, CA 94501. Phone (415) 748-6200. FAX (415) 748-6227. Circle No. 415

Graphics System Debugger

Gspot (Graphics System Processor Operating Tool) 1.0 is a symbolic debugger for TI's 34010 graphics system processor (GSP). The debugger runs on IBM PCs and compatibles, and you can configure it to work with any GSP-based hardware including TI's SDB board.

You can install the debugger as a resident program while using another debugger for the host processor. You can return to Gspot either by pressing a hot key or by the action of breakpoints in the GSP pro-

gram. Other features include symbolic debugging, C source-level debugging, a user interface similar to that of Microsoft's CodeView, on-line assembly, and a memory display/edit mode. The program also provides full TIGA support. \$995.

Pixelab Inc, 4513 Lincoln Ave, Suite 105, Lisle, IL 60532. Phone (708) 960-9339. FAX (708) 960-9396. Circle No. 416

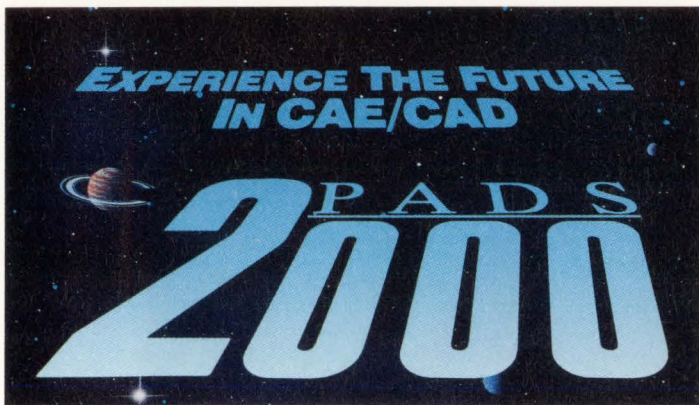
Object-Oriented Software Development System

Kappa PC version 1.1 is a high-performance development system for object-oriented application programs that run on IBM PCs and compatibles under Microsoft Windows 3.0. This interactive system incorporates facilities for object-oriented programming, rule-based reasoning, and active graphics. Because of the software's improved

memory management, applications with as many as 5000 objects can run in less than 2M bytes of memory. Working with the Windows DDE (dynamic data exchange) feature, Kappa PC can exchange data with other Windows applications such as Excel and Toolbook. The system also includes links to spreadsheets, database applications, and ASCII files that do not support DDE. You can write your applications in ANSI C or in the proprietary Kappa Application Language (KAL). Registered users of version 1.0 can upgrade to version 1.1 for \$165. For first-time purchasers, a complete 1.1 development system costs \$3500; a runtime license for each application you develop with Kappa costs \$450.

IntelliCorp, 1975 El Camino Real W, Mountain View, CA 94040. Phone (415) 965-5500

Circle No. 417



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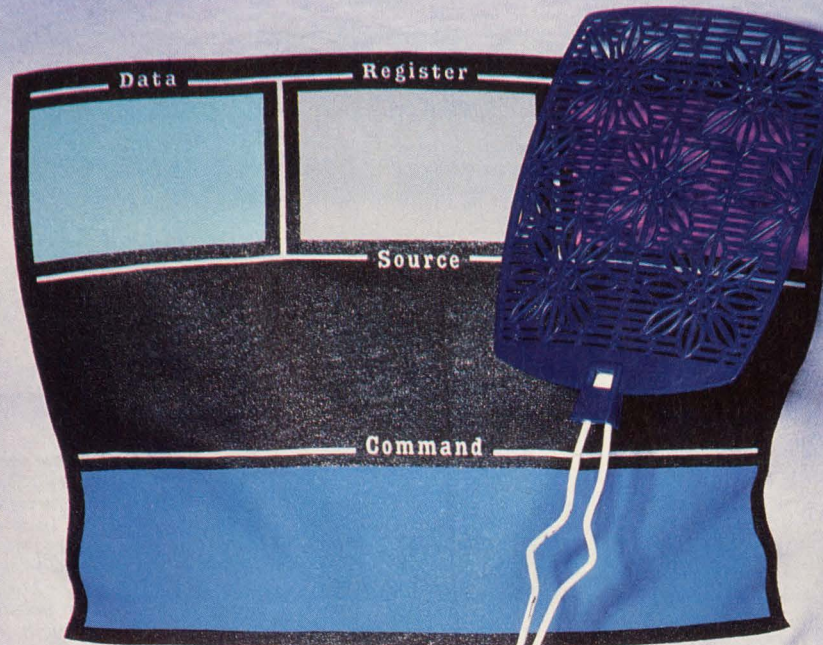
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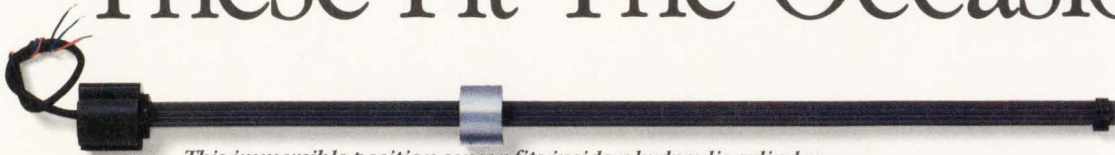
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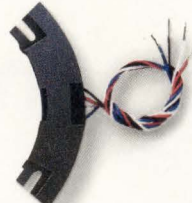
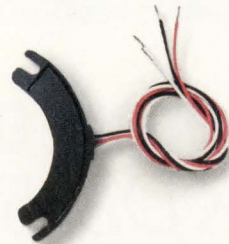
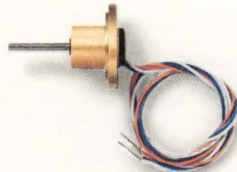
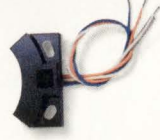
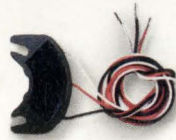
This immersible position sensor fits inside a hydraulic cylinder, using the fluid it resides in as a lubricant while saving space.



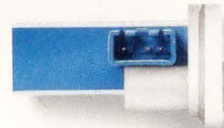
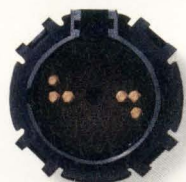
These heavy-duty "down-hole" sensor designs check the well casing diameter, while working under extreme pressure and heat.



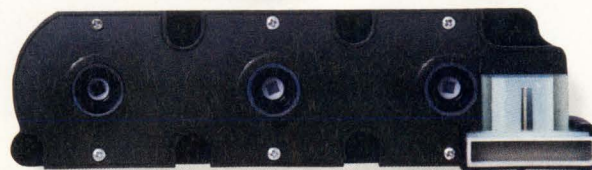
Use the same approach to angular displacement in hand held instruments as these gyro and fin position sensors, which banded in on a missile design problem.



POSITION SENSORS



Drive-by-wire designs for automotive and heavy equipment designs make reliability problems a thing of the past.

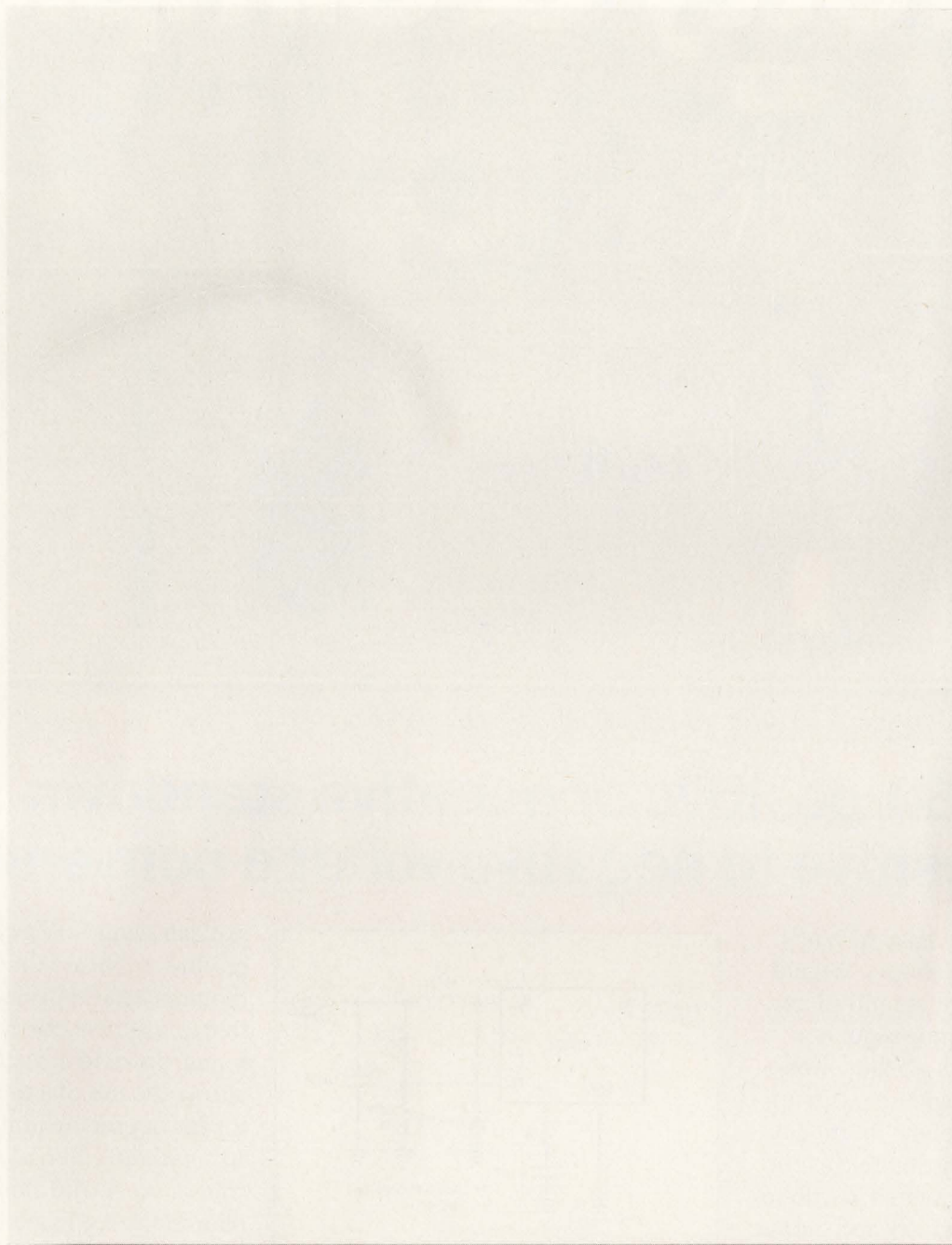


Both spring loaded and magnetically coupled position sensors for truck engine applications must withstand extremes of vibration, temperature and exposure to highway dirt and grime.

They began with a need to fit in just the right place and function dependably under any conditions. They are available in as many shapes and sizes as the challenges they're designed to meet. Their outstanding accuracy, feedback and environ-

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Tube amp isolates high voltages

Dave Cuthbert
Tektronix, Beaverton, OR

The isolation amplifier in Fig 1 employs a vacuum-tube, shunt-regulator triode (designed for TVs) and two op amps to transfer dc-to-5-MHz signals across a potential difference of 25,000V. The circuit is a gain-of-1 inverting amplifier that has a $\pm 1V$ input range. The circuit's 60-Hz rejection ratio is -100 dB.

This isolation amplifier can send signals only from a negative to a positive potential, and the system must support a 1.6-mA current flow between input and output. At potentials greater than 15 kV, the tube produces X-rays.

WARNING: You MUST shield the tube with sheet metal at least 0.1-in. thick to block the X-rays.

The circuit's op amps determine its dc accuracy. For example, the LM381 op amps shown yield wide bandwidth; precision op amps would give better dc performance.

In operation, op-amp IC₁ controls the tube's cathode

current via the tube's grid to hold the inverting input equal to V_{IN} . The cathode current, I_K , is

$$I_K = V_{IN} / ((R_1 R_2) / (R_1 + R_2)) - V_{REF1} / R_2.$$

If V_{IN} is 0V, then the cathode current is 1 mA. An input signal varying between $\pm 1V$ will vary the cathode current from 433 to 1567 μA . For a tube-anode potential of 25 kV, the grid's voltage must vary from -10.5 to $-6.5V$ to produce this range of cathode current. Because no grid current flows, the anode and cathode currents are equal.

Output op-amp IC₂ converts the anode current to an output voltage, V_{OUT} , which equals

$$V_{OUT} = ((V_{REF2} / R_4) - I_K) \times ((R_3 R_4) / (R_3 + R_4)).$$

You zero the output circuit by adjusting V_{REF2} .

You can obtain the tube from Newark Electronics (phone local office). (EDN BBS DI #914) **EDN**

To Vote For This Design, Circle No. 747

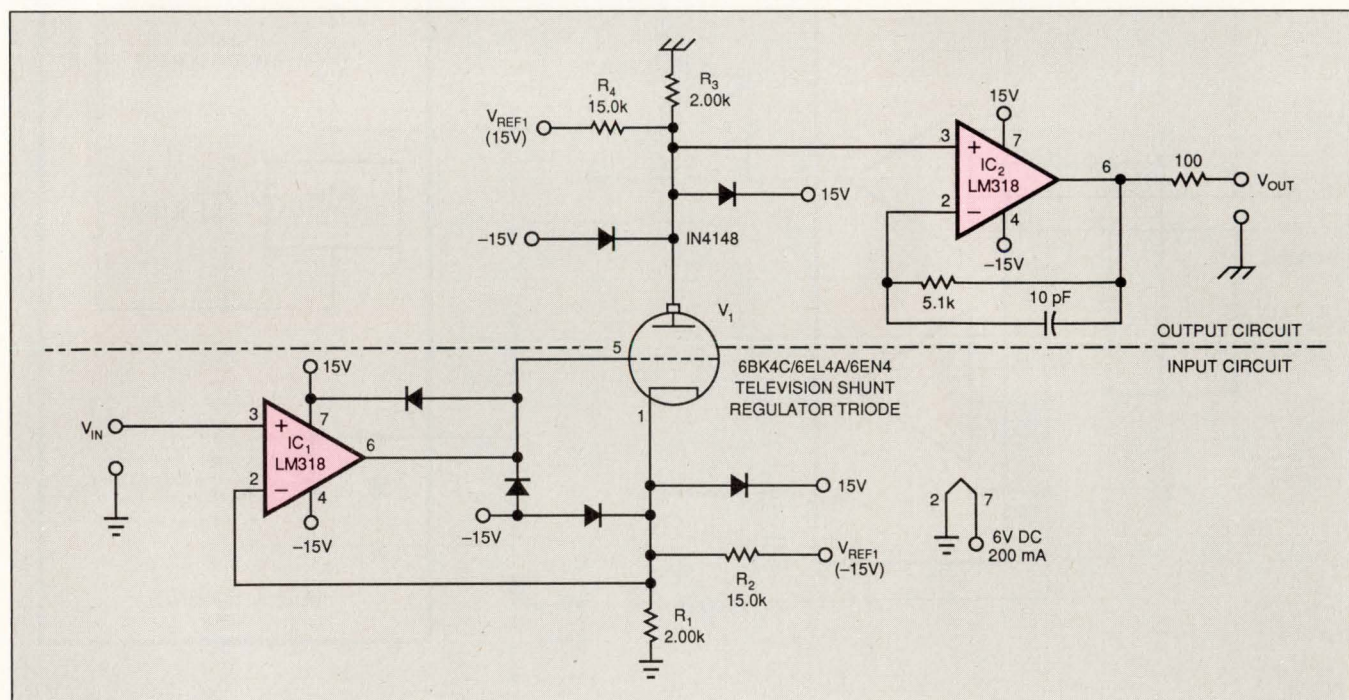
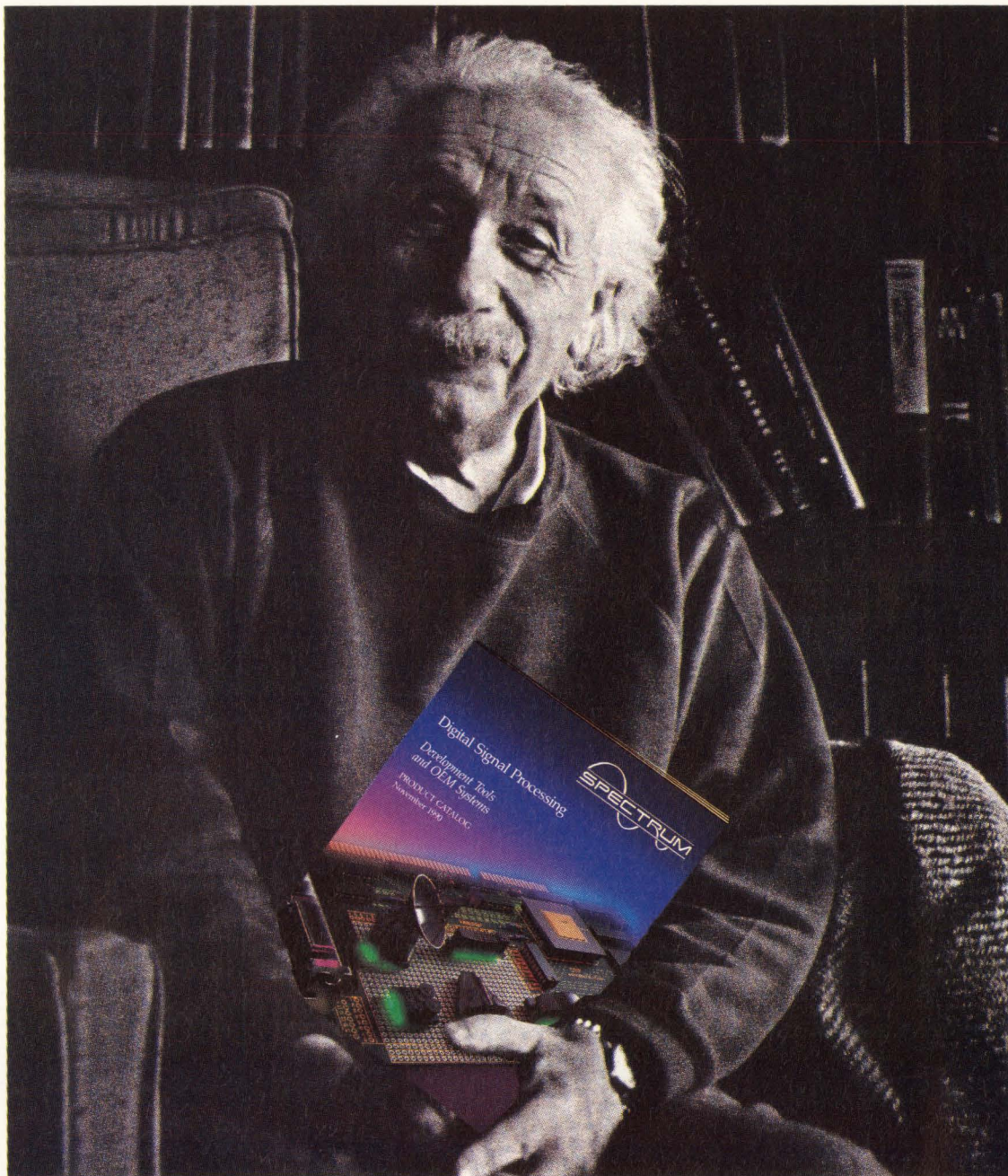


