A CAHNERS PUBLICATION APRIL 28, 1988

EDN®

ELECTRO/88 PREVIEW: SESSIONS & PRODUCTS

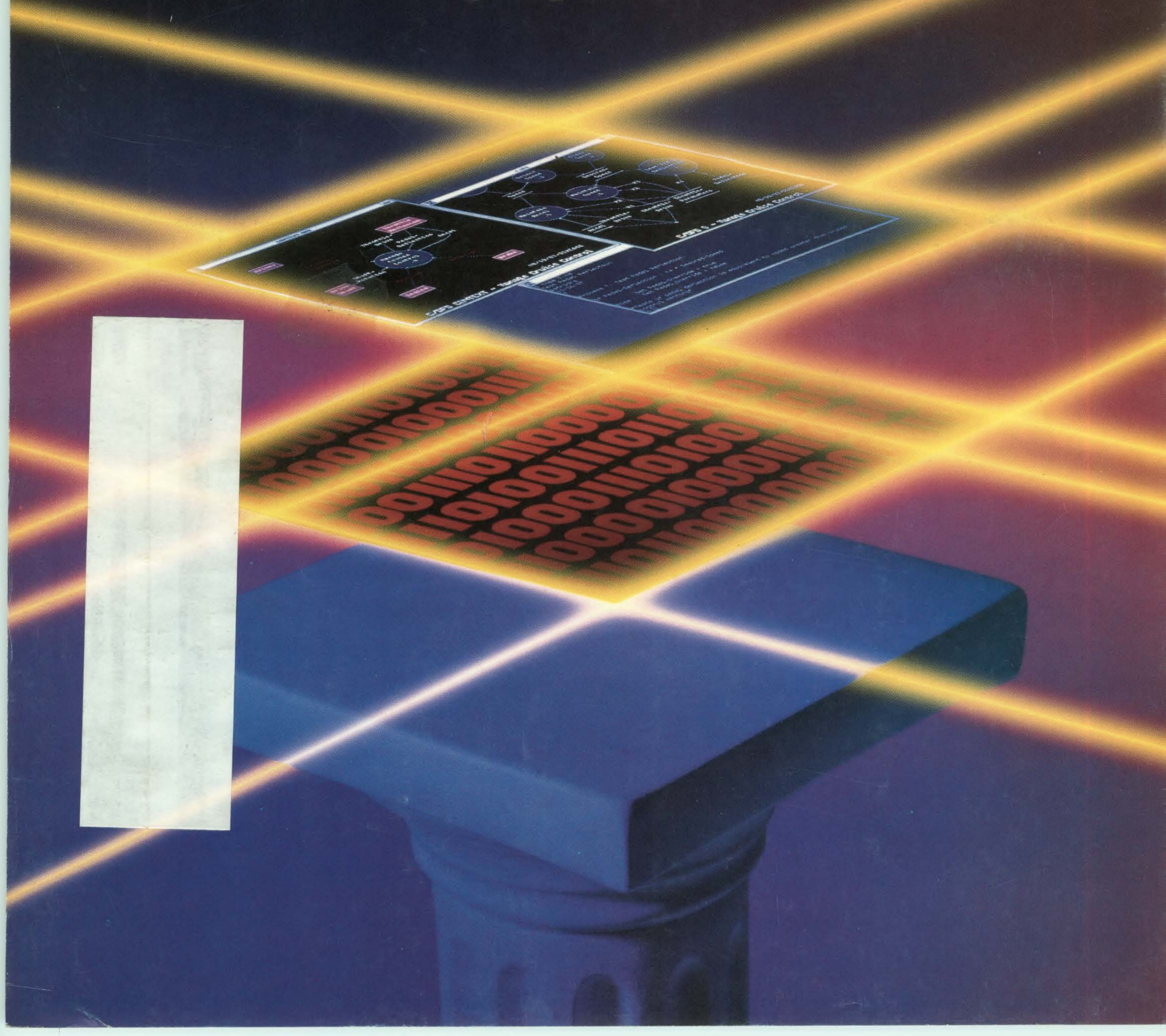
Part 5 of EDN's Decade 90 Series

Machine-vision systems perform real-world tasks

Optocoupler update

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

Close coupling of diverse CASE tools yields high-quality software



Advanced Micro
The next

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tiny SPDT switches

absorptive... reflective

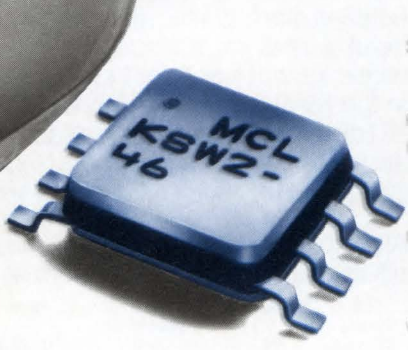
dc to 4.6 GHz from $32.95 (1-24)

Tough enough to pass stringent MIL-STD-883 tests, useable from dc to 6GHz and smaller than most RF switches, Mini-Circuits' hermetically-sealed (reflective) KSW-2-46 and (absorptive) KSWA-2-46 offer a new, unexplored horizon of applications. Unlike pin diode switches that become ineffective below 1MHz, these GaAs switches can operate down to dc with control voltage as low as -5V, at a blinding 2ns switching speed.

Despite its extremely tiny size, only 0.185 by 0.185 by 0.06 in., these switches provide 50dB isolation (considerably higher than many larger units) and insertion loss of only 1dB. The absorptive model KSWA-2-46 exhibits a typical VSWR of 1.5 in its "OFF" state over the entire frequency range. These surface-mount units can be soldered to pc boards using conventional assembly techniques. The KSW-2-46, priced at only $32.95, and the KSWA-2-46, at $48.95, are the latest examples of components from Mini-Circuits with unbeatable price/performance.

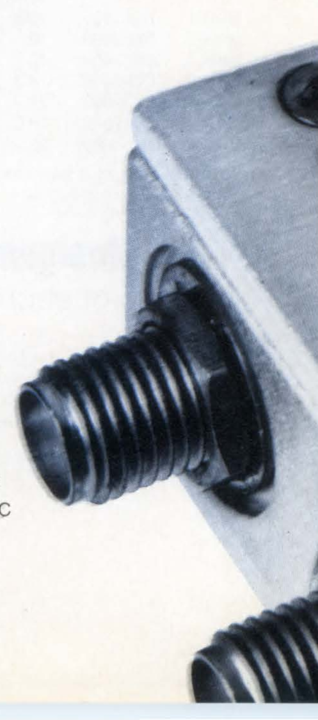
Connector versions, packaged in a 1.25 x 1.25 x 0.75 in. metal case, contain five SMA connectors, including one at each control port to maintain 3ns switching speed.

Switch fast... to Mini-Circuits' GaAs switches.



SPECIFICATIONS

Pin Model	**KSW-2-46**		**KSWA-2-46**	
Connector Version	**ZFSW-2-46**		**ZFSWA-2-46**	
FREQ. RANGE	dc-4.6 GHz		dc-4.6 GHz	
INSERT. LOSS (db)	typ	max	typ	max
dc-200MHz	0.9	1.1	0.8	1.1
200-1000MHz	1.0	1.3	0.9	1.3
1-4.6GHz	1.3	1.7	1.5	2.6
ISOLATION (dB)	typ	min	typ	min
dc-200MHz	60	50	60	50
200-1000MHz	45	40	50	40
1-4.6GHz	30	23	30	25
VSWR (typ) ON	1.3:1		1.3	
OFF	—		1.4	
SW. SPEED (nsec) rise or fall time	2(typ)		3(typ)	
MAX RF INPUT (bBm) up to 500MHz	+17		+17	
above 500MHz	+27		+27	
CONTROL VOLT.	**-5V** on, OV off		**-5V** on, OV off	
OPER/STOR TEMP.	-55° to +125°C		-55° to +125°C	
PRICE (1-24)	**$32.95**		**$48.95**	
	$72.95		**$88.95**	



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EDN

Volume 33, Number 9 April 28, 1988

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

***On the cover:** CASE tools link all phases of the software design process—from concept to maintenance. See pg 110. (Photo courtesy Tektronix Inc, Computer-Aided Software Engineering Div)*

DESIGN FEATURES

Continued on page 7

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"What if...

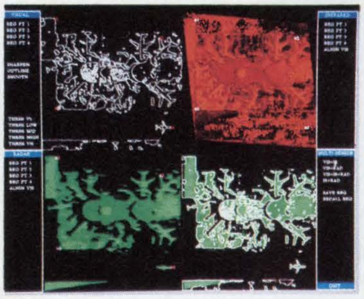
we never stop asking

HEWLETT PACKARD

Continued from page 5

EDN

April 28, 1988



***Your choice of machine-vision equipment** depends on your application and the amount of money you want to spend (pg 55).*

TECHNOLOGY UPDATE

PRODUCT UPDATE

DESIGN IDEAS

Continued on page 9

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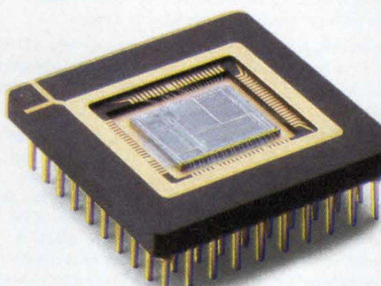
CIRCLE NO 80

Continued from page 7

"IT'S GOT POSSIBILITIES, BUT IT'S JUST TOO POWERFUL FOR MY APPLICATION NEEDS!"

DESIGN ENGINEER, 1988



Over the centuries, people have looked at the latest in technology with a bit of skepticism. The Transputer from INMOS is no exception.

When we first introduced the Transputer, designers were indeed intrigued. They were impressed with our T800—a 32-bit floating point microprocessor with an average speed of 10 MIPS and the ability to sustain 1.5 MFLOPS or 4.0 million single precision whetstones. "Incredible," designers said. "But it's more than we can use."

Not true. The fact is as a stand-alone processor, the T800 gives you benefits you can use every day. It runs programs even faster than Intel's combined 80386 and 80387 or Motorola's combined 68020 and 68881. Plus, it requires significantly less memory to hold compiled code.

And, by increasing the number of Transputers, you can increase system performance proportionally with no limit to the number of Transputers that can operate concurrently. Like linking seven T800's together to give you the processing power of a mighty Cray 1S supercomputer.

Or you could use ten IBM add-in cards from INMOS carrying ten T800's each, to enable your desktop PC to deliver 150 MFLOPS. That's like having the power of 150 11/780 VAX machines right at your fingertips.

So take another look at the Transputer. It's not just a dream for the future, it's a high-performance product for today. And it's a technology that is already taking off.

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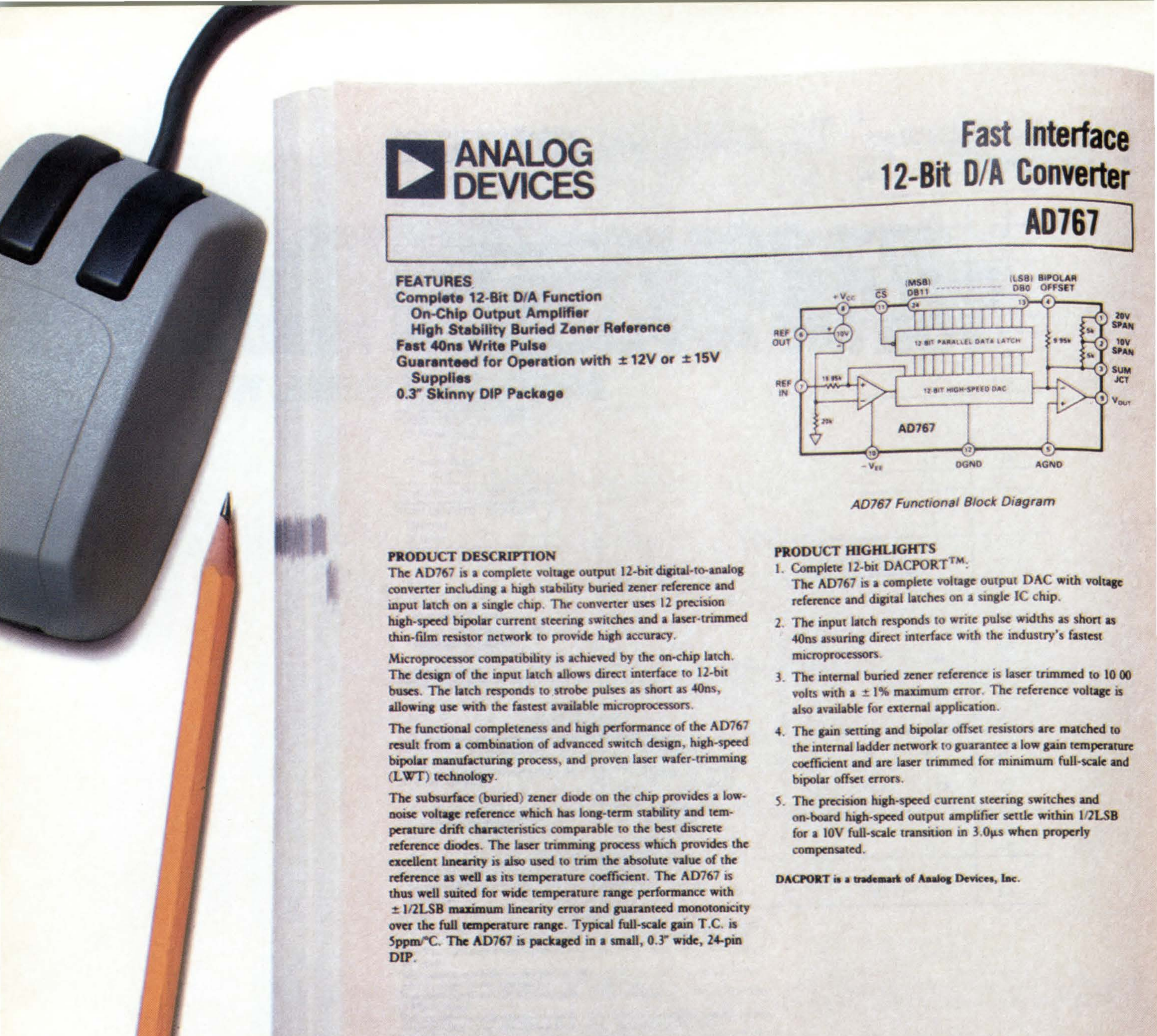


ANALOG DEVICES

Fast Interface 12-Bit D/A Converter

AD767

FEATURES
Complete 12-Bit D/A Function
On-Chip Output Amplifier
High Stability Buried Zener Reference
Fast 40ns Write Pulse
Guaranteed for Operation with ±12V or ±15V Supplies
0.3" Skinny DIP Package

AD767 Functional Block Diagram

PRODUCT DESCRIPTION

The AD767 is a complete voltage output 12-bit digital-to-analog converter including a high stability buried zener reference and input latch on a single chip. The converter uses 12 precision high-speed bipolar current steering switches and a laser-trimmed thin-film resistor network to provide high accuracy.

Microprocessor compatibility is achieved by the on-chip latch. The design of the input latch allows direct interface to 12-bit buses. The latch responds to strobe pulses as short as 40ns, allowing use with the fastest available microprocessors.

The functional completeness and high performance of the AD767 result from a combination of advanced switch design, high-speed bipolar manufacturing process, and proven laser wafer-trimming (LWT) technology.

The subsurface (buried) zener diode on the chip provides a low-noise voltage reference which has long-term stability and temperature drift characteristics comparable to the best discrete reference diodes. The laser trimming process which provides the excellent linearity is also used to trim the absolute value of the reference as well as its temperature coefficient. The AD767 is thus well suited for wide temperature range performance with ±1/2LSB maximum linearity error and guaranteed monotonicity over the full temperature range. Typical full-scale gain T.C. is 5ppm/°C. The AD767 is packaged in a small, 0.3" wide, 24-pin DIP.

PRODUCT HIGHLIGHTS

1. Complete 12-bit DACPORT™.
   The AD767 is a complete voltage output DAC with voltage reference and digital latches on a single IC chip.
2. The input latch responds to write pulse widths as short as 40ns assuring direct interface with the industry's fastest microprocessors.
3. The internal buried zener reference is laser trimmed to 10.00 volts with a ±1% maximum error. The reference voltage is also available for external application.
4. The gain setting and bipolar offset resistors are matched to the internal ladder network to guarantee a low gain temperature coefficient and are laser trimmed for minimum full-scale and bipolar offset errors.
5. The precision high-speed current steering switches and on-board high-speed output amplifier settle within 1/2LSB for a 10V full-scale transition in 3.0µs when properly compensated.

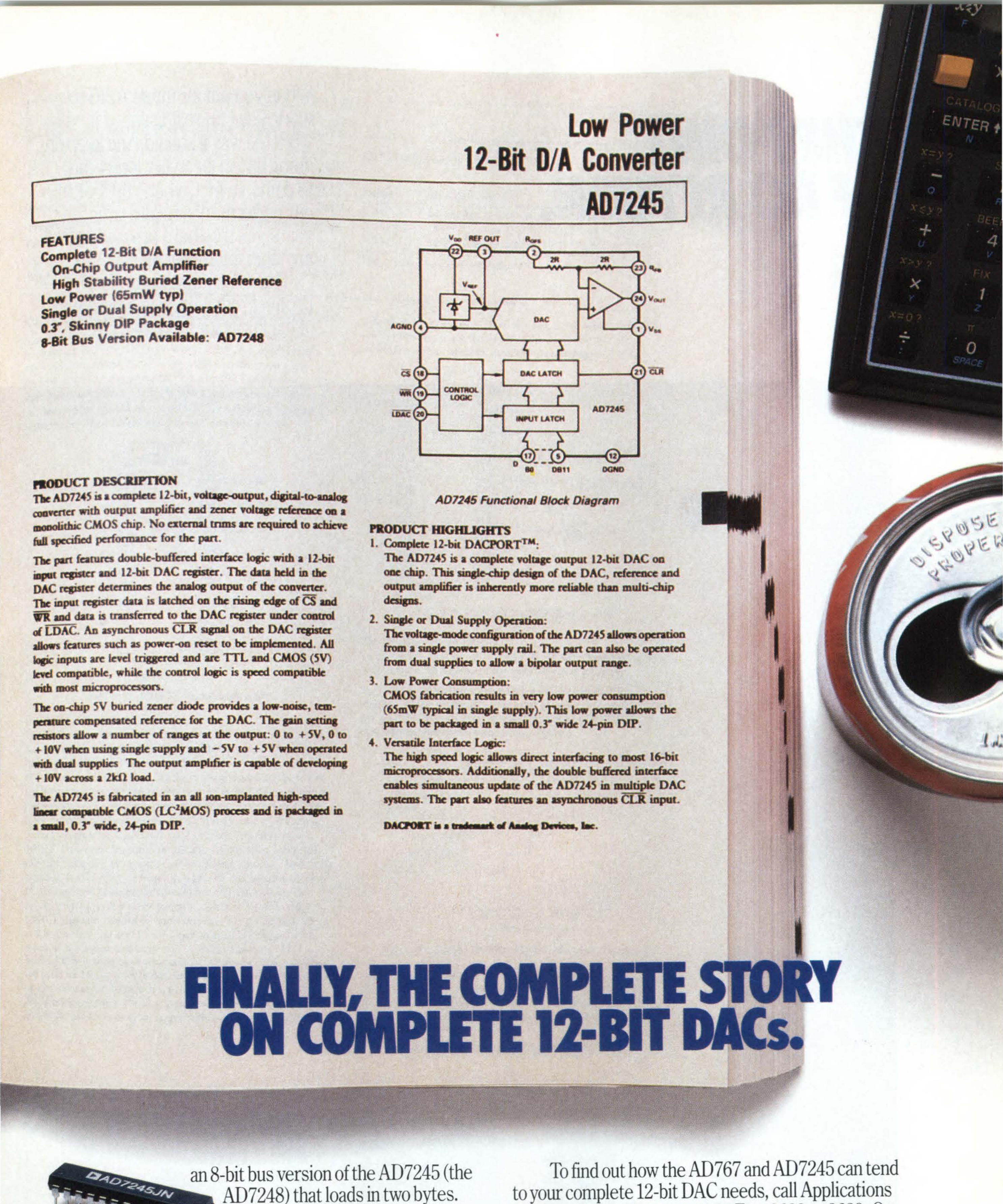
DACPORT is a trademark of Analog Devices, Inc.

Bringing complete 12-bit DAC functionality and performance to your designs no longer requires having to deal with all the problems associated

with external components. Instead, it simply requires specifying our new AD767 or AD7245.

Both the AD767 and AD7245 feature an on-chip stable buried Zener reference, output amplifier and microprocessor interface logic. And these complete functions come packed into skinny 0.3" DIPs. All this means you no longer have to deal with error budgets, product characterizations, or space constraints related to external components.

If digital interface speed is what you're after, the AD767 responds to pulse widths as short as 40ns, allowing it to be used with today's fastest processors. On the other hand, if low power dissipation is critical to your application, the LC²MOS AD7245 consumes only 65mW. There's also



Low Power 12-Bit D/A Converter

AD7245

FEATURES
Complete 12-Bit D/A Function
On-Chip Output Amplifier
High Stability Buried Zener Reference
Low Power (65mW typ)
Single or Dual Supply Operation
0.3", Skinny DIP Package
8-Bit Bus Version Available: AD7248

AD7245 Functional Block Diagram

PRODUCT DESCRIPTION

The AD7245 is a complete 12-bit, voltage-output, digital-to-analog converter with output amplifier and zener voltage reference on a monolithic CMOS chip. No external trims are required to achieve full specified performance for the part.

The part features double-buffered interface logic with a 12-bit input register and 12-bit DAC register. The data held in the DAC register determines the analog output of the converter. The input register data is latched on the rising edge of $\overline{CS}$ and $\overline{WR}$ and data is transferred to the DAC register under control of $\overline{LDAC}$. An asynchronous $\overline{CLR}$ signal on the DAC register allows features such as power-on reset to be implemented. All logic inputs are level triggered and are TTL and CMOS (5V) level compatible, while the control logic is speed compatible with most microprocessors.

The on-chip 5V buried zener diode provides a low-noise, temperature compensated reference for the DAC. The gain setting resistors allow a number of ranges at the output: 0 to +5V, 0 to +10V when using single supply and −5V to +5V when operated with dual supplies. The output amplifier is capable of developing +10V across a 2kΩ load.

The AD7245 is fabricated in an all ion-implanted high-speed linear compatible CMOS (LC²MOS) process and is packaged in a small, 0.3" wide, 24-pin DIP.

PRODUCT HIGHLIGHTS

1. Complete 12-bit DACPORT™:
   The AD7245 is a complete voltage output 12-bit DAC on one chip. This single-chip design of the DAC, reference and output amplifier is inherently more reliable than multi-chip designs.
2. Single or Dual Supply Operation:
   The voltage-mode configuration of the AD7245 allows operation from a single power supply rail. The part can also be operated from dual supplies to allow a bipolar output range.
3. Low Power Consumption:
   CMOS fabrication results in very low power consumption (65mW typical in single supply). This low power allows the part to be packaged in a small 0.3" wide 24-pin DIP.
4. Versatile Interface Logic:
   The high speed logic allows direct interfacing to most 16-bit microprocessors. Additionally, the double buffered interface enables simultaneous update of the AD7245 in multiple DAC systems. The part also features an asynchronous $\overline{CLR}$ input.

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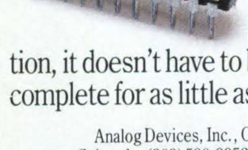
FINALLY, THE COMPLETE STORY ON COMPLETE 12-BIT DACs.



an 8-bit bus version of the AD7245 (the AD7248) that loads in two bytes.

Whether your need is determined by speed or power dissipation, it doesn't have to be limited by price. Our DACs come complete for as little as $8.40 (1000s).

To find out how the AD767 and AD7245 can tend to your complete 12-bit DAC needs, call Applications Engineering at (617) 935-5565 Ext. 2628 or 2629. Or write to Analog Devices, P.O. Box 9106, Norwood, MA 02062-9106.

ANALOG DEVICES

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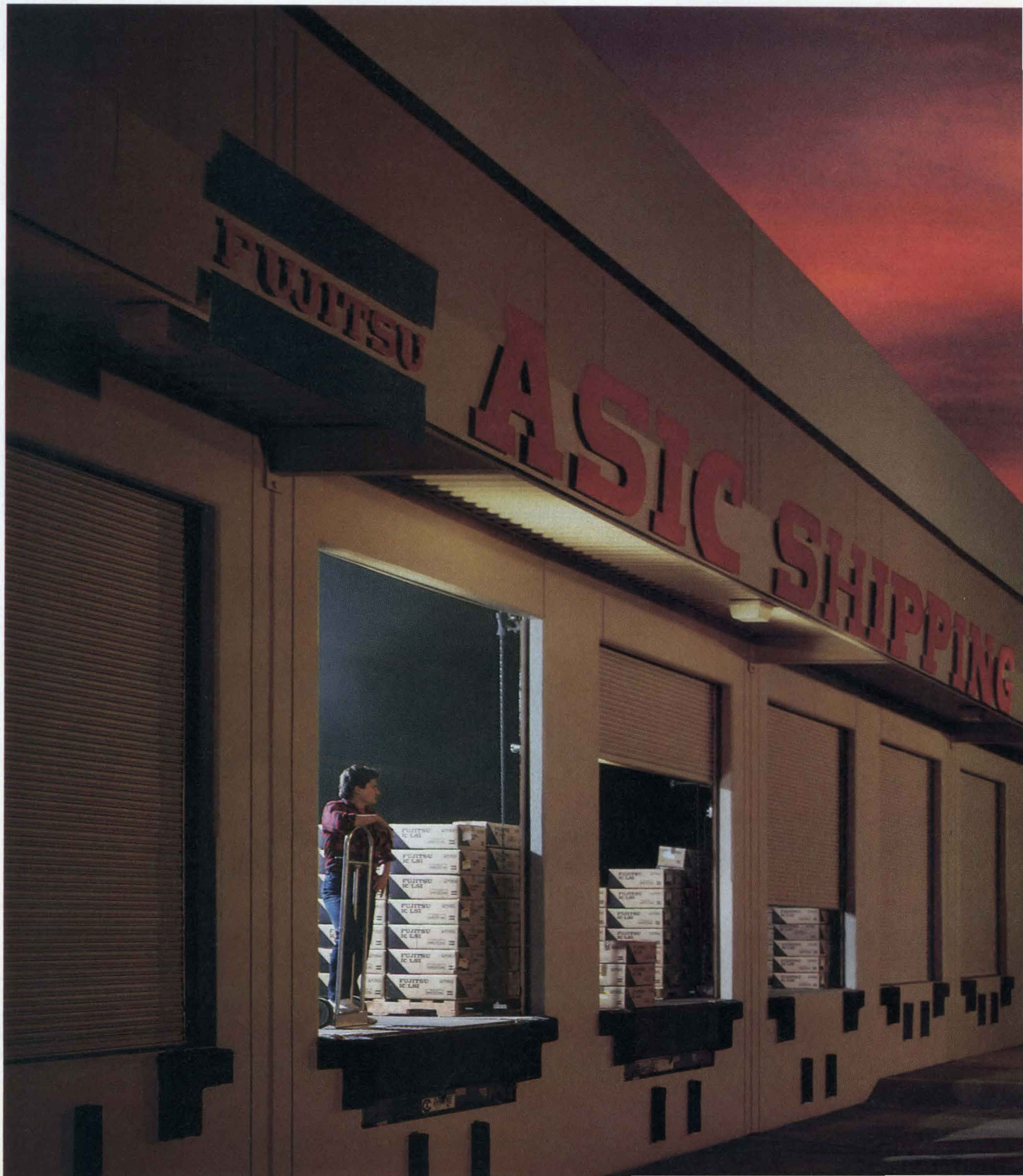


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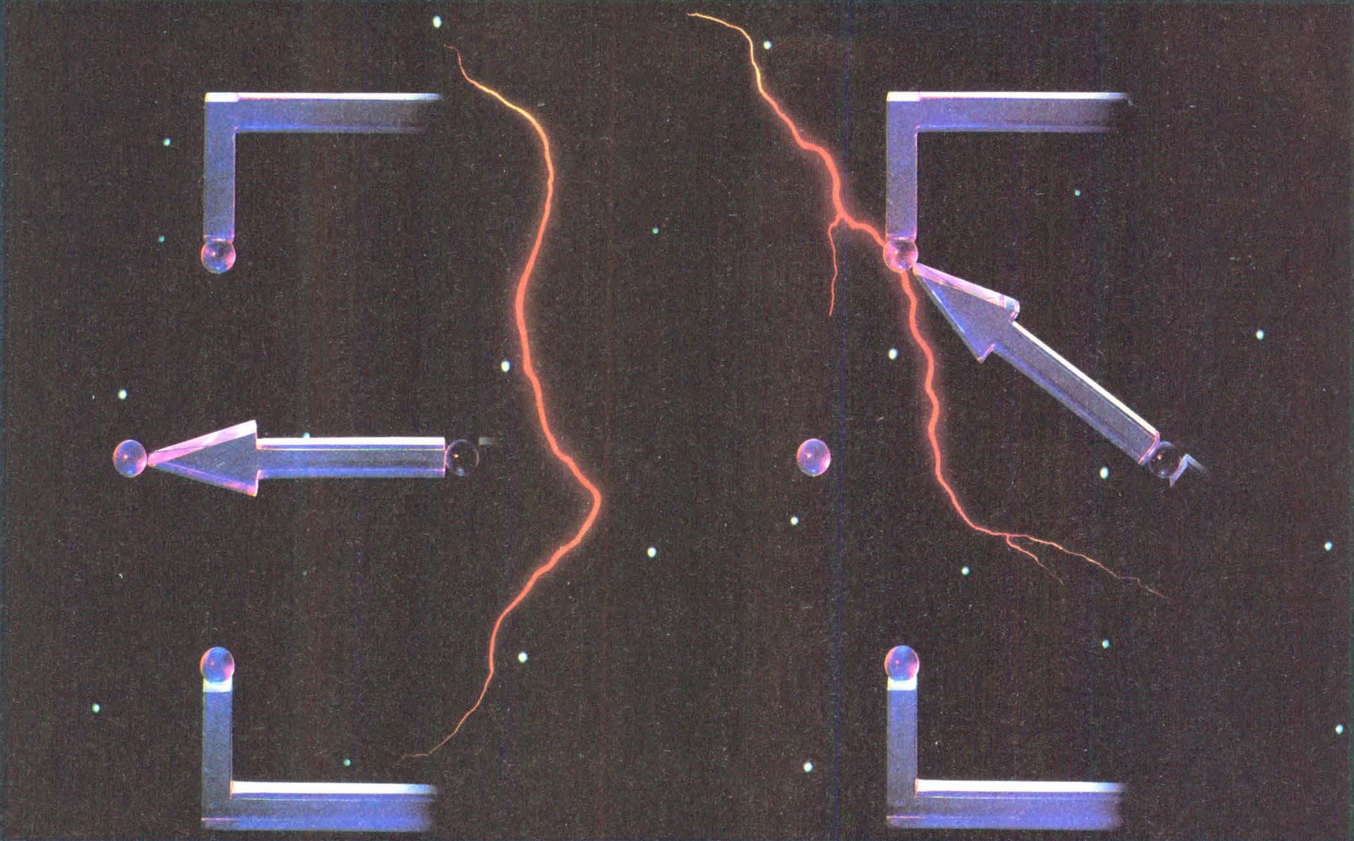

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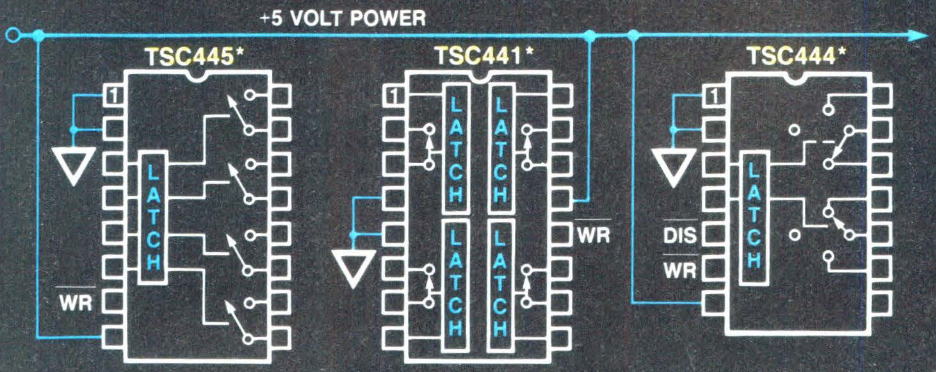

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CIRCLE NO 85

Hitachi's 3-Chip Graphics System

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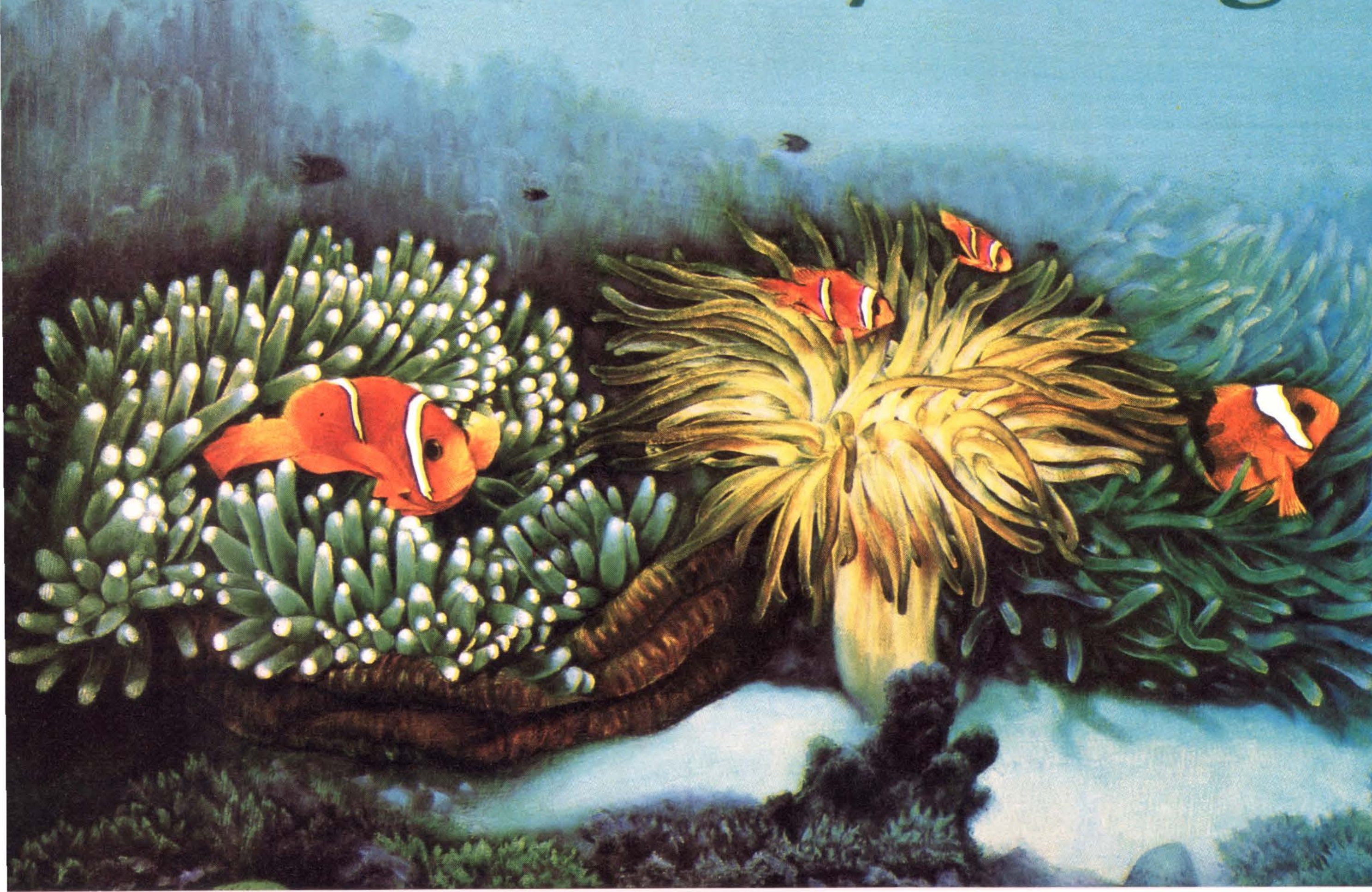
Our renowned HD63484 Advanced CRT Controller (ACRTC) has been joined by the HD63485 Graphics Memory Interface Controller (GMIC), and the HD63486 Graphics Video Attributes Controller (GVAC). The ACRTC made graphics software design simple, and now the GMIC and GVAC complete the picture by making your hardware design just as easy.

Glue logic is virtually eliminated. Development time and cost are slashed to the minimum. You end up with a graphics system so cost-effective that you can use it in high-volume, mainstream PC and OA workstation applications. High-performance graphics no longer has to be an option on your products.

A trio of devices gives unbeatable performance in every key area. The ACRTC embodies Hitachi's 2-micron CMOS technology to integrate all CRT and graphics control functions on one chip. This all-CMOS device has three on-board processors to relieve the system's CPU of many time-consuming processing tasks. The ACRTC executes 38 high-level commands—including 23 graphic drawing commands. You don't have to compute command parameters, and address translation is done in *hardware.*

The GMIC acts as an interface between the ACRTC and your frame buffer. This 64MHz Hi-BiCMOS™ device generates every control and refresh signal required by the DRAM frame buffer, including all timing signals, row-and-column addresses, and write strobes.

Every Image



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NEWS BREAKS

EDITED BY JOANNE CLAY

OPTICAL WORM DRIVE STORES 1.2G BYTES ON A CARTRIDGE

The ISi 525GB write-once, read-many (WORM) optical-disk subsystem from Information Storage Inc (Colorado Springs, CO, (303) 579-0460) stores 1.2G bytes of information on its double-sided cartridge. At any one time, an application has access to one side (600M bytes) of the cartridge. In addition, the optical drive features a 6.5M-bps data-transfer rate, which the company claims can provide better throughput than some magnetic hard-disk drives. A subsystem designed to be mounted in an IBM PC or compatible computer costs $5988 and includes the WORM drive, controller board, cables, and software. An enclosed subsystem that adds a power supply and cabinet costs $6188. The company will offer a similar drive with a SCSI interface in August. Meanwhile, the company has lowered the price of its 230M-byte ISi 525WC subsystem from $3995 to $2088.—Steven H Leibson

DSP BOARD AND SUBSYSTEM BOOST HP 9000 WORKSTATION PERFORMANCE

The DSP300 add-in board for Hewlett-Packard's 9000 Series 200/300 workstations employs an AT&T WE-DSP 32 processor to increase the speed at which the workstations perform floating-point operations. Infotek Systems (Anaheim, CA, (714) 956-9300) offers the board as a stand-alone product or as part of the GA300 graphics-accelerator subsystem. The GA300 also includes the BC305 Basic 5.0 compiler and graphics-accelerator software, and it can execute applications such as real-time modeling and animation as much as 40 times faster than the Series 200/300 processor can. Available now, the DSP300 costs $2000 (including the assembler and C compiler) and the GA300 sells for $2395. The company plans to introduce FFT and array-processing subsystems based on the DSP300 in the third quarter of 1988.—Maury Wright

MENU-DRIVEN DMM INCLUDES BAR GRAPH AND FREQUENCY COUNTER

The Model 560 menu-driven digital multimeter from Simpson Electric Co (Elgin, IL, (312) 697-2260) is a 2.5-lb, Z80-based instrument that stores 2150 readings in nonvolatile, battery-backed RAM. The basic unit costs $2195. The 560's menu interface simplifies the task of selecting storage parameters for the meter's readings. The readings have 5-digit resolution (allowing for 99,999 counts) and a minus sign. A 52-segment bar graph provides real-time voltage and autorange representations that are independent of the decibels or hertz you're measuring, so you can simultaneously take a reading and observe events at the test point in real time.

The DMM features a built-in frequency counter, true-rms ac measurements, fusing on both current inputs, low-forcing-current and high-forcing-current resistance ranges, a diode-test function, high-speed autoranging, a zero function that eliminates lead resistance in readings, digital filtering, a temperature-compensated reference, and digital calibration. The unit also provides a peak-hold function. You can order the 560 with either an RS-232C serial port or a Centronics-compatible parallel port for $2395.—J D Mosley

MONOLITHIC OP AMP OPERATES FROM ±45V SUPPLIES

Burr Brown's (Tucson, AZ, (602) 746-1111) OPA445 monolithic op amp operates from ±45V power supplies and provides an output swing of ±35V into 5-kΩ loads or generates as much as 15 mA with a maximum output swing of ±28V. The laser-trimmed part features a maximum 1-mV offset voltage, a 10-μV offset drift, and a 10V/μsec slew rate. The company offers the device for $3.80 (100) in either a TO-99 package or an 8-pin DIP with industry-standard op-amp pinouts.—Steven H Leibson

NEWS BREAKS

SOFTWARE PACKAGE INOCULATES DISKS AGAINST COMPUTER VIRUSES

After one of its computers became infected with a destructive virus program (sometimes called a Trojan horse program), Sophco Inc (Boulder, CO, (303) 444-1542) added an inoculation module to its $195 Protec software-protection package for computers running MS-DOS version 3.0 and higher. An engineer at the company had downloaded a seemingly innocuous program (an X-rated animated graphics program) from an electronic bulletin board to a computer's hard disk. That program contained an infectious module that installed delayed-action routines into executable software on the hard disk. Later, the routines destroyed the files on the disk.

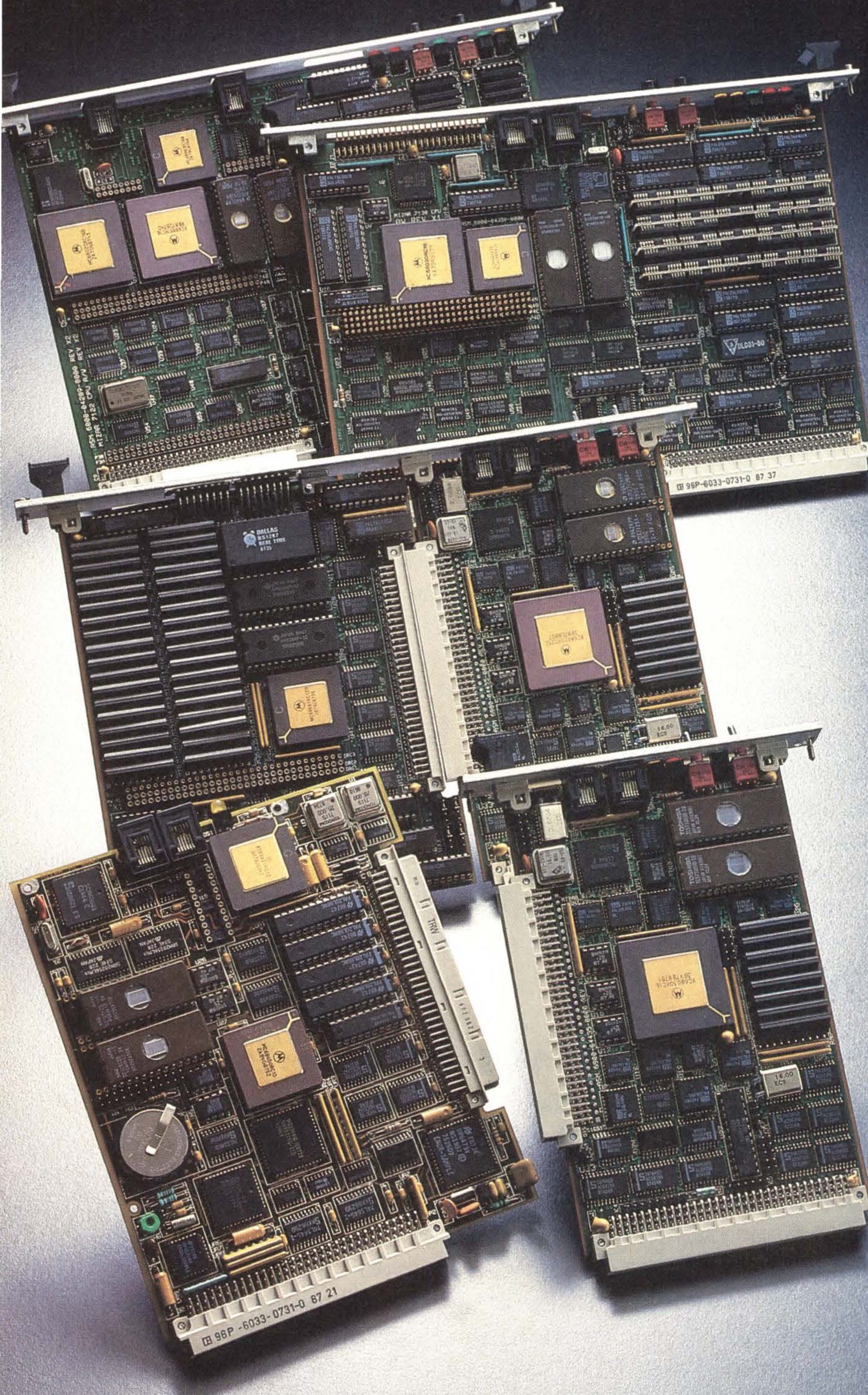
Protec version 3.2 can safeguard your programs with a protective virus program called Vaccinate, which you install in your executable files with another program called Syringe. The Protec system also includes a decoy program called Canary that you can use to test suspect software. You include Canary on a floppy disk along with the dubious software and run the suspect program. If the Canary program "dies" after the suspect program finishes, you know there's a virus program on your disk. Sophco has also initiated the Center for Computer Disease Control, which will act as a clearing house for information about such antisocial software.—Steven H Leibson

NONVOLATILE RAMs REQUIRE NO BACKUP BATTERIES

Selected customers are currently evaluating a promising new development in semiconductor memories—nonvolatile RAMs. Dubbed ferroelectric RAMs (FRAMs) or "shadow" RAMs, the prototype static-RAM devices from Ramtron Corp (Colorado Springs, CO) have a 256×1-bit organization and require no backup batteries. Instead, a pair of special storage capacitors provides backup for each bit cell. These capacitors have a thin-film-ceramic dielectric called "lead zirconate titanate" (PZT), whose bistable polarization allows the indefinite storage of data; you set the polarization state by applying a 2.5V coercive voltage. The initial product (FMx 801) operates on 5V and features 100-nsec read and write operations. Products having higher speed and higher bit density will follow. At present, the company offers the FMx only to qualified customers as a technology-demonstration vehicle, but it expects to have the product available for sale during the third quarter of 1988. The company is also developing nonvolatile dynamic RAMs (based on a 1-transistor memory cell) that have capacities of 256k bits and greater.—Tarlton Fleming

FLASH MEMORIES ALLOW IN-SYSTEM REPROGRAMMING

The 27F64 and 27F256 64k- and 256k-bit flash-memory devices from Intel (Santa Clara, CA, (800) 548-4725) feature in-circuit electrical erasure and reprogramming. You program or erase the devices by writing the appropriate command to a control register and supplying 12V to the programming pin. You program the devices one byte at a time; an erase command erases the entire memory. Erasing the devices takes less than 1 sec; reprogramming them takes less than 4 sec. If you hold the programming pin at 5V, the control register is disabled, allowing normal EPROM read operations. The 27F64 costs $8; the 27F256 is $19.90 (10,000).—Richard A Quinnell



NEWS BREAKS: INTERNATIONAL

CAD PACKAGE ALLOWS YOU TO DESIGN AND ORDER RESISTOR NETWORKS

Supplied free of charge on a floppy disk, the Resicalc CAD package from Ericsson Business Area Components (Granna, Sweden, phone (46) 39011020) allows you to design your own resistor networks on an IBM PC. The CAD package, which incorporates the design rules for the company's semicustom Erisistor resistor networks, allows you to design through-hole or surface-mounting SIP (single in-line package) resistor networks, or networks packaged in leadless chip carriers. For each internal resistor, you can specify the absolute value, absolute and relative tolerances, absolute and relative temperature coefficients, and power rating. You then define the leadout connections for each resistor, and the program automatically tells you whether the network is manufacturable as an Erisistor product. If your design isn't feasible, the program suggests parameters you can change to make it manufacturable. In addition to providing an instant guide price for the network, Resicalc allows you to dial up the company's computer on a toll-free line to obtain accurate pricing and delivery information and to place your order.—Peter Harold

CPU CARD PERFORMS 32-BIT DMA TRANSFERS TO VME OR VSB BUS

The FIC8230 intelligent VME Bus board from Creative Electronic Systems SA (Petit-Lancy, Switzerland, TLX 421320) is based on a 16- or 24-MHz 68020 μP and a 68881 or 68882 math coprocessor. The board offers an optional DMA controller that can perform 16- or 32-bit block data transfers across the VME Bus's entire 4G-byte addressing range at data rates as high as 8M bytes/sec. The DMA controller can also transfer 32-bit data over the VSB Bus at data rates in excess of 10M bytes/sec. Another DMA channel allows you to transfer data to or from an 8-bit I/O port, which you can configure for a variety of uses (for instance, you can use it as a SCSI port).

The board has 512k bytes or 1M byte of zero-wait-state CMOS static RAM that's ported to the 68020 and to the VME Bus, and is ported to the VSB Bus via a DMA channel. The board also has 128k bytes of local RAM, and it includes space for as much as 128k bytes of EPROM. Four independent 255×32-bit LIFO/FIFO buffers provide the board with message-passing capabilities. The board's additional facilities include two RS-232C serial I/O ports, a 16-bit timer/counter, and a real-time clock. The board configuration is software programmable. The FIC8230 costs between $4500 and $6000, depending on configuration.—Peter Harold

JAPAN KEY TECHNOLOGY CENTER EARMARKS ¥222M FOR RESEARCH

The Japan Key Technology Center, which is responsible for funding technological developments in the private sector and supporting local information-oriented businesses, has set aside ¥222 million to fund research in various electronic and materials technologies. The organization falls under the jurisdiction of both the Ministry of Posts and Telecommunications (MPT) and the Ministry of International Trade and Industry (MITI). It has designated ¥77 million for research on amorphous magnetic materials and electronic devices and ¥145 million for funding experimental research into high-precision light-detection devices containing superconductive materials, low-voltage EL displays, infrared-image fiber sensors, color filters for use in flat LCDs, and equipment that can measure the effects of electrostatic fields on radio waves.—Joanne Clay

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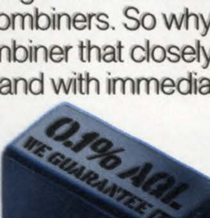

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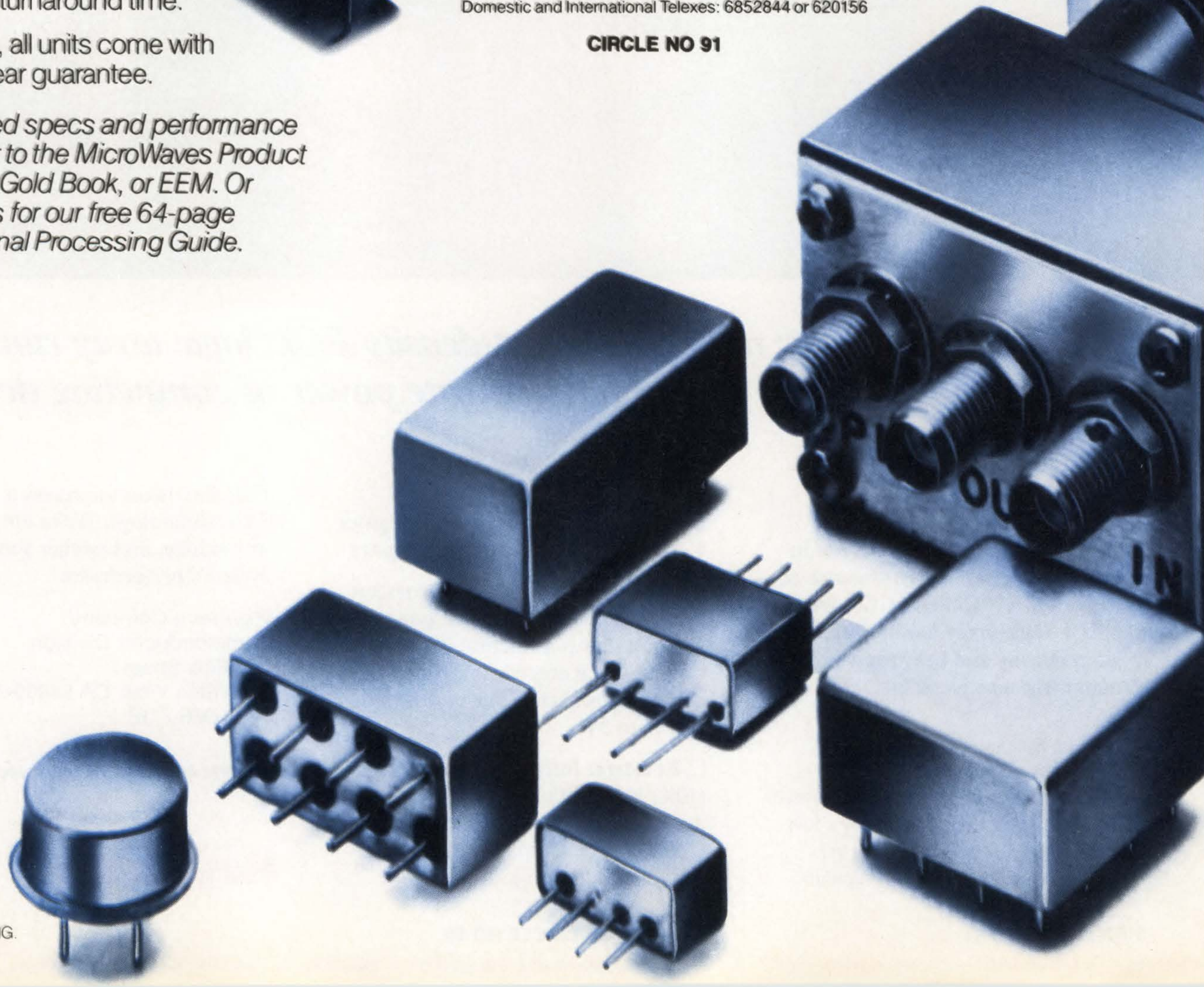
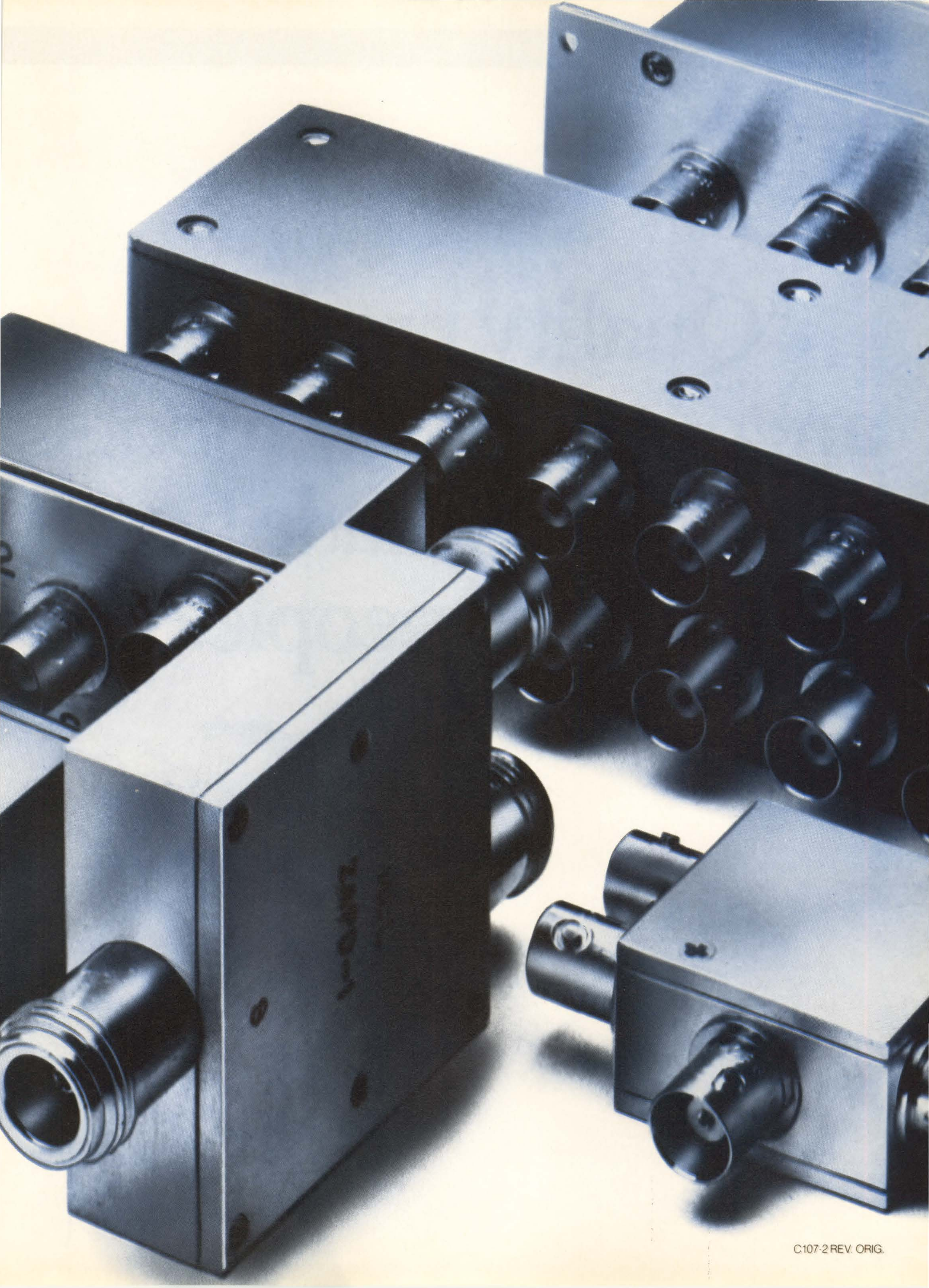


C107-1 REV. ORIG.

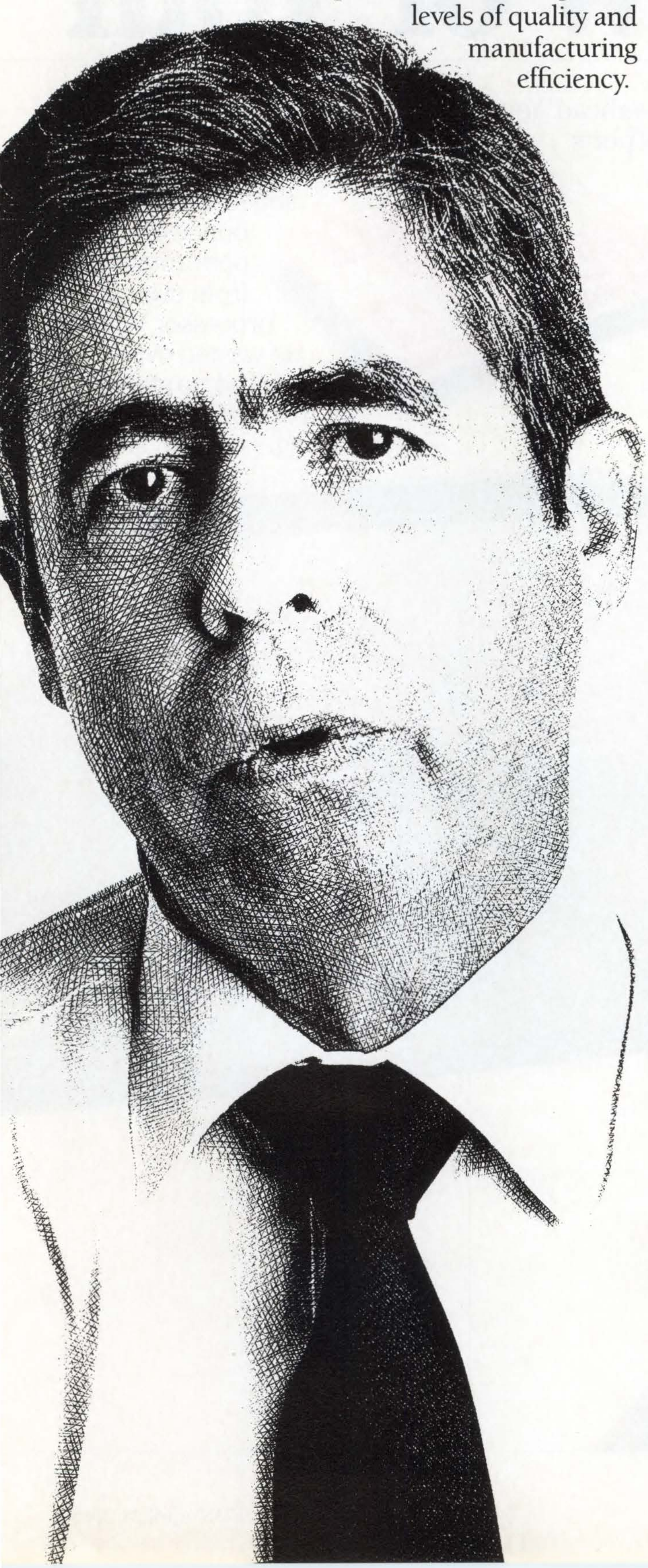


C107-2 REV. ORIG.

"Quality products are not made by robots. They're made by quality people."

Jack E. Haslup
Manufacturing Operations Manager

American electronics companies today face some serious challenges in manufacturing—the main one being how to compete successfully with our offshore rivals. That's why at Motorola we've taken several radical steps aimed at reaching new levels of quality and manufacturing efficiency.



A commitment to 6-Sigma quality levels.

Last year, Motorola began working toward a quality goal of *6 Sigma* for all manufacturing, as part of our Statistical Process Control program. That translates into a defect rate of 3.4 parts per million, or an effective yield of 99.99966%. In short, zero defects. And remember, we're talking about *board*-level here, not components.

The move to Just-in-Time manufacturing.

To reach those quality levels, we've undergone a revolutionary change in our manufacturing culture at Motorola, using Just-in-Time techniques. JIT gives us a discipline for looking at *every* step of our manufacturing process, and eliminating waste. It has already helped us shorten our build cycle over 80%. Ultimately, we want to be able to build only those products our customers want. And ship them the same day they're ordered.

The right tools for total quality control.

At Motorola, we make what amounts to custom products, using mass manufacturing techniques. To track the 78 different products we build, we've recently installed an on-line Quality Information System that uses bar code readers to gather process and quality data. We're evolving toward a "paperless" factory that experts tell us is a showcase in the industry.

The necessity of strong manufacturing for survival.

Quality and manufacturing excellence are more than just words. They're essential in today's global competitive environment. Which is why we feel—quite frankly—that only those corporate cultures focused on quality goals like 6 Sigma will survive. In fact, any VME board or system vendor who *doesn't* have strong manufacturing isn't really in this business to stay. That's why we're always ready to *demonstrate* our capabilities. Because we don't know of anyone who has a stronger commitment to quality and manufacturing excellence than Motorola. That's what being the leader means.

MOTOROLA *Microcomputer Division*

Approaching our technology from your point of view.

For reprints of this series, call 1-800-556-1234, Ext. 230; in California, 1-800-441-2345, Ext. 230. Or write: Motorola Microcomputer Division, 2900 South Diablo Way, Tempe, AZ 85282.

CIRCLE NO 92

VME/PLUS™ gives view of your

*H*old on to your seat. You're about to discover an entirely new level of VME performance.

Meet VME/PLUS. Our new family of VMEbus products with a host of sophisticated features that will give

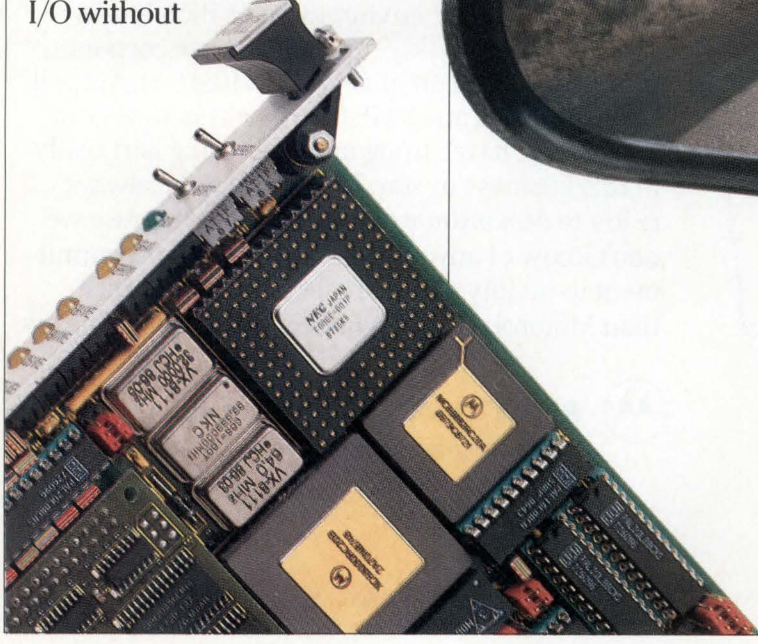
VME/PLUS

your project the kind of performance you've only dreamed about.

VME/PLUS gives you a choice of microprocessors, including a 68030 running at 25MHz without wait states. Complemented by 1MB of local memory. There's also a new VSB interface on P2. Which lets you add lots of local memory and I/O without increasing bus overhead. You also get two serial ports and up to 4MB of EPROM.

The result is system throughput that's way ahead of anything else in the VME world.

Think about the possibilities for real-time applications. For the first time, you can squeeze every ounce of performance from every processor. With no wasted overhead. And no stalls. But that's only the beginning. The newest



you a different competition.

member of the VME/PLUS family, CPU-32, comes with a powerful new real-time, multitasking monitor called VMEPROM. It's resident in EPROM, so there's no license required and no extra charge.

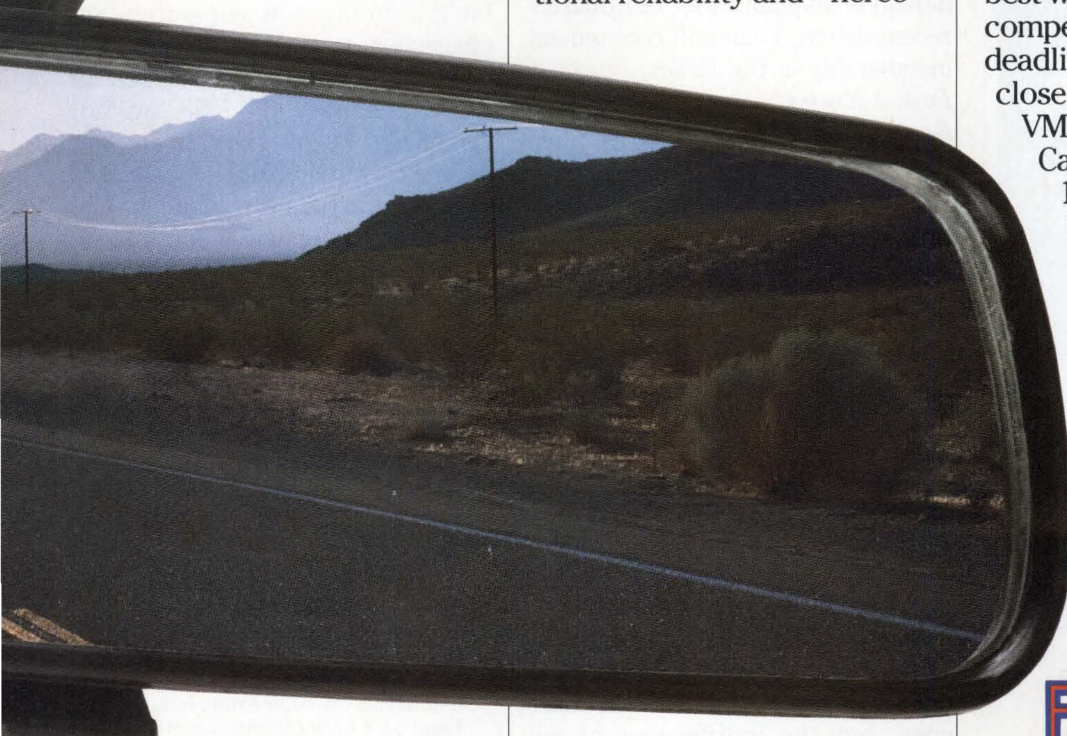
CPU-32 also includes full support for real-time operating systems and UNIX 5.3.

CPU-32 CHARACTERISTICS	
PROCESSOR	68030/16.7 TO 25 MHz
CO-PROCESSOR	68882/16.7 TO 25 MHz
ZERO-WAIT-STATE SRAM	1MB
VMEPROM	REAL-TIME, MULTITASKING MONITOR
EPROM	UP TO 4MB @ 1 WAIT-STATE
SERIAL I/O	2 RS-232 CHANNELS
SECONDARY BUS SUPPORT	VSB

What this new technology means for you is unprecedented levels of speed and system throughput, exceptional reliability and – here's the best part – lower total system cost.

And if that's not enough, we also offer a full set of off-the-shelf peripheral boards and software. All VMEbus compatible. And guaranteed to cut the wait states out of your design cycle.

So if you're looking for the best way to stay ahead of your competition and your deadline, take a close look at VME/PLUS.



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CIRCLE NO 110

SIGNALS & NOISE

IEEE will survive its current troubles

In his February 4 editorial (pg 53), Jon Titus predicted that the IEEE was facing extinction. Although I concur with Jon's observations relating to the IEEE Board of Directors' decision on approval voting, I don't feel that it spells the end for the IEEE. The IEEE has survived for 104 years and will continue to do so. Whether it has the impact it has had in the past remains to be seen. Issues such as portable pensions, reinstitution of the IRA deduction, and engineer utilization are still being worked on by committees of the IEEE. Unfortunately, all these efforts by numerous volunteers have been lost in the miasma of the Board's actions. Although I can't defend or explain away the Board's recent action, I can still recommend membership in the IEEE.

Paul J Kostek
Boeing Aerospace Co
Seattle, WA

Feerst takes prize for endurance

Bravo to Jon Titus for his editorial "The IEEE faces extinction" in the February 4 issue (pg 53). Verily he speaks the truth, but who is listening?

I've been in this business a long time, but I quit the IEEE in disgust back in 1967 for the same general reasons that Jon Titus and Irwin Feerst state. I've helped the Committee of Concerned EEs at least once, but the indifference of my fellow engineers made it seem hopeless. Irwin Feerst surely deserves the prize for patience, endurance, and faithfulness to his ideals.

Jon Titus is in a position to be a great help to the working engineer. I hope that he continues to do so.

Gene D Barber
(A working engineer)
San Diego, CA

"I HAVE AN IDEA WHY WE'VE HAD SO MUCH DOWN TIME ON OUR COMPUTERS."

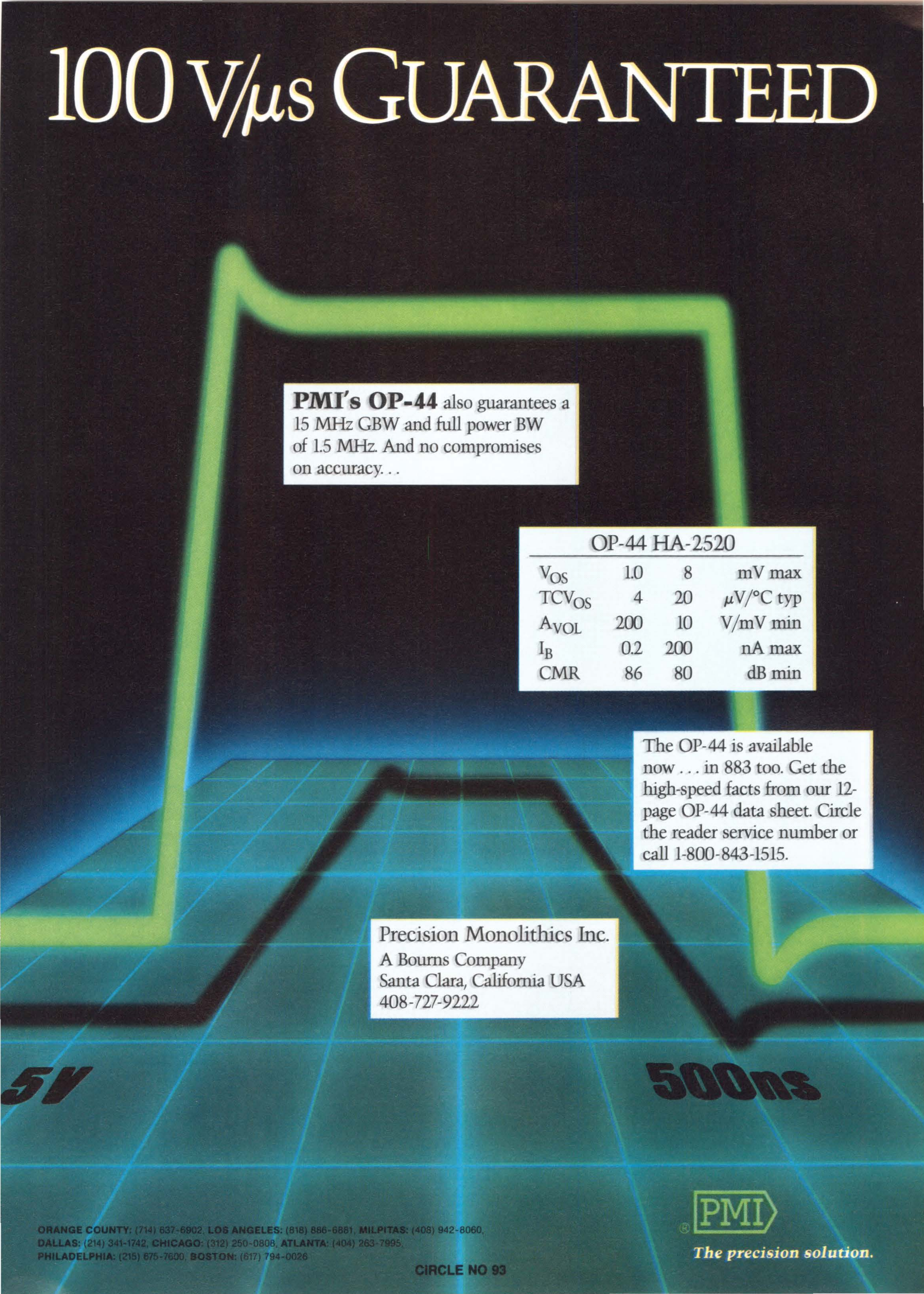
Single-chip μC comes Forth

Isn't it funny how computer languages expose intolerance in people (see Robert Johnson's letter in EDN, February 18, 1988, pg 34). Personally, I believe that anyone not using Fortran on single-chip micros should be stood up against the wall . . . . Seriously, though, Steve Leibson might like to know that Micromint (Vernon, CT, (203) 871-6170) sells a Forth chip based on the Z8.

Peter Hand
PDA Designs Ltd
Portsmouth, England

YOUR TURN

EDN's Signals and 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. Send your letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.



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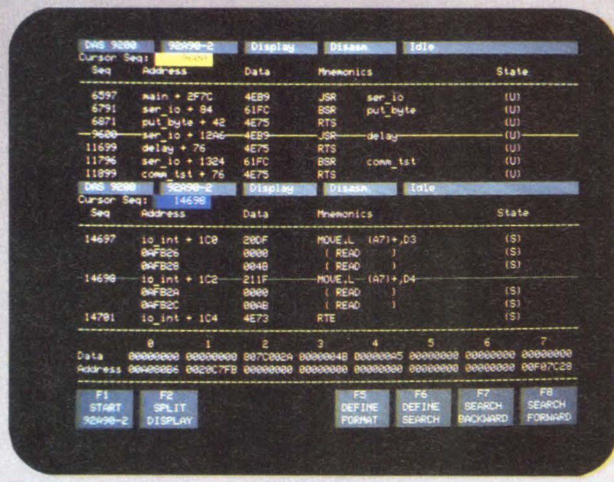
CIRCLE NO 93

DAS9200 DIGITAL ANALYSIS: NOW TEK MAKES THE IMPOSSIBLE LOOK EASY.

Software Performance Analysis, like this distribution of a subroutine's execution times, helps you easily understand the activity of your code.



Step backwards through acquired data, including subroutines, stack and register models, using time-correlated split-screen displays to pinpoint problems.

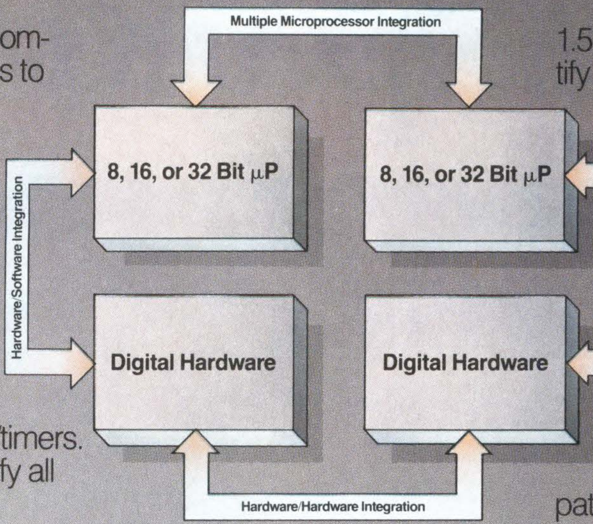
In every dimension—speed, channel width, memory depth, trigger capability, modularity and ease of use—the DAS9200 dwarfs what's been possible before.

The DAS9200 features a tightly coupled, high-speed architecture in which multiple card modules can act as a single unit. Large color-coded displays, pop-up menus, performance analysis graphs,

multi-tasking and more combine to take logic analysis to levels like these:

1 State-driven triggering at 200 MHz. You can use up to 384 channels of sync and async data acquisition. You can assurance-test high-speed logic at full speed, using 4-level state tracking and high-speed counter/timers. You can monitor and verify all timing measurements in a circuit.

2 Symbolic, real-time software debugging. Register deduction and stack simulation let you pinpoint problems like stack overflow or incorrectly restored pointers—without breakpoints or manual notation.

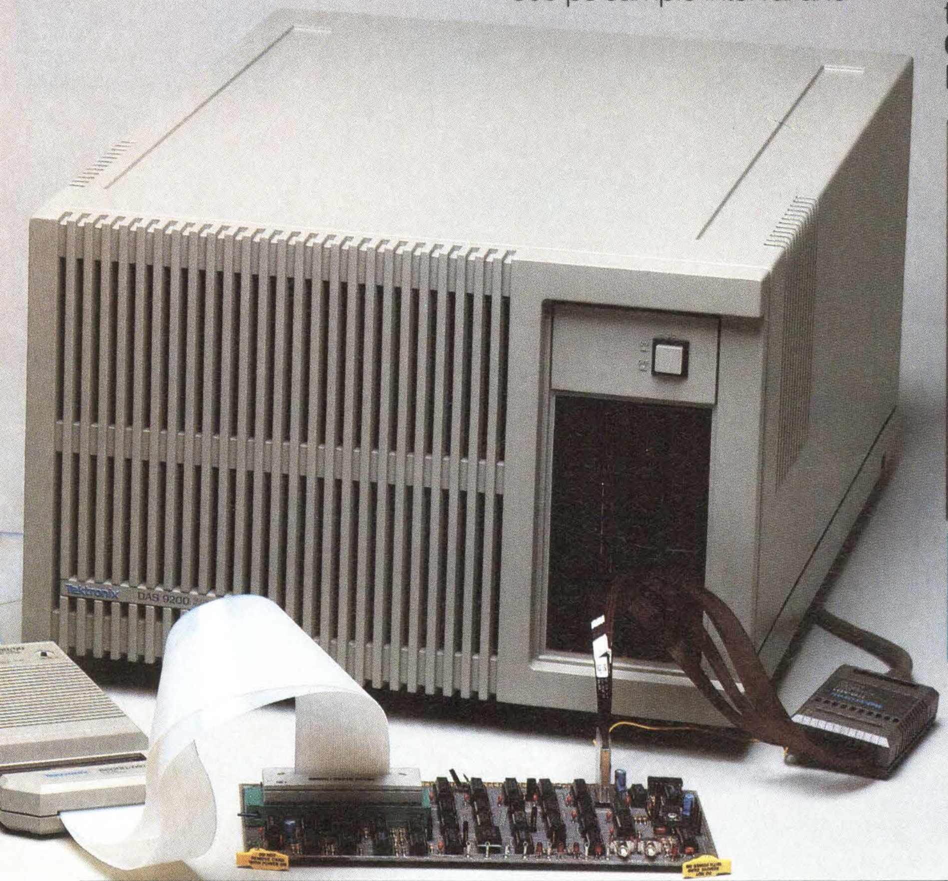


3 Simultaneous integration of up to six microprocessors. Use the dual timebases and real-time handshaking between system modules to set up split-screens displays that scroll in precise time alignment.

4 160 channels of acquisition at 2 GHz. Use up to 500 ps sample interval and 1.5 ns glitch detection to identify race conditions, spurious clocks and setup/hold violations in any logic family. System probes feature input capacitance of <1 pf.

5 Easy ASIC verification at up to 50 MHz. The DAS9200 is available as a low-cost turnkey ASIC device verification system. Featuring 50 MHz pattern generation, 8K bit vector depth, and 1 ns edge placement, it offers the power, precision and simplicity to be an attractive alternative to centralized systems.

6 Stop wishing for the impossible in digital analysis: Compare your wish list against the complete list of DAS9200 capabilities. Contact your Tek sales engineer, or call toll-free for more information. **Call 1-800-245-2036.** In Oregon, 231-1220.



Available in desktop and rack-mount versions, the DAS9200 mainframe can be augmented with up to three expansion mainframes for a total of 28 card slots.

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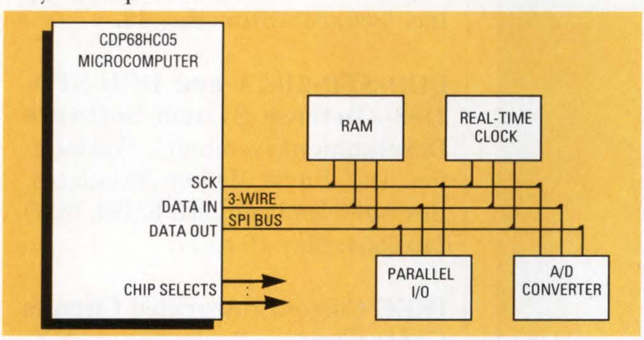
Many microcomputers rely on parallel I/O ports to communicate with peripheral devices. An inefficient method at best.

That all changes with the serial peripheral interface incorporated into our 68HC05 microcomputers.

This three-wire (plus device select) synchronous, full-duplex, serial communication system contains separate lines for input and output data, serial clock and device select. You don't have to sacrifice I/O ports to communicate off-chip: our 68HC05 micros can communicate with our own serial peripherals, the serial peripherals of other manufacturers, and even with other microcomputers via only three port lines.



True design versatility.

The real beauty of the SPI is that it eliminates limitations imposed by microcomputers.

For example, you can easily extend the amount of I/O or memory with SPI RAMs, I/O chips or shift registers. And the modular SPI bus gives you the ability to expand without losing lots of PC-board space. Reduced package sizes and minimized interconnect wiring lead to reduced board size.

And since you don't need complex software to operate the bus, you save ROM space.

Right now, we can offer you a versatile family of peripheral devices, including 128-byte and 256-byte static RAMs, a real-time clock with RAM, an 8-bit programmable I/O port, and a 10-bit 8-channel A/D converter. And more parts are coming soon, including a digital pulse-width modulator and a serial bus interface chip for networking microcomputers. These serial peripherals are also compatible with other microcomputer types.

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We can provide 6805 microprocessors for external memory address, but the heart of our SPI system is the 6805 Series high-speed CMOS microcomputers:

68HC05 Microcomputers

Features	68HC05C4	68HC05C8	68HC05D2	68HC05D2A
Pins	40	40	40	28
On-Chip RAM (bytes)	176	176	96	96
On-Chip User ROM (bytes)	4160	7744	2176	2176
Bidirectional I/O Lines	24	24	28	16
Unidirectional I/O Lines	7 inputs	7 inputs	3 inputs	3 inputs
Timer size (bits)	16	16	16	16
Prescaler size (bits)	*	*	*	*
External timer oscillator	no	no	yes	yes
Serial peripheral interface	yes	yes	yes	no
Serial communications interface	yes	yes	no	no

*prescaler fixed as ÷4

Easy to prototype, too.

If you need another reason to choose our 6805 family, here it is: they're so easy to prototype with our Piggyback! We have the 68EM05C4 and 68EM05D2 Emulators, custom 40-pin packages that contain the C4/C8 or D2 micros with a Piggyback EPROM socket.

When installed with a 27C64 EPROM, these devices together become functionally identical to a CDP68HC05C4, CDP68HC05C8 or CDP68HC05D2.

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CALENDAR

Pittsburgh Conference on Modeling and Simulation, Pittsburgh, PA. William Vogt or Marlin Mickle, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15261. May 5 to 6.

Worst-Case Circuit Analysis (seminar), Washington, DC. Design and Evaluation, 1000 White Horse Rd, Suite 304, Voorhees, NJ 08043. (609) 770-0800. May 9 to 11.

Electro/88, Boston, MA. Electronic Conventions Management, 8110 Airport Blvd, Los Angeles, CA 90045. (800) 421-6816; in CA, (213) 772-2965. May 10 to 12.

EMC Expo, Washington, DC. Karen Smith, EMC Expo, Box D, Gainesville, VA 22065. (703) 347-0030. May 10 to 12.

Analog Applications (seminar), Chicago, IL. Precision Monolithics Inc. (800) 843-1515. May 13.

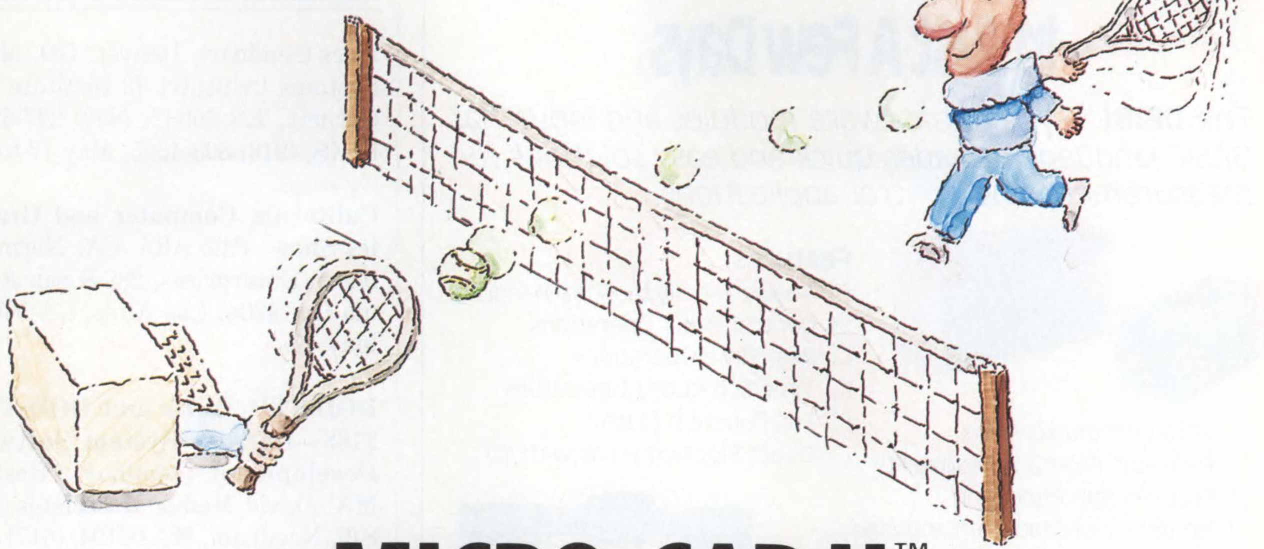
DOD-STD-2167A and DOD-STD-2168—Defense System Software Development (seminar), Washington, DC. David Maibor Associates, Box 846, Needham, MA 02194. (617) 449-6554. May 16 to 17.

IEEE Custom Integrated Circuits Conference, Rochester, NY. Roberta Kaspar, 20 Ledgewood Dr, Rochester, NY 14615. (716) 865-7164. May 16 to 19.

Modern Electronic Packaging (seminar), Minneapolis, MN. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. May 17 to 19.

C Programming: Hands-on Workshop (short course) Palo Alto, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. May 17 to 20.