Fig 1—Because a vacuum physically separates this tube's current-carrying elements, the tube can function safely (if you block the resulting X-rays) as an isolation amplifier across a 25,000V potential difference.



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Programmable resistor shifts phase

Ajoy Raman and K Radhakrishna Rao
Indian Institute of Technology, Madras, India

You can replace the fixed RC network commonly used for phase shifting sinusoidal signals with a digitally programmable circuit. The circuit in **Fig 1** replaces the

traditional circuit's resistor with a discrete, multiplying D/A converter (MDAC), which functions as a programmable resistor.

With the MDAC in a magnitude-comparison loop, the resulting circuit is a digitally programmable, frequency-independent phase shifter. For the values

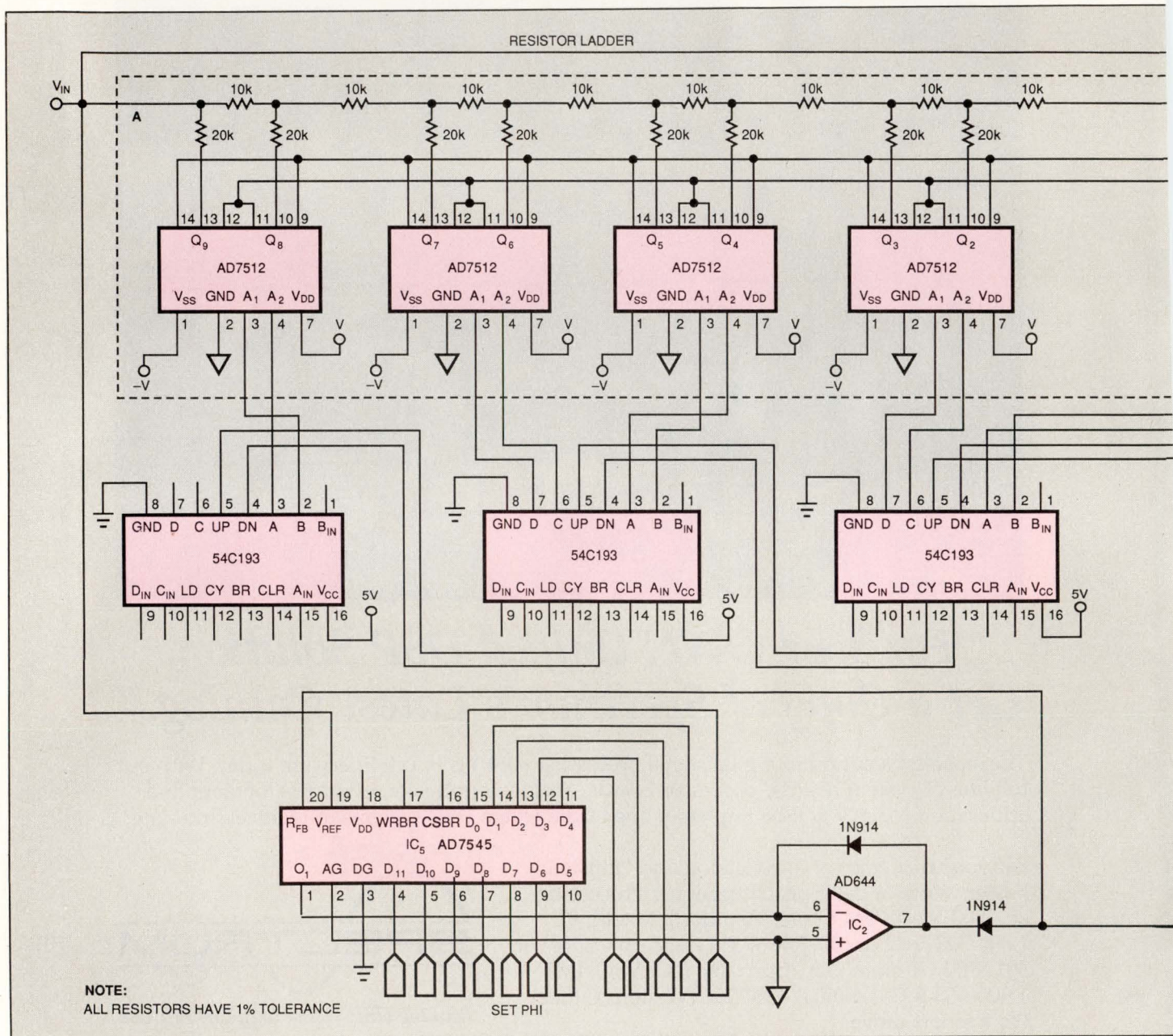


Fig 1—This digitally programmable phase shifter can replace a fixed RC network.

DESIGN IDEAS

the state of the 10 CMOS switches in the AD7512 array.

An MDAC IC's output must be close to analog ground. The MDAC made from discrete devices removes that restriction. Buffer op amp IC₁ maintains outputs B and B' at the same potential.

An RC network's phase shift, ϕ , depends on the network's attenuation factor, α :

$$\phi = -\arctan(\sqrt{1-\alpha^2}/\alpha).$$

The digitally variable resistance, together with capacitor C₁, form an RC phase-shift network. An MDAC, IC₅, attenuates the input to op amp IC₂ by the factor α . IC₅'s setphi input determines α .

The circuit's magnitude-comparison loop bridges the input and output of the programmable RC network. Op-amp IC₂ is a half-wave rectifier, as is buffer op-amp

IC₃. Comparator IC₆ compares the outputs of IC₂ and IC₃.

Depending on the state of IC₆'s output, the comparator clocks the counter comprising IC₇, IC₈, and IC₉ up or down. Consequently, the magnitude-comparison loop servos the programmable resistance's value so that the phase-shift network shifts phase by an amount proportional to α . When the phase shift is proportional to α , the average-value outputs of IC₂ and IC₃ are equal. At that point, the total phase shift equals $2 \times \phi$.

The output filter, IC₄, restores the circuit's output to the same level as its input. The filter allows the voltage across C₂ to settle to within a small ac-hysteresis band during each clock period.

(EDN BBS DI #913)

EDN

To Vote For This Design, Circle No. 748

Loop-through amp rejects common-mode noise

Barry L Siegel
Elantec, Milpitas, CA

The video-bandwidth amplifier in Fig 1 (a "loop-through" amplifier) rejects common-mode noise such

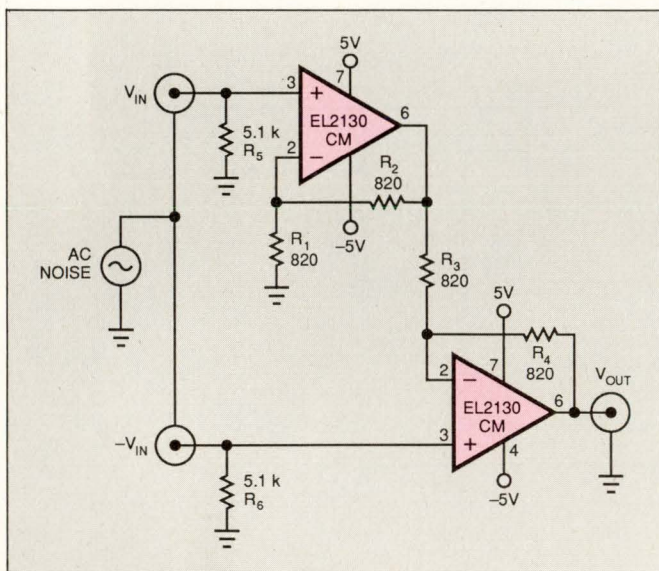


Fig 1—This video-bandwidth amplifier exhibits a -45-dB CMRR at frequencies as great as 100 kHz.

as 60-Hz hum. Usually, such circuits consume three video amps. The circuit in Fig 1 uses only two video amplifiers, yet it achieves a differential bandwidth of 60 MHz ($A_{DIFF}=2$) and an ac CMRR in excess of 45 dB at frequencies as high as 100 kHz. The circuit will also work well for $A_{DIFF}>1$.

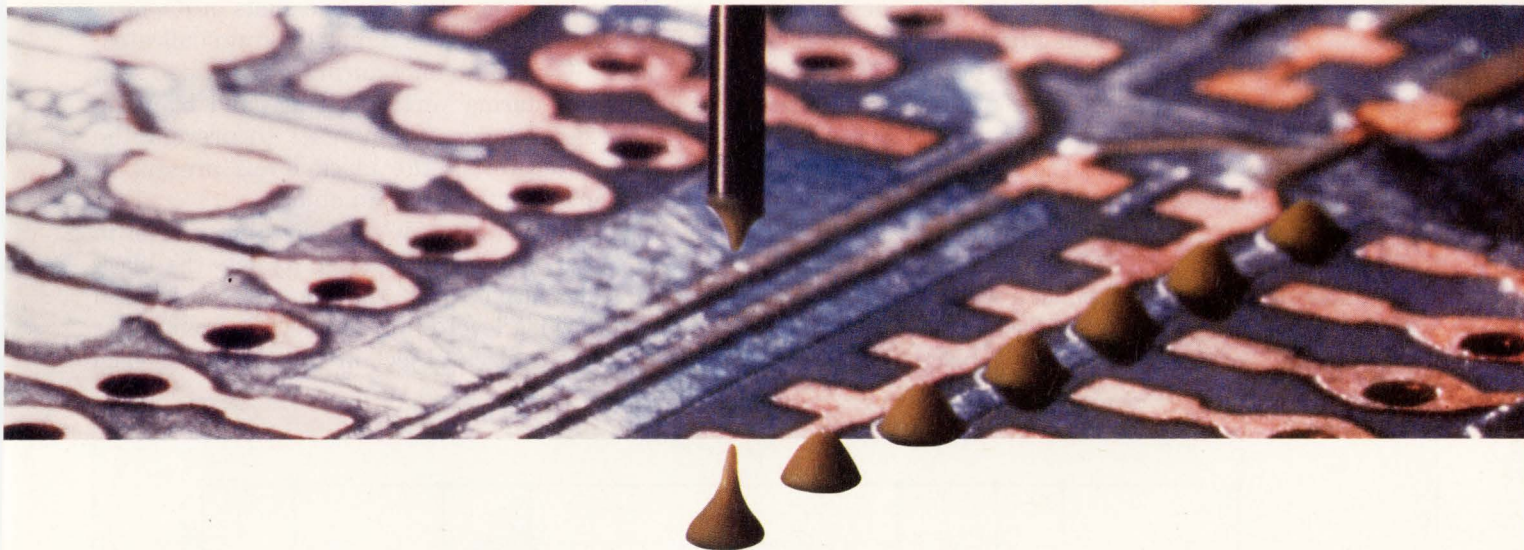
The video amps are current-feedback units, and R_2 and R_4 yield an optimized 3-dB bandwidth. You can improve both the ac and dc CMRR by varying R_1 . The circuit's design equations are

$$\begin{aligned} A_{DIFF} &\geq 1, \\ R_2 &\cong R_4 \text{ (select both for optimum bandwidth),} \\ R_1 &= R_2(A_{DIFF} - 1), \text{ and} \\ R_3 &= R_4/(A_{DIFF} - 1). \end{aligned}$$

With a $\pm 5V$ power supply, the circuit has a $\pm 1.5V$ dc common-mode range. (EDN BBS DI #915) **EDN**

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Analog voltage tracks camera images

Thomas J Dahlin
3M, St Paul, MN

Fig 1 uses a low-cost, RS-170-output video camera to track the vertical position of an object within the camera's field of view (FOV). The circuit produces an analog voltage which varies with the distance from the top of the object to the top of the camera's FOV. For example, if the object is near the top of the FOV, the output is around zero volts. As the object moves toward the bottom of the FOV, the voltage increases.

The operation of this circuit relies on a lighting setup that silhouettes the object against a white background, which assures sufficient detection contrast. The object is detected by the presence of a near-black video level

occurring in the middle of a scan line. The circuit updates its output at 60 Hz once per video field.

The circuit feeds the RS-170 video signal into IC₁, a LM1881 sync stripper. The two one-shots in IC₂ form a valid-video gate. As **Fig 2's** timing diagram indicates, the output of IC_{2B} is high only during active-video scan lines and is low during vertical-retrace and blanking times. This signal holds IC₃ in reset to prevent the circuit from interpreting the black levels present in the video blanking interval as an object.

The LM139 comparator, IC₄, detects black level in the video signal. The potentiometer R_T sets the black threshold. The output from the comparator is high when a black video level is present. The circuit tests the presence of a black object in the middle of each

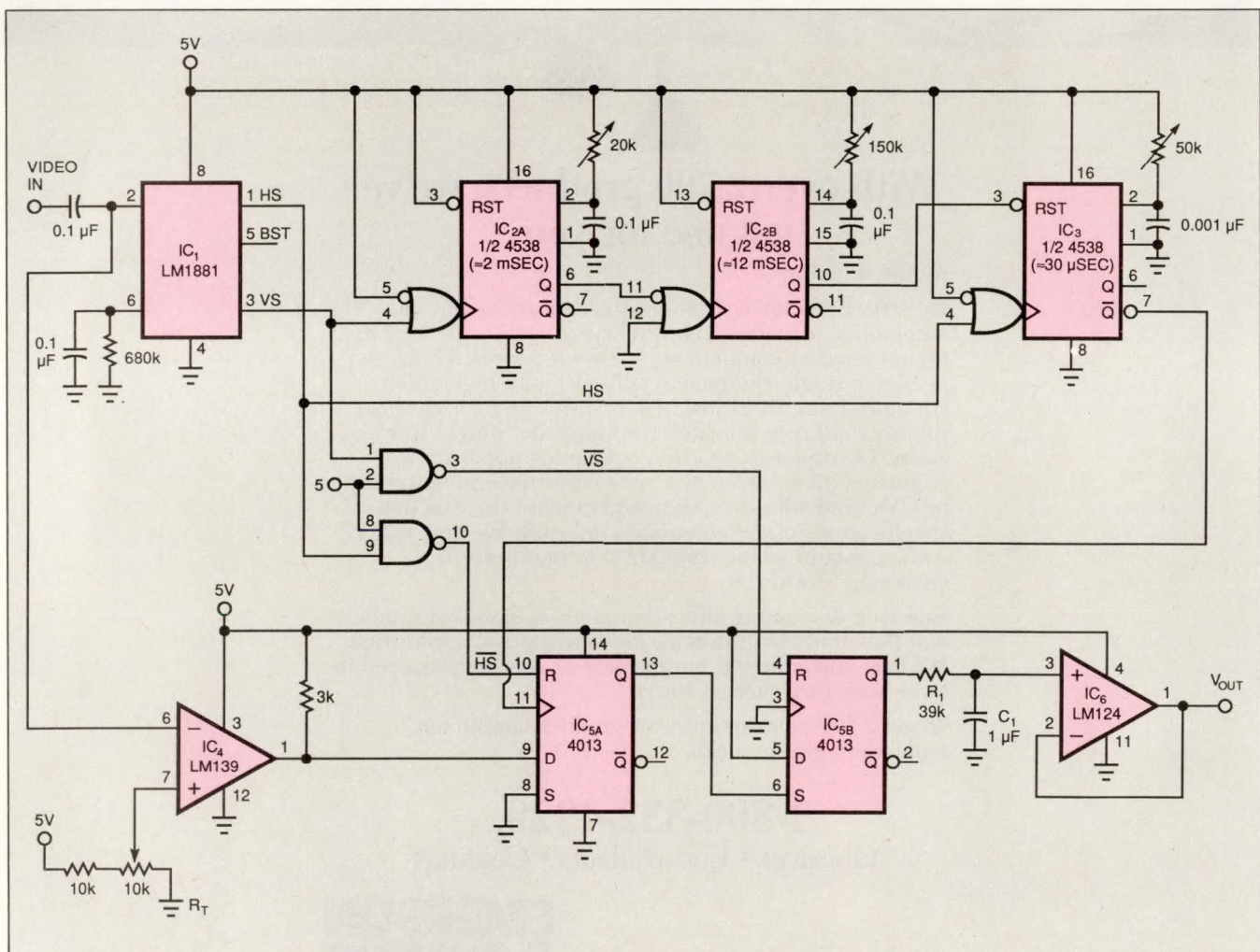
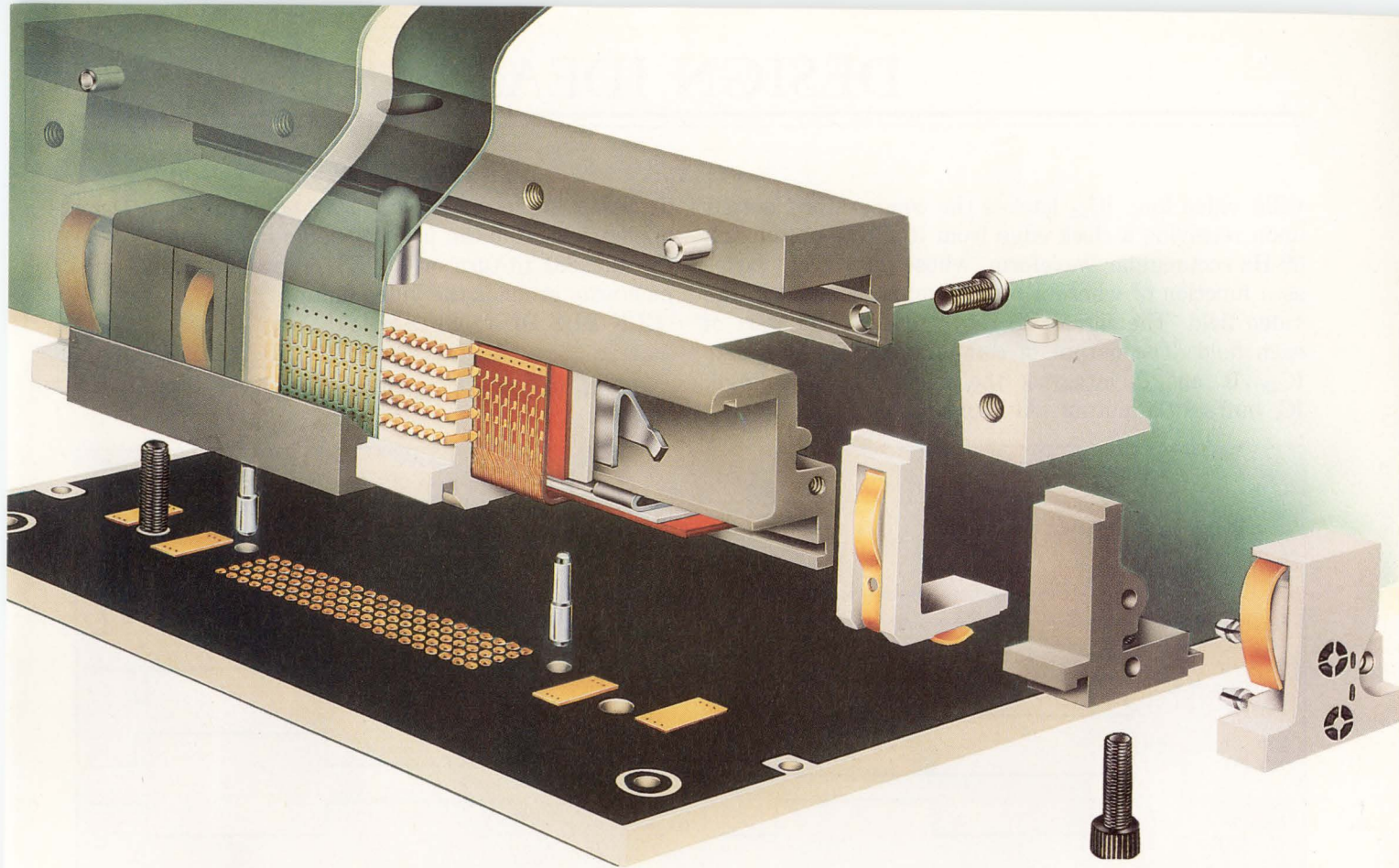
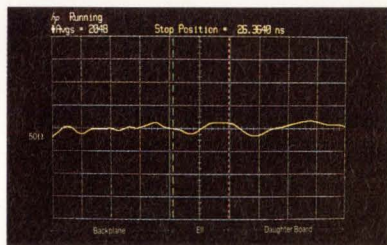


Fig 1—By detecting the presence of a black object in the active-video area, this circuit generates an analog voltage, which corresponds to an object's location in the camera's field of view.



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valid video line. IC_{5A} latches the comparator's output upon receiving a clock edge from IC₃. IC_{5B} produces a 60-Hz rectangular waveform, whose duty cycle varies as a function of where a black level is detected in the video field. The signal $\bar{V}S$ resets IC_{5B} at the start of each field. The output of comparator latch IC_{5A} sets IC_{5B}. R₁ and C₁ integrate the analog output voltage. IC₆ buffers the output. Although not shown, adding a

dc clamp to the video input may be required in some applications. You can use the clamp burst output from the LM1881 to turn on a FET or transistor that momentarily grounds the video input.

(EDN BBS DI #908)

EDN

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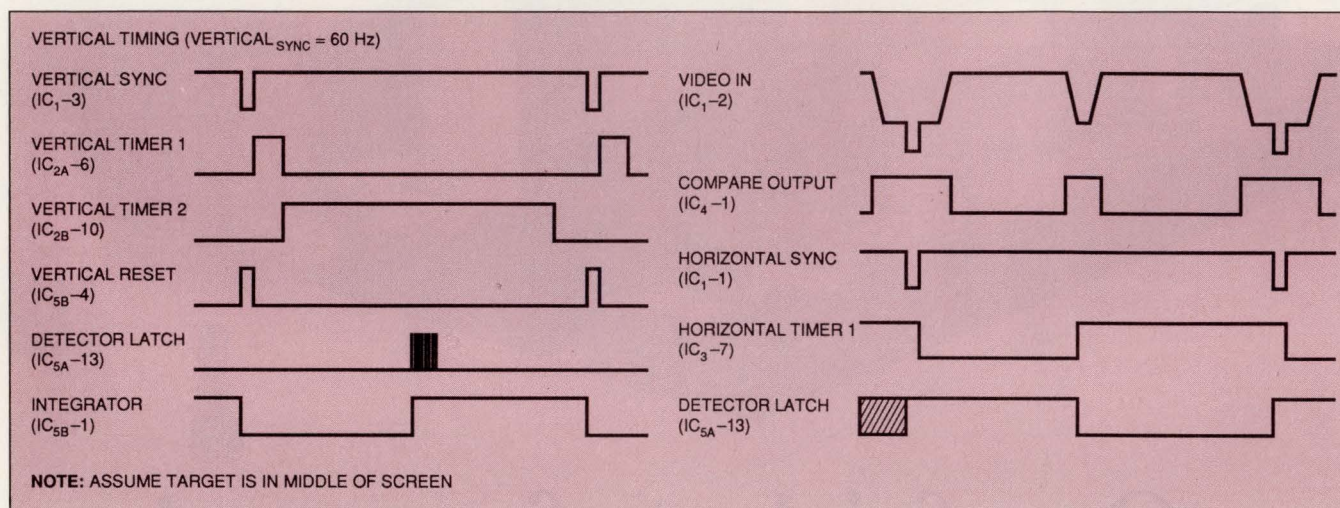


Fig 2—The video-tracking timing diagram illustrates the signals at various points in Fig 1's circuit.

FET-input amplifier settles fast

Barry L Siegel
Elantec, Milpitas, CA

The FET-input amplifier in Fig 1 slews at 700V/ μ sec and settles to within 0.01% in under 200 nsec. You can maintain low-offset drift by running both J₁ and J₂ at the same drain current. Thus, R₁ and R₂ should match to within 1% resistors. The EL2028 exhibits inherently low offset (250 μ V) and drift (3 μ V/C). A 10-k Ω , 10-turn potentiometer enables you to null the offset of both the FET source followers and the op amp. The dual FET must have an I_{DSS} in excess of 6 mA in order to preserve the high slew rate. If your application requires the op amp to drive a high capacitive load—greater than 25 pF—a snubber of 100 Ω in series with a 100-pF capacitor is recommended.

(EDN BBS DI #909)

EDN

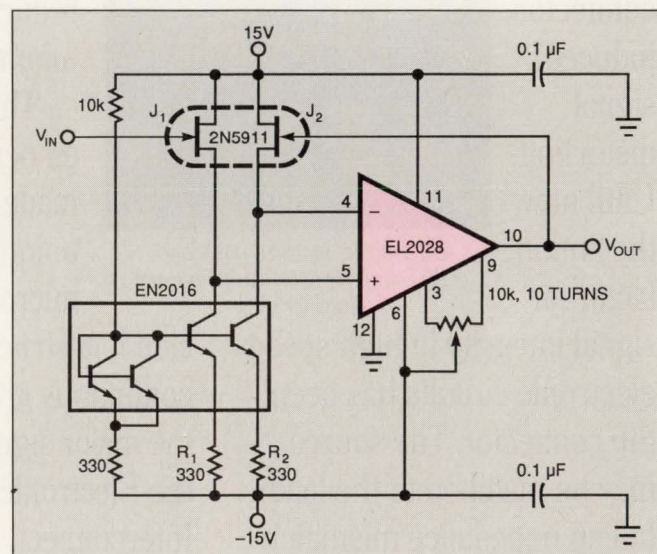


Fig 1—To maintain the low-offset drift of this FET-input amplifier, R₁/R₂ should be less than 1%.

To Vote For This Design, Circle No. 802



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TLC1540
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835 X

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Conditional skip manipulates clock

Stan Mircea-Raducu
*Research Institute for Computers
 Bucharest, Romania*

By manipulating the clock inputs to the Am2910 microsequencer, you can implement a conditional skip, which is not part of the 16 standard sequence-control instructions of the Am2910. The advantage of the conditional skip instruction is that it leaves the data/address microinstruction field free while still providing a means of conditional branching. The conditional skip instruction provides a technique for skipping the next microinstruction depending upon the test condition inputs. For example, at location 51, if the test on the condition input passes, the next executable instruction is number 53. If the test fails, it will go to 52.

You can implement either the usual continue or the new conditional skip by using the standard Am2910 continue instruction (code 14) in conjunction with another microinstruction field (the skip field). Depending on the test input, you generate either one or two clock pulses on the Am2910 clock input. For this particular design, the normal clock for the Am2910 and the pipeline register has a 250-nsec period: 150 nsec high, 100 nsec low (Fig 1a). When you execute the conditional skip and the test passes, the clock for the Am2910 corresponds to Fig 1b, and the pipeline microinstruction clock's period is 300 nsec. Because of the two low pulses, the microsequencer advances with two steps through the microprogram and executes the skip. The instruction on the Am2910 inputs I_0 through I_3 is the continue instruction.

However, when the test fails, both clocks have the normal 250-nsec period just as in (Fig 1a), and the

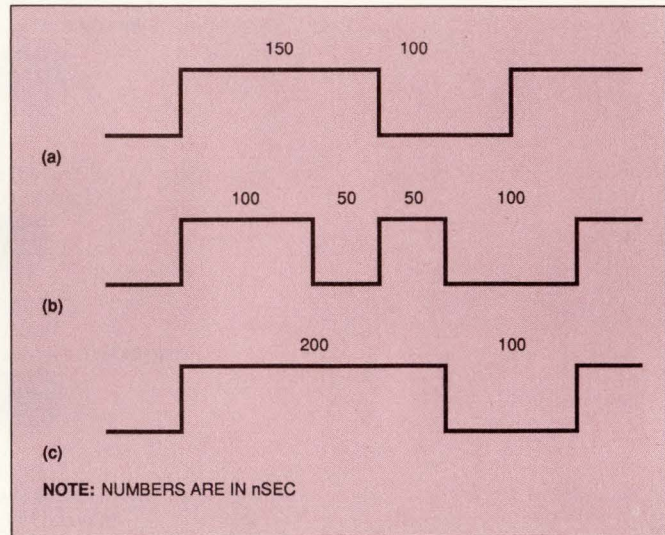


Fig 1—The conditional skip instruction modifies the standard 250-nsec clock cycle (a). If the test passes, the two short clock pulses in b cause the sequencer to jump over the subsequent instruction. The corresponding pipeline clock is 300 nsec (c). If the test fails, the clock is as shown in a.

microsequencer advances only one step. In this example, manipulating the clock in 50-nsec multiples simplified the hardware design because the available clock on the controller board was 20 MHz. The state machine for microclock generation was also easily modified to generate the extra low pulse when switching to the 300-nsec clock period. You can tune this idea to work with faster clock rates. (EDN BBS DI #911) **EDN**

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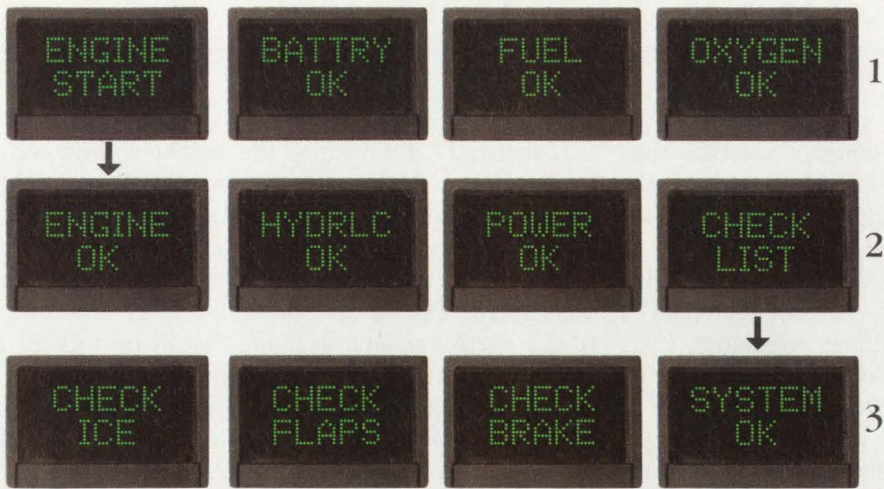
Sensor and logic form digital compass

Brian Grenoble
Maxim Integrated Products, Sunnyvale, CA

Combining a Hall-effect sensor with a few ICs provides an 8-point digital compass. Four open-collector outputs on the sensor correspond to the four cardinal points

of the compass. The sensor's Hall-sensing action activates one output for each of the principal directions: N, S, E, and W. Aligning the sensor with an intermediate direction, such as NW, grounds both of the associated outputs.