Troubleshooting Microprocessor-Based Equipment and Digital De-



MICRO-CAP II.™
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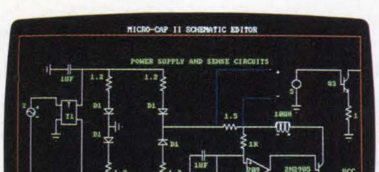
Spectrum Software's MICRO-CAP II® is fast, powerful, and feature rich. This fully interactive, advanced electronic circuit analysis program helps engineers speed through analog problems right at their own PCs.

MICRO-CAP II, which is based on our original MICRO-CAP software, is a field-proven, second-generation program. But it's dramatically improved.



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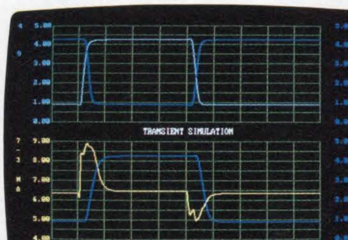

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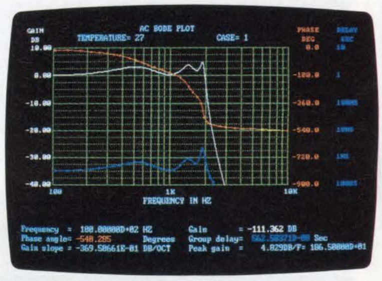

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CIRCLE NO 115

CALENDAR

vices (seminar), Denver, CO. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. May 17 to 20.

California Computer and Graphics Show, Palo Alto, CA. Norm De Nardi Enterprises, 289 S San Antonio Rd, #204, Los Altos, CA 94022. May 19.

DOD-STD-2167A and DOD-STD-2168—Defense System Software Development (seminar), Boston, MA. David Maibor Associates, Box 846, Needham, MA 02194. (617) 449-6554. May 19 to 20.

DOD-STD-2167A and DOD-STD-2168—Defense System Software Development (seminar), Orlando, FL. David Maibor Associates, Box 846, Needham, MA 02194. (617) 449-6554. May 23 to 24.

31st Annual Instrument Society of America Power Symposium, St Petersburg, FL. Bill Blazier, Illinois Power Co, 500 S 27th St, Decatur, IL 62525. (217) 424-6622. May 23 to 25.

Society for Information Display International Symposium, Anaheim, CA. Palisades Institute for Research Services, 201 Varick St, Rm 1140, New York, NY 10014. (212) 620-3388. May 23 to 27.

C Programming: Hands-on Workshop (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. May 24 to 27.

Troubleshooting Microprocessor-Based Equipment and Digital Devices (seminar), Kansas City, MO. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. May 24 to 27.

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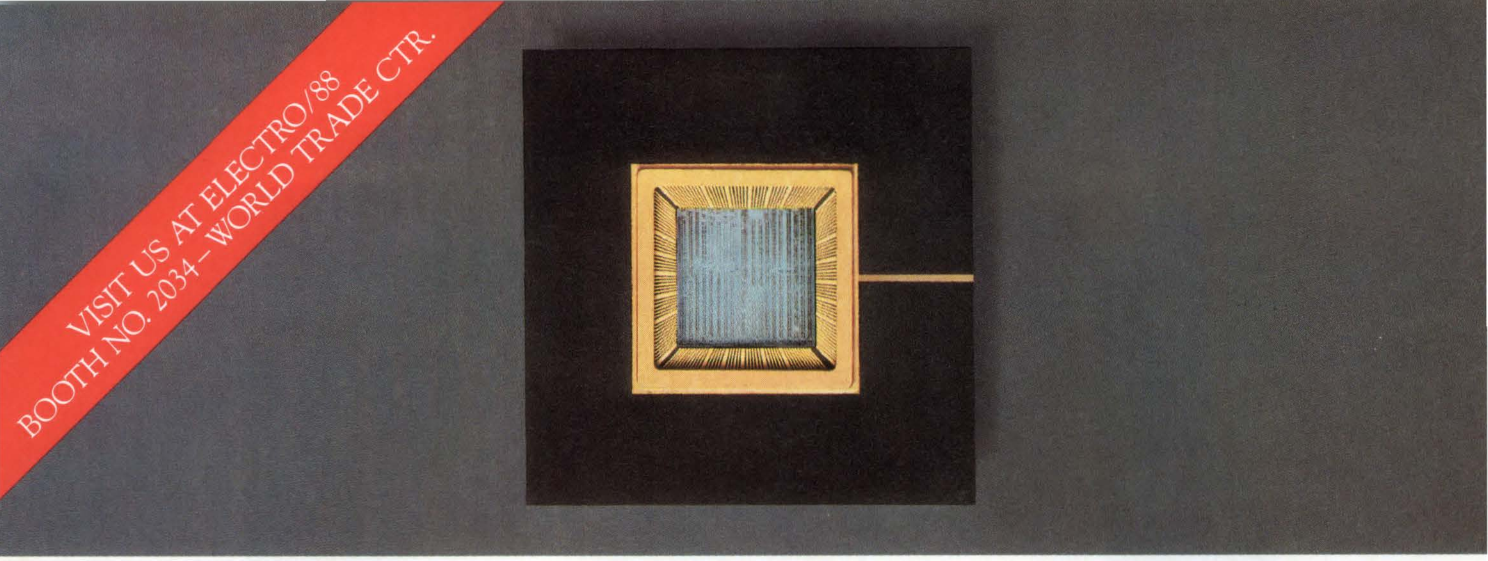

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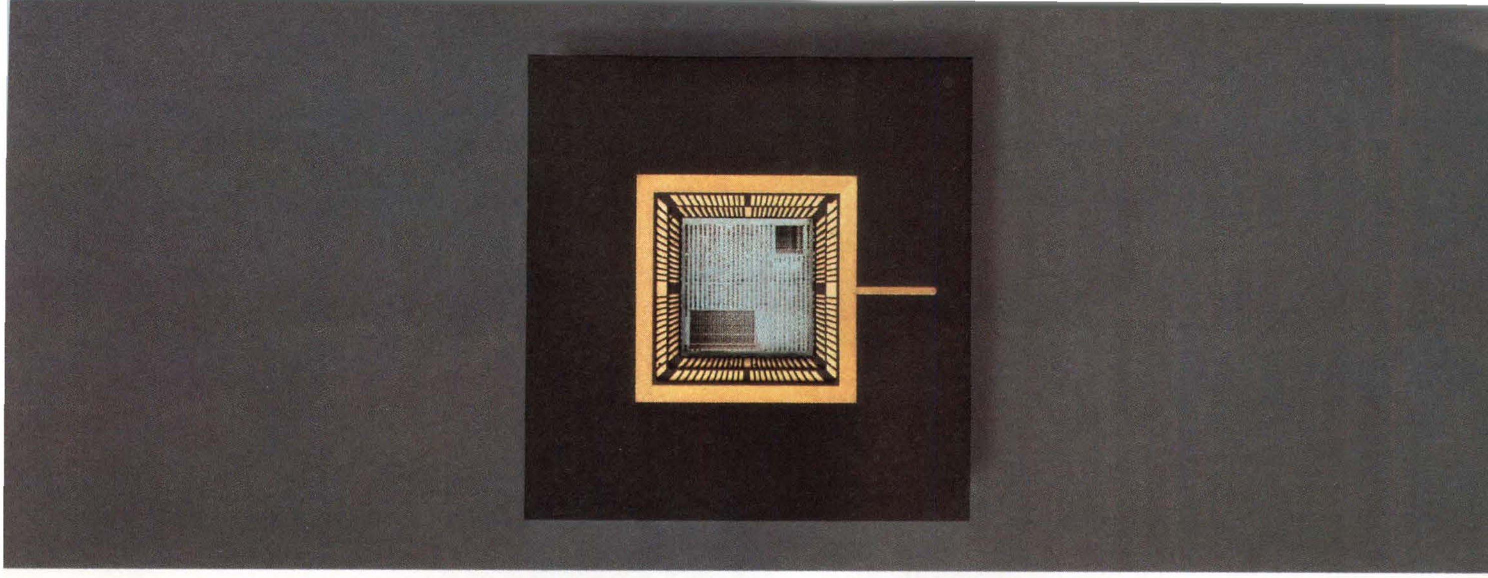

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CIRCLE NO 114

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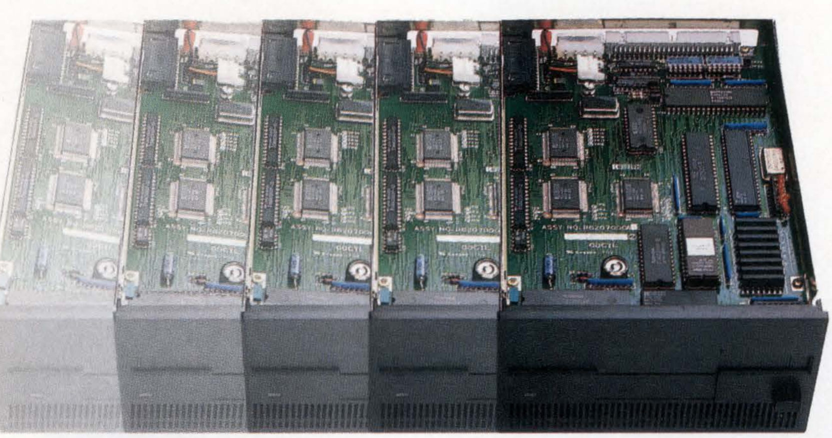

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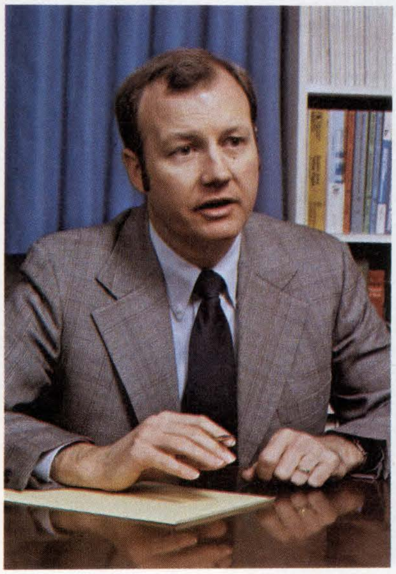
EDITORIAL

Trouble in the Pacific



There's a formula somewhere that measures a country's strength by examining its economy, social structure, and political system. Unfortunately, recent newspaper and magazine reports from Pacific-rim countries emphasize economic strengths while ignoring political and social problems. If we are going to make decisions about the electronic industry's future, however, it's worth looking beneath the veneer of economics.

Among the Pacific-rim countries, Japan stands out as an economic power for others to emulate. Yet for all its economic strength, Japan has little global political stature and feels reluctant to undertake defense tasks in the northern Pacific. It's quite likely that in a confrontation between the USA and the USSR, Japan would retreat into isolationism and refuse to involve itself. Military and political strength cuts both ways. Memories of World War II haunt nearby countries that see little good in a strong Japan.

Japan faces other problems as well. For example, it confronts a lack of long-term-care facilities for older people, who are making up more and more of the population. And although it's not frequently reported, Japan also must cope with growing unemployment and the loss of heavy-industry jobs.

Korea, too, has problems. The Koreans spend heavily on defense, primarily to guard against attack from North Korea. Keep in mind that a state of war still exists between the two countries. South Korea's defense has worked for over 35 years, but much of it depends on a continuing US military presence. Future US Congresses may be reluctant to continue aiding a nation that adopts rigid protectionist trade policies. Korea must also deal with internal unrest brought about by radicals and moderates who want to overthrow or change the government.

And consider Taiwan, the Republic of China (ROC), which still lays claim to mainland China. The republic has no chance of retaking the mainland, but authorities consider any realistic talk about a separate and independent Taiwan to be seditious. The archaic Koumintang government still contains members—elected in 1947—who "represent" mainland provinces. Although both mainland China and the republic desire reunification, each has its own irreconcilable terms. The ROC also has internal problems. Only about 15% of Taiwan's population is from mainland China, yet those people dominate the country's government. The native Taiwanese want a greater say in their own affairs, but don't expect to see great upheavals in Taiwan unless mainland China presses for reunification at all costs.

The future of Hong Kong, which will revert to mainland China—the People's Republic of China (PRC)—in 1997, remains in doubt. Companies must wonder about their local investments in Hong Kong and how those investments will fare under PRC masters. The

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CIRCLE NO 122

EDITORIAL

Evaluating the strength of Pacific-rim countries involves more than economics. Social and political structures require a close look, too.

British refuse to discuss adopting direct representative elections—a measure that might forestall the complete PRC domination of Hong Kong's laissez-faire economy. It's unlikely that the new Chinese leaders will destroy Hong Kong's economy, but they offer only vague promises of future economic and political flexibility. So, money and people from Hong Kong are already departing for Canada and the US. Labor is still plentiful and somewhat cheap in Hong Kong, but even more laborers are available at lower rates in mainland China. Once China and Hong Kong are unified, the latter may offer few new business advantages.

The fate of the Philippines also remains unknown. Corazon Aquino's "revolution" has just about run its course. Political assassinations, kidnappings, and rebel activities once again overshadow attempts at government reform. Peace talks between the government and communist and Muslim rebels have broken down, and a renewed commitment to US military facilities is in doubt.

Malaysia and Singapore—important manufacturing locations—form the southern end of the Pacific's economic rim. In Malaysia, the prime minister detains people and suspends the publication of newspapers for "disturbing the racial peace." Ethnic Chinese and Indians—among the most important economic segments of the population—remain restive. In Singapore, prime minister Lee Kuan Yew has prevented the distribution of several publications that refuse to bow to his censorship. Companies with significant investments in microcode should note that Lee recently suspended copyright protection for several publications. It could happen for bit patterns, too.

All nations and governments have their share of problems, and the events and situations noted above don't portend the demise of the Pacific-rim nations. But companies that rely upon Pacific-rim countries either as suppliers or for markets must consider the long-term stability of the region. After all, Iran was once a tower of strength and our foremost ally in the Persian Gulf. How quickly events sweep away preconceived notions of stability.

Jon Titus

Jon Titus
Editor

Instant Grat

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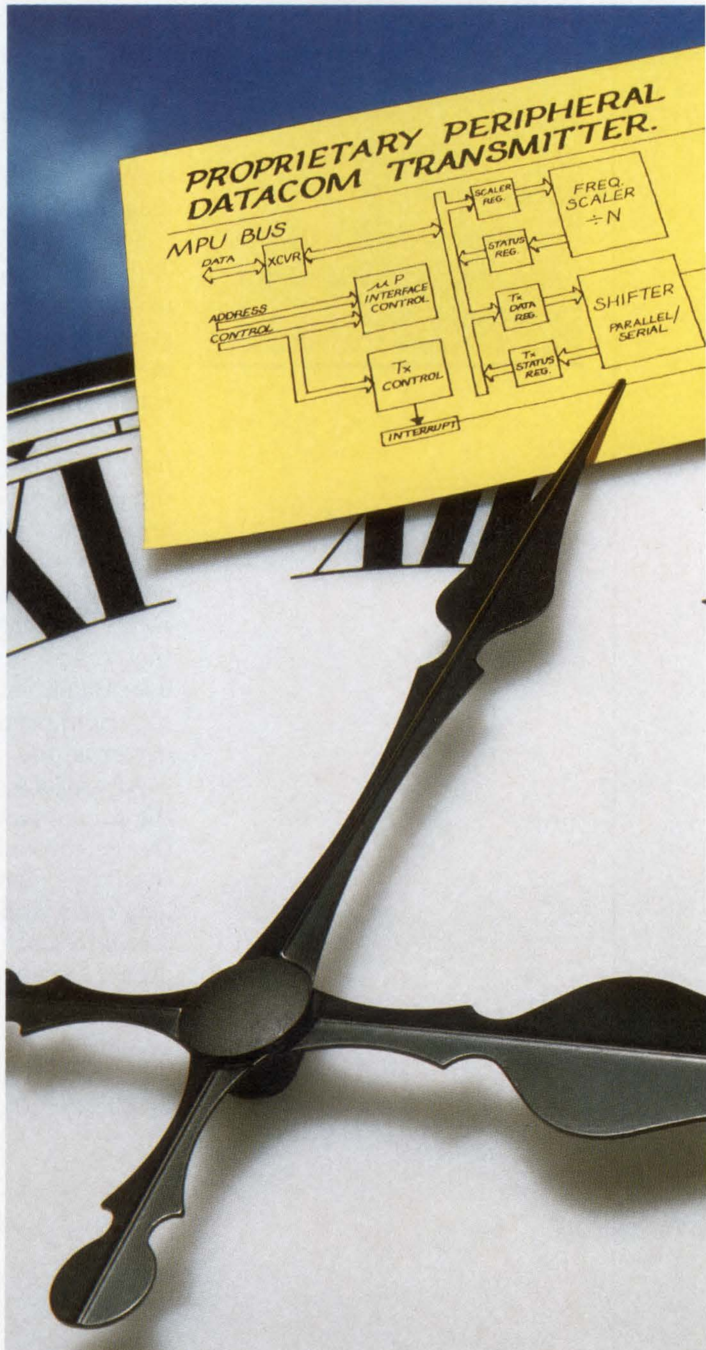

ification.

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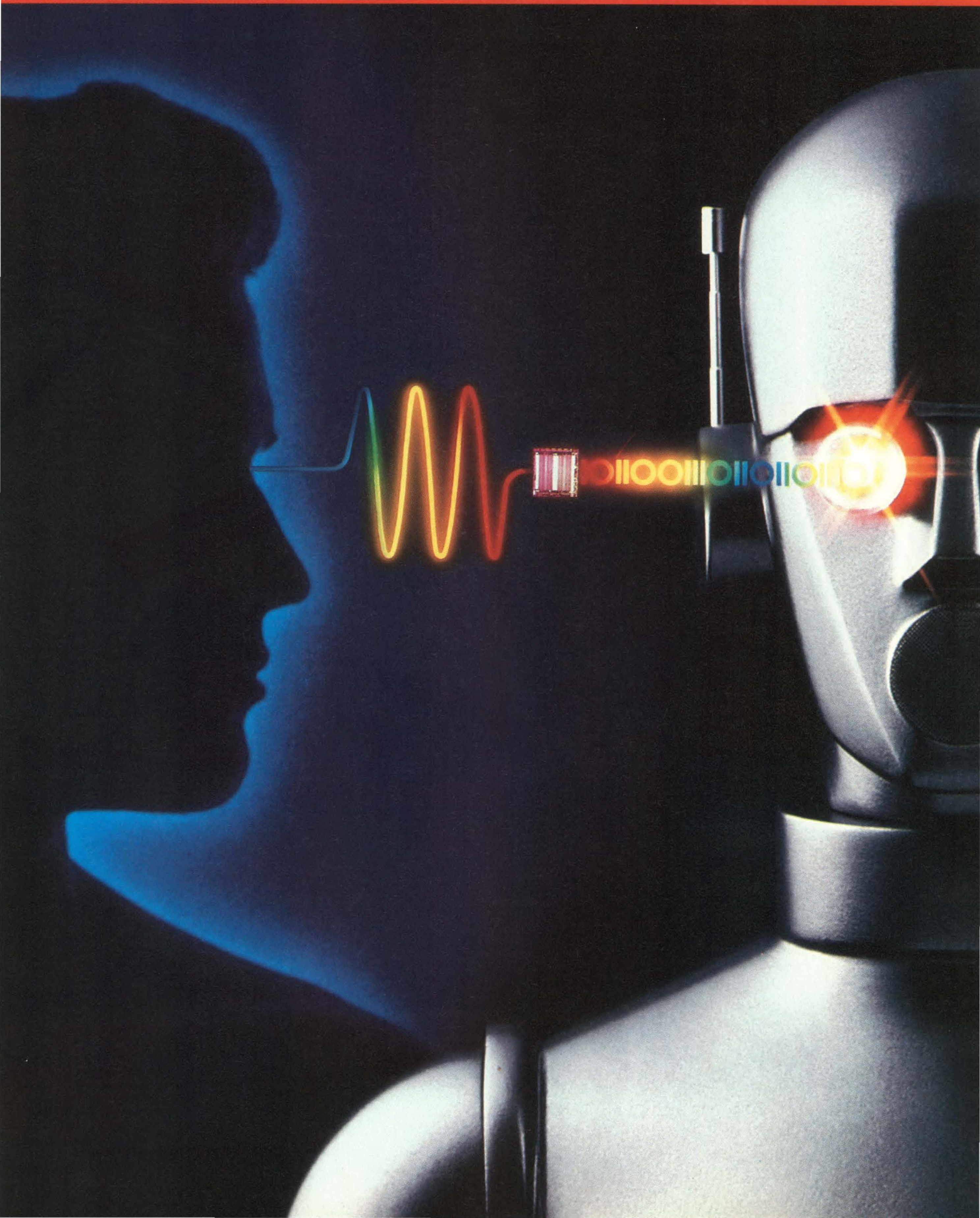
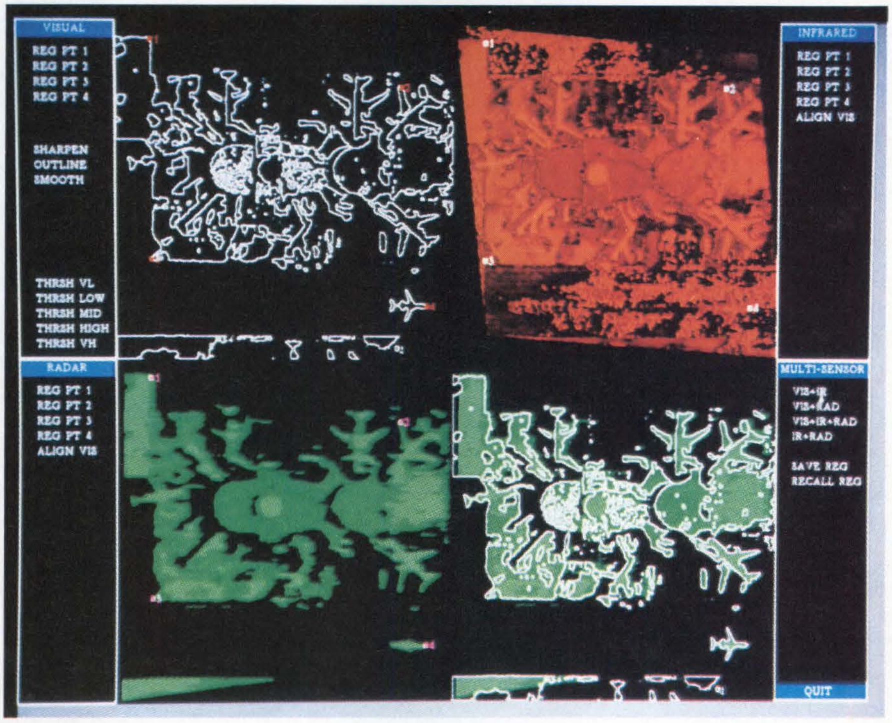


Sophisticated hardware and software beget efficient machine-vision systems

J D Mosley, *Regional Editor*



In darkness or over long distances, machines can "see" better than humans *by combining a variety of sensor data obtained from a single scene. Visual Information Technologies' Model 120 uses four Parallel Image Processors (Pips) to perform parallel operations on multispectral data. The operations shown are visual with edge enhancement (top left), infrared (top right), radar (bottom left), and all three operations fused by the windowing and overlay operations (bottom right). (Visual data courtesy Hughes Aircraft)*

Because of recent developments in machine-vision technology, you no longer need a lot of specialized knowledge to develop vision systems that let machines search for and differentiate among patterns. You can now choose from an assortment of systems, subsystems, boards, and software packages that let machines efficiently perform such real-world tasks as examining ICs for defects or scanning products on conveyor belts.

Your choice of machine-vision equipment depends on your application and the amount of money you have to spend: The available products range from expensive, standalone vision systems that you can integrate in production equipment, to moderately priced boards for workstations or personal computers, to sophisticated software algorithms that let you create customized vision systems with standard hardware.

Using radar, infrared, and image-enhancement techniques, state-of-the-art machine-vision systems can literally see in the dark or identify microscopic imperfections in a surface. By using sophisticated pattern-recognition algorithms based on artificial-intelligence (AI) paradigms, the systems can identify and analyze images in such applications as government surveillance, semiconductor inspection, film colorization, and robot guidance.

Recognition Technology, a Westborough, MA, image-processing company, describes machine vision as a cycle that begins with image acquisition, proceeds to image storage, then continues with image enhancement, feature extraction, data reduction, recognition and decision making, and further data reduction. The cycle then repeats. Current machine-vision systems can perform the steps of this cycle fairly well, but they can't always perform them in real time. For example, in 1984, a robot called Neptune used a vision system to negotiate an obstacle-strewn 35-ft room at Carnegie Mellon University—but it took more than an hour to do so.

Consider the challenge of processing and analyzing the visual information contained in a 2-dimensional television picture, in which more than one million pixels change thirty times a second. Adding the third dimension further complicates the analysis. In computer terms—according to Cognex Corp, a manufacturer of machine-vision systems—the human brain performs approximately 100 billion logical floating-point operations per second (flops) just to see objects and determine what they are. That performance is 400 times that of a Cray-1 supercomputer.

AI simplifies the task

Although you can't yet provide a machine with vision equivalent to human sight, you can focus the present technology to perform useful operations by limiting the scope of each specific vision task. For example, Cognex Corp uses artificial-intelligence (AI) techniques to modify a vision procedure that the company

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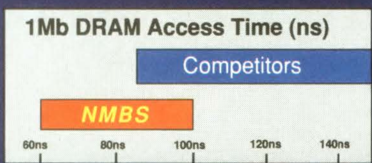

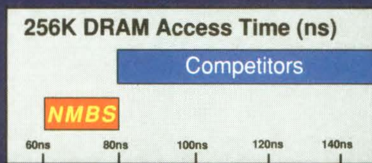

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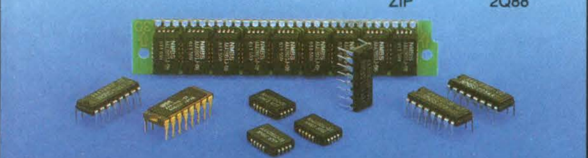

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CIRCLE NO 123

refers to as "searching." Instead of resorting to intensive calculations to compare a stored image with a sample image—a process called "template matching"—Cognex scans the sample image at low resolution and uses AI-based algorithms to make intelligent guesses about where objects should be within the image. This searching technique can give a single pc board an equivalent throughput rate that's 30 times faster than that of a Cray-1 performing traditional template-matching calculations at its maximum speed, 1000 MIPS.

The company's latest product, the Cognex 1500, is a $10,000 subsystem that can analyze the input from as many as four video cameras to locate objects and determine their positions. The 1500 was specifically designed to address the needs of OEMs and system integrators that design automated equipment for pc-board production, machine guidance, and alignment. The Cognex 1500 includes a rack-mountable chassis, a solid-state video camera, a monochrome video monitor, a trackball, cables, software, and documentation. You must supply an IBM PC to control the system via an RS-232C connection. The software's pull-down menus let you access the 1500's set of 25 instructions. You use the trackball to manipulate the cursor and to select commands, objects, and search regions.

The 1500 uses gray-scale pattern matching to locate objects and features in a scene. This method is more flexible and consistent than binary pattern-matching techniques, and it provides accuracy of better than ±0.001 in. It helps the 1500 achieve processing times ranging from 0.050 to 0.500 sec, depending on the desired accuracy, object size, and scene complexity. In addition, the embedded image-analysis algorithms let the 1500 identify the correct pattern even when the image is degraded, or when changes in color, reflectance, orientation, or contrast occur. Even a poorly focused lens will not prevent the system from correctly identifying a pattern; however, the company does note a reduction in image quality on a 1000-part scale.

Able to overcome such real-world problems as a defocused lens *or reduced contrast caused by poor lighting, a $10,000 (OEM) Cognex 1500 starter kit includes an electronics module, a video camera, a lens kit, a monitor, a trackball, cables, and documentation. You supply the PC host, which communicates with the 1500's electronics module via an RS-232C link.*

The correlation values produced by the gray-level pattern-recognition technique are statistically normalized for image gain and offset. Thus, the technique is insensitive to variations in light intensity and contrast even within a single image. Placing a colored filter over a portion of the object won't prevent the Cognex device from identifying the object.

The 1500 identifies the x and y coordinates of the pattern, and it comes with calibration software that translates the visual data on the screen into the corresponding real-world units of measure. It can thus permit a robot to reposition misaligned objects. The 1500's vision-processor board includes a 12-MHz MC68000 µP, an image digitizer with a resolution of 576×448 pixels and with 64 gray levels, as much as 2M bytes of dynamic RAM, a 512k-byte ROM, 128k bytes of battery-backed CMOS RAM, and a proprietary vision coprocessor that implements pattern matching in hardware. This proprietary vision IC is a custom circuit that interprets images through gray-scale normalized correlation; it interfaces to any 68000-family CPU. The 1.5-µm CMOS chip can perform normalized correlation three times faster than a board-level circuit, yet costs one-tenth as much.

For designers who want more extensive vision capabilities, the company also offers the Cognex 2000/DS vision-development system, which lets you write custom application programs in C on your IBM PC or compatible computer. As soon as you have debugged an application program, you can download it to a floppy disk or burn it into EPROMs to transfer full control to the 2000/DS. You need the PC only for editing, program development, and downloading.

The 2000/DS performs the same functions as the 1500, but adds image processing to manipulate its output, as well as development access to C function calls and programming utilities. The 19-in., fan-cooled, rack-mountable chassis contains a single-board vision processor (the chassis has slots for as many as four vision-processor boards), a card-cage/backplane assembly, a power supply, an 800k-byte floppy-disk drive, three RS-232C ports, six TTL digital-input ports, four TTL digital-output ports, and a 64-byte I/O expansion port. The 2000/DS also comes with a 12-in. monitor, a trackball, cables, a solid-state camera, system software and utilities, searching software, character-recognition software, inspection software, a communications program, and a text editor.

Adaptive automation meets Mac

Another challenge that developers of machine-vision systems face is that of allowing systems to adapt to changes in their environment. To enable machines to react to changes in industrial surroundings and to adjust to variations in parts, manufacturing processes, object location, and equipment speed, Automatix Inc combines standard sensors and controllers with application-specific software to create a variety of "adaptive automation" systems.

Automatix, which has already installed more than 1000 of these systems, offers a broad line of machine-vision products. Microspec, for example, is a $100,000 SMD-inspection system that examines pc boards for missing, misplaced, or incorrectly oriented components. Partracker is a software package that locates parts and solves fixturing and fit-up problems prior to robot manipulation; Seam Tracker is a vision-guided welding system. The firm also offers AI 90, an $8500 ruggedized Macintosh II-compatible computer for industrial applications, and Autovision 3, a $17,500 menu-driven vision and robot-guidance system. Every customer that purchases an Automatix product receives membership in Acuity, an international user group for industrial vision systems.

Central to the Automatix concept of adaptive automation is the Rail programming language. This proprietary interpretive language is written in C and is designed for vision processing, high-speed calculations, and robotic control. It includes algorithms for edge detection, gray-scale gradient detection, convolution filtering, structured light analysis, and connectivity analysis. With this language, your system can control as many as 16 cameras. The interpreter includes diagnostic software. Rail comes with all Autovision systems; you can order the source code under a special licensing agreement.

For $23,000, you can also order

Neural networks help a system learn to see

Machine-vision systems represent an attempt to give machines an analog to human vision that robots and other types of computer systems can use. To improve the way machines understand and use this sensory data, engineers are using an artificial-intelligence technology called neural networks.

Neural networks are intended to emulate human learning patterns; they contain loosely coupled processing elements, or nodes, that compute activity locally and share those computations with other nodes according to a weighted transfer function. Their goal is to mimic the way human brain cells exchange information and to mimic the way the brain weights the information transfer among brain cells.

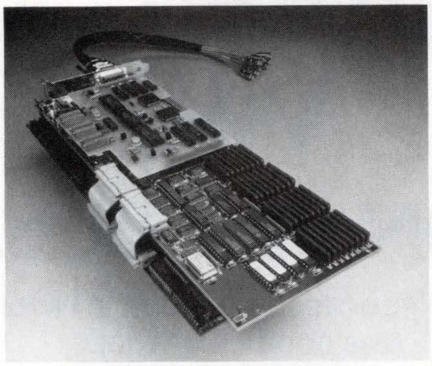
Nestor Inc, which was founded in 1975, is reportedly the oldest of the neural-network companies. The company has adapted this parallel-processing-oriented technology for use with serial-processing von Neumann hardware—specifically with IBM PC/ATs, Sun workstations, and Apollo workstations. The $25,000 Nestor Development System (NDS) uses neural-network technology to solve a wide variety of pattern-recognition problems. To use the system, you need a PC/AT or Sun or Apollo workstation with at least a 1.2M-byte floppy-disk drive, 640k bytes of RAM, and a 20M-byte hard-disk drive. If you use a PC/AT, you must have an EGA- or VGA-compatible interface and monitor, MS-DOS 3.0 or higher, a Microsoft C compiler (version 4.0 or higher), and a Microsoft mouse. You must use C for software development —all of the NDS code is written in C, although portions of the training program and the code described in the tutorial are supplied by the manufacturer as source code.

The resulting system generates a Restricted Coulomb Energy (RCE) neural network. The network develops weighted pattern maps, solving categorization problems by assigning probability estimates of complex relationships to the relevant variables. The RCE network is a patented model that uses three processing layers. The input layer has nodes that register the value of a feature of the input. The output layer has nodes that correspond to a pattern category; the fewer the output nodes triggered by a certain input, the less ambiguous the input and the greater the certainty about a pattern's identity. The internal layer of nodes constructs the mapping that will trigger the correct output node in response to a given input pattern. The network "learns" by adjusting internal-node thresholds with training signals that move from the output layer back into the internal layer.

In an RCE network, memory is stored in weight vectors between the input layer and the internal layer. Training affects only areas of the memory associated with local vectors, therefore. Accordingly, Nestor's RCE network lets you add new information without retraining the entire system; you address only the nodes associated with a particular vector threshold.

To use the Nestor Development System, you must write a feature-extractor program. The company provides examples of feature extractors in C source code. You then train the system by presenting it with a series of classified patterns; the system batch processes the patterns and uses them to define the system architecture and to store the training/testing protocol.

the Automatix Lab Development Package, which is based on the Autovision 3 and includes a CCD camera, cables, lenses, Rail, two floppy-disk drives, a 12-in. CRT, a keyboard, and manuals. The package comes with an assortment of software, including a menu-driven visual gauging system, a program that increases the speed of selected connectivity calculations, a program that identifies parts by their silhouettes, a program that uses convolution operations to locate and analyze edges and lines, a program that calculates and compares gray-scale averages and histograms, and a program that performs arithmetic and logical operations on the contents of pixel buffers.



***Plug-in boards for PC-based image processing** such as Data Translation's DT2871 color frame-grabber board) let you perform gray-scale processing, hue and saturation processing, and frequency-domain analysis at capture and display rates reaching 30 frames/sec. The DT2871 plugs into the DT7020 floating-point array processor to boost system performance during computation-intensive operations such as color edge detection, compression, and FFT analysis.*

Image processing gets smart

If you don't want to spend the money for a programmable vision system, you might be able to get away with using an image-processing system instead. Image processing is only a subset of the complex task of machine vision, but vendors have recently introduced some more-advanced image-processing systems that may be able to take the place of full-fledged vision systems in certain applications. For example, Visual Information Technologies Inc (Vitec) offers "image computers," systems that do more than mere image processing. According to the company's definition, image computing comprises computer graphics, image processing, and image analysis.

An example of a type of image computing is multisensor fusion. By combining, or "fusing," data from different sensors, a system can provide information that's more useful to you than the separate output from individual sensors. For example, Vitec's image computers can perform multisensor fusion by using Parallel Image Processor (Pip) chips to perform parallel operations on multispectral data gathered from the same scene by different sensors. The Pips are custom VLSI array processors that are specifically equipped to handle computation-intensive tasks such as convolution filtering, scaling, rotating, zooming, blending, and pixel replication.

To perform multisensor fusion on data gathered from an aircraft, for instance, you could have one Pip perform image-enhancement and edge-detection operations on visual data from a video camera while another Pip processes infrared data. At the same time, a third Pip could process radar data, and a fourth could perform windowing and overlay operations on the three types of data. By combining the visual, infrared, and radar data and fusing the result, you can greatly enhance your ability to interpret the data.

Vitec offers two image-computing systems, Model 100 and Model 120, which start at $30,000. Model 100 has four Pips that can execute 122 MIPS; four 27-MHz video processors; 6M bytes of image memory; and a 13-in., 640×480-pixel RGB monitor. The Model 120 comes with four Pips that can execute 160 MIPS; four 107-MHz video processors; 10M bytes of image memory; and a 19-in., 1280×1024-pixel RGB monitor. Each model also comes with a 16.67-MHz 68020 CPU; a 68881 floating-point coprocessor; a 32-bit VME Bus; a 140M-byte, hard-disk drive; a 60M-byte, ¼-in. tape drive; a 94-key keyboard; and a 3-button optical mouse.

The systems also come with several software packages: Vitec's Image Display List System (IDLS) for application development; an interactive IDLS script interpreter; an IDLS script-to-C translator (preprocessor); a version of the X-Windows program (developed at MIT) that has enhanced imaging features; the company's Imaging Window and Menu Tools (IDLX); a primitive module for image and graphics algorithms; and Unix, which is integrated with the Network File System (NFS).

Machines that have x-ray scanning abilities can outperform human inspectors on assembly lines, because the machines can evaluate products without destroying them. Advanced Research and Applications Corp (Aracor) manufactures industrial test and inspection instruments based on a technique called computed tomography (CT). This technique passes a collimated x-ray beam through a test object to render a cross-sectional image of that object. A CT image displays more than 1000 times more information than conventional x-ray film processes do.

Aracor has transferred this technology to the Model 4100 automatic semiconductor-irradiation system, which tests the radiation tolerance and latch-up immunity of electronic devices and ICs at the wafer stage of production. The system is available in three configurations: The $163,000 Model 4100 XP measures only radiation hardness; the $259,000 Model 4100 PL provides independent testing for latch-up and radiation hardness; and the $310,000 Model 4100 XPL integrates and automates the radiation and latch-up tests.

Another way to build a machine-vision system is to buy image-processing software for use on one of the major workstations and hook up

your own video camera for gathering data. Logica Inc's Vista-IPS tool kit, for example, is a hardware-independent software-development environment for image-processing algorithms. It has a multiuser environment and two separate user interfaces—one is a high-level interface that offers commands that resemble Basic; the other is a low-level programming environment that lets you use Vista-IPS utilities to develop image-processing primitives in your host computer's high-order program-development language.

Vista-IPS provides access to more than 200 primitives supplied in Fortran source code. You can nest as many as nine levels of test procedures for flexibility at the experimentation and design phases of the development process. The software package also assists you in converting the hardware-independent algorithms you've generated for use with the target hardware. Vista-IPS uses foreground/background processing to speed the development cycle, and it supports both interactive and batch processing. Its Autoload command provides automatic loading of procedures and primitives, and its windowing facility enables you to process smaller portions of an image or "subimages."

Vista-IPS is available for DEC VAX and MicroVAX computers running VMS or MicroVMS and for Masscomp 5000 Series computers running the RTU operating system. You must also use a Fortran compiler with Vista-IPS. Prices range from $6000 for a single-user license to $20,000 per copy for multiuser systems.

Menu-driven library

Recognition Technology offers a menu-driven library of routines written in (and callable from) the C language. The library lets your IBM PC, Multibus, or VME Bus host control the company's line of image-processing boards and subsystems. The $1795 library, RTILib/500, contains more than 300 routines that are specifically developed for machine-vision and image-processing applications. For dedicated applications, you can bypass the menu-driven executive.

The library is structured in three layers. You use the interactive, menu-driven executive layer to execute most of the RTILib/500 subroutines. The layer of high-level, C-callable subroutines performs such functions as image transforms and utilities, spatial and temporal filtering, region growing, arithmetic and statistical operation, and graphics processing. The third layer is a layer of low-level primitives and macros that provides access to the control and status registers and data tables of the various image-processing hardware modules.

RTIExec includes the Fundamental Vision Tools Menu, which has 16 screens, each offering seven to 17 additional selections. A help menu and a menu of utilities are accessible from all the other menus in RXIExec. Because most of the menu-driven commands have a one-to-one correspondence with RTILib's C-callable routines, you can quickly translate a string of menu calls into a dedicated program.

The company's latest subsystem that uses the RTILib/500 software package is the RTI-Station, a stand-alone box that connects to your IBM PC, Sun or Masscomp workstation, Multibus host, or VME Bus computer. For real-time performance, the unit includes a 10-MHz pipeline pixel processor that passes 18 bits of data bidirectionally on each clock cycle. To avoid overloading the host computer's bus, the RTI-Station contains multiple synchronous video buses for high-speed image transfers. You can store as many as 20 images on line in the RTI-Station's digital-image-storage boards. The unit digitizes each pixel of data as 8 bits of gray-scale information; thus, it provides 256 gray levels at an active-area resolution of 512×512

For more information . . .

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

Advanced Research and Applications Corp (Aracor)
425 Lakeside Dr
Sunnyvale, CA 94086
(408) 733-7780
Circle No 710

Automatix Inc
1000 Tech Park Dr
Billerica, MA 01821
(617) 667-7900
TLX 951518
Circle No 711

Cognex Corp
150 Gould St
Needham, MA 02194
(617) 449-6480
TLX 948022
Circle No 712

Data Translation Inc
100 Locke Dr
Marlboro, MA 01752
(617) 481-3700
Circle No 713

Datacube Inc
4 Dearborn Rd
Peabody, MA 01960
(617) 535-6644
TWX 710-347-0125
Circle No 714

Digital Vision Inc
66 Eastern Ave
Dedham, MA 02026
(617) 329-5400
Circle No 715

Imaging Technology Inc
600 W Cummings Park
Woburn, MA 01801
(617) 938-8444
Circle No 716

Logica Inc
3 Embarcadero Center
Suite 1720
San Francisco, CA 94111
(415) 397-0496
Circle No 717

Nestor Inc
One Richmond Square
Providence, RI 02906
(401) 331-9640
TLX 272848
Circle No 718

Recognition Technology
160 E Main St
Westborough, MA 01581
(617) 366-4800
Circle No 719

Visual Information Technologies Inc (Vitec)
3460 Lotus Dr
Plano, TX 75075
(214) 596-5600
Circle No 720

pixels. Prices for the RTI-Station start around $10,000.

Faster-than-real-time imaging

Offering an 8-bit image-processing speed faster than 1⁄30 sec on a PC/AT-type computer, the Series 151 subsystem from Imaging Technology connects to your IBM PC/AT or VME Bus computer via a proprietary interface that lets the PC/AT control the subsystem's operation. This $11,495 package gives you RS-170, RS-330, and CCIR 8-bit video acquisition. Its onboard, dual-ported frame memory can store multiple images. The 151's pipeline processing and expandable architecture enhance the subsystem's performance. Its I/O look-up tables and read/write registers facilitate such image-manipulation features as RGB pseudocolor output, graphic overlays, real-time convolutions, and real-time histograms.

The subsystem uses separate boards for its A/D interface (ADI-151), frame buffer (FB-151), pipeline processor (ALU-151), real-time convolver (RTC-151), and histogram/feature extractor (HF-151). The subsystem also uses separate buses for video data from the A- and B-frame stores, for graphic overlays, for video pipeline data, and for the video data input.

The A/D interface includes an 8-bit digitizer, programmable gain and level, and a 24-bit color display. To increase the on-line storage capability, you can plug as many as four of the frame buffers into the subsystem; each buffer contains one 16-bit frame store and two 8-bit frame stores. Automatic spin compensation adjusts for pipeline-processing delays. The pipeline processor performs three types of real-time image processing: arithmetic, logical, and bit-plane oriented. The histogram/feature extractor offers 10-bit histograms and performs feature extraction of as many as 16 features simultaneously.

The Series 151 subsystem comes with a driver-level software package called Toolbox that helps you integrate the subsystem with your host computer. You can order Itex, an optional subroutine library of image-processing functions, which includes programs for look-up-table operations, image save and restore, graphics functions, area and image geometry, image analysis and point processing, and linear/nonlinear operation. The company's line of image-processing products ranges from the $1995 PCVision+ frame grabber (for IBM PCs and compatibles) to the $28,995 Series 200 image-processing subsystem for (MicroVAX II hosts).

PC/AT-based vision systems

Another alternative to buying a costly, dedicated machine-vision system might be to develop a vision system for your IBM PC/AT gradually. For example, you could choose from the plethora of plug-in image-processing, array-processing, and data-acquisition boards that Data Translation offers, and mix and match the boards to design a custom system. The company's latest image-processing board is the $2995 DT2871, a color frame grabber with a Hue-Saturation-Intensity (HSI) chip set, which converts the red-green-blue (RGB) images from a color video camera to hue, saturation, and intensity values in 1⁄30 sec. The DT2871 captures images in 512×512-pixel resolution; each pixel represents one of 16,777,216 colors.

The benefit of converting RGB images to HSI values is that each H, S, and I value can be processed independently of the other two values. You can therefore perform operations on the visual data that you can't perform on mere RGB images. For example, to learn about the frequency and distribution of the image's colors, you can generate a histogram from just the hue values. To enhance edges or remove white noise from a color image, you can perform a convolution on just the intensity values.

Because manipulating the hue, saturation, or intensity of an image is simpler and faster than manipulating RGB information, the DT2871 color frame grabber lets a PC/AT perform color conversion in real time. The DT2871 can also convert HSI data back to an RGB image after processing.

The company offers the Aurora Subroutine Library for the DT2871; the library costs $995 and provides Pascal, C, and Fortran subroutines that permit color-image capture, processing, and display. It also lets you perform graphics operations, and it supports the functions of the $995 DT2869 video decoder/encoder, which the vendor offers as an accessory for the DT2871. The decoder/encoder reformats standard NTSC or PAL video signals from composite-video cameras and VCRs into RGB signals, and vice versa; its high analog precision preserves the digital integrity of the frame grabber's input and output.

VME Bus provides standard

Datacube, maker of the MaxVideo line of image-processing boards, notes that its products adhere to the VME Bus double Eurocard form factor, ensuring electrical and mechanical compatibility with other vendors' boards. The MaxVideo family includes the DigiMax video-signal A/D and D/A converter, which accepts input from as many as eight cameras. The vendor's FrameStore board provides three 512×512-pixel×8-bit stores that you can configure as a single 16- or 24-bit-deep frame-storage device. The Snap board performs real-time, nonlinear systolic-neighborhood processing at 180 million 8-bit comparisons/sec. The Max-SP signal processor lets you merge multiple images, perform barrel shifting, and multiply. The VFIR linear pixel processor can perform 100 million 20-bit precision multiply-accumulation operations/sec.

For $1000, you can buy MaxWare version 2.0, a software support package that provides primitive and

CμBIT FOR 6502 ON STD BUS.

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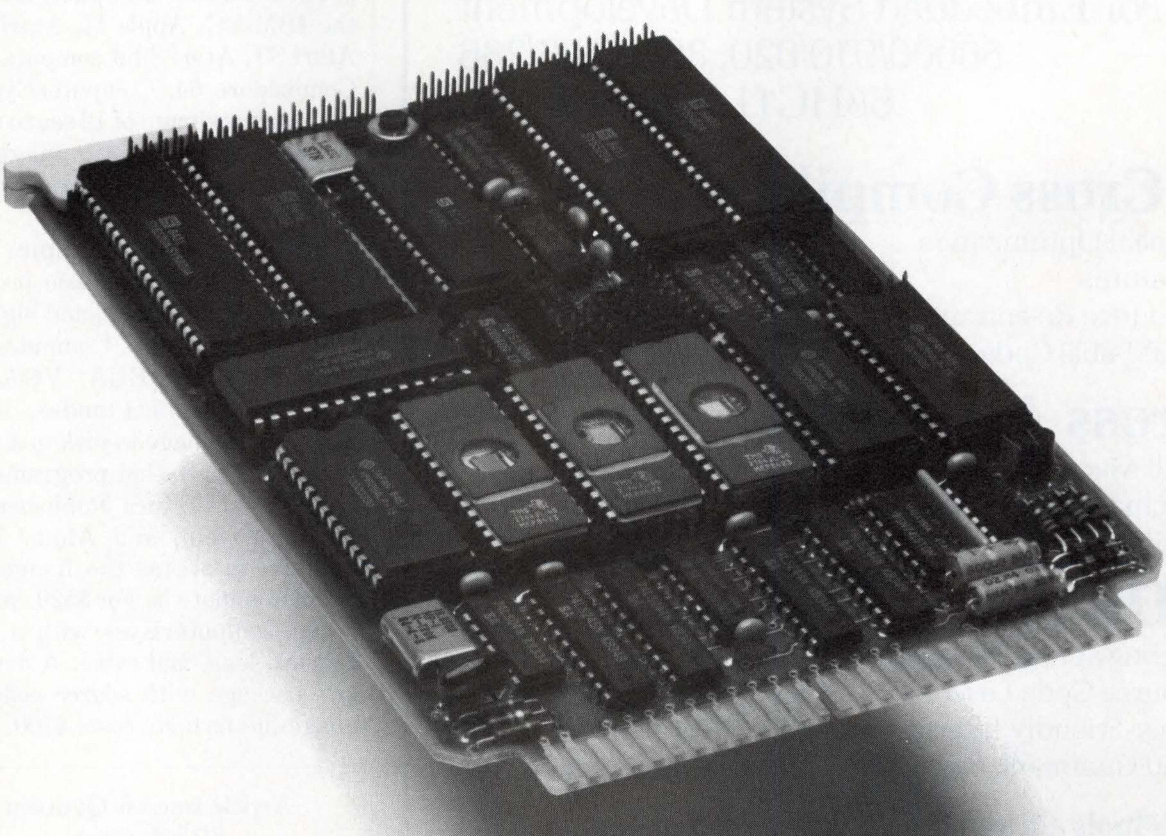

CμBIT DIVISION OF PROTEUS INDUSTRIES

190 S. Whisman Road
Mountain View, CA 94041-1577
Telephone: (415) 962-8237

diagnostic support for the aforementioned boards, as well as a number of other boards, including the ROIStore region-of-interest frame store, the MaxScan asynchronous digitizer module, the MaxMux digital crosspoint switch, and the MaxGraph graphics-overlay board.

Low-cost imaging available

As high-end products gain more sophistication and features, the technology trickles down to low-end systems, improving the capabilities of the inexpensive imaging packages available for such computers as the Atari ST and the Commodore 64. For example, Digital Vision Inc offers a $250 slow-scan image-capture program called ComputerEyes for the IBM PC, Apple II, Atari IIgs, Atari ST, Atari 8-bit computer, and Commodore 64. ComputerEyes requires a maximum of 12 sec to scan a single monochromatic image at a resolution of 640×200 pixels with 64 gray levels.

Besides offering simple digitizing, ComputerEyes also provides gray-scale, false color, and high contrast for the image. ComputerEyes supports CGA, EGA, VGA, and Hercules graphics modes. It lets you save an image to disk in a variety of formats so that programs such as Xerox's Ventura Publisher, Microsoft's Gem, and Aldus' PageMaker can access the image data and manipulate it. For $520, you can order ComputerEyes with a video camera, lens, and cable. A developer's package with source code and image-file formats costs $100. EDN

Article Interest Quotient
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High 518 Medium 519 Low 520

MULTIBUS II TAKES YOU BACK TO THE BASICS

. . . AND INTO THE FUT

MULTIBUS II OPENS UP ADVANCED APPLICATIONS IN WAYS NO OTHER BUS CAN.

When the architects of Multibus II set out to create an advanced bus, they set their sights far beyond just another souped-up traditional bus.

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A bus capable of supporting vast new levels of microcomputer performance. To make possible low cost microcomputer systems that outperform minis, and rival mainframes.

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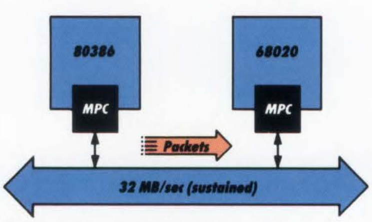

BASIC #2: HARDWARE-ASSISTED MESSAGE PASSING.
This advanced technique gives Multibus II a true sustained bandwidth of 32 megabytes per second. Standardized in a single silicon chip, message passing simplifies sytem design, and makes it possible to mix totally different microprocessor architectures and operating systems in the same application.

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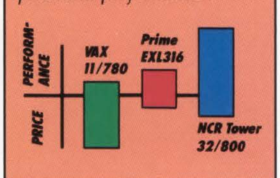
PRICE/PERFORMANCE:
A new generation of microcomputer systems based on Multibus II is now emerging, to redefine standards of price and performance.



It would be the ideal advanced bus—the perfect higher performance alternative to Multibus I, VME and other traditional architectures.

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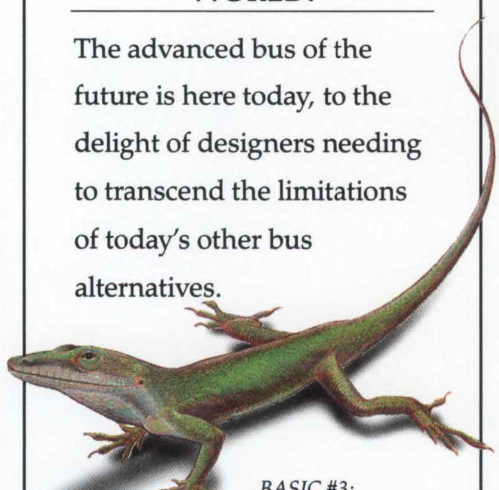
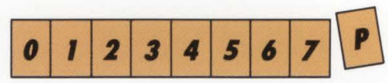
The advanced bus of the future is here today, to the delight of designers needing to transcend the limitations of today's other bus alternatives.



BASIC #3: AUTO CONFIGURATION.
Like a chameleon, Multibus II boards automatically configure themselves when system power is turned on, eliminating DIP switch hassles during configuration and maintenance.



BASIC #1: PARITY.
Multibus II's parity error detection provides the basic protection needed by advanced applications that process large volumes of data at high speeds.

For example, NCR and Prime based their newest Tower™ and EXL™ systems on Multibus II. Both provide several times the power of a VAX™ 11/780 minicomputer,

TRADITIONAL VS. A

	CHARACTERISTICS	TRADITIO
		MULTIBUS I
BASIC FEATURES	TIMING (Synchronous or Asynch)	ASYNCH
	PIN USAGE (MPX) Multiplexed (NON) Non-Multiplexed	NON
	ARBITRATION (CENT)ralized (DIST)ributed	CENT.
	INTERRUPTS (DED)icated (VIR)tual	DED.
	GLOBAL MEMORY Communications	YES
ADVANCED FEATURES	PARITY	NO
	AUTO-CONFIGURATION (Geographic Addresses)	NO
	MESSAGE PASSING (Hardware)	NO
	BUS I/F SILICON	NO
OTHER FEATURES	ADDRESS WIDTH (Bits)	20,24
	DATA WIDTH	8,16
	BOARD AREA (sq. in.)	84
	CONNECTOR TYPE	EDGE
	MAX. 5V POWER (Per slot)	24A

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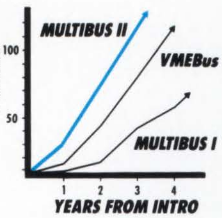

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DVANCED ARCHITECTURES

NAL BUSES	ADVANCED BUSES	
VME	MULTIBUS II	VAX BI
ASYNCH	SYNCH	SYNCH
NON	MPX	MPX
CENT.	DIST.	DIST.
DED.	VIR.	VIR
YES	YES	YES
NO	YES	YES
NO	YES	YES
NO*	YES	YES
AVAIL. '88	YES	YES
24,32	32	32
8, 16, 24, 32	8, 16, 24, 32	8, 16, 24, 32
59.8	80	73.4
DIN	DIN	ZIF
6A	15A	Not Published

aircraft flight simulators.

Throughout the world, these and scores of other companies have introduced

BASIC #4: MULTI-VENDOR COMPATIBILITY.
A host of unique features ensure that Multibus II boards will work together efficiently and dependably. The IEEE 1296 specification is complete and concise. And, the Multibus II Message Passing Coprocessor (MPC), now universally available, ensures compatibility even between boards using different processor architectures and operating system software.

or are now developing Multibus II applications that set new standards of performance, price and reliability.

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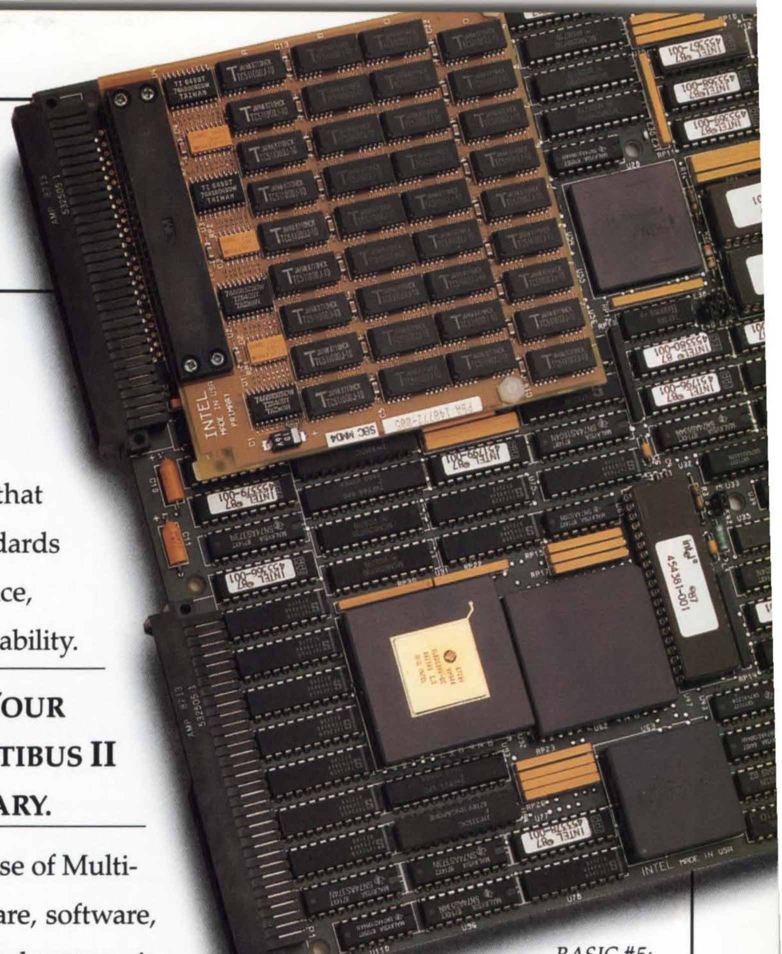

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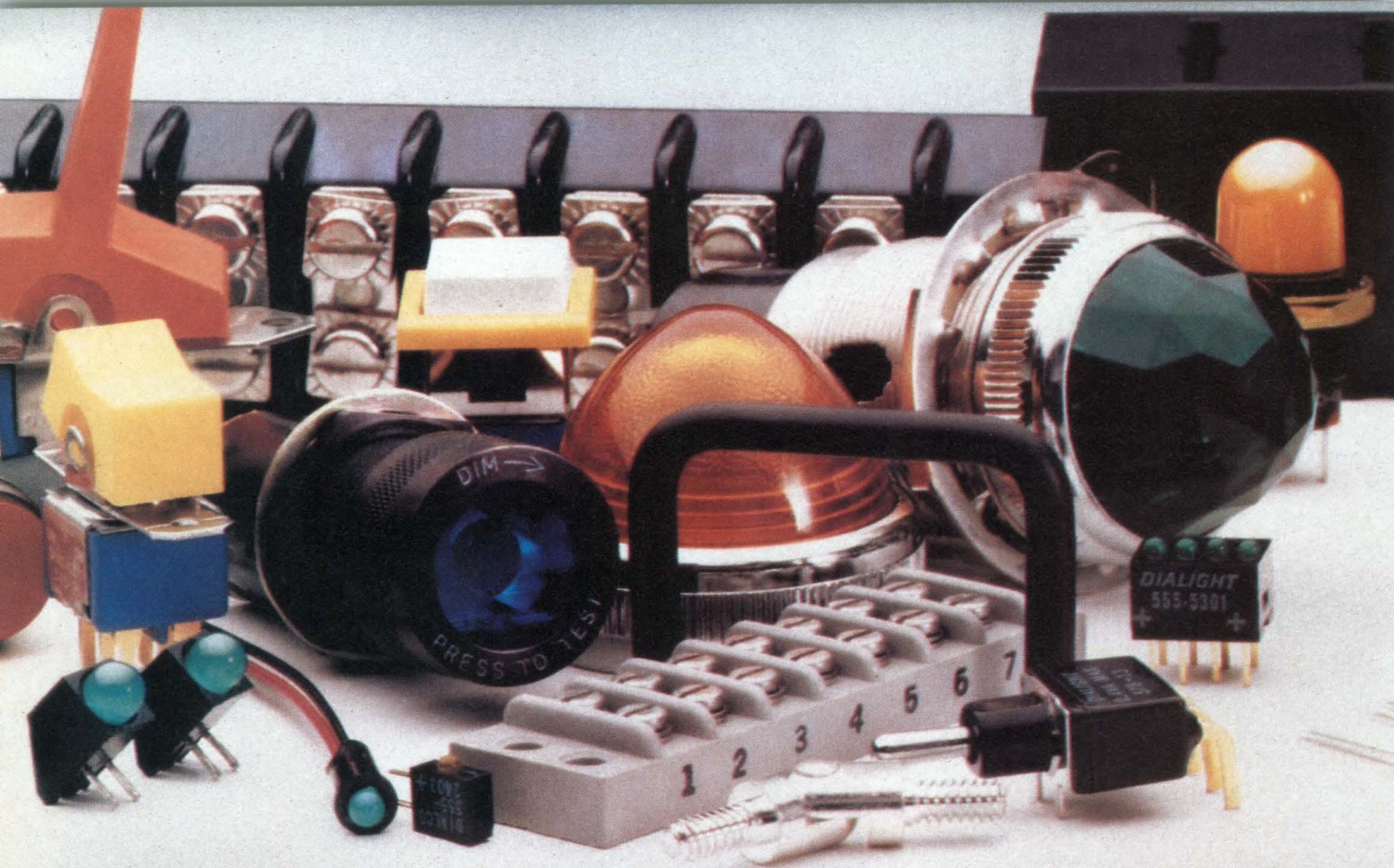
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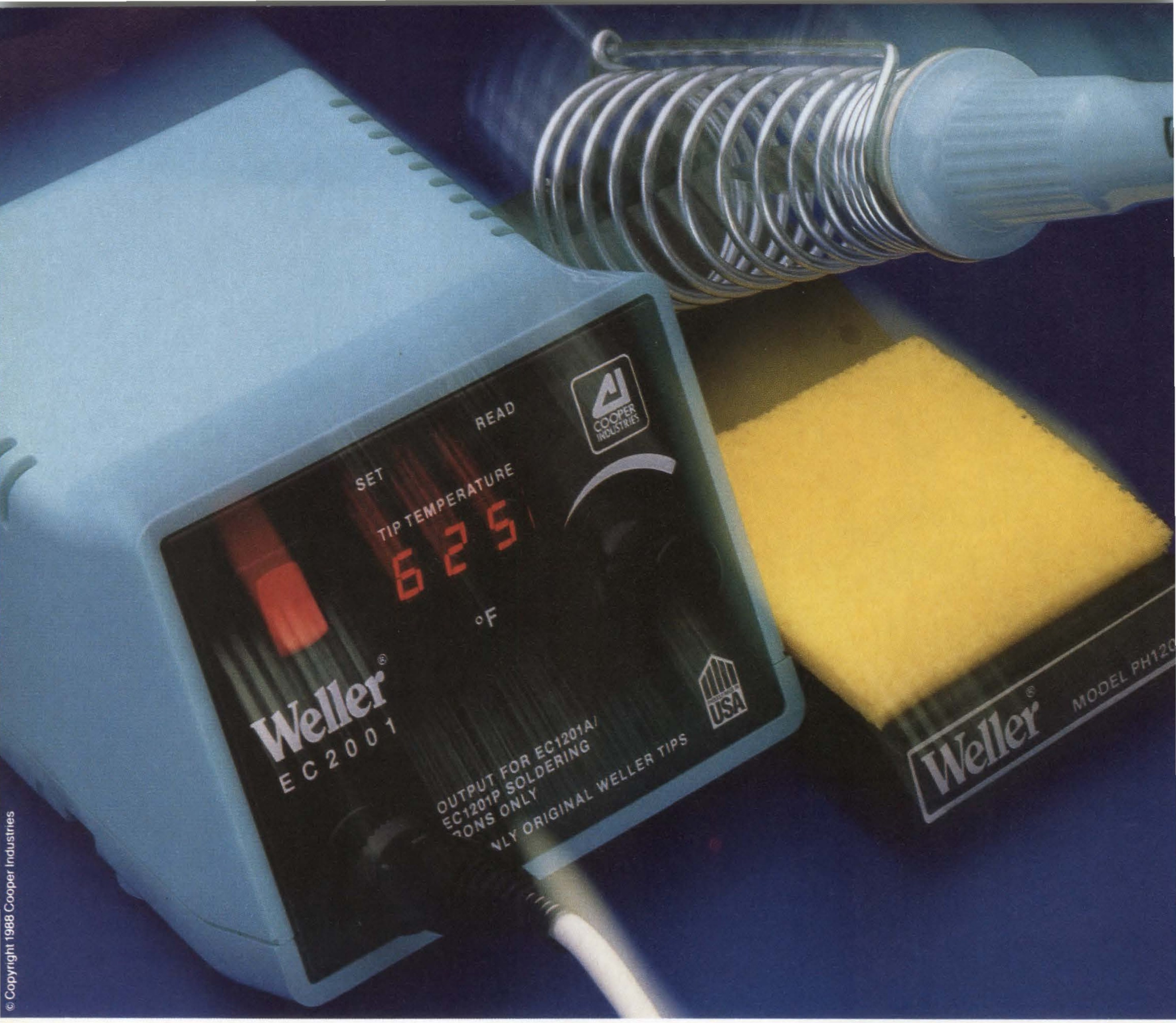
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Advances in speed and voltage ratings enhance applications for optocouplers

Dave Pryce, *Associate Editor*

The widespread use of optocouplers is testimony not only to their long history, but to the great variety of types for sale. Optocouplers are available in several possible output configurations, including LDRs (light-dependent resistors), various transistor types, logic elements, and SCRs and triacs (bidirectional triode thyristors) **(Fig 1)**.

From factory-floor networks to missiles and satellites, the use of optocouplers to provide isolation between different environments continues to increase. You'll find the devices suitable for such diverse applications as motor controls, process controls, power supplies, data transmission, CD players, VCRs, and telecommunications equipment.

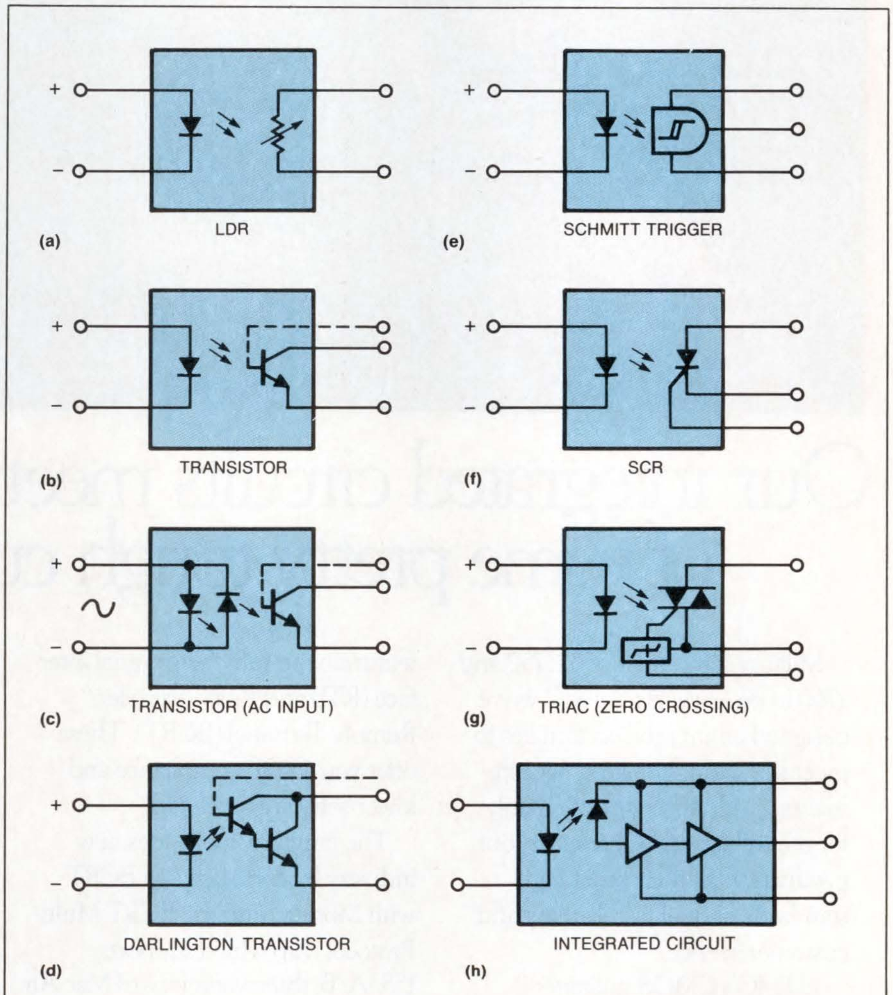

Fig 1—Optocouplers come in a wide variety of types. *The primary differences show up in the output stages, which include, but are not limited to, the types depicted here.*

It all starts with the emitter

Key to the operation of an optocoupler is the emitter (normally an LED), which generates the light energy, and the silicon detector, which is the photosensitive output device. In the case of optocouplers, the light energy from the emitter is usually in the infrared or near-infrared portion of the spectrum. Emitters are fabricated in either GaAs, GaAsP, or GaAlAs, depending on the intended application of the optocoupler and certain cost/performance tradeoffs determined by the manufacturer.

Motorola, for example, uses three different emitters in its optoelectronic products **(Fig 2)**:

- 660-nm (visible light) GaAlAs
- 850-nm (near infrared) GaAlAs
- 940-nm (infrared) GaAs.

Although the 940-nm GaAs emitter's spectral emission is not perfectly matched to the response of a silicon detector, Motorola uses this emitter in most of its optocouplers for reasons of cost effectiveness. Most general-purpose applications can tolerate a certain amount of spectral mismatch, and the resulting lower cost of the optocoupler justifies the use of such an emitter.

The 850-nm GaAlAs emitter's peak emission does closely match the response of a silicon detector, and Motorola uses this emitter in optocouplers designed for applications where high efficiency and fast speed are important.

The 660-nm GaAlAs emitter is poorly matched to the response of a silicon detector, and for this reason Motorola doesn't use it in any of its optocouplers. (This type of emitter is ideal for use in other optoelectronic products, however—in plastic fiber-optic communications systems, for example. At 660 nm, the attenuation curve of plastic fiber is near its minimum value.)

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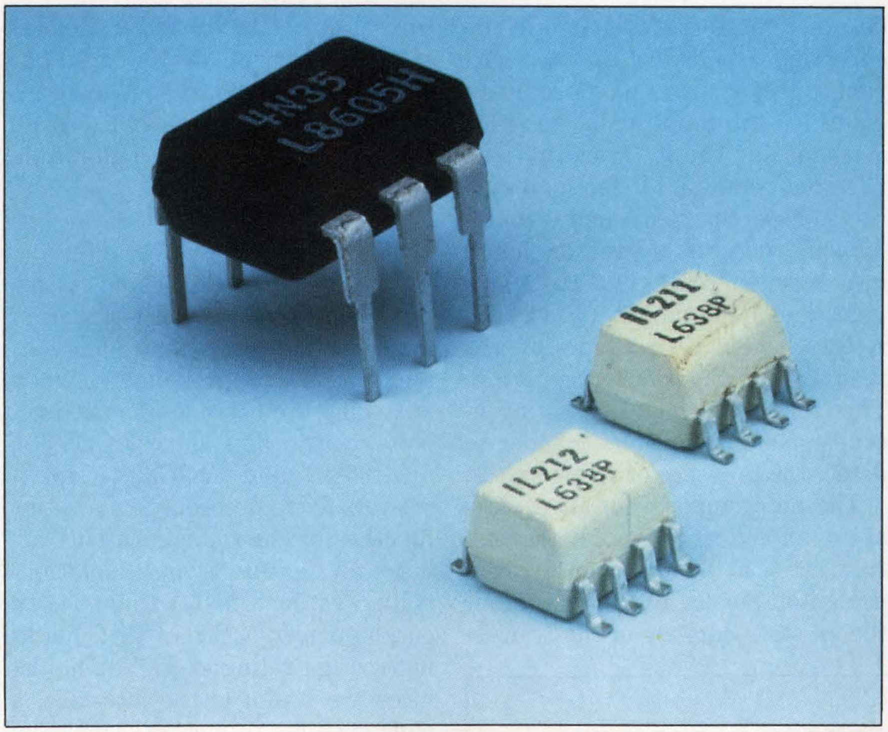

Optocouplers often come in 6- and 8-pin DIPs, *but some types are now available in SOIC (small-outline integrated-circuit) or other surface-mount packages. These types from Siemens are representative.*

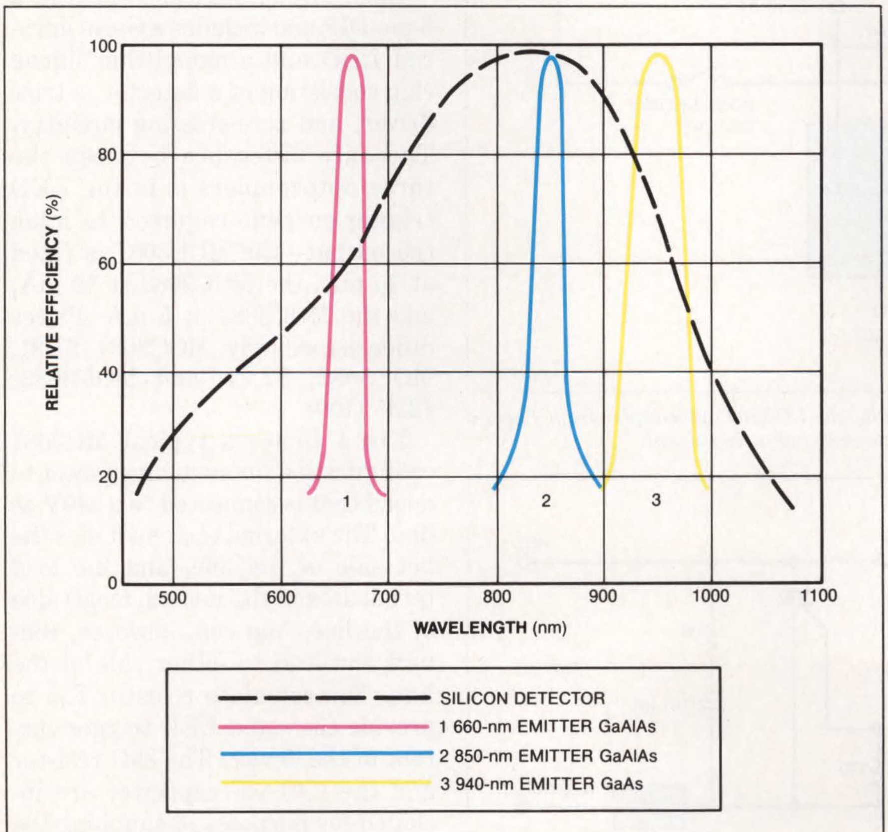

Fig 2—Optocoupler emitters are usually made from materials such as GaAs, GaAsP, and GaAlAs. *Application-dependent factors such as efficiency and the wavelength of the emitter's spectral emission determine which type a manufacturer selects. Fortunately, a silicon detector can accept a wide range of emitted wavelengths.*

approaches in their selection of LEDs for use as emitters in optocouplers. Philips in The Netherlands, for example, (along with its subsidiary in the US, Amperex Electronic Corp), uses GaAlAs emitters with wavelengths of 830 nm and 740 nm. Philips uses the 830-nm emitter with photodiodes and phototransistors whose peak sensitivity is between 800 and 850 nm; it uses the 740-nm emitter with integrated photoreceivers whose peak sensitivity is between 700 and 750 nm.

Curiouser and curiouser

Hewlett-Packard chooses to use an 820-nm GaAlAs emitter for many of its high-speed optocouplers. Curiously, HP reverses the order of the first two chemical symbols and lists the emitter material as AlGaAs.

Although many companies use GaAs and GaAsP emitters, the trend is to GaAlAs. The reason for this increase in use is because manufacturers can alter the bandgap of GaAlAs emitters to produce radiation at any desired wavelength between 650 and 900 nm. It is the gallium/aluminum ratio that determines the bandgap. Another advantage of GaAlAs emitters are their generally lower drive-current requirements, which makes them a better choice for use in optocouplers that interface with CMOS ICs.

Most manufacturers of GaAlAs emitters use a homojunction technology having a single bandgap. Philips and Amperex, however, use a single-heterojunction technology that has two epitaxial layers with different bandgaps. Philips claims that using this structure significantly lessens the degradation (over time) of the emitters' current-transfer ratio (CTR).

Compared with emitters, photodetectors don't present as many choices—or as many problems. Silicon detectors have a wide spectral response that extends from 700 to 950 nm, with a broad, flat peak between 750 and 900 nm. And, because of this wide response, they accommodate a wide range of emitter wavelengths.

Because of the choice of materials, structures, and output configurations available, optocouplers satisfy the isolation requirements of a variety of applications. One such application example uses the LDA200 dual-channel, current-monitoring switch from Theta-J Corp. The $2.75 (100) LDA200 is useful in industrial applications for input-to-output isolation and control-system monitoring, but its principal use is in telecommunication circuits (**Fig 3**). In this application, the optocoupler provides ring-current sensing and loop-current detection.

The LDA200 allows the circuit designer to select the actual in-circuit trigger point for the loop current by choosing an appropriate value for the input shunt resistor. Without a shunt resistor, the LDA200 remains off for loop currents of less than 5 μA and turns on for loop currents of greater than 6 mA. A shunt resistor of 120Ω provides loop detection at 16 mA, but rejects loop noise currents of less than 6 mA without false triggering. The other channel of the optocoupler acts in a similar manner to detect the presence of a ring signal.

The optocoupler's output devices are open-collector bipolar transistors rated at 20V. Normally, you use an output-load resistor to limit the on-state current in the transistor so as not to exceed a steady-state dissipation of 150 mW per transistor, or 400 mW for the entire package. You have a choice of an 8-pin DIP or a surface-mountable version.

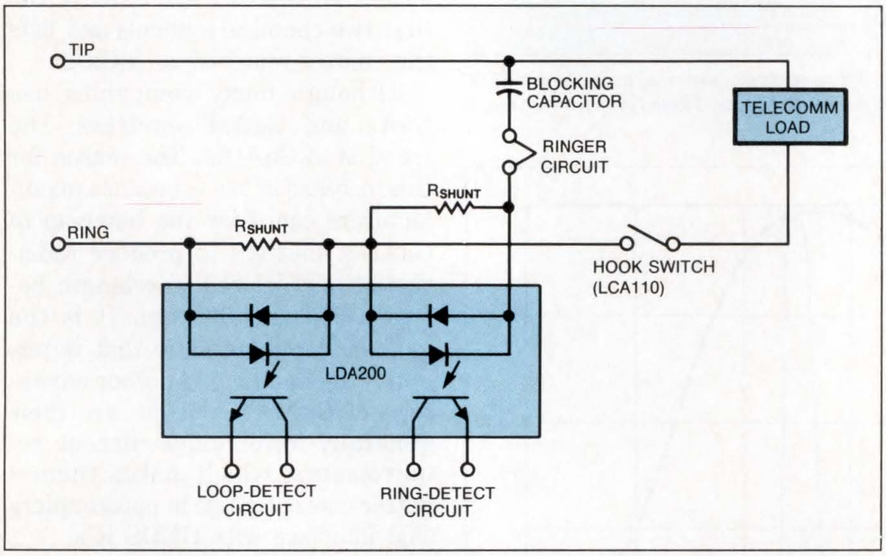

Fig 3—In this telecommunications application, *the LDA200 optocoupler from Theta-J monitors the line to detect the presence of loop current and a ring signal.*

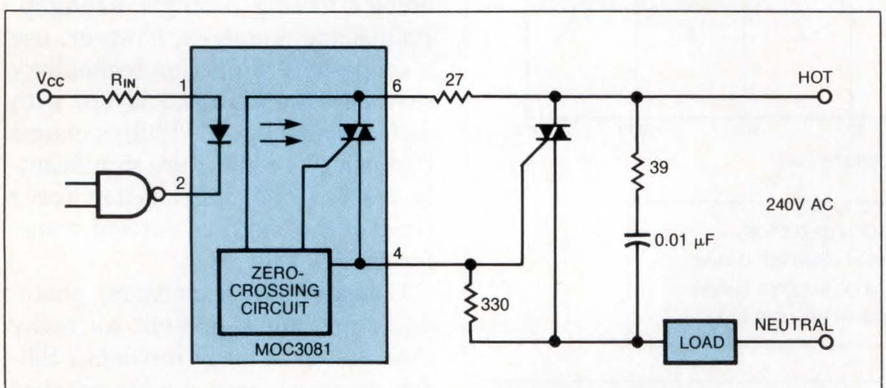

Fig 4—Optocouplers are commonly used to isolate high voltages from sensitive input circuits. *This triac-output type from Motorola switches power to a load connected to a 240V ac line. The MOC3081's blocking-voltage rating is 800V.*

Traditional uses still remain

One of the traditional applications for optocouplers is the isolation of low-voltage circuits from high-voltage circuits, particularly when switching the hot side of an ac line. Not only do the MOC3081, MOC3082, and MOC3083 optoisolators from Motorola perform this function for line voltages to 240V ac, but they feature a high isolation-voltage rating of 7500V (min) and an output driver (triac) with a blocking-voltage rating of 800V. The devices are useful in the interface of logic systems to motors, solenoids, industrial controls, and consumer appliances.

Each of the devices comes in a 6-pin DIP and includes a GaAs infrared LED and a monolithic silicon chip consisting of a detector, a triac driver, and zero-crossing circuitry. The only difference between the three optocouplers is in the LED trigger-current required to latch the output—the MOC3081 is rated at 15 mA, the MOC3082 at 10 mA, and the MOC3083 at 5 mA. Prices differ accordingly: MOC3081, $1.81; MOC3082, $2.11; and MOC3083, $2.45 (100).

Fig 4 shows a typical MC3081 configuration for switching power to a load that is connected to a 240V ac line. The external triac switches the hot side of the line, and the load terminates in the neutral (cold) side of the line. You can, however, connect the load to either side of the line. You calculate resistor R_{IN} to provide the rated LED trigger current of the device. The 39Ω resistor and the 0.01-μF capacitor are included for purposes of snubbing the triac, and they may not be necessary for certain triac-load combinations.

Siemens Components also offers a

device similar to members of the MOC3081 Series. The IL410 is a triac optocoupler with a zero-crossing detector circuit, but its internal circuitry is somewhat different. The output chip integrates a photosensitive npn transistor and a MOSFET with a triac driver. The addition of the MOSFET interface reduces the light output required from the emitter to drive the triac, thus providing an input sensitivity of 2 mA. The optocoupler has an isolation-voltage rating of 7500V, and the triac output stage has a blocking-voltage rating of 600V. Like the MOC3081 Series, the IL410 comes in a 6-pin DIP. It costs $1.95 (1000).

High-speed types are available

In addition to the optocouplers' improvements in voltage ratings, the development of high-speed devices is also advancing. Until comparatively recently, optocouplers were not known for their blinding speed. Over the past few years, however, companies like Hewlett Packard have been instrumental in changing this situation.

The HCPL-2400 logic-gate optocoupler is a good example. Designed for use in high-speed logic systems, computer-peripheral interfaces, switching power supplies, and digital isolation of ADCs and DACs, it provides a typical data-transfer rate of 20M baud. Depending on operating conditions, the device is capable of achieving speeds as high as 40M baud.

It also has high common-mode transient immunity and provides a logic-compatible output and, in contrast to a transformer, it offers dc as well as ac performance. The HCPL-2400 comes in an 8-pin DIP and costs $4.65 (100).

In a typical application circuit **(Fig 5)**, the HCPL-2400 uses the fast current-switching capabilities of Schottky TTL logic (74STTL) to attain the 20M-baud data-transfer rate. The 74S04 totem-pole driver sources current to drive the input of the HCPL-2400 optocoupler in series. The 348Ω resistor limits current to the emitter, and the 30-pF capacitor assists in speeding up the emitter's turn-on and turn-off times.

At the output side, the optocoupler, which does not require a pullup resistor, directly drives the logic element. If desired, you can substitute a noninverting buffer at either the input or the output to change the circuit's function.

Of course, fast is relative

Although not nearly as fast as the Hewlett Packard device, the industry-standard 6N135 and 6N136 **(Fig 6)** nevertheless qualify as high-speed types. They have a bandwidth of 2 MHz and a typical switching speed of 1M bps. Each device contains a GaAsP emitter and an integrated photon detector comprising a photodiode and an open-collector output transistor. Separate connections for the photodiode bias current and the collector output of the transistor reduces the base-to-collector capacitance of the output transistor. This arrangement results in speeds as much as 100 times that of a conventional phototransistor.

The UL-registered optocouplers are designed for analog- and digital-interface applications in appliances, vending machines, facsimile machines, character readers, and telephones. In particular, the 6N135 is designed for TTL/CMOS, TTL/LSTTL, and wideband analog applications; the 6N136 suits high-speed TTL.

The devices (along with other family members 6N137, 6N138, and 6N139) are available from a number of suppliers, including Texas Instruments, General Electric, General Instrument, and Hewlett Packard. They are enclosed in 8-pin plastic DIPs and vary in price from $2.50 to $3 (100).

One of the earliest types of optocouplers used an LDR as the detector element. These types are still in wide use as feedback elements in automatic gain control (AGC) circuits, and in other applications where isolated control of a variable resistance is necessary. The CLM51

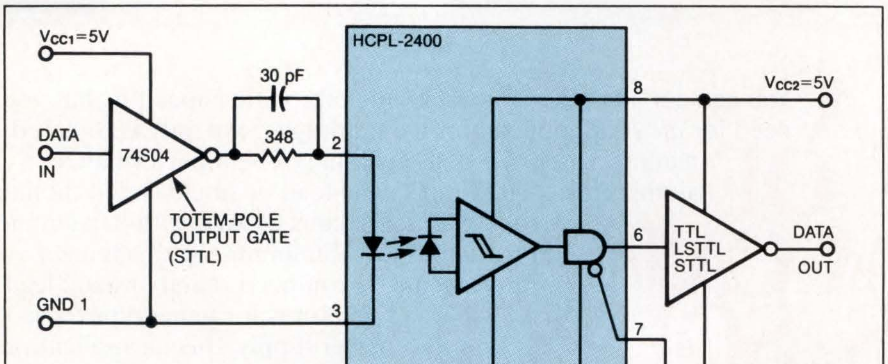

Fig 5—Designed for use in high-speed logic systems and computer-peripheral interfaces, *the HCPL-2400 from Hewlett Packard has a typical data-transfer capability of 20M baud. Depending on operating conditions, the device can achieve speeds as high as 40M baud.*

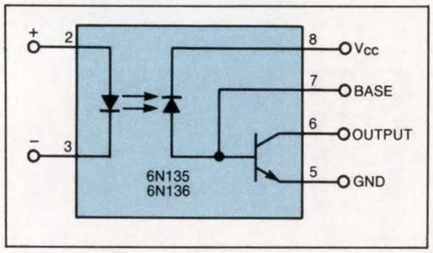

Fig 6—The 6N135 and 6N136 optocouplers are JEDEC registerd and UL approved. *The 6N135 is useful for TTL/CMOS and TTL/LSTTL applications; the 6N136, for TTL applications. The separate biasing pin for the photodiode reduces the transistor's collector-base capacitance, which speeds operation by a factor of 20 to 100 compared with conventional phototransistors. Both types are available from a number of suppliers, including Texas Instruments, General Electric, General Instrument, and Hewlett Packard.*

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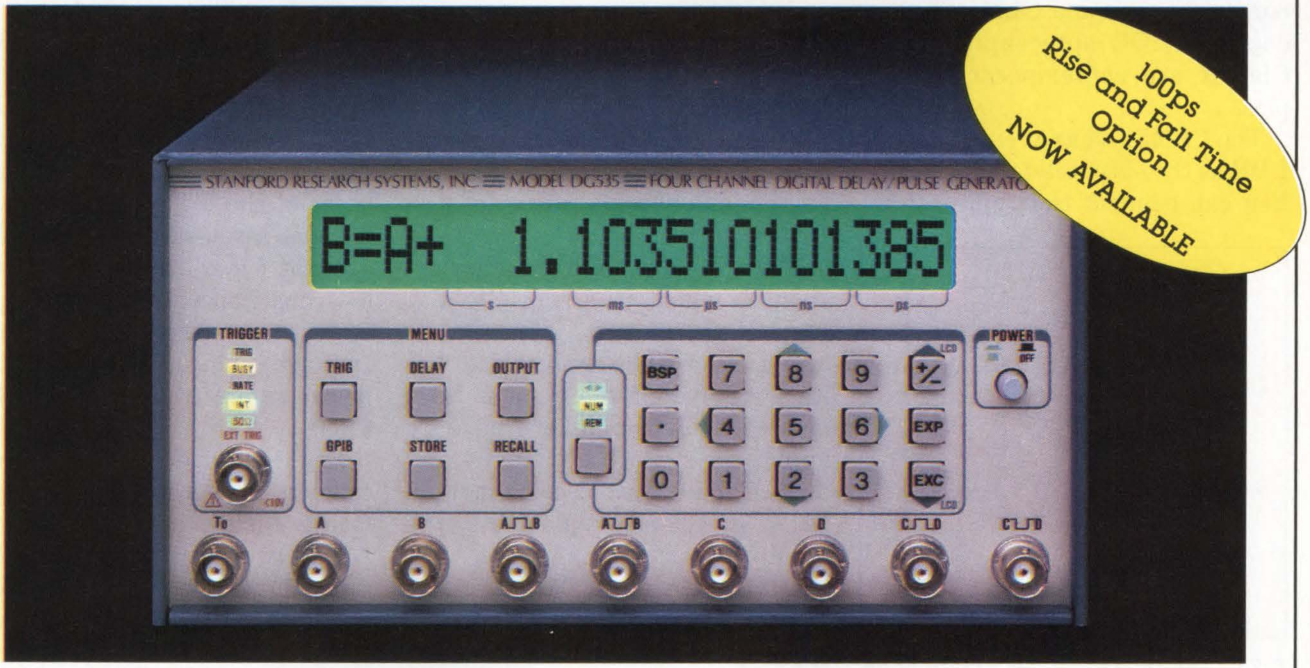

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(single channel) and CLM51-2 (dual channel) LDR optocouplers from Clairex are contemporary examples.