By detecting whether the sensor is selecting single



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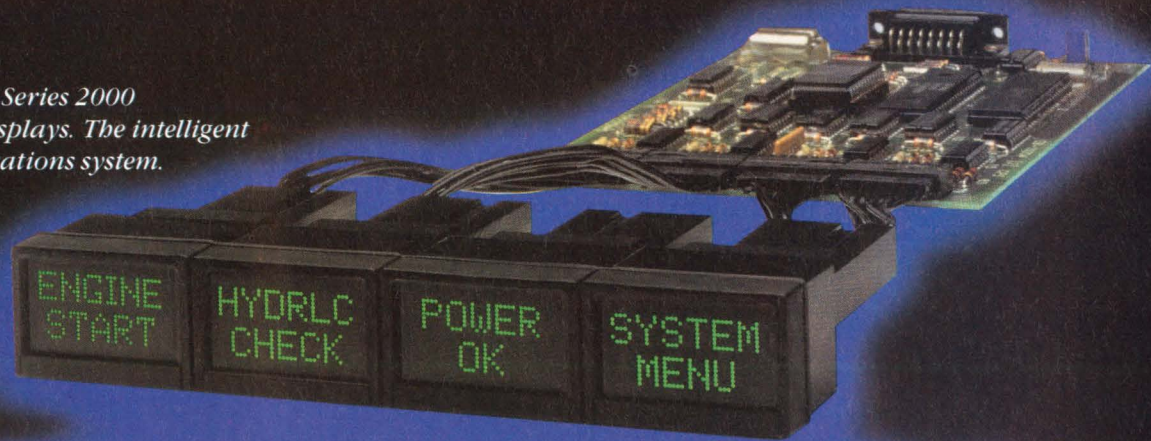
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DESIGN IDEAS

or dual outputs, the NOR-gate scheme resolves the four sensor signals into eight distinct compass readings. Following the NOR gates, eight inverters enable the system to drive medium-power LEDs.

The circuit's power supply (Fig 2) operates from an unregulated input voltage that can vary between 5.25V and 18V. The supply includes a linear regulator, IC₁, that provides 5V for the LEDs, logic, and low-power step-up converter (IC₂). The converter generates a clean, stable 10V for the sensors, which, if necessary, allows the sensor and control/display unit to be located yards apart in a noisy automotive environment. The sensor operates from 8 to 12V.

Inductor L₁ determines the actual voltage supplied to the sensor. An inexpensive barrel (bobbin) inductor, though noisy, suits this application because the control section includes no RF-sensitive components. If higher efficiency is required, toroidal-core inductors are recommended. The sensor, like any device that responds to the earth's magnetic field, should be located away from metal structures and electric motors. In most vehicles, the windshield area meets this requirement. (EDN BBS DI #910) **EDN**

To Vote For This Design, Circle No. 804

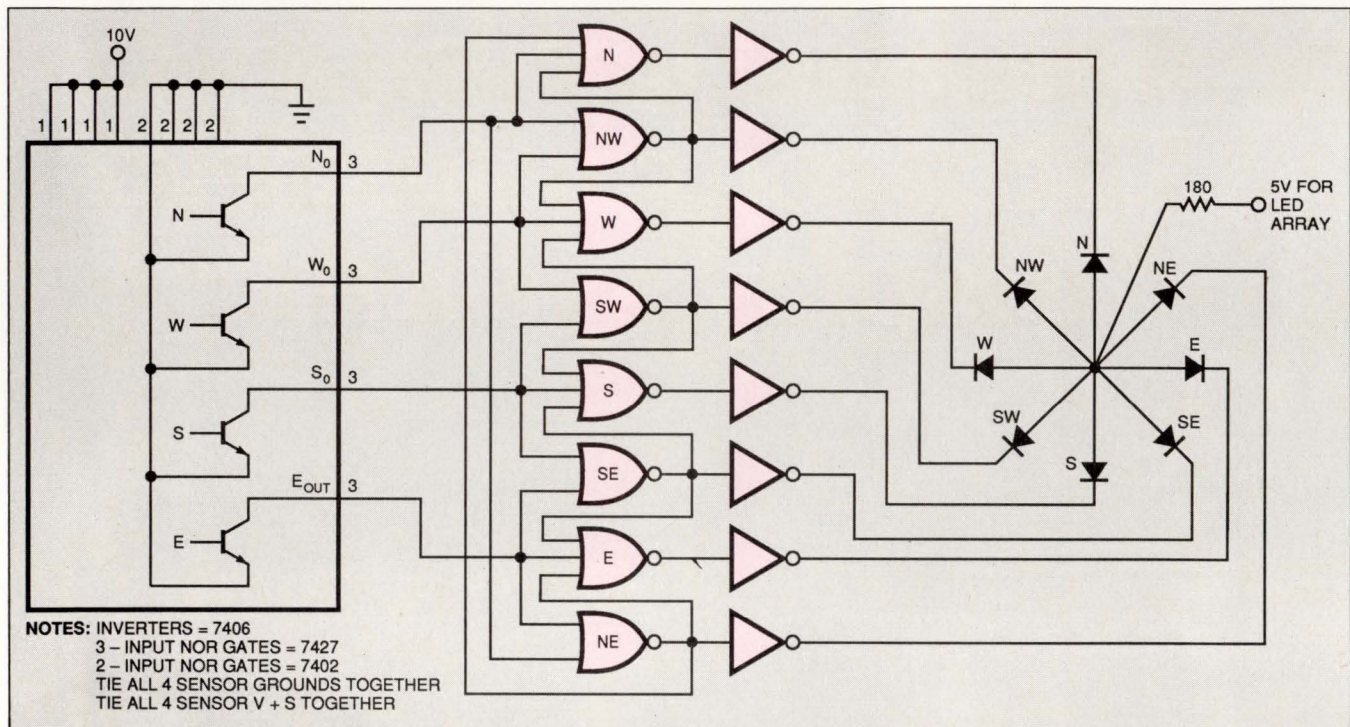


Fig 1—Based on the operation of a Hall-effect sensor, this digital compass illuminates one LED for each of eight directions.

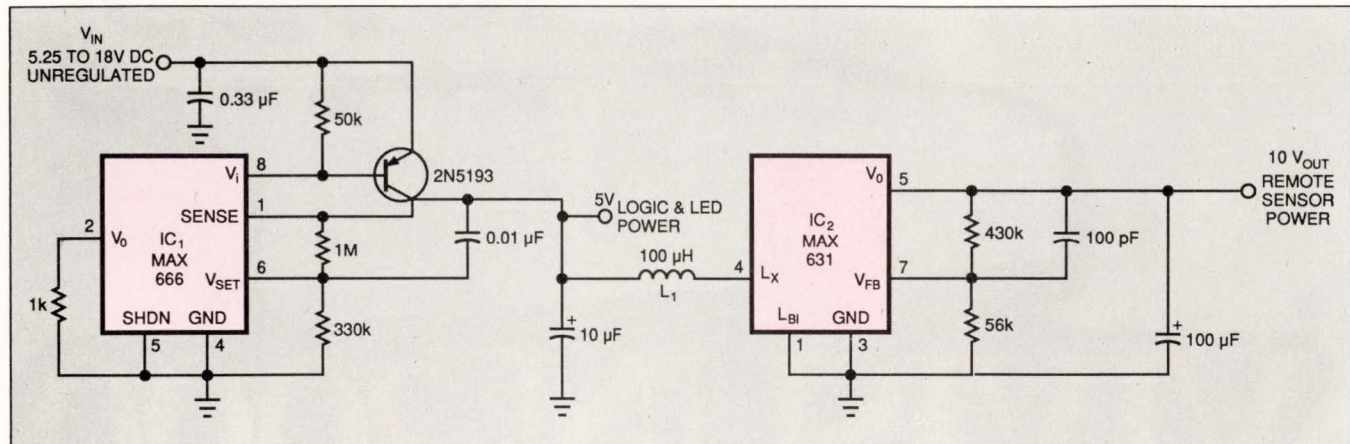
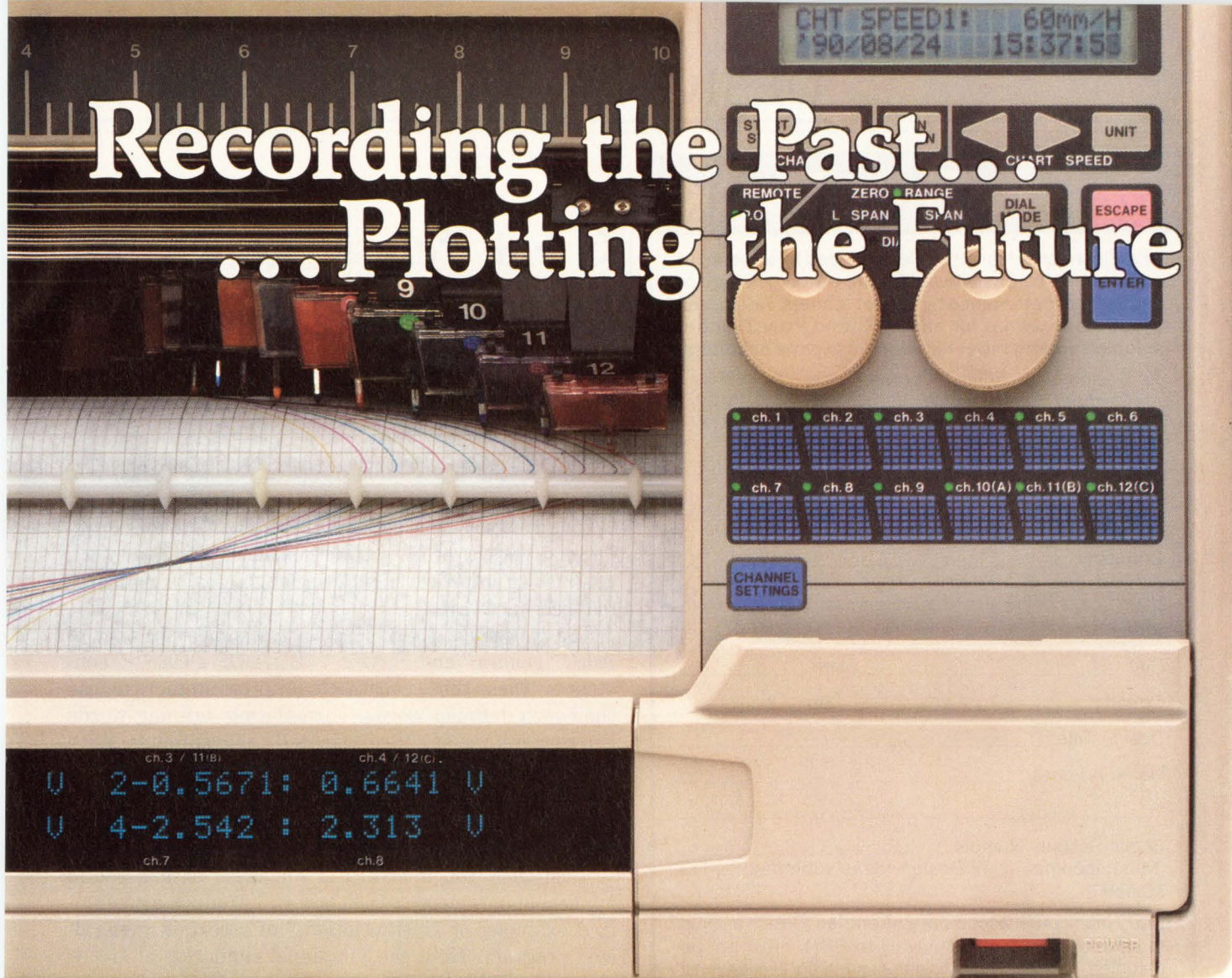


Fig 2—The compass' power-supply circuit converts a 5.25 to 18V, unregulated input to 5V for the LEDs and logic, and provides 10V for the Hall-effect sensor.

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C++ "class" generates bit manipulators

Eric Horner
Sundstrand, Rockford, IL

Posted on the EDN bulletin-board service (BBS) is a C++ "class" and related programs for generating and testing routines that set groups of bits. The class produces a variety of bit-setting routines. You need such routines to interface high-level languages to memory-mapped hardware.

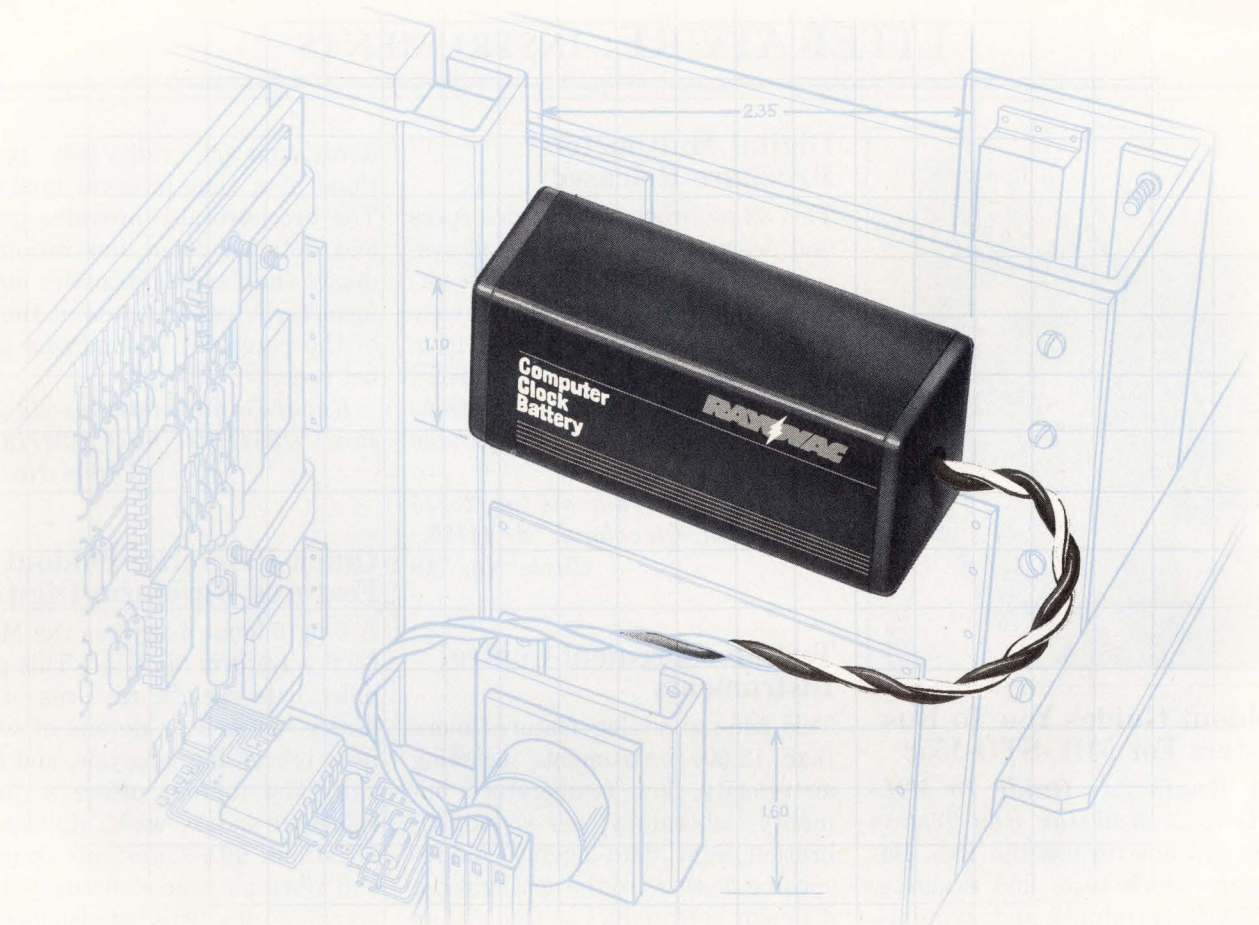
The concept of the C++ class is similar to that of Ada's "generic" and Fortran's "<BUILDS DOES>" constructs. These three constructs let programmers devise their own defining words. Formulating defining words is a cornerstone of object-oriented programming. With older high-level languages, programmers are stuck with only the defining words, such as Fortran's and Basic's DIM statement, that the language's designer deigned to include.

Each time you invoke a C++ class with a set of applicable parameters, the class will produce a customized example, or "instantiation," of a certain generalized program. Note the functional similarity of C++ classes to DIM. Each time you invoke DIM in Fortran or Basic, the statement produces a unique, named data structure according to your specifications. DIM also attaches to the data structure the routines needed to manipulate the new structure, thereby producing an "object." (EDN BBS DI #916) **EDN**

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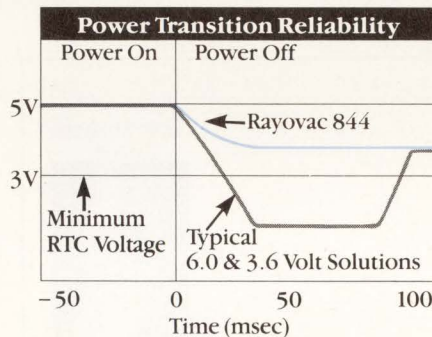
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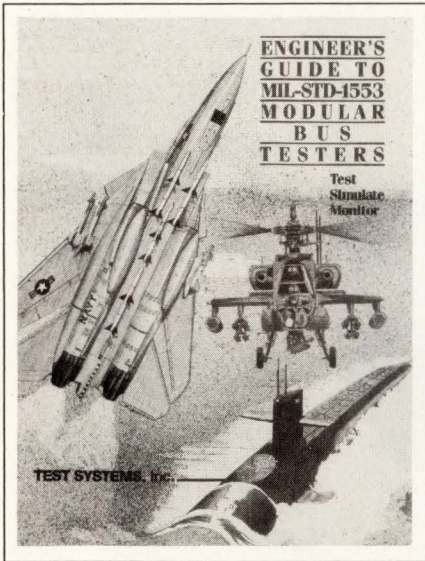
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Circle No. 716

Temperature-Measurement Reference Encyclopedia

Volume 27 of the hardbound *Complete Temperature Measurement Handbook and Encyclopedia* offers more than 1000 pages of comprehensive technical and temperature-measurement information. A few technical areas discussed in this book include custom engineering case histories; computer interfaces and data loggers; relative-humidity measurement devices; and analog meters and amplifiers. This reference book also highlights a technical-books library with price listings and delivery information.

Omega Engineering Inc, Box 4047, Stamford, CT 06907.

Circle No. 717

Digital Multimeters Brochure Released

This 32-pg brochure provides specs and descriptions of bench and system DMMs. A selector guide enclosed in the booklet allows easy comparison of various models, from battery-powered portables to IEEE units. User profiles and applications describe the features of comparable products.

Keithley Instruments Inc, 28775 Aurora Rd, Cleveland, OH 44139.

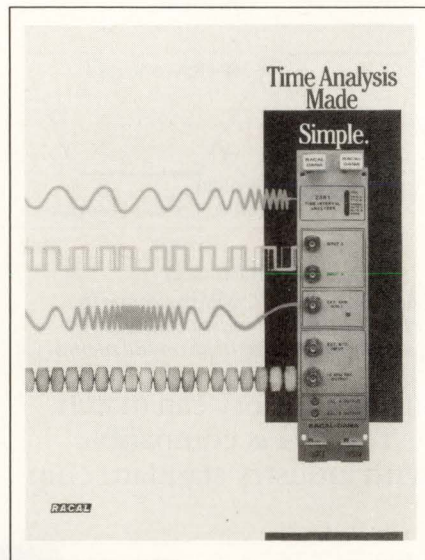
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Test-Measurement-Control Instruments

This 546-pg catalog features more than 12,000 instruments including air velocity, flow, temperature, humidity, laboratory, gas sound, vibration, light, data-logging, and recording meters. In the spotlight are a 4-color hot-product section and an introduction to a wide range of instruments.

Davis Instrument Mfg Co Inc, Seton Business Center, 4701 Mount Hope Dr, Baltimore, MD 21215.

Circle No. 719



VXIbus Time-Interval Analyzer Highlighted

A 6-pg pamphlet describes magnetic media, radar, frequency stan-

dards, and agile radio test applications of a time-interval analyzer. The brochure also provides photos and detailed color illustrations to depict the device's graphics output formats. A table located at the end of the pamphlet summarizes product specs.

Racal-Dana Instruments Inc, Box C-19541, Irvine, CA 92713.

Circle No. 720

Quick-Reference Foldout Features Waveform Digitizer

A 6-pg foldout describes the Model 6400 waveform digitizer. This pamphlet lists specific features of the device, as well as details of waveform processing, analysis, and storage. The foldout offers a quick-reference index, which divides applications into transient-, power-, and vibration- and structural-analysis categories. This list also includes medical, seismological, geophysical, and sonar applications of the waveform digitizer.

Analogic Corp, 8 Centennial Dr, Peabody, MA 01960.

Circle No. 721

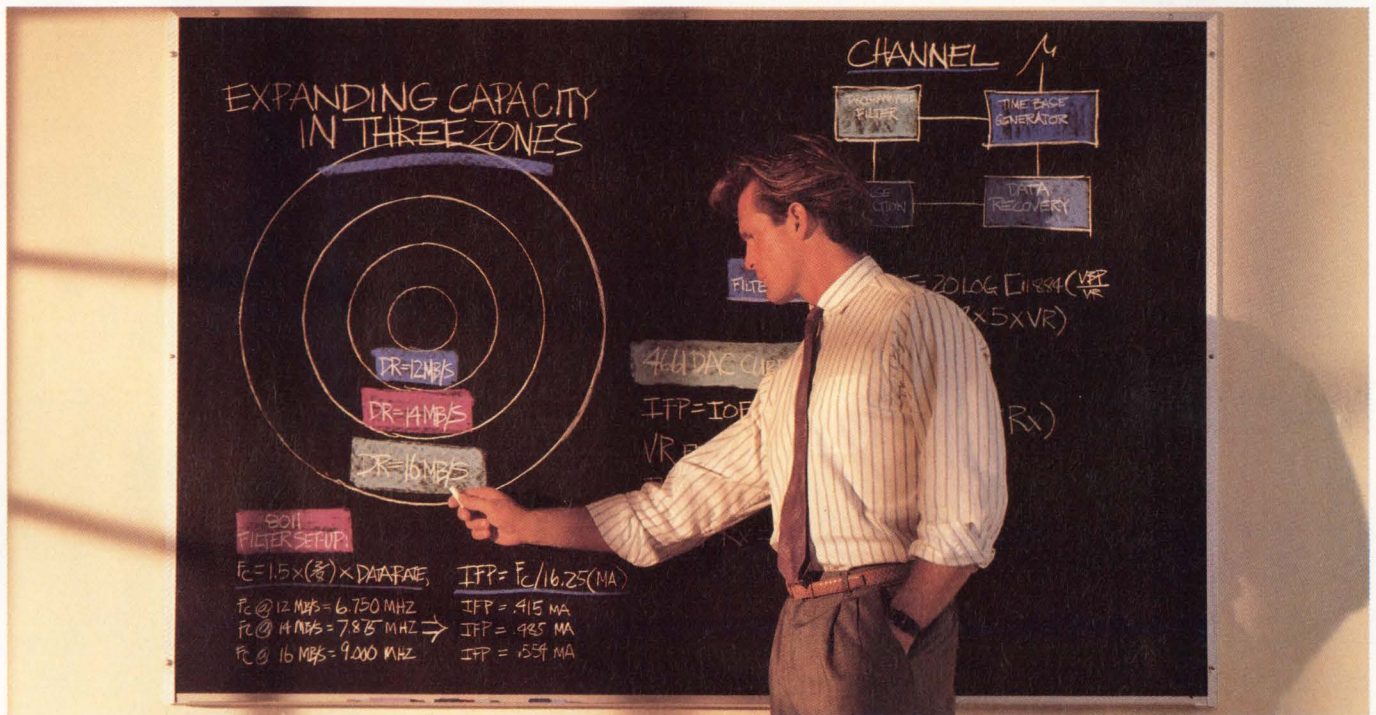
Catalog Offers Efficient Guide to Products

This 13-pg catalog discusses applications of test and measurement and video graphics devices and transcoders. A combined format of tables, photos, and specification lists provides a straightforward look at waveform monitors, vectorscopes, and test-signal generators. A business-reply section allows you to request additional information on products, listings, and applications presented in the catalog.

Magni Systems Inc, 9500 SW Gemini Dr, Beaverton, OR 97005.

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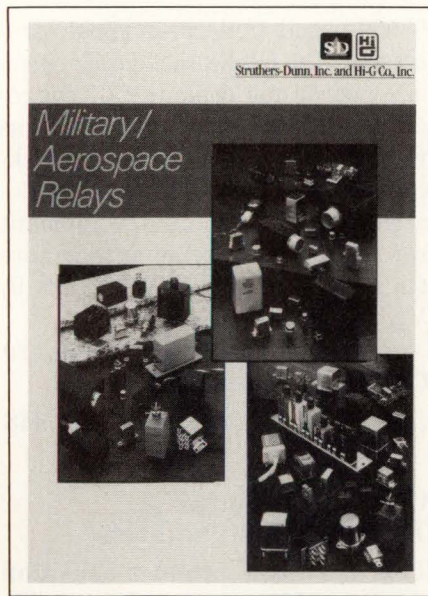
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Military/Aerospace Relays Listed

The 32-pg catalog spotlights a range of relay lines for military and aerospace applications. The catalog covers time-delay, dry-reed, mercury-wetted, magnetic-polarized, and general-purpose relays. It also presents a line of relays that includes minigridd, TO-5 case, crystal-can, solid-state, RF and time-delay devices, power monitors, and voltage sensors. An index arranged according to military specifications and a cross reference to military part numbers help you select parts.

Struthers-Dunn Inc/Hi-G Co, Lambs Rd, Pitman, NJ 08071.

Circle No. 711

Catalogs Offer SMDs, Capacitors, And Resistors

The 1990-91 Resistor/Capacitor Data Book lists a complete line of capacitors and resistors. Containing more than 700 pages, the book describes aluminum electrolytic, ceramic, tantalum, film and variable capacitors, fixed resistors, trimmers, and nonlinear resistors. Each section provides a reference index, and the book features a cross-reference index of competitors. The Surface Mount Device Catalog contains a full listing of surface-mount

resistors, capacitors, and semiconductors. The 140-pg publication provides design, performance, and specifying data for numerous devices: tantalum and monolithic ceramic capacitors, aluminum electrolytic capacitors, thick-film and precision metal-film resistors, high-performance trimmers, miniature selector switches, and discrete semiconductors. The latest addition to the catalog is the section on surface-mount semiconductors, containing a cross-reference index.

Philips Components, 2001 W Blue Heron Blvd, Riviera Beach, FL 33404.

Circle No. 712



Publication Highlights Flush-Mounting Switches

The 8-pg technical catalog of switches includes the flush-mounting Series 61 bezel version of modular oil and watertight indicators, lighted pushbuttons, and 2- and 3-position keylock switches. Other presentations are the membrane Series 96, a high-reliability switch system, and the all-plastic mounting flange for the Series 04. Also included are mounting dimensions, types of illumination, accessories, lens shapes, and colors.

EAO Switch Corp, 198 Pepe's Farm Rd, Milford, CT 06460.

Circle No. 713

Brochure Features Circuit-Protection Devices

The 12-pg Circuit Protection Devices Catalog presents an overview of general operating principles and application of thermal breakers. It describes automatic-reset and manual-reset circuit breakers and high-amp automatic- and manual-reset circuit breakers in both panel-mount and firewall-mount packages. Other devices listed include enclosed diodes and short-stop automatic and modified reset 12 and 24V circuit protectors. Specifications and illustrations complete the publication.

USD Products, 7300 W Wilson Ave, Chicago, IL 60656.

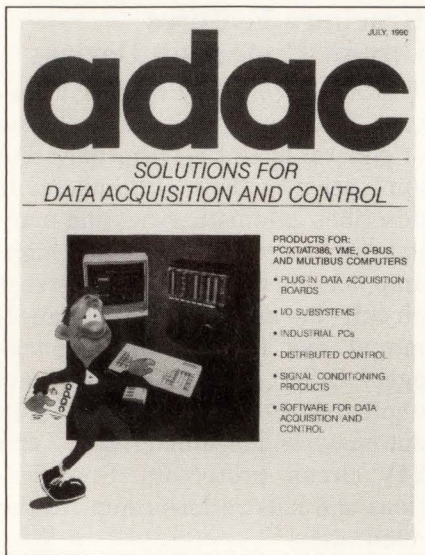
Circle No. 714

Guides To Bondings And Encapsulation Compounds

These four application selector guides deal with adhesives, sealants, coatings, and potting and encapsulation compounds. One chart has a listing of more than 30 different 1-component curable compositions. The 2-pg guide on thermally conductive, electrically insulating epoxy systems provides viscosity, gel and cure times, service operating temperature ranges, thermal conductivity, and application recommendations for 15 grades. It describes both 2- and 1-component systems. The 2-pg chart for potting and encapsulation compounds lists the above specifications as well as room-temperature and heat curing, and UV curing grades. In addition to the standard specs, the guide to microelectronic resin systems includes sections for adhesives and sealants, impregnants, coatings, potting, and encapsulation compounds. The guide for compounds presents a wide range of products to meet the varied requirements of the electronics industry.

Master Bond Inc, 154 Hobart St, Hackensack, NJ 07601.

Circle No. 715



Catalog Presents Computer And Bus Products

This 92-pg catalog divides products into the following categories: PC data acquisition; VME data acquisition; signal conditioning; and Multi-bus and Unibus data acquisition. Six application notes discuss gain and resolution, plug-in I/O boards vs I/O subsystems, and the Pico-Bus—a flexible I/O Bus. Recent additions to the product line include Direct Connect for laptop-compatible data acquisition and EZ-Lab temperature-, pressure-, and current-measurement systems. A glossary of terms and an index of model numbers round out the publication.

Adac Corp, 70 Tower Office Park, Woburn, MA 01801.

Circle No. 445

Brochure Presents System Solutions

This 6-pg Systems Overview brochure describes on-line data-collection system solutions. It details how the company's integrated systems architecture has provided solutions for many Fortune 1000 companies. The publication describes uses of the system for quality control/inspection, material handling, machine monitoring, labor reporting/tracking, inventory control, plant and equipment maintenance, and

statistical process control. The brochure also discusses the company's Strategic Alliance and VAR Partnership Programs.

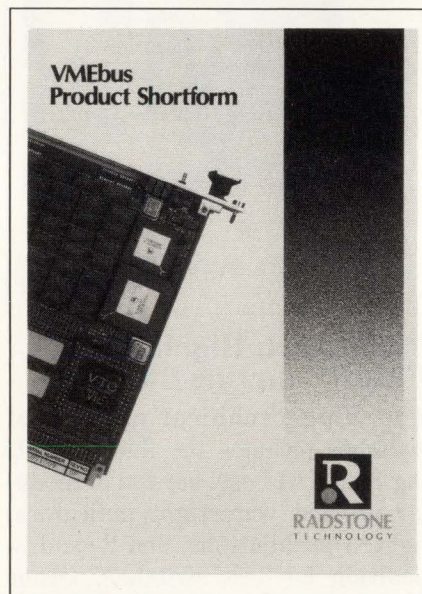
Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Circle No. 446

Note Deals With STD Bus Programming Solution

Interrupt Handling with STD Bus Systems focuses on the programming aspects of interrupt handling in an STD DOS environment, with special reference to the shared interrupt and cascaded interrupts. This 8-pg application note defines and discusses interrupts, interrupt configurations, multiple interrupt controllers, and many other issues related to the Intel 80 Series of μ Ps and the STD Bus.