The CLM51-2 has a center-tapped LDR as the output detector **(Fig 7)**. You can connect the typical 2-kΩ resistor elements in series or parallel to alter the total reference resistance over a 4:1 range. By varying the LED current from 0.1 to 10 mA, you can vary the reference-resistance value over a 10:1 range. The maximum current rating of the LED is 40 mA.

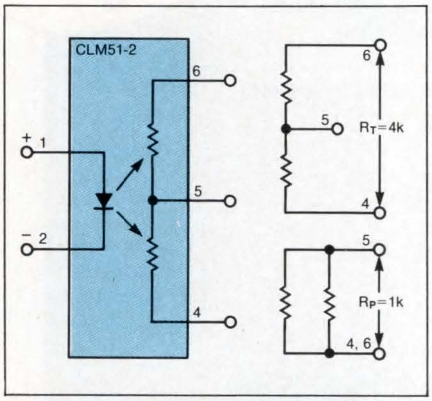

Fig 7—This optocoupler has an LDR as the detector. *You can set the reference resistance of the Clairex CLM51-2 at 1, 2, or 4 kΩ. By varying the LED current from 0.1 to 10 mA, you can vary the reference-resistance value over a 10:1 range.*

The optocoupler's frequency response, which is essentially flat from dc to 100 kHz, is more than adequate for audio applications, and its 3 dB roll-off point of 3 MHz makes it useful for higher-frequency applications. Both the single- and dual-channel versions come in 6-pin DIPs. In 100-piece quantities, the CLM-51 costs $1.74, and the CLM51-2 sells for $2.05.

EG&G Vactec also makes LDR-type optocouplers. These devices have a wide range of axial-lead types that use neon lamps, incandescent lamps, or LEDs as the light source. Available resistance values range from 100Ω to 10 kΩ.

Vactec's VTL-5 types, for example, use an LED emitter and come in plastic molded packages with either four leads (single element) or five leads (dual element). Characteristics of the VTL-5 Series, which includes seven single- and two dual-element types, are low distortion, low capacitance, and wide frequency response spanning dc to 5 MHz. In large quantities (10,000), their prices range from about $0.80 to $1.50.

Logic-oriented types of optocouplers, which make digital interfacing easier, are also available. About two years ago, General Instrument—a supplier of optoelectronic products for nearly twenty years—introduced its Optologic line of logic-to-logic couplers. These devices provide buffer and inverter interfaces for LSTTL/TTL and LSTTL/CMOS logic. The 74OL6000 Series, part of the Optologic family, includes devices with totem-pole outputs and open-collector outputs. These products have found acceptance in such applications as transmission-line receiver/driver interfaces, bus interfaces, and high-speed ac/dc voltage sensing.

General Instrument's most recent product introduction, however, is not a logic coupler. The $1.17 (5000) MCT9001 is a dual phototransistor optocoupler that features two isolated channels in a standard 8-pin DIP. The end-stackable package (two packages fit into a 16-pin DIP socket) offers a high packing density and reduced insertion costs.

The device has a CTR of 50% (min) and 600% (max) at LED currents of 5 mA. Each output transistor is rated at 50 mA (max) and has a dissipation rating of 150 mW. The MCT9001 is also fairly fast; 3 μsec turn-on and turn-off times are typical. **EDN**

For more information . . .

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

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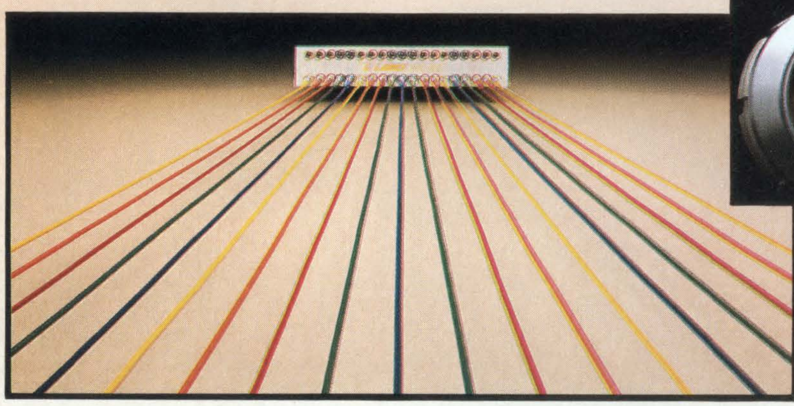

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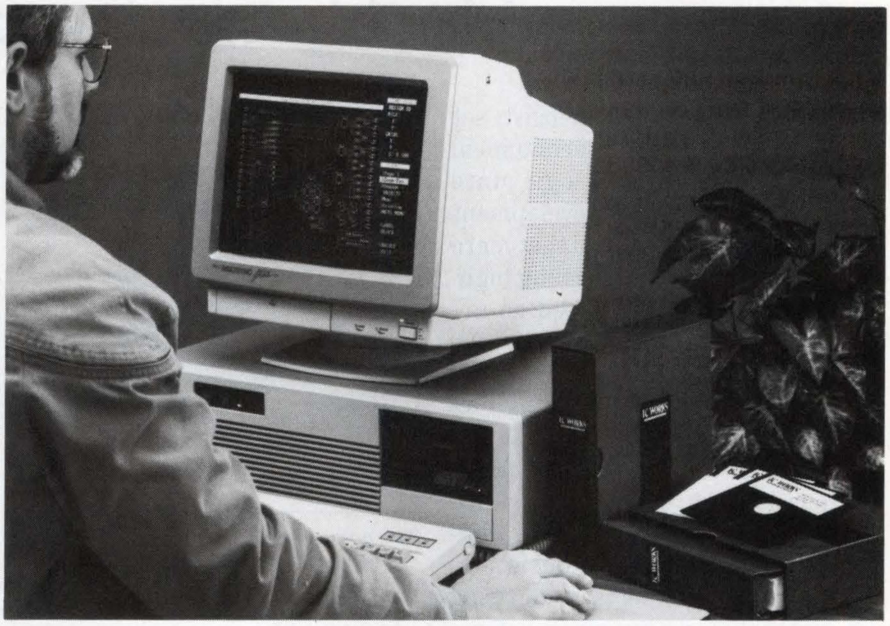
CIRCLE NO 178

Software package relieves designer of physical details of ASIC design



When you use this automated ASIC-design package, you don't have to deal with the physical details of the design. IC Works can generate 50 placement alternatives from 50 different initially randomized cell placements in order to provide the best solution.

You can avoid dealing with the physical design details of ASIC design if you use IC Works software to create the devices. Once you've completed the schematic capture and design verification, the computer handles the rest of the design process automatically, from cell placement through routing, clock generation, and rule checking. The complete package (including the schematic capture, cell libraries, and validation tools) sells for $10,000.

The software requires an IBM PC/AT or compatible running MS-DOS, a color monitor with an EGA card, a hard disk, and a mouse. IC Works is tailored to run on a standard computer, so it doesn't need any hardware accelerators.

During schematic capture, you can connect as many as 14 pages of schematics in one file. You can also define macros to represent frequently used circuits, or to simplify the top-level schematic. If you don't choose to name them yourself, the computer automatically labels circuit elements and nets. Command menus or sub-menus are available on screen at all times; you can, for example, bring up a window when selecting elements for placement. Whenever you are working with a net, all nodes of the collection flash for easy identification.

The cell library for IC Works is based on a 2-μm, double-metal CMOS process and offers over 100 entries, including Boolean gates, counters, shift registers, and adders. You can add RAM, ROM, and PLA structures to your design simply by specifying their configuration and any necessary programming. You can also define custom cells by using the building blocks in the library. Thus you can make a 3-bit adder or a 5-bit counter if that is what your circuit needs. The library is not proprietary, so you can take your final design to any foundry you wish.

IC Works offers a variety of timesaving test and verification tools. While designing, you can perform logic simulation and timing verification on various parts of the design. You can then save the test vectors generated by this method for use in verifying the final design.

Initially, the automatic cell placement is randomized; then the software swaps pairs of cells until it reaches a workable routing pattern. Because the results of this technique strongly depend on the initial random placement of cells, you have the option of running an optimization routine that examines 50 different placements for the best results.

The computer can automatically place the cells and route the connections, or you can maintain complete control of the placement. In either case, the software provides complete electrical- and design-rule checking of the final layout at the transistor level.

In order to take advantage of the automatic features in IC Works, you will have to live with some restrictions. For example, you must use synchronous design techniques, because all of the storage devices in the cell library include a connection to a master clock. Some of the routines, such as the one that optimizes the device layout, take hours to run. Finally, the package handles designs limited to about 5000 gates. The company does offer a $5000 prototype fabrication service and guarantees the resulting devices will perform as simulated.

—Richard A Quinnell

IC Designs, 12020 113th Ave NE, Kirkland, WA 98034. Phone (206) 821-9202. TLX 4949856.

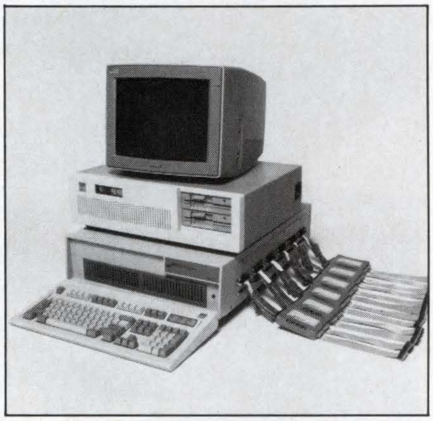
Circle No 697

Mid-range development tools streamline µprogrammable chip-based system design

By combining a comprehensive set of software tools with economical hardware—including a logic-state analyzer—the Step-50 development system improves the odds that mere mortals can develop and debug high-performance products based on microprogrammed processors. Although products using microprogrammed computing elements are faster and harder to duplicate than those based on fixed-instruction-set processors, until recently they have been quite difficult to develop because designers had to become experts in devising not only hardware but also machine-language software. Furthermore, available development systems either performed unneeded functions and cost too much, or they lacked features required to debug complex products with high confidence.

An IBM PC/AT or compatible computer hosts the Step-50. The software, based on MS/PC-DOS (version 3.x), runs under Microsoft Windows (version 2.03). An enclosure slightly larger than the PC/AT system's unit houses the hardware. It connects to the system under test via 16-channel pods; you can attach as many as ten of these pods at once. The unit's 4k-word writeable control store (WCS) supports a target-system word width of 160 bits. The 80-bit-wide, 25-MHz real-time trace memory is also 4k-words deep and is organized as a circular buffer. You can effectively increase the buffer's depth by specifying qualifications of data before storing it.

The logic-state analyzer includes clock and breakpoint controls. Using a Windows dialogue box, you can qualify trigger conditions—or data to be captured in the trace memory—with as many as five 80-bit match words and with a sequence of four independent state-machine levels. In addition, you can select sequencing from one or more of the 80-bit match words and/or from the address and data-range comparators. You control the logic-state analyzer with either the keyboard or a mouse.



***The probes used** with the mid-range Step-50 are identical to those used by the entry-level and top-of-the line members of the vendor's product line. You also use the same software with all members of the family.*

The software furnished allows you to load the WCS, edit and save its contents, compare those contents against disk files, search the WCS for data patterns, and duplicate lines or blocks of code. You can also fully define the op-code symbols and trace-display format. The system accepts bit patterns entered as binary, octal, or hexadecimal codes or as user-defined symbols. An event counter determines the number of occurrences of a selected pattern. Another software feature lets you save trace data and compare it with other traces.

The Step-50 is part of a product family that includes the Micro-Step at the low end and the Step-40 at the high end. All of the family members are PC-based. They have the same user interface and work with the same probes and compatible software. At approximately $6500 for a typical configuration, the Micro-Step is an entry-level product targeted at teaching prospective microcode developers what the process is all about. Its maximum word width is 128 bits, and it lacks a logic-state analyzer. The Step-40, which starts at about $25,000, is aimed at integration of multiple microcoded processors within systems.

The vendor believes that Step-50 is ideal for developing subsystems and systems that have a single microcoded processor. In more complex systems, where the integration of multiple processors is necessary, the Step-40 is the tool of choice.

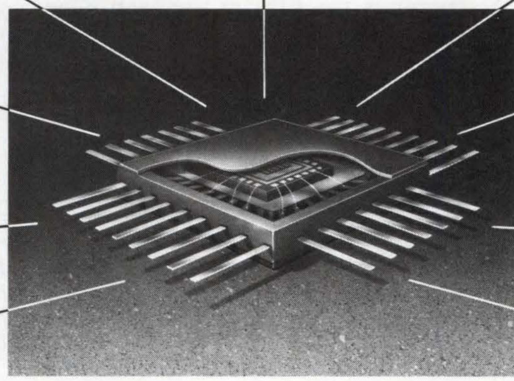
Aside from its probes, the Step-50 configuration is fixed. It costs $15,000 without probes; $16,800 with probes for 96 channels; and $18,000 when configured for the maximum of 160 channels.

—Dan Strassberg

Step Engineering, Box 3166, Sunnyvale, CA 94088. Phone (408) 733-7837. TWX 910-339-9506.

Circle No 695

SONY'S ECL LOGIC HAS THE GUTS TO CHALLENGE GaAs PERFORMANCE.



When you need high-speed logic, it really pays to look into Sony's ECL logic family.

Because like GaAs technology, you'll find incredibly fast process speeds. Up to 4 GHz.

But unlike GaAs technology,

you'll also find amazingly low costs and design simplicity.

Not to mention that our ECL technology, unlike most, requires very low power. Under 1 watt, in many cases.

Sony's ECL logic family is made possible by our unique 1-micron, 10-GHz, FT process. The very process that's made our high-speed, 8-bit, 300 MSPS, A/D converters so popular.

And via our 200-gate array technology, we offer a limitless range of logic functions. Many available in 24 and 32-lead flat packs. The list you see here is only partial. So if you don't see what you need, please inquire with your specific requirements.

SONY'S HIGH-SPEED ECL LOGIC FAMILY

Part Number	Function	tpd	fmax	Power	Package
CXB1100Q	Quad 3-in OR/NOR	390 ps	1.5 GHz	530 mW	24 FLAT
CXB1101Q	Quad 3-in AND/NAND	470 ps	1.5 GHz	700 mW	24 FLAT
CXB1102Q	Quad 2-in EXOR/NOR	490 ps	1.5 GHz	680 mW	24 FLAT
CXB1103Q	Quint Line Receiver	410 ps	1.5 GHz	650 mW	24 FLAT
CXB1104Q	Dual D Flip Flop	620 ps	3.2 GHz	520 mW	24 FLAT
CXB1105Q	Triple Fan-out Buffer	590 ps	1.5 GHz	720 mW	24 FLAT
CXB1106Q	4-Stage Ripple Counter		3.4 GHz	720 mW	24 FLAT
CXB1107Q	Decision Circuit		3.2 GHz	430 mW	24 FLAT
CXB1108Q	Laser Driver		2.0 GHz	740 mW	16 FLAT
CXB1109Q	Quad D-FF with Master Reset	620 ps	3.4 GHz	790 mW	24 FLAT
CXB1110Q	16 to 1 Multiplexer	610 ps	1.5 GHz	680 mW	24 FLAT
CXB1111Q	Look Ahead Carry Block	580 ps	1.5 GHz	610 mW	24 FLAT
CXB1112Q	Phase Frequency Detector	720 ps	0.8 GHz	500 mW	24 FLAT
CXB1113Q	4 to 1 Multiplexer		2.0 GHz	950 mW	24 FLAT
CXB1114Q	1 to 4 Demultiplexer		2.5 GHz	1100 mW	24 FLAT
CXB1130Q	9, 8, 4-bit Multiplexer		1.6 GHz	730 mW	32 FLAT
CXB1131Q	9, 8, 4-bit Demultiplexer		1.6 GHz	1000 mW	32 FLAT
CXB1132Q	9, 8, 4-bit Universal Shift Register		1.3 GHz	910 mW	32 FLAT
CXB1133Q	22, 15, 7-Stage Scrambler		1.6 GHz	600 mW	24 FLAT
CXB1134Q	22, 15, 7-Stage Descrambler		1.6 GHz	610 mW	24 FLAT
CXB1135Q	8-16 bit Comparator		1.3 GHz	630 mW	32 FLAT
CXB1136Q	8-bit Universal Counter		1.2 GHz	730 mW	32 FLAT
CXB1137Q	8-bit Shift Matrix	1250 ps		700 mW	24 FLAT
CXB1138Q	4-bit Arithmetic Logic Unit	1460 ps		680 mW	24 FLAT

Sony's ECL logic family is available now, backed by the quality, reliability and nationwide service you expect from any Sony product.

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WI Waukesha (414) 542-5352

CIRCLE NO 160

Menu-driven DMM features bar graph

The Model 560 DMM is a sophisticated DMM with an abundance of features and includes a menu-driven interface to access them all. This meter is the fifth in Simpson Electric's Professional Series of instruments—and it demonstrates an impressive and innovative change of pace. The basic unit costs $2195 and consists of a 2.5-lb Z80-based DMM that stores 2150 readings in nonvolatile, battery-backed RAM.

The 560 gives you readings with 5-digit resolution (99,999 counts); it also indicates negative polarity. Its 52-segment bar graph provides real-time voltage and autorange representations that are independent of the dB or Hz you're measuring, so you can take a reading and monitor the test point in real time simultaneously.

In addition to the standard ohms range, the meter has a high-power ohms range that is useful in testing semiconductor junctions. Other features include frequency counting, true RMS, fusing on both current inputs, diode testing, high-speed autoranging, digital filtering, a TC reference, and digital calibration. A zero function eliminates lead resistance in your readings. The unit also provides a peak-hold that is completely independent of A/D converters, so it can catch small line transients that would otherwise be lost.

The menu interface simplifies the task of selecting storage parameters for the meter's readings. Using it, you can specify the range for stored readings; you can also set the storage rate and the dB reference. A REL SET option lets you key in a reading so that subsequent input is displayed relative to that reading. The nonvolatile RAM also stores the meter's final settings so that the unit maintains the same range limits when you turn it off and on again.

Providing a menu-driven user interface, *the Model 560 digital multimeter includes a frequency counter and a dual display with bar graph.*

Two interface options are available: a Centronics-compatible parallel port or an RS-232C serial port. Each is fully isolated, has its own power supply, and costs $200. Unfortunately, there are no field upgrades, so you have to send the unit back to Simpson for an interface installation. Or you can simply order a 560 with either port already installed for $2395. If you plan to take a lot of range-limited readings, you'll want to use a printer with the meter because the 560's display doesn't provide as much information as you get on a printout.

—J D Mosley

Simpson Electric Co, 853 Dundee Ave, Elgin, IL 60120. Phone (312) 697-2260. TLX 722416.

Circle No 696

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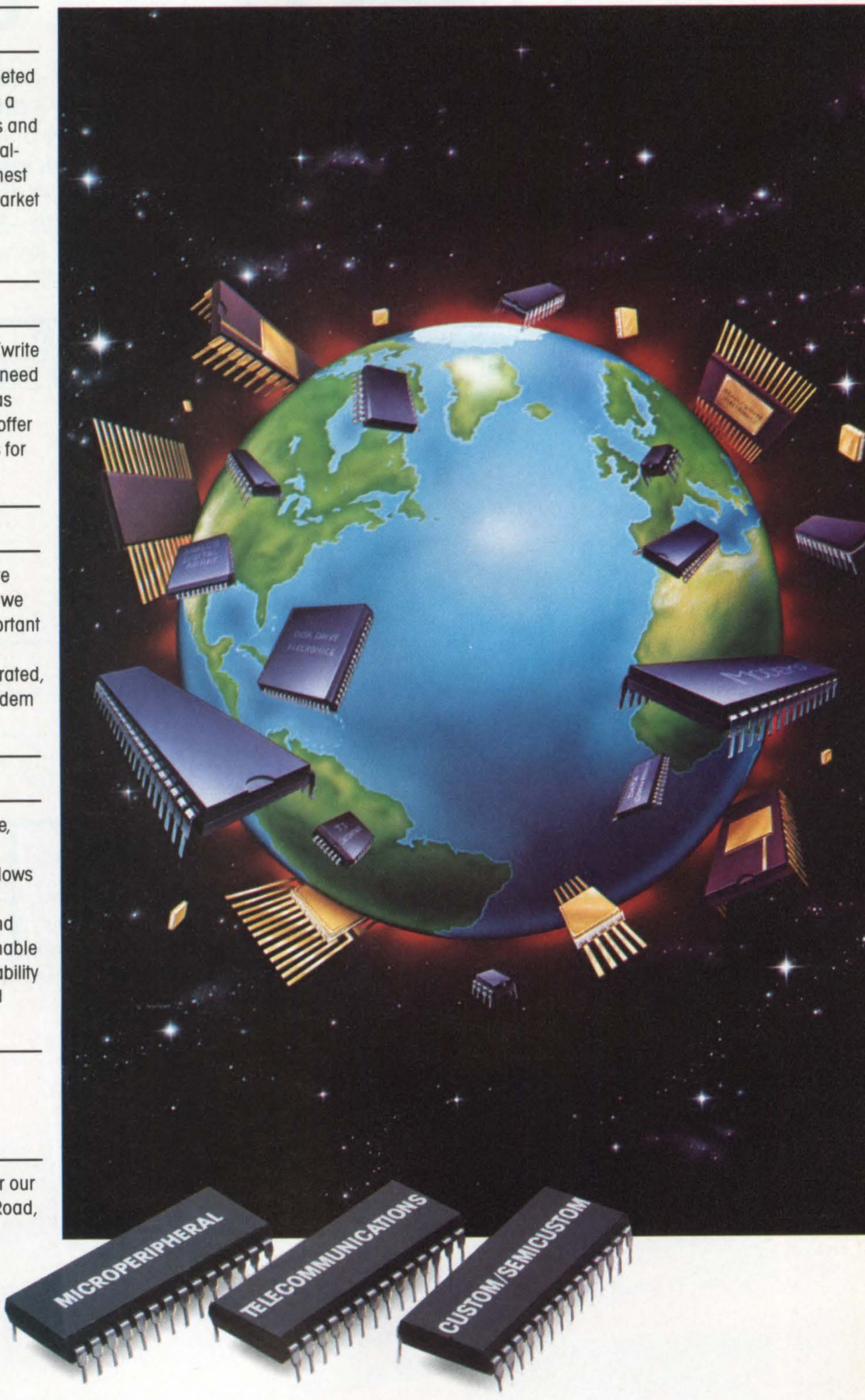

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The big news is SGS-THOMSON's MK48Z08. The MK48Z08 has an 8K × 8 architecture—plus a battery cell life of over 11 years at 70°C. Four configurations are offered for maximum design flexibility. Each conforms to JEDEC 28-pin DIP packaging to allow direct replacement of conventional 8K × 8 SRAMs, 2764 EPROMs or 8K × 8 EEPROMs.

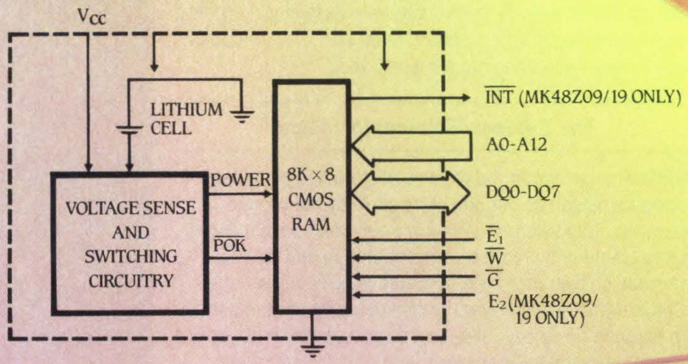
Unlike EEPROMs, with our unique ZEROPOWER memories, there's no limit to the number of write cycles you can perform. Plus, the combination of fast read and write cycles and no additional circuitry requirements makes the chip a breeze to interface with your microprocessor.

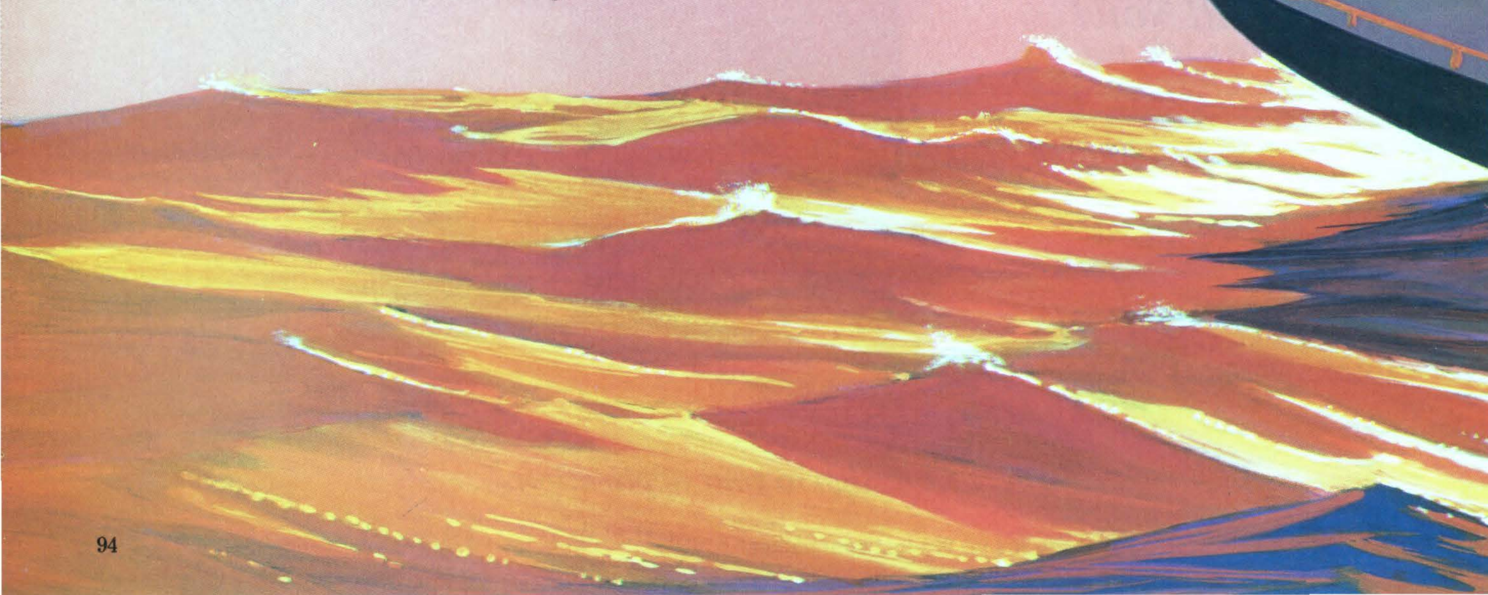
Don't worry about reliability, either. Our 16K and 64K ZEROPOWER devices (even higher densities are just over the horizon) are based on the industry's most sophisticated assembly technology and over 5 years of proven battery experience.

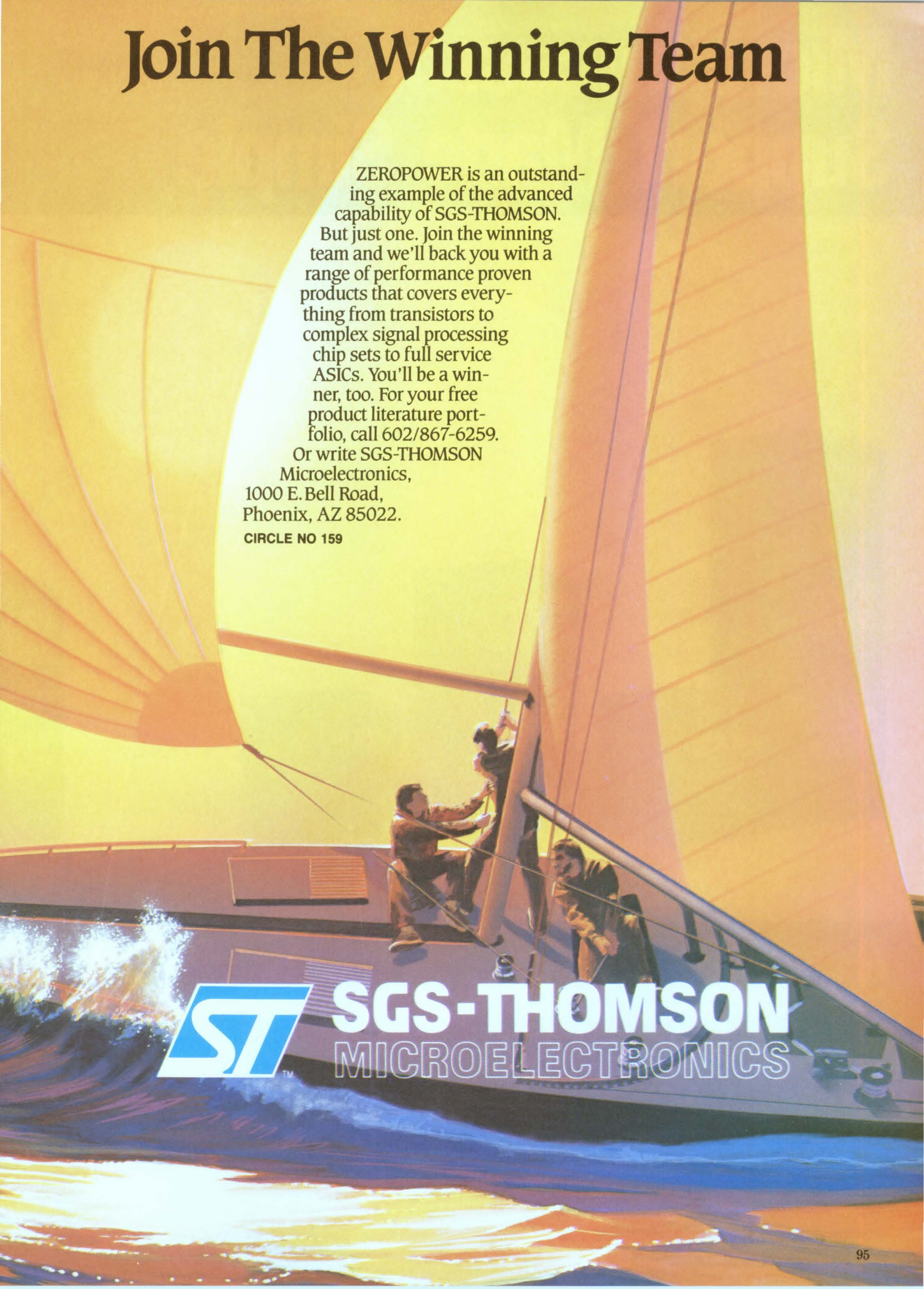
For convincing reliability documentation and a complete set of application notes, contact the winning team—SGS-THOMSON Microelectronics, 1000 E. Bell Road, Phoenix, AZ 85022. 602/867-6259.

DEVICE	TEMP RANGE	WRITE PROTECT VOLT.	BATTERY LIFE OVER TEMP	U.L. RECOG	SPEED	KEY FEATURES
MK48Z02	0-70 C	4.75V	11 yrs.	Yes	120-250ns	2K × 8 SRAM unltd. write cycles
MK48Z12	0-70 C	4.5V	11 yrs.	Yes	120-250ns	2K × 8 SRAM unltd. write cycles
MKI48Z02	-40-85 C	4.75V	6 yrs.	Yes	120-250ns	2K × 8 SRAM indust. temp. range
MK148Z12	-40-85 C	4.5V	6 yrs.	Yes	120-250ns	2K × 8 SRAM indust. temp. range
MK48T02	0-70 C	4.75V	11 yrs.*	Yes	120-250ns	2K × 8 SRAM w/realtime clock
MK48T12	0-70 C	4.5V	11 yrs.*	Yes	120-250ns	2K × 8 SRAM w/realtime clock
MK48Z08/09	0-70 C	4.75V	11 yrs.	Yes	150-250ns	8K × 8 SRAM w/additional CE and power fault flag (– 09)
MK48Z18/19	0-70 C	4.5V	11 yrs.	Yes	150-250ns	8K × 8 SRAM w/additional CE and power fault flag (– 19)

*3.3 yrs. minimum clock operating in battery backed mode.



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CIRCLE NO 159
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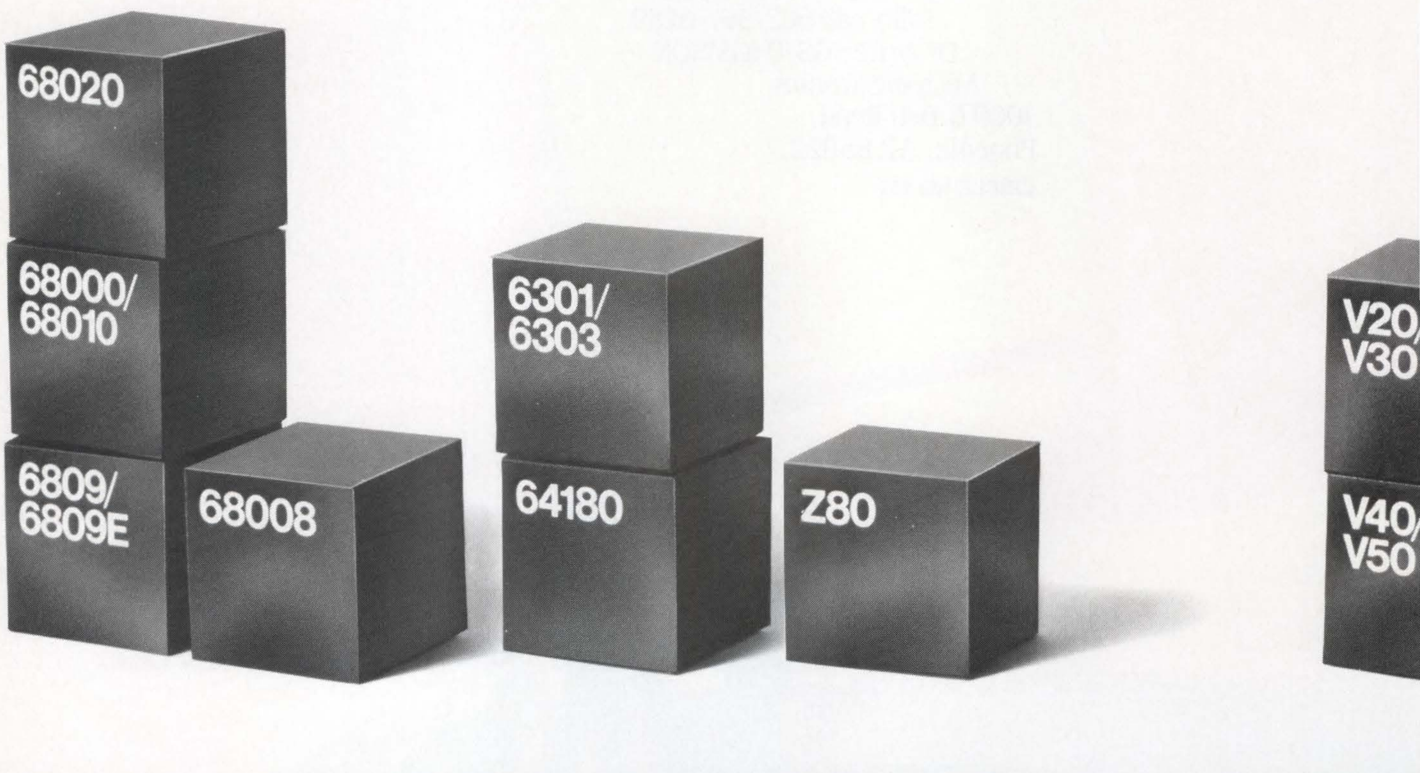
Microprocessor Support Made Simple



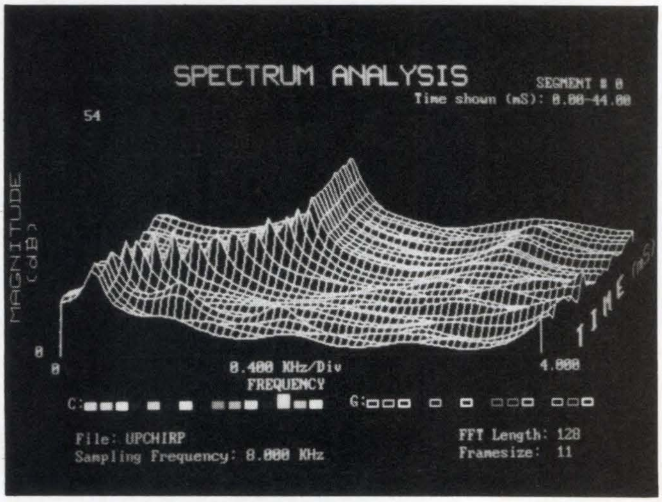
Now, ZAX simplifies microprocessor design, integration and testing with their advanced line of ERX- and ICD-series emulators. You simply tell us the processor that drives your design and we tailor a development system especially for your environment, including full software support.

Our ERX-series emulators provide over *80 debugging commands, with 256,000 hardware breakpoints, real-time performance analysis, high-level language debug and trace analysis* of program execution while you emulate in real-time. And they interface directly to your personal computer (AT-class) to provide you with a complete host development station and emulation manager. This consolidated approach utilizes industry-standard equipment and eliminates the use of a proprietary dedicated chassis.

ZAX established the benchmark for standalone emulation tools when they introduced their versatile line of ICD-series emulators. Completely flexible, ICD-series emulators can be interfaced to *either a simple terminal or host computer* (from pc to mainframe) depending on your requirements. This makes them ideal for both *in-house development* and *on-site testing.*

READERS' CHOICE

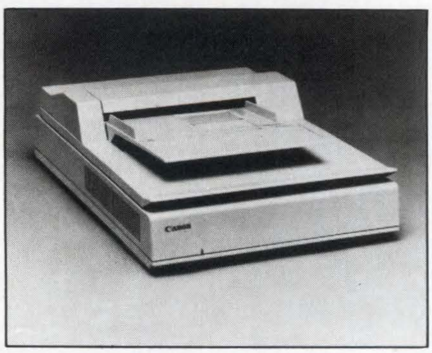
Of all the new products covered in EDN's **February 4, 1988,** issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **February 4, 1988,** issue, or use EDN's Express Request service.



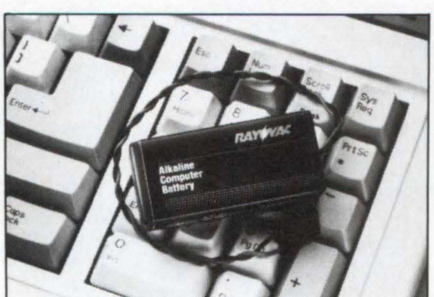
▲ DSP SOFTWARE
Hypersignal and Hypersignal Plus are DSP (digital signal processing) programs that run on IBM PC/XT, PC/AT, PS/2, and compatible computers (pg 240).
Hyperception
Circle No 605

MOTION CONTROLLER
The LM628 motion-control processor simplifies the control of dc and brushless dc motors by performing real-time computational tasks (pg 104).
National Semiconductor
Circle No 601

▲ VISION SYSTEM
The Intellevue 386 vision computer is based on an 80386 μP with 1M bytes of zero-wait-state static RAM and an 80287 math coprocessor (pg 229).
Intelledex
Circle No 604

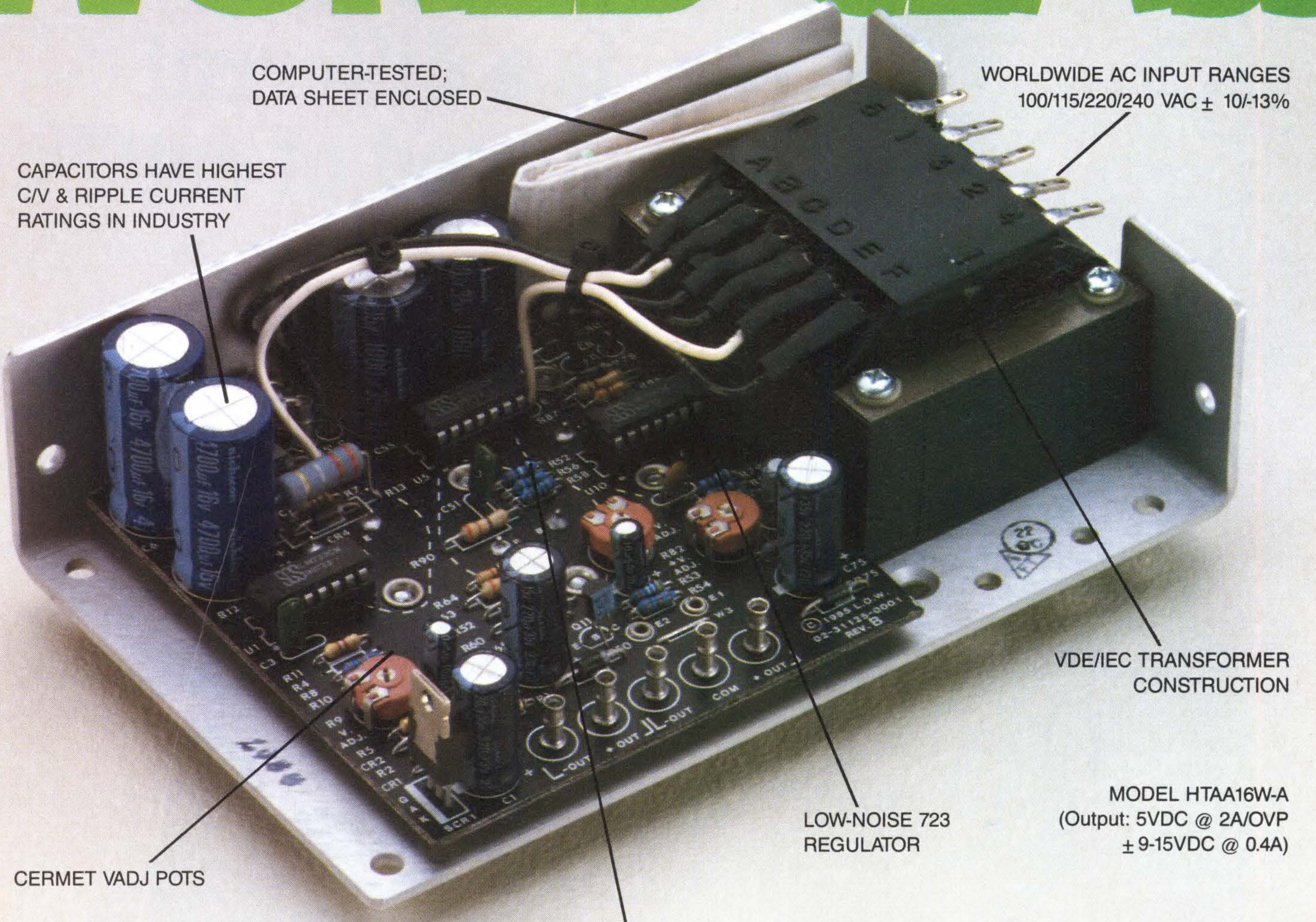


▲ IMAGE SCANNER
The desktop IX-12F image scanner provides 300-dot/in. image scanning for text, graphs, drawings, maps, and pictures and can enter them into a computer (pg 212).
Canon USA Inc
Circle No 603



◀ CLOCK BATTERIES
The Model 843 and 844 batteries utilize a 4.5V, 1-Ahr alkaline system and replace the lithium battery that comes with all IBM PC/AT computers (pg 203).
Rayovac Corp
Circle No 602

WORLD CLASS



Condor's International linear power supplies — certified to UL544.

Condor's *International Series II* D.C. power supplies virtually eliminate primary-secondary shorting because each coil uses a separate bobbin surrounded by two layers of glass-impregnated plastic, giving complete mechanical and electrical isolation.

The best low-noise 723 regulator chips are used throughout the line, together with proven, reliable semiconductors. TO3-cased pass elements are hermetically sealed, and the latest high-density, high-ripple current rating capacitors from proven, high-quality vendors ensure long life and reliability.

International Series II features:

- 7 power levels — 3 to 150W
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- Meets EMI per FCC/VDE B (most units)
- Hermetically sealed power transistors
- MTBF 200,000+ hours per Mil Hndbk 217D
- 2-hour burn-in with cycling
- Full 3-year warranty
- 5th-generation design by Tom Ingman — most copied designer in the power supply industry

Sixty-five *International Series II* models are approved to UL478/1012; CSA C22.2 and TUV certified to VDE 0806 and IEC 435, 1 & 2. Twenty-six models are also approved to UL544. Call us today and put Condor's world-class power supplies to work for you!

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CIRCLE NO 149

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Samtec people believe that our customers deserve the finest products and services. Whatever you need—catalogs, samples, cross-reference guides, quotations, shipment dates—you'll get SUDDEN SERVICE that other vendors can't (or won't) match. Give us a try. You won't be disappointed.

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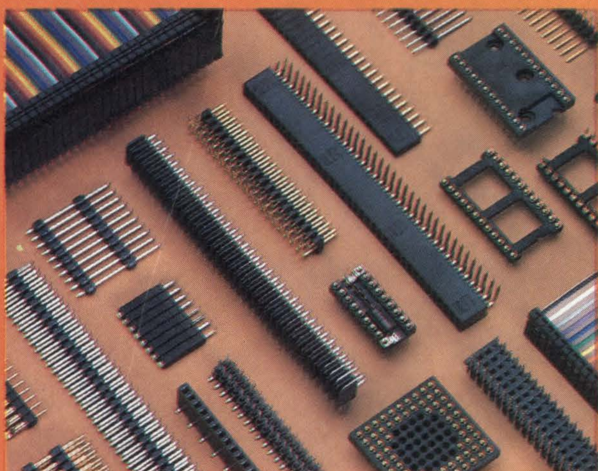
Samtec's *SUDDEN SERVICE* gets the highest customer approval for product quality, on-time delivery.

Everybody claims superior products and service. We'll simply summarize and document* some of the reports we continually receive from Samtec customers who *demand* the best from their suppliers. Large companies, medium-size companies, small firms—they have all come to rely upon Samtec SUDDEN SERVICE. They have given us the highest possible quality rating for zero defect parts, on-time delivery and prompt, reliable service.

Large orders or small, they all receive the same "as promised" service that makes Samtec "a different breed of cat". Try us. You'll be pleasantly surprised.



CUSTOMER EVALUATION SCORECARD*

Customer	Product	Quality Rating for Samtec
Company "A"	Computers	100%
Company "B"	Industrial Controls	100%
Company "C"	Test Instrumentation	100%
Company "D"	Cellular Radios (Telecom)	100%
Company "E"	Medical Instrumentation	100%
Company "F"	Computers	Zero Defects
Company "G"	Telecommunications	100%
Company "H"	Industrial Motors	100%
Company "I"	Telecommunications	100%
Company "J"	Medical Instrumentation	100%
Company "K"	Heart Pacemakers	Excellent

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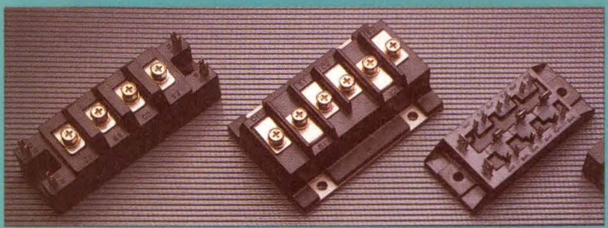

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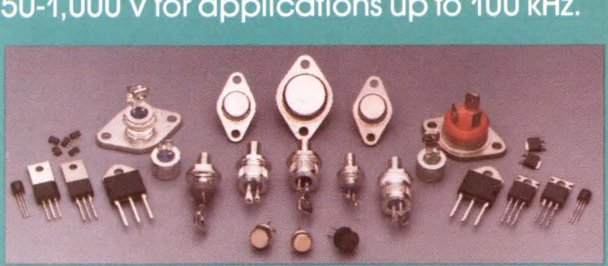

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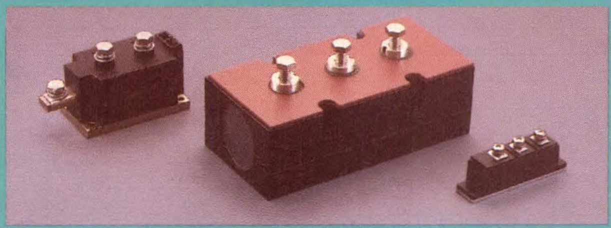

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LEADTIME INDEX

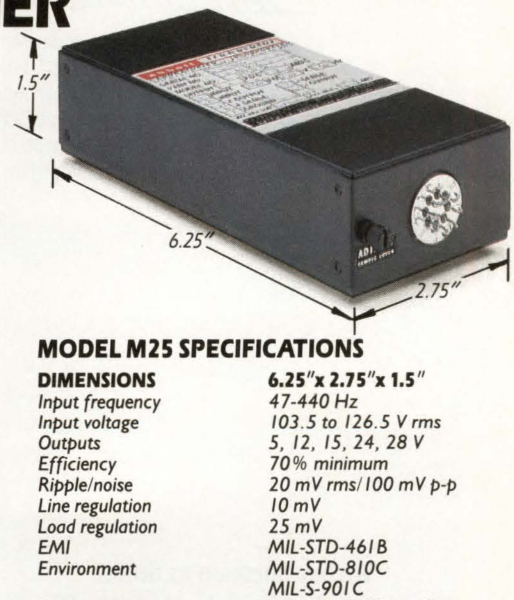
Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
TRANSFORMERS								
Toroidal	6	23	47	18	6	0	7.2	7.3
Pot-Core	0	8	67	17	8	0	10.3	7.8
Laminate (power)	5	45	27	14	9	0	7.6	8.3
CONNECTORS								
Military panel	0	0	73	27	0	0	10.2	10.8
Flat/Cable	22	39	30	9	0	0	4.6	5.6
Multi-pin circular	9	25	25	25	8	8	8.6	9.4
PC (2-piece)	7	29	50	14	0	0	6.8	7.4
RF/Coaxial	10	50	35	5	0	0	4.6	5.3
Socket	23	54	14	9	0	0	3.6	4.7
Terminal blocks	32	59	4	5	0	0	2.3	5.4
Edge card	24	33	38	5	0	0	4.5	5.7
D-Subminiature	20	40	35	5	0	0	4.4	5.1
Rack & panel	22	36	21	21	0	0	5.8	6.4
Power	20	27	40	13	0	0	5.8	5.5
PRINTED CIRCUIT BOARDS								
Single-sided	0	47	48	5	0	0	5.6	5.4
Double-sided	0	48	48	4	0	0	5.4	5.8
Multi-layer	0	25	63	12	0	0	7.5	7.5
Prototype	0	79	13	8	0	0	3.9	4.3
RESISTORS								
Carbon film	49	27	14	10	0	0	3.3	4.2
Carbon composition	29	38	14	19	0	0	4.9	4.0
Metal film	31	35	26	8	0	0	4.1	4.4
Metal oxide	23	38	31	8	0	0	4.5	4.6
Wirewound	10	32	32	26	0	0	7.4	8.8
Potentiometers	24	40	60	16	0	0	5.0	6.1
Networks	27	32	27	14	0	0	5.0	6.3
FUSES	38	38	19	5	0	0	3.1	4.4
SWITCHES								
Pushbutton	24	43	28	5	0	0	3.9	5.8
Rotary	21	32	37	5	5	0	5.7	6.1
Rocker	11	47	32	10	0	0	5.1	5.4
Thumbwheel	6	22	55	6	11	0	8.7	7.7
Snap action	8	38	46	8	0	0	5.7	6.5
Momentary	17	33	39	11	0	0	5.5	6.3
Dual in-line	13	50	31	6	0	0	4.4	6.6
WIRE AND CABLE								
Coaxial	27	41	27	5	0	0	3.8	4.2
Flat ribbon	35	42	19	4	0	0	3.0	5.5
Multiconductor	22	50	17	11	0	0	4.1	4.6
Hookup	56	33	7	4	0	0	1.9	3.2
Wire wrap	31	50	12	6	0	0	2.9	4.2
Power cords	35	38	23	0	4	0	3.6	5.9
POWER SUPPLIES								
Switcher	11	17	50	11	11	0	9.0	7.4
Linear	11	33	45	11	0	0	6.0	7.7
CIRCUIT BREAKERS	6	26	42	26	0	0	8.0	8.0
HEAT SINKS	25	32	43	0	0	0	4.1	5.1
RELAYS								
General purpose	24	19	38	14	5	0	7.0	6.1
PC board	19	33	26	22	0	0	6.3	7.2

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
RELAYS								
Dry reed	27	20	27	26	0	0	6.7	8.6
Mercury	20	20	30	30	0	0	7.6	9.1
Solid state	12	35	35	18	0	0	6.4	8.9
DISCRETE SEMICONDUCTORS								
Diode	37	27	18	12	3	3	5.6	7.0
Zener	37	19	18	18	4	4	7.0	7.3
Thyristor	11	21	47	11	5	5	8.8	8.8
Small signal transistor	30	10	20	30	5	5	9.5	7.4
MOSFET	10	35	20	30	0	5	8.7	10.2
Power, bipolar	19	25	19	31	0	6	8.8	9.3
INTEGRATED CIRCUITS, DIGITAL								
Advanced CMOS	12	19	44	25	0	0	7.9	9.6
CMOS	19	23	27	27	4	0	8.0	7.1
TTL	39	22	17	17	5	0	5.8	6.5
LS	33	29	14	19	5	0	6.0	5.9
INTEGRATED CIRCUITS, LINEAR								
Communication/Circuit	23	15	46	16	0	0	6.5	8.7
OP amplifier	23	14	36	18	5	4	8.6	6.3
Voltage regulator	27	11	35	19	4	4	8.3	7.2
MEMORY CIRCUITS								
RAM 16k	13	20	33	27	0	7	9.5	9.7
RAM 64k	11	37	16	31	0	5	8.5	8.8
RAM 256k	0	25	38	25	6	6	11.0	10.0
RAM 1M-bit	0	17	33	33	0	17	14.4	12.5
ROM/PROM	0	17	25	50	8	0	12.4	11.0
EPROM 64k	17	28	17	33	5	0	8.5	9.5
EPROM 256k	7	20	20	53	0	0	10.5	9.3
EPROM 1M-bit	0	18	27	46	9	0	12.2	11.6
EEPROM 16k	0	22	14	64	0	0	11.8	10.6
EEPROM 64k	0	19	25	56	0	0	11.3	10.9
DISPLAYS								
Panel meters	7	21	43	29	0	0	8.5	6.7
Fluorescent	0	18	27	55	0	0	11.3	8.5
Incandescent	20	40	10	30	0	0	6.4	6.5
LED	32	20	36	12	0	0	5.2	8.1
Liquid crystal	0	12	44	44	0	0	10.8	10.5
MICROPROCESSOR ICs								
8-bit	24	18	29	29	0	0	7.3	7.6
16-bit	6	25	19	50	0	0	10.0	9.3
32-bit	0	15	15	62	8	0	13.5	7.6
FUNCTION PACKAGES								
Amplifier	20	20	30	30	0	0	7.6	6.4
Converter, analog to digital	7	29	28	36	0	0	8.6	8.6
Converter, digital to analog	0	46	27	27	0	0	7.4	9.2
LINE FILTERS	13	20	40	27	0	0	7.9	9.4
CAPACITORS								
Ceramic monolithic	17	25	46	12	0	0	6.1	5.8
Ceramic disc	30	30	22	18	0	0	5.2	5.1
Film	14	38	19	24	5	0	7.4	4.8
Aluminum electrolytic	19	23	35	23	0	0	6.9	4.8
Tantalum	24	32	32	8	4	0	5.5	6.2
INDUCTORS	5	37	42	16	0	0	6.7	9.3

Source: *Electronics Purchasing* magazine's survey of buyers

ABBOTT'S NEW M25; A HIGHER PERFORMANCE, 25-WATT SWITCHING POWER SUPPLY



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DIMENSIONS	**6.25"x 2.75"x 1.5"**
Input frequency	*47-440 Hz*
Input voltage	*103.5 to 126.5 V rms*
Outputs	*5, 12, 15, 24, 28 V*
Efficiency	*70% minimum*
Ripple/noise	*20 mV rms/100 mV p-p*
Line regulation	*10 mV*
Load regulation	*25 mV*
EMI	*MIL-STD-461B*
Environment	*MIL-STD-810C*
	MIL-S-901C
Input protection	*MIL-STD-1399 sec 103*
Operating temperature range	*−20°C to 71°C*
Storage temperature range	*−55°C to 85°C*
MTBF (ground benign)*	
Standard	*176,000 hours*
ER Option	*759,000 hours*
MTBF (naval sheltered)*	
Standard	*33,000 hours*
ER Option	*125,000 hours*

**MIL-STD-217D (50°C baseplate)*

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MILITARY POWER SUPPLIES

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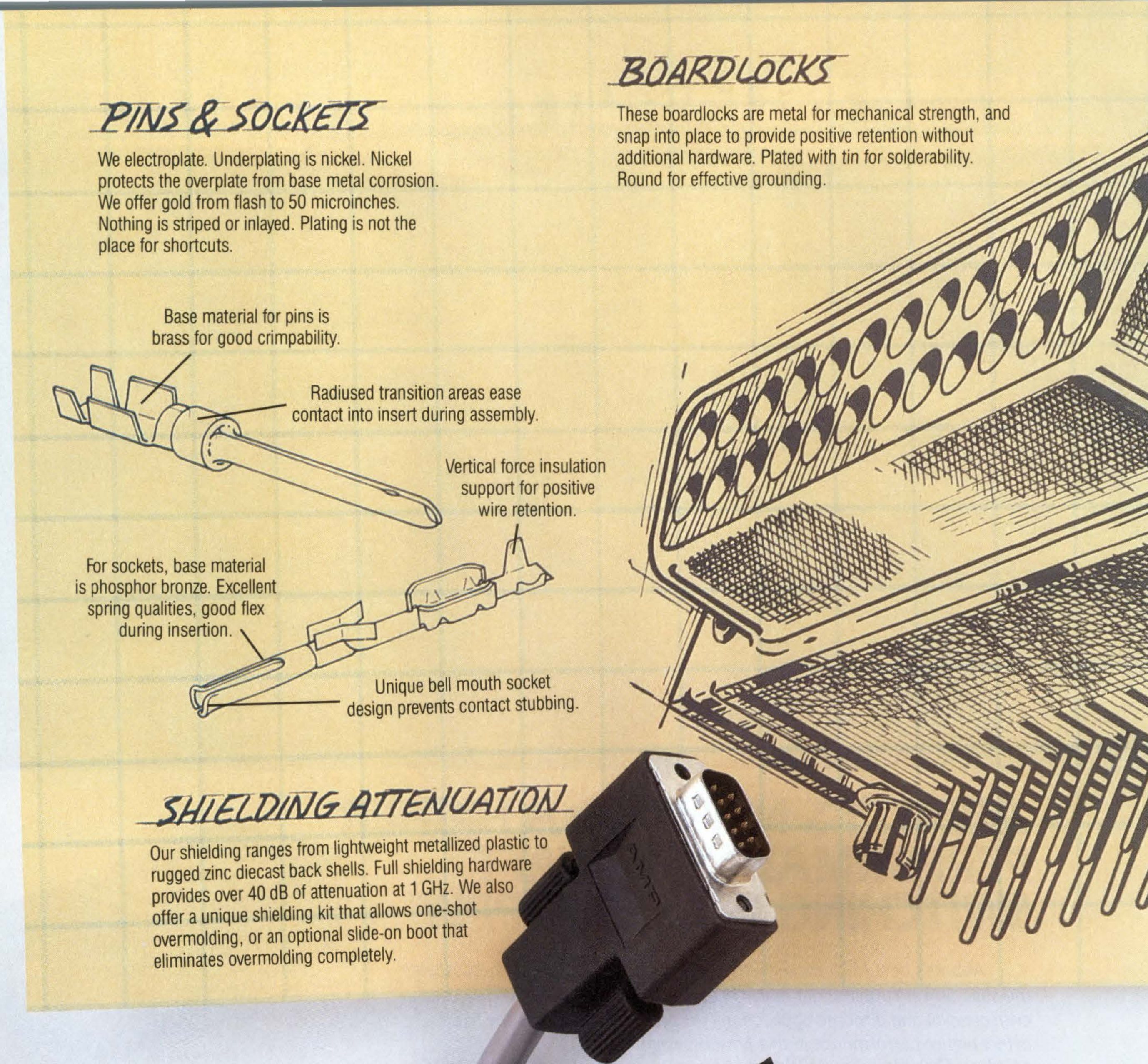

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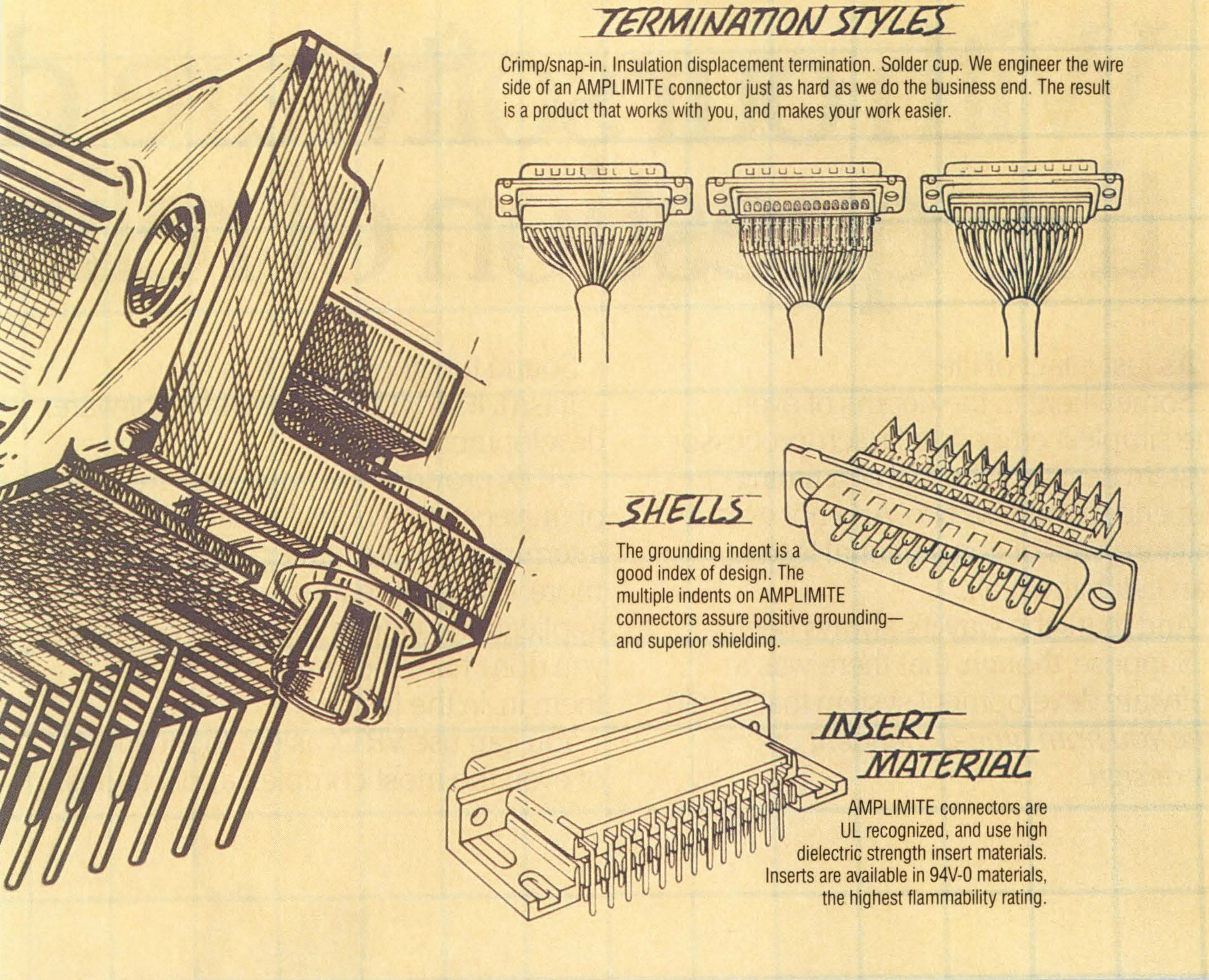

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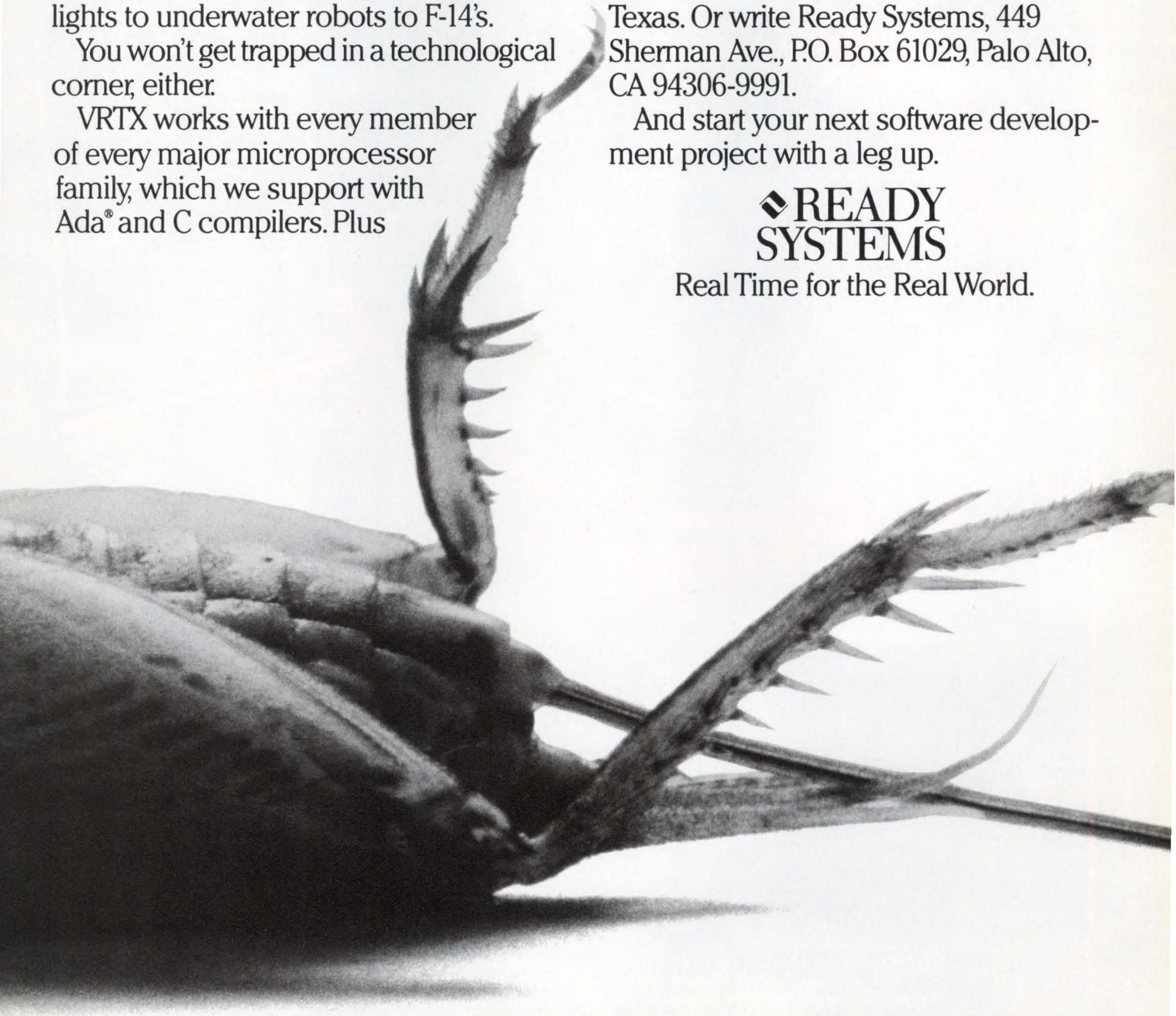

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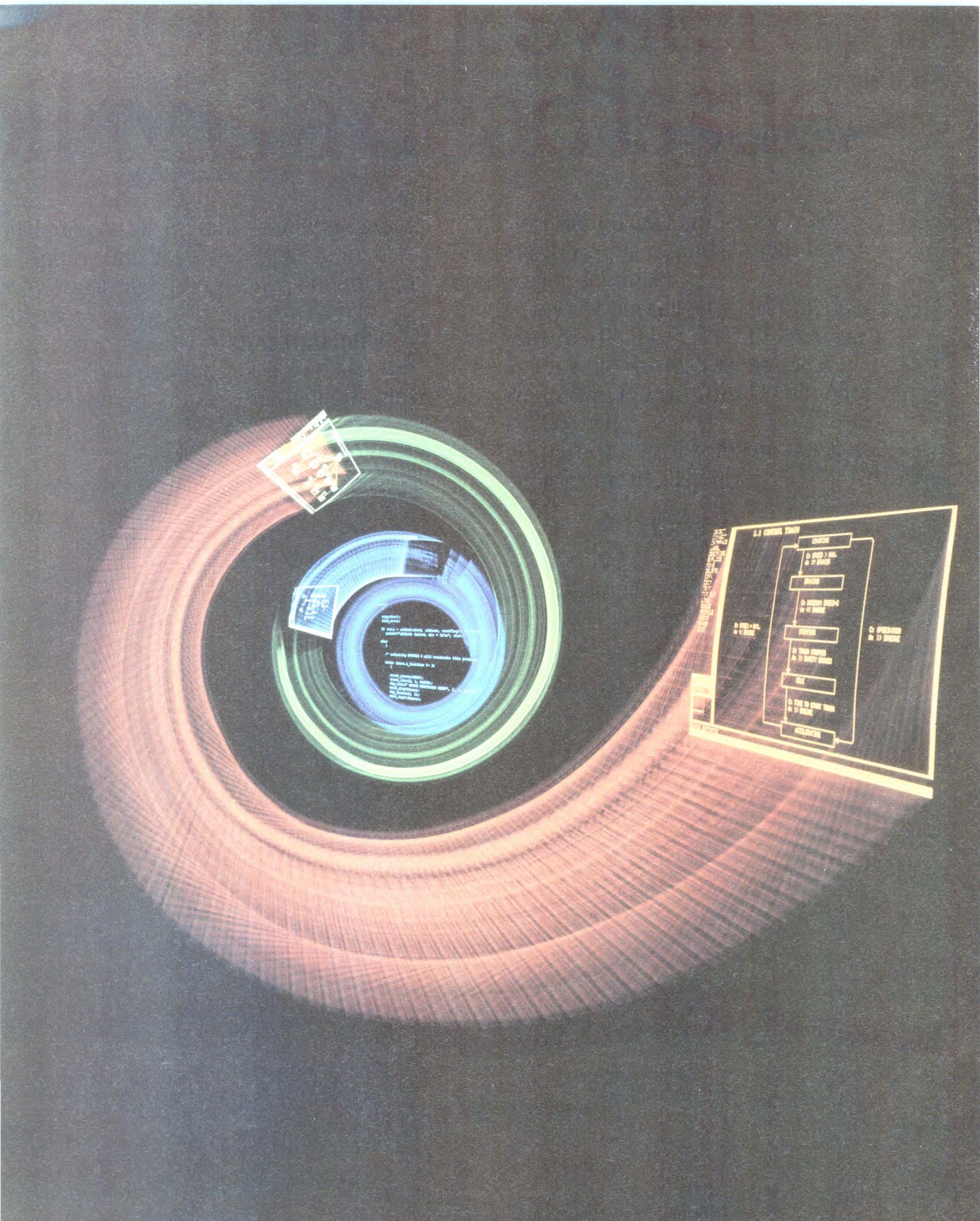

Representing the life cycle of a software system as a spiral can be illuminating. Each proposed modification of the system starts a new pass through the loop comprising requirements analysis, module design, coding, and testing, and yields a result that is different (displaced) from the previous one.
(Photo courtesy Index Technology)

CASE tools

More and more, CASE (computer-aided software engineering) is becoming vital to the success of large projects, and vendors are starting to make progress in filling two of the technology's most serious gaps—code generation and intertool communication.

Chris Terry, *Associate Editor*

An ideal set of CASE tools would not only help you analyze your system requirements and design the program modules to fulfill those requirements, but would also automatically generate the code, perform version-control and maintenance functions, and allow you to extract any drawing or specification or code block from the database for inclusion in the documentation. For maximum versatility, the ideal toolset would allow you to import data from or export data to other vendors' CASE tools and, by means of reverse-engineering techniques, it would help in updating existing programs and systems that weren't originally designed with CASE.

Unfortunately, the ideal CASE toolset does not yet exist. Considerable gaps in the sequence of CASE design remain, and the necessary technology, or industry-wide agreement, to fill these gaps is lacking. CASE tool vendors (of which there are currently more than 50) are well aware of these gaps, however, and are working to develop more sophisticated tools and to integrate these more closely. *(Ed Note: Because the price of a CASE toolset varies so much—from $1000 to $97,000—and because the price is so dependent on the target system and configuration you have in mind, this report does not include prices.)*

At present, the toolsets are strongest in the requirements-analysis and module-design phases—so-called front-end tools. Recently, too, reverse-engineering tools for the maintenance phase have started to become a reality. The biggest gaps still show up in the code-generation phase and in intertool-communication capabilities, but here, too, improvements are in progress.

All CASE toolsets provide a means of fully and accurately specifying *what* a software system must do: The system-requirements phase is the key to success or failure. At this stage, it's feasible and relatively inexpensive to change the design to satisfy new customer requirements, and to ensure that the logic of the design is correct and makes allowance for future changes. The ease or difficulty with which you can make such changes depends on the complexity of the project.

In a large project, it's not easy for any one designer to grasp the whole picture of what the system must do. CASE tools allow as many people as necessary to work on different parts of the design; built-in functions check the completeness and consistency of each part of the system requirements. Because CASE tools give you instant access to all sections of a design, you can look up the interfacing information that you'll need to ensure that your own section joins accurately and smoothly to the other sections.

Many of today's CASE tools offer you a choice among

At present, the toolsets are strongest in the requirements-analysis and module-design phases—so-called front-end tools.

several design methodologies for two main reasons. First, such flexibility means that you won't necessarily have to learn a new methodology to be able to use a particular tool. Second, if you're already familiar with several methodologies and their notations, you can apply the methodology that best suits your problem.

The notation and the kind of diagram available for requirements analysis vary widely according to the toolset. The most common convention is the data-flow diagram (DFD) of Yourdon and DeMarco's structured-analysis methodology, in which curved lines (representing data elements) connect circles (representing processes) and short pairs of parallel lines (representing storage areas) **(Fig 1)**. Cadre's Teamwork and Index Technology's Excelerator use this type of convention. Some tools may also use Warnier/Orr diagrams, in which each process is named at the root of a large curly brace, and where subtasks appear at the tips of the brace; they in turn are further decomposed into subtasks. Appropriately, Ken Orr & Associates' Brackets toolset uses this type. Or your tool may use Nassi-Shneiderman "structograms,"which are a form of decision table; an example is Softlab's Maestro. If your toolset is intended for database design, it is more likely that it uses Chen-Merise diagrams, which emphasize the nature and interrelationships of data structures, rather than of processes (Chen & Associates' ER-Designer utilizes these types of diagrams).

Front-end tools check internal consistency

A key feature of all system-specification CASE tools is the ability to store descriptions of data elements and processes in a database (called the data dictionary). The tools use the information in the data dictionary to crosscheck every entry, not just against the design rules of your chosen methodology, but also against your previous entries. The tools detect and report errors such as data elements that are never used, inconsistent naming of data elements, and many others.

Most tools provide many levels of detail so that you can break down a large task into a number of subtasks, and each of those, in turn, into "subsubtasks." The built-in completeness and consistency checks can help at this stage, for example, by warning you if your description of a process requires an input data element that you haven't yet defined. The decomposition of tasks is often called structured analysis (a term that Edward Yourdon and Tom DeMarco originated), and it continues until you reach a level of detail that will let you start to specify how to perform the subtasks.

When you've completed the system-requirements phase, you know what the system must do, in sufficient detail, to start identifying the program modules that will accomplish the tasks and subtasks you've specified. You're now embarking on the implementation phase—what Yourdon and DeMarco identified as structured design. Here you'll be using a different CASE tool, one that will allow you to specify not only what a program module will do, but how it will do it, its relationship to other modules, and how it will communicate with them.

The structured-design tool draws on the data dictionary that the structured-analysis tool has created, and adds new specifications to the dictionary. Here, too, built-in consistency and completeness checks prevent many of the conflicts that can arise when different programmers work on different parts of a system.

Many structured-design CASE tools, like their structured-analysis counterparts, provide a choice of methodology and allow you to apply the design methods best suited to your problem. For example, tools that implement the Boeing-Hatley extensions to DeMarco's original structured-design methodology, such as Cadre's Teamwork/RT and Index Technology's Excelerator, are particularly well-suited to the design of embedded real-time systems. The notation allows you to show the relationships between both synchronous and asynchronous events in the system.

When you've completed the implementation phase, you have a specification of each program module from which you can start coding. Some CASE tools allow the module specification in the database to contain skeleton

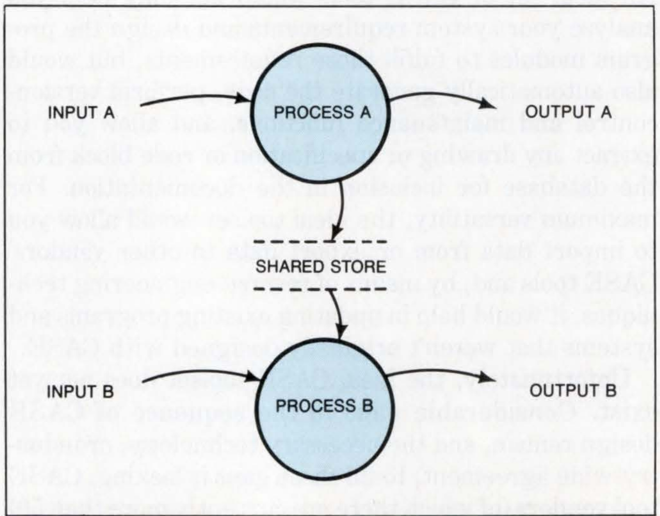

Fig 1—This simple data-flow diagram *shows the symbology of the Yourdon-DeMarco structured-analysis methodology.*

TABLE 1—REPRESENTATIVE CASE TOOLS WITH CODE GENERATORS AND REVERSE ENGINEERING

VENDOR	PRODUCT	FEATURES
ADVANCED TECHNOLOGY INTERNATIONAL	SUPERCASE	CODE FRAMES, CROSS DEVELOPMENT, REVERSE ENGINEERING
APTOOLS	APTOOLS	FULL CODE(ADA)
CADRE TECHNOLOGIES	TEAMWORK/ADA	CODE FRAMES (ADA)
COMPUTER COMMAND & CONTROL CO	MODEL	FULL CODE (ADA, C, PL/1)
HEARTLAND SYSTEMS	SOURCEVIEW	CODE FRAMES (C, COBOL, PASCAL), REVERSE ENGINEERING
ICONIX SOFTWARE ENGINEERING	POWERTOOLS	CODE FRAMES (ADA, C, FORTRAN, LISP, MODULA-2, PROLOG), REVERSE ENGINEERING
I-LOGIX	ADA PROTOTYPER	CODE FRAMES (ADA)
INTEGRATED SYSTEMS	AUTOCODE	FULL CODE (ADA, C, FORTRAN), CROSS-DEVELOPMENT
INTERACTIVE DEVELOPMENT ENVIRONMENTS	SOFTWARE THROUGH PICTURES	CODE FRAMES (ADA, C, PASCAL)
PROMOD INC	PRO/SOURCE, PROMOD/MD, RE-SOURCE	CODE FRAMES (ADA, C, PASCAL), REVERSE ENGINEERING
RATIONAL	R1000	FULL CODE (ADA) CROSS DEVELOPMENT
SCANDURA INTELLIGENT SYSTEMS	PRODOC	CODE FRAMES (ADA, C, PASCAL), REVERSE ENGINEERING
SOFTLAB	MAESTRO	CODE FRAMES (COBOL, PL/1, C)
SOFTWARE PRODUCTS & SERVICES (SPS)	EPOS	FULL CODE (ADA, C/ATLAS, FORTRAN, PASCAL, PEARL), CROSS DEVELOPMENT, REVERSE ENGINEERING
SYSCON	SKETCHER	CODE FRAMES (ADA), REVERSE ENGINEERING
TASC	ADAGRAPH	CODE FRAMES, FULL CODE (ADA), CROSS DEVELOPMENT
TELEDYNE BROWN	TAGS	FULL CODE (ADA) CROSS DEVELOPMENT

code or code fragments in the high-level language (HLL) of your choice.

It's at this point in the design sequence that you'll find one of the big gaps in CASE technology. An ideal toolset would be able to access all of the design data you've created and, from it, automatically generate a complete set of production code that would implement your design. Granted, satisfactory code generators for specialized tasks such as screen painting and report formatting have been around for several years, but designing a reliable *generalized* code generator has proven far more difficult.

Vendors are achieving some progress in this area, though, and of the more than 50 vendors of CASE tools, six now offer "full-code" generators that automatically generate 75% or more of the HLL code for implementing the program modules **(Table 1)**. Eleven other vendors offer code generators that produce either code frames or skeleton HLL code. Both of these types use the data contained in the front-end tools' central database and generate output, usually consisting of Ada, Pascal, or C statements. Code generators for Modula-2, Lisp, Prolog, PL/1, and Fortran do exist, but they are not widely available.

The full-code generators usually require that you define hardware-specific features of the target system by means of a program-definition language (PDL), and that you supply a library of previously coded low-level routines. The generators that produce code frames or skeleton code require even more manual intervention in order to ensure that new or modified hand-coded routines are reflected in the design data.

Some code generators also suffer from another problem, namely that they can't generate code for target machines with a different architecture than that of the host on which you're doing your development work. This restriction can pose a serious problem if you're cross-developing software for embedded systems. However, two vendors do offer Ada code-frame generators, and four others offer Ada full-code generators for embedded systems **(Table 1)**.

When you've completed the coding of the modules—automatically or by hand—the straightforward part of the job is over. Now the complex tasks of correlation, *A key feature of all system-specification CASE tools is the ability to store descriptions of data elements and processes in a database.*

testing, and configuration control begin. Most of the tools for these tasks are currently outside the realm of a CASE toolset's capabilities, but some do exist, and others are available from other vendors.

Correlation is the process of verifying that every function in the system requirements is implemented by some program module, and of identifying that module. Testing includes performance-analysis procedures to ensure that the code executes and also that every part of the code is executed at least once. CASE tools for automatic correlation and testing are rare; however, the Tektronix Tekcase toolset's Auditor tool provides a complete audit trail from system requirements to software deliverables. Also, Hewlett-Packard's HP/Teamwork toolset provides links to its AX-BA performance-analyzer tool.

Configuration control is the process of ensuring that the complete system always contains the latest version of each module. Typical tools for this are DEC's Test Management System (TMS) and Configuration Management System (CMS) and the Unix Make utility. The configuration-control process begins during the implementation phase, and continues into the maintenance phase.

Tying up the loose ends

When you've reached the maintenance phase, reverse-engineering tools can provide valuable aid in two distinct ways. First, you can use them to ensure that the final code does indeed perform all the required functions and that changes in the production code are reflected in the design database. Second, you can apply them to the source code of existing programs that require updating, maintenance, or enhancement, but were not designed with the aid of CASE tools.

For example, reverse-engineering tools, such as ReSource in the Promod toolset and Designer in the Tekcase toolset, accept HLL source code as input,

Manufacturers of CASE tools

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

Advanced Technology International
350 Fifth Ave
New York, NY 10118
(212) 947-4755
Circle No 650

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945 Concord St
Framingham, MA 01701
(617) 875-5142
Circle No 651

Asyst Technologies
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Montreal, Quebec, Canada H2Z 1S8
(514) 871-0108
Circle No 652

Atherton Technology
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Santa Clara, CA 94089
(408) 734-9822
Circle No 653

Cadre Technologies Inc
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(401) 351-5950
Circle No 654

CAP Gemini Software Products
2350 Valley View Lane, Suite 420
Dallas, TX 75234
(214) 247-5454
Circle No 655

Case Technology Inc
2141 Landings Dr
Mountain View, CA 94043
(415) 962-1440
TLX 506-513
Circle No 656

Caseware Inc
1590 Corporate Dr
Costa Mesa, CA 92626
(714) 754-0308
Circle No 657

CGI Systems
1 Blue Hill Drive Plaza
Pearl River, NY 10965
(914) 735-5030
Circle No 658

Chen & Associates
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(504) 928-5765
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2401 Walnut St, Suite 402
Philadelphia, PA 19103
(215) 854-0555
Circle No 660

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138 Technology Dr
Waltham, MA 02154
(617) 894-7000
Circle No 661

Digital Equipment Corp
1 Iron Way
Marlboro, MA 01752
(617) 329-7700
Circle No 662

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557 Dixon Rd, Suite 110
Rexdale, Ontario, Canada M9W 1H7
(416) 249-2246
Circle No 663

Heartland Systems
1601 Kasold Dr
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(913) 749-2626
Circle No 664

Hewlett Packard
Logic Systems Div
Box 617
Colorado Springs, CO 80901
(303) 590-5889
Circle No 665

Higher Order Software Inc
Box 178
Somerville, MA 02143
(617) 628-8500
Circle No 666

Iconix Software Engineering
2800 28th St, Suite 320
Santa Monica, CA 90405
(213) 458-0092
Circle No 667

I-Logix
124 Mt Auburn St
Cambridge, MA 02138
(617) 576-5732
Circle No 668

Index Technology Corp
1 Main St
Cambridge, MA 02142
(617) 494-8200
TWX 910-380-7014
Circle No 669

Integrated Systems
2500 Mission College Blvd
Santa Clara, CA 95054
(408) 980-1500
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analyze it, and generate corresponding module-design and data-flow diagrams that the front-end tools can use as input. This capability allows you to utilize the full potential of CASE in a task that traditionally has been notoriously difficult and time-consuming.

All of the fundamental data necessary for proper documentation of a project is contained in the central design database originally created by the front-end tools. This data is in the form of drawings and data-element specifications, process specifications, interface specifications, and program-module specifications. The database may also contain skeleton code or substantial amounts of production code, depending on the nature of the toolset. Documentation tools can present integration problems, partly because they are, in themselves, complex systems that may be too large to be included in a CASE toolset, and partly because the best ones come from non-CASE vendors and may use an internal format incompatible with the one the CASE toolset uses.