Ziatech Corp, 3433 Roberto Ct, San Luis Obispo, CA 93401.

Circle No. 447



Catalog Presents VMEbus Board-Level Items

This 4-color, 8-pg catalog lists a range of board-level, software, and development-system products. Processor boards described include 68030- and 68020-based multiprocessor boards, as well as 68010-based single-board computers and

68000-based general-purpose processors. The publication details memory boards for commercial, ruggedized, and MIL-spec applications as well as a selection of SCSI and disk-controller boards. The catalog describes a variety of development software for systems integrators such as Unix, VRTX32, OS-9, VXWorks, and Ada.

Radstone Technology Corp, 20 Craig Rd, Montvale, NJ 07645.

Circle No. 448

Charting Your Way To Data-Bus Products

This data-bus product-selection chart provides an at-a-glance guide to more than 30 characteristics of data-bus products for MIL-STD-1553 applications. Color-coded tabulations highlight the 2-sided chart, which lists single and dual transceivers, bit processors, remote terminal units, interfaces, card assemblies, and testers.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No. 449

Booklet Offers Services For VXibus

This 8-pg brochure delineates the vendor's flexible VXibus integration services. After stating the benefits, the 4-color publication identifies the optimal instruments for users' applications; subsystem and system configurations (including end-to-end specification); and development of customized modules and application software.

Racal-Dana Instruments Inc, 4 Goodyear St, Irvine, CA 92718.

Circle No. 450

Volume Concentrates On Data Acquisition

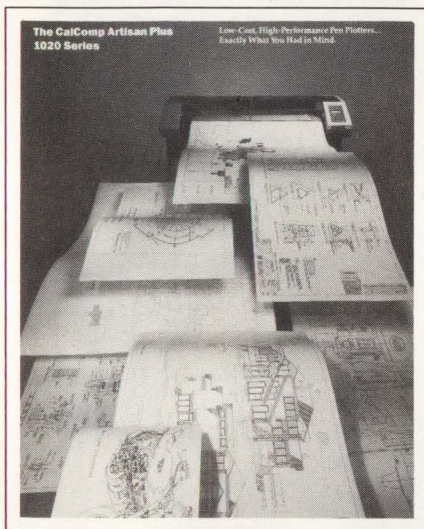
The Data-Acquisition Handbook, Vol 27 (No. 2 of a 6-volume set) presents a plethora of state-of-the-art equipment. The book, which

LITERATURE

features more than 600 pages, covers data-acquisition and engineering software; communications-based acquisition systems; data-logging systems; an expanded line of recorders, printers, and plotters; industrial-process controls; and signal conditioners. It also covers communications products and accessories with an enlarged selection of IEEE products. A library of technical books is also listed.

Omega Engineering Inc, Box 4047, Stamford, CT 06907.

Circle No. 451



Booklet Describes Pen Plotters

This 6-pg brochure features the Artisan Plus 1020 Series of pen plotters. The booklet is divided into sections that describe the plotters' cost efficiency, performance and throughput, quality output, plotting flexibility, computer and software compatibility, and reliability, as well as the company's service and support. It examines the three 8-pen models, including the E-size model with roll-feed capability. Several 4-color reproductions of drawings illustrate applications ranging from architecture and mechanical engineering to mapping and circuit-board design.

CalComp Inc, 2411 W La Palma Ave, MS 37, Anaheim, CA 92801.

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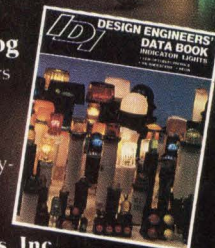
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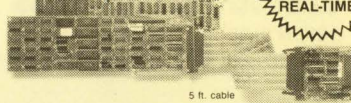
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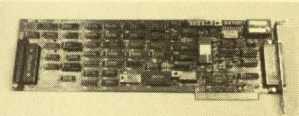
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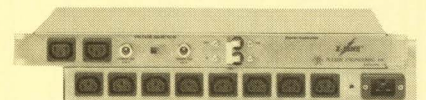
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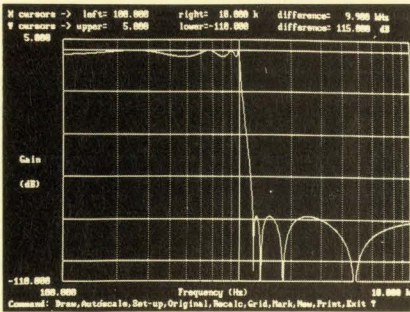
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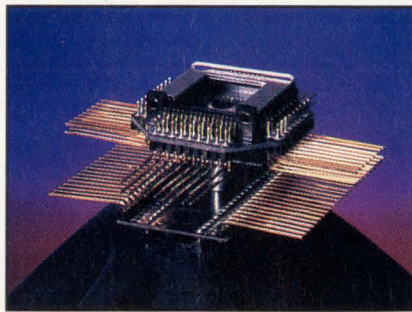


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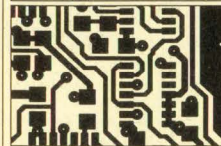
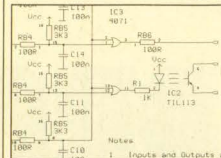
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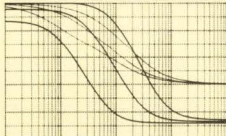
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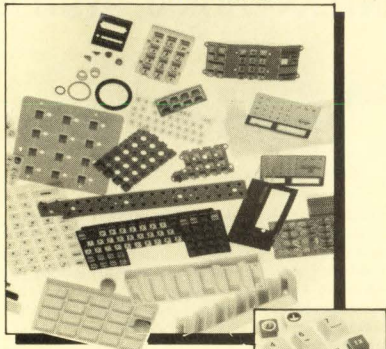
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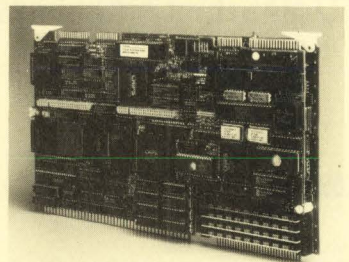
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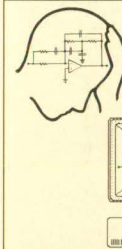
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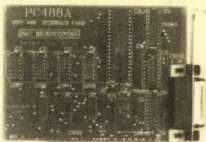


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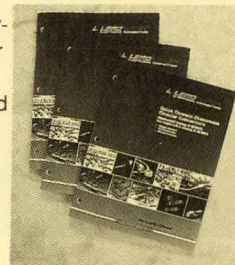
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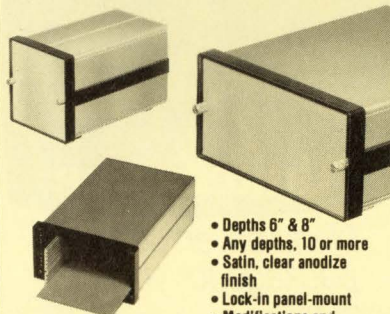
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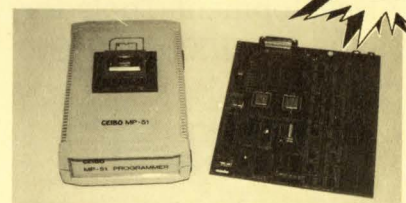
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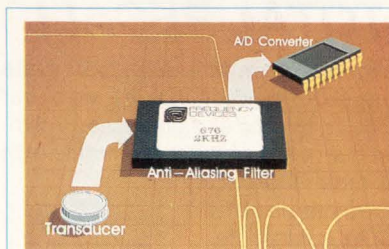
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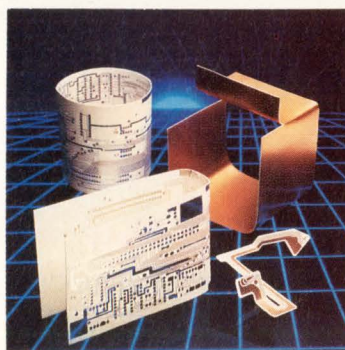


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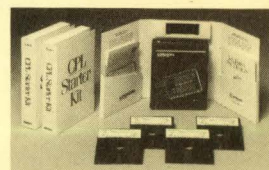
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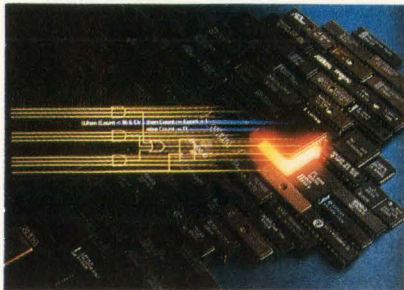


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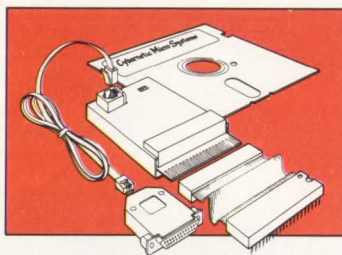
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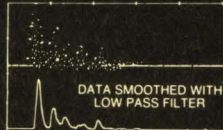
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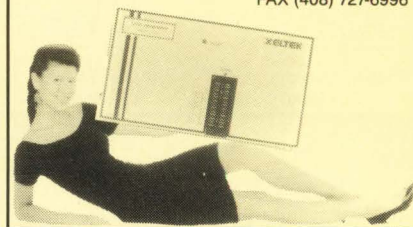
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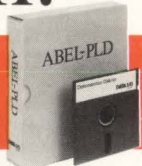
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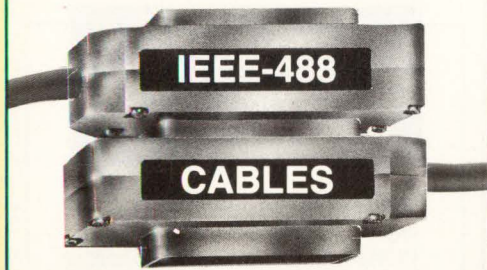


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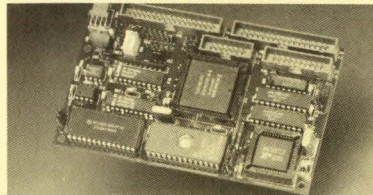


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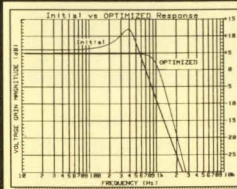
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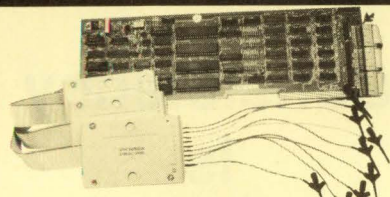
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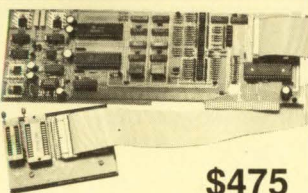


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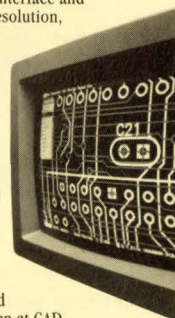
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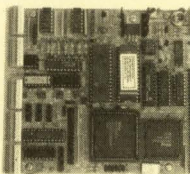
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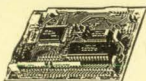
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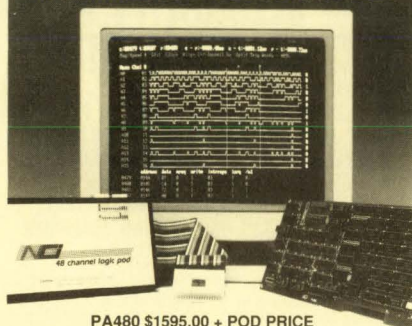


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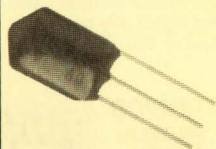
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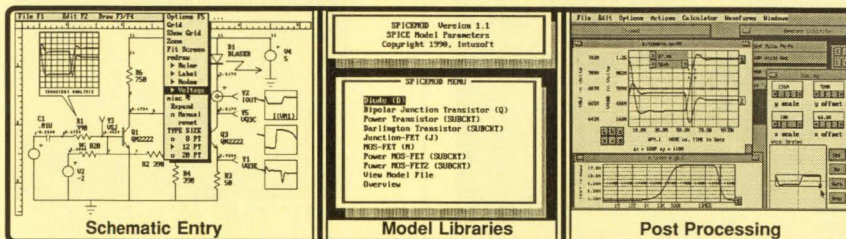
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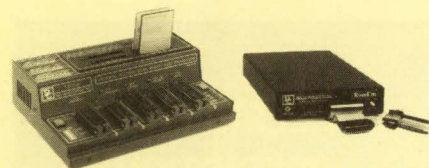
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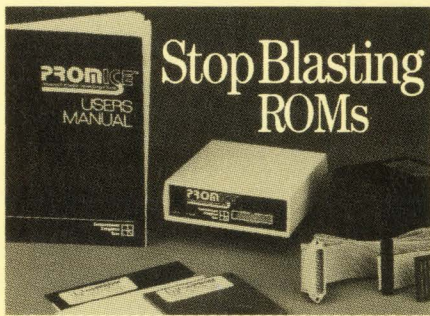
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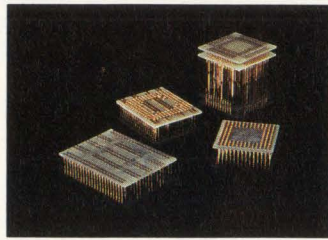
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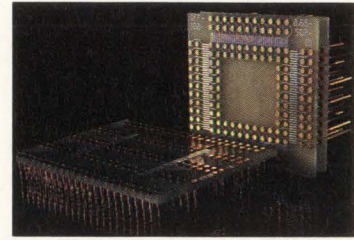
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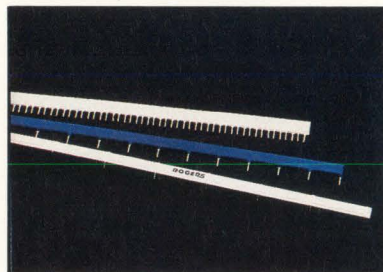


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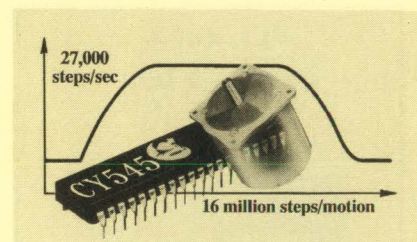
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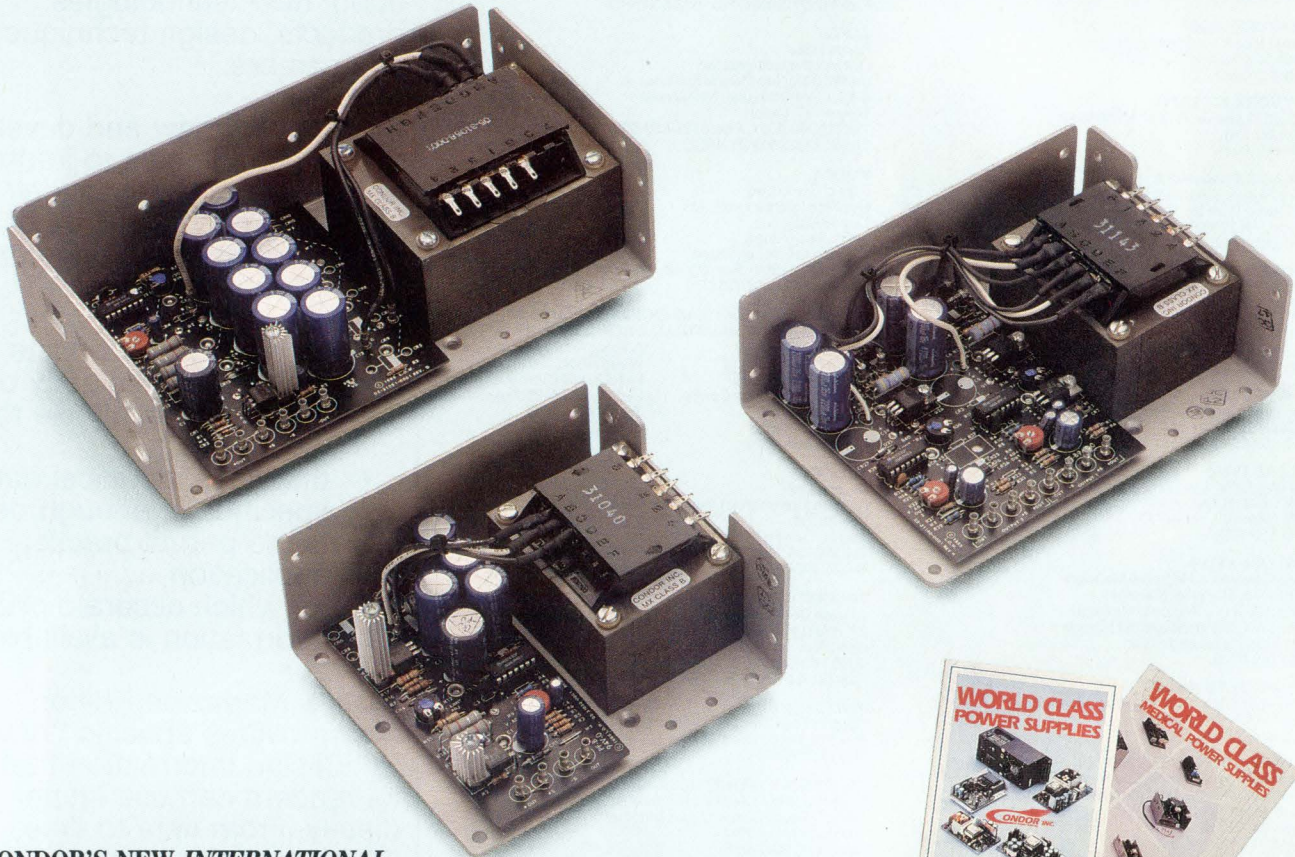
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Lotus Development Corp vs Paperback Software International

Judge rules software's look and feel can be copyrighted

Joseph S Iandiorio, Attorney at Law

The software industry has regarded the "look-and-feel" doctrine of copyright protection for software with mixed emotions. Simply stated, the doctrine says that if someone creates a software program that looks and feels like an existing, copyrighted program then that person has infringed on the copyright, whether or not the codings of the two programs are similar.

Some people were in favor of such strong protection because they believed it would do away with the need for licensing every piece of software to every customer. They thought the software industry would be able to rely solely on the protection a copyright affords to prevent unauthorized copying, the same way the recording and film industries do.

Other people felt that such broad protection would stifle the creation and development of new software products. They feared that copyrights would prevent software developers from borrowing the ideas behind new products to use in their

own programs, which has long been a common practice.

The first case to deal with an infringement of copyright based on a software program's look and feel was Lotus Development Corp vs Paperback Software International.

The two computer programs at issue were Lotus 1-2-3 and Paperback's VP-Planner. Lotus brought the lawsuit against Paperback because it claimed that VP-Planner imitated 1-2-3's menus and keystrokes—in other words, its user interface. The case was recently decided by the federal district court in Boston, MA, and the court's ruling didn't endorse either of these extreme positions.

Lotus 1-2-3, VP-Planner, and the other programs considered during the course of the trial—Visicalc, Multiplan,

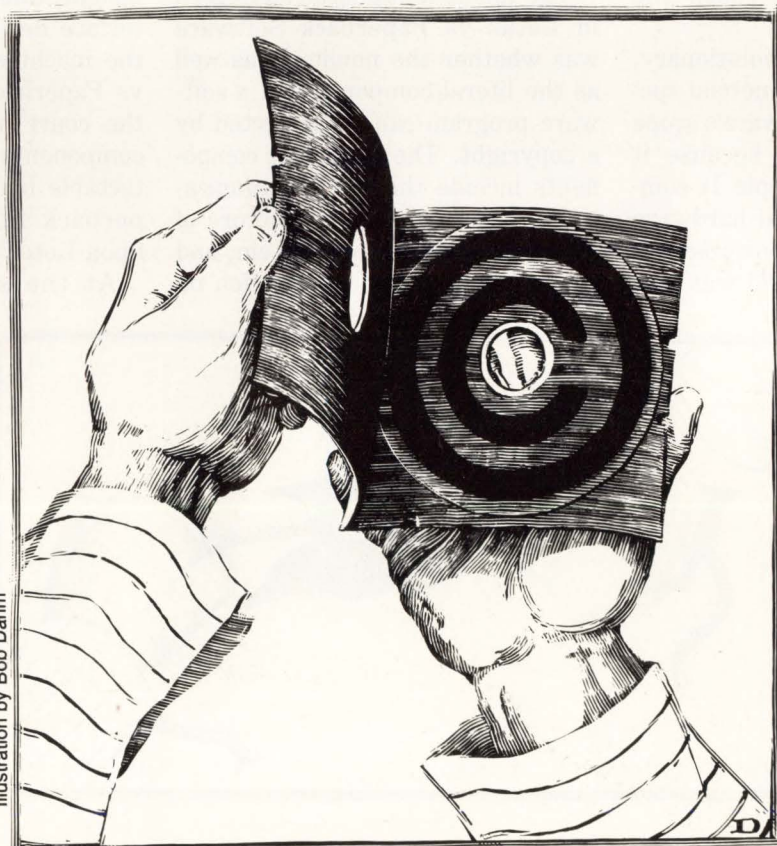


Illustration by Bob Dahm

PROFESSIONAL ISSUES

Supercode 4, and Excel—are all expressions of the same idea. They are all electronic spreadsheets. It was clear from the beginning that the idea of an electronic spreadsheet cannot be protected by copyright because it is both functional and obvious. But each of these programs, with the exception of VP-Planner, develops that core idea in a different way. Each program is different in its structure, appearance, and method of operation, and each of these different ways of expressing the same idea may be copyrighted.

A magic blackboard

The electronic spreadsheet was invented by Daniel Bricklin, a student at the Harvard Business School (Cambridge, MA). He envisioned a magic blackboard that would recalculate numbers throughout itself whenever the user made a change in one part. He eventually transformed his idea into Visicalc, which was the first electronic spreadsheet to reach the market.

Bricklin's idea was revolutionary, and Visicalc was a commercial success. However, the software's scope wasn't very extensive because it was written for the Apple II computer, which has limited hardware capabilities. A later conversion of Visicalc for the IBM PC was less than successful because it failed to take full advantage of that computer's capabilities.

Mitchell Kapor and Jonathan Sacks, two young computer programmers, saw an opportunity. They adopted Bricklin's basic idea for an electronic spreadsheet but expressed it in a different, more powerful way. They took

A central feature of copyright law is that the form of the expression is protectable, but the underlying idea is not.

full advantage of the IBM PC's expansive memory and versatile screen display and keyboard. They called their program 1-2-3, and after it was introduced in 1983 it rapidly became a bestseller.

No one denied that these two programs were based on the same idea, but each expressed that idea in a different way. A central feature of copyright law is that the form of the expression is protectable, but the underlying idea is not. When Paperback Software introduced VP-Planner, the company believed it was introducing another variation of the basic idea of an electronic spreadsheet. Lotus, however, saw too many similarities to 1-2-3 and in 1987 decided to sue.

The fundamental issue addressed in *Lotus vs Paperback Software* was whether the nonliteral as well as the literal components of a software program can be protected by a copyright. The nonliteral components include the overall organization of a program, the structure of a program's command system, and the presentation of information on

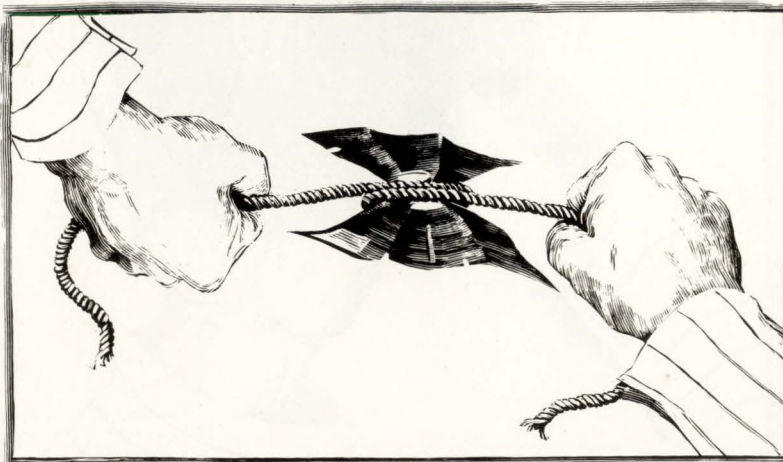
the screen. Courts have ruled in the past that the copyrights on musical compositions, plays, motion pictures, and works of literature can be infringed on even if their literal aspects are not copied. For example, even if the exact words of a book aren't copied, its copyright is infringed upon if someone copies the setting, characters, or plot with a resulting substantial similarity.

The literal aspects of a software program—the source code and the object code—are copyrightable. There is no dispute about that. Flowcharts, too, are copyrightable. It would be an infringement to take a detailed description such as a flowchart and convert it into a computer language. It has already been held a violation of the copyright of a book to take a detailed description of a program in prose and program it in source code.

The court said that creating a suitable user interface is a more difficult intellectual task, requiring greater creativity, originality, and insight, than converting the user interface design into instructions for the machine. In the case of *Lotus vs Paperback Software*, therefore, the court held that the nonliteral components of a program are protectable by copyright and that Paperback Software had infringed upon Lotus's copyright.

At the same time, the court rejected the notion that computer programs couldn't be copyrighted because they were not works of an author but rather useful articles. (Useful articles are specific physical expressions of a general idea and are protectable under patent law.)

The court went on to explain that the conventional applica-

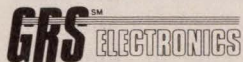


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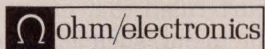
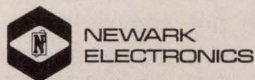


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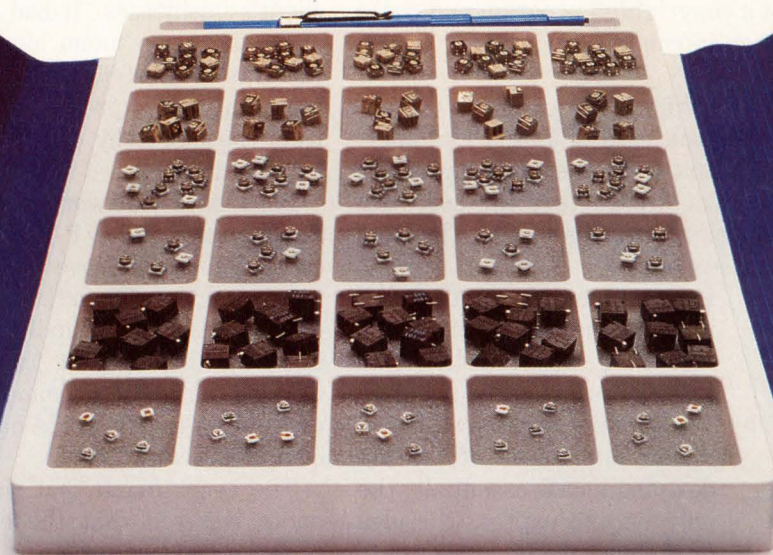


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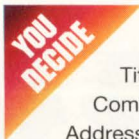
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PROFESSIONAL ISSUES

tion of the look and feel doctrine was not helpful in analyzing this case because it didn't deal with the fundamental issue of whether a particular nonliteral portion of a software program is protectable. In earlier cases, the look and feel doctrine had been applied, not to determine the copyrightability of nonliteral aspects but to judge similarities between the nonliteral aspects of a copyrighted program and those of an infringing program.

A new 3-part test

For the case of Lotus vs Paperback Software, the court developed its own 3-part test for software copyright infringement. The test consists of

- Determining the underlying idea of the program so the idea can be distinguished from the expression of the program
- Determining whether the particular expression of the underlying idea is essentially the only way to express the idea or if there are other ways
- Determining whether or not the elements of the expression have been substantially copied.

Paperback's VP-Planner evolved in a way similar to Lotus 1-2-3. Dr James Stephenson, the originator of VP-Planner, recognized—like Kapor and Sacks—that Visicale wasn't sufficient to meet the financial planning needs of some companies and didn't take advantage of recent advances in computer hardware. In January 1982, he began creating his own electronic spreadsheet. By the following January, he had developed much of the user interface for his program, including the menu command

The court found copying to be overwhelming and pervasive, and Paperback freely admitted it copied the essential elements of 1-2-3.

hierarchy. In April 1983, he installed an operational version of his electronic spreadsheet at one of his client's businesses. It had substantially the same menu hierarchy as the January 1983 version. That hierarchy was expressed differently from the hierarchy of both Visicale and Lotus 1-2-3.

Paperback Software bought out Stephenson and VP-Planner and continued to improve the spreadsheet program. Then they made the decision that eventually brought the litigation against them. They decided that to be a commercial success, VP-Planner would have to be compatible with 1-2-3.

The court found that the defendants believed that the only way to make the two programs compatible was to ensure that the arrangement and names of commands and menus in VP-Planner conformed to that of Lotus 1-2-3. Such compatibility would let users transfer spreadsheets created in 1-2-3 to VP-Planner without losing functionality for any macros. In addition, such compatibility would let

users switch from 1-2-3 to VP-Planner without having to learn new commands.

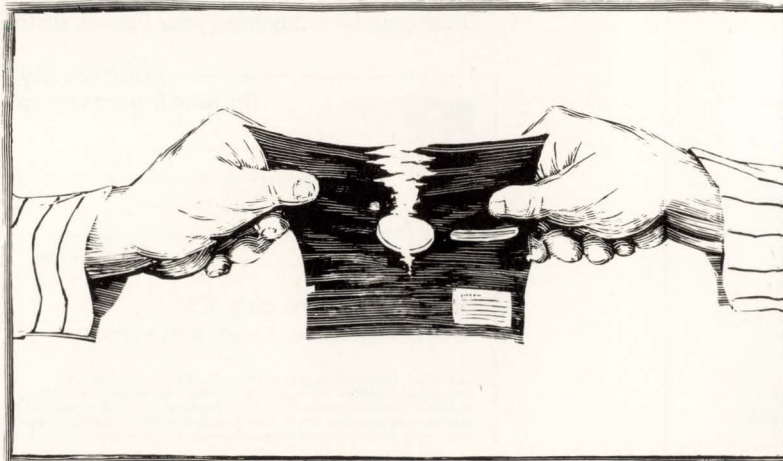
The intent of VP-Planner was clearly set forth in its users' manual:

"VP-Planner is designed to work like Lotus 1-2-3, keystroke for keystroke . . . VP-Planner's worksheet is a feature-for-feature work alike for 1-2-3. It does macros. It has the same command tree. It allows the same kind of calculations, the same kind of numerical information. Everything 1-2-3 does, VP-Planner does."

"It has the same command tree" as 1-2-3 means that Paperback Software deliberately copied the expression embodied in the 1-2-3 menu hierarchy.

The court found that Lotus's L-shaped menu screen and the particular key chosen to call up the menu were not copyrightable because they were not essential to the expression of the spreadsheet idea. But the court ruled that other elements of the menu, such as the precise structure, sequence, and organization of the menu command system, were distinctive details of expression and therefore could be copyrighted.

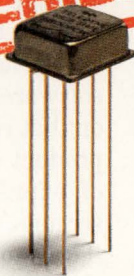
Lotus's particular expression of a menu structure is not essential to the idea of an electronic spreadsheet, nor is it essential to the somewhat less abstract idea of a menu structure for an electronic spreadsheet. The idea of a menu structure can be expressed in a great many ways: through the overall



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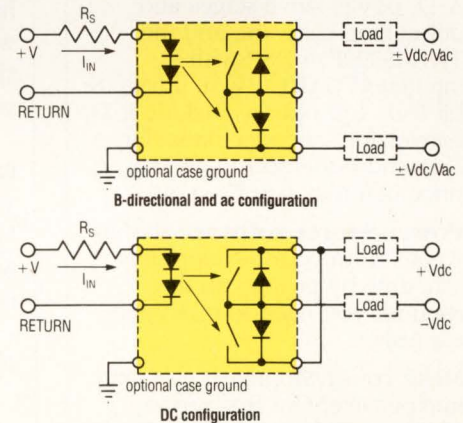
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DC Load Voltage (V_{LOAD})	80	180	350	V_{DC}
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Turn-On Time (T_{ON})	800	800	500	μs
Turn-Off Time (T_{OFF})	300	600	500	μs

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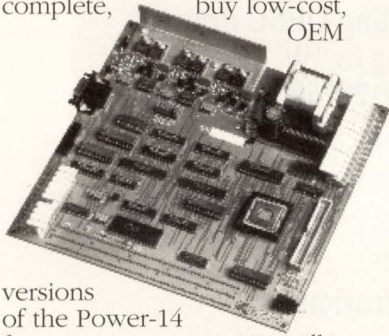
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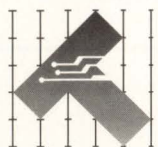
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CIRCLE NO. 61

PROFESSIONAL ISSUES

It has already been held a violation of the copyright of a book to take a detailed description of a program in prose and program it in source code.

structure; the order of commands in each line; the choice of letters, words, or symbolic tokens to represent each command; the presentation of these symbolic tokens on the screen (first letter only, abbreviations, full words, full words with one or more letters capitalized or underlined); the type of menu system used (1-, 2-, or 3-line moving-cursor menus, pull-down menus, or command-driven interfaces); and the length of the prompts.