Ways exist to overcome this incompatibility, however. One way is to arrange for the CASE tool to export text and drawings in print-image form, which the documentation tool can then treat as if it were keyboard input. Some toolsets, such as Cadre's Teamwork (which is also the basis of both the Hewlett-Packard and the Tektronix toolsets), Index Technology's Excelerator, and Teledyne Brown's Tags, now provide means by which Context's highly sophisticated documentation tool can request any data from the CASE database in print-image format. The Context tool does not directly access the design database, but can request both text and drawings in a print-image format that it can then store and incorporate into the system documentation.

The integration of different tools within a particular vendor's toolset is receiving the urgent attention of all CASE vendors except those few (Tektronix, Teledyne Brown, and SPS) that already offer toolsets that cover all phases of development from system requirements,

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San Francisco, CA 94103
(415) 543-0900
Circle No 671

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Topeka, KS 66604
(913) 273-0653
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Knowledgeware
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Atlanta, GA 30026
(404) 231-8575
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131 Hartwell Ave
Lexington, MA 02173
(617) 863-5800
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McDonnell Douglas ISG
Dept L863, Bldg 302-1E
Box 516
St Louis, MO 63166
(800) 325-1087
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Nastec Corp
24681 Northwester Hwy
Southfield, MI 48075
(313) 353-3300
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Promod
23685 Birtcher Dr
Lake Forest, CA 92630
(714) 855-3046
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Rational
1501 Salado Dr
Mountain View, CA 94043
(415) 940-4700
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Sage Software
3200 Monroe St
Rockville, MD 20852
(301) 230-3200
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Scandura Intelligent Systems
1249 Greentree Lane
Narberth, PA 19072
(215) 664-1207
Circle No 680

Softlab Inc,
188 The Embarcadero
Bayside Plaza
San Francisco, CA 94105
(415) 957-9175
Circle No 681

Software Design Tools Inc
Sunset/Vine Tower, Suite 1126
6290 Sunset Blvd
Los Angeles, CA 90028
(213) 463-6102
Circle No 682

Software Products & Services Inc
14 E 38th St
New York, NY 10016
(212) 686-3790
TLX 852616
Circle No 683

Syscon
3990 Sherman St
San Diego, CA 92110
(619) 296-0085
Circle No 684

TASC
1700 N Moore St, Suite 1220
Arlington, VA 22209
(703) 558-7400
Circle No 685

Tektronix
CASE Div
Box 4600, M/S 92-635
Beaverton, OR 97076
(503) 629-1573
Circle No 686

Teledyne Brown Engineering
300 Sparkman Dr
Cummings Research Park
Huntsville, AL 35807
(205) 532-1482
Circle No 687

Visible Systems Corp
49 Lexington St
Newton, MA 02165
(617) 969-4405
Circle No 688

Visual Software Inc
3945 Freedom Circle, Suite 540
Santa Clara, CA 95054
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Yourdon Software Engineering
1501 Broadway
New York, NY 10036
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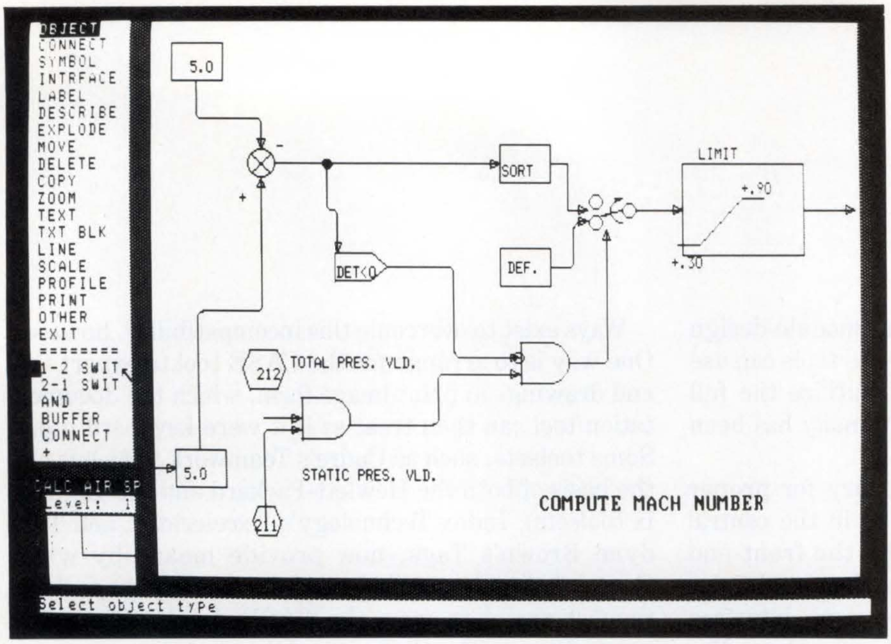

***CASE toolsets such as the Excelerator** from Index Technology are well-suited to embedded, real-time system design. The toolset's notation enables the portrayal of synchronous vs asynchronous events.*

through coding, to maintenance. The vendors' goal is to approach, as closely as possible, the ideal of a complete toolset whose components all generate and modify a single database throughout the life cycle of the software system. The continual use of a shared design database eliminates the synchronization problems that can arise when different team members each have a separate copy of the database.

Large projects may use a mixture of tools

Within any given toolset, integration problems arise mainly because some of the individual tools that ought to be part of a complete toolset do not exist in a form that is compatible with the other tools. Again, code generators serve as a good example of this problem. The code generator in the Maestro toolset from Softlab, for instance, requires PDL input in addition to the Nassi-Shneiderman structograms. The Teledyne Brown Tags toolset also incorporates a code generator, which receives its input from a proprietary specialized Input/Output Requirements Language (IORL) and currently generates only Ada source code (though the company intends to add VHDL ((VHSC Hardware Description Language)) as an output option during 1988). Of the six vendors who offer full-code generators, only three currently offer more than one HLL as output. Of the 10 who offer code-frame generators as part of their toolsets, five offer Ada, Pascal, and C as the output languages.

All of the other CASE toolsets available require either that you code by hand from the module-design specifications, or that you use a stand-alone code generator from some other vendor (such as DEC). The majority of such stand-alone generators are intended for management-information-system applications and generate Cobol code or code frames. However, Index Technology's Excelerator toolset does now generate diagrams that Pansophic Systems' Telon series of code generators can use directly.

A very large project may require that different vendors at widely separated geographic locations develop different portions of the project. It is possible (and even probable) that the different vendors may use different CASE toolsets, and that the coordinating agency uses yet another toolset. There is at present no easy way to export data from one CASE tool to another, but vendors are at work on this intertool-communication problem.

Cadre has proposed extensions to the EDIF (Electronic Data Interchange Format) that would permit the interchange of data between CASE tools from different vendors, and also between CASE and CAE tools. A committee is currently working on translating Cadre's proposals into generally acceptable form, and it's possible that the use of EDIF may prove the best means of interchanging data between incompatible CASE tools at widely separated locations. However, EDIF is not easy to use and, as yet, no wild acclamation for it has been heard.

Atherton Technology has taken a different approach to intertool communication with its 4-layered Software Backplane. This tool is designed to provide you with uniform and independent access to many different software tools, while maintaining features that are native to the hardware of the host machine.

A monitor layer, based on MIT's X-Windows, provides a common display environment that gives all CASE tools a similar look and feel. The vendor claims that this characteristic will reduce the effort needed to learn the characteristics of an entire toolset. A management-control layer provides a variety of services, including source-version control and configuration management. An object-management layer provides a repository for all project-related data and imposes a single, consistent view of the data so that a variety of incompatible tools can share the information. And finally, a portability layer contains a generalized operating system that maps Software Backplane standard serv-

ices to the native functions of the host operating system.

The vendor claims that once you've ported a CASE tool to the Software Backplane, the tool will run without any change on any hardware system that is equipped with the Software Backplane. The Software Backplane is compatible with the Sun-3 family of workstations operating under Unix and with all VAX and MicroVAX systems running under VMS or MicroVMS.

The world of CASE is still developing and changing rapidly. There are already indications that in the near future some vendors will start using artificial-intelligence techniques to enhance the capabilities of their tools, especially those of code generators. For now, as you weigh the value of the various CASE tools, keep in mind certain questions: How closely is the code generator coupled to both the front-end design tools and the back-end testing and maintenance tools? How complete are the design techniques and tools? What percentage of the finished code can the generator produce? Does the generator support prototyping (that is, quick simulation of the human interface and main operations)? Does the generator support cross development?

This last question will be of particular importance to you if you are designing embedded systems, because the target machine may be very different from the host on which your CASE tools run—and some code generators generate code only for the host or a very similar machine.

Another question you may want to ask is whether the tool produces documentation that is compatible with federal or military standards. Some CASE toolsets provide documentation that fully conforms to these standards, others do not.

Happily, you can easily gain access to a wealth of information to help you in your investigation. Some sources include CASE conferences and the papers presented there; vendor-run training seminars, which help you to focus on your specific needs and on finding the tool that best suits those needs; and at least one independent monthly journal, *Case Outlook* (**Ref 1**), which is devoted to surveys of CASE technology. **EDN**

References

1. *Case Outlook*, Case Consulting Group, Portland, OR ($395/year).

2. Terry, Chris, "Customer training and reverse engineering promise to escalate the acceptance of CASE," *EDN*, March 17, 1988, pg 73.

Article Interest Quotient (Circle One)
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Products that set the pace.

Samsung's sophisticated manufacturing facility at Bucheon employs internally-developed Advanced CMOS and Bipolar processes.

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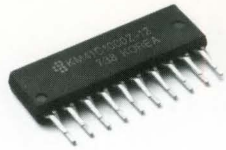
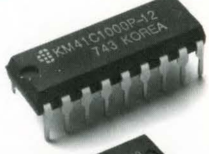
Samsung's new 1Mb DRAMs set today's fast memory pace.



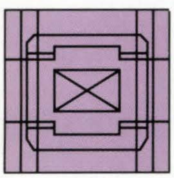
In the 1Mb DRAM, Samsung's pacesetting CMOS technology provides superior immunity to electrostatic discharge, lower soft error rates and high immunity to latchup.



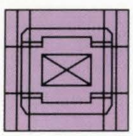
The KM41C100X and KM44C25X series of one-megabit DRAMs in CMOS technology are our latest high-density memory offerings. Fabricated using Samsung's internally developed CMOS technology, they feature line widths as fine as 1 μm.

This leading technology enables us to offer a device with very low power consumption and high-speed access times. Our pace setting DRAMs are designed for computing applications from mainframes and minis to high performance graphics stations and work stations, as well as for instruments and telecommunications products.

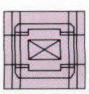
Samsung technology has evolved from 2.5 micron to sub-micron in just four years.



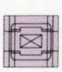
1984-64K
117μ^2 cell size
2.5μm geometry



1985-256K
62.5μ^2 cell size
1.6μm geometry



1987-1Mb
27μ^2 cell size
1.0μm geometry



1988-4Mb
10.25μ^2 cell size
0.8μm geometry

Our 1Mb DRAMs are manufactured in production volumes at our 6-inch wafer fabrication facility, considered to be one of the most advanced of its kind, using very high-resolution steppers and state-of-the-art etching and implantation equipment. Samsung is adding DRAM wafer capacity with a new 6-inch facility which will be equipped to manufacture our 4Mb DRAM.

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All are available in plastic DIP, ZIP, and SOJ or PLCC industry standard packages.

Our packaging technology is not limited to components. Samsung SIP and SIMM memory modules for the 256K and 1Mb DRAMs offer a cost effective method of utilizing surface mount technology to increase board density.

Part Type	Organ.	Features	Speeds	Packages	Avail.
KM41C1000	1M x 1	Fast Page mode	100,120	DIP, ZIP, SOJ	Now
KM41C1001	1M x 1	Nibble mode	100,120	DIP, ZIP, SOJ	2Q '88*
KM41C1002	1M x 1	Static Column mode	100,120	DIP, ZIP, SOJ	2Q '88*
KM44C256	256K x 4	Fast Page mode	100,120	DIP, ZIP, SOJ	2Q '88
KM44C258	256K x 4	Static Column mode	100,120	DIP, ZIP, SOJ	2Q '88
KM41256	256K x 1	Page mode	120,150	DIP, ZIP, PLCC	Now
KM41257	256 x 1	Nibble mode	120,150	DIP, ZIP, PLCC	Now
KM41464	64K x 4	Page mode	120,150	DIP, ZIP, PLCC	Now
KM4164	64K x 1	Page mode	120,150	DIP	Now
KMM48/9256	256K x 8/9	Page or Nibble modes	120,150	SIP module	Now
KMM58/9256	256K x 8/9	Page or Nibble modes	120,150	SIMM module	Now
KMM48/91000	1M x 8/9	Fast Page mode	100,120	SIP module	2Q '88
KMM58/91000	1M x 8/9	Fast Page mode	100,120	SIMM module	2Q '88

*Samples available now.

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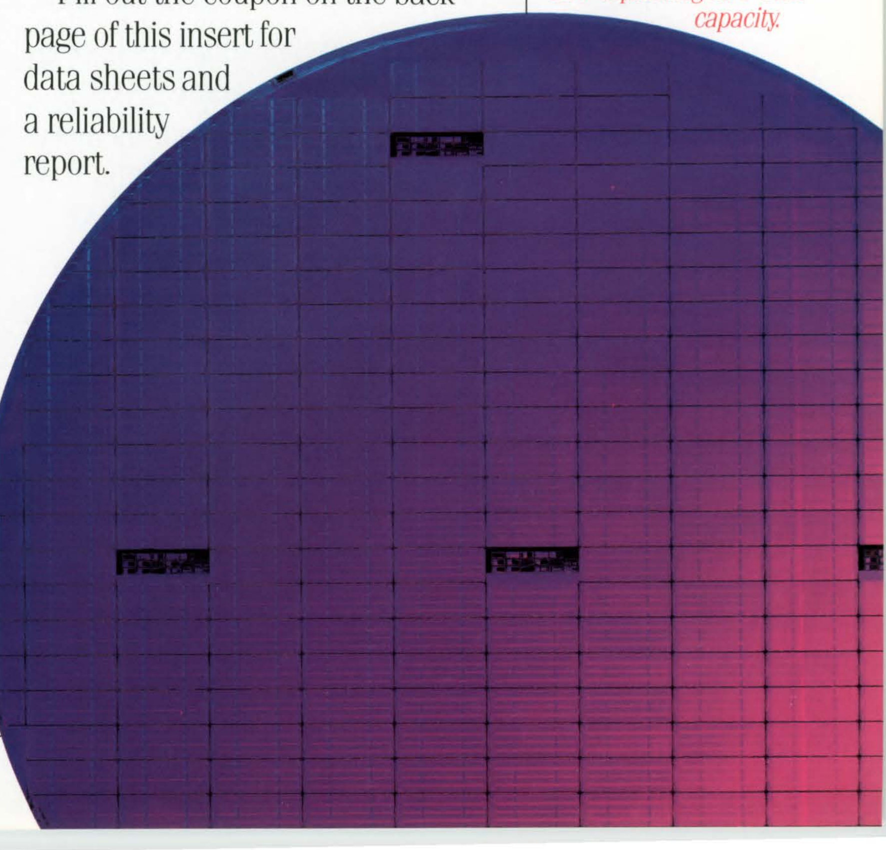
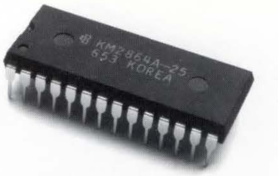


Circle No. 167

Samsung EEPROMs also outpace industry standards.



Advanced Samsung 16K and 64K EEPROMs are now available in production quantities.

Samsung's 64K and 16K EEPROMs meet or surpass all industry standards for performance, reliability and quality. They have standard endurance ratings of 10,000 erase/write cycles and data retention ratings of 10 years.

And our "H" version 64Ks offer a quick 2 millisecond per byte write time, reducing write time by a factor of 5.

Part Type	Organization	Speed	Features	Technology	Pinout	Availability
KM2816AP	2K x 8	250,300,350	10ms (max) write time	NMOS	24 pin	Now
KM2817AP	2K x 8	250,300,350	Ready/Busy, 10ms (max) write time	NMOS	28 pin	Now
KM2864AP	8K x 8	250,300,350	Data Polling, 10ms (max) write time	NMOS	28 pin	Now
KM2865AP	8K x 8	250,300,350	Data Polling, Ready/Busy, 10ms (max) write time	NMOS	28 pin	Now
KM2864AHP	8K x 8	250,300,350	Data Polling, 2ms (max) write time	NMOS	28 pin	Now
KM2865AHP	8K x 8	250,300,350	Data Polling, Ready/Busy, 2ms (max) write time	NMOS	28 pin	Now
KM28C64P	8K x 8	150,200,250	Data Polling, 32-byte Page Mode, Low Power, 5ms (max) write time	CMOS	28 pin	May '88*
KM28C65P	8K x 8	150,200,250	Data Polling, 32-byte Page Mode, Low Power, 5ms (max) write time	CMOS	28 pin	May '88*

*Samples available now.

Our new 64K KM28C64 series (available 2nd quarter 1988) is fabricated with our pacesetting floating gate CMOS processing. It features low power dissipation of 100μA standby and access times of 150ns, 200ns and 250ns. These advanced 8K x 8 EEPROMs also feature a 32-byte page mode to slash write times to 150 microseconds per byte and a 5-millisecond write cycle. This allows the entire 64K memory to be written in only 1.3 seconds.

Samsung's EEPROMs excel in such rugged applications as communications, instrumentation, robotics and industrial control. All our EEPROMs meet JEDEC pinout standards.

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The fast pace continues with Samsung low power SRAMs.

Samsung's 256K (32K x 8) KM62256 SRAMs are available with access times of 100ns, 120ns and 150ns, all in low-power versions with standby current of only 4μA (typical).

Samsung SRAMs are fabricated using 1.2 μm CMOS technology. In 1988, we are ramping up 256K and 64K SRAM production.

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The KM62256 256K SRAM is fabricated using our internally developed 1.2 μm CMOS technology which meets both high speed and low power requirements. We offer 80ns 64K SRAMs and 100ns 256K SRAMs in high volume. They're ideal for process control, medical instruments, and hand held devices.

Samsung is ramping up production of both the 256K and 64K CMOS SRAMs. Our complete line is available now in industry standard packages and pinouts.

Part Type	KM62256L	KM6264AL
Organization	32K x 8	8K x 8
Speeds	100, 120, 150ns	80, 100, 120ns
Package	28 DIP	28 DIP
Max Current (standby)	100μA	100μA
Availability	Now	Now

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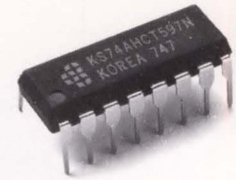
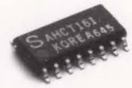
Samsung Advanced AHCT CMOS Logic Family keeps pace with the fastest 16- and 32-bit microprocessors.





Samsung's Advanced CMOS Logic is available in both DIP and SOIC packages.

Available now in production quantities, our Advanced AHCT CMOS Logic Family meets the demands of your 16- and 32-bit designs for high speed, high drive and low power.

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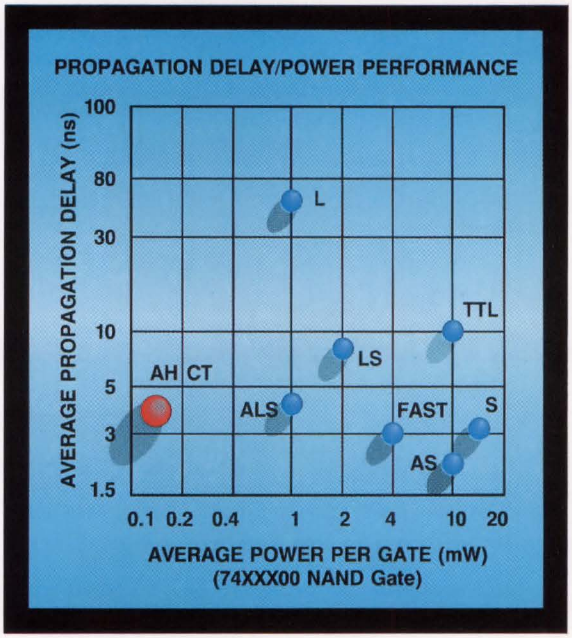
For power reduction in your existing designs, AHCT offers pin-for-pin, part-for-part replacement for ALS and FAST.™ It fits right in and reduces power tenfold. Yet our AHCT doesn't have a premium price. It costs the same as ALS.

Fill out the coupon on the back page of this insert for free samples and a data book.



Circle No. 170

KS74AHCT PARTS LIST

Gates and Inverters	
00	20
01	21
02	22
03	27
04	30
05	32
08	51
09	58
10	86
11	132
12	133
14	266

Buffers & Line Drivers	
125	367
126	368
210	465*
240	466*
241	467*
244	468*
365	540
366	541

Flip-Flops	
73	399
74	534
76	564
78	574
107	670
109	794*
112	821*
173	822*
174	823*
175	824*
273	825*
374	826*
377	

Latches	
75*	793*
77*	841*
259	842*
373	843*
533	844*
563	845*
573	846*

Transceivers/Registered Transceivers		
242*	643	652*
243*	645	658*
245	646	659*
640	648	664*
	651*	665*

Counters		
160	190	590*
161	191	591*
162	192	592*
163	193	593*
168	390*	
169	393	

Decoders/Encoders		
42	148*	238
138	154	239
139	155	

Multivibrators		
121*	123*	423*

Logic Level Converters	
4049	4050*

Multiplexers	
151	253
153	257
157	258
158	352
251	353

Shift Registers	
164	299
165	595
166	596
194	597
195	

Arithmetic Circuits	
181*	522*
182*	679
183	680
280	682
518*	684*
519	686*
520*	688
521	689*

*Part types available in 2Q '88. All other part types available now.

FAST is a trademark of Fairchild Semiconductor, Inc.

Samsung's KSV3110 combo A/D-D/A and KSV3208 A/D set the pace in flash converters.

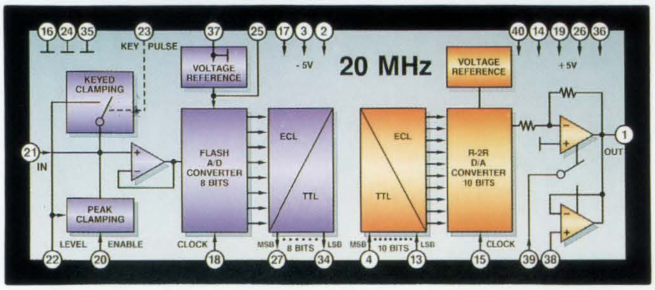
KSV3110 Combo A/D-D/A Flash Converter

KSV3208 A/D Flash Converter

The pacesetting technology of our single-chip KSV3110 A/D-D/A data converter provides independent 8-bit A/D converter functions and 10-bit R-2R D/A converter functions over an operating range of DC to 20MHz.

With the ease of design you get with the KSV3110's two chips in one, you'll save both money and real estate, leaving room and resources to add other features. And having fewer parts cuts down power drain and boosts system reliability.

The KSV3110 gives TTL-compatible input/output, 1% absolute non-linearity and selectable peak level input or keyed clamping.



The impressive linear characteristics of the KSV3110 are shared by our new KSV3208 A/D flash converter. It provides the same features for applications that don't require D/A conversion.

Samsung also offers the support chips to ease the integration of the KSV3110 into video applications. For example:

- KA2606 Sync Separate IC
- KA2153 Chrominance Signal Processor for NTSC systems
- KA2154 Video Chroma Deflection System for NTSC and PAL systems

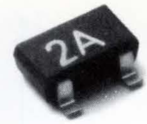
Fill out the coupon on the back page of this insert for samples and a Flash Converter IC Data Book.

Circle No. 171

Part Type	Resolution A/D	Resolution D/A	Linearity A/D	Linearity D/A	Conversion Speed	Industry Part
KSV3110N-10	8 bits	10 bits	± ½ LSB	± ½ LSB	20 MSPS	
KSV3110N-9	8 bits	10 bits	± ½ LSB	± 1 LSB	20 MSPS	
KSV3110N-8	8 bits	10 bits	± ½ LSB	± 2 LSB	20 MSPS	
KSV3110N-7	8 bits	10 bits	± ½ LSB	± 4 LSB	20 MSPS	
KSV3100AN-8	8 bits	10 bits	± ½ LSB	± 2 LSB	20 MSPS	UVC3101
KSV3100AN-7	8 bits	10 bits	± ½ LSB	± 4 LSB	20 MSPS	UVC3101
KSV3208N	8 bits		± ½ LSB		20 MSPS	
KAD0820ACN	8 bits		± ½ LSB		1.5 μsec	ADC0820BCN
KAD0820BCN	8 bits		± 1 LSB		1.5 μsec	ADC0820CCN
KAD0808IN	8 bits		± ½ LSB		100 μsec	ADC0808CCN
KAD0809IN	8 bits		± 1 LSB		100 μsec	ADC0809CCN
KDA0800CN		8 bits		± ½ LSB	*100 nsec	DAC0800LCN
KDA0801CN		8 bits		± 1 LSB	*100 nsec	DAC0801LCN
KDA0802CN		8 bits		± ¼ LSB	*100 nsec	DAC0802LCN
KDA0806CN		8 bits		± 2 LSB	*150 nsec	DAC0806LCN
KDA0807CN		8 bits		± 1 LSB	*150 nsec	DAC0807LCN
KDA0808CN		8 bits		± ½ LSB	*150 nsec	DAC0808LCN
KS7126CN	3½ digit		± ½ LSB		333 msec	TSC7126
KS25C02	CMOS 8-bit successive approx. register					DM2502
KS25C03	CMOS 8-bit successive approx. register					DM2503
KS25C04	CMOS 12-bit successive approx. register					DM2504

*Settling Time

Samsung's SOT-23s set the pace for surface mount technology.



Samsung has 100 types of SOT-23 available now.

Samsung has introduced 100 types of SOT-23s with an AOQL of 100 ppm or better—all with competitive pricing. They're ideal for both hybrid and surface mount applications. The entire line is in full production and available from stock. Samsung can deliver SOT-23s in the quantities you need when you need them.

SOT-23 PART TYPES

MMBR5179	MMBT5087	MMBTA55
MMBT2222A	MMBT5088	MMBTA56
MMBT2484	MMBT5401	MMBTA63
MMBT2907A	MMBT5550	MMBTA64
MMBT3904	MMBT6428	MMBTA70
MMBT3906	MMBTA05	MMBTA92
MMBT4123	MMBTA06	MMBTA93
MMBT4124	MMBTA13	MMBTH10
MMBT4125	MMBTA14	MMBTH17
MMBT4126	MMBTA20	MMBTH24
MMBT4401	MMBTA42	BCX70G
MMBT4403	MMBTA43	BCX71G

66 other types also available

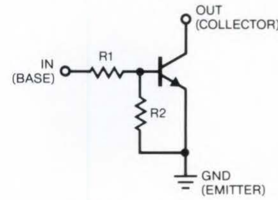
Samsung now has available a new family of digital transistors, the KSR1000 Series (NPN) and KSR2000 Series (PNP), with 40 part types in each family. They're especially useful for applications where logic circuits are being interfaced with electromechanical systems.

We also offer an extensive line of industry standard TO-92, TO-126, and TO-220 transistors, plus TIP-Series power transistors, small signal transistors, high speed high voltage switching power transistors, Darlington power transistors and 1500V TO-3P transistors.

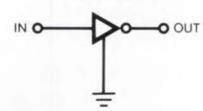
Fill out the coupon on the back page of this insert for samples and a copy of our new Transistor Data Book.

Circle No. 172

Internal Circuit



Function



Samsung's new KSR1000 and KSR2000 Series digital transistors are especially useful for applications where logic circuits are being interfaced with electromechanical systems.

Samsung sets a fast pace in delivering linear ICs.

The quality of Samsung linear ICs has gained them solid market acceptance. We now have over 250 industry-standard ICs available for immediate delivery. And Samsung has invested substantially to ensure that you get the latest technology, with high reliability in high volume at very low cost.

Fill out the coupon on the back page of this insert for samples and a data book.

Voltage Regulators
KA336Z-5 (LM336-5)
KA431CZ* (TL431)
KA431CN (TL431)
LM723CN
LM317T
MC78TXXCT
MC78XXCT
MC78XXACT
MC78LXXACZ
MC78MXXCT
MC79LXXACZ
MC79MXXCT
MC79XXCT
μA78S40CN
KA385Z-1.2 (LM385-1.2)

OP AMPS
KA301AN* (LM301A)
LM741CN*
MC1458CN*
MC4558CN*
LM358N*
LM358AN*
LM348N*
LM324N*
LM324AN*
MC3403N*
KS271 (TLC271)
KS272 (TLC272)
KS273 (TLC273)

Telecommunications ICs
KA2410N—Tone ringer
KA2411N—Tone ringer
KA2418N—Tone ringer with bridge diode
KA2412FN—Speech network
KA2413N—DTMF
KS5808N—DTMF
KS5805AN/BN—Pulse dialer
KS5819N—Pulse/DTMF (22 DIP)
KS5820N—Pulse/DTMF (18 DIP)
KT3040—CODEC filter
KT5116—CODEC
LM567N*—Tone decoder
LM567LN—Tone decoder Micropower

Timers
KS555N* (CMOS)
KS555HN* (CMOS)
KS556N* (CMOS)
NE555CN*
NE556CN*
NE558CN

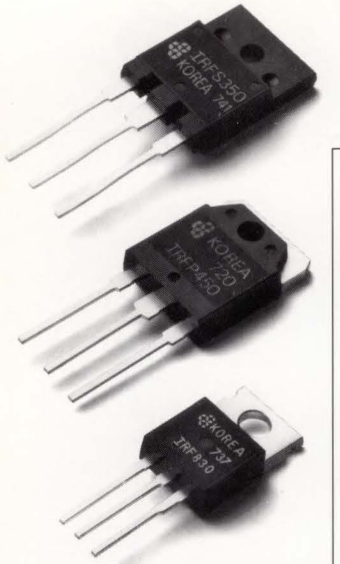
Comparators
KA319N
KA710CN
LM311N*
LM393N/AN*
LM339N/AN*
KS374N (TLC374)
KA361N (LM361)

RS-232 Interface
MC1488N*—Driver
MC1489N/AN*—Receiver

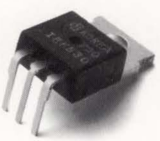
*Also available in surface-mount package (SOIC).

Circle No. 173

Samsung's MOSFETs have had fast-paced market acceptance.



Samsung's high-quality, industry-standard MOSFETs directly replace IR and Motorola® and are competitively priced.



Samsung's industry-standard power MOSFETs have rapidly gained market acceptance. Independent testing has demonstrated their excellent quality and superior ruggedness (2J at 500V). Each is screened to MIL-STD-750 specifications.

Our MOSFETs directly replace IR and Motorola.® They're available in a variety of packages, including lead-formed TO-220s, state-of-the-art TO-247 FULL PACK and DPAK.

And Samsung is an established supplier with over 400 part types, in both N and P channel, one of the broadest lines on the market. Our MOSFETs range from 60V to 700V. Plus, we're especially deep in the 500V to 700V range. All with competitive pricing.

Fill out the coupon on the back page of this insert for samples, a data book, and a ruggedness application note. Circle No. 174

TO-247 Full Pack N-Channel Types

IRFS130	IRFS443
IRFS133	IRFS450
IRFS140	IRFS453
IRFS143	SSS4N70
IRFS150	SSS6N70
IRFS153	SSS10N70
IRFS230	SSS4N60
IRFS233	SSS6N60
IRFS240	SSS8N60
IRFS243	SSS15N60
IRFS250	SSS6N55
IRFS253	SSS8N55
IRFS330	SSS15N55
IRFS333	SSS20N50
IRFS350	SSS20N45
IRFS353	SSS25N40
IRFS430	SSS25N35
IRFS433	SSS40N20
IRFS440	SSS40N15

TO-3P Package N-Channel Types

IRFP120	IRFP423
IRFP121	IRFP430
IRFP122	IRFP431
IRFP123	IRFP432
IRFP130	IRFP433
IRFP131	IRFP440
IRFP132	IRFP441
IRFP133	IRFP442
IRFP140	IRFP443
IRFP141	IRFP450
IRFP142	IRFP451
IRFP143	IRFP452
IRFP150	IRFP453
IRFP151	SSH3N70
IRFP152	SSH4N70
IRFP153	SSH6N70
IRFP220	SSH10N70
IRFP221	SSH4N60
IRFP222	SSH6N60
IRFP223	SSH8N60
IRFP230	SSH15N60
IRFP231	SSH4N55
IRFP232	SSH6N55
IRFP233	SSH8N55
IRFP240	SSH15N55
IRFP241	SSH4N50
IRFP242	SSH20N50
IRFP243	SSH4N45
IRFP250	SSH20N45
IRFP251	SSH5N40
IRFP252	SSH25N40
IRFP253	SSH5N35
IRFP320	SSH25N35
IRFP321	SSH7N20
IRFP322	SSH8N20
IRFP323	SSH40N20
IRFP330	SSH7N18
IRFP331	SSH8N18
IRFP332	SSH7N15
IRFP333	SSH8N15
IRFP340	SSH40N15
IRFP341	SSH7N12
IRFP342	SSH8N12
IRFP343	SSH12N10
IRFP350	SSH10N10
IRFP351	SSH12N08
IRFP352	SSH10N08
IRFP353	SSH12N06
IRFP420	SSH10N06
IRFP421	SSH12N05
IRFP422	SSH10N05

TO-3P Package P-Channel Types

IRFP9120	IRFP9220
IRFP9121	IRFP9221
IRFP9122	IRFP9222
IRFP9123	IRFP9223
IRFP9130	IRFP9230
IRFP9131	IRFP9231
IRFP9132	IRFP9232
IRFP9133	IRFP9233
IRFP9140	IRFP9240
IRFP9141	IRFP9241
IRFP9142	IRFP9242
IRFP9143	IRFP9243

TO-3 Package N-Channel Types

IRF120	IRF423
IRF121	IRF430
IRF122	IRF431
IRF123	IRF432
IRF130	IRF433
IRF131	IRF440
IRF132	IRF441
IRF133	IRF442
IRF140	IRF443
IRF141	IRF450
IRF142	IRF451
IRF143	IRF452
IRF150	IRF453
IRF151	SSM3N70
IRF152	SSM4N70
IRF153	SSM6N70
IRF220	SSM10N70
IRF221	SSM4N60
IRF222	SSM6N60
IRF223	SSM8N60
IRF230	SSM15N60
IRF231	SSM4N55
IRF232	SSM6N55
IRF233	SSM8N55
IRF240	SSM15N55
IRF241	SSM4N50
IRF242	SSM20N50
IRF243	SSM4N45
IRF250	SSM20N45
IRF251	SSM5N40
IRF252	SSM25N40
IRF253	SSM5N35
IRF320	SSM25N35
IRF321	SSM7N20
IRF322	SSM8N20
IRF323	SSM40N20
IRF330	SSM7N18
IRF331	SSM8N18
IRF332	SSM7N15
IRF333	SSM8N15
IRF340	SSM40N15
IRF341	SSM7N12
IRF342	SSM8N12
IRF343	SSM12N10
IRF350	SSM10N10
IRF351	SSM12N08
IRF352	SSM10N08
IRF353	SSM12N06
IRF420	SSM10N06
IRF421	SSM12N05
IRF422	SSM10N05

TO-3 Package P-Channel Types

IRF9120	IRF9132
IRF9121	IRF9133
IRF9122	IRF9140
IRF9123	IRF9141
IRF9130	IRF9142
IRF9131	IRF9143
IRF9220	IRF9232
IRF9221	IRF9233
IRF9222	IRF9240
IRF9223	IRF9241
IRF9230	IRF9242
IRF9231	IRF9243

TO-220 Package N-Channel Types

IRF510	IRF741
IRF511	IRF742
IRF512	IRF743
IRF513	IRF820
IRF520	IRF821
IRF521	IRF822
IRF522	IRF823
IRF523	IRF830
IRF530	IRF831
IRF531	IRF832
IRF532	IRF833
IRF533	IRF840
IRF540	IRF841
IRF541	IRF842
IRF542	IRF843
IRF543	SSP3N70
IRF610	SSP4N70
IRF611	SSP4N60
IRF612	SSP6N70
IRF613	SSP6N60
IRF620	SSP6N55
IRF621	SSP4N60
IRF622	SSP4N55
IRF623	SSP4N50
IRF630	SSP4N45
IRF631	SSP5N40
IRF632	SSP5N35
IRF633	SSP7N20
IRF640	SSP8N20
IRF641	SSP7N18
IRF642	SSP8N18
IRF643	SSP7N15
IRF710	SSP8N15
IRF711	SSP7N12
IRF712	SSP8N12
IRF713	SSP12N10
IRF720	SSP10N10
IRF721	SSP12N08
IRF722	SSP10N08
IRF723	SSP12N06
IRF730	SSP40N06
IRF731	SSP10N06
IRF732	SSP12N05
IRF733	SSP10N05
IRF740	

TO-220 Package P-Channel Types

IRF9510	IRF9610
IRF9511	IRF9611
IRF9512	IRF9612
IRF9513	IRF9613
IRF9520	IRF9620
IRF9521	IRF9621
IRF9522	IRF9622
IRF9523	IRF9623
IRF9530	IRF9630
IRF9531	IRF9631
IRF9532	IRF9632
IRF9533	IRF9633
IRF9540	IRF9640
IRF9541	IRF9641
IRF9542	IRF9642
IRF9543	IRF9643

TO-126 Package N-Channel Types

IRFA1Z0	IRFA1Z3

Please select below what you would like to receive on each Samsung product and mail this coupon to Product Marketing Department,

DRAMs	☐ Data Sheet ☐ Reliability Report	Part Type ______
SRAMs	☐ Data Sheet ☐ Reliability Report	Part Type ______
EEPROMs	☐ Samples ☐ Data Sheet ☐ Reliability Report	Part Type ______
ADVANCED CMOS LOGIC FAMILY	☐ Data Book ☐ Samples: KS74AHCT	Part Type ______
FLASH CONVERTERS	☐ Samples ☐ Data Book	Part Type ______
SOT-23s	☐ Samples ☐ Data Book	Part Type ______
LINEAR ICs	☐ Samples ☐ Data Book	Part Type ______
POWER MOSFETs	☐ Samples ☐ Data Book ☐ Ruggedness Application Note	Part Type ______

Samsung Semiconductor, Inc., 3725 North First Street, San Jose, CA 95134-1708.

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Setting the Pace.

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Semiconductor
3725 North First Street,
San Jose, CA 95134-1708

Motorola is a registered trademark of Motorola, Inc.

On April 5th, Intel made a major announcement about advanced 32-bit embedded control technology.

On April 12th, we'll explain it.

Intel unveiled three advanced embedded control technologies, two 32-bit embedded processors, and a radically new memory product line on April 5th.

On April 12th, seminars begin worldwide to show how to design significantly more powerful 32-bit systems that provide unparalleled price performance. The fully supported 80376 and 80960 families of embedded processors, and the breakthrough flash memory technology will be discussed in detail.

These free seminars will include lectures, comprehensive demonstrations, printed materials and a good lunch.

You're invited.

Call (800) 548-4725 for details, or to secure a spot.

And call now, as seating is limited, and we have a lot of explaining to do.

intel®

Alabama	Huntsville	4/29/88	Maryland	Baltimore	4/26/88	Pennsylvania	Philadelphia	4/12/88
Arizona	Tempe	4/18/88	Massachusetts	Boston	4/15/88		Pittsburgh	5/18/88
California	Anaheim	4/22/88	Michigan	Detroit	4/25/88	Texas	Austin	4/21/88
	Los Angeles	4/20/88	Minnesota	Minneapolis	4/14/88		Dallas	4/19/88
	San Diego	4/21/88	Missouri	St. Louis	5/19/88		Fort Worth	4/18/88
	Santa Clara	5/4/88	New Jersey	Kenilworth	5/13/88		Houston	4/20/88
	Van Nuys	4/19/88	New York	Binghamton	5/11/88	Virginia	Charlottesville	4/28/88
Colorado	Denver	5/3/88		Long Island	4/13/88		Tysons Corner	4/27/88
Connecticut	Stratford	4/14/88		Rochester	5/10/88	Washington	Bellevue	5/5/88
Florida	Ft. Lauderdale	4/28/88		Tarrytown	5/12/88	Wisconsin	Milwaukee	4/13/88
	Orlando	4/26/88	North Carolina	Charlotte	5/4/88	Canada	Montreal	5/24/88
Georgia	Atlanta	4/25/88		Raleigh	5/3/88		Ottawa, Ontario	5/25/88
Illinois	Chicago	4/12/88	Ohio	Cleveland	5/19/88		Toronto	5/20/88
Indiana	Indianapolis	5/17/88		Dayton	5/17/88		Vancouver, BC	5/6/88
Kansas	Kansas City	5/18/88	Oregon	Portland	5/6/88			

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Microtec quality and customer support have become the industry cross-development standard. What other company has the confidence to actually publish all fixes and ECOs for all products, for everyone to see? Whatever the host processor, whatever the target system, Microtec is committed to helping your software creation move from generation to generation, from technology to technology, forever. From pSOS to VRTX to MS-DOS to UNIX to VMS. From assembler to Pascal to C to Fortran. From Motorola to Intel to Hitachi to Zilog. From IBM to DEC to HP to Apollo to Sun. From crossassemblers to crosscompilers. From source debuggers running on hosts that are simulating target systems to the advanced in-circuit emulators from HP, TEK, Atron, Applied, Sophia, ZAX and Taiwan's Microtek. There're only two phone numbers you'll ever need. Microtec's is 800-551-5554 (408-733-2919 in CA). The other is Dial-a-Prayer.

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Electro/88

For 1988, Electro's technical and tutorial program expands to 54 sessions, 35 of which focus on software. Even for those whose work doesn't involve computers, Electro offers much food for thought.

Dan Strassberg, *Associate Editor*

No beans in Boston; plenty of fish
Chinese food if that's your dish[1]

Though the estimated 45,000 EEs who descend on Boston in mid-May are certain to partake of the city's copious gustatory enticements, it's not food for the body that will attract them. Rather, it's a bountiful platter of food for thought, in the form of Electro/88—the Eastern US's largest electronics-industry show and convention. Electro alternates between Beantown and the Big Apple. This year, it's Boston's turn. Electro/88 will be served up at the World Trade Center (WTC) on Commonwealth Pier and the Bayside Exposition Center from Tuesday May 10 through Thursday May 12.

The convention's theme for 1988 is "The Technology Bridge." In a marked departure from previous Electros, the expanded, 54-session technical/tutorial program boasts 35 sessions related to software. The program emphasizes the application of software to the hardware-design process. In prior years, a computer-oriented program called Mini-Micro Northeast ran concurrently with Electro. But because computer technology is now so inextricably intertwined with every branch of electronics, Electro has subsumed Mini-Micro, which no longer exists as a distinct event.

Exhibitors include 900 companies

Most engineers who visit Electro attend not only for the professional program but also to see the wares on display and to get answers to specific technical questions from the show's exhibitors. This year, nearly 900 companies will exhibit their products in 1300 booths that will be divided approximately equally between Bayside Expo Center and the WTC. Among the exhibitors will also be some noncommercial organizations that aren't selling anything. For example, representatives of the IEEE Region I Committee on Women and Minorities and the Boston section of the Society for Women Engineers will be in Booth 2160 at the WTC to distribute information on the achievements of women and minorities in engineering.

Lester Thurow will deliver keynote address

It's an Electro custom to get up early to hear the keynote address. This year's program adheres to that tradition: The keynote breakfast will be held at 8:00 AM on Tuesday May 10 at Anthony's Pier 4 Restaurant (on

PROFESSIONAL-PROGRAM SESSIONS

WORLD TRADE CENTER

			TUESDAY, MAY 10
COMMERCIAL COMPLEX 1	**COMMERCIAL COMPLEX 2**	**COMMERCIAL COMPLEX 3**	**TEACHERS UNION E**
9:00 AM TO 11:30 AM **TUTORIAL 1** MARKETING, THE KEY TO PRODUCT SUCCESS	9:00 AM TO 11:30 AM **TUTORIAL 2** ELECTRICAL CAD	9:00 AM TO 11:30 AM **TUTORIAL 3** TECHNICAL DOCUMENTATION FOR ELECTRONIC PRODUCTS	9:00 AM TO 11:00 AM **SESSION 4** MODERN METEOR-BURST COMMUNICATIONS
12:30 PM TO 2:30 PM **SESSION 7** SALES AND MARKETING: CLOSING THE SOFTWARE GAP	12:30 PM TO 2:30 PM **SESSION 8** MODELING STRATEGIES FOR ASIC DESIGN	12:30 PM TO 2:30 PM **TUTORIAL 9** COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)	12:30 PM TO 2:30 PM **SESSION 10** HIGH-TEMPERATURE SUPERCONDUCTORS
3:30 PM TO 5:30 PM **SESSION 13** EXPORTING SOFTWARE TO JAPAN—FACT OR FANTASIES	3:30 PM TO 5:30 PM **SESSION 14** DESIGN TOOLS FOR NEW PROGRAMMABLE SILICON DEVICES: DOES ONE SIZE FIT ALL?	3:30 PM TO 5:30 PM **SESSION 15** CORPORATE ELECTRONIC PUBLISHING	3:30 PM TO 5:30 PM **SESSION 16** ROBOTS IN THE REAL WORLD
			WEDNESDAY, MAY 11
9:00 AM TO 11:30 AM **TUTORIAL 19** ENGINEERING TO MEET CUSTOMER NEEDS	9:00 AM TO 11:30 AM **TUTORIAL 20** SOFTWARE DEVELOPMENT FOR REAL-TIME EMBEDDED SYSTEMS	9:00 AM TO 11:30 AM **TUTORIAL 21** DESIGN FOR TESTABILITY	9:00 AM TO 11:30 AM **TUTORIAL 22** COMPUTER INTEGRATED MANUFACTURING AND BUSINESS DECISIONS
12:30 PM TO 2:30 PM **SESSION 25** SYSTEM SOLUTIONS FOR INCREASING SALES AND MARKETING PRODUCTIVITY	12:30 PM TO 2:30 PM **SESSION 26** CASE TOOLS IMPROVE MANAGEMENT OF THE SOFTWARE CYCLE: INTRODUCTION, USAGE, HISTORIES, FUTURE TRENDS	12:30 PM TO 2:30 PM **SESSION 27** SUCCESSFUL SYSTEM-DESIGN TECHNIQUES USING ASICs	12:30 PM TO 2:30 PM **SESSION 28** CLEAN-ROOM AUTOMATION FROM CIM TO ROBOTS
3:30 PM TO 5:30 PM **SESSION 31** SOFTWARE DESIGN TECHNIQUES FOR INNOVATIVE PLD ARCHITECTURE	3:30 PM TO 5:30 PM **SESSION 32** COMPUTER-AIDED SOFTWARE ENGINEERING (CASE)	3:30 PM TO 5:30 PM **SESSION 33** CHARACTERIZATION AND TESTING OF ANALOG-TO-DIGITAL CONVERTERS FOR DIGITAL SIGNAL PROCESSING APPLICATIONS	3:30 PM TO 5:30 PM **SESSION 34** MACHINE-VISION APPLICATIONS IN ELECTRONICS MANUFACTURING
			THURSDAY, MAY 12
9:00 AM TO 11:30 AM **TUTORIAL 37** MARKETING YOUR PRODUCT, YOUR DEAL, AND YOUR COMPANY	9:00 AM TO 11:00 AM **SESSION 38** ENGINEERING EDUCATION—RESPONDING TO REAL WORLD DEMANDS	9:00 AM TO 11:00 AM **SESSION 39** STRATEGIC DEFENSE INITIATIVE: ASSESSMENT OF PROGRESS AND PROSPECTS	9:00 AM TO 11:30 AM **TUTORIAL 40** MECHANICAL CAD/CAM
12:30 PM TO 2:30 PM **SESSION 43** SIMULATION OF ANALOG AND MIXED-MODE CIRCUITS	12:30 PM TO 2:30 PM **SESSION 44** THE ROLE OF CONFIGURATION-MANAGEMENT TOOLS IN SOFTWARE DEVELOPMENT ENVIRONMENTS	12:30 PM TO 2:30 PM **SESSION 45** SOFTWARE TOOLS FOR TEST AND MEASUREMENT APPLICATION PROGRAM DEVELOPMENT	12:30 PM TO 2:30 PM **SESSION 46** HIGH-INTEGRATION SOLUTIONS FOR PERSONAL COMPUTER/PERSONAL SYSTEM DESIGN
3:30 PM TO 5:30 PM **SESSION 49** LEAP INTO THE 90s WITH AN ACCELERATED NEW-PRODUCT DEVELOPMENT CYCLE	3:30 PM TO 5:30 PM **SESSION 50** UNIQUE SOFTWARE CONSIDERATIONS FOR MICROCONTROLLERS WHEN LISTING HIGH-LEVEL LANGUAGES	3:30 PM TO 5:30 PM **SESSION 51** TEST PROGRAM GENERATION: EXTRACTING TESTER PROGRAMS FROM SIMULATION	3:30 PM TO 5:30 PM **SESSION 52** INDUSTRIAL REQUIREMENTS FOR REAL-TIME DIGITAL SIGNAL PROCESSING (DSP) APPLICATIONS

BAYSIDE EXPOSITION CENTER

TEACHERS UNION F	TEACHERS UNION G
9:00 AM TO 11:30 AM **TUTORIAL 5** IMPLEMENTING COMPUTER INTEGRATED MANUFACTURING (CIM)	9:00 AM TO 11:30 AM **TUTORIAL 6** INTRODUCTION TO GaAs DEVICES, TESTING AND EVALUATION METHODS
12:30 PM TO 2:30 PM **SESSION 11** INTRODUCING NEW PRODUCTS TO MANUFACTURING THROUGH CIM	12:30 PM TO 2:30 PM **SESSION 12** ADVENTURES IN TECHNOLOGICAL INNOVATION: HOW THE MASSACHUSETTS MIRACLE WORKS
3:30 PM TO 5:30 PM **SESSION 17** PROCESS PLANNING AND SIMULATION OF MANUFACTURING OPERATIONS	3:30 PM TO 5:30 PM **SESSION 18** DEVELOPMENT TOOLS FOR DIGITAL SIGNAL PROCESSORS (DSPs)
9:00 AM TO 11:00 AM **SESSION 23** RECENT ADVANCES IN "APPLICATION SPECIFIC" PLDs	9:00 AM TO 11:00 AM **SESSION 24** ENHANCING GLOBAL SECURITY THROUGH INFORMATION SHARING
12:30 PM TO 2:30 PM **SESSION 29** ARTIFICIAL INTELLIGENCE IN MANUFACTURING	12:30 PM TO 2:30 PM **SESSION 30** RISK ASSESSMENT AND RESPONSE
3:30 PM TO 5:30 PM **SESSION 35** PUBLISHING OPPORTUNITIES IN THE IEEE	3:30 PM TO 5:30 PM **SESSION 36** SOCIAL IMPLICATIONS OF ARTIFICIAL INTELLIGENCE
9:00 AM TO 11:00 AM **SESSION 41** COMPUTER BACKPLANE INTERFACE USING HIGH-SPEED LOW-POWER CMOS INTERFACE ICs	9:00 AM TO 11:00 AM **SESSION 42** RISC TECHNOLOGY ENTERS THE MAINSTREAM
12:30 PM TO 2:30 PM **SESSION 47** MECHANICAL CAE IMPACTS ON PRODUCT DEVELOPMENT	12:30 PM TO 2:30 PM **SESSION 48** FLOATING-POINT COPROCESSORS FOR ADVANCED PERSONAL MICROPROCESSORS
3:30 PM TO 5:30 PM **SESSION 53** SUPPORTING THE ETHICAL ENGINEER	3:30 PM TO 5:30 PM **SESSION 54** AN ARCHITECTURAL OVERVIEW OF CACHE CONTROLLERS FOR 32-BIT MICROPROCESSORS

Northern Ave near the WTC). Tickets to the breakfast cost $20; you can buy them at the door. Those who attend will be treated to a talk by internationally acclaimed economist Lester C Thurow, who is Gordon Y Billard professor of management and economics and dean of the Sloan School of Management at Massachusetts Institute of Technology (MIT). Thurow served on the Council of Economic Advisors during the administration of President Lyndon Johnson. He has written or edited 12 books, including *Poverty and Discrimination*, *Investment in Human Capital*, *The Impact of Taxes on the American Society*, *Generating Inequality*, *The Zero-Sum Society*, and *Dangerous Currents: The State of Economics*. He is also a frequent guest on television talk shows.

The 54-session professional program will start at 9:00 AM on each of the three show days. Half of the sessions will take place at the WTC's Commercial Complex; the other half will run in Teachers' Union Rooms E, F, and G at Bayside.

Technical program includes 11 tutorial sessions

Of the 54 sessions in the technical program, 11 are billed as tutorials. All the tutorials will take place from 9:00 to 11:30 AM—some at the WTC, others at Bayside. Five tutorials are scheduled for Tuesday, four for Wednesday, and two for Thursday. Because some sessions overlap, you may find it desirable to team up with a colleague, making each person responsible for attending certain sessions. For example, if you're interested in "Electrical CAD (Computer-Aided Design)" and "Implementing CIM (Computer-Integrated Manufacturing)," which will run concurrently, you can't be at both tutorials yourself.

However, in this particular instance and some others, you get a sort of second chance. If you attend the CAD tutorial on Tuesday, you can attend a tutorial on CIM and business decisions the following morning at Bayside. Readers of EDN's recent Technology Update on automatic test-pattern generation may want to make a point of obtaining further information on the subject by attending the "Design for testability" tutorial slated for Wednesday morning at the WTC.

Other tutorials of particular interest to EDN readers include Wednesday's "Software development for real-time embedded systems" and "Recent advances in application-specific PLDs," and Tuesday's "Introduction to GaAs devices: testing and evaluation methods."

Many of the sessions not billed as tutorials also cover subjects in which EDN readers have indicated great interest. One such is "Design tools for new programmable silicon devices: does one size fit all?" This session will be held on Tuesday from 3:30 to 5:30 at the WTC. Another especially significant session takes place at the same time at Bayside. It's entitled "Development tools for digital signal processors (DSPs)."

Wednesday features a cluster of sessions sure to attract many EDN readers: for example, "CASE tools improve management of the software cycle: introduction, usage, histories, future trends;" "Successful sys-

Please come to Boston (but don't bring your car)

Very few people haven't heard what a nightmare it is to drive in Boston. Though Boston drivers' reputation for daring and erratic behavior may be undeserved, even the most well-adjusted motorist is bound to be daunted by the scarcity of parking spaces and the inscrutable, albeit quaint, web of narrow one-way streets, which were literally laid out by eighteenth-century cows seeking the Common grazing ground. Furthermore, the zeal of the Boston Police Department's meter attendants is deservedly legendary, and, to top it all, despite some recent improvement, Massachusetts retains the title of car-theft capital of the world.

It's a good idea, therefore, not to drive to Boston if you can avoid it. With that caveat in mind, here's how to get to Electro/88 while preserving a least a portion of your sanity: Take Boston's MBTA or "T," which is a (pretty decent) public transportation system.

The Red Line gets you there

Both the World Trade Center (WTC), which is located at Commonwealth Pier on Northern Ave (in the South Boston section of the city) and the Bayside Exposition Center (in the Dorchester section) are within walking distance of the Red Line, one of the T's four major rapid-transit lines. The WTC is near the South Station stop; the Bayside Exposition Center is near the JFK Library/U Mass stop on the Ashmont branch of the Red Line.

If you don't feel like walking the approximately 1½ miles from South Station to the WTC, you can take the City Point (No 7) bus, which stops close to the WTC. Similarly, if you don't feel like walking to Bayside from the JFK/U Mass Red Line station, you can take the No 8 bus or a shuttle run by Brush Hill Transit Co. Be sure to have a supply of quarters handy whenever you plan to ride a T bus. The T doesn't allow its drivers to accept bills or to make change.

Shuttle links WTC and Bayside

To travel between the Bayside Exposition Center and the World Trade Center, you can take one of the shuttle buses; they'll run continuously during the hours when Electro is open and will also stop at major Boston hotels.

If, despite all warnings, you insist on driving all the way to Electro, you can pay to park in a large lot at Bayside Exposition Center or another at the WTC. There will be additional parking for show attendees (for a fee) near Anthony's Pier 4 Restaurant on Northern Ave not far from the WTC. Remember, though, that the total capacity of these lots is approximately 3900 cars, and Electro's attendance will exceed 45,000 people.

To reach the Bayside Expo Center from north of Boston, take Interstate 93 south to exit 15 and follow the signs. From the south, take I-93 north to either exit 14 or 15 and follow the signs. From the west, take the Mass Pike to its terminus at I-93, and follow I-93 south to exit 15, then follow the signs.

If you're driving and are unfamiliar with Boston, it's probably better to park at Bayside and take the shuttle to the WTC than to attempt to park at or near the WTC.

If you pay at the door and are not a member of the IEEE or ERA (Electronic Representatives Association), admission to Electro will cost $20 for both the exhibits and the technical sessions. Admission for members is $10. For those who preregistered by mail prior to April 21, the cost was $5.

Exhibit hours are 9:30 AM to 5:00 PM on all three days. The professional program's hours are 9:00 AM to 5:30 PM on all three days.

When using the Electro Products section of EDN to plan your visits to exhibitor booths, remember that booths 1 to 1899 are at Bayside, and 1900 and above are at the WTC.

tem design techniques using ASICs;" "Software design techniques for innovative PLD architectures;" "Computer-aided software engineering (CASE);" and "Characterization and testing of analog-to-digital converters for digital-signal-processing applications." The last is one of the very few Electro/88 sessions targeted primarily at analog designers.

Thursday's sessions include a number of especially timely topics, such as "RISC technology enters the mainstream," and "Computer backplane interface using high-speed low-power CMOS interface ICs." The session entitled "Simulation of analog and mixed-mode circuits" should attract analog designers, while engineers interested in test-program design are likely to choose "Software tools for test and measurement application-program development." Or you can choose the session "High-integration solutions for personal computer/personal system design" or "Floating-point coprocessors for advanced personal microprocessors."

Good sessions just keep coming

The professional program will still be running at full speed on Thursday afternoon, when the WTC will host the session "Test program generation: extracting tester programs from simulation," and one entitled "Unique software considerations for microcontrollers when listing high-level languages." At the same time, Bayside will be the scene of the sessions "An architectural overview of cache controllers for 32-bit microprocessors" and "Industrial requirements for real-time DSP applications."

To make it easier to choose sessions to attend, Electro's organizers have divided the technical program into "threads," each of which encompasses a group of related sessions. The threads and the numbers of the associated sessions are as follows (tutorials are indicated in italics).

- Electrical, mechanical, and software design process: *2*, 8, 14, *20*, 26, 32, *40*, 43, 47, 49.
- Documentation: *3*, *9*, 15, 44.
- Testability: *21*, 33, 45, 51.
- Release Process: *5*, 11, 17, 29.
- Fabrication: *22*, 28, 34, 52.
- Marketing: *1*, 7, 13, *19*, 25, 37.

This listing of tutorials and technical sessions omits mention of some other Electro/88 events. When you register, you can get information on such events as awards presentations and a seminar on "real-world selling techniques."

So, even if there are no beans in Boston, for EEs there should be no cause for dismay this May. If you want to *know* beans about the state of the art, you can attend Electro/88. It will provide plenty of food for thought. **EDN**

Reference

1. From the song *Boston Beans* by Lee, Raskin, and Schluger. Copyright 1962, Denslow Music Co, Los Angeles, CA. (Incidentally, you can, of course, obtain baked beans in Boston.)

Article Interest Quotient (Circle One)
High 494 Medium 495 Low 496

Museum shows EE memorabilia

No EE should visit Boston without stopping at the Computer Museum. The museum, located at 300 Congress St on Museum Wharf, is only a stone's throw from the World Trade Center (WTC). Go down Northern Ave (where the WTC is located) toward Boston, and turn left on Sleeper St, just before the bridge. The museum will be on your left at the corner of Sleeper St and Congress St. A landmark you can use to spot Museum Wharf is a building shaped like a milk bottle. It's probably best to walk to the museum from the WTC; as one (native Bostonian) EDN staffer puts it, "there's no place to pahk yah cah.

The computer museum chronicles the history of digital technology from a time before the advent of electronics to the present. Exhibits describe such historic computers as ENIAC at the University of Pennsylvania, Mark I at Harvard, Whirlwind I at MIT, TX-0 at Lincoln Lab, and AN/FSQ-7 on the DEW line. More modern machines—including PCs—are covered, too.

The museum is open from 10:00 AM to 5:00 PM Tuesday through Sunday. It stays open later on Fridays. Admission for adults is $4.50; full-time students and children can obtain reduced rates.

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- **Incorporating EMI shielding in your design**
  CIRCLE NO. 39
- **Applications and material selection**
  CIRCLE NO. 40
- **FCC/VDE compliance for commercial equipment**
  CIRCLE NO. 41
- **MIL-SPEC compliance for military systems**
  CIRCLE NO. 42
- **TEMPEST applications**
  CIRCLE NO. 43
- **EMI testing**
  CIRCLE NO. 44

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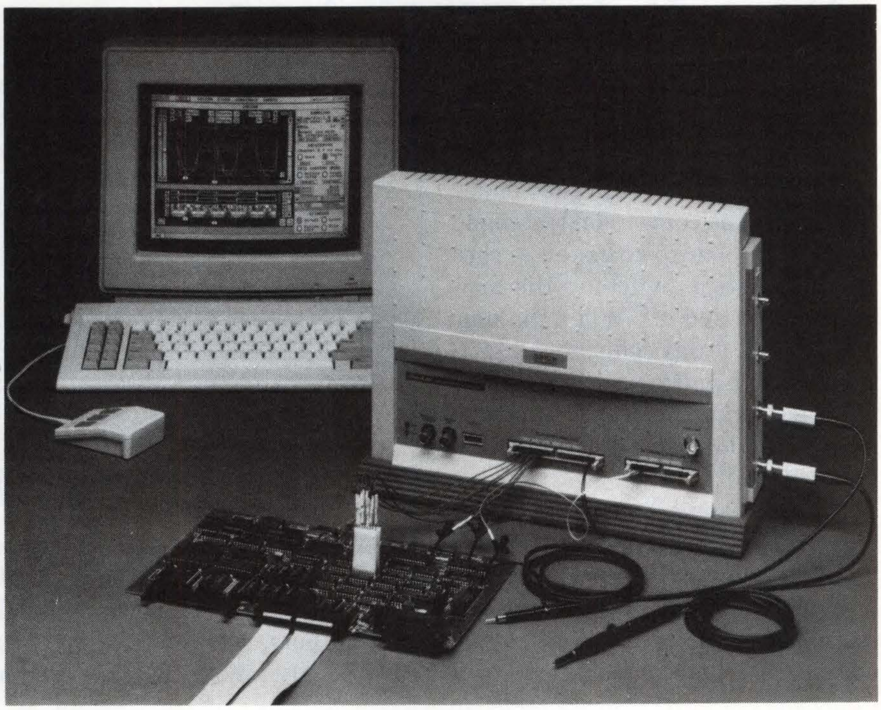
See us at ELECTRO, Booths 1555, 1557

Instrument combines 48-channel LA, 100-MHz DSO, and stimulus generator



The Omnilab 9240 is a combination digital-storage oscilloscope (DSO), logic analyzer (LA), and digital stimulus generator that comes in an attaché-case-sized enclosure. The unit is hosted by an IBM PC, PC/AT, or compatible computer. The scope offers a 100-MHz bandwidth; the 48-channel LA samples at 200M samples/sec.

Unlike separate instruments, the DSO and LA are designed to work in tandem. In combination with a feature named Multiview, the Select trigger system allows you to observe time-correlated analog and digital displays. Select combines the features of scope and logic-analyzer triggering. You can qualify the trigger conditions by use of truth tables stored in RAM, as well as by programming minimum and maximum time delays. Besides letting you see time-correlated displays, Multiview lets you watch digital data alone, analog data alone, or analog and digital displays representing separate time intervals.

Continuous sampling in conjunction with flexible triggering permits the unit to capture and display every occurrence of infrequent events such as missing pulses, metastable states, noise glitches, and bus contentions. From $8900.

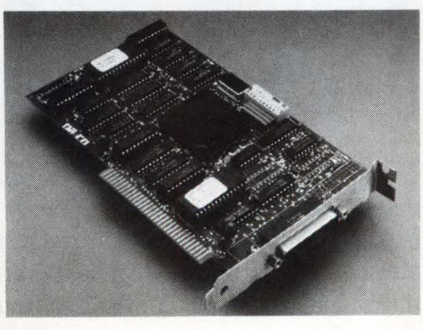
Orion Instruments, 702 Marshall St, Redwood City, CA 94063. Phone (800) 245-8500; in CA, (415) 361-8883. TLX 530942. Booth Nos 2741, 2743, and 2745.

Circle No 530

PC Bus card supports industry-standard graphic formats on flat-panel displays

The PC6424 half-sized card for the IBM PC Bus works in the IBM PC, PC/XT, PC/AT, and compatibles, letting you use electroluminescent panels, ac-plasma panels, and some LCD panels as display devices. The board supports the following standards: the CGA, double-scan CGA, MDA, Hercules graphics card, and 400-line-resolution mode. It can coexist on the PC Bus with other monochrome and color display-adapter cards.

The board contains a BIOS (basic input/output system) ROM that



initializes the controller without necessitating the loading of software drivers. The unit is compatible with display matrices of 640×200, 640×400, and 720×350 pixels.

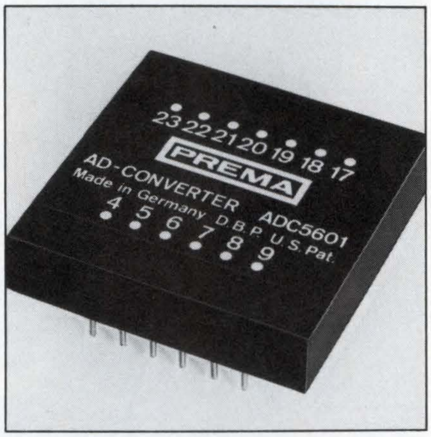
The card includes an interface for the vendor's infrared touch-panel input device. $350 (100).

Digital Electronics Corp, 31047 Genstar Rd, Hayward, CA 94544. Phone (415) 471-4700. TLX 172073. Booth No 475.

Circle No 534

Modular analog-to-digital converter offers 25-bit resolution

The 2×2×0.4-in. ADC 5601 uses a proprietary conversion technique to produce a 25-bit result in 20 sec or a 14-bit result in 10 msec. The vendor claims that the conversion technique eliminates charge-transfer errors associated with switching the analog input on and off. When the unit signals that it has completed a conversion, you apply a pulse train to its shift-command input, and the module serially shifts out the conversion result.



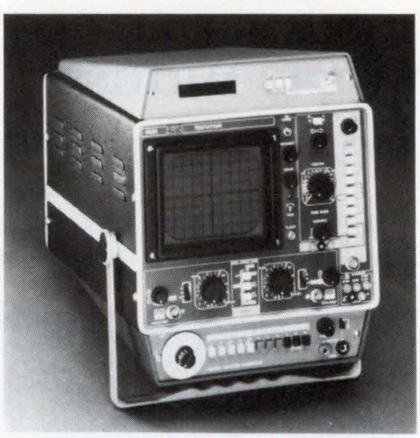
You must connect a crystal to provide the module's timing reference and can use crystals that operate from 3.0 to 3.7 MHz to do so. You must also provide a voltage reference in the range of 6 to 8V to a 100-MΩ-impedance input; high-quality, temperature-compensated zener diodes, which have nominal 6.8V outputs, are well-suited to this purpose. By pin strapping, you can configure the unit to accept an input of either 0 to −5V or ±2.5V; the input impedance equals 10 kΩ. After the module has undergone a 5-minute warmup, its temperature coefficient of gain, which is additive to the reference drift, equals <0.8 ppm/°C. The offset drift is <0.6 μV/°C. The nonlinearity is <±1 ppm of full scale. The power required is <600 mW from ±15 and +5V supplies. The power supply rejection typically equals 1 ppm/%V_S. $360.

Prema Precision Electronics Inc, 6290 Sunset Blvd, Suite 1126, Los Angeles, CA 90028. Phone (213) 463-2294. Booth No 2811.

Circle No 532

Portable unit includes scope, counter, function generator, and power supplies

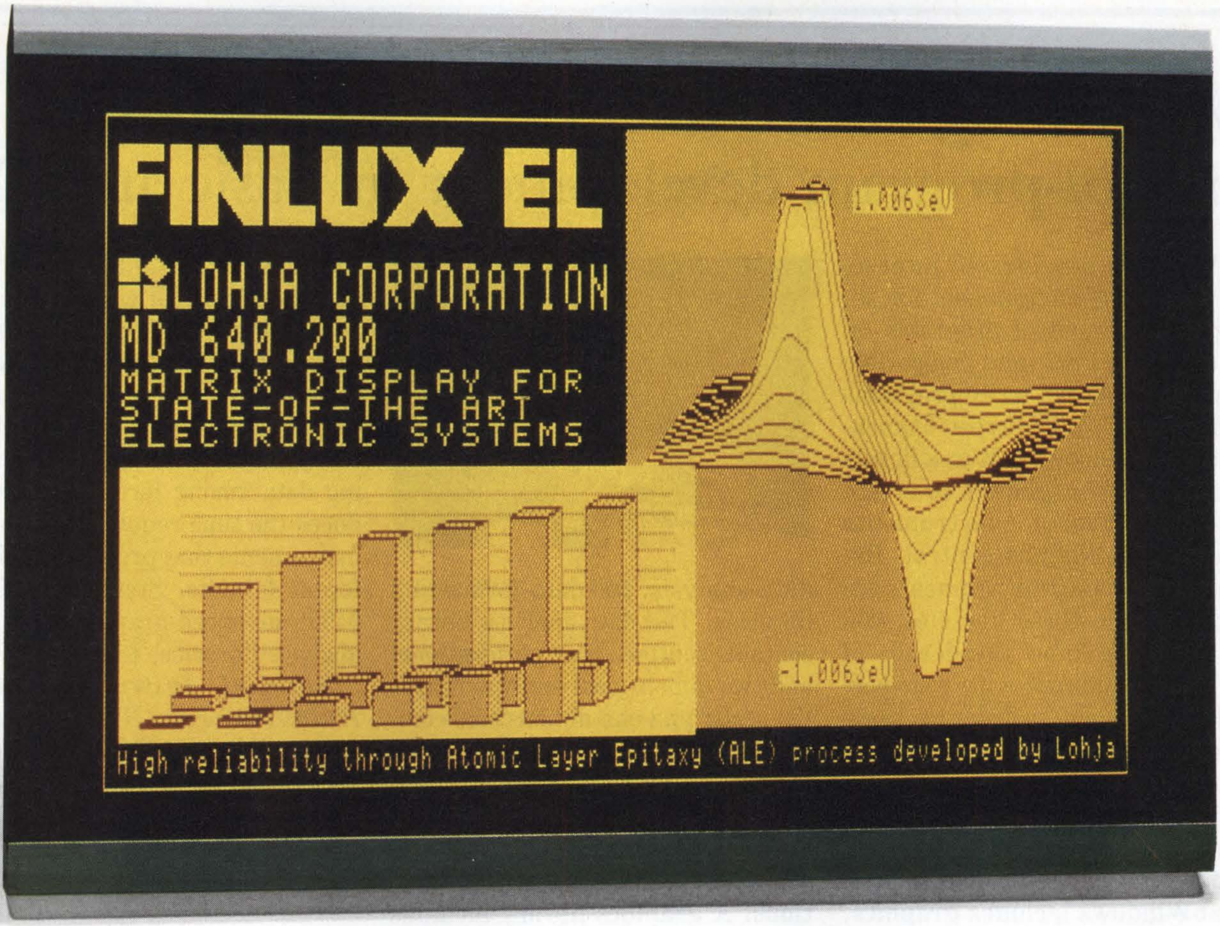
Testation 4444, housed in a 21-lb, 13×11×18-in. package, provides instruments commonly used for the development and testing of low-frequency analog circuits. The unit includes a dual-trace oscilloscope with a 20-MHz bandwidth; a 1-Hz-to-100-kHz function generator that produces sine, square, and triangular waves; a 3-output, regulated power supply that produces 5V at 1A, 12V at 200 mA, and −12V at 200 mA; and a 20-MHz frequency counter with 10-mV-rms maximum-sensitivity inputs that you can connect to the scope or to an external source. The counter's timebase accuracy, which varies no more than ±30 ppm from 0 to 50°C, is ±20 ppm at 25°C.



A 2-channel curve tracer lets you display and compare V/I characteristics of components. The scope has single-ended inputs with a maximum sensitivity of 2 mV/div. You can subtract one channel from the other to provide a differential input. A 5× magnifier provides a maximum sweep speed of 100 nsec/div. A calibrator provides a 200-mV square wave whose amplitude accuracy is ±2%. The function generator produces square and triangular waves whose maximum amplitude is 10V p-p into 600Ω. The maximum sine wave output equals 1.5V rms. A step attenuator reduces the generator's output by 20, 40, or 60 dB. $750.

ET&T Corp, 3001 Redhill Ave, Bldg 1-219, Costa Mesa, CA 92626. Phone (714) 557-2703. TLX 678352. Booth No 2624.

Circle No 531



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MD640.200-20	+5V/ +12V	640x200 pixels	4.8 x 7.68 in. (122 x 195mm)	6.24 in. (158.5mm)H 9 in. (228.5mm)W 1.38 in. (35.0mm)D	16.8 oz. (470g)
MD512.256-39S** 37S 38S	+5V/ +12V +5V/ +15V +5V/ +24V	512 x 256 pixels	3.85 x 7.69 in. (195.2 x 97.7mm)	5.67 in. (140mm)H 10.2 in. (260mm)W 1.38 in. (35.0mm)D	23 oz. (650g)
MD640.400-52	+5V/ +12V	640 x 400 pixels	4.8 x 7.68 in. (122 x 195mm)	6.24 in. (158mm)H 9 in. (228.5mm)W 1.38 in. (35.0mm)D	20 oz. (560g)
MD640.350-60	+5V/ +12V	640 x 350 pixels	4.8 x 7.05 in. (122 x 179mm)	6.24 in. (158mm)H 9 in. (228.5mm)W 1.38 in. (35.0mm)D	20 oz. (560g)
MD320.256-71	+5V/ + 15V	320 x 256 pixels	3.0 x 3.78 in. (76.7 x 96 mm)	4.33 in. (110mm)H 5.12 in. (130mm)W 1.38 in. (35.0mm)D	15 oz. (420g)

*Process developed by Lohja Corporation, Finland

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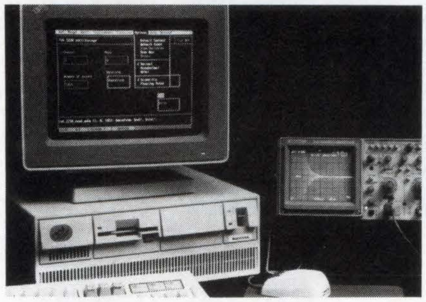
CIRCLE NO 138

Windowing environment for PCs supports control-program development in Basic and C

LabWindows provides an interactive windowing environment for development of control programs on the IBM PC, PS/2, and compatible computers. You can write programs in Microsoft C or in Microsoft QuickBasic. LabWindows features libraries that enable beginners to create control programs for instruments under IEEE-488 bus control. Because many popular instruments are represented in these libraries, you don't need to know the details of how to communicate with your particular instrument in order to create the control programs.

To generate code sequences with LabWindows, you access pull-down menus and select functions by using a mouse or keyboard commands.



LabWindows includes graphics, data-analysis, and data-formatting libraries. The data-analysis library contains routines that perform one- and two-dimensional array arithmetic, scalar and one-dimensional complex arithmetic, and statistical functions. An optional library includes digital signal processing, matrix and vector arithmetic, advanced statistics, and curve-fitting functions. A graphics library includes routines for two-dimensional data plotting, multiple curve plots, and bar charts. An advanced graphics library provides axonometric and contour plots and interactive cursors. The data-formatting library contains routines for converting data among formats, which reduces the time required to program instruments that process data in different formats. Standard package, \$495; advanced-graphics and data-analysis libraries, \$895.

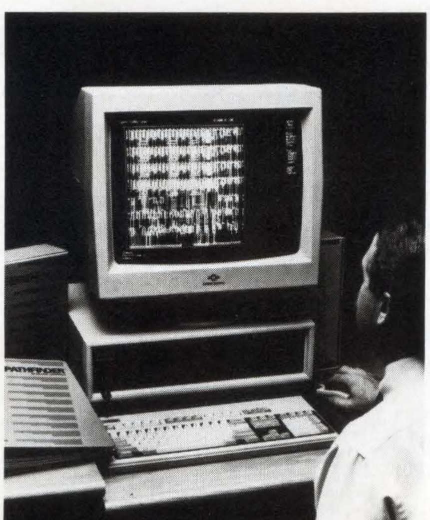
National Instruments Corp, 12019 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488. TLX 756737. Booth Nos 2803 and 2805.

Circle No 535

Schematic-capture and autorouting software works with popular CAD tool

The Pathfinder pc-board design system consists of a schematic-capture and layout program and an autorouter. Pathfinder works in conjunction with Autodesk Inc's Autocad program to provide mechanical as well as electrical-design capability on IBM PCs, PC/XTs, and PC/ATs. Included in the price of the autorouter is a 32-bit, parallel-processor card with 1M byte of RAM. You install the card in the system unit of the host computer.

The vendor claims that the schematic-capture and layout program places no limitations on board, grid, or schematic size; the number of schematic pages; or the number of parts, part types, pins/part, nets, pad sizes, hole sizes, or board layers. The schematic-capture function can extract net lists from ASCII files, and lets you highlight individual nets.



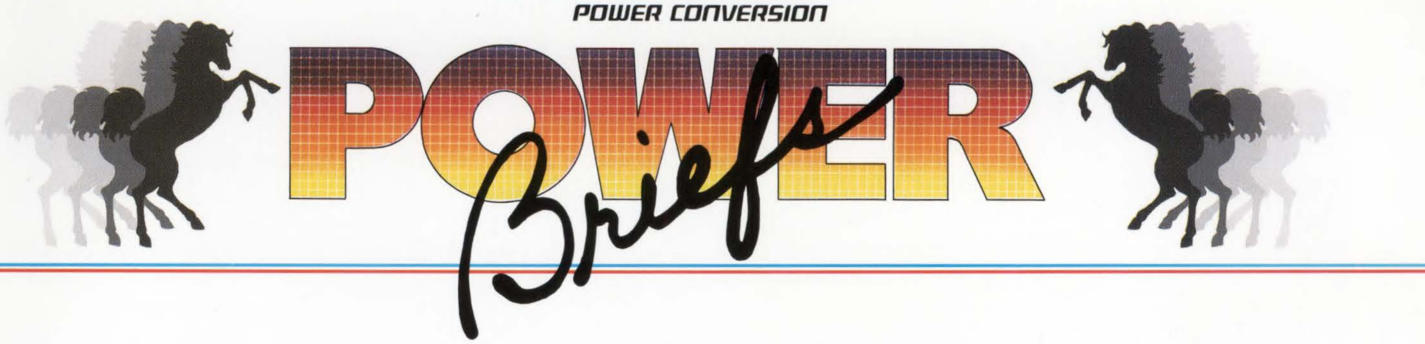
The autorouter handles 16-layer boards and offers user-redefinable strategies and 45° routes. It is reentrant, operates in single or multiple passes, and supports three algorithms: fast probe, exhaustive search, and rip up and reroute. For each 256k bytes of RAM on the coprocessor board, the autorouter can handle a board area of approximately 56 in.^{2} and as many as 89,600 pins. Schematic capture and layout, \$1995; autorouter, \$2995.

Bishop Graphics CAD Systems Corp, Box 5007, Westlake Village, CA 91359. Phone (818) 991-2600. TLX 662400. Booth Nos 2356 and 2358.

Circle No 533

COMPUTER PRODUCTS®

POWER CONVERSION



COMPACT 250 & 400 WATT SWITCHERS FEATURE FOUR-OUTPUT PARALLELING

The PPM and PFS Series 250 and 400 Watt cased switchers incorporate a unique closed-loop current sharing control circuit which permits simultaneous paralleling of up to four outputs, each with remote sensing. In addition, a single-point failure protection circuit assures that a single failure in a redundant power system will not cause the power bus to fail.

The series can provide as many as seven outputs.

Low profile cases only 5" wide by 2.75" high permit convenient stacking of the supplies. Power density is up to 2.4 Watts per cubic inch, and all models are efficiently cooled by a miniature internal ball bearing DC fan.

These switchers employ a bridge-driven forward converter using 100kHz MOSFET switching. The auxiliary outputs have either linear or magnetic amplifier regulation and are incorporated in three plug-in modules. Control circuitry is fabricated on a single circuit board using surface-mount technology. Standard features include switch selectable 115/230 VAC input, input line filter, remote on/off, power good signal, remote sensing, thermal protection with warning signal, overload protection, overvoltage protection, soft start and inrush current limiting. Optional features include current sharing, OVP crowbar and DC OK signal on main output, current monitor signal and others.

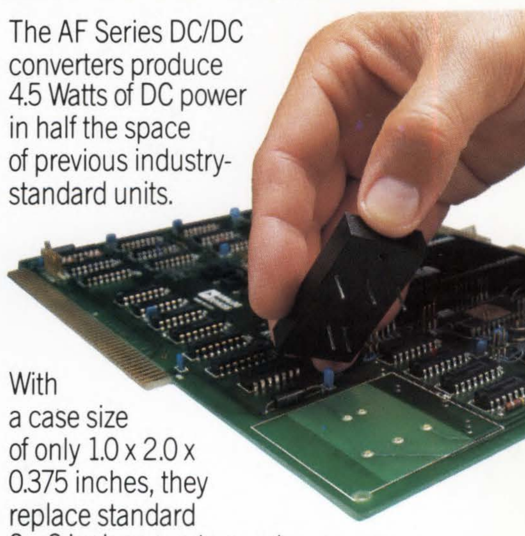
There are 25 stocked standard models in the 250W and 400W series. The models are UL recognized, CSA certified, and TUV approved.

Key Specifications:

Line Regulation	0.2%
Load Regulation	0.2%
Holdup Time	30 msec. min.
Efficiency	70 to 85%
Oper. Temp. Range	0° to 65°C

From Computer Products/Power Products **Circle No. 1**

NEW 4.5 WATT DC/DCs NEED ONLY HALF THE SPACE



The AF Series DC/DC converters produce 4.5 Watts of DC power in half the space of previous industry-standard units.

With a case size of only 1.0 x 2.0 x 0.375 inches, they replace standard 2 x 2 inch converters, yet have the same pinouts.

This series is fabricated with surface-mounted components on a miniature thick-film substrate to achieve 6 watts per cubic inch power density and efficiencies up to 66%. Available in single (+5, +12 or +15V) and dual (±12V or ±15V) outputs, the input voltage can be either +5 or +12VDC

Other key specifications include ±1.0% line regulation, 0.5% load regulation, and 40mV p-p ripple and noise. These converters are ideal for board-mounted applications in computers, I/O boards, telecommunications, process control and scientific instruments. The AF Series is on distributor shelves now.

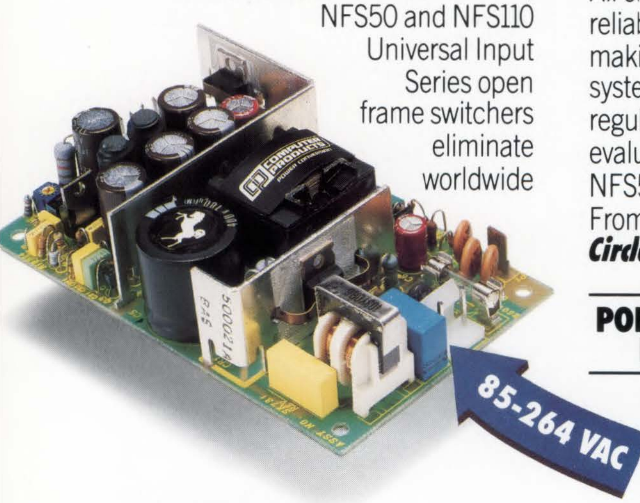
From Computer Products/Stevens-Arnold

Circle No. 2

Your Partner in Power

UNIVERSAL INPUT SWITCHERS OPERATE FROM 85 TO 264 VAC

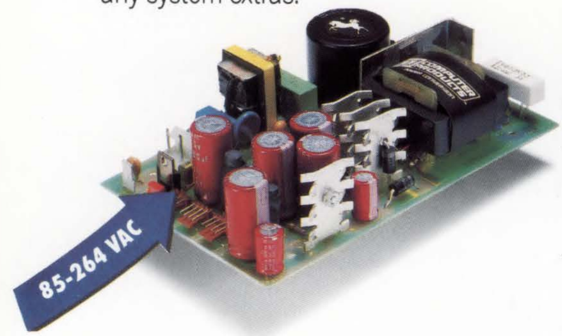
Operate from any line voltage from 85 to 264 VAC without changing jumper wires or switches. Computer Products/Boschert's new NFS40, NFS50 and NFS110 Universal Input Series open frame switchers eliminate worldwide



line voltage selection problems and offer system design flexibility.

On the low end, the NFS40 series of single and multiple output 40 watt switchers measures a tiny 5" x 3" x 1.2". These switchers provide more than 2.2 watts/cubic inch, and will fit into very small spaces.

The NFS50-7608 50 watt switcher directly replaces the industry standard 6.3" x 3.9" 40 watt unit. No need to mechanically redesign. Just drop it in and enjoy the benefits of universal input, plus 10 additional watts for any system extras.



For small to medium systems, check out the NFS110 series 110 watt switchers. The +12V output will deliver up to 9 amps to start disk drives. The small 7.0" x 4.25" x 1.8" size delivers more than 2.0 watts per cubic inch.

All of these switchers will operate reliably with no load on the output, making them ideal for expansion systems. Also, each output is fully regulated. NFS40 and NFS110 evaluation units are now available. NFS50 is in distribution.

From Computer Products/Boschert
Circle No. 3

POPULAR DC/DC CONVERTERS HAVE NEW LOW PRICES

Design in high performance and reliable operation at new low prices. The ES, EA and H series have filled a lot of PC boards to date but never so economically. Prices have been reduced by 10% for the ES series and 15% for the H and EA series. Also, the H and EA series are available in new 1.0 x 2.0 x 0.38 inch non-conductive packages. Check the table below and send for the latest data on our top performers. Or better yet, call your distributor for these low cost solutions.

Series	Output Power	Output Type	Input Voltage	Output
H	1 Watt	Single	5, 24, 48V	±5V @ 200mA
EA	1.8 Watts	Dual	5V	±12 or ±15V @ 60mA
ES	15 Watts	Triple	12, 24, 48V	+5V & ±12V +5V & ±15V or ±5V & +12V

From Computer Products/Stevens-Arnold
Circle No. 4

TAKING THE RISK OUT OF CUSTOM OPEN FRAME SWITCHERS

Computer Products/Boschert can take the risk out of custom switcher development. You get a predictable, highly reliable switcher, based on our well-known standard circuits.

Here's why:

Field-Proven Building Blocks. The quickest, least expensive way to build a custom switcher is using existing circuits. Computer Products/Boschert has hundreds of building blocks, field proven over our 15 year history. We understand their use and limitations. Your custom design is predictable, economical and virtually risk-free.

Appropriate Topology. Using the wrong topology is either costly or unreliable. Since we understand and build virtually every type of switcher, there is no need to squeeze your custom needs into our favorite topology. You get the correct topology for your power requirement.

Experience. Your supply is built by a company exclusively dedicated to switchers for 15 years. Our ability to integrate electrical, mechanical and thermal designs is exceptional. Our new medium power designs deliver more than 2 watts/cubic inch. The result is a highly compact switcher that meets or exceeds your system requirements.

Safety Approval. UL and CSA usually take no more than eight weeks. Full VDE certification usually takes only 12 to 16 weeks after your final prototype approval. TUV approval is also available.

Manufacturability. Every supply we make is designed with manufacturability in mind. We use a common parts base, with well characterized components that meet our conservative stress derating guidelines. Check for further information on custom switchers.

From Computer Products/Boschert
Circle No. 5

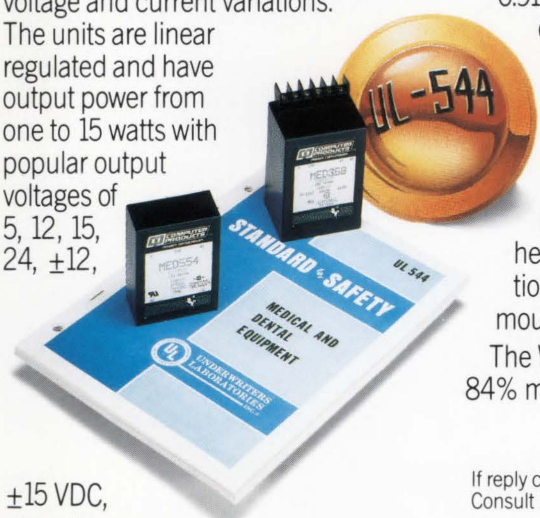
POWER Briefs No.1

LINEAR POWER MODULES MEET UL544 MEDICAL REQUIREMENTS

For UL544 approval you can rely on Computer Products/Power Products new MED 300/500 Series of AC/DC encapsulated power modules. They meet or exceed the stringent UL544 requirements for medical equipment. These supplies are recommended for use in non-patient contact medical, dental and laboratory applications where high isolation and low leakage are critical.

The MED 300/500 series is provided in single, dual and triple output models offering 63 different output voltage and current variations.

The units are linear regulated and have output power from one to 15 watts with popular output voltages of 5, 12, 15, 24, ±12,



±15 VDC, plus others available. Standard protection features such as overtemperature, overload and short circuit protection are included.

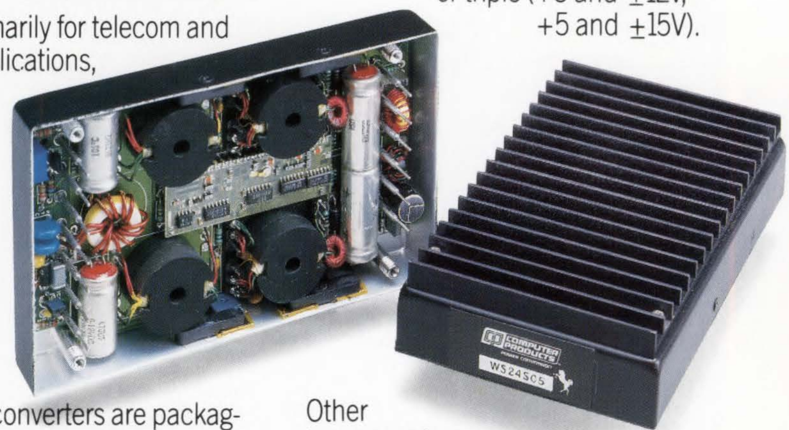
The power modules incorporate a split-bobbin wound transformer which provides high isolation between primary and secondary with low coupling capacitance. This results in 2500 VAC isolation voltage and less than 10uA leakage current.

The units are available in either printed circuit mountable or chassis mountable packages. In addition to UL544 approval the series is CSA certified.

From Computer Products/ Power Products ***Circle No. 6***

100 WATT DC/DC CONVERTERS HAVE LOW PROFILES, HIGH EFFICIENCIES

Designed primarily for telecom and computer applications, the new WS Series from Computer Products/ Stevens-Arnold offers 100 watts with single, dual, and triple outputs. The converters are packaged in a low profile case (3.5 x 5.5 x 0.91 inches) producing a power density of 5.7 watts per cubic inch. Available in chassis mount with screw terminations or printed circuit board mounting. The PCB mount version is supplied with a heat sink (adds 0.35 inches to height) which allow for conventional cooling with *no* special mounting required.



The WS Series has an efficiency of 84% minimum and a 2:1 input range of either 18 to 36 VDC or 36 to 72 VDC Output ranges supplied are single (+5, +12 or +15V), dual (+5 and +12V), or triple (+5 and ±12V, +5 and ±15V).

Other important features include 500 VDC isolation, input surge protection, reverse voltage protection and remote on/off control with idle currents down to 10mA.

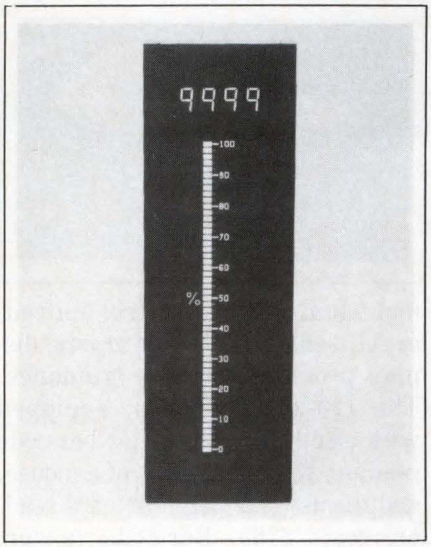
Key Specifications:

Line Regulation . . . . . . ±0.5% max.
Load Regulation . . 2.0% (to no load)
Ripple and Noise . . 100mV p-p max.

This series is available through distribution.

From Computer Products/Stevens-Arnold ***Circle No. 7***

If reply card is missing, please circle reader service number.
Consult 1987/88 EEM, page 643 for local sales office or call (305) 974-5500, Ext. 7514.

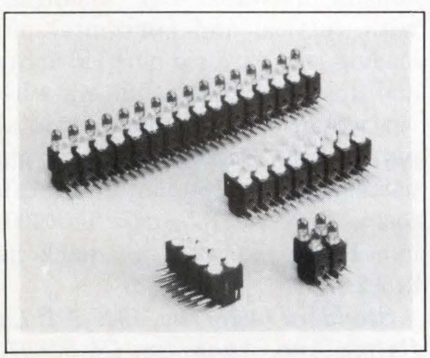


BAR GRAPH

The Model K051 51-segment LED-array bar graph features an analog bar that follows the level of an analog input signal with a response time of 55 msec. Simultaneously, a 4-digit readout displays the signal-input level with 0.1% accuracy. The unit measures 11.5×3.5 in. You mount it through a front panel cutout and secure it with two adjustable retaining clips. The unit comes with a 110/220V ac power supply mounted on it. The standard unit features red LEDs; you can obtain amber, green, and multicolored LEDs as options. $400. Delivery, eight to 10 weeks ARO.

Dixson Inc, Box 1449, Grand Junction, CO 81502. Phone (303) 242-8863. TWX 910-929-6991. Booth Nos 2203 and 2205.

Circle No 536

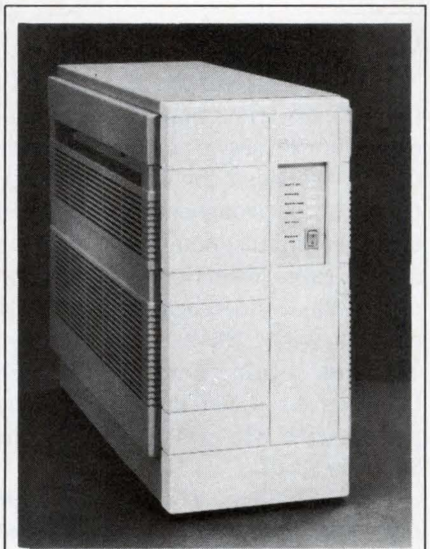


LED ARRAYS

T-1 LED arrays are arranged in single- or double-row packages for right-angle mounting on a pc board. The preassembled LEDs come in blocks of 1, 2, 4, 8, and 16 to save assembly time. The blocks are arranged on a 2.54-mm pitch according to DIN 41494 requirements. The LEDs have a maximum installed height of .41 in., feature tinned terminals, require no mounting hardware, and operate over −40 to +85°C. They come in red, green, and yellow. The double-row packages provide such combinations as red/red, green/green, yellow/yellow, red/yellow, red/green, and yellow/green. From $0.50.

Elma Electronic Inc, 41440 Christy St, Fremont CA 94538. Phone (415) 656-3400. FAX 415-656-3783. Booth Nos 2650 and 2652.

Circle No 537

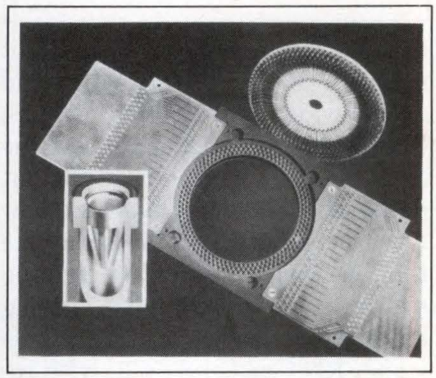


POWER SOURCE

The SPS/R standby power source features a 1-msec transfer time. When operating from ac power, a regulator, whose efficiency is 95%, passes the input sine wave through with less than 1% distortion. The regulator maintains the output voltage within +5 to −8% in the event of ac-input-voltage variations from +15 to −25%. If the input voltage falls below −25%, the unit shifts to inverter/battery power and supplies an output voltage within ±2% of nominal, with less than 5% harmonic distortion. When the ac power returns to within −25% of its normal level, the unit shifts power back to the ac input with no breaks at the zero-voltage crossing. You can order 60-Hz units, with 120V ac input/output voltages, rated for 500, 1000, or 1500 VA. $1445.

Sola, 1717 Busse Rd, Elk Grove Village, IL 60007. Phone (312) 439-2800. TLX 280538. Booth No 2703.

Circle No 539



RECEPTACLE

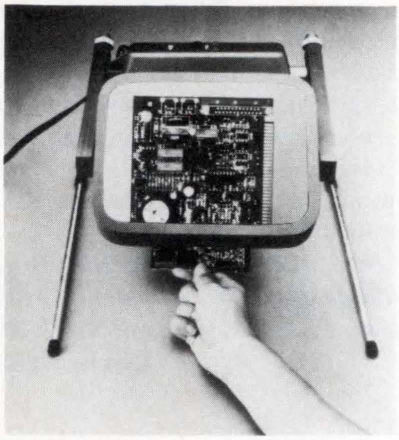
You can insert the 0300 6-finger receptacle with relatively little force. For example, when used in a circular probe card, the receptacle requires only 34 lb of insertion force. Its funnel-shaped design reduces the possibility of misalignment. This suits the device to applications that entail repeated plugging and unplugging. The device features a shell constructed of brass alloy 360 and contacts made of beryllium copper alloy 172. You can obtain a 0.320- or 0.397-in.-long receptacle. The device is suited for use with the vendor's 3137 pin. $0.08 (10,000).

Mill-Max Mfg Corp, Box 300, 190 Pine Hollow Rd, Oyster Bay, NY 11771. Phone (516) 922-6000. TWX 510-221-1820. Booth Nos 1069 and 1071.

Circle No 538

MAGNIFIER

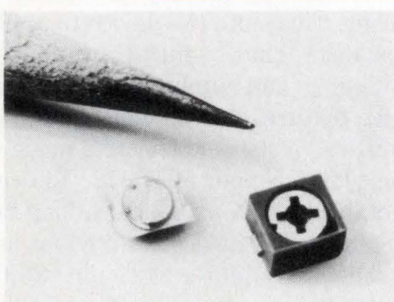
The MasterLens Illuminated Stereo Magnifier features a 6×8-in. rectangular glass lens that provides an



extralarge viewing field. The unit causes less than 2% distortion and can provide magnification of more than 3 diopters, depending on the focal length. There is sufficient depth of field under the lens to allow free hand movement. You can rotate the lens and a fluorescent lighting system to obtain the best viewing angle. Model STV-1, with portable stand, $299; model STV-2, with retractable arm, $389.

Contact East Inc, Box 786, North Andover, MA 01845. Phone (617) 682-2000. TLX 383088. Booth No 206.

Circle No 540

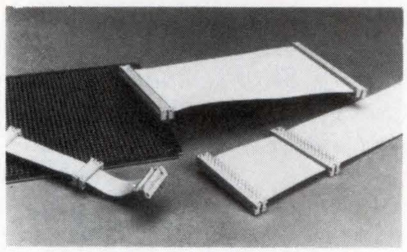


TRIMMER CAPACITORS

Surftrim surface-mounted trimmer capacitors are suited to vapor-phase reflow soldering. The vendor offers them unsealed or in sealed membranes that protect them against contaminents. You can obtain the unsealed devices in 3.2×4.5×2.8-mm carrier-and-reel packages and the sealed devices in 4.0×4.5×2.8-mm carrier-and-reel packages. The vendor offers the devices with eight capacitance ranges from 1.7 to 60 pF. The capacitors operate over −25 to +85°C. They are rated at 100V dc, feature 220V dc dielectric withstanding voltage, and provide insulation resistance of 10^4 MΩ min at 100V dc. $0.36 (10,000).

Sprague-Goodman Electronics Inc, 134 Fulton Ave, Garden City Park, NY 11040. Phone (516) 746-1385. TLX 144533. Booth No 218.

Circle No 541



CONNECTORS

You can permanently attach LATCON 2-row transition, .050-in. flat-cable connectors to pc boards, eliminating the need for headers. They come with preassembled sockets and covers, but open on one end for lateral cable insertion. The vendor offers the connectors for 10 to 64 circuits with .100-in. row spacing. You can obtain them with either 0.118-in. or 0.157-in. solder pins, plated with 315 μin. of tin. From $0.53 to $3.67.

Panduit Corp, 17301 Ridgeland Ave, Tinley Park, IL 60477. Phone (312) 532-1800. Booth Nos 342, 343, 348, and 349.

Circle No 542

KEYBOARD

The G80-2000 multi-option keyboard is IBM compatible. Its layout is identical to that of the IBM 3270 keyboard, with 10 function keys on its left end and another 24 arranged in two rows along its top. The keyboard comes with an enhanced version of SmartKey that provides an extra 96 functions by permitting each function key to function alone,

and when shifted, control-shifted, or ALT-shifted. A liquid crystal display provides operator guidance. The 123-key keyboard, equipped with electronic options for bar-code reading, the installation of a mouse, and the use of a magnetic-card reader, costs $765. Bar-code reader, $170; light pen, $45; and mouse, $45.

Cherry Corp, 3600 Sunset Ave, Waukegan, IL 60087. Phone (312) 360-3585. Booth Nos 1431, 1433, 1435, 1437, and 1439.

Circle No 543

LOGIC BOARDS

Metric Series wire-wrap logic boards come in Eurocard sizes ranging from 3U×160 to 9U×400 mm. They are available with power and ground for the VME Bus, Multibus II, and IEEE 896 Futurebus, or in uncommitted versions for special development. The low-noise boards feature SMT decoupling capacitors throughout the board. You can obtain the boards in a variety of pin patterns, including a low-density universal DIP mounting, a high-density universal DIP mounting with vertical pin loading, a high-density universal DIP mounting with vertical and horizontal pin loading, and a hybrid pin grid array and universal DIP mounting with vertical or vertical and horizontal pin loading. Depending on its pin pattern, a 3U×160-mm board can cost as little as $155 and a 9U×400-mm board can cost as much as $1592.

Standard Logic Inc, 4940-A E La Palma Ave, Anaheim, CA 92807. Phone (714) 779-2897. Booth No 2137.

Circle No 544

FLUKE AND PHILIPS-THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE®

PHILIPS

Counter-fit

If you think all low-cost frequency counters are inferior imitations of precision lab instruments, guess again. Fluke has a new 120 MHz counter that's a perfect fit for test systems, bench tops and budgets.

Honest performance at only $995.

The Philips PM 6666 counter delivers seven full digits of resolution at gate times of one second. More than 20 measurement functions. Automatic trigger-level setting. And first-rate input protection to 350V. All packaged in a rugged, shielded metal case.

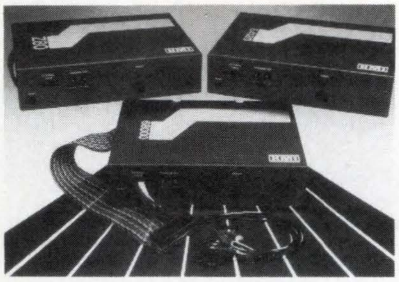
Add full programmability with the GPIB/IEEE-488 option. A 1.1 GHz input. Or Philips' unique mathematically-controlled crystal oscillator timebase for precise measurements with no warm-up time.

All this performance is backed up by one of the most trusted names in instrumentation: Fluke, with service and support that's never more than a phone call away.

So don't take chances. For genuine solutions to fit your test and measurement needs, come to Fluke. For more information and complete specifications, phone **1-800-44-FLUKE ext.77.**

John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206.
U.S.: (206) 356-5400 CANADA: (416) 890-7600.
OTHER COUNTRIES: (206) 356-5500.

FLUKE®

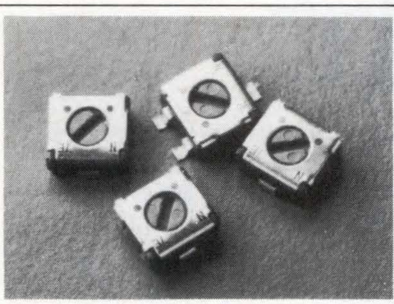


EMULATORS

The HMI-200 Series of in-circuit emulators now includes units that support the 8051/8031 family (including the Oki 80C59 Series), the 68HC11, the 6809, and the 8085. All units include two 72-bit×4k-frame trace buffers, logic-analyzer features, a general-purpose interval timer, and advanced break- and trigger-point parameters. The 6809 and 8085 emulators allow bank selection within emulation memory. They can also track the target system's bank selection mechanism. The 8051 emulator can trace all four of the microcontroller's ports in addition to address, data, and status values. This emulator can also use bit patterns on the 8051's 16 TTL inputs to qualify break and trigger conditions. The 68HC11 unit supports all of the μC's modes. $4750.

Huntsville Microsystems Inc, Box 12415, Huntsville, AL 35082. Phone (205) 881-6005. Booth No 2596 and 2598.

Circle No 564



ROTARY SWITCH

The surface-mount CS-4 spdt selector switch has a 4.5×5-mm outline. For a dc resistive load, the contact rating equals 0.5 VA; the maximum voltage and current ratings equal 16V and 100 mA from −25 to +70°C. A high-temperature housing material allows the switch to survive IR and vapor-phase soldering processes for five minutes. The switch can also withstand immersion-type cleaning processes, even with the use of low-viscosity liquids. The rotational life and total rotational angle spec at 20 cycles and 90°, respectively. The units are available in J-hook and gull-wing styles in bulk or in tape-and-reel packaging. $0.50 (5000).

Mepcopal Co, 11468 Sorrento Valley Rd, San Diego, CA 92121. Phone (619) 453-0332. Booth No 1349.

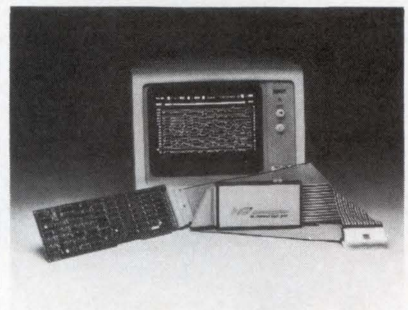
Circle No 553

ENCLOSURES

The MVE line of knock-down vertical enclosures offers the strength and rigidity of welded enclosures. These easy-to-assemble units are made of 13-gauge, cold-rolled steel and feature an EPA-approved, textured acrylic-enamel finish. The enclosures' strength and rigidity come from the design of their corners. A heavy-gauge mounting plate is welded into the top of each corner post. This plate is recessed into the columns. When the assembler tightens the corner bolt, the plate and the contact area of the cabinet frame deflect, forming a broad contact surface. The corner joints' tab-and-slot construction also guarantees correct assembly. The corner posts are always in the proper position for side-panel and door mounting. The MVE line includes models that are 42, 61, and 70 in. high, 25 or 30 in. deep, and 19 in. wide. From $520 to $670.

Precision Fabrication Technologies Inc, Highway 16 W, Monon, IN 47959. Phone (800) 558-7297; in IN, (219) 253-6666. Booth No 2769.

Circle No 547

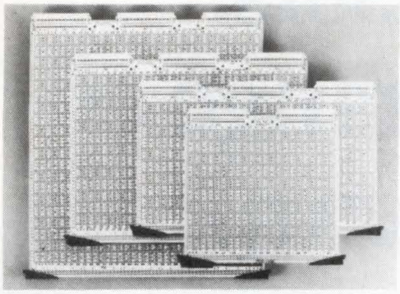


LOGIC ANALYZER

The PA480 logic analyzer is built on an IBM PC bus card. Disassembler pods are available for the 68000 and Z80 μPs. General-purpose pods support 48 channels at 25 MHz and 12 channels at 100 MHz. Using an internal clock, the 100-MHz pod can sample at 100-, 50-, 10-, 5-, 1-, 0.5- and 0.1 MHz. It will also sample at twice the frequency of a 50% duty-cycle external clock. The pod has one fixed TTL threshold plus two variable thresholds—one for even-numbered channels, the other for odd-numbered channels. You can set the variable thresholds from −5V to +5V. Four of the channels have glitch detection; they can detect glitches whose width at the threshold is 5 nsec or more. PA480, $1595; general-purpose pods, $350; 16-bit disassembly pods, $695; 8-bit disassembly pods, $495.

NCI, Box 11025, Huntsville, AL 35814. Phone (205) 837-6667. Booth No 2936.

Circle No 563

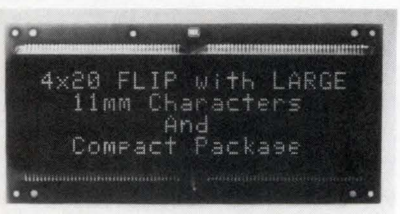


WIRE-WRAP BOARDS

The Series 207 Schottky-compatible wire-wrap boards are available with standard connector power commitments for VME Bus, Multibus II, or the company's Metric configurations. The board's construction and layout minimize system noise, crosstalk ringing, and propagation delay, and provide the fast rise and fall times associated with Schottky devices. All four boards feature 4-layer construction with copper interpinning around each pin on all layers. You can selectively commit any pin to the power and ground planes, and plated-through holes are spaced on 0.2-in. centers to equalize current flow and accommodate surface-mount decoupling capacitors. $625 to $1630.

Mupac Corp, 10 Mupac Dr, Brockton, MA 02401. Phone (617) 588-6110. Booth No 737.

Circle No 556

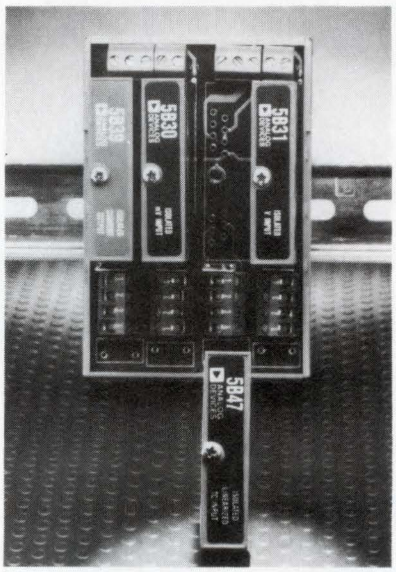


DISPLAY

The Model 3601-34-080 4-line×20-character vacuum-fluorescent display module has 11.3-mm-high characters that are formed from a 5×7 dot matrix and are readable from a distance of 10 ft. It operates from a 5V supply, and an onboard μP controls all display functions. A standard serial interface accepts either RS-232C or RS-422 data at 1200 or 9600 bps. The module displays the full 96-character ASCII font as well as additional European characters and scientific symbols. The blue-green display has a brightness level that specs at 160 fL and is dimmable to 80 fL via software control. $274 (100). Delivery, four to six weeks ARO.

IEE Inc, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311. TLX 4720556. Booth No 1453.

Circle No 551



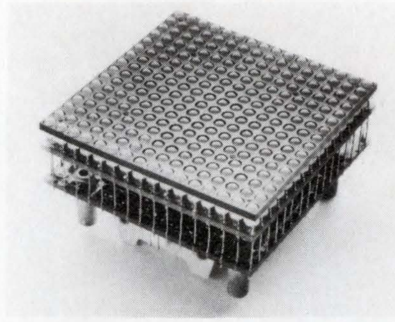
SIGNAL CONDITIONER

The 5B47 module accepts input signals from J-, K-, T-, E-, R-, S-, and B-type thermocouples and provides a linearized and isolated 0 to 5V output. It has a selectable signal-span range of ±5 mV to ±0.5V and processes J- and T-type thermocouple signals with ±0.5°C accuracy (combined nonlinearity, hysteresis, and repeatability). The zero and span accuracy equals ±0.05% of span. The normal mode rejection specs at 60 dB.

The module has a 240V-rms input-protection rating, 160-dB CMR, and a 1500V rms input-to-output common-mode voltage rating. The device includes cold-junction compensation circuitry that corrects errors caused by parasitic thermocouples formed by wire connections and screw terminals. Other features include open-thermocouple detection and a −25 to +85°C operating temperature range. $130 (250).

Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02121. Phone (800) 245-3900; in MA, (617) 461-3643. Booth No 1035.

Circle No 554



LED MODULE

Composed of 256 T1-type LED lamps arranged in a 16×16 matrix, the TLMM502A1 display module is available in red, green, and amber. It can replace CRTs in large-scale information-board applications—for example, airport and advertisement signs. The display module uses digital RGB driving circuits to provide compatibility with CRTs. As a result, it provides simple interface requirements in either graphic or alphanumeric display applications. It also has a Bright terminal that lets you adjust display brightness over a 1/16 to 15/16 range—a total of 16 gradient levels. $150 (100). Delivery, 10 to 12 weeks ARO.

Toshiba America Inc, Semiconductor Products Div, 2692 Dow Ave, Tustin, CA 92680. Phone (714) 832-6300. Booth No 2034.

Circle No 555

DC/DC CONVERTERS

The QWS Series 30W single-output dc/dc converters employ current-mode control technology and have no minimum output loading requirements. Internal control loops provide tight regulation for all outputs.

Text continued on pg 156

The ICE pacesetter that drives 15X faster than existing systems.

Rev-up your emulation performance. Do it faster and better than ever before. The SA98 from Sophia combines the flexibility to go from 8- to 32-bit microprocessors, and is fully compatible with IBM's PC/AT or XT. The SA98 is setting the pace as the price/performance leader.

Parallel Interface
Get a real speed boost over traditional RS-232 type interface with Sophia's unique parallel interface. You'll gain an 8X improvement in down load time. Optimize portability between IBM PC/AT, XT, or compatibles with Sophia's MS-DOS software drivers.

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Sophia's proprietary Direct Access Controller doesn't sidetrack ICE performance. It cuts through the curves others have to follow. The SA98, at high-speed, down loads to the target memory. Makes memory and data I/O modifications during program execution. Has full symbolic debugging. And you can view and augment trigger and trace conditions on-the-fly.

Dual Processor Emulation
Used in tandem, two SA98's emulate two separate 8- or 16-bit microprocessors simultaneously on a single host. Set your independent debug triggers, and emulation. The split screen feature displays code execution for each . . . independently.

Get Your Hands on the SA98
Experience the SA98 in action. Drive away with the real performance leader. You've got to see it to believe it.

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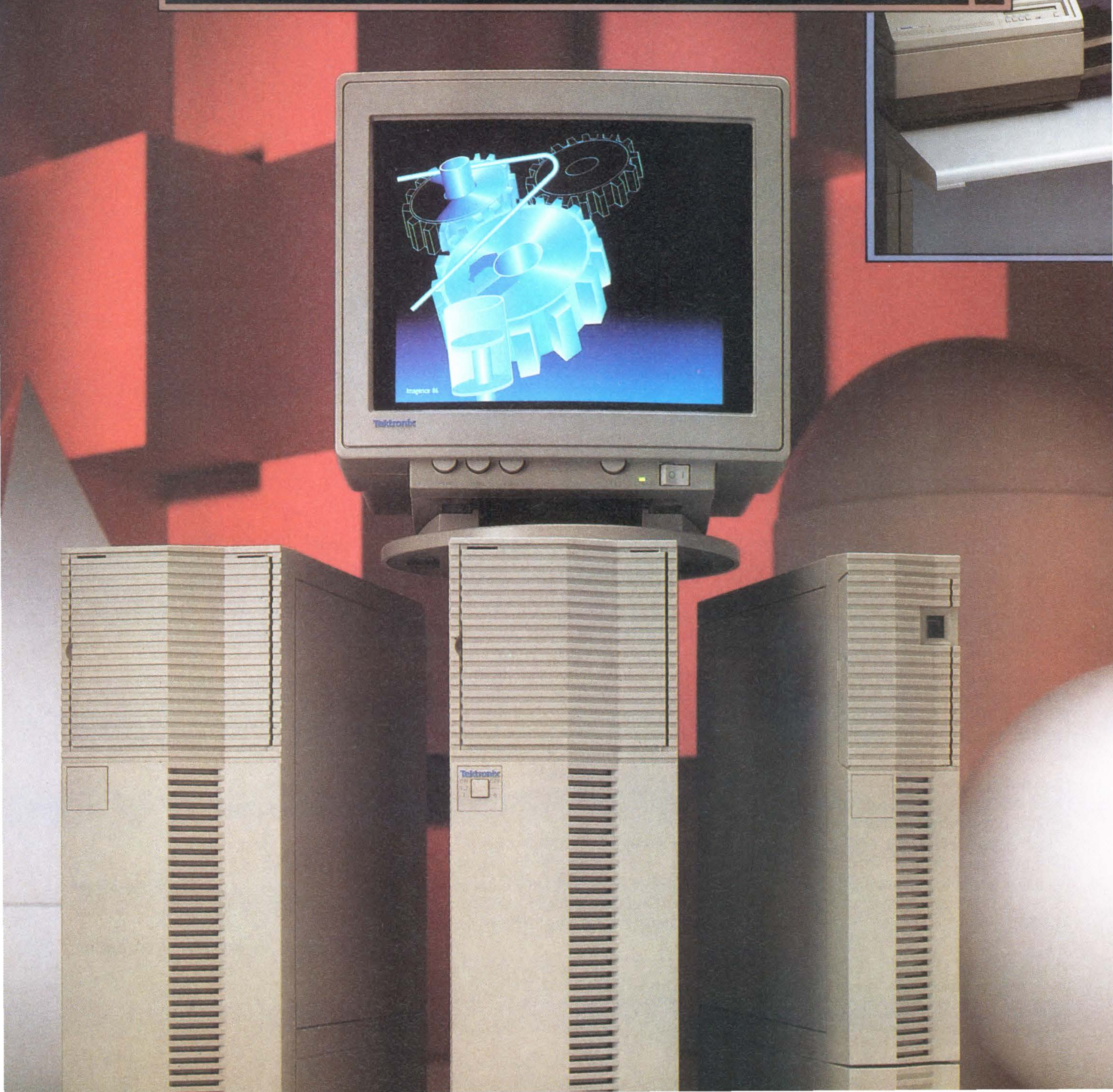
CIRCLE NO 183

TEK UNIX-BASED WORKSTATIONS

THE ONLY LINE OF GRAPHICS WORKSTATIONS DESIGNED AS IF THERE IS A TOMORROW.



Finally there are graphics workstations as committed to incorporating industry standards and to ensuring upgradability, as to breaking today's graphics throughput barriers. You know that barriers are made to be broken. But that your investment in hardware and software, in systems and training, is made to last.

That's why Tek's new 4300 Series Workstations are designed with parallel graphics and compute processors. This architecture gives you the choice of putting Tek graphics to work in a workstation or terminal configuration. And because you can later upgrade that terminal to a fully integrated workstation, you know your investment in Tektronix engineering has lasting value.

Just as forward-looking is the fact that the 4300 Series includes the industry's most established standards: UNIX, 68020 processors, Ethernet, TCP/IP, X Windows, and Tek PLOT 10® software, enhanced to complement the high throughput of these new systems.

With 14 different configurations, a common user interface, Tek's de facto graphics standard, and unsurpassed quality, the 4300 Series allows not just leading performance until the next breakthrough comes along —but growth for tomorrow.

For more information on the 4300 Series, contact your local Tek representative today.
Or call 1-800-225-5434.
In Oregon, 1-235-7202.

CIRCLE NO 184

Graphics courtesy of: Imagence/Paris using DALIM, PLOT 10® TekniCAD, ESRI, SDRC/CAE, and MCS.

Tektronix
COMMITTED TO EXCELLENCE

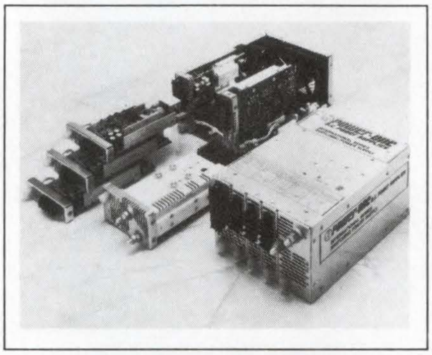
All modules operate at 100 kHz. Models are available that operate on nominal input levels of 24 and 48V dc, having 9 to 36V and 20 to 72V limits, respectively. All units output either 5, 12, or 15V. The full-load efficiency specs at 82 to 86% and is virtually unaffected by line and load changes. The output accuracy specs at ±1%.

The converter noise and ripple measures 75 mV p-p over a 20-MHz bandwidth. The transient response is less than 200 μsec with a 50% load change, and the temperature coefficient equals ±0.02%/°C. Load and line regulations spec at 0.5%. The converters are housed in encapsulated, all-metal cases to minimize radiation problems. $139. Delivery, stock to six weeks ARO.

International Power Devices Inc, 155 N Beacon St, Brighton, MA 02135. Phone (617) 782-3331. TLX 989752. Booth No 2724.

Circle No 546

POWER SUPPLY

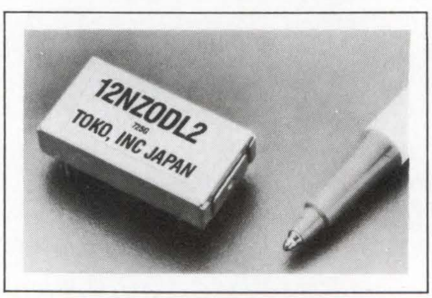


The Model SPM5 switch-mode power supply provides as much as 1500W of output power from as many as 15 outputs. It's based on a modular-design concept that allows you to specify a tailored multiple-output power system from a wide variety of off-the-shelf single-, dual-, and triple-output plug-in power modules. All outputs are independent and floating, and can be configured for either positive or negative output levels. The outputs use fully isolated MOSFET switching regulators to achieve high conversion efficiency in a small package—the power density measures 3.4W/in^3.

Current-mode control techniques help achieve precise current sharing when you operate outputs in parallel. The supply features field-selectable ac inputs that are compatible with worldwide requirements—90 to 132/180 to 264V, 47 to 440 Hz. The units meet VDE, IEC, CSA, and UL safety standards, and FCC and VDE EMI limits. $924 (250).

Power-One DC Power Supplies, 740 Calle Plano, Camarillo, CA 93010. Phone (800) 235-5943; in CA, (800) 421-3439. Booth Nos 464 and 466.

Circle No 548

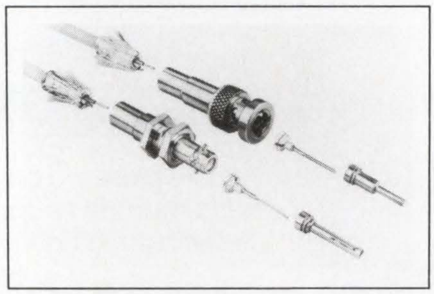


DC/DC CONVERTERS

The DL Series dc/dc converters use a thick-film circuit design to pack a 2W output capability into a 7.3×30×16-mm package. In addition, they feature a ceramic substrate that dissipates heat very rapidly. Three models are available in the series; all operate on 12V inputs and output either −5, −12, or −15V. The switching frequency ranges from 100 kHz to 140 kHz, depending on the model. The −12 and −15V models operate at 65% efficiency and the −5V unit has a 55% efficiency. Built-in choke coils and a well-shielded case virtually eliminate EMI/RFI problems. The case features grounding tabs and pc-type terminations that simplify installation. From $36.50.

Toko America Inc, 1250 Feehanville Dr, Mt Prospect, IL 60056. Phone (312) 297-0070. TLX 724372. Booth No 1526.

Circle No 557

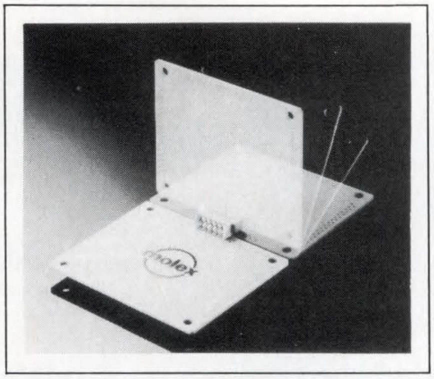


CONNECTORS

The field-installable, solderless, concentric twinax connectors in the 450 Series are designed for MIL-STD-1553B and MIL-STD-1760 digital data-bus applications. The series includes cable plugs and jacks, bulkhead cable jacks, and right-angle plugs. The connectors' plating satisfies the 500-hour salt-spray requirements of MIL-STD-1344A. Sealing gaskets and heat-shrink tubing provide weatherproofing. Center and intermediate contacts are interchangeable between pin or socket configurations; this interchangeability improves polarization capabilities and minimizes inventory requirements. The keying options include threaded types as well as 3- and 4-lug bayonet versions in multiple-lug positions. $15 to $20 (1000).

Trompeter Electronics Inc, Box 5069, Westlake Village, CA 91359. Phone (818) 707-2020. TWX 910-494-1210. Booth No 374.

Circle No 552



PC-BOARD CONNECTORS

These 2-piece hinged connectors feature a 1.25-mm contact centerline spacing. Measuring only 10.3×6.7 mm, the connectors are available in even-numbered sizes ranging from 4 to 20 positions. The connector design makes it easy to access the pc-board surface. The connectors mate on the co-planar axis or board-edge to board-edge, and allow you to rotate the boards by as much as 90°. They also mate in the reverse position when the pc boards are lined up in parallel position.

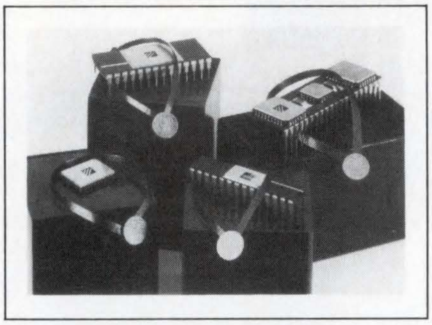
The connectors utilize a high-pressure, tuning-fork-type contact system. The terminals are tin-plated phospher bronze. To facilitate soldering operations and board-mounting stability, solder tails are arranged in a staggered pattern. The mating and rotation lifetime spec at 30 and 50 cycles, respectively. The connector housings are molded of UL 94-V0-rated polyester. The connectors have per-circuit contact ratings of 125V at 1A. $0.054/circuit. Delivery, seven to eight weeks ARO.

Molex Inc, 2222 Wellington Ct, Lisle, IL 60532. Phone (312) 969-4550. TLX 254069. Booth No 1708.

Circle No 549

STATIC RAMs

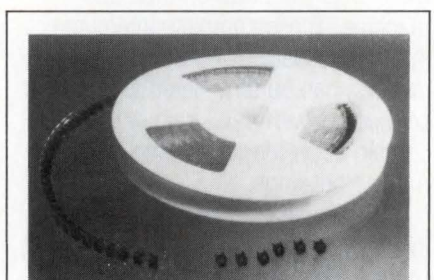
The 256k×1-bit EDI81256C and the 64k×4-bit EDI8464C static RAMs offer access times of 34, 45, and 55 nsec. The EDI8832C, organized as 32k×8-bits, provides access times of 45 and 55 nsec. The ×1 and ×4



devices are available in a 24-pin, 300-mil DIP or a 28-pin LCC; the ×8 device is available in a 28-pin, 600-mil DIP or a 32-pin LCC. All of the devices conform to JEDEC standard pinouts and meet the requirements of MIL-STD-883C. The EDI8M1664C is a high-speed 64k×16-bit module, containing four 32k×P8-bit devices in leadless chip carriers surface-mounted on a ceramic substrate on a 40-pin, 600-mil DIP. EDI81256C and EDI8464C, $302 to $453; EDI8832C, $223; EDI8M1664A, commercial version, $249 to $445; military version, $496 to $860 (100).

Electronic Designs Inc, 42 South St, Hopkinton, MA 01748. Phone (617) 435-2341. TLX 948004. Booth Nos 2827 and 2829.

Circle No 561

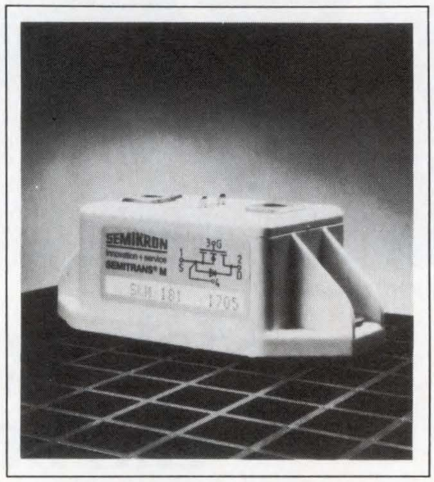


SURFACE-MOUNT LED

The configuration of the 6200 Series right-angle, surface-mount LED provides easy visibility, making the device particularly suitable for high-density applications where boards are mounted in parallel. The device is available in red, green, and yellow. The 12 models include standard and low-current versions as well as standard and low-current versions that include a resistor and operate from 5V. The series' design and packaging meet the requirements of automated surface-mount production-line equipment. The device can withstand the processing temperatures of either IR or vapor-phase reflow soldering operations. It's available on 16-mm tapes that hold 1000 LEDs/reel. $0.89 (1000).

Industrial Devices Inc, 260 Railroad Ave, Hackensack, NJ 07601. Phone (201) 489-8989. Booth No 2143.

Circle No 550

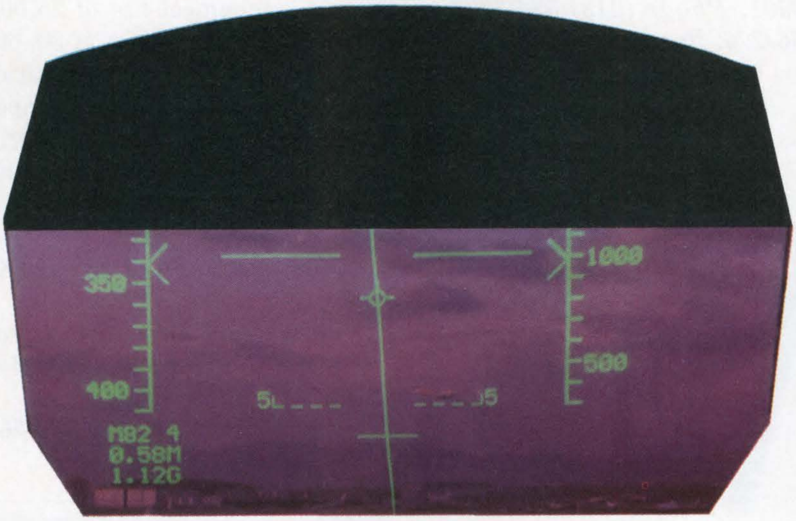


POWER MODULES

The SKM-181 rated at 30A, 800V and the SKM-151F rated at 50A, 500V each contain several power MOSFETs connected in series and in parallel in an isolated package. The SKM-151F also includes an integrated fast-recovery diode. The package has an isolation voltage rating of 2500V. The short internal connections minimize lead inductance and the possibility of parasitic oscillations. The modules also eliminate the labor-intensive job of paralleling TO-3 or TO-220 devices. A single module can replace as many as six individual TO-3 power MOSFETs. Because of the top-mounted connections, it is easy to connect the modules to bus bars. SKM-151F $70 (50).

Semikron Inc, Box 66, Hudson, NH 03051. Phone (800) 258-1308; in NH, (603) 883-8102. Booth No 818.

Circle No 558

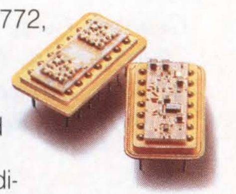


IF YOU'RE NOT CONSIDERING OUR OP AMPS, YOU'RE NOT GETTING THE WHOLE PICTURE.

Teledyne Philbrick op amps. The front-runners for speed and accuracy. Fast settling over a wide bandwidth is the essence of high-performance op amps in sophisticated, high-speed data acquisition, microwave transmission and video/CRT applications. So it pays to specify the best: the 1467 and 1493 operational amplifiers from Teledyne Philbrick.

These Teledyne Philbrick designs are specially engineered to maximize DC characteristics and high-speed performance. The 1467, 1GHz gain-bandwidth op amp ensures 70ns settling times to ±0.01%FS while providing ultra-low input offset voltage of ±30µV and input offset voltage drift of ±1µV/°C.

The 1493, a dual 350MHz gain-bandwidth op amp, features individual compensation and offset adjustments, FET inputs, 180ns settling times to ±0.01%FS and 80dB isolation at 100KHz.



Qualified to MIL-STD-1772, Teledyne Philbrick is a leading manufacturer of high-performance, high-reliability standard and custom microcircuits for industrial, medical, military and space applications worldwide. Send for complete specifications or call us toll-free at 1-800-325-1330 (outside MA).

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UB2, 5NH, U.K.
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JAPAN:
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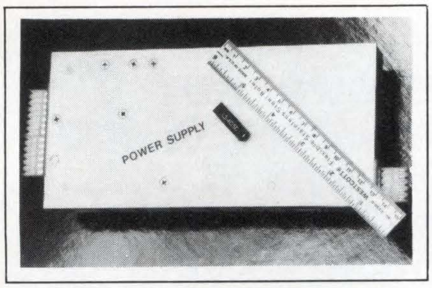
Taiko No. 3 Bldg.
2-10-7 Shibuya-Ku
Tokyo 542, Japan
Tel: 797-5251
Telex: 781-24335
Fax: 797 5255

CIRCLE NO 186

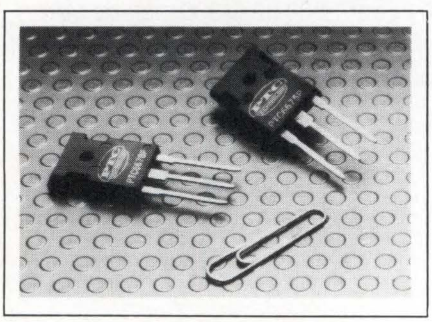


SMPS CONTROLLER

Designed for resonant-mode switching power supplies, the LD405 uses frequency modulation to control the regulation. The pulse width is held constant while the frequency is varied in response to load changes. Operating at high frequencies in the resonant mode, the device provides several advantages over conventional modes of operation. These advantages include reduced power-supply size and weight, reduced switching losses, and reduced component stress caused by zero-current switching. Other features include overload shutdown, soft start, and the ability to drive power MOSFETs directly. 16-pin plastic DIP, $3.50 (1000).

Gennum Corp, Box 489, Station A, Burlington, Ontario, Canada L7R 3Y3. Phone (416) 632-2996. TLX 0612996. Booth Nos 389 and 391.

Circle No 560

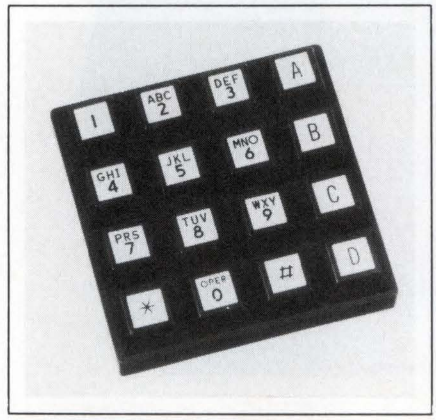


POWER TRANSISTORS

The PTC6675P and PTC6678P npn power transistors, available in TO-247 plastic packages, are electrically equivalent to the 2N6675 and 2N6678 devices in TO-3 metal cans. The TO-247 devices can replace TO-3 types in nonhermetic environments. The PTC6675P is rated at 10A, and the PTC6678P is rated at 15A. Both devices have sustaining-voltage ratings of 400V. The switching characteristics include a storage time of 2.5 μsec and a fall time of 0.5μsec. PTC6675P $3.45, PTC6678P $4.75 (100).

Power Technology Components, 23201 S Normandie Ave, Torrance, CA 90501. Phone (213) 534-3737. TLX 664276. Booth No 2934.

Circle No 559



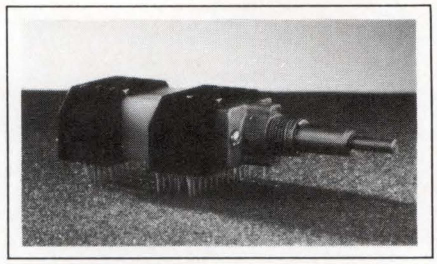
16-BUTTON KEYPAD

Encapsulated in a military grade, silicone rubber boot, the Series 84 4×4-button keypad is sealed from its environment when mounted on a panel. A snap-dome contact system provides tactile feedback, and the contact side of the dome is gold plated to ensure low contact resistance for 3M operations/button. Each button switch is rated at 24V dc/10 mA. The device also features EMI shielding and custom button legends. $25.85 (100). Delivery, six to eight weeks ARO.

Grayhill Inc, 561 Hillsgrove Ave, Box 10373, LaGrange, IL 60525. Phone (312) 354-1040. Booth No 1301.

Circle No 566

ROTARY SWITCH



You can use the S-400 rotary switch, which comes in 8- and 12-pin versions, in applications that require multifunction switching in a minimum amount of space. The switch construction provides for the sealing in of the lifetime lubricant and allows a mechanical life of 25,000 operations. Detent angles of 30, 60, and 90° are available, as are a variety of shaft and bushing sizes. Special options include molded Delrin spacers between decks and shaft extensions. The switch can carry 6A and has a make/break rating of 0.1A at 125V ac and 0.25A at 28V dc. $8 (OEM qty).

Electroswitch, 2510 North Blvd, Raleigh, NC 27604. Phone (919) 833-0707. Booth No 2858.

Circle No 565

CLOCK OSCILLATOR

This clock oscillator provides dual outputs, using independently operating crystals. It uses high-speed CMOS technology and is TTL compatible. Frequencies from 4 MHz to 60 MHz are available. The module not only saves board space, but costs less than two individual clocks. For frequencies in the 4-MHz to 18-MHz range, the module costs $2.90 (25,000). Evaluation samples are available.

Pletronics Inc, 9026 Roosevelt Way NE, Seattle WA 98115. Phone (206) 523-9395. TLX 4740170. Booth No 2119.

Circle No 562

POWER PLUS SAFETY.

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

Specify Maxell Super Lithium Batteries for critical applications where a safe battery is imperative.

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*Recognized under the Component Program of Underwriters Laboratories.

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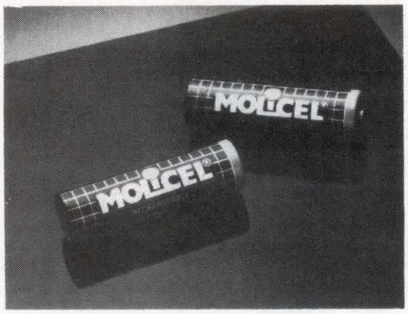
CIRCLE NO 185

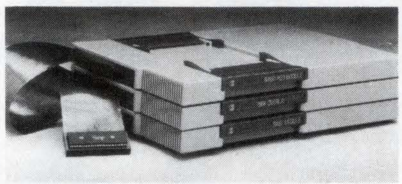


LITHIUM CELLS

The Molicel rechargeable lithium cell comes in an AA-sized package and can operate from 1.3 to 2.4V. You can choose various voltage limits, depending on the discharge rate, operating temperature, and capacity and life-cycle requirements. The cell features an 0.6 Ahr capacity and, after one year at room temperature, provides 90% charge retention. The unit operates from −30 to +55°C and, when subjected to a discharge current of 120 mA, reaches a 1.3V cut-off voltage in 300 minutes. The unit weighs 22g. $3 (10,000).

Moli Energy LTD, 3958 Myrtle St, Burnaby, British Columbia, Canada V5C 4G2. Phone (604) 437-6927. TLX 04356708. Booth No 2228.

Circle No 545



EMULATOR

The EL 800 in-circuit emulator performs zero-wait state emulation of the Z-80H μP at 8 MHz and of the HD64180 at 6 MHz and does so without preempting any interrupts. To minimize propagation delays, the emulator uses a hybrid circuit that plugs into the target μP socket and drives the 16-in. cable back to the emulator. The vendor provides the emulator in the form of 8.5×11×0.85-in. modules that stack on top of each other and snap together to make electrical as well as mechanical connections. You need only purchase one module; you add additional features by adding modules. A single power supply drives all the units. Your personal computer must run MS-DOS version 3x and have 640k bytes of RAM. $4850.

Applied Microsystems Corp, Box 97002, Redmond, WA 98073. Phone (206) 882-2000. TLX 185196. Booth Nos 804, 806, and 808.

Circle No 567

SIMULATOR

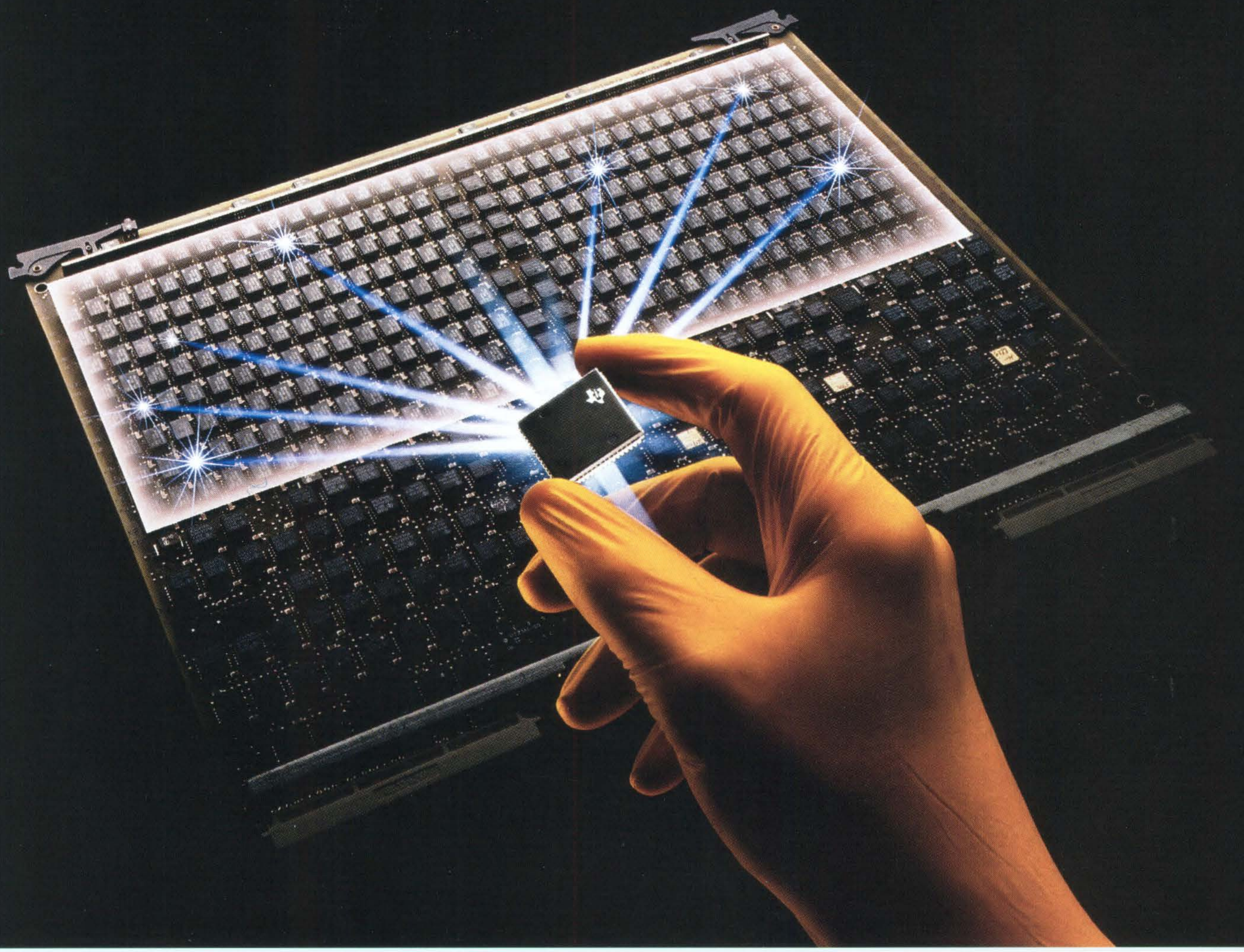
The handheld NSG 432 electrostatic discharge simulator tests electronic equipment for susceptibility to electrostatic discharges as defined in 16 current and proposed national and

Text continued on pg 167

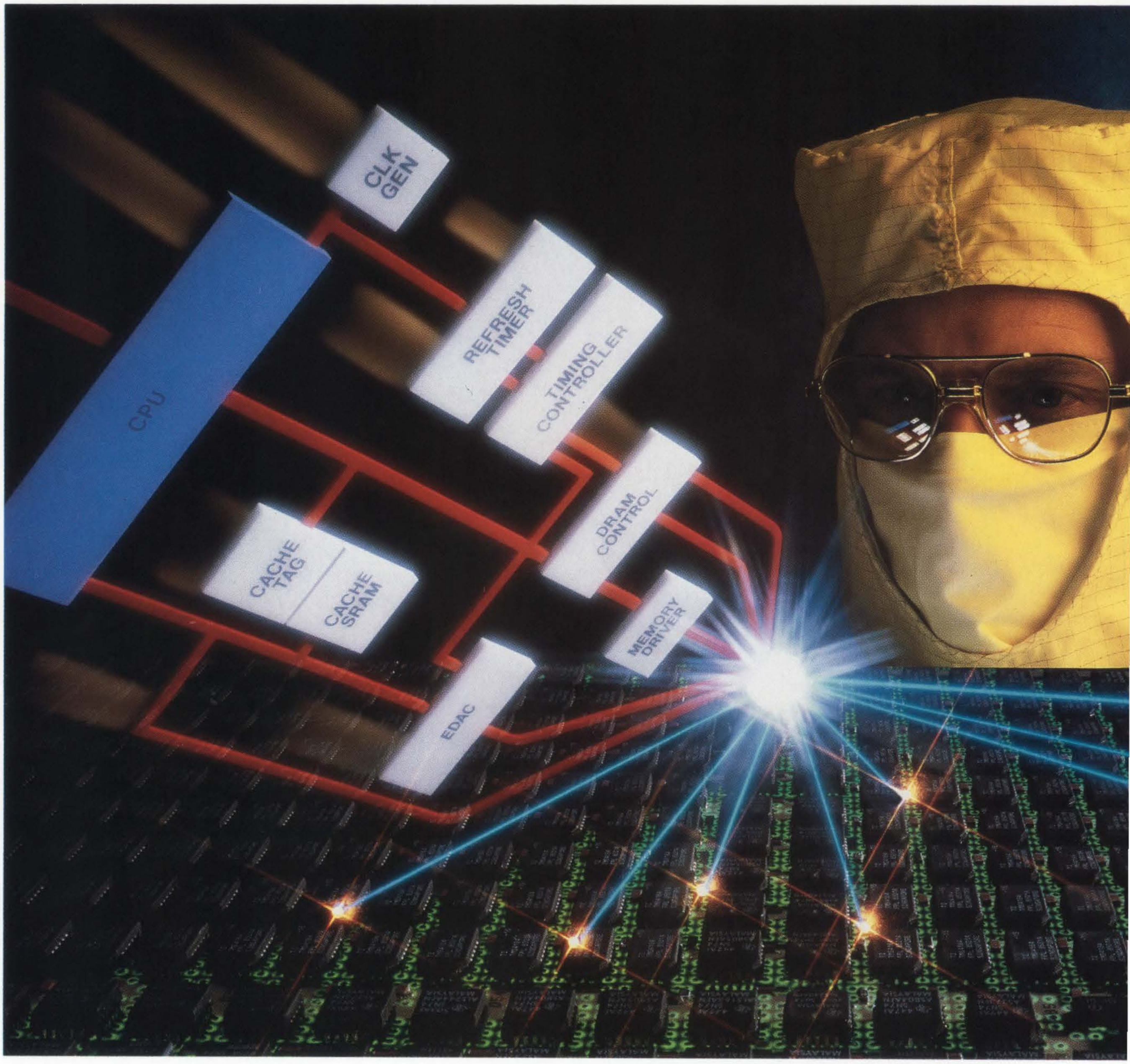
CIRCLE NO 8

TEXAS INSTRUMENTS REPORTS ON MEMORY MANAGEMENT

IN THE ERA OF MegaChip TECHNOLOGIES



Memory-management ICs from you bring memory arrays up to



Memory systems are a prime area for significant improvements in overall system throughput. Read how TI's memory-management ICs can get you in and out of memory faster no matter which processor you choose.

You can now solve a problem whose solution has eluded design engi neers for years: How to catch memory speeds up to CPU speeds. The solutio lies with TI's advanced memory-management circuits, and you can use them with whichever processor best suits your application.

Texas Instruments can help processor speeds.

TI's comprehensive Memory Management Design Kit *(see page 4)*.

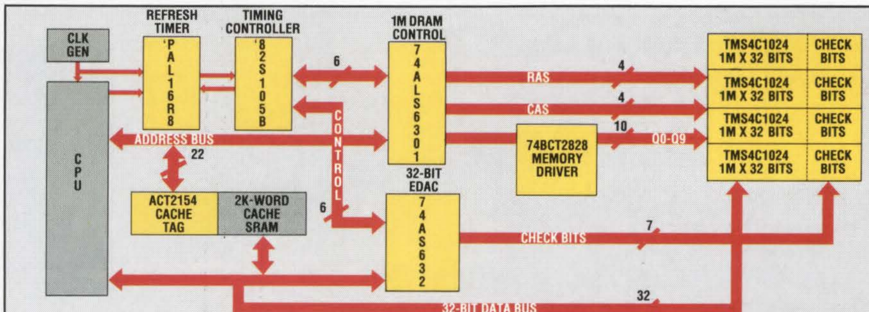
TI addresses your major memory-design concerns

To immediately improve memory-access time, use both main and cache memories, as shown in the block diagram. This approach can produce up to a 3X increase in system performance.

Frequently accessed data and instructions are stored in a few high-speed static random-access memories and "tagged" by a TI industry-standard cache controller (SN74ACT2151/4). These 2K×8 CMOS controllers are the fastest available and can support deep cache architectures of 16K or even 32K.

TI's MegaChip Technologies

Our emphasis on volume manufacturing of high-density circuits is the catalyst for ongoing advances in how we design, process, and manufacture semiconductors and in how we serve our customers. These are our MegaChip™ Technologies. They are the means by which we can help you and your company get to market faster with better, more competitive products.



High-speed memories can be designed with less effort and implemented more cost-effectively by using TI's family of universal memory-management ICs. These devices, all of which are contained in TI's Memory Management Design Kit, will work with and enhance almost any high-speed processor.

This scheme is cost-effective because slower, less expensive dynamic random-access memories (DRAMs) can be used for main memory.

When you must assure system integrity, use of an error-detection-and-correction (EDAC) circuit can improve system reliability 500-fold. Since this approach is necessary with memory arrays larger than half a million bits, TI offers its leadership 32-bit EDAC.

The SN74AS632 detects dual-bit errors and detects and corrects single-bit errors while avoiding processor wait states. And at 25 ns for error detection, it meets your high-performance needs.

Interfacing between processor and main memory gets tougher as speeds increase. But TI has the SN74ALS6301 DRAM timing controller. It can handle any DRAM up to 1 Mbit and incorporates only the essential functions on chip to improve flexibility and speed and to allow for custom timing routines. This controller supports nibble- and page-mode access and scrubbing-mode refresh to increase memory output.

Soon to come: An ASIC (application-specific integrated circuit) solution.

Reducing over/undershoot is accomplished by TI's 2000 Series buffers and drivers — 25-ohm series-damping resistors on the output prevent false reads at DRAM input. For example, the SN74BCT2828 driver can reduce undershoot by 40% compared to traditional approaches. TI's 2000 Series has a high-drive current suitable for VME and MULTIBUS® II bus structures.

You can use any or all of TI's memory-management ICs to obtain the superior performance that marks a market winner. And there's no design rule that says your memory-management chips and your CPU have to come from the same supplier.

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▶ *Turn page for more information.*

The tools you need to design a high-performance memory-management system are between these covers:

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  - —SN74BCT2828 10-bit Buffer/Driver with series-damping resistor
  - —TIBPAL16R8-10 and TIB82S105B High-speed Programmable-logic Devices for user-defined timing control
  - —TMS4464 256K DRAM
- *Memory Management Applications Handbook* containing applications reports and briefs that supply valuable insights into memory-management system design.
- Data sheets on TI circuits designed for efficient memory management.
- Memory-management-product software graphic-symbol libraries and supporting documentation for use with Futurenet™ or Mentor Graphics™ CAE systems.

For more information on TI's Memory Management Design Kit, call 1-800-232-3200, ext. 3203, or contact your nearest TI field sales office or authorized distributor.

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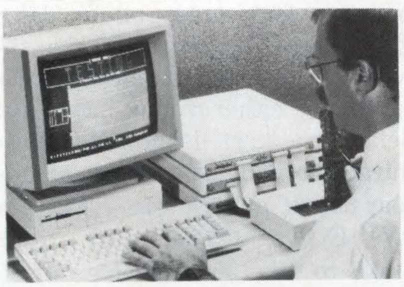
27-4510A

TEXAS INSTRUMENTS

international standards. The standard unit produces a positive-polarity output that you can set from 2 to 25 kV; you can obtain negative-polarity output by replacing a plug-in module. To use the gun-shaped unit, you select the voltage you want it to dispense, then touch the unit's tip to the part of the device under test where you want to simulate the effect of a static discharge. Pulling the standard unit's trigger prompts the discharge of a 150-pF capacitor through a 150Ω resistor to generate a narrow pulse. You can special order units that have different R and C values. The gun runs off a separate, high-voltage supply; you can obtain an optional power supply that lets you initiate discharges once per second. $4900 in PR.

Schaffner EMC Inc, 825 Lehigh Ave, Union, NJ 07083. Phone (201) 851-0644. TLX 6853444. Booth Nos 2717 and 2719.

Circle No 568



TEST SYSTEMS

MCP-2 software adds analog test-generation and analysis capabilities to systems containing as many as 15 of the vendor's MFI-1000 mainframes, including GFT-family component and populated-board testers. According to the vendor, the software eliminates most of the programming usually required to produce test programs and thus greatly reduces the time you must devote to their creation. The software's "learn" mode builds a tolerance database from a statistical sample of known-good units; the software uses this database to create analog- and digital-waveform guard bands. You can create test vectors with a waveform editor or you can transfer them from simulators. A macro control language, which links tests with conditional branching, eases component-level fault isolation. MCP-2, $695; test systems, from $5000.

Array Analysis, 200 Langmuir Lab, Brown Rd, Ithaca, NY 14850. Phone (800) 451-8514; in NY, (607) 257-6800. Booth No 2833.

Circle No 569

BAR-CODE SCANNER

S25 Series handheld, noncontact, bar-code scanners include units that feature internal decoding and a DB-25 connector that connects directly to a computer's RS-232C port. The scanners read 0.007-, 0.010-, and 0.020-in. bars. The units, enclosed in polycarbonate housings, employ visible-red light sources composed of four or six LEDs, depending on the bar size. You use a thumb-activated trigger to switch on the LEDs during scans; at other times, the LEDs remain in an off-state in order to conserve battery life. $310 to $575.

Skan-a-matic Corp, Box S, Elbridge, NY 13060. Phone (315) 689-3961. TWX 710-545-0220. Booth No 2125.

Circle No 570

PULSE GENERATOR

The DG535 pulse-and-delay generator outputs complementary pulses on two pairs of lines after effecting programmable, crystal-controlled delays. These delays can span 0 to nearly 1000 sec, and you can set them in 5-psec increments. The unit includes four independent delay generators. You can determine the width of an output pulse by programming either a start and a stop delay or a start delay and a pulse duration. You can choose among four output pulse levels—TTL (0 to 4V), ECL (-1.8 to -0.8V), NIM (-0.8 to 0V), and variable (offset, adjustable from -3 to 4V; amplitude, adjustable from 0 to 4V). The generator drives high-impedance or 50Ω loads with a 2-nsec transition time on the ECL output and with a 3-nsec transition time on the TTL output. The overshoot equals <100 mV+10% of the pulse amplitude. The unit, which is fully programmable via an IEEE-488 interface, will output pulses continuously from 0.001 Hz to 1 MHz. It can also output bursts of two to 32766 pulses. $2995.

Stanford Research Systems Inc, 1290D Reamwood Ave, Sunnyvale, CA 94089. Phone (408) 744-9040. TLX 706891. Booth No 2154.

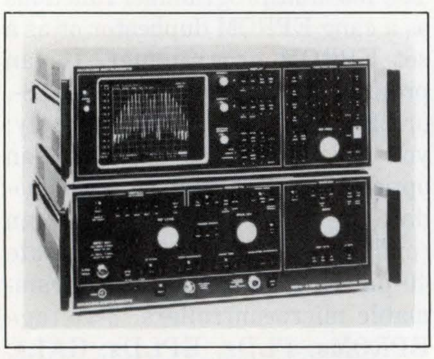
Circle No 572

DIGITIZERS

Century Series waveform digitizers consist of four models: an 8-bit-resolution unit that takes 1.3G samples/sec; an 8-bit unit that takes 200M samples/sec and can store 2M samples; an 8-bit unit that takes 100M samples/sec and can store 2M samples; and a 12-bit unit that takes 5M samples/sec and that, if fully expanded, can store 8M samples. These digitizers, suited to bench mounting or rack mounting, feature modular construction, which lets you add channels. You can operate additional digitizers independently or you can synchronize them to capture multichannel data. $8950 to $16,950. Delivery, four to six weeks ARO.

LeCroy Corp, 700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977. Phone (914) 425-2000. TWX 710-577-2832. Booth Nos 2211 and 2213.

Circle No 571



SPECTRUM ANALYZER

The 2383 spectrum analyzer covers 100 Hz to 4.2 GHz. It offers a 3-Hz min resolution bandwidth and a ±1.5-dB accuracy at 4.2 GHz. A tracking generator prevents frequency drift from impairing synchronous swept measurements. An FM demodulator allows display of demodulated audio signals. An active probe permits the instrument to make high-impedance measurements at frequencies as high as 1.25 GHz. On a single screen, the analyzer can display a full-band sweep covering 100 Hz to 4.2 GHz. The residual responses are −110 dBm, and the intermodulation equals <−90 dBc. The analyzer's IEEE-488 port lets you dump displayed spectra to plotters and storage devices. $41,950. Delivery, 60 days ARO.

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401. Phone (201) 934-9050. Booth Nos 2509 and 2511.

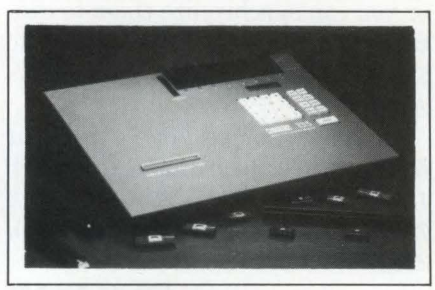
Circle No 573

DATA RECORDER

The RTP-650A instrumentation tape recorder records 14 channels of dc-to-40-kHz information and a voice channel on standard Beta-format cassettes. You can trade off recording time for bandwidth: When operating in the standard FM mode at the maximum tape speed, the unit records 40-kHz data for 3.3 minutes with a 47-dB S/N ratio; when running in this mode at the lowest tape speed, it records 625-Hz data for 3 hours and 28 minutes with a 39-dB S/N ratio. If the unit is operating in the optional direct-record mode at the maximum tape speed, the bandwidth extends from 200 Hz to 150 kHz with a 30-dB S/N ratio; if the unit is running at the slowest tape speed in the same mode, the bandwidth extends from 100 Hz to 2.35 kHz with a 26-dB S/N ratio. The vendor offers the unit with an option that enables it to perform PCM recording that conforms to IRIG 106-80. $35,750.

Kyowa Dengyo Corp, 81 Ruckman Rd, Closter, NJ 07624. Phone (201) 784-0500. TLX 135067. Booth No 2925.

Circle No 574

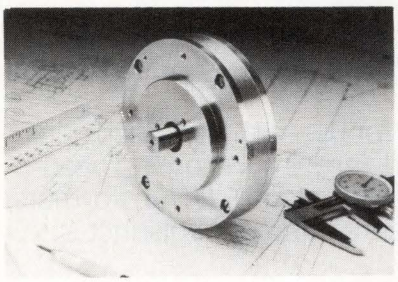


PROGRAMMER

The 135 Multiprogrammer functions as a gang EPROM duplicator or as a set EPROM programmer. It can program as many as eight 24-, 28-, or 32-pin devices simultaneously; you can obtain the unit with an option that enables it to accommodate 16 devices. The vendor can configure the unit to accommodate 40-pin EPROMs, 40-pin programmable microcontrollers, 3-voltage EPROMs, PLDs, EPLDs, GALs, and bipolar PROMs. When you use the unit as a set programmer, it can program 16- or 32-bit words disposed in two or four devices. The unit includes a 256k-byte memory, which you can expand to 2M bytes; a 25-key keypad; a 16-character×2-line alphanumeric liquid crystal display; a parallel printer port; and an RS-232C interface operable at speeds as high as 19,200 bps. $1195.

Bytek Corp, 1021 S Rogers Circle, Boca Raton, FL 33487. Phone (305) 994-3615. TLX 4998369. Booth No 2954.

Circle No 575



SERVOMOTOR

The 4.38-in.-wide, 0.92-in.-thick N Series servomotors produce 69 oz-in. of torque over 0 to 4000 rpm. They provide a peak torque of 755 oz-in. The motors rotate without cogging even at low speed. Their rated terminal voltage equals 30V, and their rated current is 7.9A. They feature 0.85Ω terminal resistance and <100-μH armature inductance. Their moment of inertia ranges from 0.396 to 0.586 kg-cm^2. One motor in the series has a tachometer output that produces 3.5 V/krpm. $550. Delivery, eight to 10 weeks ARO.

PMI Motion Technologies, 49 Mall Dr, Commack, NY 11725. Phone (516) 864-1000. TWX 510-223-0007. Booth No 432.

Circle No 576

CAE SYSTEM

EE Designer III is a complete CAE software package that runs on the IBM PC/AT, PC/XT, and compatibles. The software supports 2M bytes max of expanded memory and lets you design pc boards as large as 32×32 in. and with as many as 36 layers. You can include as many as 64,000 connection segments and 64,000 text strings. The schematic design module provides for forward and back annotation of multipage schematics to the layout, and for automatic parts packaging of gates with pin numbers and part identification. The on-line net-list-generation feature automatically adds parts to the net list as you incorporate them into your design. The system lets you edit, copy, and mirror symbols. The simulation module handles both analog and digital circuits, and can simulate as many as 50 nodes simultaneously. The layout module allows you to edit and view as many as 16 layers simultaneous-

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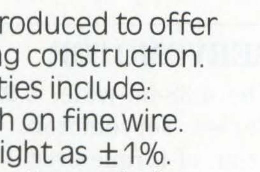

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CIRCLE NO 189

ly, with a grid resolution of 1 to 800 mils. The package includes an autorouter that minimizes the number of layers in your design. $3995.

Visionics Corp, 343 Gibraltar Dr, Sunnyvale, CA 94089. Phone (408) 745-1551. TLX 346352. Booth Nos 2838 and 2840.

Circle No 577

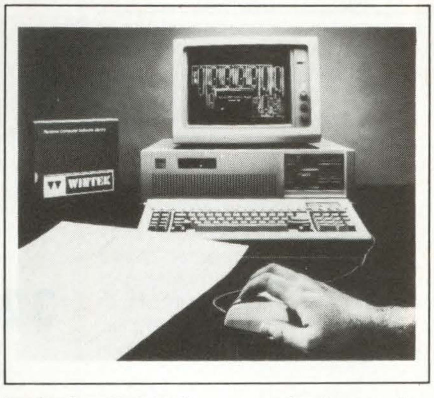
DEBUGGER

The Xray68K high-level debugger/simulator package runs on a variety of host computers and generates code for the Motorola 68000 family of μPs. The package includes the MCC68K C cross-compiler, a relocating macro crossassembler, a linking loader, and a library utility. You can write your application in C, using your standard editor, and then assemble and link it to generate native code for the target machine. The debugger/simulator emulates the target machine in software and allows you to control and examine the execution of your code either at the assembly-language level or in terms of C source-code lines. You can set both simple and complex breakpoints and display both interrupts and user I/O operations. Alternatively, you can direct simulated target output to a disk file for later examination and analysis. From $3500 to $14,000.

Microtec Research Inc, 3930 Freedom Circle, #101, Santa Clara, CA 95054. Phone (408) 733-2919. TLX 4990808. Booth Nos 2619 and 2621.

Circle No 578

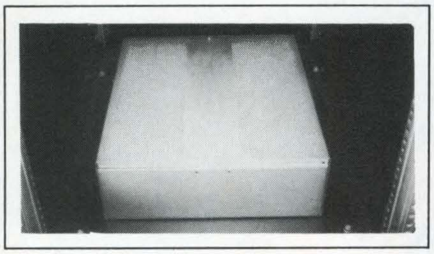
SCHEMATIC CAPTURE



The HiWire-Plus schematic-capture software package runs on the IBM PC and compatibles and has been enhanced by the addition of an ECL component library and a ladder-diagram library. Other new features include 0.001-in. resolution, the ability to create pc-board layouts with as many as 250 layers and the ability to handle boards as large as 60×60 in. You can direct output to pen plotters, dot-matrix printers, and laser printers. The package includes utilities for the creation of net lists and a bill-of-materials, and for comparing these with your final board layout. The vendor offers a 3½-in. diskette version of the package for use on the IBM PS/2 family and some laptop machines. $895.

Wintek Corp, 1801 South St, Lafayette, IN 47904. Phone (800) 742-6809; in IN, (317) 742-8428. TLX 709079. Booth No 519.

Circle No 579



IMPELLER BLOWER

The 803N-2 motorized impeller blower comes in a smaller, more efficient package than do centrifugal blowers. The blower is balanced in two planes to ensure minimum vibration, and you can mount it in any position. The motor and bearings are sealed to provide maintenance-free operation. If you mount the blower on the floor of the equipment frame, you must maintain a $^{15}/_{16}$-in. clearance between the frame base and the floor for air intake. The blower operates on 115V ac at 50/60 Hz and draws 1.18 amps. Its speed is variable between 2200 and 2570 rpm, and it delivers 445 to 540 cfm at a noise level of −55 dB. The blower case, which also contains a filter, measures 5×14.5×13.5 in. $265.

Amco Engineering Co, 3801 N Rose St, Schiller Park, IL 60176. Phone (312) 671-6670. TWX 910-227-3152. Booth Nos 1308, 1310, and 1312.

Circle No 580

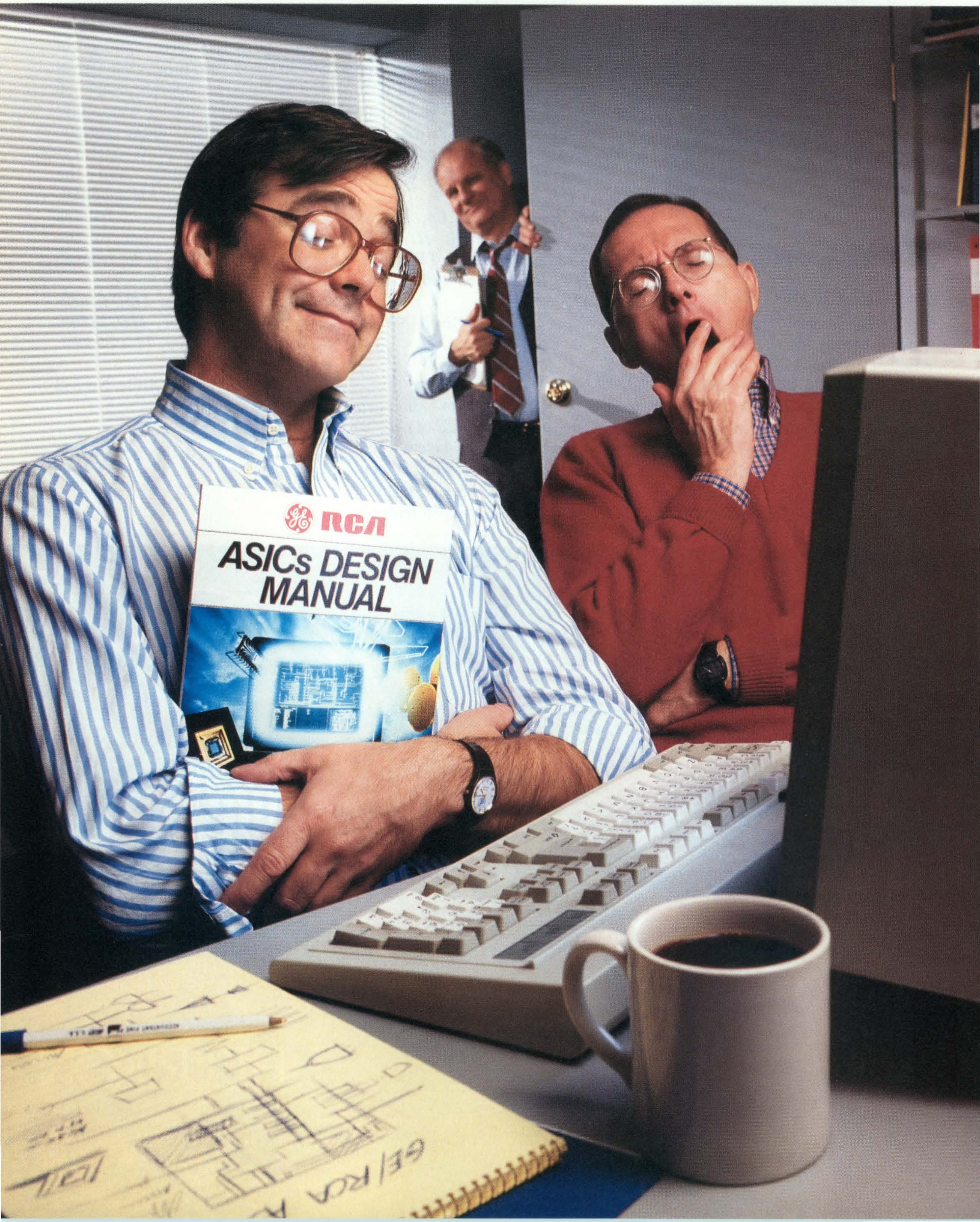
CMOS BACKUP

μPowerCell 2.8V lithium-iodine batteries feature a shelf life of over 20 years at temperatures below 37°C. The vendor offers them in two configurations, round or rectangular. The round, axial-lead B-35 features 35-mAh capacity and comes on sequenced tape reels for automatic insertion. The rectangular B-400, B-600, and B-1000 have capacities of 400, 600, and 1000 mAh, respectively. The batteries operate over −55 to +125°C. The vendor also offers the DRM and DRM2 data-retention modules, which provide battery-switchover capability, and the NVRM (nonvolatile RAM module), which features 2k bytes of Toshiba static RAM in addition to the switchover capability. B-35, from $3 (100).

Catalyst Research, 1421 Clarkview Rd, Baltimore, MD 21209. Phone (301) 296-7000. TLX 898095. Booth No 1269.

Circle No 582

Our ASICs

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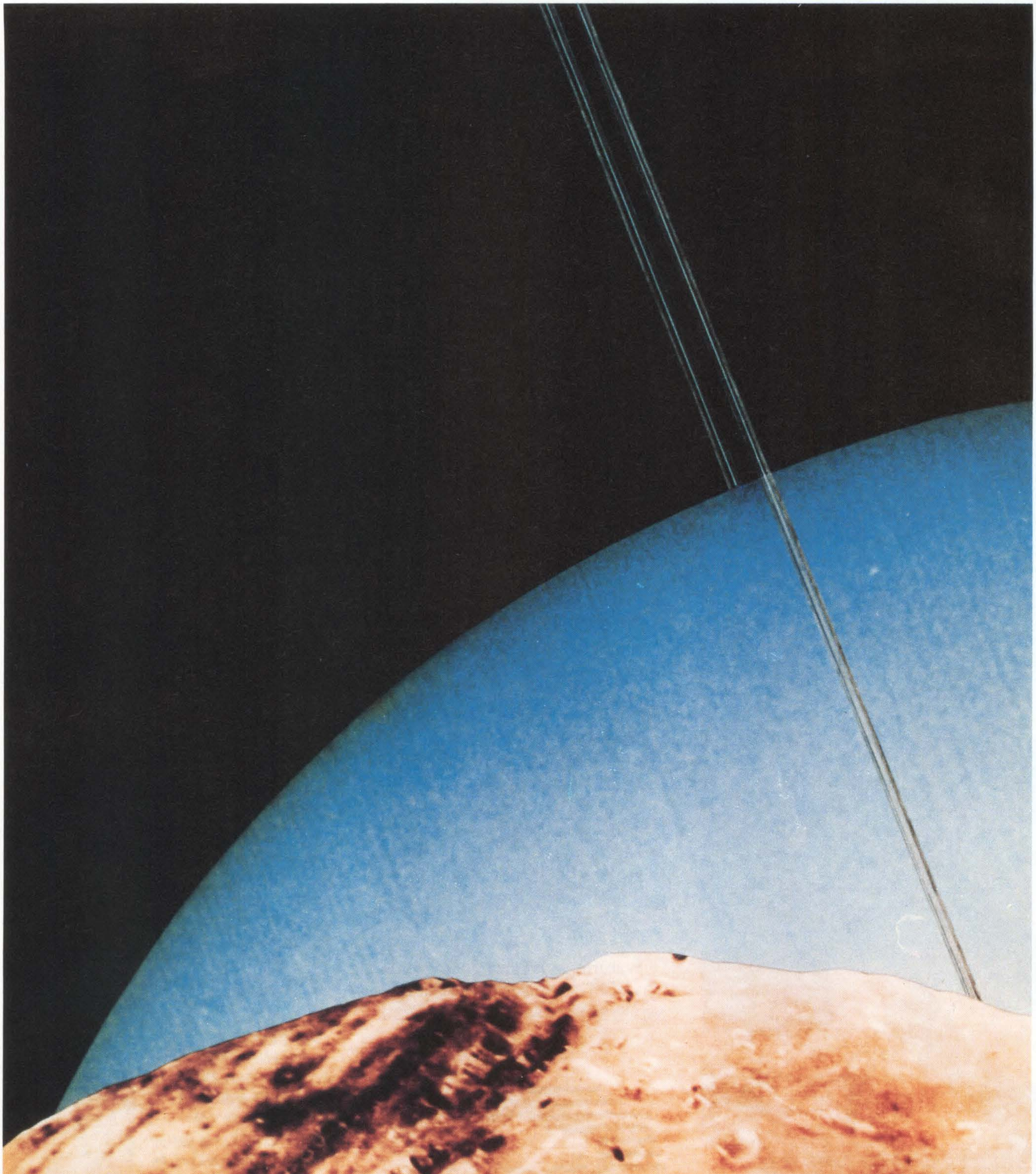


Nine years and approximately 1,750,000,000 miles from the nearest service depot *on Earth, Voyager 2 photographed Uranus, its rings, and its moons, including the moon Miranda (shown in the foreground of this composite photo). Missions such as those of the Voyager spacecraft underscore the need for ultrareliable space systems. Voyager 2 will fly by Neptune in August 1989. (Photo courtesy Jet Propulsion Lab/NASA)*

Fault-tolerant design spans terrestrial and space applications

The growing commercialization of space will boost many more electronic systems into orbit in the 1990s. Fault-tolerant design techniques developed originally for aerospace systems will pervade the electronics industry as customers demand the utmost in reliability from every electronic product, even those intended for use on Earth.

Steven H Leibson, *Regional Editor*

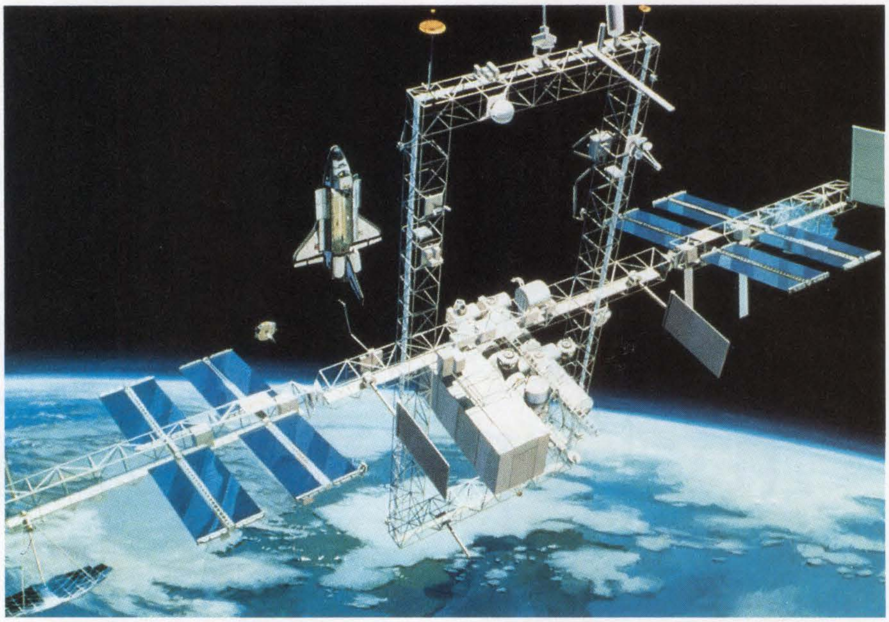
Space has been a commercial frontier for more than 20 years, thanks to communications satellites. In the 1990s, a lot more hardware is headed off Earth both to enhance existing communications facilities and to expand the commercial use of space into other areas. President Reagan recently revealed a new space initiative that calls for increased commercialization of space, and several companies are now deeply involved in plans to make that vision real. As a result, during the next decade, engineers will design many more electronic systems for spaceborne applications than they have in past years.