The fact that some of these command terms are quite obvious or overlap with another company's particular command terms doesn't mean that the command structure taken as a whole can't be copyrighted. If particular characteristics that are not distinctive individually have been brought together in a way that makes the whole a distinctive expression of an idea, then the whole is copyrightable.

Copying was a nonissue in the case of Lotus vs Paperback Software. The court found the copying to be overwhelming and pervasive, and Paperback freely admitted it copied the essential elements.

The new test for software copyright infringement worked well:

- The Lotus user interface was an expression of an idea, not the idea itself.
- A number of other ways to express the idea exist.
- Paperback Software had copied a substantial portion of Lotus's expression.

Lotus wins 1-2-3.

Although this ruling was the decision of a federal trial court and is

not binding on other federal courts (as it would be if it were the decision of a US appeals court or the US Supreme Court), it nevertheless establishes a major, definitive, and persuasive authority for two reasons. First, the decision was reached through a thoughtful and thorough analysis of the issues by a well-respected judge. Second, because the issues involved were fully litigated by major competitors, there was ample opportunity for all the facts and arguments to be presented.

What the decision means to the average programmer is that he or she can build on and improve existing ideas embodied in copyrighted software without fear of infringing on that copyright as long as the final product doesn't use the same form of expression—the user interface, screens, or symbols—in the same flow and organization. You can design a new spreadsheet. You just can't make it look like Lotus's.

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Author's biography

Joseph S Iandiorio is a patent, trademark, and copyright attorney working in Waltham, MA. He earned a BSEE from Villanova University (Villanova, PA) and a JD from George Washington University (Washington, DC). Before opening his legal practice, he worked for three years as a patent examiner for the Patent and Trademark Office in Arlington, VA.

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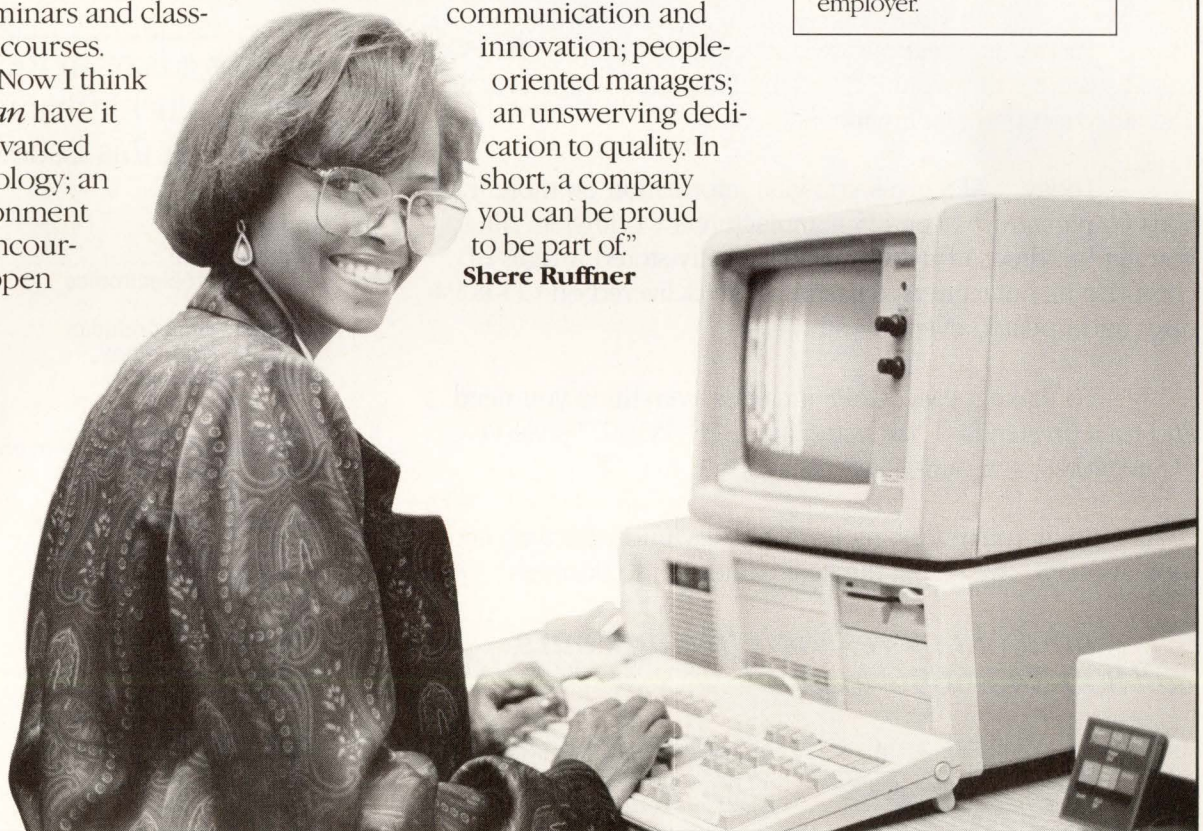
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Fujitsu Microelectronics	28-29,
	59, 126-127
General Semiconductor	106-107
Goldstar Technology	234A-D
ILC Data Devices	94
Integrated Device	99
Intel	88-89, 231
International Rectifier Semiconductor	81
Linear Technology	216
LSI Logic	14-15, 108-109
Maxim Integrated Products	121, 123, 125
Micron Technology	100
Motorola Semi	C2, 10-11, 63,
	104-105, 192-193
NCR Corp.	128-129
OKI Semi	34, 83-85
Powerex Corp.	154
Precision Monolithics	61
Raytheon Co. Semi Div	30-31
Samsung Semi	16-17
Siemens AG	83
Siemens Components	110-111
Signetics Corp.	54-55
Silicon Systems Inc.	235
Zilog	37

EDN's INTERNATIONAL ADVERTISERS INDEX

Academic Press	241	Inova Microelectronics	100	Samtec Inc	190-191
ACCEL Technologies Inc	199, 245	Instrument Specialties Co Inc	36	SBE	2
Aerospace Optics	229	Integrated Device Technology Inc	99	Selco Products Inc	246
AMP	160-161	Intel	88-89, 257	Sencore	151-153
Ancot Corp	157	Intermetrics Inc	213	Siemens Corp*	110-111
Apex Microtechnology Corp	87	International Rectifier	81	Siemens Matsushita Components GmbH, Munich**	83
Asem Industria**	34	Interphase Corp	71	Signetics Corp	54-55
AT&T	172	Interpoint	138	Silicom Ltd	64
Augat	225	Introl Corp	202	Silicon Systems Inc*	235
Basicon Inc	241	Intusoft	247	Siliconix Inc	50
Basler Electric	139	IOtech Inc*	169-170	Single Board Solutions	242
Bayer AG**	28-29	Ironwood Electronics Inc	248	Sola Electric	140
B&C Microsystems	243, 247	Itol	244	Sony	43, 48-49
Bourns	253	ITT Cannon	45, 167	Sophia Systems Inc	95
BP Microsystems	247	JST Corp	189	Spectrum Signal Processing Inc	219
Bruel & Kjaer Instruments**	168A	Kepeco Inc	158-159	Spectrum Software	205
Buckeye Stamping Co	243	L-Com Inc	241	Stag Microsystems Inc	86
Burr-Brown Corp	113, 157	Lemo USA Inc	243	Standard Research Systems Inc	25
BV Engineering	242	Linear Technology Corp	216	Tatum Labs	242
CAD Software Inc	212	Link Computer Graphics	245	T-Cubed Systems Inc	248
Cadence	32-33	Logical Devices Inc	243	TECI	244
Cahnerns CAPS	242, 247, 264	Loughborough Sound Images Limited**	12	Teknic Inc	256
Capilano Computer Systems Inc	244	LSI Logic Corp	14-15, 108-109	Teknor	65
Capital Equipment Corp	64, 245	Marathon Power Technologies	155	Tektronix	38-39, 67-69
Cascade Microtechnologies	212	Marshall	40, 227, 240	Teledyne Solid State	255
Ceibo Ltd	243	MathSoft Inc	136	Television Equipment Assoc Inc	243
Chomerics Inc	187	Maxell	144-145	Teltone Corp	247
Cirris Logic	96	Maxim Integrated Products	121, 123, 125	Thomas and Betts Corp	181
Comtran Integrated Software	245	MCG Electronics Inc	182	Tri-L Data Systems Inc	245
Condor	250	Meta Software Inc	200	UMC	102
Cybernetic Micro Systems	244, 248	Metalink Corp	245	Universal Data Systems	C3
Cypress Semiconductor	23	Micron Technology Inc	101	Unkel Software	244
Dale Electronics Inc	1	Microstar Laboratories	124	US Industrial Distribution	184
Data I/O Corp	147, 149, 244	Microtek	236	Valid Logic Systems Inc	52-53
Deltron Inc	78	Milpower	148	Velotec	82
Dexter Magnetics	42, 44	Mini-Circuits Laboratories	3, 4, 46-47, 26-27	Vicor	137
Dialight Corp	174	Mitel Semiconductor	74	VMETRO Inc	120
Digital Equipment Corp*	12-13	Mitsubishi	117-119	Volgen America	150
Diversified Technology	176-177	Molex Inc	266	Wall Industries	182
Du Pont Co	183	Motorola Inc	10-11, 63, 104-105, 192-193, C2	Wintek Corp	243
Duncan Electronics Div	214-215	MWS Wire Industries	171	WR Grace	223
EG&G Wakefield Engineering Inc	78	National Hybrid	122	Xeltek	241, 244
Elgar	146	National Instruments	6	Xentek	82
Emcor Products	178	NEC Corp	206-207, 208-209, 210-211	Zilog Inc	37
Emulation Technology Inc	242	NEC Electronics	56	Z-World	246
Endicott Research Group	82	NCI	246	Zyrel Inc	247
Ericsson	156	NCR Corp	128-129		
E-T-A Circuit Breakers	248	Needham Electronics	246		
Exor	247	Nichicon Corp	142		
Export Software**	85	Nohau Corp	112, 241		
Fairchild Defense	244	NordicTrack	42		
Fenner Industrial	44	Number One Systems Ltd	242		
Forbes Wagon Creek Ranch	79	OKI Semiconductor*	34, 83, 84-85		
Franklin Software Inc	248	OrCAD Systems Corp	8		
Frequency Devices	243	Orion Instruments	242		
Fujitsu APD	59	Otto Controls	186		
Fujitsu Microelectronics Inc*	28-29, 126-127	Philips Discrete Products Div*	130-131		
GCOM Inc	247	Pico	74, 198		
General Devices	188	Power Systems	70		
General Semiconductor Industries Inc	106-107	Powerex Inc	154		
General Silicones	242	Powertronic	245		
Goldstar Technology*	234A-D	PreciDip**	13		
Grammar Engine Inc	248	Precision Interconnect	185		
Graptec Corp	231	Precision Monolithics Inc	61		
Hamamatsu Corp	180	Prem Magnetics	C4		
Harting Elektronik	73	Pulizzi Engineering	241		
Heineman Prof Publishing**	168B	Qua Tech Inc	246		
Hewlett-Packard Co	18, 20, 114-115, 179	RAF Electronic Hardware Inc	116		
House	246, 248	Rayovac	233		
HyperLynx	245	Raytheon	30-31		
Hyperstone electronics	136	RLM Research	242		
ILC Data Device Corp	94	Rogers Corp	243, 248		
Inco	75	Saelig Co	246		
Industrial Devices Inc	239	Samsung Semiconductor	16-17		

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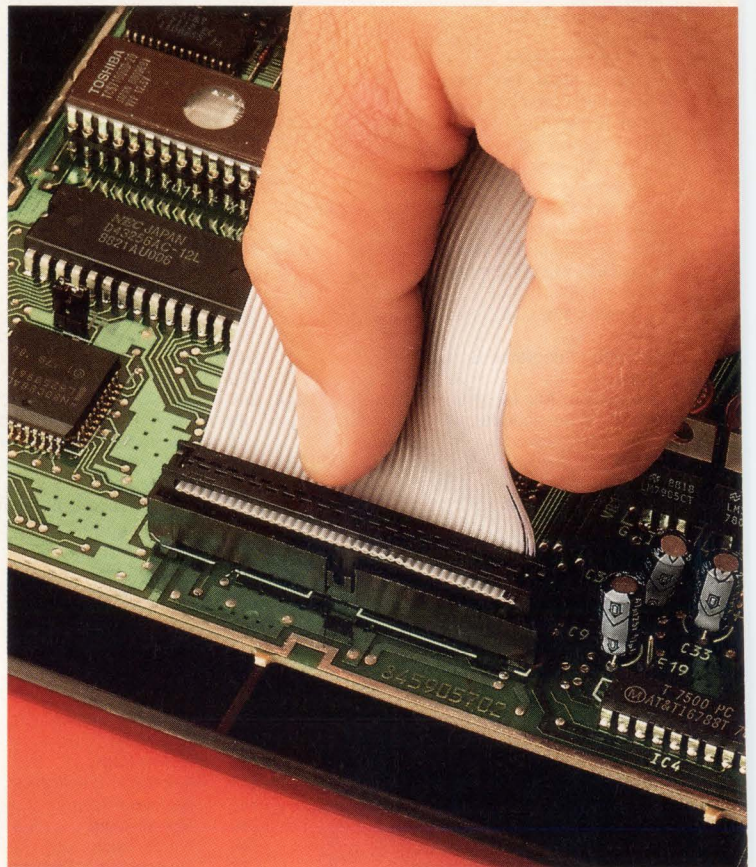
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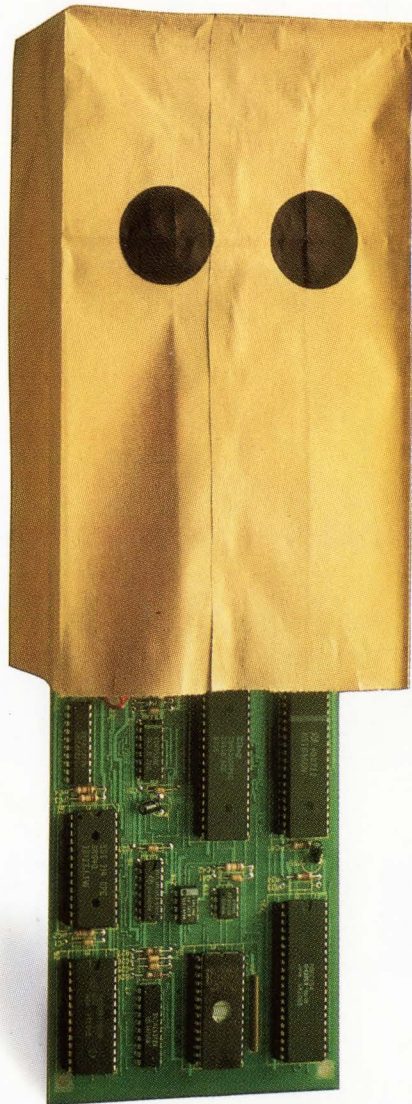
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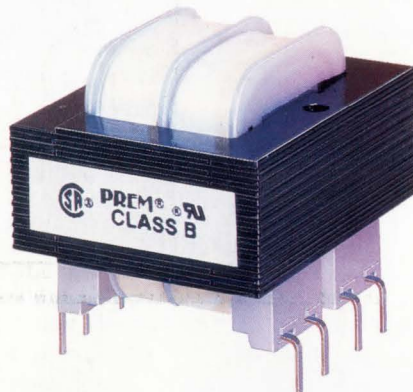
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