Systems for use in space must meet stringent reliability requirements. They must also withstand the unusual environmental hazards present in space, such as temperature extremes and radiation. What's more, as electronics spreads throughout earthbound applications, any system that plays a vital role in the health and welfare of human beings will have to meet requirements similar to those for spaceborne systems. Whether they're designing systems for use in space or on Earth, therefore, more engineers will have to become better acquainted with fault-tolerant design.

Space presents immediate challenges

The US's permanently manned space station, which NASA plans to make operational by 1997, represents a major opportunity for progress in space electronics. Just for its construction, the station requires extensive development of automated systems that manage data, environmental-control, life-support, thermal, and power systems. NASA divided the space-station project into four work packages and, last December, awarded contracts for these packages to Boeing Aerospace Co (Huntsville, AL), McDonnell Douglas Astronautics Co (Huntington Beach, CA), the Astro-Space Div of General Electric Co (Valley Forge, PA), and the Rocketdyne Div of Rockwell International (Canoga Park, CA).

In February 1988, President Reagan revealed a new space policy that plays up the role of private companies in US space efforts. In fact, firms in the US such as Space Services Inc (Houston, TX), with its Conestoga Series small boosters, are already attacking the first major hurdle—cost-effective access to orbit—by developing independent launch systems to supplement US



The US's permanently manned space station, *which is scheduled to become operational in 1997, presents several opportunities for designing fault-tolerant systems that manage data, environmental-control, life-support, thermal, and power systems. In addition, the space station will provide a platform for conducting manufacturing-related investigations, which will also require fault-tolerant systems to oversee the experiments. (Photo courtesy NASA)*

government vehicles. One forward-looking company, Orbital Transport Services Inc (Phoenix, AZ), is developing an electromagnetic catapult that employs superconducting storage rings to provide the electrical energy for launching a payload into orbit.

A space station smaller than NASA's planned one, the industrial space facility (ISF) designed by Space Industries Inc (Houston, TX), is scheduled to become operational in 1991, much earlier than the manned space station. The unmanned ISF will provide a platform for materials research and automated manufacturing. Unlike the manned space station, it will not incorporate life-support systems, but will be visited occasionally by the space shuttle for repairs, supplies, and retrieval of manufactured products.

Many other countries, attracted by the potential profits in satellite delivery, have entered the space-transportation business. The European Space Agency (ESA) has already launched several payloads with its Ariane booster series, and has recently decided to build an improved model—the Ariane 5—as well as the Hermes space shuttle and the Columbus manned space laboratory. China and the USSR have also entered the competition by selling rides on their respective Long March and Proton heavy-lift boosters. Japan, though not yet in the fray, is currently developing a commercial launch vehicle of its own. Consequently, a lot of electronic hardware will be heading for space during the 1990s.

Though more electronic systems will end up in space during the 1990s, many engineers today lack the expertise to design systems for extraterrestrial environments. Electronic systems in space applications must tolerate radiation, and few engineers are familiar with the components and techniques necessary to build radiation-resistant circuitry (see **box,** "Proofing electronic systems against radiation").

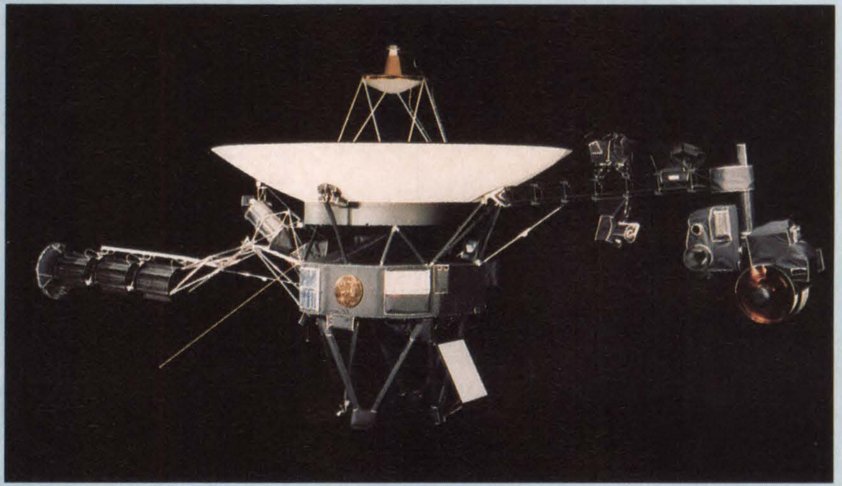
Space hardware must also be very reliable, because on-site service is either very costly or unavailable. Furthermore, most space equipment must be robust enough to handle unplanned problems without human intervention. Today, engineers developing equipment for aerospace applications are some of the world's leading experts on fault-tolerant, redundant design.

Aircraft need fault tolerance

According to Gary Kravetz, vice president of engineering at Fail-Safe Technology Corp (a consulting firm specializing in reliable-system design), engineers first started using fault-tolerant and fail-safe designs for aircraft flight-control systems in the 1960s. At that time, aeronautical engineers were starting to design inherently unstable airframes, such as that of the F-16 fighter, that required a computer to dynamically position the control surfaces for stable flight. The control computers had to be absolutely reliable, because computer failure in such applications results in catastrophic consequences—the plane will fall out of the sky.

Proofing electronic systems against radiation

Besides requiring reliability, redundancy, and robustness, spaceborne systems encounter an environmental hazard not common to most terrestrial applications: radiation. All ICs tolerate radiation to some extent, but because manufacturers are always trying to optimize other characteristics such as yield or speed in their commercial parts, chips that are not specifically hardened against radiation may not have repeatable radiation tolerance from lot to lot. Engineers confer hardness on a design by using special device geometries and spacings and by fabricating the chips with carefully controlled processes.



Voyager's mission posed some tough challenges *for designers trying to harden the spacecraft's electronic systems against radiation. One such challenge presented itself in the form of reports from Pioneer 10 and 11—a year after the Voyager design was finished—that the radiation intensity in the vicinity of Jupiter was 1000 times greater than experts had estimated. The discovery required Voyager's designers to provide the craft with additional radiation hardening. (Photo courtesy JPL/NASA)*

Spurred by the US government's requirements for radiation-hardened devices in military and space applications, several companies now offer ICs specifically built for high-radiation environments. For example, Harris Semiconductor (Melbourne, FL), offers several lines of rad-hardened analog and digital ICs. The company even offers a hardened version of the Intel 8086 μP, which Ball Aerospace Systems Div (Boulder, CO) has incorporated in its subsystem processor, a computer subsystem that Ball plans to use as a controller in future spacecraft designs.

The United Technologies Microelectronics Center Inc (UTMC, Colorado Springs, CO) also offers rad-hardened ICs. The company makes both standard parts and ASICs for systems that must tolerate radiation. Recently, UTMC introduced the UTD-R family of gate arrays, which meets all of its data-sheet specifications after absorbing a 1M-rad (Si) dose of radiation. That's about the radiation dosage an unshielded system must endure while orbiting the Earth for 10 years.

Different types of radiation (neutrons, ionizing radiation, and heavy ions) affect semiconductors differently. In addition, different dose rates create varying effects. Because device physicists don't yet fully understand all of the changes that different types of radiation produce in semiconductors, few standards for testing an IC's radiation hardness exist. Most of the existing standards were created by the US Department of Defense.

Rad-hardened-system design has remained a rather esoteric field that's limited mostly to military and space applications. However, because of the growing number of electronic systems in space, more engineers will need to develop expertise in rad-hard design. The IEEE's Nuclear and Plasma Sciences Society serves as an excellent source of information concerning radiation effects on electronic devices. The society sponsors an annual Nuclear and Space Radiation Effects Conference (NSREC) that includes a short course on rad-hard design methods for the uninitiated. This year's conference will take place in Portland, OR, from July 11 to 15. For more information about the 1988 NSREC, contact Bobby Buchanan at Spire Corp (Bedford, MA, (617) 275-6000).

PART FIVE
DECADE 90
The future of system design

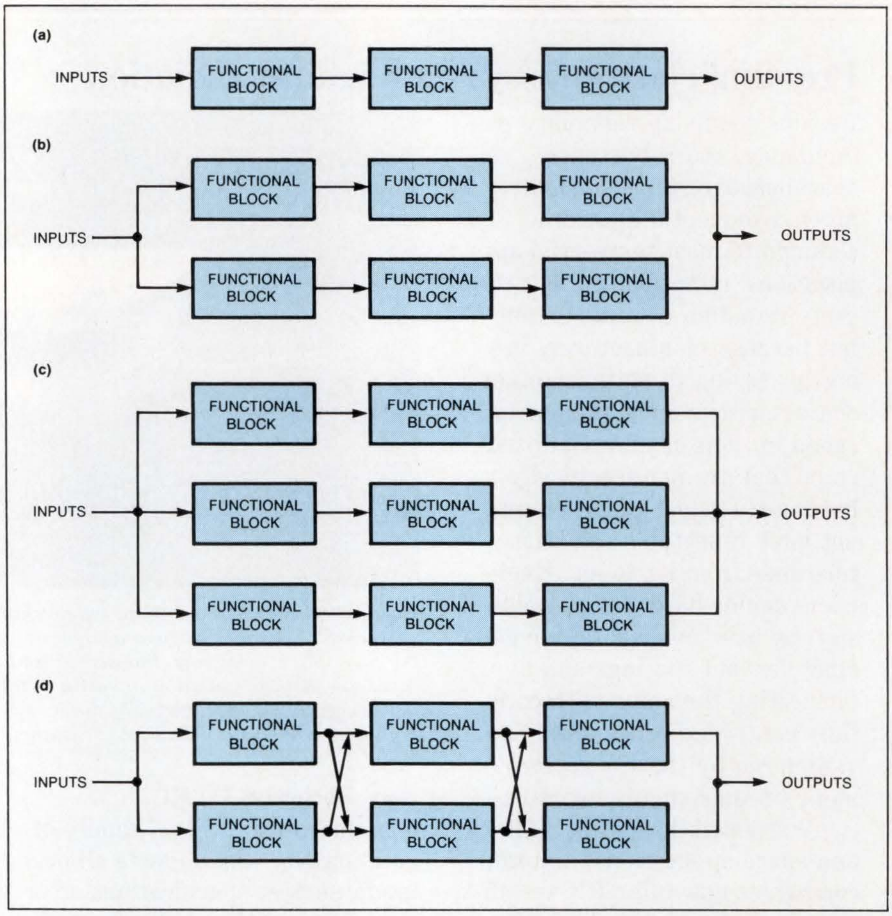


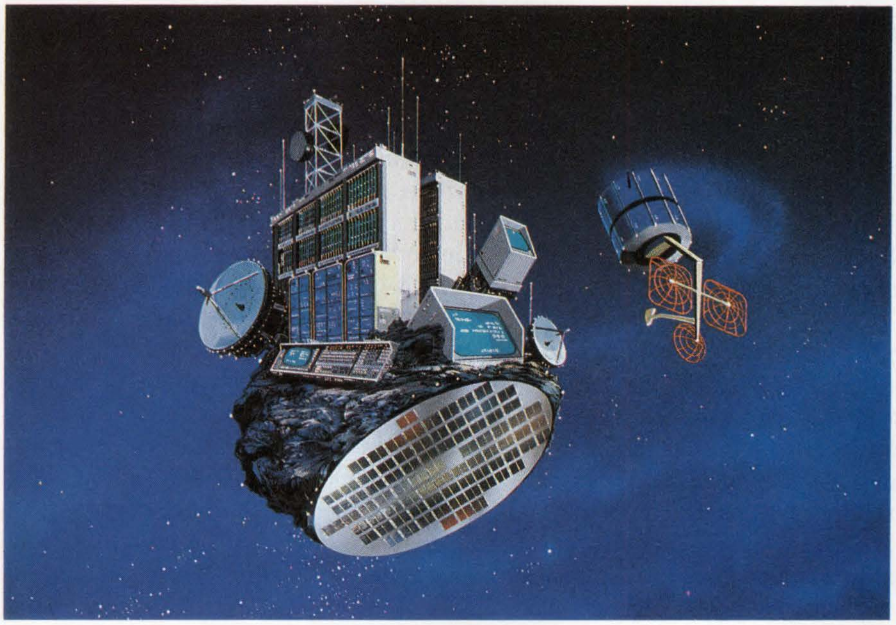
Fig 1—You can represent a complex system as a string of functional blocks, *assign the string a reliability figure, and then compute the expected failure rate for the entire string **(a)**. Should that figure not meet your system specs, you can add a parallel, redundant system **(b)**, or even two of them **(c)**, to boost the overall system reliability. To achieve even greater reliability, usually at lower cost, spacecraft designers often use cross-strapping, which allows one system to use functional components from another system in case of a failure **(d)**.*

Kravetz says that spacecraft requirements for electronic control systems vary according to the mission. The first orbiting satellites had fairly simple electronic systems, because they could rely on human ground controllers to rectify problems by radio control. Attitude controls, however, were made fail-safe so that a control-system failure would not plunge the satellite into the atmosphere before the ground crew could correct the fault.

Ball Aerospace Systems Div (Boulder, CO) specializes in building unmanned orbital spacecraft. William H Follett, deputy director of spacecraft systems at Ball, says that the aerospace industry has developed several approaches to improving system reliability. For example, you can represent a complex system as a series of functional blocks, assign a reliability figure for the string, and then compute the expected failure rate for the entire string **(Fig 1a)**. Should that figure not meet your system specifications, you can add a parallel, redundant system **(Fig 1b)**.

If that step does not achieve the desired system reliability, you could add another redundant system to the design **(Fig 1c)**, but spacecraft designers often use a different approach, cross-strapping, which allows one system to use functional components from another system in case of a failure **(Fig 1d)**. Cross-strapping achieves better reliability than simple replication, and it does so at a lower hardware cost than you'd incur by building systems with triple redundancy.

For orbital spacecraft, ground controllers can manually switch components into operation by using cross-strapping. Planetary probes such as the Voyager and Galileo spacecraft developed by the Jet Propulsion Laboratory at the California Institute of Technology (Los Angeles, CA), however, can't depend on ground control, because planets and other celestial objects occasionally block radio transmissions. Such spacecraft require electronic control systems that are not only fail-safe, but redundant, self-repairing, and autonomous as well.



Commercial space development in the 1990s will strengthen *the communications systems already in orbit and will initiate the era of manufacturing in space. Such enterprises require robust, reliable, redundant electronic systems that can manage operations, providing a less-expensive alternative to constant human attention. (Photo courtesy Motorola Inc, Phoenix, AZ)*

Robust, redundant, highly reliable systems certainly are critical for space applications. But they're important for applications on Earth, too. For example, by the early 1990s, at least one auto manufacturer will offer vehicles with drive-by-wire steering, in which there's no mechanical linkage between the steering wheel and the front wheels. Such a system requires less energy to operate than a hydraulic power-steering system does. The electronic steering subsystem in a drive-by-wire car had better be as robust, reliable, and redundant as any of the circuitry in a planetary space probe. In addition, as electronics become more pervasive in medical equipment, redundant and reliable design will be needed to safeguard a patient's health and well being.

Other applications in which lives hang in the balance include automated transportation, such as San Francisco's BART (Bay Area Rapid Transit) system, and industrial process control. Such applications demand fault-tolerant electronic systems. Moreover, after the USSR's Chernobyl disaster and the Three Mile Island scare in the US, many utility companies are retrofitting manual control systems in nuclear power plants with fault-tolerant, computer-based controls.

Computers in the loop

In the past, most designers resisted using computer-based control systems in critical control loops because the computers simply weren't reliable enough. Now, however, the highly reliable design techniques developed for aerospace applications greatly reduce that problem. Further, industrial disasters, such as explosions or fires in refineries or chemical plants, underscore the utility of fault-tolerant backup computers in emergencies that a human operator can't cope with.

In fact, even lower-risk applications benefit from fault-tolerant and fail-safe design. Tandem Computers (Cupertino, CA) has offered its highly reliable NonStop minicomputers for many years. The machines find use in such applications as transaction-processing systems (computers that process the information from automatic tellers, for instance), in which the financial institutions often determine that it's less expensive to pay for a very reliable system than it is to re-enter data lost because of a computer failure.

Reliability is cheap enough for µCs

Fail-Safe Technology Corp believes that microcomputer-based applications can also benefit from highly reliable design techniques. The company will start shipping its FS-66 series of 80286- and 80386-based, fault-tolerant, PC-compatible computers later this year. Each FS-66 incorporates two µPs and an ASIC that monitors the operation of both processors. If one processing subsystem should fail, the ASIC switches operations over to the second µP.

Fail-Safe claims that the FS-66 computers will provide 99.99% uptime and an MTBF of three years, yet will cost about the same as equivalent PCs from IBM.

Fail-Safe says that its machines will find use in critical data-processing equipment such as file servers, where the loss of one machine could stall or lose data from several tasks. In fact, NASA has expressed interest in using FS-66 computers to control experiments aboard the space shuttle, where a computer failure could destroy a multimillion-dollar experiment. Fail-Safe Technology also plans to incorporate the FS-66 technology in a single-board computer for embedded applications.

Many of the systems designed over the next decade will borrow freely from the fault-tolerant design techniques developed for space. Because of the greater number of electronic systems on Earth, because so many Earth systems need fault tolerance, and because technology of the 90s will make fault tolerance much less expensive to build into systems, you can expect designers of earthbound systems to take over the lead from aerospace designers in creating such rugged systems during the 1990s, further driving system engineers to adopt fault-tolerant design universally.

You can employ fault tolerance today

The tools and technologies needed to create highly reliable electronic systems are appearing rapidly. Soaring IC integration levels, for instance, are helping to make redundant design easier than ever for engineers who can wield the proper design techniques. And system-level CAD tools can simulate the performance of alternative designs; thus, you can iteratively improve a design to create the optimal solution. By rapidly creating software simulations of a prototypical system and testing them in simulated environments, you can find and eradicate many flaws before they creep into your hardware. Simulation also allows you to pit your designs against situations that could be very difficult or impossible to create in a physical test, but that could occur in the systems' target environment.

Testability is another key to reliable design: It lets you quickly verify prototype systems and thoroughly test freshly manufactured systems, ensuring that they contain no hidden flaws. Gigascale levels of integration make vast quantities of transistors available to designers so they can dedicate enough circuitry to test and maintenance functions. Built-in-test circuits will help functioning systems diagnose and perhaps even repair themselves before critical failures occur.

Finally, advanced packaging technologies such as SMT and TAB will help you create the very compact, lightweight systems that many future applications will require. These improved technologies will also boost intrinsic system reliability by reducing the number of interconnections in a typical system and increasing the reliability of the remaining connections.

Whether they're destined for space or for terrestrial applications, electronic systems of the 1990s will be more reliable than today's designs. Many of your customers already perceive reliability as a key differentiating factor when making purchase decisions, and that attitude will become more prevalent in the future. In fact, applications involving life-or-death situations—and applications where errors are extremely costly—absolutely require highly reliable, fault-tolerant designs. In any case, reliability will be a big selling point for almost any type of system in the next decade. The companies that recognize and act promptly to satisfy these needs will become the leading system designers of the 1990s. **EDN**

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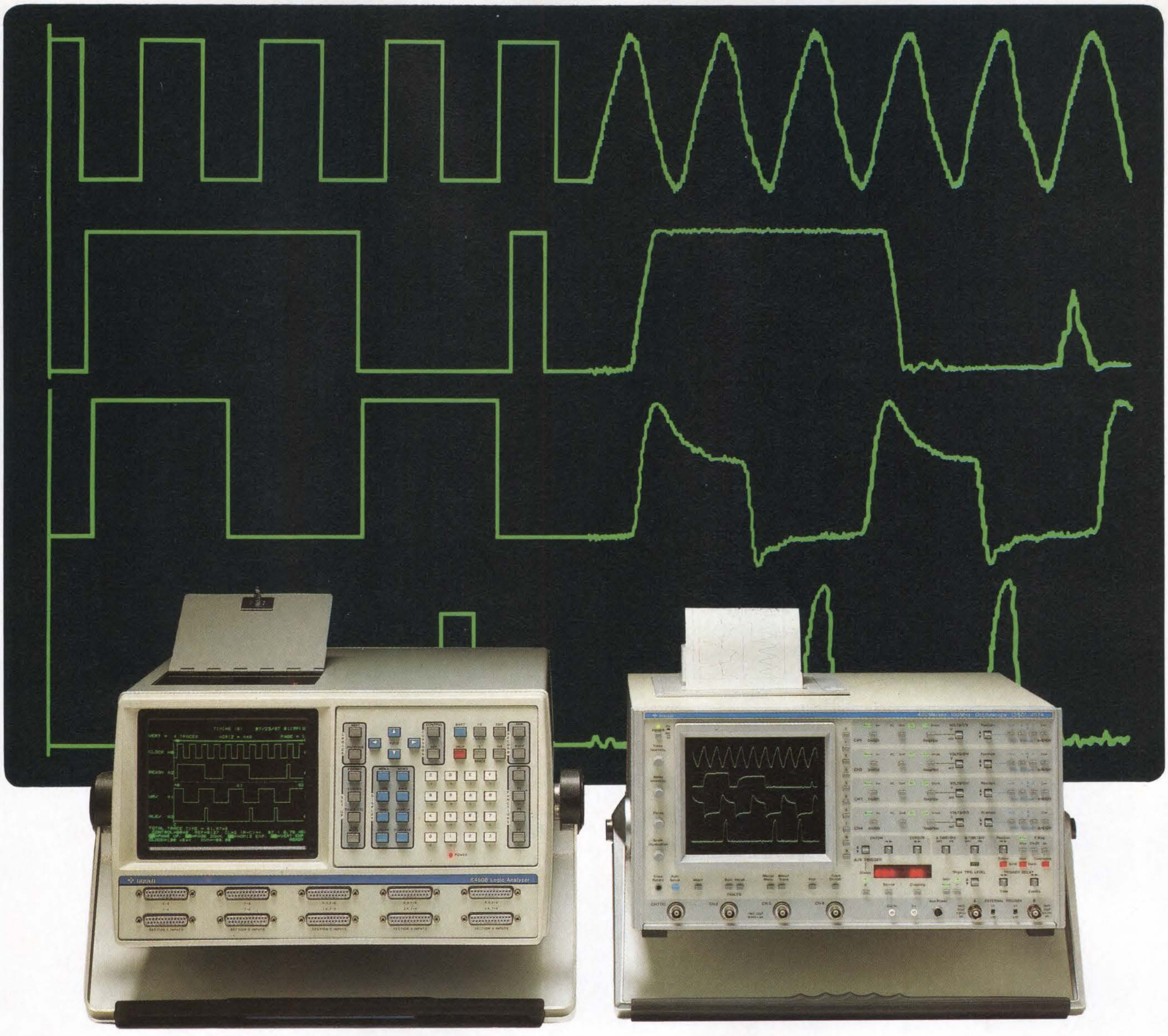

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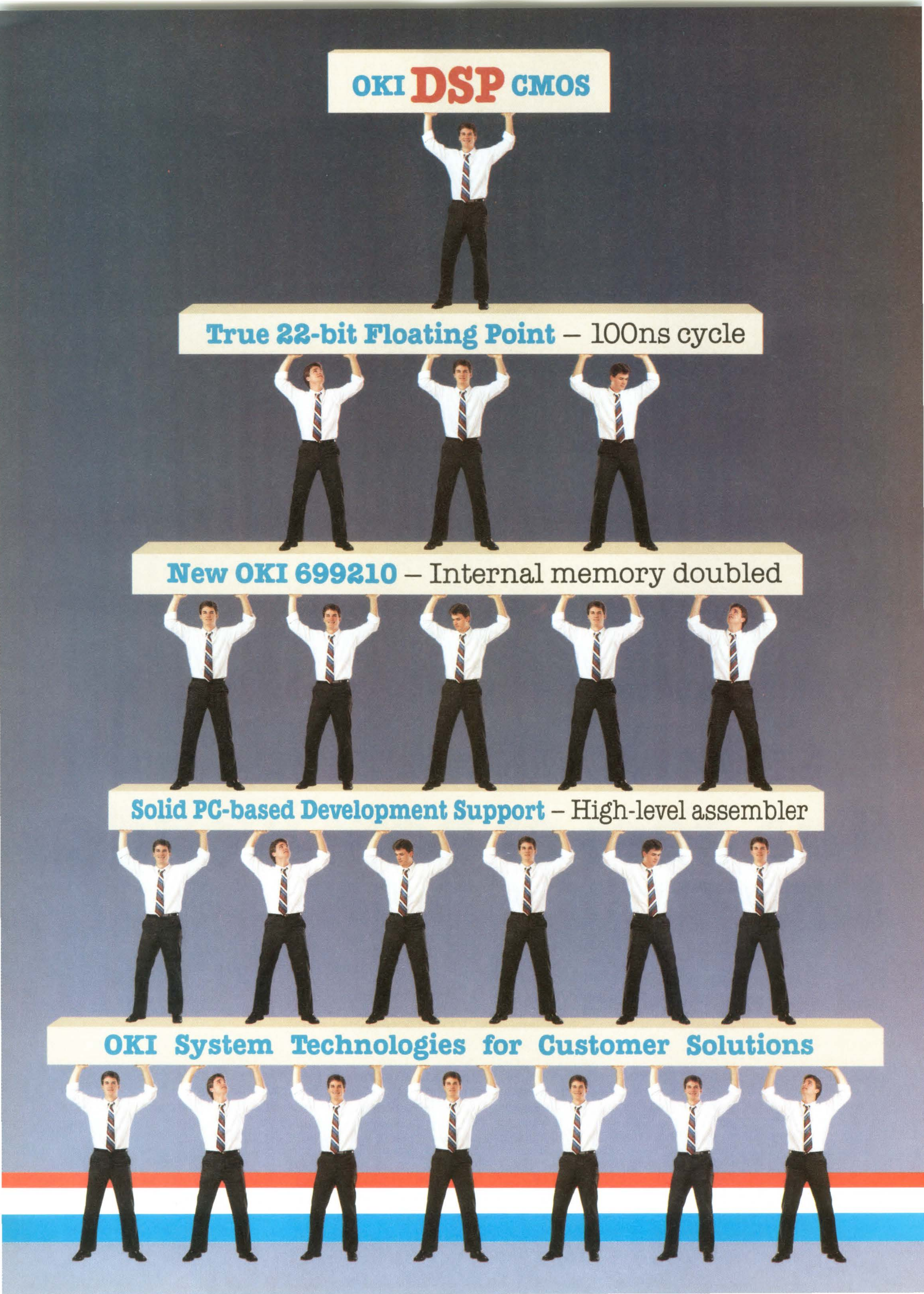

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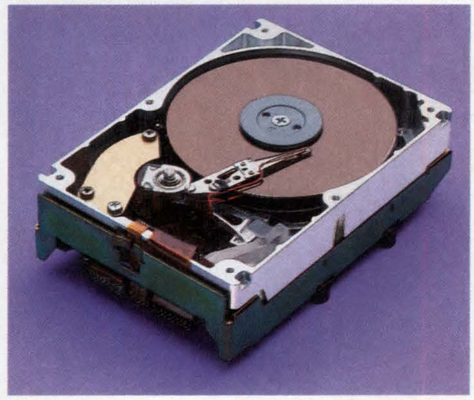

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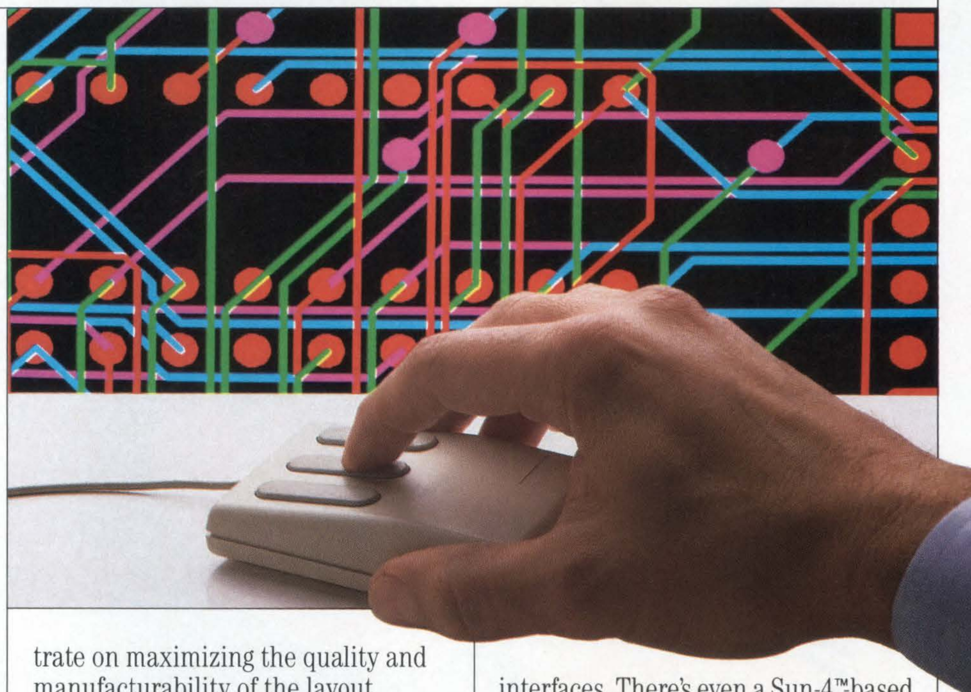

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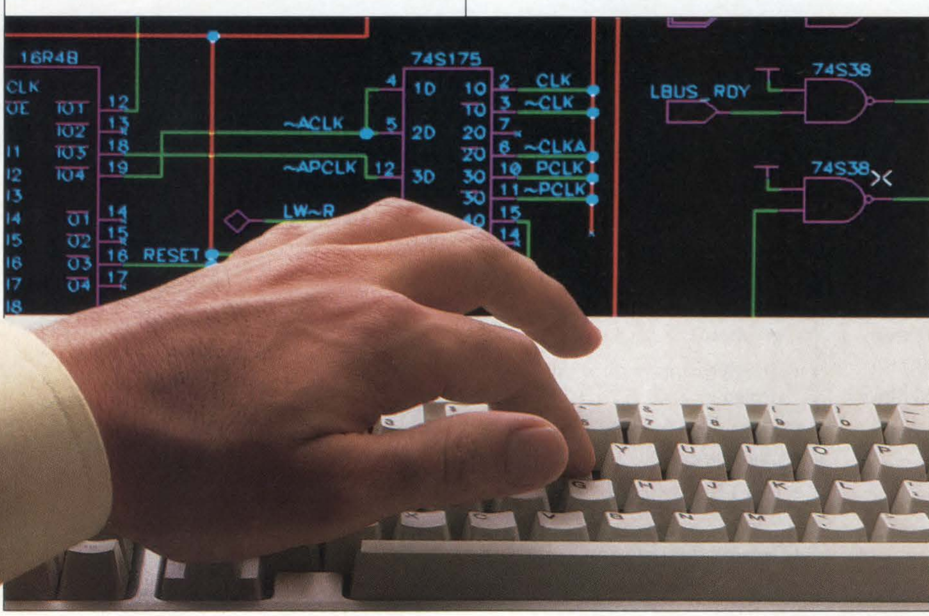


Silicon compilers tame 10,000-gate-plus ASICs, gate arrays

Traditional design methods that manipulate gates or simple macrocells become unwieldy at densities of tens of thousands of gates per chip. However, silicon compilation offers a new paradigm for the management of these large, complex designs.

William J Stenzel, *Tandem Computers Inc*

Silicon compilation is an alternative to gate arrays and standard cells for implementing ICs. A silicon compiler creates layouts of part or all of a chip from a high-level description. Therefore, when using a silicon compiler, you can focus your efforts on high-level verification and system-timing issues rather than on low-level circuits and gates. Conceived for custom chips, silicon-compilation techniques also prove useful for gate arrays containing more than 30,000 gates.

Unlike gate-array or standard-cell designs, which require a gate-by-gate approach, silicon compilers allow you to manipulate high-level functions. You'll find silicon compilers' advantages most evident when you design data-path blocks and specify compiler functions in terms of latches, register files, multiplexers, arithmetic and logic units (ALUs), and shifters as well as in terms of their connections to data buses. In contrast, when using standard cells or gate arrays, you build up high-level functions from a library of low-level elements, such as gates and flip-flops, and then route signals between them.

Compiled chips, like standard-cell chips, require full wafer processing, in contrast to gate arrays, which require only the personalization of an existing base wafer's metalization. Consequently, nonrecurring expense (NRE) and time required to fabricate prototypes of a compiled chip are similar to those of standard-cell chips and higher than for small gate arrays.

Silicon compilation excels at highly structured, regular functions, such as data paths and memories. Such functions appear, for example, in digital signal processors, which are primarily structured blocks with most of their interconnections going to the external pins. Further, more complex chips may have islands of regularity in a sea of interconnection.

Look at your application to decide if your design is large enough to benefit from compilation. To consolidate only a few thousand gates of random logic, you might find a gate array more cost-effective. Designs in excess of 10,000 gates are the best candidates for compilation.

Compiler vendors offer two types of tools

When evaluating silicon-compiler vendors, you will find that some offer generic tools while others offer tools specific to their own foundries. Two that offer generic tools are Compiler Systems Corp (San Jose, CA) and Seattle Silicon Corp (Bellevue, WA). You may compile your design for fabrication at one of several

Silicon compilers allow you to manipulate high-level functions; you needn't work at the gate level.

foundries these two companies' compilers support. In contrast, VLSI Technology Inc (San Jose, CA) offers compilation tools customized to VLSI Technology's fabrication process.

Other differences among compiler vendors lie in the features their compilers offer. Compilers from Silicon Compiler Systems and VLSI Technology are complete packages, including data entry, simulation, and timing analysis. Seattle Silicon's offering requires a third-party CAE workstation and software to provide many functions, such as schematic capture and logic simulation. Finally, Silicon Compiler Systems and Seattle Silicon offer tools that let sophisticated customers such as semiconductor houses create their own block compilers. This feature enables such customers to add proprietary functions or to tune functions to their own processes.

Changing your mindset

When first using a silicon compiler, you might need to make some changes to your design approach, particularly if your experience is with board-level TTL. Estimating whether or not a given design will fit onto a chip requires a set of guidelines that differ from those for pc-board layout. For example, when you size the pc-board area for a TTL design, half a dozen inverters and a 64k-byte RAM take about the same amount of space. Conversely, area within compiled chips depends more on the amount of logic in a function. Moreover, interconnections within a chip consume considerable space, occupying as much area as active logic in many cases.

Circuitry details, too, might dictate some changes in your design methods when you first use a silicon compiler. For example, although most systems use an edge-triggered register methodology that's familiar to TTL designers, Silicon Compiler Systems' Genesil differs in that it supports a latch-based scheme with 2-phase, nonoverlapped clocks and precharged buses, more typical of custom IC designs.

In contrast to edge-triggered schemes, which use registers as state elements that sample inputs at a clock edge (and which allow data an entire clock period to propagate through the subsequent logic before being sampled at the next clock edge), 2-phase latch-based schemes use transparent latches as state elements. The latches propagate data from their inputs to their outputs when the clock that enables them is asserted, and they hold their data when the clock is not asserted.

In the 2-phase scheme, a clock generator converts a master clock into two phases: phase A and phase B. Phase A is asserted when the master clock is high; phase B, when the master clock is low. These two phases are interlocked so that they are never simultaneously asserted (hence the term "2-phase nonoverlapped").

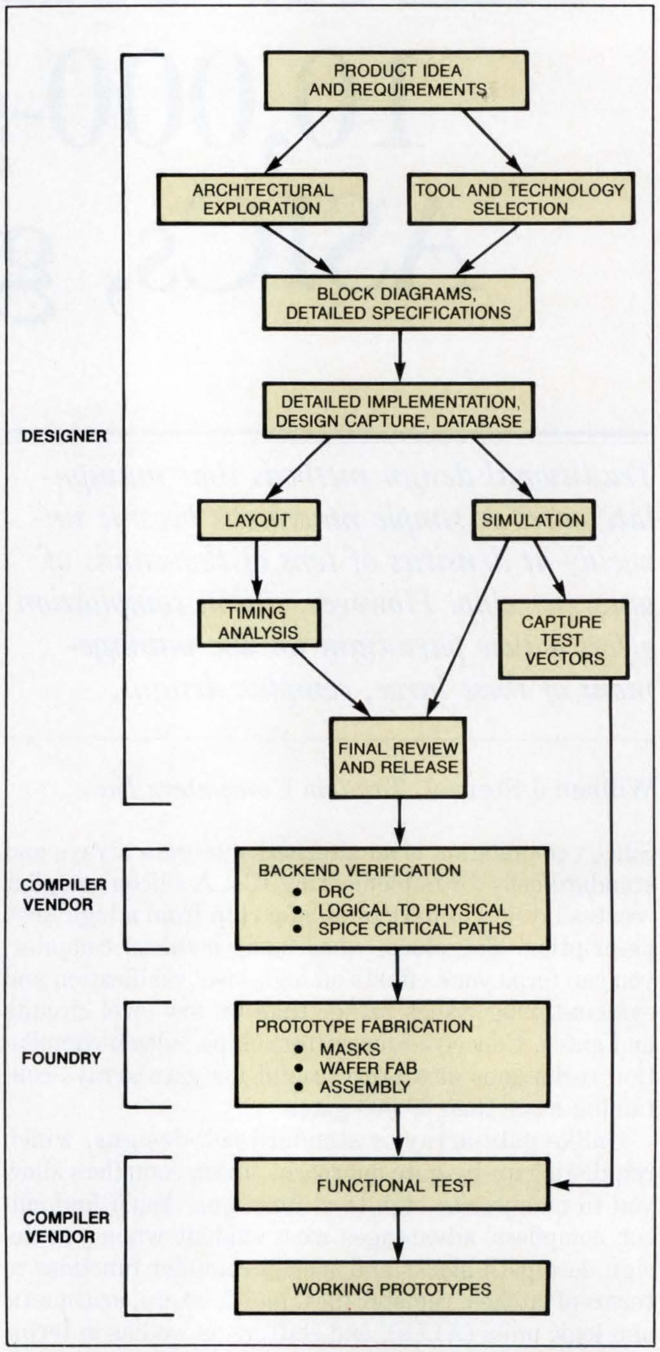


Fig 1—The designer, the compiler vendor, *and the silicon foundry must all cooperate to bring an IC from an idea to a working chip.*

You must alternate which phase controls the latches throughout your design: Signals originating in a latch controlled by phase A must terminate in a latch controlled by phase B. When a phase A latch is propagating, the subsequent phase B latch is holding, and vice versa, thus eliminating race conditions. Transparent latches require roughly half the space and internal logic as edge-triggered registers. Hence, they provide an advantage in chip size. After becoming familiar with the technique, you will find the latch-based scheme to be flexible and useful for pushing the performance of critical timing paths.

Design process

Fig 1 charts the steps—covering several design disciplines—that you must take to transform your product idea into a working chip. You must organize major projects with an awareness of these disciplines. During the specification and initial design phase, several engineers might each concentrate on a functional area of the design. As the project progresses, each engineer might focus on simulation, layout, or timing analysis.

In the architectural-definition phase, you must determine how to map your idea onto chips and evaluate design alternatives against system cost and performance requirements. Using the compiler, you can create trial designs of major blocks for evaluation. Because you describe blocks by their functional attributes, the compiler can capture the rough design and do the detail work necessary to determine size and speed estimates.

For example, within a data path, you could specify interconnections between ALUs, latches, register files, and multiplexers via major buses (as you would when drawing a conceptual block diagram). You can sketch the design alternatives and have the compiler expand the sketch into full detail to facilitate experimental designs for architectural evaluation. By the end of this phase, you will produce block diagrams and detailed specifications for the design.

Cost estimates

The major variables in a chip's cost are its size, package, and foundry. You can estimate size by experimenting with designs on the compiler and incorporating major logic blocks, signal buses, and an allowance for details not included in the rough design. High pin counts can create pad-limited chips in which I/O pads on the periphery determine the die size. As the die size increases, chip cost dramatically increases. Your foundry should help by estimating the cost based on die size.

Pin-count estimates should include power and ground pins. To reduce noise from simultaneously switched outputs, you need at least one power and ground pin for every eight to ten simultaneous outputs. The required ratio varies with the speed of the output drivers and the fabrication process. As pin counts increase, package costs also increase. Ceramic pin-grid-array (PGA) packages of 100 to 180 pins are available, but they can add $10 to $20 to parts cost.

Design capture

To implement your design, the compiler must capture several layers of information. Working from the inside of the chip to the outside, you should follow these steps in the design capture:

- Define the functional blocks and specify block interconnections.
- Specify chip I/O pads for function and location on the chip periphery.
- Connect the pads to the internal circuitry.
- Specify the package type and the bonding between chip I/O pads and package pins.

At the block-specification phase, you begin by selecting the desired type of functional block from a block-creation menu. The detailed specification varies with the type of block. For example, a random-logic block would comprise simple gates. Seattle Silicon and Silicon Compiler Systems support a schematic-capture mode using third-party CAE workstations. In this mode, you could specify the random-logic block by interactively drawing a schematic of the gates and identifying the external ports. Alternatively, Silicon Compiler Systems also supports a menu-driven, text-oriented means of specifying random-logic blocks.

A RAM or FIFO block, on the other hand, requires different information. The meaningful parameters for these blocks are size, organization, and timing. You may specify these parameters in a menu-driven fashion by filling in the appropriate blanks for the number of inputs, the number of words, the speed options, whether the block is to be single or multiple ported, and whether or not the output is latched.

Such blocks as read-only memory (ROM) or programmable-logic arrays (PLA) need this type of menu-driven structural information; in addition, they require programming information to specify their contents. For example, Genesil accepts truth tables, fuse maps, logic equations, or state-machine descriptions as formats for conveying PLA contents. Logic minimizers, such as Espresso from the University of California at Berkeley, *Silicon compilation excels at implementing highly structured, regular functions, such as data paths and memories.*

are available for PLA minterm reduction on several compilers.

You also have options in the method of specifying ROM contents. Genesil includes a macro assembler that can create symbolic macros and generate ROM contents by macro assembly. Alternatively, you can use a file containing the object code as ASCII ones and zeros. (At Tandem, designers develop microcode on a system other than the compiler and then port the finished object code to the compiler, formatting it appropriately along the way.)

Consider also complex blocks such as data paths. Genesil uses a menu-driven approach to specify data-path elements, bus connections, and orientation. Under Genesil, the entire data path is the same bit width (that is, number of bits in a word slice), although some elements allow masking of selected bits. (Although this scheme might sound restrictive, it's actually quite versatile.)

After you create the functional blocks, you must interconnect them. Genesil uses a textual net list to connect the external ports on each functional block to a named net. Seattle Silicon uses a third-party CAE-workstation schematic package to interconnect blocks.

Careful planning and good naming conventions are important to the interconnection phase. If several engineers work on different portions of a complex chip, prior agreement on net names and spellings will allow smooth and accurate net listing. Make the port names the same as the net names whenever possible.

Chip layout

The first step in chip layout is compiling the functional blocks, transforming them from a text description into a custom layout. After compilation, you can manipulate them as blocks having signal ports on their edges, without dealing with their internal layout. The rest of the layout phase consists of placing the blocks and routing their interconnections.

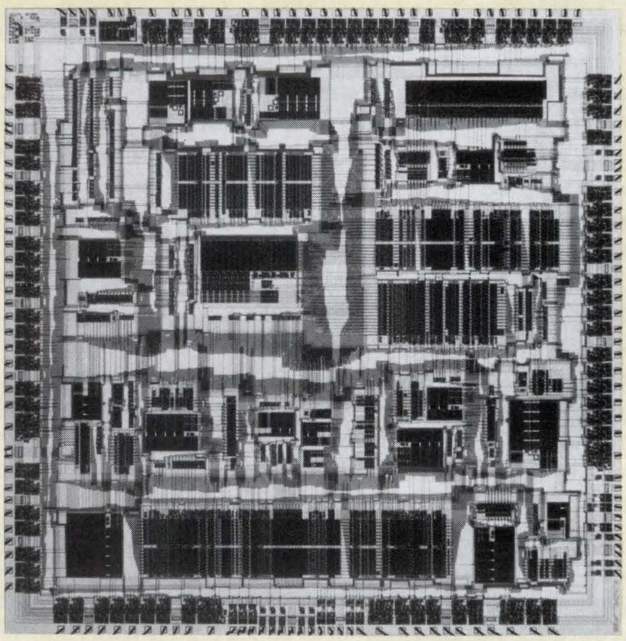
Compilers rely on an automatic signal router for interconnection. Because a chip's size is flexible at this stage, the router can push blocks away from each other to make room for the interconnections, guaranteeing that all the interconnections can be made. However, the result can be a very large chip. Designers exert the most influence on the layout through their placement of the blocks. Other factors affecting layout include the relative priority of signals and, on some compilers, assignment of routing channels.

You should have a layout plan in mind for the overall interconnection of the blocks (such as where major buses tie to which blocks). Although compilers have placement aids or even auto-placement algorithms available, your insight is important in producing a tight layout of a complex chip. Experimenting with alternate layouts will be fruitful, both for trying significantly different placements and for fine tuning the most promising placement. Achieving a good layout is very much an iterative process.

Background

Silicon compilers began generating interest in 1983 and 1984 **(Refs 1, 2, and 3),** and they have since evolved into practical tools, yielding such products as graphics controller chips **(Ref 4).**

The information in this article is based on the experience of designers at Tandem Computers, who used silicon compilation to realize four CMOS chips employed in the company's NonStop CLX, a user-serviceable distributed on-line transaction-processing (OLTP) system. One of the chips—the CPU—measures approximately 500×500 mils and contains 60,000 transistors.



Tandem Computers Inc produced this CPU chip *with a silicon compiler for its NonStop CLX fault-tolerant computer. Part of a four-chip set, the CPU measures 500×500 mils and contains over 60,000 transistors.*

The compiler should assure adequate power and clock distribution. For example, Genesil calculates the power of each block and uses a power/ground bus width based on the total power of all blocks downstream from a given point. This procedure results in power buses that begin with a width of the power bonding pad and taper progressively. Clock lines may benefit from high-priority routing and several-times wider-than-minimal metal lines. In some cases, the clock lines can be isolated from other signals by surrounding them with ground lines.

Because interconnection delays stemming from wiring capacitance can be significant in CMOS, you must monitor the chip's critical paths while optimizing the chip size.

Simulation—verifying your design

Verifying your design through simulation is essential to maintaining the project schedule and budget. The expense, effort, and time required for chip iterations make a first-pass success highly desirable. Good simulation tools and a careful strategy make first-pass success attainable. The compiler generates a simulation model for your design automatically, ensuring that what you simulate corresponds to what you implemented.

Table 1 describes several levels at which to simulate. As you enter your design, you may interactively simulate small portions. For example, you may perform a check on a piece of control logic by manually applying a few patterns and observing the response. This level does not provide comprehensive verification, but it's a good indication that you're on the right track.

At the next level, you can apply hand-coded simulation vectors to the whole chip or to large parts of it. These vectors can become production-test vectors. This level is more rigorous and is reproducible as a regression test. However, it still relies on your ingenuity to specify the stimulus and response. Because simulation runs can require hundreds or thousands of vectors, the simulator must check for the expected response to a given stimulus and automatically flag any discrepancies. This rigorous simulation is far superior to the alternative of visually checking a printout of the simulator's output for erroneous responses.

Finally, you can embed the chip into a model of its intended application and perform system-level simulations. This level can expose subtle bugs and boundary conditions that you would not normally find in your lab.

TABLE 1—LEVELS OF SIMULATION

TYPE	CHARACTERISTICS/USE
INTERACTIVE	• GOOD FOR INITIAL DESIGN CHECKOUT OR TROUBLE SHOOTING. • POOR FOR COMPREHENSIVE VERIFICATION. • POOR REPRODUCIBILITY.
HAND-CODED VECTOR	• ALLOWS SIMULATOR TO CHECK EXPECTED RESULTS. CAN BE RERUN AFTER CHANGES AS A REGRESSION TEST. • CAN BE USED AS PART OF PRODUCTION TEST. • RELIES ON DESIGNER INGENUITY TO COVER ALL TEST CASES. CAN OVERLOOK SYSTEM-LEVEL PROBLEMS.
SYSTEM-LEVEL	• EXERCISES CHIP IN SYSTEM ENVIRONMENT. • GIVES HIGHEST DEGREE ON CONFIDENCE. • CONVERGES MICROCODE/SOFTWARE AND HARDWARE VERIFICATION. • CAN EXTRACT RESPONSES FOR PRODUCTION TEST.

Timing analysis

Accurate prediction of the performance of your chips is an important part of the design. You need to relate your system's goals and constraints and identify the areas of your chip that need fine tuning.

Two main components of CMOS circuit delays are the gate propagation delay and the additional delay arising from the capacitance and resistance of the interconnection. To obtain accurate timing numbers, you need to incorporate the interconnection loading derived from the actual layout of the chip. In a large chip, the interconnection delay of a signal crossing the chip can exceed a gate's nominal propagation delay. An excessive interconnection delay indicates a very long routing or a net with a large fan-out. You can shorten the delay by increasing the strength of the driver, altering the placement of the chip to shorten the interconnection length, or revising the logic to reduce the fan-out.

Two classes of timing-prediction tools exist. The more traditional tool is based on circuit simulation. Using a model of your circuit, you can stimulate it to trace specific circuit paths to obtain their delay. In general, the more accurate the calculations, the slower the simulator. Spice, a commercially available circuit simulator, is an example of a very accurate and computation-intensive tool. One of the main drawbacks of this type of tool is that it gives you information about only the paths you specify and already suspect—not unexpectedly slow paths.

The second class of timing tool, static analysis, can examine all paths and tell you which are the longest.

Two types of compiler vendors exist: those offering generic tools and those offering tools specific to their own foundries.

Static timing analyzers first characterize the delay from input transitions at each gate to the output transition at the gate's loads. They then trace the paths through the circuit, adding up the delays as they go. The most powerful form of analysis traces paths from their origin in a clocked element to their termination in a clocked element. In a synchronous system, this analysis identifies the critical paths limiting clock speed.

The static-analysis tool's obvious benefit is that it tells you about timing paths you may not have realized were slow. Other capabilities of a sophisticated static tool include incorporating external setup and hold requirements, checking margins on internal hold times, and the ability to specify timing paths to be ignored. Genesil also has the ability to automatically extract a Spice model of a specified path to allow more exact timing simulation where desired. The accuracy of a static timing analyzer depends on the sophistication of its models of transistor characteristics and resistive and capacitive loading. Static timing analyzers better suit synchronous circuits than asynchronous ones.

You can use both timing tools to observe the effects of temperature, variations in voltage, and variations in the fabrication process.

The next step is to assure that the physical mask that the compiler produced accurately represents your design. To accomplish this task, compiler vendors provide various types of post-design checks. The most basic is the traditional design-rule check (DRC). The DRC program processes the mask's data against the physical design rules for the foundry you have selected, checking that trace width and spacing meet a minimum specified size and that the transistors are properly formed, for instance. This checking assures that the chip can be fabricated.

Checking the mask

You can make an additional check by programmatically extracting the circuit's topology (that is, by deriving the circuit elements and the net list that they implement from the mask). This extraction can further verify the physical design, either by direct comparison to the logic design you previously simulated or by simulation against the same stimulus/response vectors you previously used.

You may wonder why compilers need this type of post-verification; after all, they should automatically generate correct silicon. However, one of the benefits of a silicon compiler is that it facilitates large, complex chip designs, such as microprocessors. Designers demand rich sets of design elements, and vendors enhance their products for higher density and performance. The result is that as designers push beyond what has been done before, a possibility of generating bugs exists. Even a single error in a chip can cause a malfunction; therefore, post-verification is essential to ensuring correct silicon.

TABLE 2—PROTOTYPE FABRICATION STEPS

TASK	TIME	COST
FINAL VERIFICATION	2 TO 4 WEEKS	SEE NOTE
DATABASE CONVERSION	1 WEEK	\$2k TO 10k
PLOT APPROVAL	2 DAYS	—
MASK GENERATION	1 TO 2 WEEKS	\$30k TO 40k
WAFER FABRICATION	6 TO 10 WEEKS	\$1k TO 20k
ASSEMBLY	1 TO 2 WEEKS	—
PACKAGE PART TEST	1 TO 2 WEEKS	SEE NOTE

NOTE: PART OF BROKERAGE PACKAGE FROM COMPILER VENDOR.

After verification, build prototypes

When your chip has completed final verification, you are ready to build prototypes. Several compiler vendors offer a brokerage service, for which they coordinate initial fabrication with the foundry and deliver the working parts to you. Seattle Silicon and Silicon Compiler Systems offer this service with guarantees of working parts.

To ensure a smooth path for your prototypes and to prepare for production, you need to begin a business relationship with your foundry well in advance of first silicon. This preparation can insure that the right resources and materials are in place when you need them. For example, if you specify a package type that the foundry does not stock, the lead time to procure it can be longer than the fabrication time.

Advance discussions can also clarify the time and charges for fabrication. The overall time and charges for getting tested parts are substantially more than for simply running a wafer lot. You need to make certain that you understand the steps in the process **(Table 2)**. For example, starting from a database tape, the foundry converts database formats for the mask vendor and has the masks fabricated, inspected, and repaired before processing. After processing, the parts are assembled. You also need to allow time for testing, either at the foundry or at the compiler vendor. **Table 2** de-

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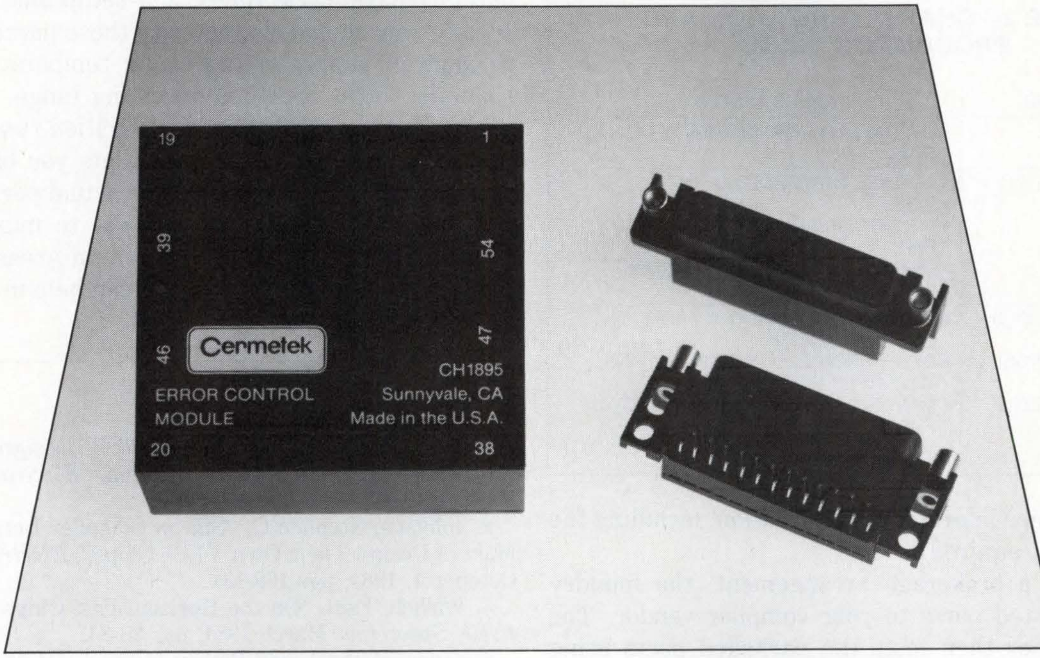

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You may need to make some changes to your design approach, particularly if your experience is with board-level TTL.

TABLE 3—CHARACTERIZATION AND PRODUCTION TESTS

TYPE OF TEST	AREAS TESTED
FUNCTIONAL	• OVERALL LOGICAL INTEGRITY OF CHIP.
DC PARAMETRIC	• VOLTAGE THRESHOLD OF INPUT PINS. • VOLTAGE AND CURRENT OF OUTPUT PINS. • LEAKAGE CURRENT OF INPUT AND 3-STATE PINS.
AC—SETUP/HOLD	• CHIP INPUT SETUP/HOLD FROM EXTERNAL CLOCK
—OUTPUT DELAY	• DELAY FROM CLOCK OR INPUT PINS TO OUTPUT PINS.
—CYCLE TYPE	• MAXIMUM OPERATING FREQUENCY FOR CLOCK.

scribes the steps in prototype fabrication, including the time and cost required.

If you use a brokerage arrangement, the foundry delivers untested parts to your compiler vendor. The compiler vendor then tests the packaged parts using test vectors from your simulation runs. This test assures functional parts and provides some speed testing. The compiler vendor's involvement usually ends here.

You must still do substantial test development to put your parts into production. Production tests have three broad components: functional tests, dc tests, and ac tests **(Table 3)**.

Functional tests find fabrication faults quickly. The vectors used for simulation during design verification may not be appropriate for production. Verification typically assumes that the logic elements are perfect and checks to determine if your design functions as intended. These tests can have poor fault coverage or can be excessive in length. One current weakness of silicon compilers is poor support for fault-grading tools with which you improve production tests.

Compilers support transporting simulation vectors to selected IC testers. (With Genesil, Tandem designers needed to develop a format converter for Sentry Schlumberger Inc and Ando Corp for production. Once this tool was in place, they captured vectors from system-level simulations and incorporated them into production tests. This tool proved to be very effective: The chips could be tested with the same stimuli that they would ultimately encounter in the system.)

Dc and ac tests check the chip against its data-sheet specifications. The dc tests include input-voltage thresholds, output voltage levels at specified currents, and input and 3-state leakage currents. Ac tests include output delays, cycle times, and setup and hold times. Ideally, you should characterize these parameters over a range of supply voltages and temperatures corresponding to the specified operating range. Use a sampling of parts over different fabrication runs to include process variations. This testing lets you balance your system requirements against the actual performance of the chips and establish test limits to maximize your yield. It can also indicate problem areas requiring further attention. Your foundry can help in performing this characterization. **EDN**

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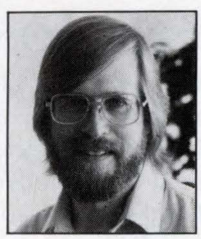
Author's biography



William Stenzel is a development engineering manager for Tandem Computers Inc (Cupertino, CA) and has been with the company for seven years. He is currently responsible for processor and memory development for distributed systems. Prior to Tandem, he spent five years with Hewlett-Packard, where his responsibilities included management of a custom CMOS processor project. He received his BS in Computer Engineering and MS in Computer Science from the University of Illinois.

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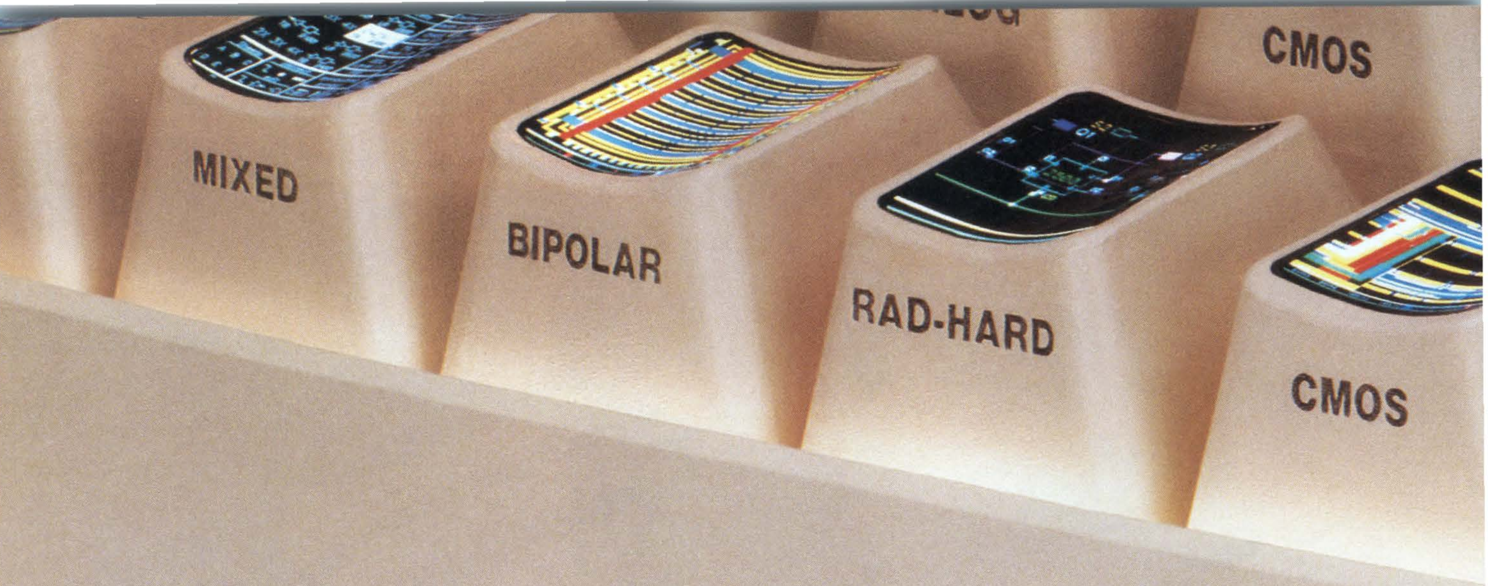

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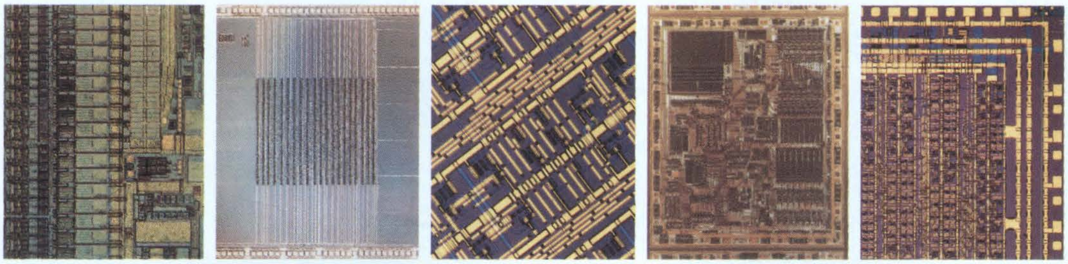

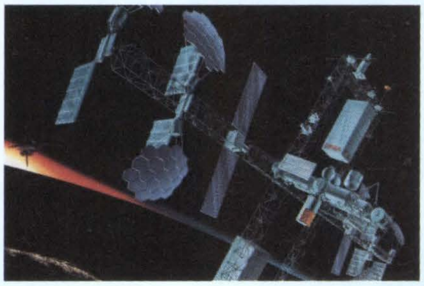

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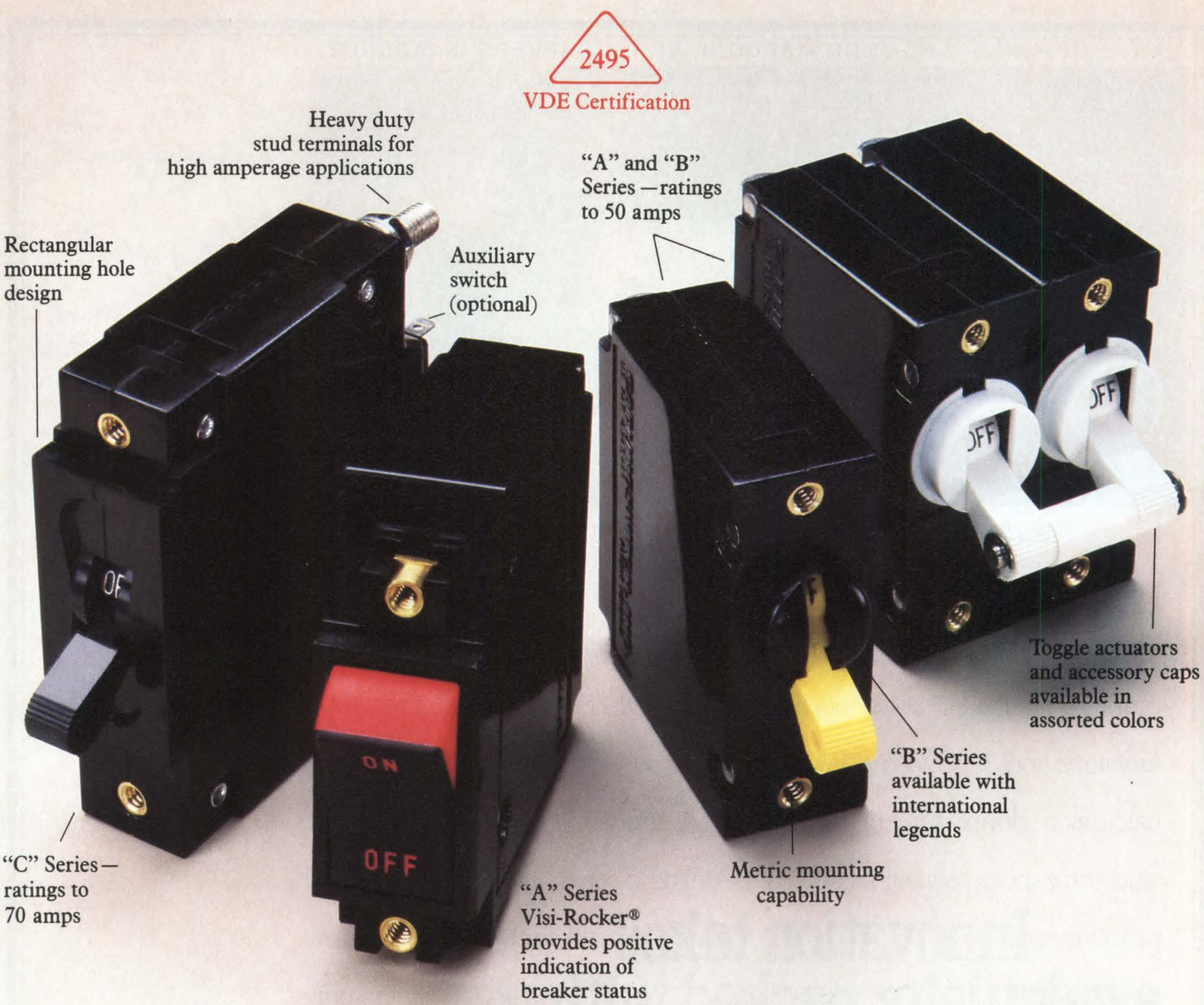

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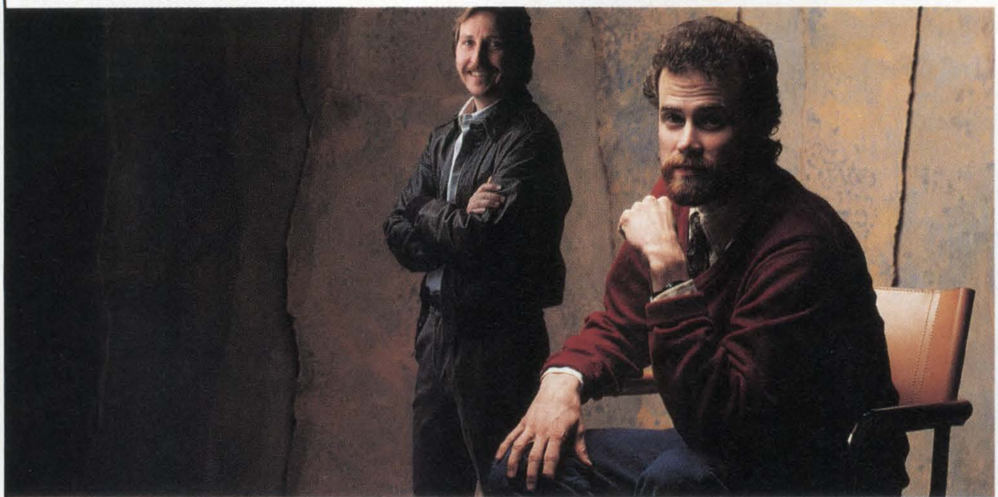

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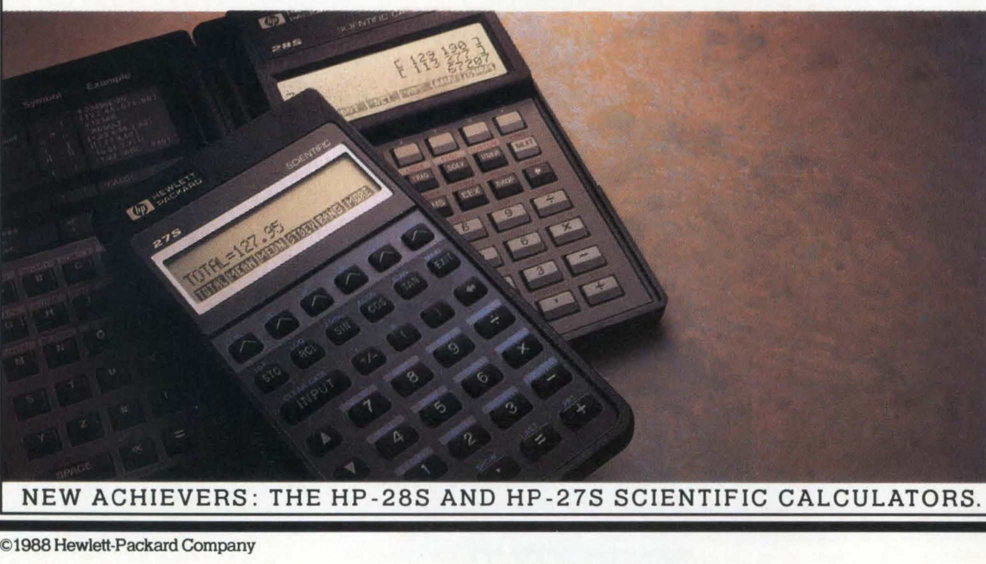

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Take care when choosing controllers for flat-panel displays

Emissive flat-panel displays are well suited for applications requiring ruggedness and minimum size and weight. To optimize overall system performance, you must select a controller that's right for the job, keeping in mind that a flat-panel display's control requirements are more stringent than are a CRT's.

Colin McManus, *Digital Electronics Corp*

Flat-panel displays can outperform traditional CRTs in many applications. However, integrating a flat-panel display into a system involves far more than simply choosing the display. Selecting the proper display controller is even more important when it comes to overall system performance.

Among the factors you must consider are the flat-panel displays' physical interface requirements. A flat-panel display has a discrete pixel matrix that imposes much more stringent timing requirements than do CRTs. You must also understand how to evaluate manufacturer's performance specs, what hardware configurations are available, and what levels of software support the display manufacturer provides. With all these factors in mind, you must carefully weigh trade-offs between cost, integration time, and design-cycle time before committing to a specific controller.

The following discussion concentrates on emissive-type flat panel displays: electroluminescent (EL), plasma, or vacuum fluorescent. Although light-emitting properties vary among these display technologies, the technologies all have similar control principles. To help you understand the terms used to describe display interfaces, consider first the components of a typical display/controller subsystem.

The display itself is the piece of glass containing the basic light-emitting elements—electroluminescent film or neon-gas cells, for example. The drive electronics, which connects directly to the display, consists of basic signal-timing circuits and high-voltage interfaces. Functionally, the drivers take a fairly conventional set of video signals and transform them into the high-voltage pulses required to operate an emissive-type flat-panel display. Normally, display manufacturers sell the display and the drive electronics bundled together.

A display controller—such as the familiar CRT controller—is a circuit that takes data (such as ASCII characters) from a host computer and transforms them into video signals. Although similar in function, flat-panel-display controllers differ from CRT controllers with respect to the video-interface and timing signals that the respective devices generate.

Even among flat-panel displays, drive-signal requirements vary widely. However, some operating principles remain consistent for most drive circuits. For

Although input-signal requirements vary for different display technologies, some operating principles are consistent for most drive circuits.

example, two orthogonal sets of electrodes—the row and column electrodes—typically form the display matrix. The display medium separates these electrode sets: The column electrodes are typically on the front of the display, and the row electrodes are on the back. Each picture element (pixel) forms at the junction of a row and column electrode. The pixel emits light only if both these electrodes are activated.

A picture builds up row by row just as in a CRT. The row electrodes sequentially activate one at a time. During each row period, the column electrodes corresponding to the pixel in that row turn on. Therefore, while a CRT activates one pixel at a time, the flat panel display shows a row at a time.

The drive electronics consists of three elements—the row drivers, the column drivers, and the timing and control circuits **(Fig 1)**. The row and column drivers act as the high-voltage interface circuits. The row and column drivers each contain a shift register; the column drivers also include a buffer latch. Connected together, the row drivers form a long shift register with one output set high and all others set low. Each horizontal-sync input pulse shifts the active output by one.

The column drivers also form a long shift register. In this case, however, the registers contain pixel data for the next row. When a row is complete, the horizontal-sync pulse transfers the shift-register data to the buffer latches, which are connected directly to the high-voltage outputs. During this transfer, the row drivers activate a new row.

The timing and control circuit produces the actual signals for the drivers. In addition, it acts as a safety check by blanking the display if the input video-sync signals do not fall within their proper frequency range, and it also controls power-saving functions.

Establishing contact with the timing circuit

The user interface to this timing circuit is of most concern here. Generally, the interface consists of four signals—video data, video clock, horizontal sync, and vertical sync.

Horizontal-sync frequencies typically vary from 15.6 kHz for a 512×256-pixel array to 25.6 kHz for a 640×400-pixel matrix. Usually, video-clock rates are higher than the value necessary to support horizontal sync—as high as 15 MHz for the smaller displays and 20

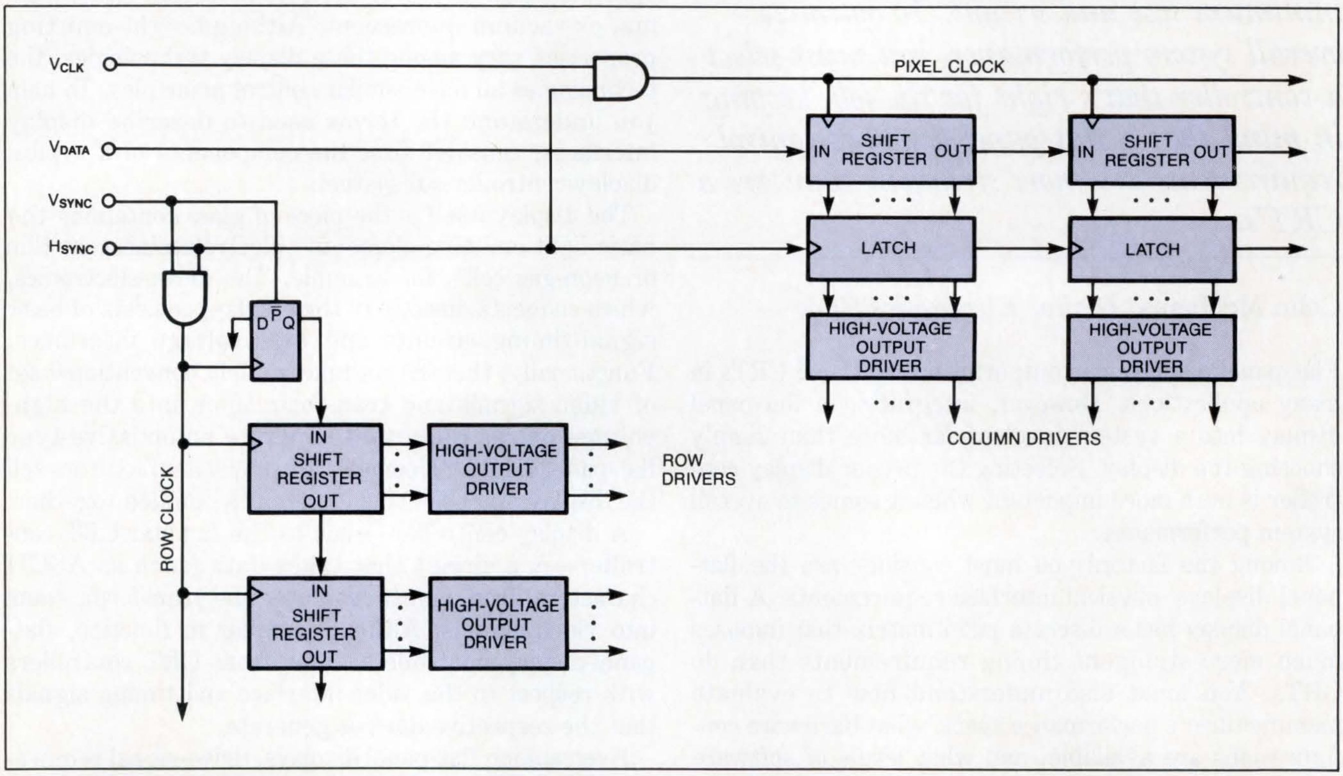


Fig 1—A flat-panel display's drive electronics *typically includes three elements: row drivers, column drivers, and timing and control circuits.*

MHz or more for larger displays. This parameter is critical because some display controllers cannot write new data into the display memory during the image-refresh period. These controllers can only write new data during a period that corresponds to a CRT's retrace time.

At first glance, you might assume that you can use a CRT controller to drive a flat-panel display. However, input-signal requirements are much tighter for flat-panel displays, and the flat-panel display's input signals must contain more information. Two basic display-surface phenomena come into play here: The flat panel has a discrete pixel matrix while the CRT has a continuous display surface, and the flat-panel display has no border around the edge, as does a CRT.

The flat panel's discrete pixel matrix requires the controller to sample the incoming video data instead of transferring it continuously to the screen. To recognize a valid sample, the input circuit needs a video-clock signal that has a specific relationship to the data.

Because the flat panel has no edge border, controller circuitry must know precisely when blanking ends and starts—when video data is good, in other words. To satisfy this requirement, flat-panel controllers often use a blanking-control signal rather than the HSYNC signal typically found in CRT controllers.

Consequently, it's difficult to drive a flat-panel display with a controller designed for a CRT, and the results are usually disappointing. Nevertheless, two control schemes are often attempted. One technique brings out the video-clock signal and modifies the HSYNC and VSYNC signals as necessary. However, you would find this approach a difficult one to implement unless you have a thorough working knowledge of the controller circuit and access to schematics and timing diagrams. At best, this approach might yield a working prototype but not a product that's suitable for production.

In the second approach, designers employ circuitry that accepts the output signals of the CRT controller and converts them to drive the flat panel. On the surface, this task seems simple enough, but the scheme has basic problems that stem from the fact that there is not enough information implicit in the CRT signals.

Specifically, there are three issues—matrix size, video-clock generation, and regeneration of the front- and back-porch timing signals. The controller's inherent image matrix size must match that of the flat-panel display exactly. This matching is easy enough for PC-based controllers because most of the common matrix sizes for flat-panel displays are geared to PC-display standards.

When it comes to the video clock, it's a simple matter to use a PLL to produce a signal that has the right frequency. However, it is not so easy to define and maintain the right phase relationship with the video data. Because this clock latches the data into the driver shift registers, its active edge must occur while the data signal is stable. CRT controllers provide a horizontal-sync pulse for synchronization purposes. Unfortunately, its exact phase relationship to the data stream isn't controlled because CRTs have no need for phase-relationship data.

You can compensate for this shortcoming by designing a manual phase adjustment into the clock circuit. The clock signal itself must be very stable, however, because any frequency variations cause the image pixels to flutter. Such stability is difficult to attain because the synchronizing signal for the PLL (the horizontal-sync signal) is $\frac{1}{640}$ times the output clock signal.

Finally, there's the question of front- and back-porch timing-signal regeneration. For CRTs, small changes are not noticeable because of the border of unused display area around the image. For a CRT, changes in porch timing simply move the image by small amounts left or right. A flat-panel display has no such border, however, so data shifted past the edge disappears. Consequently, for a flat-panel display, a shift of only one pixel to the left may make the leading characters on each line unreadable.

With a PC-based controller, the application program running at the time sets the exact porch size. Although most applications-program writers follow the standard IBM guidelines for the porch settings, there is no way to guarantee what the exact value will be. Porch-size values also change depending on the operating mode—text or graphics. Consequently, you might have to make a manual adjustment every time the video controller switches from text to graphics mode.

The alternative, and by far the most satisfactory approach, is to design or buy a controller specifically tailored for flat-panel displays. Enigmatically, this controller circuit can employ a CRT-controller chip because the CRT chips do in fact generate all the required timing signals. The video-clock-phase and porch-timing problems just detailed arise because the required signals are not available at the output of a complete CRT-controller circuit board.

The **box,** "Examples illustrate interfacing details," *Because a flat-panel display has a discrete pixel matrix, the controller must sample the incoming video data rather than transfer it directly to the screen.*

discusses how the necessary signals for a particular flat-panel display can be derived from a CRT controller chip. Over the years, various flat-panel displays' interface-signal requirements have differed in many aspects. However, you can now find more similarities. For example, panel manufacturers are starting to loosen the timing and parameter specifications. Planar (Beaverton, OR), for instance, is providing programmable back-porch delay times on its recently introduced 640×400-pixel display.

Examples illustrate interfacing details

Signal requirements vary among flat-panel displays. For example, the Planar 512×256 EL display's interface includes four active signals: video data (VID), video clock (VCLK), horizontal or row synch (HS), and vertical or frame sync (VS). These signals are supported by three mode inputs: video-signal polarity (VIDPOL), video-clock polarity ((VCLKPOL), and video input-mode select (DATASEL).

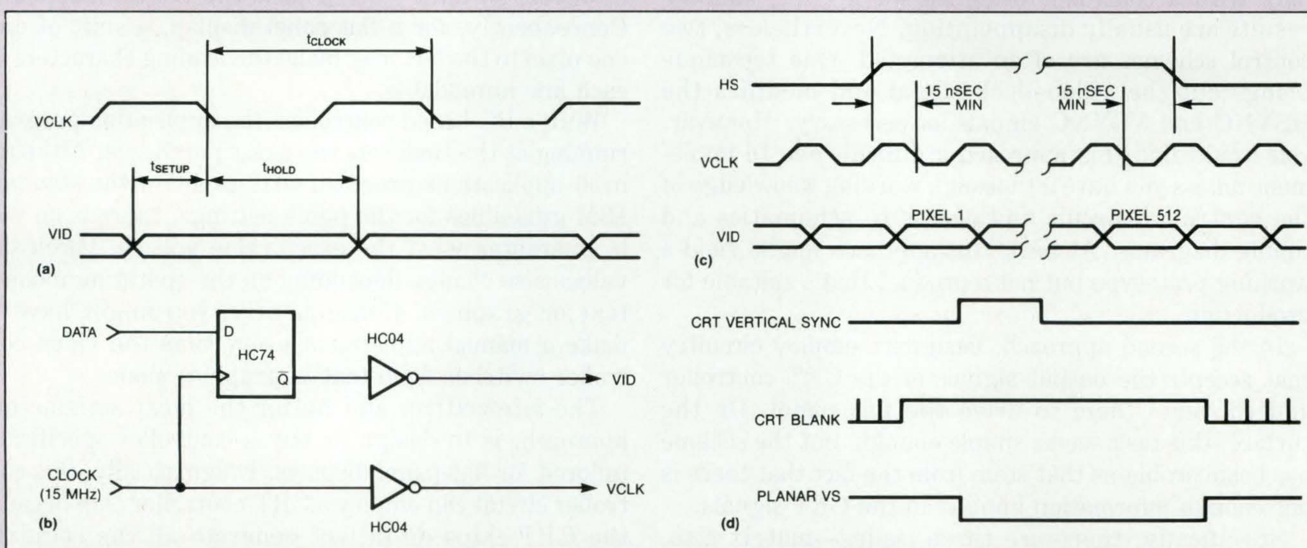
The polarity inputs, when high, ensure that a logic 1 indicates a lit pixel on video data and that the clock's falling edge latches data.

The input mode-select signal determines whether the video data will be sent on one line or two. For the 2-line mode, two adjacent pixels are sent as a pair each clock cycle. This mode effectively halves the frequency and thus can reduce EMI problems. The following discussion, however, assumes the single data-line mode.

First, the video clock signal latches data into a shift register, so the data must satisfy minimum setup and hold times: 20 nsec each with respect to the falling clock edge for the display's default modes. At a 15-MHz clock frequency, the cycle time, t_{CLK}, is only 66 nsec.

Unlike a CRT's corresponding horizontal-sync signal, the flat-panel display's HS signal must also indicate when data is valid. Each display line consists of 512 bits of valid picture data, and HS must go high at the beginning of the first valid data bit and go low at the end of the last valid data bit. Thus, this signal is more like a CRT's blanking signal than a horizontal-sync signal, and in fact the blanking signal can be used for HS, although it must pass through a synchronization stage at the controller's output, as the video data does.

VS is similar to a CRT's vertical-sync signal, but VS must in-



***Timing for flat-panel displays** differs from that for CRTs. A Planar display, for example, requires that data satisfy setup and hold times **(a)**, which can be ensured by device propagation delays in a synchronizing circuit **(b)**. The HS signal also must meet stringent timing requirements **(c)**. VS can be derived from CRT-controller signals **(d)** and must meet HS/VS edge-timing requirements **(e)**; a simple circuit suffices for VS generation **(f)**. For an NEC display, timing requirements differ somewhat **(g)**.*

Fig 2 illustrates a typical flat-panel-controller output stage. This output stage can drive all popular sizes of EL displays as well as many plasma models. The circuit can readily control displays from Planar, Sharp (Paramus, NJ), GTE (Greenland, NH), Sigmatron-Nova (Thousand Oaks, CA), Finlux (Cupertino, CA) and World Products (distributor for NEC, Sonoma, CA).

In general, display controllers fit into one of two categories—dumb controllers and smart controllers. Performance and architecture, overhead requirements,

dicate when the first line of valid data occurs.

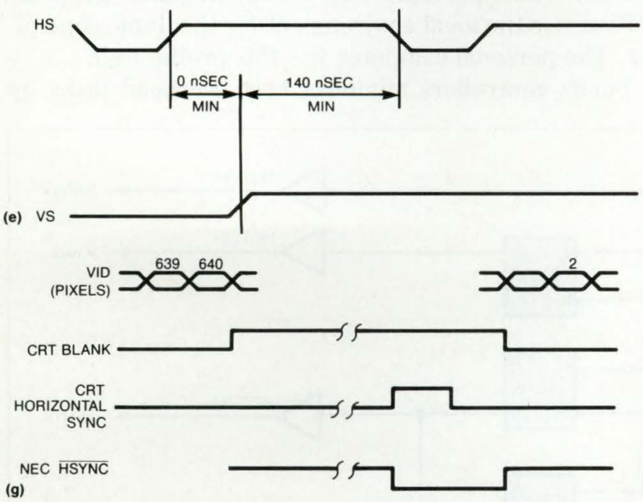
Control of the Planar display also requires care in setting line-count parameters. The display must receive 260 HS pulses, requiring that—if a blanking signal is used for HS—the controller chip's active-line parameter be set to 260 instead of 256. (Only the first 256 lines will be displayed, so it's not important what data reside on the last four lines. Note too that lines beyond 260 are not only not necessary—they may cause the display to flicker.) In addition, the duration of VS should be kept short—to no more than three or four HS periods.

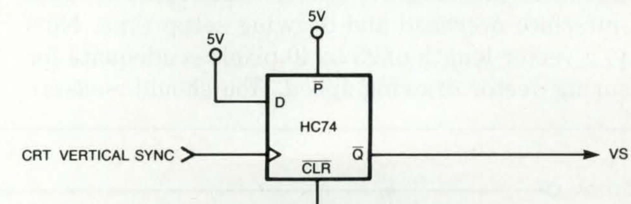
Timing requirements differ somewhat for the NEC 640×400 Model PD640G400CA-100A display. It lacks the Planar display's mode lines but adds a brightness-control line.

The NEC unit's $\overline{\text{HSYNC}}$ signal indicates an end of a row, as does the Planar unit's HS signal, but $\overline{\text{HSYNC}}$ also affects brightness: When low the display is blanked, so for maximum brightness $\overline{\text{HSYNC}}$'s low state should be kept as short as possible.

In addition, although the leading and trailing edges of Planar's HS define the end and beginning of valid data, only the trailing edge of $\overline{\text{HSYNC}}$ is critical (it defines the start of valid data), so the leading edge can be delayed after the end of valid data. For best results with the NEC display, a CRT controller chip's parameters should be set so that horizontal retrace or blanking time consists of a long front porch followed by a short sync pulse and back porch.

The NEC display's brightness input is driven by an on-time duty-cycle controller; the input is a variable-length pulse signal that's synchronized with $\overline{\text{HSYNC}}$. Feeding $\overline{\text{HSYNC}}$ into a one-shot can generate the brightness input.





In general, display controllers fit into one of two categories—dumb controllers and smart controllers.

and ease of application are the main factors that define these categories.

Many designers rely on drawing-performance specs to evaluate display controllers. It's very difficult to compare these speed parameters on an apples-to-apples basis because vendors usually measure and report performance differently. For example, there are three popular measures of performance—pixels per second, vectors per second, and text characters per second.

Although the pixel/sec parameter is commonly used to specify performance, it is probably the most misleading because pixels are not written continuously but in bursts. Unless a system can continuously write pixels at the specified pixel/sec rate, the average number of pixels per second will be much lower than the burst rate. Manufacturers often publish the burst rate rather than the more important average rate.

The drawing operation itself also greatly influences pixel rate. For example, a simple block-fill operation can run at a much higher pixel rate than a vector-drawing routine. You can write as many as 16 or 32 pixels in a single cycle for a block-fill operation while you have to individually write each pixel for a vector-draw operation. Obviously, it's important to know the relationship between the published pixel/sec rate and the drawing operation.

A system's vector/sec drawing capability is a much better measure of overall performance. This parameter is much more meaningful because it incorporates both host-interface overhead and drawing setup time. Normally, a vector length of 25 to 40 pixels is adequate for measuring vector drawing speed. You should measure performance by continually sending instructions for at least several seconds and then calculating the average time it takes to draw one vector. It's important to use random vectors here to maximize the setup overhead—using the time it takes to draw a single vector is not a valid measure of performance.

The text-character/sec spec is also a useful parameter for evaluating and comparing text-display speeds. As with vectors, it's important to consider the average speed over a time period rather than the time it takes to display a single character.

Architectures aren't all the same

With a dumb controller, the host has to do all of the display processing. A typical unit consists of a 2-port video memory, an automatic refresh controller that continuously cycles through the video memory and sends data to the display, and logic circuitry that generates the four display-control signals. The refresh controller can only read the video memory; the host has to draw all the figures and graphics in the video memory. Most popular graphics boards available for personal computers are examples of dumb controllers.

Because the host must generate the display image, a dumb controller places a considerable burden on the host. You can use a character-generator ROM to generate text easily, but it is much more difficult to generate graphics. An application involving a powerful, lightly burdened host processor and readily available graphics software is the ideal environment for the dumb controller. The personal computer fits this profile well.

Smart controllers minimize host overhead tasks by

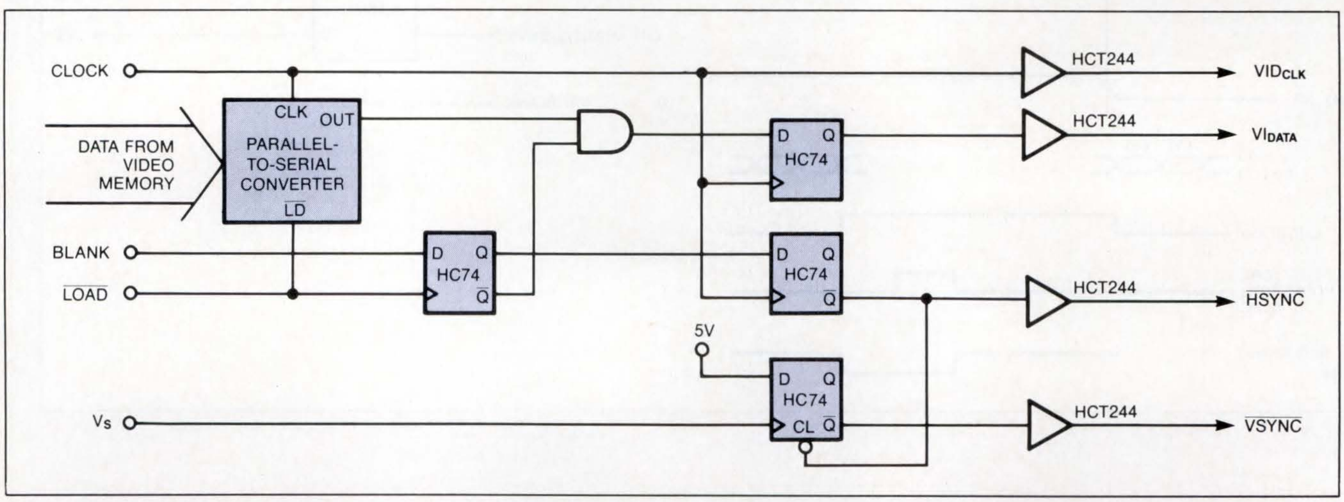


Fig 2—Flexibility is a key feature *of today's flat-panel controllers. This output stage, for example, can drive all popular sizes of EL displays as well as many plasma-type devices.*

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CIRCLE NO 209

Smart controllers minimize host overhead tasks by providing local intelligence at the display-control level.

providing local intelligence at the display-control level. There are two popular architectures.

There's smart and then there's smart

Low-end smart controllers consist of a general-purpose microcontroller coupled with a dumb refresh unit and video memory. You can program this typical low-end controller with a limited set of drawing algorithms that reside in its program memory. Such a controller might include simple algorithms for drawing lines, circles, rectangles, and so on. Although this low-end smart controller does ease the host's overhead burden, it must still implement all the drawing algorithms in software and also handle all communications with the host. As a result, the microcontroller's speed limits display performance. The block diagram in **Fig 3** illustrates a typical low-end smart controller.

The high-end smart controller couples a general-purpose processor and a specialized drawing processor into a pipelined architecture to achieve high-speed performance. Using this approach, the controller can execute the three main program sections of the DDA (digital differential analyzer), a commonly used vector-drawing algorithm, simultaneously. The drawing processor computes the coordinates of the next pixel while the previous pixel is being written into memory. In parallel, the general-purpose processor handles the setup for the next figure. Tasks are done in parallel; while the DDA processor is calculating the next bit location to modify, the memory-control interface is performing a read-modify-write operation for the current one. In contrast, a low-end smart controller system only modifies the video memory once each time the microprocessor goes through the algorithm's loop.

The block diagram in **Fig 4** exemplifies a high-end smart controller. Note that one of the two processors is dedicated to I/O control and display-list processing. It communicates with the host via a serial or parallel interface. The host communicates to the controller via a high-level ASCII-based command set. The graphics processor provides parallel display processing and control functions.

Don't overlook software-support considerations

Design-cycle time is an important consideration when choosing a flat-panel-display system for any application. Design cycle time for product introductions is often short given today's market demands and competitive pressures. Because the development effort for custom software can easily exceed one man-year, it's important for designers to seriously consider the tradeoffs between custom display systems and off-the-shelf systems.

Although a dumb controller usually minimizes system hardware costs, it can also extend design cycle time because it lacks a high-level command set and other features. In addition, it burdens the host with display-control tasks. Smart controllers can significantly reduce design-cycle time while simultaneously maximizing the level of overall system performance.

When evaluating either low- or high-end smart controllers, it's important to look for built-in terminal-

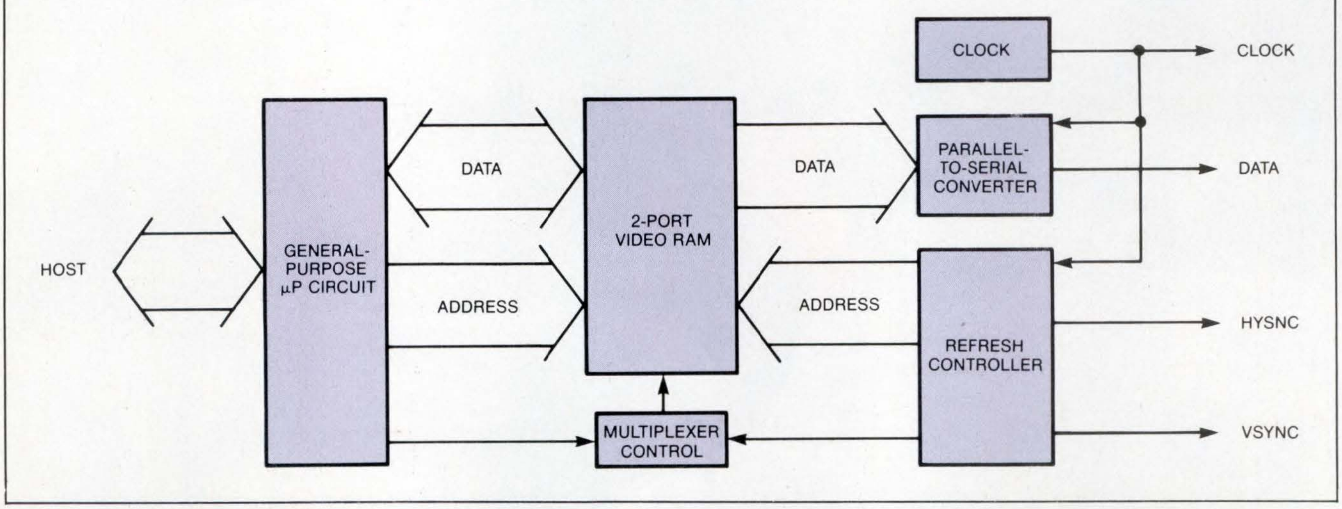

Fig 3—Although this low-end smart controller eases *host-overhead tasks, it must still implement all the drawing algorithms in software and handle all communications with the host.*


MOTOROL
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A high-level graphics and control command set is essential for developing applications quickly and cost effectively.

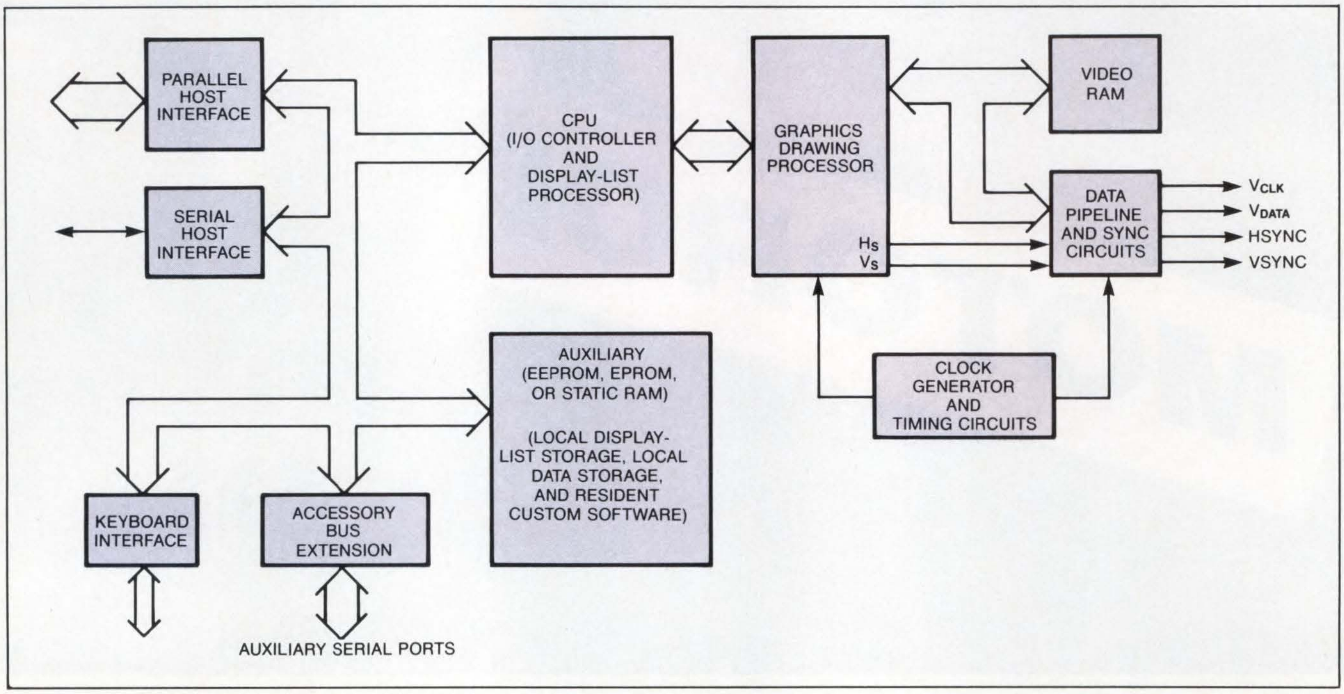


Fig 4—High-end smart controllers typically employ a dual-processor design. *One processor controls all I/O tasks while the second provides parallel display processing and control functions.*

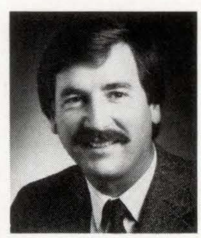
emulation capabilities, a high-level graphics and display-control command set, and other special features. Standard terminal-emulation capability allows you to easily interface the display and controller to existing applications routines.

A high-level graphics and display-control command set is essential for developing and revising applications quickly and cost effectively. In addition to graphics primitives (such as vector, arc, and circle) and operations (such as fill), the controller should provide window and clipping operations and DMA operations to video memory.

The ability to locally store frequently used, host-accessible frames (display lists) is another important feature to look for in a smart controller. Storing display frames locally removes a significant burden from the host because it negates the need to transfer the display list for the frame—the host merely sends to the controller a single command that indicates which frame to display. The controller then locates the display list in its local memory and uses it to generate the display.

There are a few other issues to consider when evaluating smart controllers. There's the interface question, for example. Does the controller offer standard serial and parallel ports for fast and easy connection to the host system? Can you use all of the ports simultaneously? If operator input comes in whole or in part from a keyboard, you must consider whether the controller offers a straightforward keyboard interface. Flat-panel display applications often call for a touchscreen interface, so you should consider whether the controller supports touchscreen input. **EDN**

Author's biography



Colin McManus is vice president of engineering at Digital Electronics Corp (Hayward, CA). With the company five years, he was previously employed at Humphery Instruments. Colin holds BSEE and MSEE degrees from Queens University in Belfast, Ireland. While four children take up a good deal of his spare time, Colin busies himself with carpentry projects and reading history when time is available.

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CIRCLE NO 208

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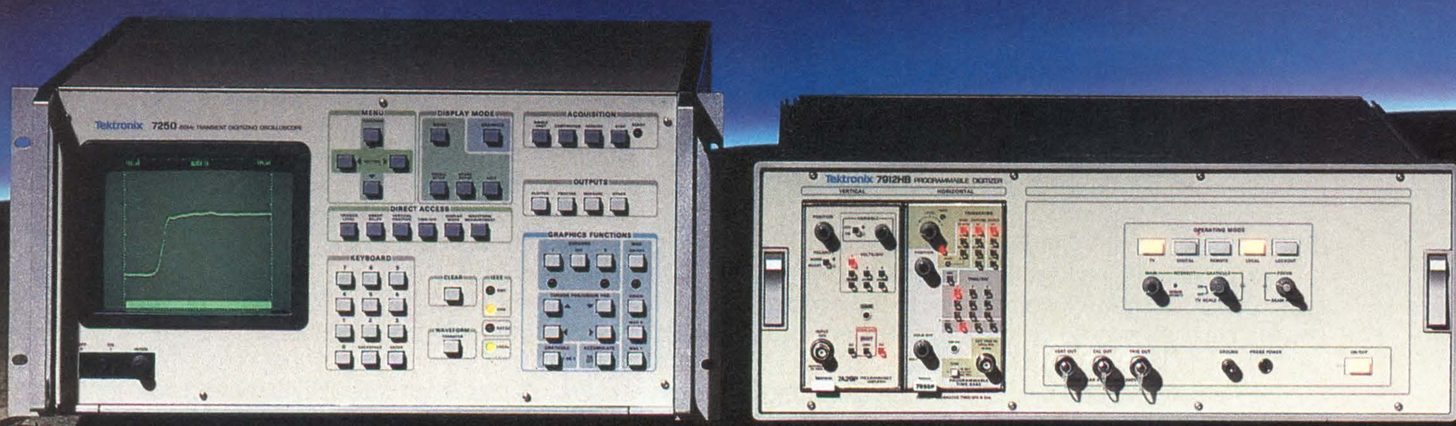
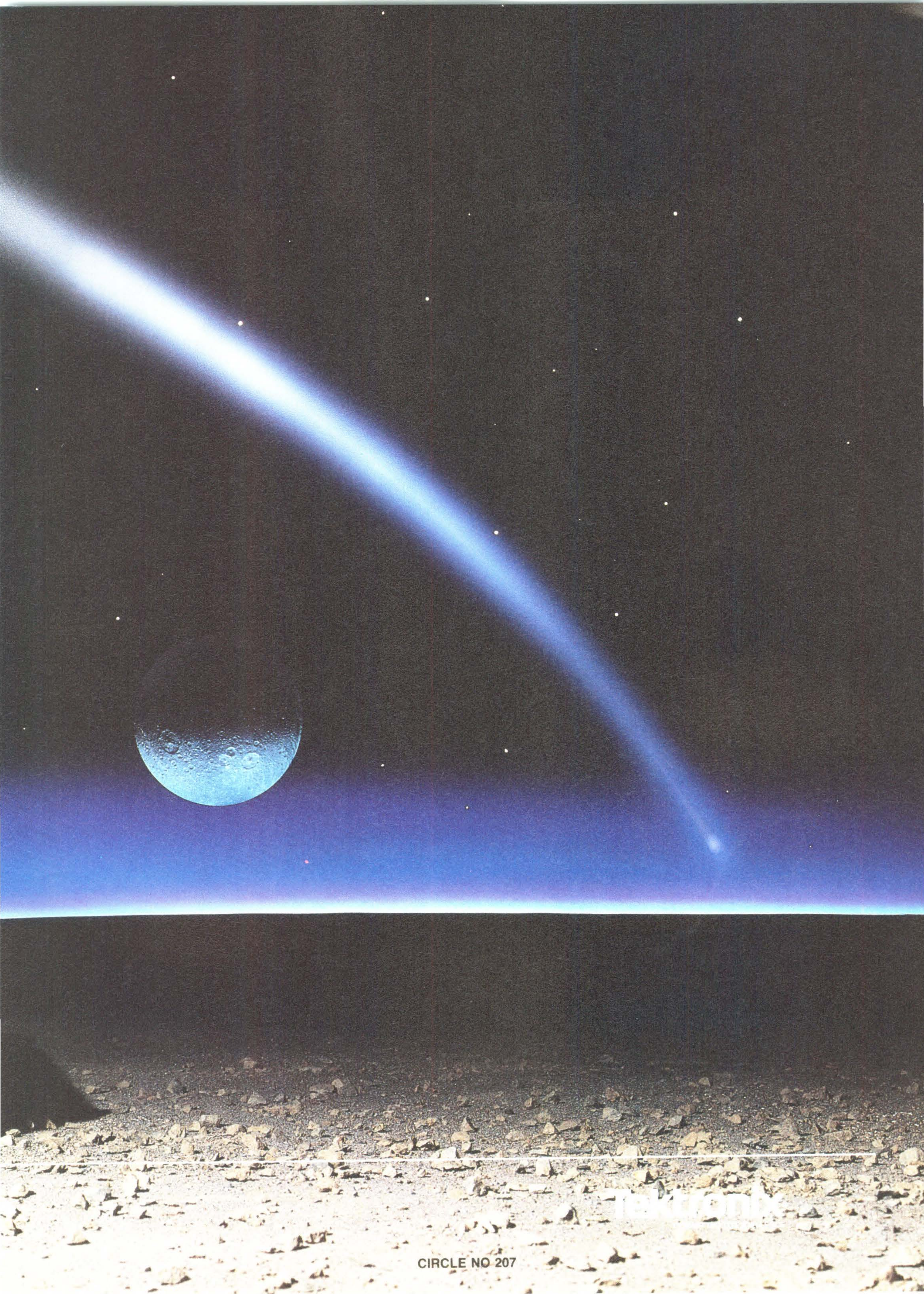
Vertical Resolution	11 bits	9 bits
Input Signal Range Vertical	5V full scale, 10 divisions	80mVto 8V full scale, 8 div.
Input Sensitivity	500mV/div.	10mV/div. to 1V/div.
Fully Programmable	Yes	Yes

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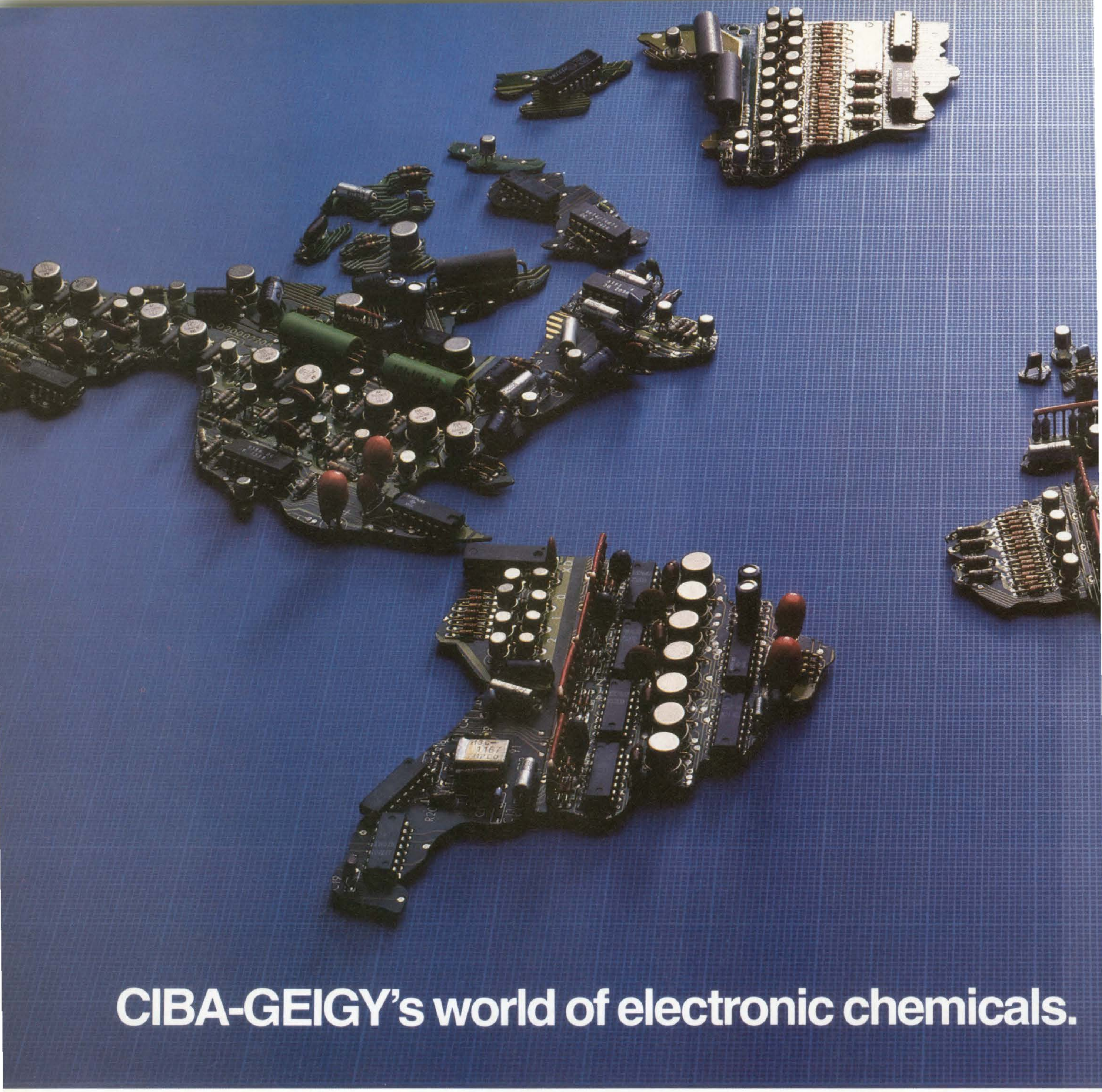
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CIRCLE NO 206

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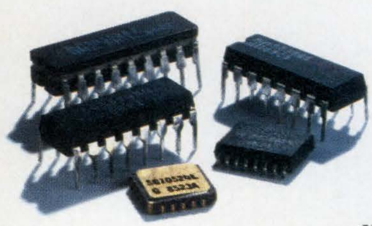

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CIRCLE NO 205

Mini dc/dc supplies simplify redundancy in parallel systems

You can significantly increase the reliability of an uninterruptible power supply (UPS) by connecting dc/dc converters in parallel to implement redundancy. Miniature, on-card dc/dc converters make it possible to design parallel-redundant systems that offer higher efficiency than that attainable from conventional UPS designs.

Lars Thorsell, *Rifa Power Products*

A source of uninterrupted power is increasingly becoming a requirement for computing systems. A total or even partial power failure, and the subsequent loss of data, can be catastrophic for many applications. In such applications, you must address the problem of fault tolerance in your equipment design. Many of these critical applications rely on uninterruptible power supplies (UPS) to satisfy the requirement of continuous operation. Miniature, on-card dc/dc converters, connected in parallel, provide a highly reliable, redundant power-distribution system.

Conventional UPS systems, on which many of these critical applications rely, suffer from the reliability limitations of their internal electronic circuitry. You can increase the reliability of a power-distribution system by introducing parallel redundancy. In many situations, however, this solution introduces new difficulties of thermal management, size, efficiency, and cost. Miniature dc/dc converters make it possible to design UPS systems that exhibit efficiencies as high as 65%, as compared with the 40% that's typical of conventional UPS systems that use parallel redundancy. Before exploring these efficient UPS designs, it might be useful to gain some insight into the design of a conventional UPS system.

Conventional UPS has shortcomings

A conventional UPS (**Fig 1**) consists of an ac/dc rectifier that also serves as a battery charger; a battery, and a dc/ac inverter. An on-line UPS (**a**) operates continuously and provides a power-line conditioning filter as well as battery back-up. A standby UPS (**b**) has a bypass switch that switches in the UPS only when a line failure occurs. The start-up time of a standby UPS is usually shorter than the hold-up time of the principal supply in the equipment, so no power interruption occurs during the switchover.

Although a conventional UPS solves problems related to interruptions or bad conditions in the main ac power line, it cannot deal with faults that occur in the power-conversion circuits. The overall power system requires a dc/ac converter after the battery in the UPS, followed by an ac/dc supply in the equipment (**Fig 2**). This dual conversion process is the weakest link in the overall power system because of the electrolytic filter

Although a conventional UPS solves problems related to the main ac line, it cannot deal with faults in the power-conversion circuits.

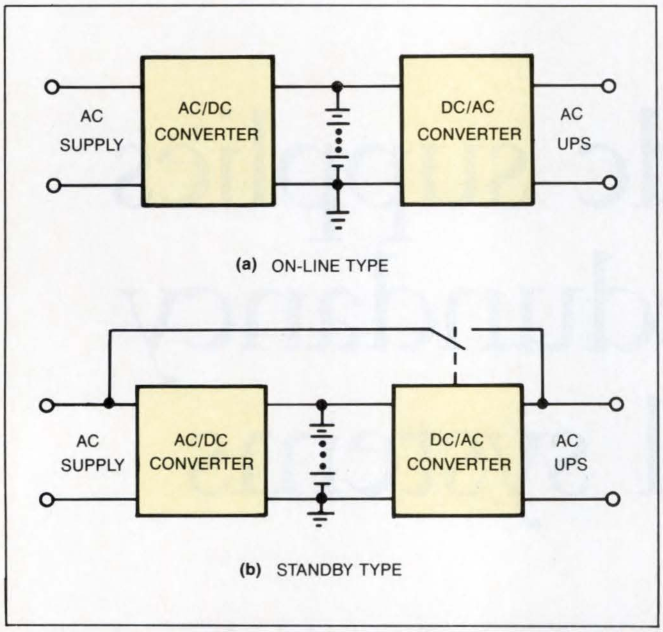


Fig 1—A conventional UPS comes in two configurations. *An on-line type* ***(a)*** *operates continuously, and provides line filtering and battery back-up. A standby type* ***(b)*** *has a bypass switch that switches in the UPS only in the event of a line failure.*

capacitors—often operated at levels near the capacitors' specified operating limits—used to reduce line-frequency ripple. Electrolytics are also required for long hold-up times in the ac/dc supply.

Further, the dual power conversion lowers the overall efficiency of the power system, and this reduced efficiency also contributes to lower reliability figures. Inverter circuits used in the UPS typically have an MTBF (mean time between failure) of 50,000 hours, and switch-mode supplies typically have MTBFs from 50,000 to 100,000 hours. In fact, the down time attributable to power-conversion faults can be four times the down time caused by interruptions in the main ac supply (see **box,** "Weak links limit UPS reliability").

To overcome the down-time problem, UPS designers build parallel-redundant functions into the weak links of the power system **(Fig 3).** Successful parallel redundancy depends on the use of redundant parts that are easily repairable or replaceable. In calculating the MTBF of the system, it's safe to assume that faults occur one at a time and that supervisory circuits with alarms detect the fault occurrences. The MTTR (mean time to repair) must be many times lower than the MTBF.

Because doubling up all the weak-link circuits leads to bulkiness as well as high costs, designers often duplicate only the principal power-supply unit **(Fig 4).** Note, however, that the nonduplicated inverter substantially reduces the overall reliability figures.

The outputs of the redundant power supplies connect to the load through ORing diodes. The diodes are required because of the existence of relatively low-reliability components, such as electrolytic capacitors, on the output side of the power supplies. The voltage drops and power dissipation attributable to the diodes can contribute appreciable losses in a high-power system.

Raising redundancy reliability

A more reliable UPS is illustrated in **Fig 5.** The ac/dc supply in the equipment receives back-up from a battery and battery charger. This back-up scheme eliminates the need for large electrolytic units acting as hold-up capacitors. The dc voltage from the supply feeds directly to dc/dc converters, thereby eliminating the dual power-conversion reliability figures from the overall reliability calculations.

Achieving redundancy is a matter of connecting dc/dc converters in parallel. The dc/dc converters are

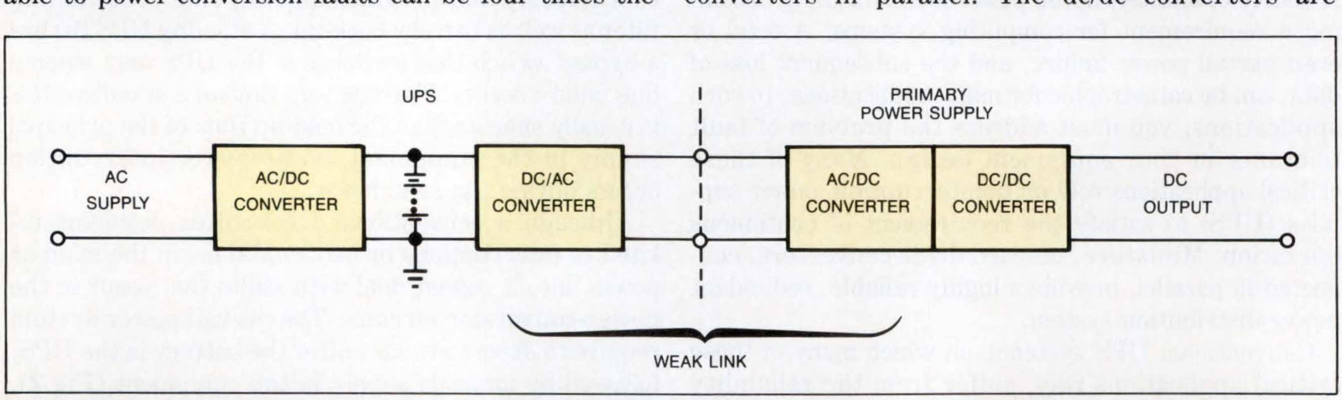


Fig 2—The weak link in a conventional UPS system *is the dual power-conversion circuitry. The electrolytic filter capacitors used to reduce line-frequency ripple and to provide long hold-up times are the main contributors to reliability compromises in these systems.*

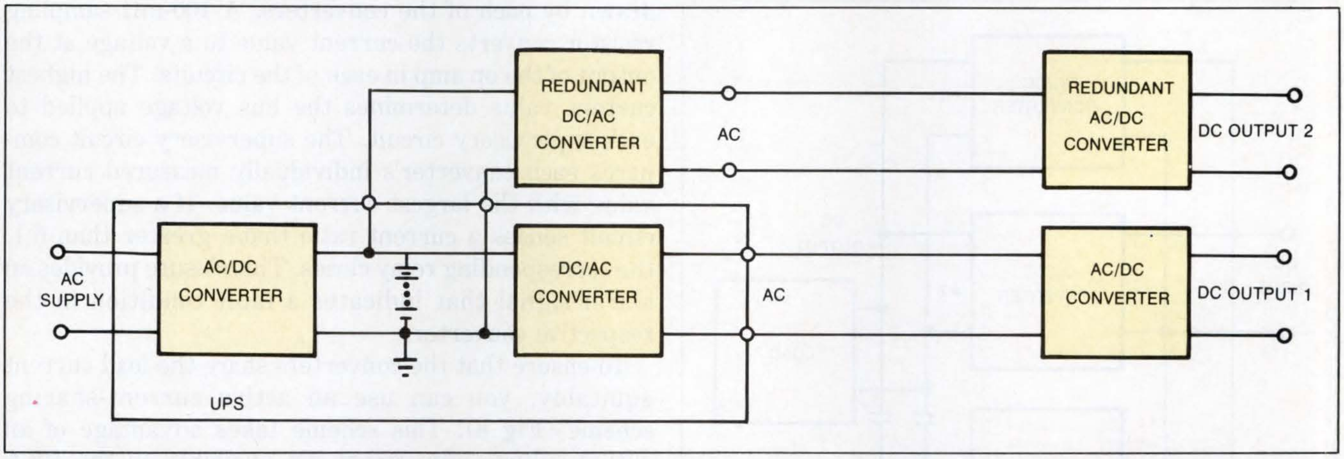


*Fig 3—**Building redundancy into a conventional UPS system** can be bulky and expensive. In this configuration, both the dc/ac inverters and the ac/dc output rectifier supplies have redundancy.*

mounted on system cards to conserve space. They use high switching frequencies, and can therefore use smaller and more reliable (vs electrolytics) ceramic capacitors to eliminate ripple-frequency components. For example, the PKA Series of dc/dc converters uses a 300-kHz switching frequency in a full-wave bridge arrangement. This series quotes an MTBF of 200 years (approximately 1.75 million hours). (See **box**, "Converter switching frequencies creep upward".)

The battery directly feeds the dc/dc converters, which are connected in parallel to the load without the use of ORing diodes **(Fig 6)**. This connection method is possible thanks to the use of reliable ceramic capacitors on the converters' outputs. The system achieves redundancy by adding only one extra unit instead of duplicating the entire power supply. To build a 100W system, five 25W dc/dc converters, connected in parallel, are enough to ensure redundancy. Only 125W power capability is needed, compared with the 200W needed to double up on the power supplies.

Distributing the individual dc/dc converters around the various system boards enhances the system reliability. The heat dissipation is spread evenly throughout the system. This uniform distribution eliminates hot spots that would arise from the concentration of bulky power units.

Fig 7 illustrates a redundant system that uses on-card dc/dc converters connected in parallel. This connection works well when the distributed resistances (R_{DISTR}) range between 20 and 40 mΩ. The converters will typically share the load current in a 3:2 ratio, with a worst-case ratio of 2:1.

The supervisory circuits measure the input currents

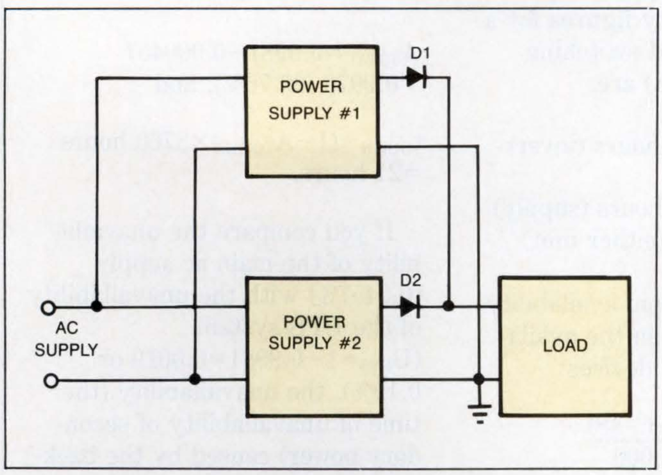


*Fig 4—**Doubling up on the power supplies yields redundancy** in this configuration. The ORing diodes are required because the supplies' output circuits contain weak-link components (electrolytic capacitors).*

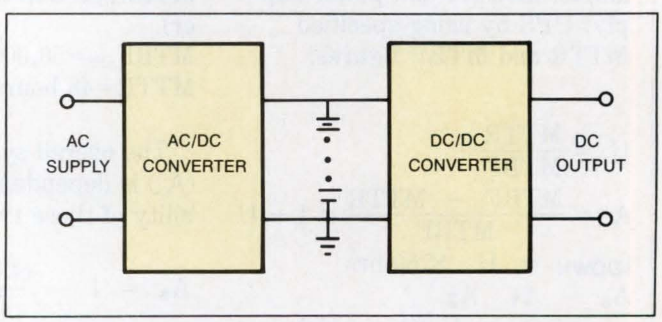


*Fig 5—**A more reliable UPS structure** eliminates the dual power-conversion circuitry seen in **Fig 4**. This architecture eliminates the need for large electrolytic capacitors that would otherwise be required for hold-up purposes.*

The down time attributable to power-conversion faults can be four times the down time arising from interruptions in the main ac supply.

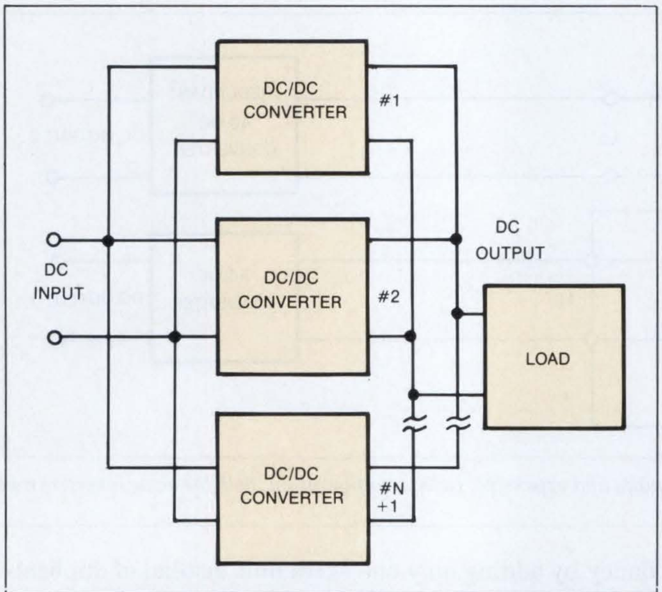


Fig 6—A redundant system built with parallel dc/dc converters *connects directly to the load without the need for ORing diodes. This is a reliable configuration, thanks to the use of small ceramic filter capacitors in the converters' outputs.*

drawn by each of the converters. A 100-mΩ sampling resistor converts the current value to a voltage at the output of the op amp in each of the circuits. The highest current value determines the bus voltage applied to each supervisory circuit. The supervisory circuit compares each converter's individually measured current value with the largest current value. If a supervisory circuit senses a current ratio that's greater than 6:1, the corresponding relay closes. This closure provides an alarm signal that indicates a fault condition in the respective converter.

To ensure that the converters share the load current equitably, you can use an active current-sharing scheme **(Fig 8)**. This scheme takes advantage of an output-voltage adjustment pin available on the PKA Series of dc/dc converters. Each converter has two regulation loops. One of these loops senses the output current of the respective converter through a 20-mΩ sampling resistor. The highest current value sets the reference voltage on the output bus. This voltage is distributed as a reference value to the individual regulation loops. Each of the regulation loops compares the

Weak links limit UPS reliability

The overall reliability of a power supply is determined by the weakest parts in the system. In a UPS, these parts are the inverter and the succeeding ac/dc power supply, because both these blocks use electrolytic capacitors for filtering. You can obtain representative reliability figures for a 2-subpart (for example, inverter and power supply) UPS by using specified MTTR and MTBF figures:

$$U = \frac{MTTR}{MTBF}$$

$$A = \frac{MTBF - MTTR}{MTBF} = 1 - U$$

$$t_{DOWN} = U \cdot 8760 \text{ hrs}$$

$$A_S = A_1 \cdot A_2 = (1 - U_1)(1 - U_2)$$

$$A_S = 1 - (U_1 + U_2)$$

(neglecting $U_1 \cdot U_2$),

where A is the operational availability of a subpart of the system, U is the unavailability, t_{DOWN} is the accumulated down time (for example, 1 year), and A_S is the system availability.

Typical reliability figures for a UPS's inverter and switching power supply (SPS) are:

$MTBF_{UPS}$=50,000 hours (inverter)
$MTBF_{SPS}$=50,000 hours (supply)
MTTR=48 hours (either unit)

The overall system availability (A_S) is dependent on the availability of these two devices:

$$A_S = 1 - \frac{(48 + 48)}{50{,}000} = 0.9981 = 99.81\%.$$

This figure does not include the unavailability of the main ac supply. A practical figure for the unavailability of the main supply is $U_M=4.57\times10^{-4}$. Taking this value into account, the overall availability is

$A_{TOTAL}=0.9981-0.000457$
$=0.9976$ (99.76%), and

$t_{DOWN}=(1-A_{TOTAL})\times8760$ hours
=21 hours.

If you compare the unavailability of the main ac supply (0.0457%) with the unavailability of the UPS system ($U_{SYS}=1-0.9981=0.0019$ or 0.19%), the unavailability (the time of unavailability of secondary power) caused by the backup system is more than four times greater than that attributable to the main ac supply.

reference value with individually sensed output-current values.

The second loop senses the distributed voltage and compares it with that of a stable reference diode. The outputs of the two regulation loops are connected in parallel and sent to the voltage-adjust pin on each dc/dc converter. If either the sensed value of the output current or the sensed distributed voltage differs from its respective reference value, the control loop adjusts the voltage of the appropriate dc/dc converter to balance the load distribution.

Each converter has a supervisory circuit for its input

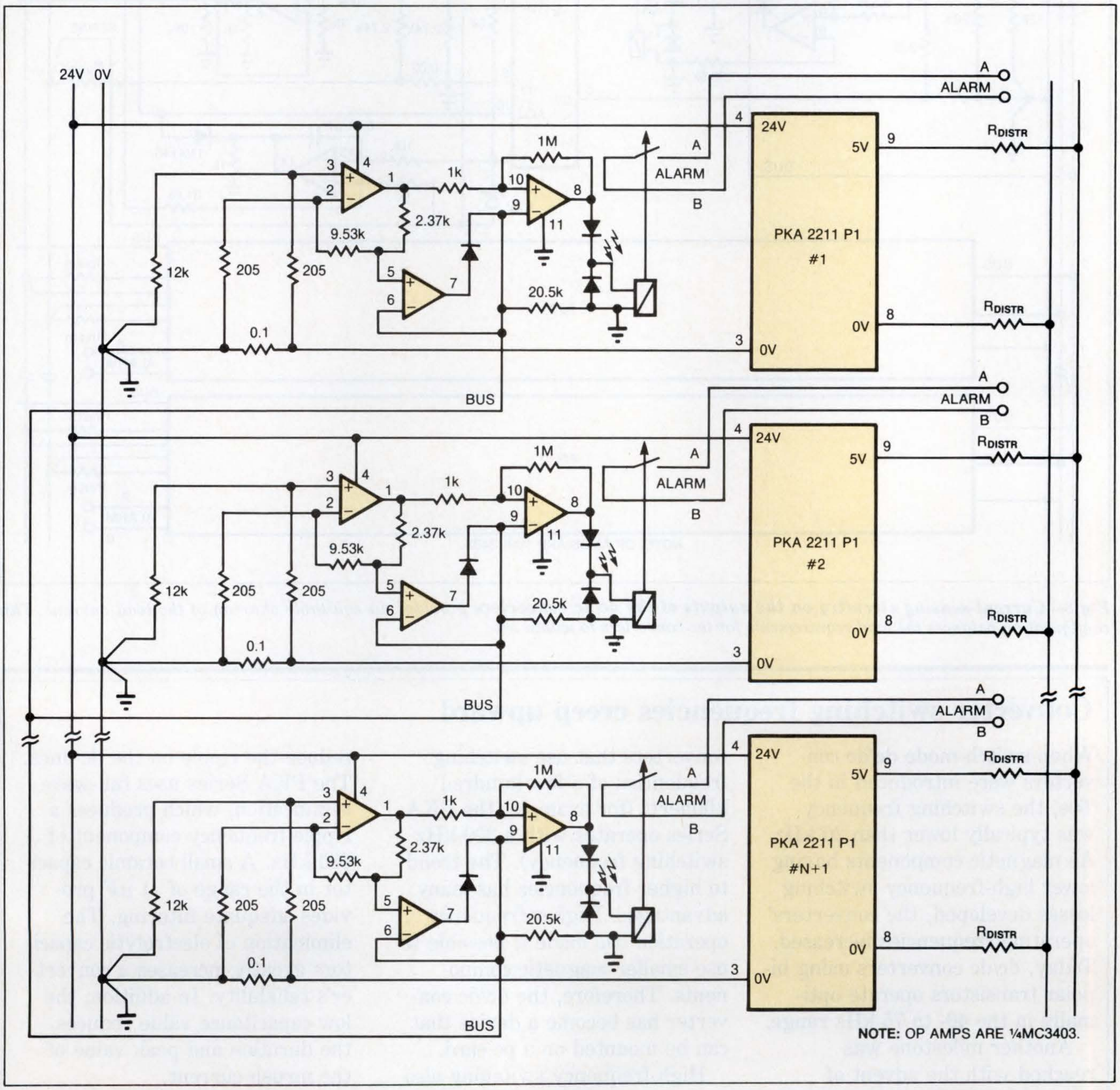


***Fig 7—Supervisory circuits sense the input currents to the dc/dc converters** and trigger an alarm when a fault is detected. The converters in this configuration typically share the load current in a 3:2 ratio. If a ratio exceeds 6:1, an alarm indicates a fault condition in the appropriate converter.*

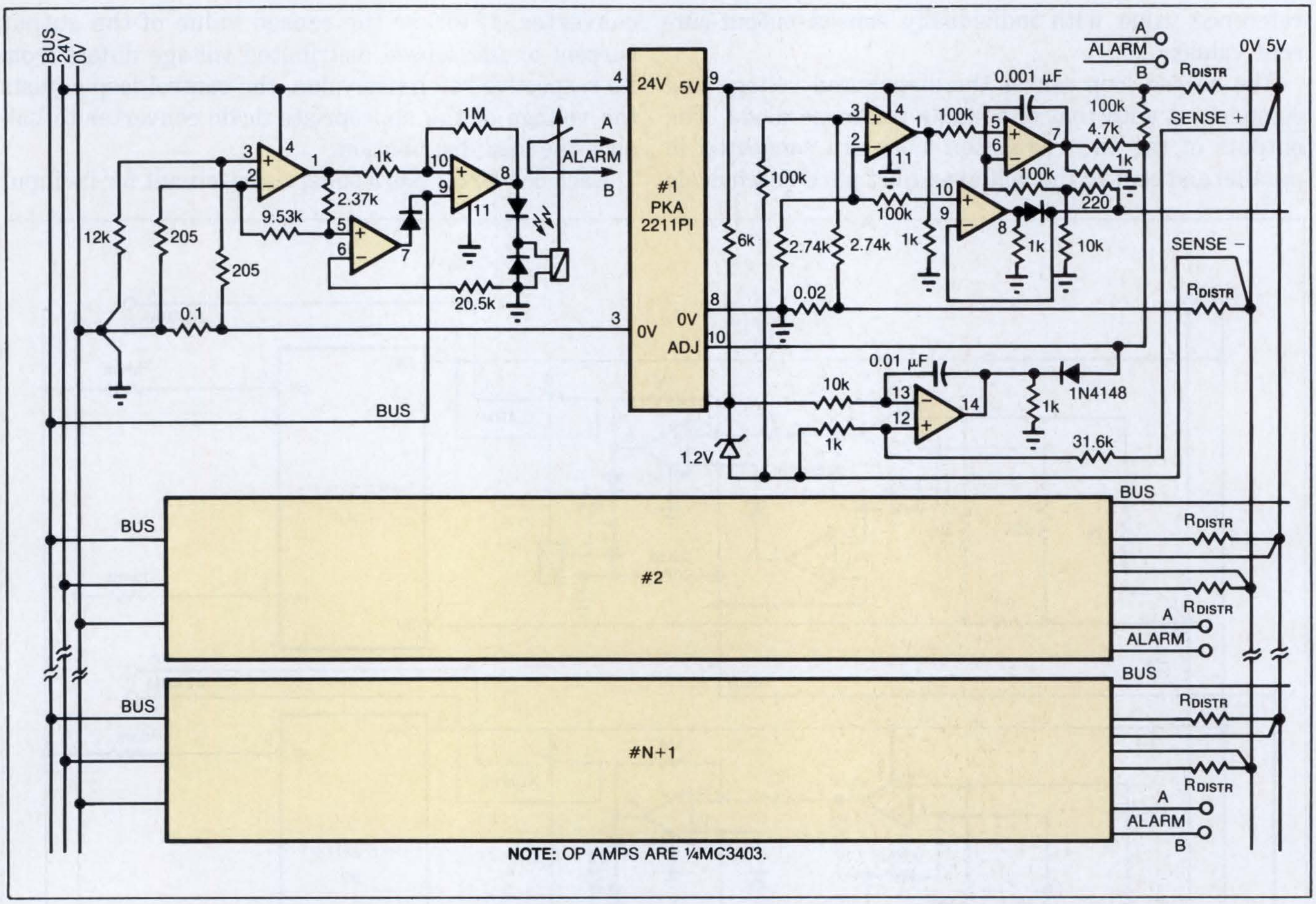


Fig 8—Current-sensing circuitry on the outputs of the dc/dc converters provides an equitable sharing of the load current. This configuration balances the load requirements for the converters to within 5%.

Converter switching frequencies creep upward

When switch-mode dc/dc converters were introduced in the '60s, the switching frequency was typically lower than 20 kHz. As magnetic components having lower high-frequency switching losses developed, the converters' operating frequencies increased. Today, dc/dc converters using bipolar transistors operate optimally in the 40- to 75-kHz range.

Another milestone was reached with the advent of power MOSFETs. It became possible to build efficient dc/dc converters that use switching frequencies of a few hundred kilohertz (for example, the PKA Series operates with a 300-kHz switching frequency). The trend to higher frequencies has many advantages. Higher-frequency operation has made it possible to use smaller magnetic components. Therefore, the dc/dc converter has become a device that can be mounted on a pc card.

High-frequency switching also makes it possible to use smaller and more reliable capacitors to reduce the ripple on the dc lines. The PKA Series uses full-wave rectification, which produces a ripple-frequency component of 600 kHz. A small ceramic capacitor in the range of 1 μF provides adequate filtering. The elimination of electrolytic capacitors greatly increases a converter's reliability. In addition, the low capacitance value reduces the duration and peak value of the inrush current.

current. This supervisory circuit triggers an alarm circuit similar to the one in **Fig 7**. The current-sharing scheme can balance the load requirements for the dc/dc converters to within 5%. Consequently, the units are never overstressed, and never operate at their maximum rated output power. This low-stess environment naturally enhances the converters' reliability.

When dc/dc converters are connected in parallel, the only factor that affects the overall operation is a failure in the output circuitry of a converter. Therefore, the reliability of the output circuitry of the converters is the sole contributor to the overall reliability figure. The MTBF of the output circuitry in the PKA Series of dc/dc converters is 4500 years. Therefore, the overall reliability figure is

$$\text{MTBF} = 4500 \text{ years} \div (\text{number of converters in parallel})$$

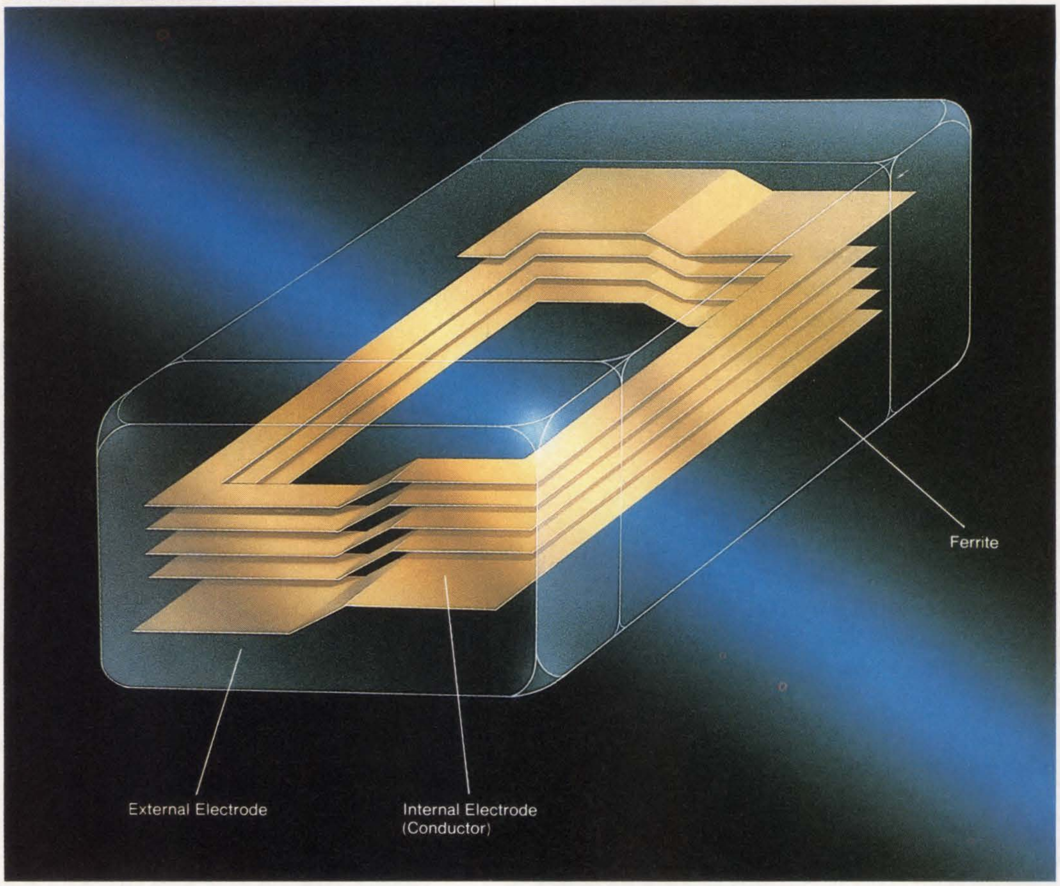
If the overall MTBF figure determined by this expression is not adequate, then you can connect the outputs of the dc/dc converters through ORing diodes. However, the remote-sensing circuits must then compensate for the voltage drops across the diodes.

Efficiencies of about 65% are achievable from parallel-connected dc/dc converters that don't use the ORing diodes. This number compares favorably with the typical 40% efficiency of a conventional UPS. **EDN**

Author's biography

Lars Thorsell is product marketing manager for Rifa Power Products in Stockholm, Sweden. After receiving a BSEE from the Stockholm Tekniska Institute in 1969, he designed power supplies and power systems in the power-supply department at Ericsson for nine years. He then gained four years of experience in the semiconductor industry while working as an applications engineer and product marketing manager at SGS Scandinavia AB. Before joining Rifa, Thorsell served as product manager and marketing manager for Ulceco Power Products.

Article Interest Quotient (Circle One)
High 485 Medium 486 Low 487



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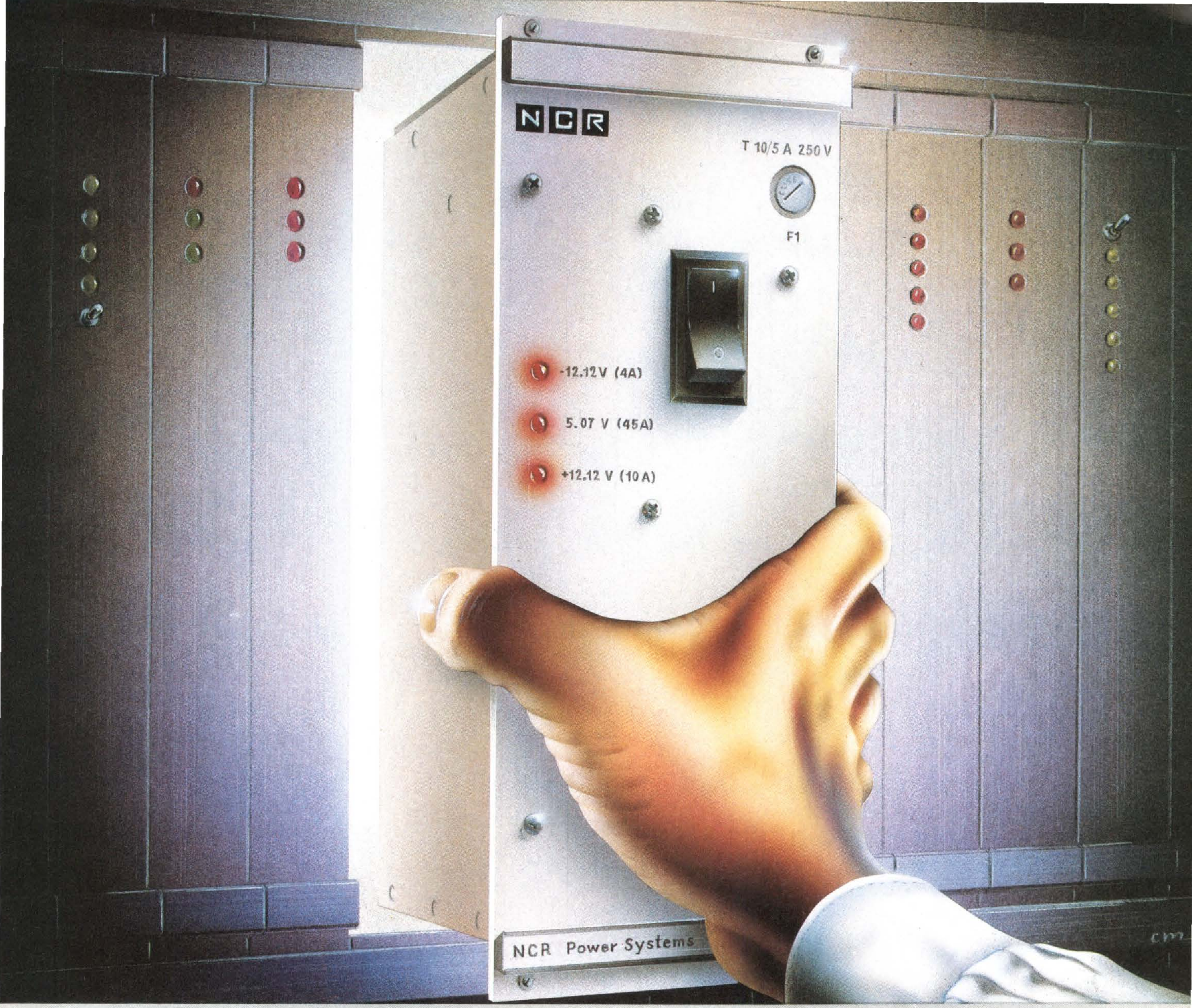

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CIRCLE NO 203

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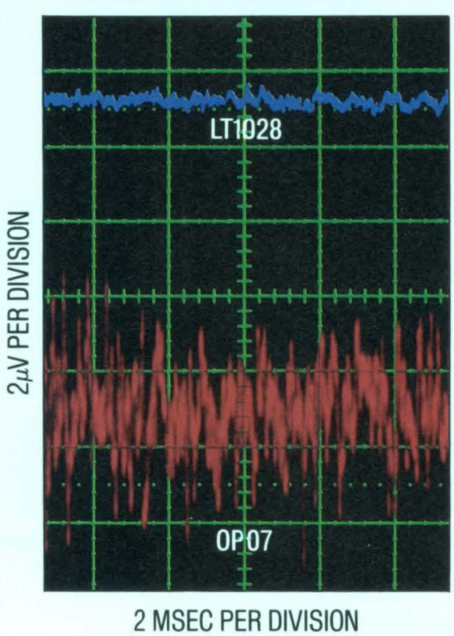

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CIRCLE NO 197

EDITED BY TARLTON FLEMING

Electronic thermometer has 10-mV/°F output

Bill Donofrio and Dennis R Bernard
Moore Research Ctr, Grand Island, NY

Using type-K thermocouple wire, you can build an inexpensive electronic thermometer that generates 10 mV/°F (**Fig 1**). Because type-K thermocouples are reasonably linear for the range of 0 to 660°C, you can obtain a moderately accurate temperature measurement for this range by adding a scaling voltage to the cold-junction reference voltage.

The 9V battery powers a bridge circuit in which the temperature sensor, IC_2, and the 2.5V reference, IC_3, provide a signal and reference voltage, respectively. You should place the cold-junction thermocouple close to the temperature sensor. Note that the chromel wires form secondary junctions where they attach to the circuit (nodes A and B). To avoid introducing dc errors, you should maintain these junctions at the same temperature by placing them close together. Bypass capacitors C_6 and C_7 guard against errors due to RF pickup.

Potentiometer R_5 produces a temperature-dependent scaling voltage, and the chopper-stabilized op amp, IC_1, amplifies (with a gain of 1001) the sum of the scaling and thermocouple voltages. As a result, the output V_T equals the sum of the thermocouple cold-junction voltage plus the scaling voltage (0.744 mV), divided by 0.0226. Potentiometer R_6 determines the 0.0226 figure.

To calibrate the circuit, first adjust R_4 for 2.554V across IC_3. Then adjust R_3 so the voltage across IC_2 equals 10 mV times the ambient temperature (in °K). Place the hot-junction thermocouple in a well-stirred mixture of crushed ice and water, and adjust R_5 so that the op-amp output (across R_6) equals 0.744V. To complete the calibration, adjust V_T to 0.32V using R_6. **EDN**

To Vote For This Design, Circle No 748

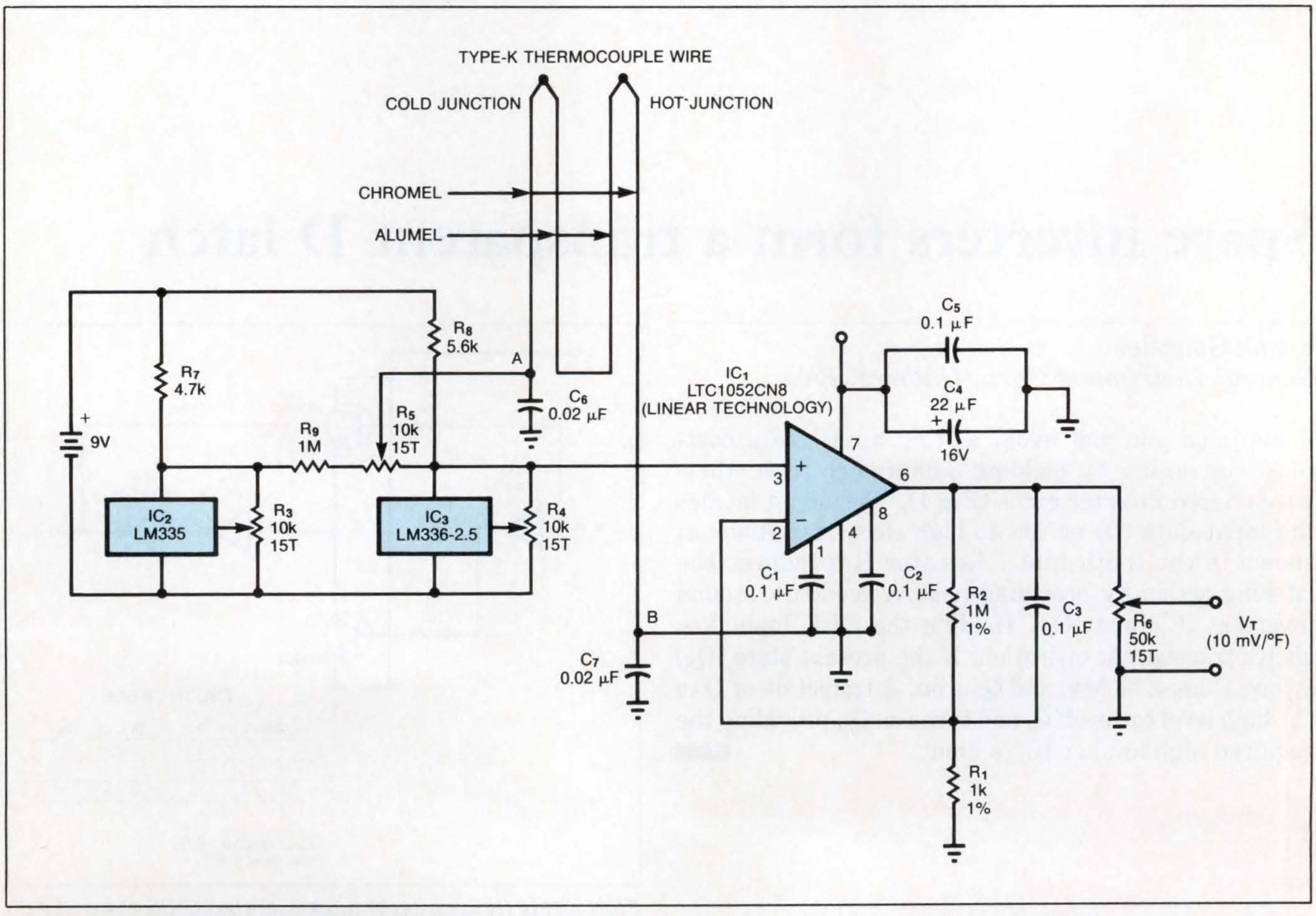


*Fig 1—**This circuit adds a linearizing voltage** to the thermocouple voltage and produces an output V_T of 10 mV/°F.*

Add two 16-bit pointers to the 8031 μP

Noor Singh Khalsa
EG&G Inc, Los Alamos, NM

Although Intel's 8031 μP has only one 16-bit pointer (DPTR), the device's page-mode addressing feature allows you to add two more. The 8031 restores any value on the P2 output port (the upper address byte) following each instruction fetch, so you can use the R0 and R1 registers for indirectly addressing memory in the current "page" selected by P2:

```
MOVX    A,@R0
MOVX    A,@R1
```

By dedicating two other registers (such as R6 and R7) for the upper address byte, you can form two 16-bit pointers, R6,R0 and R7,R1, for use in accessing the external memory **(Table 1)**. This technique does not affect the DPTR, so you can avoid the code space otherwise needed to save the 2-byte DPTR (two push instructions and two pop instructions). Because a subroutine call or an MOVX A, @DPTR instruction will modify the P2 value following an instruction fetch, you mustn't execute these instructions without restoring the P2 pointer value. **EDN**

TABLE 1—BLOCK-MOVE ROUTINE

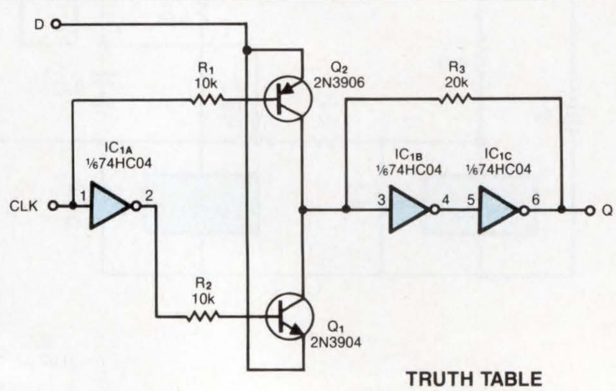
```
BLKMOVE: MOV   P2,R6          ; SELECT PAGE OF MEMORY
                              ; TO ACCESS
         MOVX  A,@R0          ; READ BYTE AT R6,R0
         MOV   P2,R7          ; CHANGE PAGE
         MOVX  @              ; STORE BYTE AT R7,R1
         INC   R0             ; INCREMENT SOURCE
                                POINTER
         INC   R1             ; INCREMENT DESTINATION
                                PTR
         DJNZ  R3,BLKMOVE     ; BYTE COUNT STORED IN R3
```

To Vote For This Design, Circle No 749

Spare inverters form a transparent D latch

Frank Gonzalez
General Instrument Corp, Hatboro, PA

Sometimes you can avoid adding an IC to a cost-conscious design by building a data latch with otherwise-unused inverter gates **(Fig 1)**. The circuit latches the input data (D) on low-to-high clock transitions as shown in the truth table. Resistor R_3 produces the latching action by providing positive feedback around inverters IC_{1B} and IC_{1C}. Holding the CLK input low allows transparent operation: If the present state (Q_N) is low, D must be low, and Q_1 is on. A transition of D to the high level turns off Q_1 and turns on Q_2, providing the required high level at IC_{1B}'s input. **EDN**



TRUTH TABLE

CLK	D	Q_P	Q_N
↑	0	0	0
↑	0	1	0
↑	1	0	1
↑	1	1	1

Q_P = PRESENT STATE
Q_N = NEXT STATE

Fig 1—This transparent D latch operates on the clock signal's rising edge. Operation is transparent when the CLK input is low.

To Vote For This Design, Circle No 750

Adders enable detection of multiple inputs

S Murugesan
ISRO Satellite Centre, Bangalore, India

The **Fig 1** circuit determines whether more than one input in a group of digital inputs is active. It is simpler and more versatile than an earlier idea ("Tree structure detects multiple inputs," EDN, February 19, 1987, pg 195): It provides a digital measure of the number of active inputs, and it allows you to establish a threshold for majority-decision applications (that is, whether the number of active inputs is more than, less than, or equal to a value between 1 and 15). You can monitor more inputs by cascading the adders.

Each binary adder, IC_1 and IC_2, forms two full adders (FAs). Each FA monitors three input lines and generates a 2-bit output representing the number of inputs active. IC_3 and IC_4, by summing the outputs of two FAs plus an input line, individually measure how many in a group of seven inputs is active. Similarly, by monitoring the 3-bit outputs of IC_3 and IC_4 plus one input, IC_5 measures how many in the group of 15 are active. The OR gate (IC_6) simply indicates whether more than one input is active. EDN

To Vote For This Design, Circle No 746

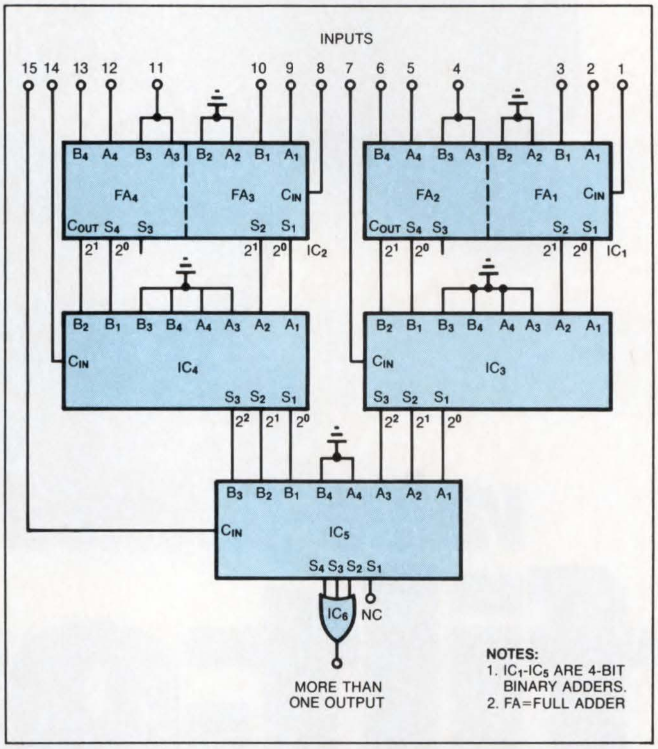


***Fig 1—By counting in parallel, these binary adders** determine the number of active inputs among a group of 15. The OR gate indicates whether more than one is active.*

Program aids resistive-divider calculations

Hugh M Adams
Rtronics Inc, Pensacola, FL

Listing 1 helps you solve the general problem shown in **Fig 1**: how to determine the maximum possible value for V_2 and the minimum possible value for V_1, given the expected minimum and maximum values for V_1 and the values and percent tolerances for R_1, R_2, and R_3. **Fig 2** shows a typical application for this network. The goal in this case is to choose optimum resistor values that will set the voltage regulator's output within the specified limits of 4.5 to 5.5V.

The regulator, IC_1, includes a voltage reference

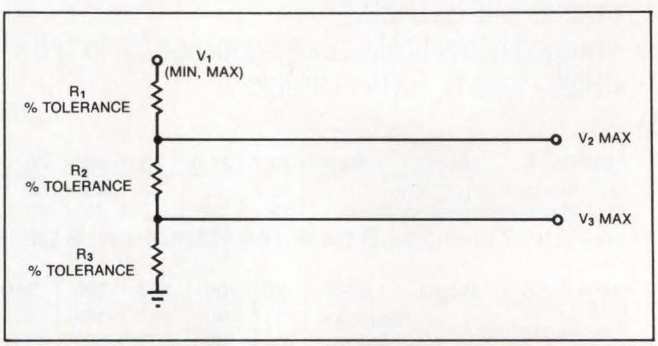


***Fig 1—This circuit illustrates the general problem that Listing 1** solves. You provide the V_1 minimum and maximum inputs, plus a value and tolerance for each of the resistors.*

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CIRCLE NO 241

whose output (pin 6) can have any value from 6.95 to 7.35V. You must choose reasonable values and tolerances for resistors R_1-R_3. After receiving these eight data items, the program takes less than five seconds to calculate the resulting values for V_2 max and V_1 min. You continue to alter the inputs and rerun the program until it produces satisfactory outputs, a procedure that typically takes 5 to 10 minutes. (Note that an LM723 regulator's reference should not deliver more than 1 mA. For that device, you should double the resistor values to 1.36 kΩ, 2 kΩ (the potentiometer), and 4.3 or 4.4 kΩ.) **Listing 1** is written in HP Basic, but the program is also available in True Basic for the IBM PC.

EDN

To Vote For This Design, Circle No 747

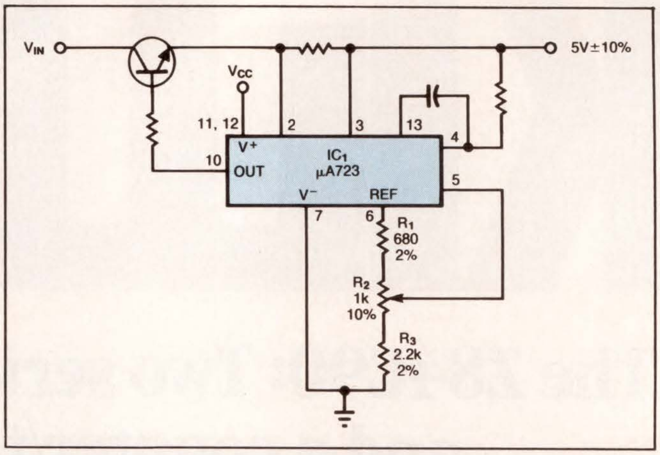


Fig 2—Using the Listing 1 program, *you can choose a combination of standard values and tolerances for resistors R_1-R_3 that will be nearly optimum for production.*

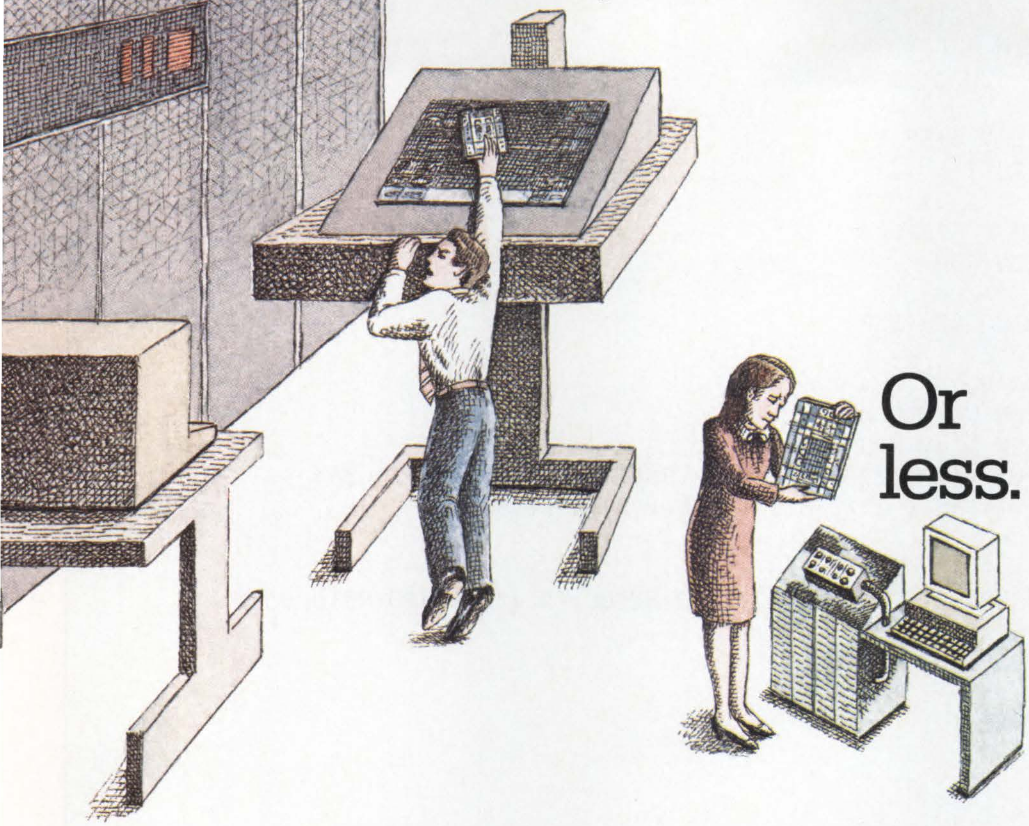
LISTING 1—RESISTIVE-DIVIDER PROGRAM

```
10 CLEAR
20 REM THREE RESISTOR DIVIDER PROGRAM
30 OPTION BASE 1
40 DISP "THIS PROGRAM AIDS IN SOLVING THE VOLTAGE DIVIDER PROBLEM"
50 DISP "FOR A DIVIDER HAVING THREE RESISTORS AND TWO INPUT VOLTAGE."
60 DISP
70 DISP
80 DISP "ENTER INPUT VOLTAGES V1MIN AND V1MAX";
90 INPUT V1MIN,V1MAX
100 DISP "ENTER R1,R1TOL(%)";
110 INPUT R1,R1TOL
120 DISP "ENTER R2,R2TOL(%)";
130 INPUT R2,R2TOL
140 DISP "ENTER R3,R3TOL(%)";
150 INPUT R3,R3TOL
160 DISP
170 DISP
180 R1L=R1*(1-R1TOL/100)
190 R1H=R1*(1+R1TOL/100)
200 R2L=R2*(1-R2TOL/100)
210 R2H=R2*(1+R2TOL/100)
220 R3L=R3*(1-R3TOL/100)
230 R3H=R3*(1+R3TOL/100)
240 DIM RM(8,3)
250 MAT RM=ZER
260 FOR W=1 TO 4
270 RM(W,1)=R1L
280 NEXT W
290 FOR W=5 TO 8
300 RM(W,1)=R1H
310 NEXT W
320 FOR W=1 TO 5 STEP 4
330 RM(W,2)=R2L
340 RM(W+1,2)=R2L
350 NEXT W
```

Listing continued on pg 244

You shouldn't buy more board tester than you need.

we never stop asking "What if..."



Now, you don't have to settle for too little or too much in a board tester. You can get one that's just right for you. From HP.

The HP 3065 family of board testers offers you flexibility. So you can get a system that fits your board mix, process, volume, and budget. Right now. And you can add capability or upgrade at any time to keep pace with your needs.

Our family begins with the HP 3065ST, our standard digital in-circuit tester starting under $100,000. And goes all the way to the HP 3065AT, one of the most advanced combinational testers on the market. You can combine controllers, test stations, and options for the exact system you need.

And no matter which you choose, you get software and fixture compatibility up and down the line. Networking with CAE/CAD workstations and simulators. Built-in analog functional instruments. A digital test library for 4,500 devices.

You get something else, too: HP experience in ATE dating back to 1975, with more than 85 service offices and 2,000 in-circuit testers installed worldwide. Plus, product reliability backed by our exclusive 99% Guaranteed Uptime Program.*

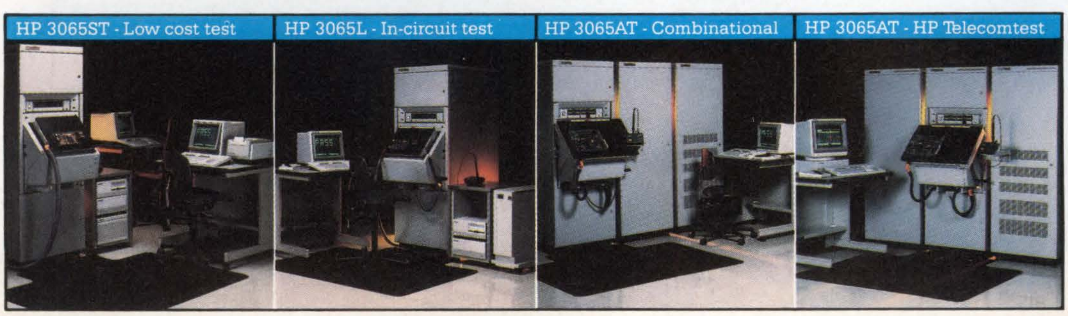
It all means better value for you. And, because our board test family offers systems at each level of price/performance, you buy just what you need . . . no more and no less.

Call HP today for a *free* videotape!

For a free videotape on the HP board test family, or more information, call 1-800-634-TEST (in Colorado, call collect: 303-669-9325.)

HEWLETT PACKARD

CIRCLE NO 195



*Some restrictions apply.

LISTING 1—RESISTIVE-DIVIDER PROGRAM *(Continued)*

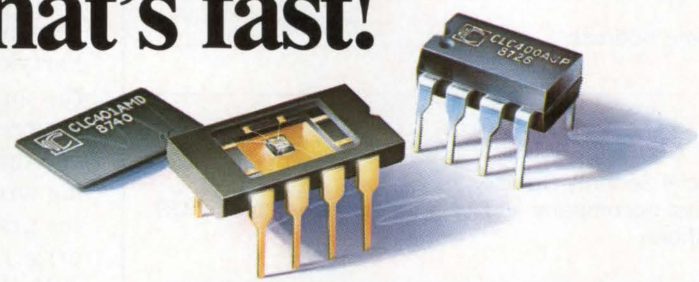
```
360 FOR W=3 TO 7 STEP 4
370 RM(W,2)=R2H
380 RM(W+1,2)=R2H
390 NEXT W
400 FOR W=1 TO 7 STEP 2
410 RM(W,3)=R3L
420 NEXT W
430 FOR W=2 TO 8 STEP 2
440 LET RM(W,3)=R3H
450 NEXT W
460 DIM V2A(8,2),V3A(8,2)
470 FOR J=1 TO 2
480 FOR I=1 TO 8
490 IF J=1 THEN V1=V1MIN
500 IF J=2 THEN V1=V1MAX
510 V2A(I,J)=V1*((RM(I,2)+RM(I,3))/(RM(I,1)+RM(I,2)+RM(I,3)))
520 V3A(I,J)=V1*(RM(I,3)/(RM(I,1)+RM(I,2)+RM(I,3)))
530 NEXT I
540 NEXT J
550 DISP "R1=";R1;R1TOL;"%";"R2=";R2;R2TOL;"%";"R3=";R3;R3TOL;"%"
560 DISP
570 DIM V2B(16),V3B(16)
580 W=0
590 FOR J=1 TO 2
600 FOR I=1 TO 8
610 W=1+W
620 V2B(W)=V2A(I,J)
630 V3B(W)=V3A(I,J)
640 NEXT I
650 NEXT J
660 FOR X=1 TO 15
670 LET SW=0
680 FOR K=16 TO X+1 STEP -1
690 IF V2B(K-1)<=V2B(K) THEN 740
700 SW=1
710 TM=V2B(K-1)
720 V2B(K-1)=V2B(K)
730 V2B(K)=TM
740 NEXT K
750 IF SW=0 THEN 770
760 NEXT X
770 DISP "V2MIN=";V2B(1)
780 FOR X=1 TO 15
790 SW=0
800 FOR K=16 TO X+1 STEP -1
810 IF V3B(K-1)<=V3B(K) THEN 860
820 SW=1
830 TM=V3B(K-1)
840 V3B(K-1)=V3B(K)
850 V3B(K)=TM
860 NEXT K
870 IF SW=0 THEN 890
880 NEXT X
890 DISP "V3MAX=";V3B(16)
900 END
```

Because you're thinking fast...

you need responsive suppliers as well as fast parts. Comlinear is tuned in. With high quality, high speed products. Assistance from R&D-level applications engineers to help develop your ideas quicker. Sales and distribution that get you what you need fast. Quality product documentation with guaranteed specs so you don't waste time. In your business, time is everything. Count on us for the speed you need.

Introducing monolithic op amps with 10ns settling times and 150-200MHz bandwidths.

That's fast!



Now, only from Comlinear, monolithic op amps with incredible high-speed, fast-settling performance.

Our new 200MHz CLC400 is designed for low-gain applications (±1 to ±8) and settles in a mere 10ns to 0.1%. For gains greater than 7, choose our 150MHz CLC401, with the same 10ns settling time. Both feature low power (150mW), low distortion, stability without compensation, plus overload and short circuit protection. They're ideal as flash A/D drivers and D/A current-to-voltage converters, or in video distribution and line driving applications.

Our experience in high speed amplifiers now brings you monolithic op amps with numbers like you've never had before. A new dimension in performance is now available for your analog designs.

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CIRCLE NO 193

Design Entry Blank

$75 Cash Award for all entries selected by editors. An additional $100 Cash Award for the winning design of each issue, determined by vote of readers. Additional $1500 Cash Award for annual Grand Prize Design, selected among biweekly winners by vote of editors.

To: Design Ideas Editor, EDN Magazine
Cahners Publishing Co
275 Washington St, Newton, MA 02158

I hereby submit my Design Ideas entry.

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Company ______________________

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Social Security Number ______________
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In submitting my entry, I agree to abide by the rules of the Design Ideas Program.

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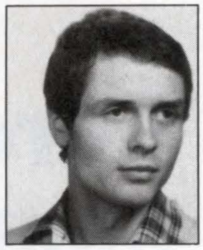
Date ______________________

Your vote determines this issue's winner. All designs published win $75 cash. All issue winners receive an additional $100 and become eligible for the annual $1500 Grand Prize. **Vote now,** by circling the appropriate number on the reader inquiry card.

ISSUE WINNER

The winning Design Idea for the February 4, 1988, issue is entitled "Zero-current sensor protects relay contacts," submitted by B Erik Valeur of Electronic Instrument & Specialty Corp (Stoneham, MA).



Winning Idea improves upon earlier design

Andrzej Partyka's Design Idea, "Frequency divider generates 50% duty cycle," is the 1987 Design Idea of the year, and Mr Partyka is the recipient of the $1500 cash award that goes along with it. The Design Idea originally appeared in the September 3, 1987, issue of EDN, but Mr Partyka got the inspiration for his winning idea from an earlier issue of EDN.

As he read Irwin Cohen's entry, "Divider produces symmetrical output" in EDN's January 23, 1986, issue, he realized, "it could be done better." According to Mr Partyka, his approach to obtaining a 50% duty cycle has the advantage of being more elegant and easier to comprehend. In addition, his solution is more general, and therefore more applicable. (Of course, there's nothing wrong with Mr Cohen's Design Idea—it didn't win the grand prize, but it did garner the $75 issue-winner prize.)

Mr Partyka currently lives in New Jersey, but he grew up and went to school in Poland. He attended Silesian Polytechnic Institute in the city of Gliwice in southern Poland. In 1981 he received a BS in electronics, and in 1982 he earned an MS in the same discipline. Shortly thereafter he moved to New Jersey and began working for Blonder Tongue Labs, where he was involved in voice and television signal coding. He now works in Syosset, NY, for Ademco, a company that specializes in security hardware and servicing. Mr Partyka was hired to work on long-range radio communications, but he's also interested in bandwidth-efficient and spread-spectrum data communications.

Outside of the sphere of electronics, Mr Partyka's interests lie in the area of music. He enjoys listening to classical music in particular. Despite his claims that, because he doesn't play an instrument, he isn't an artist, it's obvious that he is creative. All of the editors at EDN congratulate you, Mr Partyka, for winning the 1987 Design Idea grand prize.—*Clare Mansfield*

Packaged Systems

Control Point

Test and Control Systems Product News from Ziatech

Spring 1988 **Ziatech Corporation**

Inside Control Point

Page Two
New Packaged STD Bus Computer

The new ZT 300 from Ziatech is a packaged STD Bus computer with an NEC V20 Single Board Computer and STD DOS. This industrial computer is available in several versions, with networking and GPIB capabilities.

Page Three
New STD Mass Storage Subsystems

Ziatech has introduced microfloppy, Winchester, and Bubble Memory units that integrate controller and drive while fitting into an STD Bus card cage.

Page Four
New GPIB SBC and Software

A new single board GPIB computer and a new easy-to-use software driver are Ziatech's latest GPIB products.

MEMBER STDMG STD MANUFACTURER'S GROUP

New Industrial Computer Serves Test and Control Applications

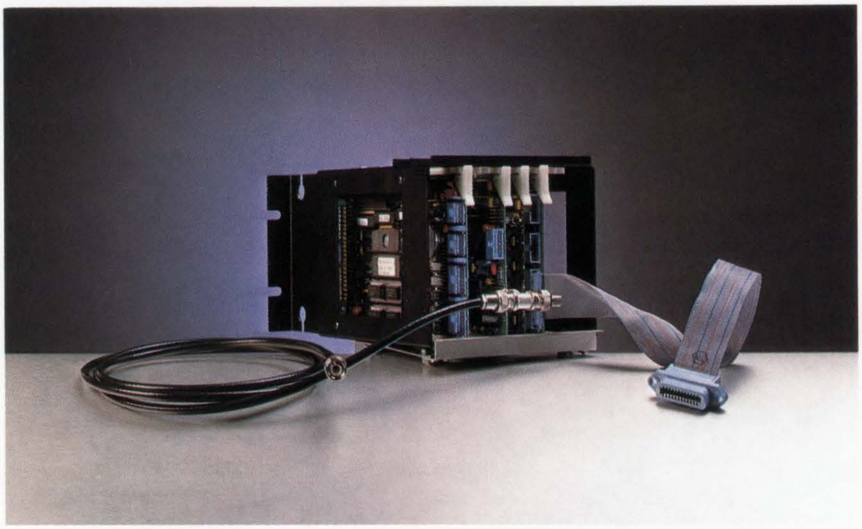
The ZT 300 Industrial Computer is the first of a series of packaged IBM-compatible STD Bus systems from Ziatech. Ziatech's family of packaged systems will be on display at Control Expo, June 7-9, at the O'Hare Exposition Center, Rosemont, IL. (For more information on the ZT 300, see page 2 and/or check box A on the return card.)

ZT 300 Model 6 Computer Features

- NEC V20 Processor
- STD DOS
- Microfloppy and Winchester disk support
- STD-8088 and IBM XT compatibility
- Monitor and keyboard
- 19" rack-mounted card cage with power supply
- Network model
- IEEE 488 option
- Processor, I/O and enclosure options

ZIATECH CORPORATION

New Packaged STD Bus Computer Family Integrates Many Ziatech Products



The ZT 300-IB Remote Computer is both a remote node on Ziatech's Z-NET industrial network and a NEC V20-based GPIB controller. This model lets other nodes on a network remotely control IEEE 488 instruments attached to the ZT 300-IB RC.

The New ZT 300 Industrial Computer from Ziatech is a packaged IBM-compatible STD Bus system for industrial control and testing applications.

NEC V20 SBC

The new computer is available in three models. The Model 5 features an NEC V20-based single board computer with STD DOS in firmware, leaving 15 user slots in the system's rack-mounted card cage/power supply. The Model 6 (see photo, page one) includes the same features plus a monitor, keyboard, integrated microfloppy and hard disk drives, with eight user slots.

STD Network Capability

The third model is called the ZT 300 Remote Computer. It is packaged in a smaller card cage for use as a remote network node in Z-NET, a local industrial network for Ziatech STD DOS-based systems. Based on the ARCNET protocol and ViaNet software, the ZT 300 RC is designed for embedded industrial networks where its ability to be remotely controlled from a supervised node is important.

The ZT 300 At A Glance

- NEC V20 SBC
- STD DOS
- Network Model
- IEEE 488 Option
- IBM XT and STD-8088 Compatibility
- Processor, I/O options

IEEE 488 Capability

For instrumentation applications, all the ZT 300 models are available in an IEEE 488 (GPIB) configuration. This option includes an IEEE 488 interface and a software of choice (four available).

The combination of the ZT 300 RC and the IEEE 488 interface results in a powerful instrument controller that expands the geographic limitations of GPIB control. In this configuration, other nodes on a network can control the instruments attached to the ZT 300-IB RC. This is accomplished through GPIB calls directly to a GPIB device driver on the ZT 300-IB RC node. While the limit of GPIB control is normally 20 meters, Ziatech's Z-NET LAN provides access to instruments up to four miles away.

System Development

STD DOS system development for the ZT 300 is available in two versions. The ZT 300 Model 6 provides stand alone development capability with an IBM-compatible monitor and keyboard connected directly to the STD DOS system. The PC-Assisted (PCA) version (Model 5) is the most cost-effective configuration because it utilizes a user's PC for its console and mass storage requirements.

Ziatech's unique Virtual System Console (VSC) simplifies PC-assisted development by enabling the PC console to switch from control of the PC to the serially-connected STD system at the touch of a key. With VSC, the PC disks and other resources are transparently accessible to the STD system.

Expanded Memory and Multiprocessing Option

Among the many options to the ZT 300 computer is the ZT 8825 Extended Memory System, an STD Bus memory unit that provides the ZT 300 with large solid state disks or expanded main memory.

Multiprocessing, via the ZT 8830 Intelligent Control Processor is another powerful option available on the ZT 300 to increase its I/O performance in demanding situations.

For more information on the ZT 300, check box A on the return card.

New Floppy, Winchester and Bubble Mass Storage for STD Bus

The first fully integrated disk drive subsystems for STD DOS industrial computers are now available from Ziatech Corporation. The ZT 8856 Integrated Microfloppy Disk Drive, the ZT 8857 Integrated Hard Disk Drive, and the ZT 8858 Integrated Bubble Memory Drive provide mass storage support to Ziatech's STD DOS systems in the form of compact, modular units that are plugged directly into the STD Bus backplane.

Modular Units Plug into STD Bus Backplane

The new peripheral units require no cabling or assembly by the user, and are well suited to industrial OEM applications that require easy user interfacing, debugging, and maintenance.

The integration of the disk controller and disk drive into a single unit also significantly improves system MTTR (Mean-Time-To-Repair).

720 Kbyte Microfloppy

The ZT 8856 Integrated Microfloppy Disk Drive is a completely self-contained controller and 3 1/2" microfloppy disk drive, with 720 Kbyte storage capacity. It features push-button ejection and reliable, double-sided recording.

20 Mbyte MicroWinchester

The ZT 8857 Integrated Hard Disk Drive is a self-contained controller and a microWinchester hard disk with 20 Mbyte capacity. The ZT 8857 includes an SCSI controller, 2 Kbyte dual-ported FIFO data buffer, and self-diagnostic capabilities.

720 Kbyte Bubble Memory

The ZT 8858 Integrated Bubble Memory Drive combines a Ziatech disk controller with a Magnesys bubble memory drive and a removable data cartridge in a single modular unit. Offered in a 720 Kbyte industrial strength configuration, the ZT 8858 is a good substitute for microfloppy disk drives in environments too harsh for conventional disk media.

Bubble memory is most effective for applications involving high temperature, humidity, and vibration. A real-time data collection system for earth-moving vehicles is one example of an application where the ZT 8858 was the only workable solution.

Ziatech also offers separate microfloppy, microWinchester and bubble memory disk drives that are designed to be used with Ziatech's ZT 8850 STD Bus Disk Controller, and are plugged into the STD Bus backplane separately.

For more information on Ziatech's integrated disks, check box B on the return card.

The ZT 8856 Integrated Microfloppy Disk Drive and ZT 8857 Integrated Winchester Disk Drive are self-contained modular units providing mass storage to STD DOS systems.

About Control Point

Control Point is a bimonthly newsletter published by Ziatech Corporation for OEMs and system integrators designing industrial automation and instrumentation applications.

Control Point examines the new products, applications, and issues in today's test and control industries.

Ziatech Corporation, established in 1976, manufactures STD Bus-based computers, development and operating systems for the STD Bus, and IEEE 488 interfaces for MULTIBUS, STD Bus and personal computer systems.

For more information on Ziatech STD Bus and IEEE 488 products, return the Control Point Postcard, or call Ziatech at 805-541-0488.

ZIATECH
CORPORATION

New Software Driver for GPIB Interfaces

EZ.488, a new software driver from Ziatech, supports Ziatech's IEEE 488 interfaces for the IBM Personal System/2 (ZT/2), IBM and compatible PCs (ZT 1444/1488A), and STD Bus Systems (ZT 8847/8848).

Easy-to-use driver

This new driver is Ziatech's most general purpose approach and easiest to use. Initially installed into PC DOS/MS DOS and automatically loaded at system start-up time, EZ.488 allows the user to access IEEE 488 interfaces at a high level through any language. The EZ.488 syntax is comparable to the HP 85 instrument controller when using BASIC.

Ziatech offers two other types of software driver support to simplify the implementation of microcomputer-based test and measurement systems.

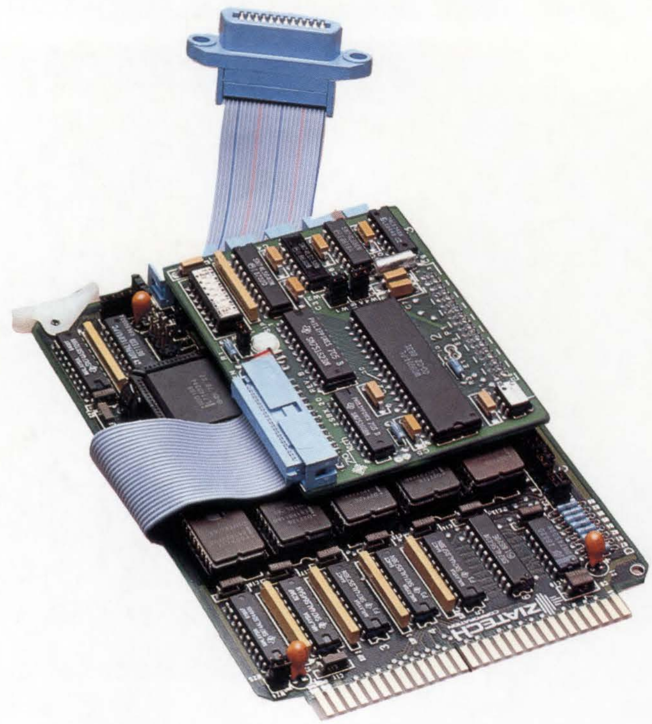
INSTALL.488

INSTALL.488 is an installable driver like EZ.488, but offers more efficient language interfaces for C, Pascal, FORTRAN, and Assembly. It also allows existing application software written for IBM and National Instruments GPIB interfaces to work with Ziatech hardware.

LINK.488

LINK.488 drivers are linked directly to the user's application code, without the overhead of an operating system. This makes for even more efficient IEEE 488 operation and the highest performance. LINK.488 drivers support several versions of C, Pascal, and Assembly languages. Both controller and talker/listener versions are available.

For more information on EZ.488 and Ziatech's IEEE 488 product line, check box C on the return card.



Ziatech's SBC-IB Single Board GPIB Computer

New Single Board GPIB Computer

Ziatech's new SBC-IB combines the 16-bit processing power of an 80188-based STD Bus single board computer (SBC) with complete IEEE 488 (GPIB) hardware and software capability.

For Test Systems and Instruments

Designed for OEMs and end users building GPIB test systems and embedded instrument controllers, the SBC-IB is available in three models. The Model 14 uses the ZT 8814 SBC with the 80188 at 5 MHz. The Model 15 uses the ZT 8815 SBC with the 80188 at 8 MHz, while the Model 30 gives GPIB capabilities to Ziatech's ZT 8830 Intelligent Control Processor.

Low Cost, Small Package

All the SBC-IB models are ideally suited for applications requiring real-time performance and high-speed programmable GPIB I/O. The SBC-IB provides these features at a low cost and in a very small package.

Software Support

Application software can be developed for the SBC-IB using Ziatech's Level 1 Development System. Two software driver packages are also available to simplify the implementation of GPIB instrument control: a talker/listener driver set for use in embedded device applications, and a controller set for controlling other instruments and devices.

For more information on the SBC-IB, check box D on the return card.

ZIATECH CORPORATION
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San Luis Obispo, CA 93401 USA
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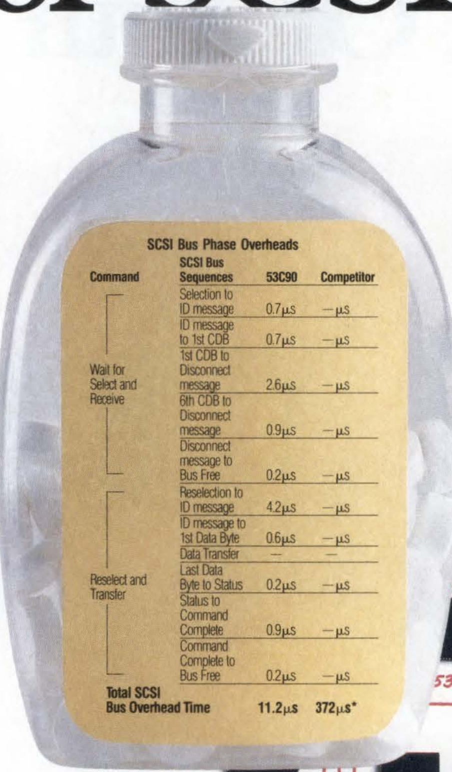
CIRCLE **120** ON INQUIRY CARD

NCR keeps raising the standards for SCSI.



SCSI Bus Phase Overheads

Command	SCSI Bus Sequences	53C90	Competitor
Wait for Select and Receive	Selection to ID message	0.7μs	—μs
	ID message to 1st CDB	0.7μs	—μs
	1st CDB to Disconnect message	2.6μs	—μs
	6th CDB to Disconnect message	0.9μs	—μs
	Disconnect message to Bus Free	0.2μs	—μs
Reselect and Transfer	Reselection to ID message	4.2μs	—μs
	ID message to 1st Data Byte	0.6μs	—μs
	Data Transfer	—	—
	Last Data Byte to Status	0.2μs	—μs
	Status to Command Complete	0.9μs	—μs
	Command Complete to Bus Free	0.2μs	—μs
Total SCSI Bus Overhead Time		**11.2μs**	**372μs***

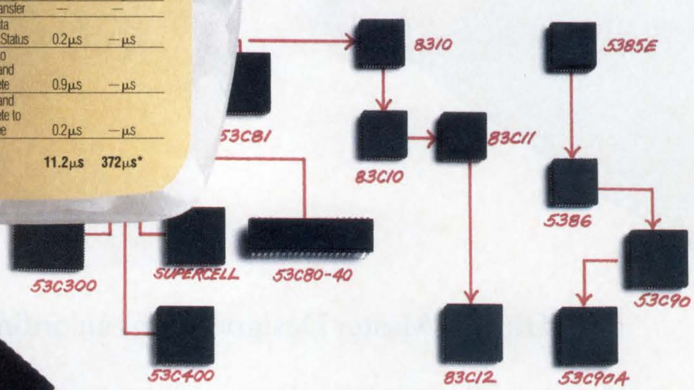
Finally, a cure for SCSI overheadaches.

NCR's 53C90 is the only chip that can give you fast, fast, fast relief from overheadaches. Using combination commands, dedicated sequential logic and dual-ranked registers for command pipelining, the 53C90 is quickest on and off the bus. Plus NCR implements complex bus sequencing in hardware, not time-wasting software.

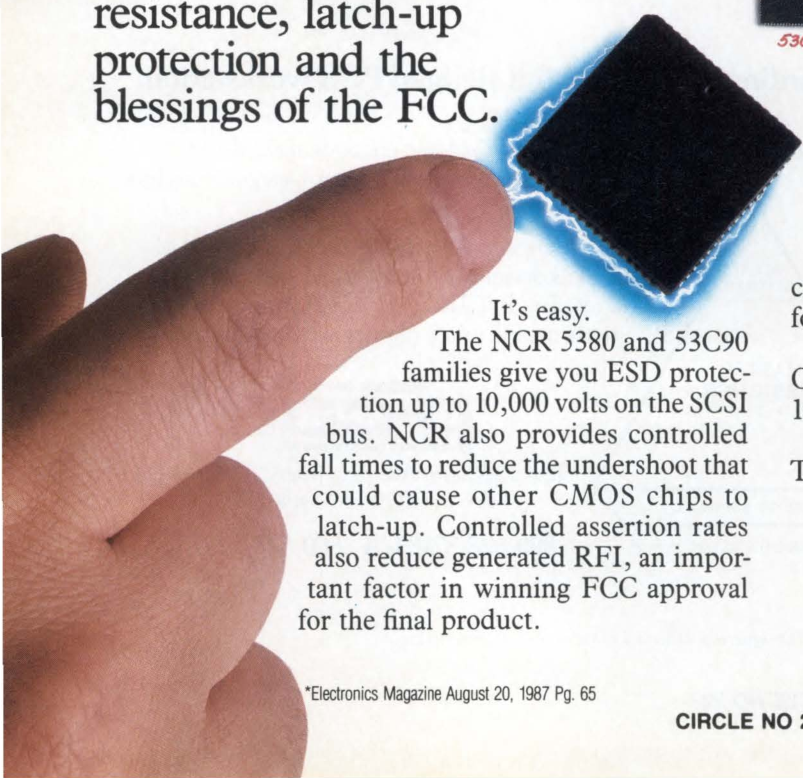
Transfer rates? NCR's 53C90 delivers the SCSI bus maximum of 5.0 MBytes/sec synchronous and 3MBytes asynchronous at 25MHz for the full length of the bus.

A big, well-connected family.

NCR's family goes back to the "Mayflower" of SCSI controllers with the 5385 in 1982. The most recent offshoot–the high-performance 53C90A. Other family members include a single chip host bus adapter (53C400), an integrated buffer controller (53C300) and even an ASIC supercell for circuit designers. Plus we'll be there with SCSI II.



How to get zap-resistance, latch-up protection and the blessings of the FCC.



It's easy.

The NCR 5380 and 53C90 families give you ESD protection up to 10,000 volts on the SCSI bus. NCR also provides controlled fall times to reduce the undershoot that could cause other CMOS chips to latch-up. Controlled assertion rates also reduce generated RFI, an important factor in winning FCC approval for the final product.

Raise your standards.

Because our chips have an edge in technology, they can help give you an edge in the market. So don't settle for the standard, call NCR today.

For documentation call our hot line 1-800-334-5454. Or write to, NCR Microelectronics, SCSI Products, 1635 Aeroplaza Drive, Colorado Springs, CO 80916.

For technical assistance, call 1-800-525-2252, Telex 452457.

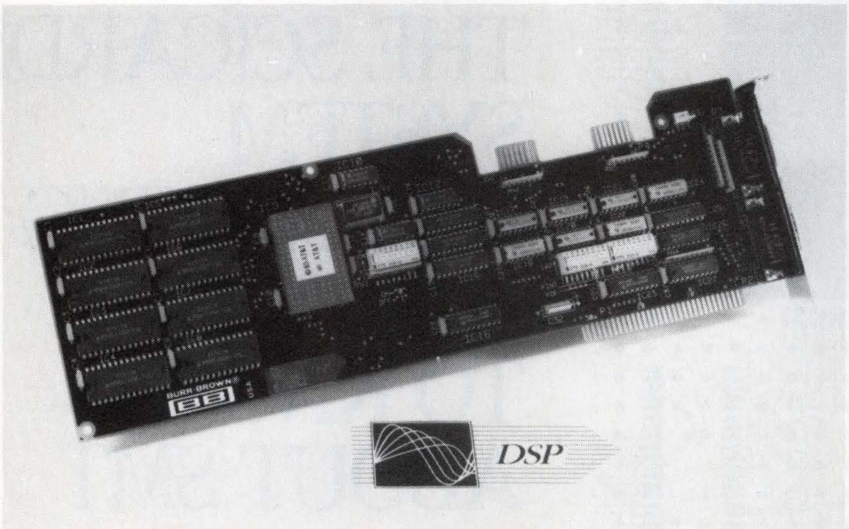
NCR

NCR Microelectronics Division

*Electronics Magazine August 20, 1987 Pg. 65

CIRCLE NO 221

COMPUTERS & PERIPHERALS



DSP BOARD

- *Based on AT&T's DSP32 digital signal processor*
- *Software includes a C compiler operating under MS-DOS*

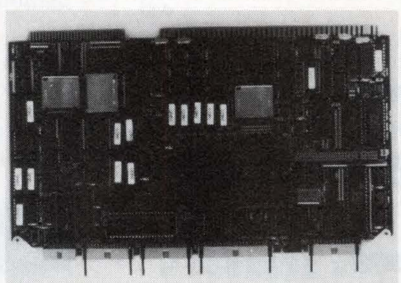
The DSPeed digital signal-processing board for the IBM PC contains an AT&T WE DSP32 floating-point processor, 64k bytes of RAM, and buffered serial I/O ports. It can implement FIR (finite impulse response) filters at a rate of 250 nsec/tap and perform a 1024-point complex FFT in 20 msec. The board transfers data across the parallel IBM PC bus or over a high-speed serial bus. By using the multiple-arithmetic-unit architecture and pipeline data processing available in the WE DSP32 chip, the board can do floating-point calculations at a rate of 8 million/sec. AT&T support tools include an assembler/linker, a simulator, and a C compiler operating under MS-DOS. The simulator is a debugging facility that allows access to all registers and memory. $995.

Burr-Brown Corp, Applications Engineering, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491.

Circle No 370

1-BOARD COMPUTER

- *Uses an 8-MHz 80286 with memory management for Multibus*
- *100% software compatible with Intel's SBC 286/12*



The CD21/8286 single-board computer with 2M or 4M bytes of zero-wait-state, dual-port RAM is designed for an 8-MHz 80286 μP. The Multibus board provides memory management and is 100% software compatible with Intel's SBC 296/12. It includes interfaces for an 80287 coprocessor, an 82258 DMA controller supporting three direct and eight multiplexed channels, four serial I/O channels, a synchronous or asynchronous LBX interface, and an SBX connector. It also includes two 28-pin EPROM sockets, a parallel I/O port, programmable timers, and Multibus interface and priority interrupt logic. One of the four I/O ports can be configured as either an RS-232C or an RS-422/449 port. RMX86 and RMX286 operating systems are available. 2M-byte version, $2035; 4M-byte version, $2980 (100).

Central Data Corp, 16023 Newton Dr, Champaign, IL 61821. Phone (800) 482-0315; in IL, (217) 359-8010. TWX 910-245-0787.

Circle No 371

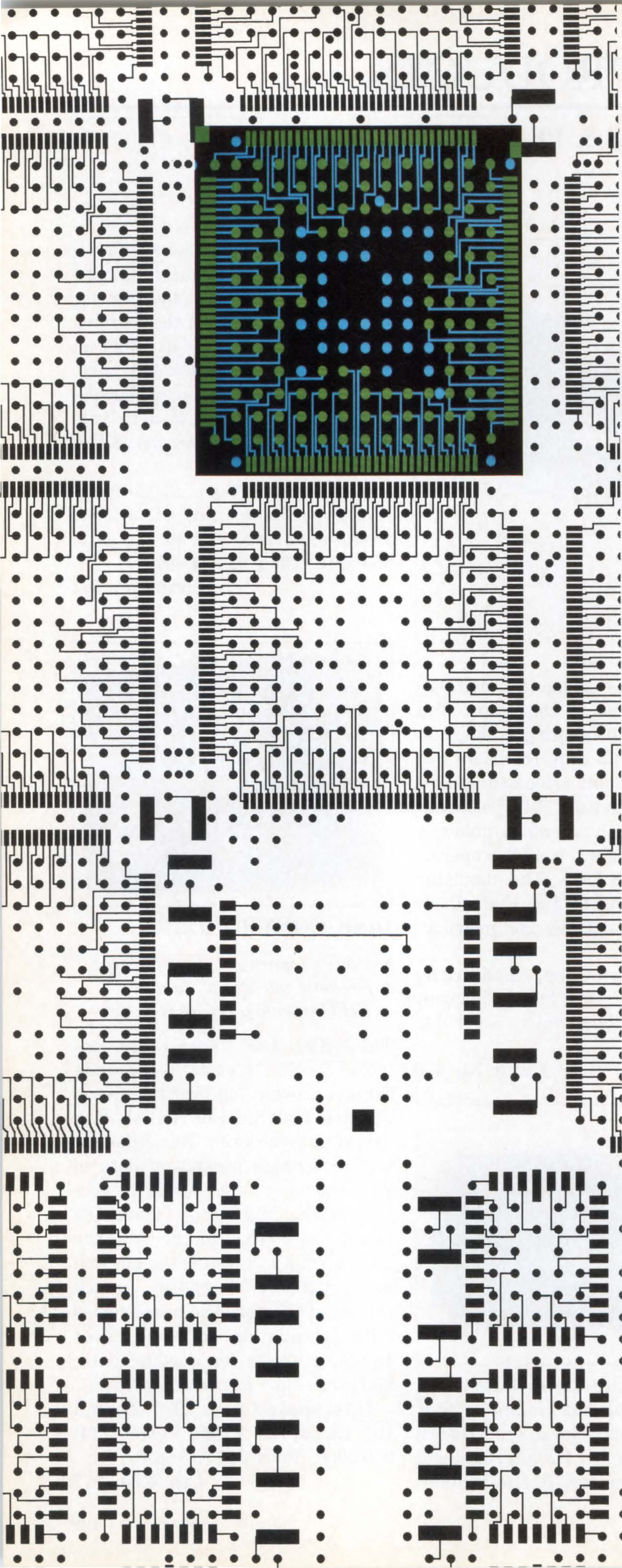
DISK CONTROLLER

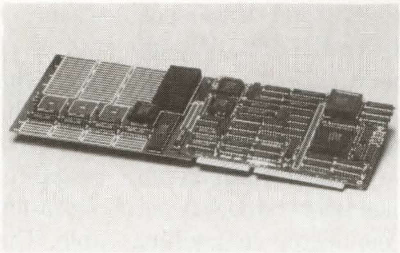
- *For Sun workstation interfaces*
- *Formats packets of data in FIFO memory before transfer*

The V/SMD 4400 Phoenix disk controller for Sun workstations and file servers provides an interface for as many as four SMD or SMD-E disk drives. A proprietary Buspacket interface formats packets of data in FIFO memory before acquiring control of the VME Bus. Once the board has control of the bus, the FIFOs empty as fast as the bus and memory allow, followed by a quick release of the bus. The board comes with installation software, boot ROMs, a driver for queuing data, and a run-time formatter. $3350.

Interphase Corp, 2925 Merrell Rd, Dallas, TX 75229. Phone (214) 350-9000. TWX 910-997-6245.

Circle No 372





GRAPHICS BOARD

- *Based on National's Advanced Graphics Chip Set*
- *Reaches 1600×1280-pixel resolution, using IBM PC/AT*

Based on National's Advanced Graphics Chip Set, the Ultra 2000BW graphics board for the IBM PC/AT achieves a standard viewable resolution of 1600×1280 pixels, expandable to 2048×1536 pixels. It also handles addressable resolutions of 2048×2048 pixels/plane. The board can support as many as three additional memory planes that are stored off screen. According to the vendor, it has a 160M pixel/sec fill rate, an 80M pixel/sec bit/blt (bit-block transfer) rate, and a 10M-pixel/sec draw rate in any direction with solid or patterned lines, as well as 128k bytes of EPROM and 2M bytes of program memory. Standard unit with 1600×1280-pixel resolution, $1595.

Informations Now Inc, 6915 Hightech Dr, Midvale, Utah 84047. Phone (801) 561-1100. TLX 4992230.

Circle No 373

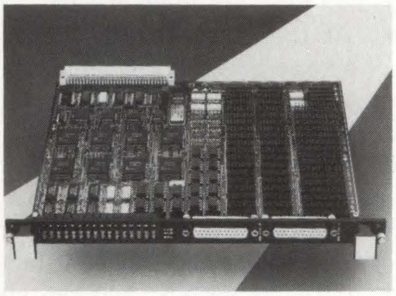
MODEM

- *Complies with CCITT V.33 and V.29 standards*
- *Uses trellis-coded modulation and features error correction*

The 2362 leased-line modem complies with the CCITT V.33 and V.29 standards. It operates at speeds from 4800 to 14.4k bps. When the modem is in V.33 operating mode, the data rates are 14.4k bps and 12k bps. At these speeds, the modem uses error-correction coding and an 8-state trellis-coded modulation to provide 99.99% error-free transmission. When the modem operates in V.29 mode, the data rates are 9600, 7200, and 4800 bps. The unit employs quadrature amplitude modulation and V.29 speeds. You can obtain an optional 4- or 6-channel time division multiplexer (TDM), all of whose channels feature asynchronous to synchronous conversion. You can obtain the modem as a stand-alone unit or in a card version, and you can also order an enclosure that accommodates as many as 16 modem cards. Stand-alone unit, $3195; card version, $2915; 4-channel TDM unit, $3795; 6-channel TDM unit, $3995.

Codex Corp, Maresfield Farm, 7 Blue Hill River Rd, Canton, MA 02021. Phone (617) 364-2000.

Circle No 374



SERIAL I/O BOARD

- *Provides 16 serial I/O ports for VME Bus systems*
- *Has drivers for the OS-9/68000 operating system*

The VME-68500-SI double-Eurocard VME Bus board provides 16 independent serial I/O ports that conform to either the RS-232C, RS-423, and V.24 specifications or to the RS-422, RS-485, and V.11 specifications. Employing the RS-485 capability, you can use the board to configure low-cost LANs over more than 1000m of cable. Each port connects to a 25- or 15-pin D connector via a ribbon cable. The leadout via these ribbon-cable connections matches the DTE (data-terminal equipment) or DCE (data-communication equipment) pinouts of the relevant EIA and ISO standards. You can mount 25-pin D connectors via the board's front panel. Front-panel LEDs indicate TX-data and RX-data activity, as well as the "busy" status of each serial port. Software drivers for use under the OS-9/68000 operating system are available. DM 2480.

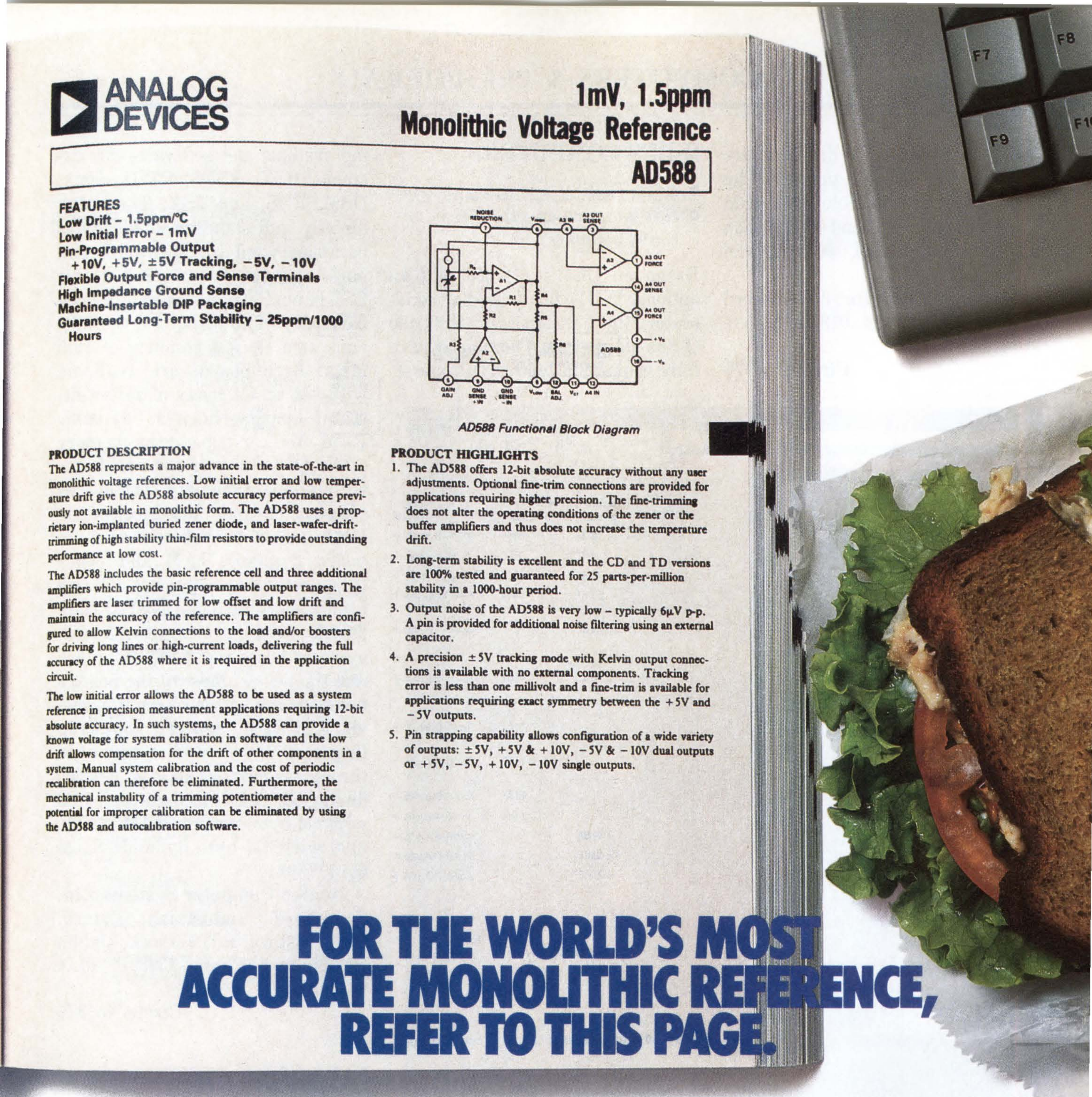
EKF Elektronik GmbH, Weidekampstrasse 1A, 4700 Hamm 1, West Germany. Phone (02381) 12630. TLX 828621.

Circle No 375

PRINTERS

- *Print 200 cps in draft-quality dot-matrix mode*
- *Perform line, block, and dot-character graphics*

The Models 4/20 and 4/21 dot-matrix printers provide draft-quality printing at 200 cps. The Model 4/20 is an 80-column printer, and the Model 4/21 is a 136-column printer. They accomplish letter-quality printing at 40 cps and perform line, block, and dot-character graphics. Variable character sizes and double-width horizontal spacing are standard features, along with variable line spacing under DIP-switch control. The dot-graphics resolution is 240 dots/in. horizontally and 72 dots/in. vertically. Twenty fonts are resident on



ANALOG DEVICES

1mV, 1.5ppm Monolithic Voltage Reference

AD588

FEATURES
- Low Drift – 1.5ppm/°C
- Low Initial Error – 1mV
- Pin-Programmable Output
  +10V, +5V, ±5V Tracking, −5V, −10V
- Flexible Output Force and Sense Terminals
- High Impedance Ground Sense
- Machine-Insertable DIP Packaging
- Guaranteed Long-Term Stability – 25ppm/1000 Hours

AD588 Functional Block Diagram

PRODUCT DESCRIPTION

The AD588 represents a major advance in the state-of-the-art in monolithic voltage references. Low initial error and low temperature drift give the AD588 absolute accuracy performance previously not available in monolithic form. The AD588 uses a proprietary ion-implanted buried zener diode, and laser-wafer-drift-trimming of high stability thin-film resistors to provide outstanding performance at low cost.

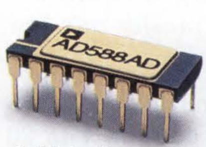
The AD588 includes the basic reference cell and three additional amplifiers which provide pin-programmable output ranges. The amplifiers are laser trimmed for low offset and low drift and maintain the accuracy of the reference. The amplifiers are configured to allow Kelvin connections to the load and/or boosters for driving long lines or high-current loads, delivering the full accuracy of the AD588 where it is required in the application circuit.

The low initial error allows the AD588 to be used as a system reference in precision measurement applications requiring 12-bit absolute accuracy. In such systems, the AD588 can provide a known voltage for system calibration in software and the low drift allows compensation for the drift of other components in a system. Manual system calibration and the cost of periodic recalibration can therefore be eliminated. Furthermore, the mechanical instability of a trimming potentiometer and the potential for improper calibration can be eliminated by using the AD588 and autocalibration software.

PRODUCT HIGHLIGHTS

1. The AD588 offers 12-bit absolute accuracy without any user adjustments. Optional fine-trim connections are provided for applications requiring higher precision. The fine-trimming does not alter the operating conditions of the zener or the buffer amplifiers and thus does not increase the temperature drift.
2. Long-term stability is excellent and the CD and TD versions are 100% tested and guaranteed for 25 parts-per-million stability in a 1000-hour period.
3. Output noise of the AD588 is very low – typically 6μV p-p. A pin is provided for additional noise filtering using an external capacitor.
4. A precision ±5V tracking mode with Kelvin output connections is available with no external components. Tracking error is less than one millivolt and a fine-trim is available for applications requiring exact symmetry between the +5V and −5V outputs.
5. Pin strapping capability allows configuration of a wide variety of outputs: ±5V, +5V & +10V, −5V & −10V dual outputs or +5V, −5V, +10V, −10V single outputs.

FOR THE WORLD'S MOST ACCURATE MONOLITHIC REFERENCE, REFER TO THIS PAGE.



If the voltage references you've been using have forced you to choose between low initial error and low drift, we'd like to refer you to our new AD588. With only 1mV of initial offset and 1.5ppm/°C of drift over temperature, it offers the best absolute accuracy possible in a monolithic reference.

This exclusive combination provides a range of user-programmable voltage outputs. You can choose from single +10V, +5V, −10V, and −5V ranges, simultaneous outputs of +10V and +5V, or −10V and −5V, or even a ±5V tracking range.

All of this is available with typical long-term stability of 15ppm, with selected versions tested for 1,000 hours and certified to be less than 25ppm. And you can get the AD588 for about half the cost of similar hybrid or in-house designs. Prices start at $12.75 in 100s, to be exact.

For the most accurate reference on the AD588, call Applications Engineering at (617) 935-5565, Ext. 2628 or 2629. Or write to Analog Devices, P.O. Box 9106, Norwood, MA 02062-9106.

ANALOG DEVICES

Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (303) 590-9952; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094; Washington: (206) 251-9550; Austria: (222) 885504; Belgium: (3) 237 1672; Denmark: (2) 845800; France: (1) 4687-34-11; Holland: (1620) 81500; Israel: (052) 28995; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 31 57 60; United Kingdom: (932) 232222; West Germany: (89) 570050

CIRCLE NO 219

plug-in cartridges or disk and are downloaded into the printer. The printers are compatible with IBM graphics printers and the Epson FX-80. Model 4/20, $645; Model 4/21, $899.

Honeywell Bull Inc, 300 Concord Rd, Billerica, MA 01821. Phone (617) 671-2517.

Circle No 376

Q-BUS COMPUTERS

- *Runs PDP-11 operating system*
- *Has as much as 4M bytes of onboard memory*

Based on DEC's J11 μP and an optional FPJ11 floating-point accelerator, the SBCM80 and SBCM90 Q-bus single-board computers are fully compatible with PDP operating systems and software—for example, RSX, RSTS, RT-11, Unix, DSM, BOS, and TSX. They plug directly into standard 22-bit Q-bus backplanes and are downward compatible with the 16- and 18-bit LSI-11 bus. The M80 runs at a clock frequency of 15 MHz, and the M90 runs at a clock frequency of 18.5 MHz. Both boards are available with 1M to 4M bytes of zero-wait-state, parity-checked dynamic RAM. You can expand the memory of the 1M-byte versions to 4M bytes with off-board memory. The boards support normal- and block-mode DMA transfers between the onboard dynamic RAM and other Q-bus modules. Additional onboard facilities include four DLV11-J compatible serial I/O lines, space for 32k bytes of bootstrap EPROM, and a real-time clock. Most of the board's functions are software configurable via EEPROM, and the bootstrap firmware allows you to sequence through as many as six boot devices during system initialization. M80 with 1M-byte dynamic RAM, £2500; M90 with 4M-byte dynamic RAM £5150 (50).

Mentec Computer Systems Ltd, Sandyford Industrial Estate, Leopardstown Rd, Foxrock, Dublin 18, Ireland. Phone 952316. TLX 93309.

Circle No 377

PARALLEL SYSTEM

- *Processes data at 4 to 20 MIPs*
- *Bus has a data-transfer rate of 100M bytes/sec*

The Multimax 310 modular parallel-processing system delivers 4 to 20 MIPS. You can configure the system, using 16M to 64M bytes of shared memory, a streaming cartridge-tape drive, and from 300M bytes to 4.8G bytes of disk capacity. According to the manufacturer, its Unix-based UMax 4.2 and UMax V operating systems allow the 310 to take full advantage of the power of parallel processing. An entry-level

Grayhill shrinks the I/O module

to save you space, money, and problems

This new series of space-saving I/O modules for control applications measures 0.40″ deep and 1.00″ high, compared to 0.60″ and 1.25″ for "standard" models, and reduces the length of a 16-module rack by 4 inches! (The wide side is the same 1.70″ as standard modules, for plug compatibility.)

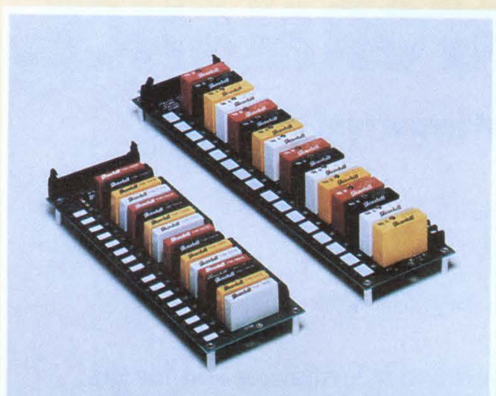
Grayhill mini-modules consume 30% less power than their big brothers, and offer immunity from false triggering caused by electrical transients (per IEEE-472). Using SMT construction, Grayhill shrinks the package, yet upgrades performance even compared to its own standard modules, much less anyone else's. AC output units have lower leakage current, DC output units offer faster switching, and AC input modules have a higher input impedance.

The new mini-modules come in all standard configurations, at pricing comparable to standard-size I/O modules.

They plug into 16 module racks without screws; a hold-down strip keeps them in place. Surface-mount LEDs with writing space provide status and function indication.

Using the new modules saves you cost at least four ways—you use a smaller rack, a smaller power supply, a smaller enclosure, and you save the labor of screwing modules into place. And you get better performance besides.

What else could you ask for? How about local availability from Grayhill distributors worldwide! You get that too. So now your next step is send or call for free literature. Do it today.



COMPARISON CHART

PHYSICAL CHARACTERISTICS	STANDARD I/O MODULES	MINI I/O MODULES
Module dimensions	0.60″x1.70″x1.25	0.40″x1.70″x1.00
16-position rack length	14″	10″
Installation	Individual screw-down	Hold-down strip
ELECTRICAL CHARACTERISTICS		
Power consumption/ module-AC output	18 milliamps	12 milliamps
Pass IEEE-472	No	Yes
Switching speed—DC output	75 μs turn on 500 μs turn off	20 μs turn on 40 μs turn off
Input impedance—AC input	14K Ohm (120 VAC) 45K Ohm (240 VAC)	22K Ohm (120 VAC) 60K Ohm (240 VAC)

Grayhill INC.
561 Hillgrove Avenue, P.O. Box 10373
LaGrange, Illinois 60525-0373 USA
Phone: (312) 354-1040 FAX: (312) 354-2820
TLX or TWX: 190254 GRAYHILL LAGE

configuration, which operates at 4 MIPS, includes 16M bytes of memory, 300M bytes of disk capacity, a tape cartridge, and an Ethernet interface. An 11-slot Nanobus backplane transfers data at 100M bytes/sec. The modular parallel-processing boards are based on National's NS32032 and NS32332 μPs, which can support as many as 200 users. From $89,000 to $500,000. Delivery, 60 days ARO.

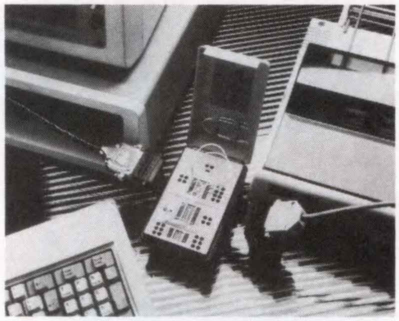
Encore Computer Corp, 257 Cedar Hill St, Marlborough, MA 01752. Phone (617) 460-0500.

Circle No 378

BREAKOUT BOX

- *Monitors 15 RS-232C lines with red and green LEDs*
- *Data lines illuminate the LEDs*

The Easy Bob Model 725 breakout box for monitoring RS-232C lines has two 3-in. ribbon cables with



dual-gender DB25 connectors for easy insertion into an RS-232C line. The box monitors 15 lines with red and green LEDs. Positive voltages illuminate the red LEDs, and negative voltages illuminate the green LEDs. One spare LED set (red and green) is positioned at the top center of the unit to monitor lines other than those with dedicated LEDs. You can enable the 25 monitor points, using 25 DIP switches—one for each line of the connector. Each point has a socket which accepts a jumper wire to configure different interconnections. The unit requires no power or batteries; the voltage on the data lines illuminates the LEDs. It comes complete with jumper wires and an operator's manual. $99.

Beckman Industrial Corp, 3883 Ruffin Rd, San Diego, CA 92123. Phone (619) 495-3224.

Circle No 379

CONTROLLER BOARD

- *For IBM PS/2, Models 50, 60, 80, and compatibles*
- *Provides 10M-byte/sec DMA transfer rate*

You can use the ACB-2610 controller board for the ST412/506 MFM hard-disk-controller board with the IBM PS/2 Models 50, 60, 80, or a compatible computer. It features 1:1 sector interleaving and a host DMA transfer rate of 10M bytes/sec. The board runs with MS-DOS, OS/2, Xenix,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and Unix operating systems. At the heart of the controller is the company's AIC-011 programmable media sequencer and the AIC-6225 bipolar monolithic data separator. The board has a data-to-disk transfer rate of 5M bps with full-track buffering and a read-ahead cache. An optional 8k-, 32k- or 64k-byte buffer is available. $160 (1000).

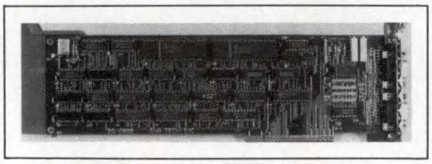
Adaptec Inc, 580 Cottonwood Dr, Milpitas, CA 95035. Phone (408) 432-8600.

Circle No 380

RS-422A BOARD

- *Fit in IBM's PS/2 Models 50, 60, and 80 computers*
- *Two serial ports have data rates from 50 to 256k baud*

The DS-2000 communications board for the IBM PS/2 Models 50, 60, and 80 has two independent RS-422A interfaces. Balanced-line serial drivers and receivers provide communications to a limit of 4000 ft. D-9 connectors provide noise rejection when communications occur through shielded cables. A 16550 asynchronous communications element, containing a UART and a programmable baud-rate generator, controls each port. The transmission rate of each interface is individually programmable from 50 to 256k baud. The address and the interrupt used by each port are selectable. The possible addresses include COM1 through COM8, and the possible interrupts include IRQ3, IRQ4, IRQ7, and IRQ9. $395.



Qua Tech Inc, 478 E Exchange St, Akron, OH 44304. Phone (216) 434-3154. TWX 510-101-2726.

Circle No 381

68020 COMPUTERS

- *192 users at a time can use Unix System V-type system*
- *Mountable in 19-in. industry-standard racks*

As many as 192 users can log onto the System 22 and System 22E 25-MHz 68020 computers at the same time. The systems run the C-XIX 3.0 operating system, the company's enhanced multiprocessor version of AT&T's Unix System V, Rel 3.0. The System 22 has 4M bytes of parity-checked RAM and is expandable to 96M bytes; the System 22E has 4M bytes of RAM with error-correction code and is expandable to 128M bytes. Using from one to 10 modules, you can expand the systems to achieve computing power as high as 32 MIPS. The systems also include a file I/O processor, a 180M-byte Winchester disk, a 60M-byte cartridge tape, a Centronics parallel port, a SCSI port, and an

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Phone 507-289-3371
TWX #9105652374
FAX #507-287-3405

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See us at the Electro Show, Booth #1456-1458.

CIRCLE NO 217

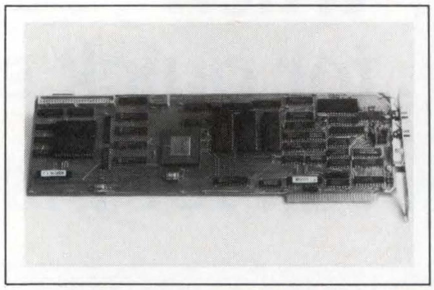
Ethernet port. The systems support bit-mapped graphics displays, using 68020 display processors. A 17-user System 22, $19,000; a 70-user System 22E, $56,000.

Counterpoint Computers, 2127 Ringwood Ave, San Jose, CA 95131. Phone (408) 434-0190. TLX 856884.

Circle No 382

DEVELOPMENT BOARD

- *For Analog Devices' ADSP-2100 digital signal processor*
- *System comes with a debug monitor and simulator*



The ADSP-2100 development system for the IBM PC, PC/XT, PC/AT, and compatible computers can develop software for the Analog Devices' ADSP-2100 Digital Signal Processor. It comes with a debug monitor and Analog Devices' Cross-Software and Simulator. The board comes with 8k×24 bits of program memory that has a 45-nsec access time. The program memory is expandable on board to 32k×24 bits, and the data memory is 8k×16 bits expandable off board to 16k×16 bits. Both memories are dual-ported to the PC. The system includes a 200-kHz, 12-bit A/D converter and a D/A converter. The converters can be clocked externally or from an onboard 16-bit timer running at 4 MHz. The debug monitor controls all of the board's functions, providing memory-access commands, register examination, breakpoints, and a Help facility. ADSP-2100, including PC plug-in board, debug monitor, documentation and Cross-Software and Simulator, $2995; without Cross-Software and Simulator, $2595.

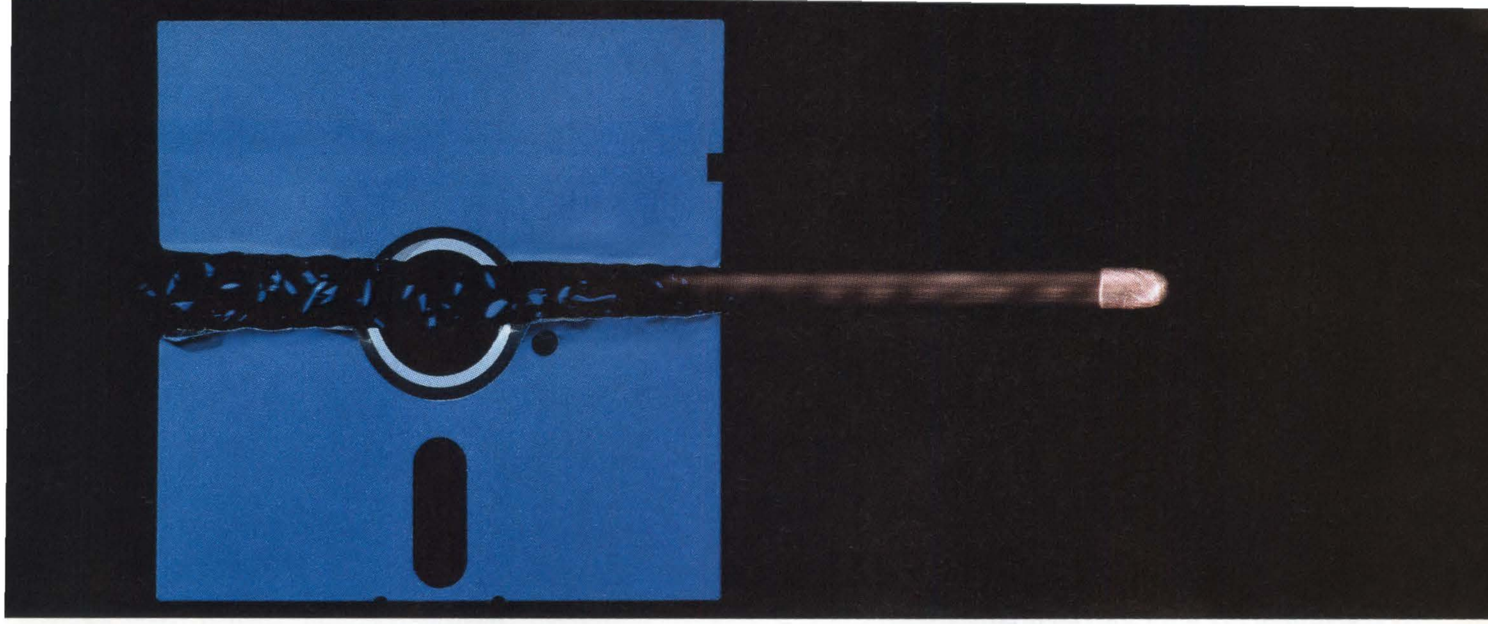
Spectrum Signal Processing Inc, 460 Totten Pond Rd, Waltham, MA 02154. Phone (800) 323-1842; in MA, (617) 890-3400.

Circle No 383

TRANSPUTER BOARDS

- *Provide parallel processing for DEC MicroVax computers*
- *Compatible with Inmos' Micro-VMS tool-set software*

Using the QT0 and QT4 Q-bus-compatible Transputer boards, you can add the parallel-processing power of Transputer arrays to MicroVax computers. The QT0 contains a single IMST212 Transputer that provides a bridge between the Q-bus and four Transputer links. Each link appears to the VAX as a separate



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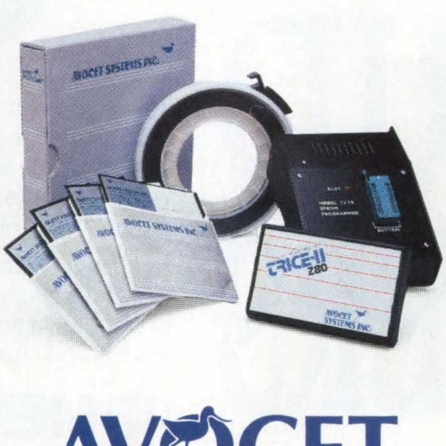

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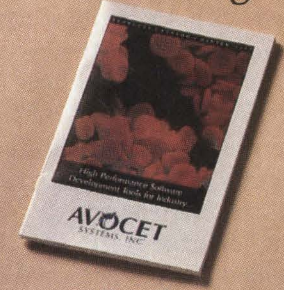

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CIRCLE NO 216

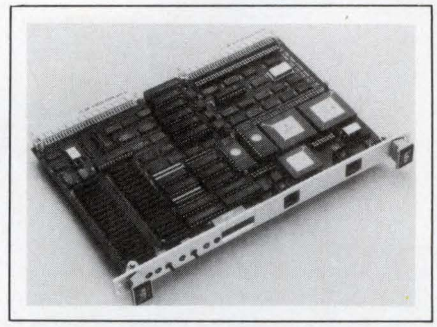
DEC-standard device; DMA accesses over the Q-bus are accomplished via dual-port buffers. The Transputer links operate at data rates of 5M, 10M, or 20M bytes/sec. The IMST212 Transputer provides local intelligence for each link with independent subsystem control. The board comes with device-driver software and benchmark applications. Linked to the VAX via the QT0's Transputer links, one or more QT4 boards allow you to configure a Transputer array with the required topology. Each board houses as many as four IMST414 or four IMST800 32-bit Transputers, each provided with 1M byte of dynamic RAM. You can select the cycle time of the Transputers, and the board will accept the Inmos IMST800-30 Transputer without modification. To create a multiuser program-development environment, you can use the boards with the Inmos stand-alone Occam Micro-VMS tool set. QT0 £1795; QT4 with IMST414 Transputer £3995.

Caplin Cybernetics Corp Ltd, 47 Cannon Drive, London E14 9SU, UK. Phone 01538 1716. Fax 01-538 4151.

Circle No 384

32-BIT CPU BOARD

- *25-MHz 68020 CPU and 1M byte of RAM for VME Bus*
- *Real-time processor with memory protection*



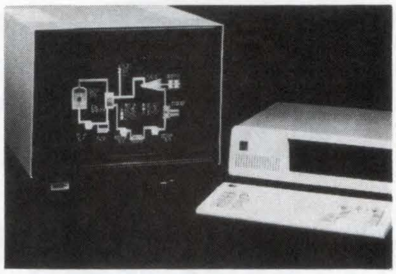
The MZ 7122 32-bit CPU board for the VME Bus features a 25-MHz 68020 CPU, 1M byte of dual-ported RAM with parity, as much as 128k bytes of EPROM, two RS-232C ports, and a time-of-day clock with battery backup. It has a 32-bit master/slave interface to the VME Bus along with an interrupt handler, an interrupt generator, a mailbox interrupt, and controller functions with 4-level arbitration. Its options include a VSB memory expansion interface, a 68851 paged-memory-management unit, and a 68881 or 68882 floating-point coprocessor. Software support for the board includes VRTX/32 Real-Time Executive from Ready Systems, OS-9 from Microware Systems, and PDOS from Eyring Research. $2695.

Mizar Inc, 1419 Dunn Dr, Carrollton, TX 75006. Phone (800) 635-0200; in TX, (214) 446-2664. TWX 510-600-4272.

Circle No 385

EGA MONITOR

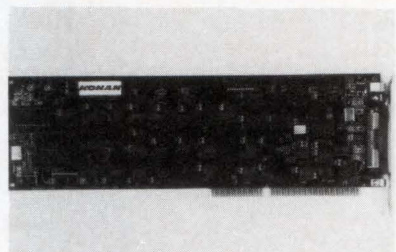
- *Provides automatic sync from 20 to 33 kHz*
- *Preconverged CRT has trio dot pitch of 0.31 mm*



The EG2040 Model 1 19-in. monitor for the IBM PC/AT and compatible computers runs with an IBM EGA card or compatibles; it adjusts to resolutions from 640×350 to 640×480 pixels as well as other resolutions in the 20- to 33-kHz range. The preconverged CRT has a trio dot pitch of 0.31 mm. The vertical scan frequency ranges from 40 to 100 Hz. The video bandwidth is 65 MHz and the user controls include power, brightness, and degaussing. The TTL inputs provide a color palette of 16 out of 64 colors. The monitor is available in a 19-in. metal enclosure or a RETMA standard 19-in. rack mount. From $1587.

Colorgraphic Communications Corp, Box 80448, Atlanta, GA 30366. Phone (404) 455-3921.

Circle No 386



DISK CONTROLLER

- *Achieves average access time of 3 msec*
- *Host-to-controller transfer rate is 4M bytes/sec*

The Ten Time caching disk controller for the IBM PC, PC/AT, and compatible computers contains a cache RAM with battery backup that controls as many as two ST506/412 disk drives, achieving an average disk access time of 3 msec. The board also controls two floppy-disk drives. The caching algorithm produces 90 to 95% hits in most applications. Consequently, the effective transfer rate of all data requests is 4M bytes/sec. A zero-latency read allows the drive to start reading and transferring data immediately, regardless of which data sector the head lands on. $595.

Konan Corp, 4720 S Ash Ave, Tempe, AZ 85282. Phone (602) 345-1300.

Circle No 387

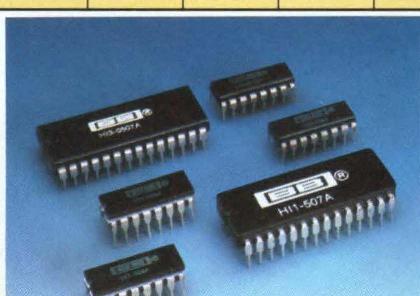
Now it's safe to switch HI-506A-HI-509A MUXs.

MODEL	HI3-0506A-5	HI1-0506A-5	HI1-0506A-2	HI3-0507A-5	HI1-0507A-5	HI1-0507A-2	HI3-0508A-5	HI1-0508A-5	HI1-0508A-2	HI3-0509A-5	HI1-0509A-5	HI1-0509A-2
Channels												
Single Ended	16	16	16				8	8	8			
Differential				8	8	8				4	4	4
Temp Range (°C)	0/+75	0/+75	−55/+125	0/+75	0/+75	−55/+125	0/+75	0/+75	−55/+125	0/+75	0/+75	−55/+125
Package	28-Pin Plastic DIP	28-Pin CERDIP	28-Pin CERDIP	28-Pin Plastic DIP	28-Pin CERDIP	28-Pin CERDIP	16-Pin Plastic DIP	16-Pin CERDIP	16-Pin CERDIP	16-Pin Plastic DIP	16-Pin CERDIP	16-Pin CERDIP
Price	$13.50	$14.75	$28.69	$13.50	$14.75	$28.69	$7.35	$8.25	$17.35	$7.35	$8.25	$17.35

Drop-in replacements
Our new CMOS analog multiplexers are identical, drop-in replacements for the "other" HI-506A series parts. Same performance. Same pin-outs. Same dielectric isolation. Same circuit behavior. Same model numbers and data sheets.

Proven quality, fast delivery
We make these MUXs completely, from silicon to stock. We control production and quality throughout to make sure you get the parts you need when you need them.

*U.S. unit prices, in 100s.



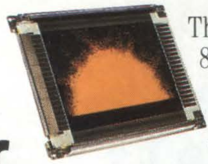
Key HI-506A/509A Features
- input overvoltage protection to 70Vp-p
- ±15V signal range
- break-before-make switching
- 3.5μs max settling time (0.01%)

Call us today for samples and quotes. Contact our nearest sales office or Applications Engineering, 602/746-1111. Burr-Brown Corp., P.O. Box 11400, Tucson, AZ 85734.

BURR-BROWN®

CIRCLE NO 214

ONCE YOU'VE SEEN FUJITSU'S AC PLASMA DISPLAY, YOU'LL TAKE A DIM VIEW OF ANYTHING ELSE.



The only way our bright new 8050 display looks anything like the others is through a pair of sunglasses.

That's because the 8050 is without a doubt the brightest, most readable display in its class.

It's the first 10-inch, AC-memory, flat panel display to deliver 640 x 400 resolution with an extraordinary 44 foot-lamberts of brightness. Along with a contrast ratio of greater than 20:1. All in a package just over one inch thick.

In fact, the only thing more impressive than these numbers is looking at the display yourself. Then you'll really appreciate its exclusive solid black background. And the brightness and flicker-free clarity of text and graphics.

And what's truly amazing is that you'll get this remarkable performance under some of the worst possible conditions. Like bright sunlight. And viewing angles up to 120 degrees.

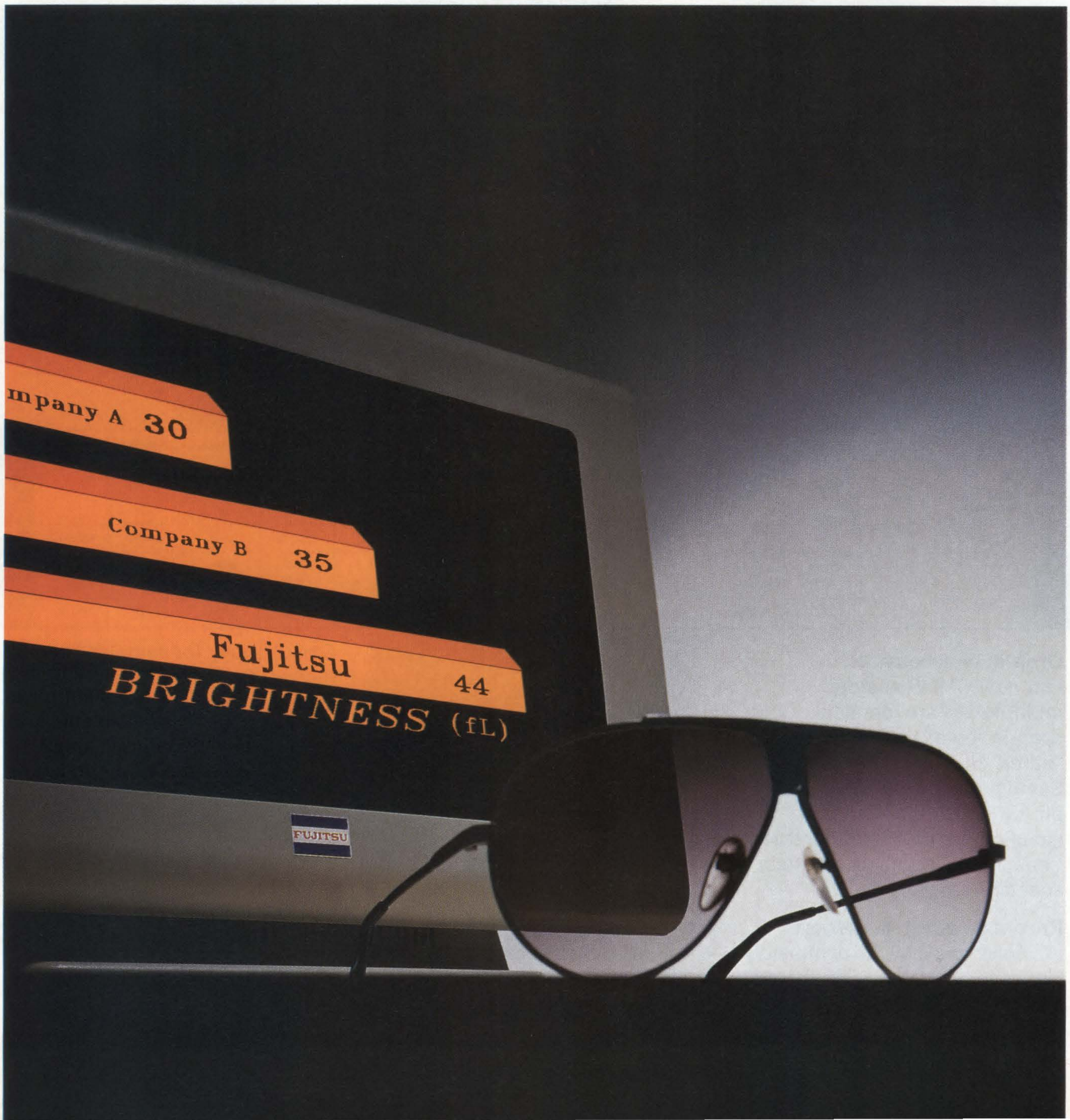
So if your application calls for the clearest images with maximum contrast, call us today at **1-800-556-1234, Ext. 238.** Inside California call, **1-800-441-2345, Ext. 238.** Or write Fujitsu Component of America, Inc., 3330 Scott Boulevard, Santa Clara, CA 95054-3197.

We'll brighten your day.

CIRCLE NO 225

FUJITSU

FUJITSU
COMPONENT OF AMERICA, INC.



NEW PRODUCTS

COMPONENTS & POWER SUPPLIES

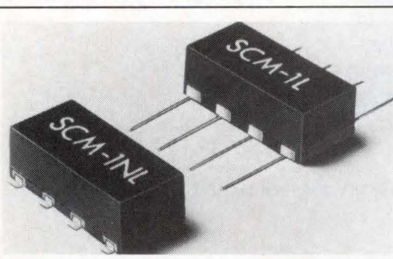
PROCESS INDICATOR

- *Combines alarm and indicator in one unit*
- *Accepts a wide range of process-level input signals*

The Model 40235 is designed for applications where both an alarm and an indicator light are needed in the same panel space. Standard features include a metal ⅛-DIN case, a 0.56-in. LED display, 12 or 24V dc outputs for driving external transducers or 2-wire current transmitters, a relay output rated for 8A at 115V ac, and screw-terminal wiring connections. You can select common process-level signal inputs, such as 4- to 20-mA, 1 to 5V, or 0 to 10V. You can also choose the display offset (within ±2000 counts) and the full-scale spans (10 to 2000). An extra right-hand digit (dummy zero) is available when needed to display in a count-by-10 mode. Front-panel controls include pushbutton setpoint display and setting, deadband range (0.1 to 10% of span), and zero and span adjustments. $249.

Extech Instruments Corp, 150 Bear Hill Rd, Waltham, MA 02154. Phone (617) 890-7440.

Circle No 390



RF MIXERS

- *Operate from 1 to 500 MHz*
- *−55 to +100°C temperature range*

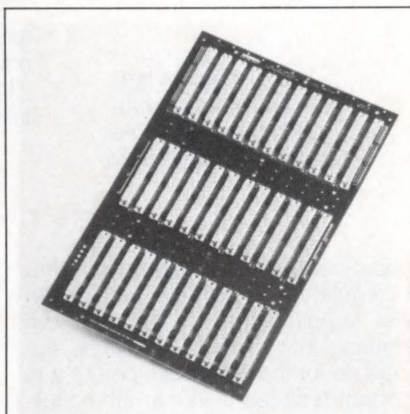
Offering a 1- to 500-MHz operating range, SCM-1 RF mixers work with a 7-dBm local-oscillator (LO) output and have a 6-dB conversion loss. LO to RF and LO to IF isolation measure 45 and 40 dB, respectively. The 1-dB compression point is 1 dBm. Two versions are available; the SCM-1L with leads, and the SCM-1NL without leads. Both have solder connections on the edge to improve soldering reliability. Each unit is housed in a nonhermetic plastic-ceramic package that measures 0.8×0.4×0.3 in. Operating range is −55 to +100°C. $2.49 (1000).

Mini-Circuits Lab, 2625 E 14th St, Brooklyn, NY 11235. Phone (718) 934-4500.

Circle No 391

BACKPLANE

- *Compatible with both VME and Sun card cages*
- *Features a combined microstrip and stripline design*



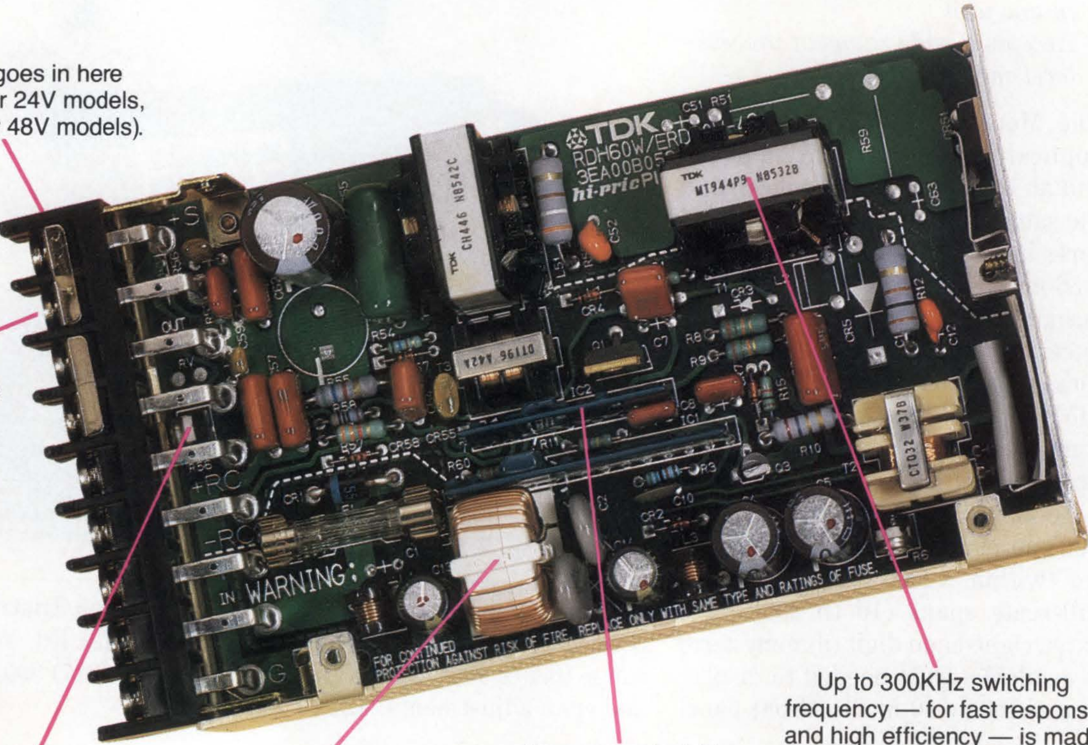
This 12-slot, 9U backplane meets all specifications for any Sunbus models requiring such a configuration. Based on transmission-line technology, the backplane is mechanically compatible with both VME and Sun card cages. It duplicates the Sun backplane and includes the signal busing necessary to implement the Sun proprietary P2 bus. The 5-layer combination microstrip/stripline design provides high-performance operation as high as 40 MHz. Bus bars facilitate the power hook-up and disconnection. $1275.

Dawn VME Products, 47073 Warm Springs Blvd, Fremont, CA 94539. Phone (415) 657-4444.

Circle No 392

How to turn the d-c you have into the d-c you want.

Pass it through a KEPCO/TDK ERD d-c to d-c converter



Your d-c goes in here (20~30V for 24V models, 40~56V for 48V models).

The d-c delivered here is stabilized to better than 0.2% (typ). As you increase your load to the rated load current, the voltage will remain constant within 0.3% (typ).

The input can be of either polarity, because the output is transformer-isolated from the input, and is fully floating off ground.

You can adjust the output voltage with a trimmer reachable through the enclosure.

Onboard EMI filter reduces the conducted noise fed back on your input bus within the limits of MIL-STD-461B.

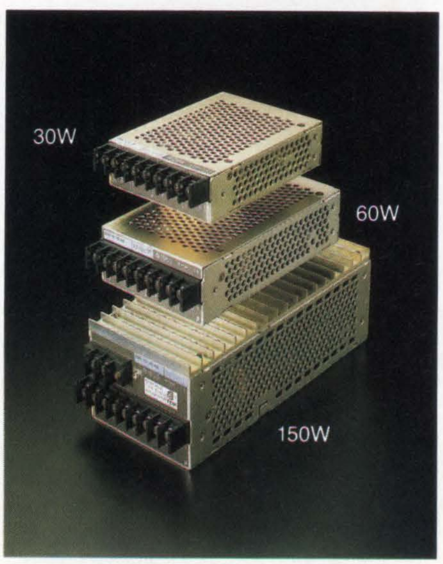
Our custom hybrid microcircuits (surface mount components on alumina substrates, sealed against moisture) reduce parts population, improve reliability.

Up to 300KHz switching frequency — for fast response and high efficiency — is made possible by a new, very low-loss TDK ferrite.

The model shown is our ERD 15-10-48. Output is 15V/10A; input is 48V.

Kepco d-c to d-c converters are not simple "regulators". They are full-fledged power supplies that do for your d-c everything that a-c to d-c voltage stabilizers do for the power company's a-c. Important features built into all models include:

- Self-contained heat sinks, convection cooled (no need to bolt an ERD to an external cold plate).
- Remote error sensing (allows for a voltage drop up to 0.4V in the wires to the load).
- Remote on/off (an optically isolated TTL logic control).
- Rectangular current limit (allows you to drive non-linear loads, parallel units, and use redundancy paralleling).
- LED power OK status indicator.



- Overvoltage protector (reduces the output to zero if the voltage tries to exceed the preset limit).
- Three sizes: 30 Watts, 60 Watts, and 150 Watts.
- Low cost, immediate availability.
- 5-Year warranty.

For more information or a demo for your lab, please write or call Dept. KRF-05, KEPCO, INC., 131-38 Sanford Avenue, Flushing, NY 11352 USA
(718) 461-7000 • TWX #710 582 2631
FAX (718) 767-1102.

KEPCO®
THE POWER SUPPLIER™

See us at Electro/88 • Kepco Booth 236, 238
CIRCLE NO 213

STEPPER MOTORS

- *Provide 200 or 400 steps per revolution*
- *Holding torques range from 6.2 to 9.5 oz-in.*

These high-resolution, 1.8°, size 11 stepper motors feature an excellent torque-to-size ratio. Holding torques range from 6.2 to 9.5 oz-in. Dynamic torques span 3.9 to 5.9 oz-in. and the standard accuracy ranges within ±5%. These direct-drive motors feature ball-bearing construction and measure only 1.5 in. long by 1.067 in. wide. The motors deliver 200 or 400 steps per revolution in full- or half-step, bipolar or unipolar drive schemes. Special winding configurations and other custom modifications are available. From $20. Delivery, 90 to 120 days ARO.

Clifton Precision, Litton Systems Inc, Box 160, Murphy, NC 28906. Phone (704) 837-5115. TWX 510-935-1068.

Circle No 393

PROTECTION DIODES

- *Protect data buses against electrostatic discharges)*
- *Provide short-circuit protection for data lines*

The TH6P04T6V5CL and TH6P05T25CL Transils, which feature eight bidirectional clamping diodes in a single 20-pin DIP, suit data-bus protection applications.

EASY

40-220 WATT POWER SUPPLIES ARE NOW EASY TO SELECT...

Simply find the output configuration you need. And call. It's that EASY.

WATTS	MAIN	CH 2	CH 3	CH 4	MODEL No.	TYPE
40	+5V/2.5A	+12V/2.0A	−12V/0.1A		RBT 41	PCB
60	+5V/5.0A	+12V/2.5A	−12V/0.5A		RBT 61	PCB
70	+5V/6.0A	+12V/2.5A	−12V/0.7A	−5V/0.7A	RBQ 71	PCB
135	+5V/15A	+12V/4.0A	−12V/0.7A	−5V/0.7A	RBQ 131	L BRACKET
135	+5V/15A	+15V/3.2A	−15V/0.7A	−5V/0.7A	RBQ 132	L BRACKET
135	+5V/15A	+12V/3.0A	−12V/0.7A	+24V/1.5A	RBQ 133	L BRACKET
135	+5V/15A	+15V/2.4A	−15V/0.7A	+24V/1.5A	RBQ 134	L BRACKET
175	+5V/20A	+12 or 15V/4A	−12 or 15V/3A	−5V/1.0A	RBQ 171	U CHANNEL
175	+5V/20A	+12 or 15V/4A	−12 or 15V/3A	+24V/1.5A	RBQ 173	U CHANNEL
220	+5V/25A	+12 or 15V/4A	−12 or 15V/3A	−5V/1.5A	RBQ 221	U CHANNEL
220	+5V/25A	+12 or 15V/4A	−12 or 15V/3A	+24V/3.0A	RBQ 223	U CHANNEL

EASY TO QUALIFY

- UL, CSA, IEC 380/VDE 0806
- Replaceable internal fuse
- Full output to 50°C
- FCC 20780 & VDE 0871 level A
- 115/230 VAC selectable input
- Full power convection cooled

IT'S EASY TO SEPARATE VENDORS.

Just read on...

TALK TECHNICAL. Get answers to your technical questions. Today. Talk to one of our Technical Sales Engineers—located near you. Or call a member of our 40-220W Technical Staff. Who else offers such technical service?!

DELIVERY. We have a National Sales Organization and a nationwide Distribution Network to get your unit in your hands—quickly.

TEST DATA. Computer generated Test Data—furnished with every unit. The power supplies we ship you do work. You know it. We know it. The Test Data verifies it.

QUALITY. Everyone claims it. acdc electronics proves it with the industry's highest customer acceptance rate for over 30 years.

HARD?

HARD to find a 40-220W power supply that works? Not any more. The 40-220 power supply you need is on the shelf. Tested. Ready for shipment. Certain to pass qualification. And priced competitively. Just call 619/439-4200.
How HARD is that?

1500w 800w 500w 300w 175w 70w 15w
1600w 1000w 750w 400w 220w 135w 40w

ACDC's POWER OFFERING

acdc electronics

401 Jones Road, Oceanside, CA 92054.
TEL: 619/757-1880. TLX: 350227. FAX: 619/439-4243

CIRCLE NO 223

The devices have breakdown voltages of 6.5 and 25V, respectively, and clamping voltages of 12 and 35V, respectively. At 5V, they have shunt capacitances of 500 and 300 pF, respectively. Their overload voltage rating is 25 kV. In addition to shunting the data bus with the protection diodes, the devices also provide protection against continuous short circuits on the lines. In the event of short circuits, the pin-to-die bonding wires within the package act as fusible links, which open circuit the line. TH6P04T6V5CL, $5.50; TH6P05T25CL, $5 (1000).

SGS-Thomson Microelectronics, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 394

DC/DC CONVERTERS

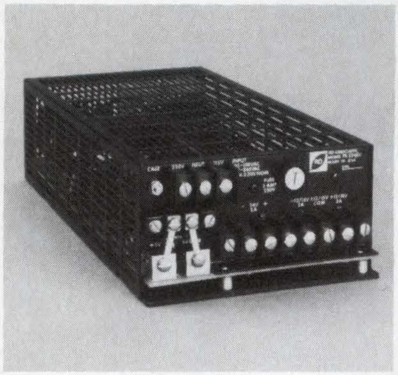
- *Provide a minimum efficiency of 80%*
- *Line and load regulations are 0.2%*

The XC Series dc/dc converters accept any input voltage between 24 and 72V dc and provide one of three outputs: 5V at 3A, 12V at 1.25A, or 15V at 1A. All three converters have an 80% (min) efficiency, even for 20% load levels. Key specifications include 0.2% for both line and load regulations, 30-mV output noise (p-p), 500V dc isolation, and −25 to +80°C operating range. Internal circuitry supplies 8 hours min short-circuit protection, and an internal thermal-limit circuit shuts a unit down when the case temperature exceeds the specified limit. The converters automatically restart when the temperature returns to normal. Filter circuits provide conducted-noise protection for both the input and the output. A 6-sided shielded case minimizes RFI problems. $120.

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. TLX 338506.

Circle No 395

COMPONENTS & POWER SUPPLIES



POWER SUPPLY

- *One output dedicated to disk-drive needs*
- *Includes self-recovering OVP on all outputs*

The quad-output Model 524EU power supply employs a 50-kHz MOSFET design with independent magnetic amplifiers in the secondary windings. The supply outputs are 5V at 20A, 12V at 3A, −12V at 2A, and 24V at 2A (for disk drive applications). The secondary windings are adjustable to 15V at 2.5A and −15V at 1.5A. You can select input ranges of 105 to 130 or 198 to 265V ac. All outputs are current limited and have continuous overload, short-circuit, and overtemperature protection. Self-recovering overvoltage protection is provided on all outputs. The supply has no minimum load requirements and includes input protection that meets the IEEE-587 voltage transient test. Power-fail and logic-inhibit signals are available as options. From $395.

RO Associates Inc, 246 Caspian Dr, Sunnyvale, CA 94088. Phone (408) 744-1450. TWX 910-339-9304.

Circle No 396

OSCILLATORS

- *Suitable for use in military and avionics equipment*
- *Tolerance of ±100 ppm over operating temperature range*

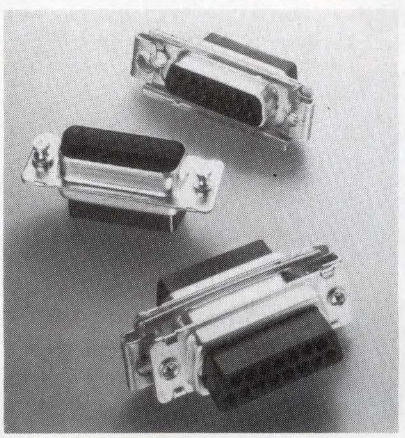
The outputs of QC6111- and QC6112-Series surface-mount crys-

CIRCLE NO 72

tal oscillators are TTL/CMOS compatible and TTL compatible, respectively. They are available with output frequencies in the 875-kHz to 28-MHz range. In addition, the oscillators have an operating-environment specification that meets or exceeds the requirements of MIL-0-55310/19—making them suitable for use in military and avionics equipment. All the oscillators are housed in a 40-pin ceramic-chip-carrier package, and they have an operating temperature range of −55 to +125°C. Over this operating temperature range, their frequency tolerance (relative to their nominal frequency) is ±100 ppm. For even more demanding applications, the oscillators will be available in a radiation-hard form, constructed from high-purity quartz crystal and SOS circuitry. Approximately £40 (100).

Salford Electrical Instruments Ltd, Times Mill, Heywood, Lancashire OL10 4NE, UK. Phone (0706) 67501. TLX 635106.

Circle No 397



CONNECTORS

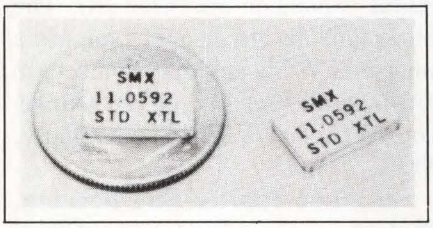
- *Compatible with the IEEE-802 standard*
- *Grounding indents for EMI/RFI compatibility*

These Amplimite 15-position subminiature D connectors feature preassembled slide latches and locking posts that save valuable installation time and effort. Compatible with

the IEEE-802 standard for LAN interfaces, these tin-plated, metal-shell plug and receptacle connectors have a lifetime spec of 500 mating/unmating cycles. The plug shells feature grounding indents for EMI/RFI compatibility. Slide-latch version, \$2.30; locking-post model, \$1.44 (1000). Delivery, stock to six weeks ARO.

AMP Inc, Box 3608, Harrisburg, PA 17105. Phone (717) 564-0100.

Circle No 398



CRYSTALS

- *Operate from −55 to +150°C*
- *Compatible with automatic assembly equipment*

Devices in the SMX Series of ceramic surface-mount AT quartz crystals measure 0.07×0.4×0.25 in. They are available with frequencies between 5 and 160 MHz. The standard operating range is −55 to +150°C; typical drive level is 150 μW. Crystals with room-temperature tolerances of 0.001, 0.005, or 0.01% are available. The basic construction features soldering pads that make the units compatible with automatic assembly equipment. \$4.80 to \$9 (1000). Delivery, 10 to 12 weeks ARO.

Standard Crystal Corp, 9940 E Baldwin Pl, El Monte, CA 91731. Phone (818) 443-2121.

Circle No 399

DESKTOP UPS

- *Protects desktop equipment from line failures*
- *Includes line-supply filtering and internal batteries*

Measuring 15.75×15.75×2.95 in. (400×400×75 mm), the DT300 uninterruptible power supply is small enough to fit under most desktop computers or word processors. In the event of a line-input failure, or a drop in the line voltage of 15% or more, the unit automatically switches over to its integral-battery backup power. The integral batteries can provide as much as 15 minutes of backup power to connected equipment. An audible and visual alarm indicates that the line supply has failed, and a second audible alarm indicates that only one more minute of battery backup is left. The output power is rated at 300 VA, and the unit operates from 220/240V 50-Hz line-input supplies. The unit also includes line-input filtering to protect connected equipment against noise, interference, voltage spikes, or voltage surges that appear on the line supply. It has two 220/240V 50-Hz output connectors supplied from the uninterruptible supply, and one output socket that is supplied from the filtered line input. £300.

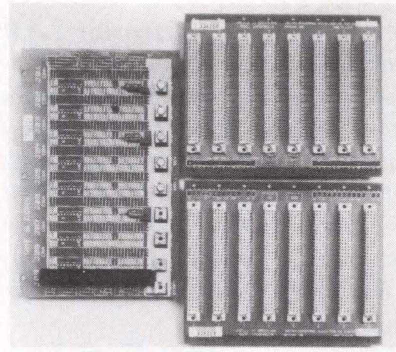
Dowty Power Conversion Ltd, Brunel Rd, Salisbury, Wiltshire SP2 7PT, UK. Phone (0722) 28801. TLX 477064.

Circle No 400

BACKPLANES

- *Designed for VME Bus applications*
- *5- to 20-slot versions available*

The VMEJ Series of backplanes is available in a variety of sizes and configurations to meet almost any VME Bus application. Both the VMEJ1 and VMEJ2 models come with anywhere from 5 to 20 slots. You can order the VMEJ1 with anywhere from 6 to 21 power terminals; the VMEJ2 line, from 4 to 10 power terminals. All versions have a multilayer backplane design that conforms to the most recent VME Bus



specifications, jumper positions for daisy-chaining Bus Grant and IJack signals, 20A power terminals, and 32-bit expansion and user I/O. The backplane design also lets you use a plug-in VMX board that connects to I/O-bus rows A and C on the connector. A 5-slot VMEJ1 backplane, $195.

Stanford Applied Engineering, 3520 De La Cruz Blvd, Santa Clara, CA 95050. Phone (408) 988-0700. TWX 910-338-0132.

Circle No 401

Continued on pg 288

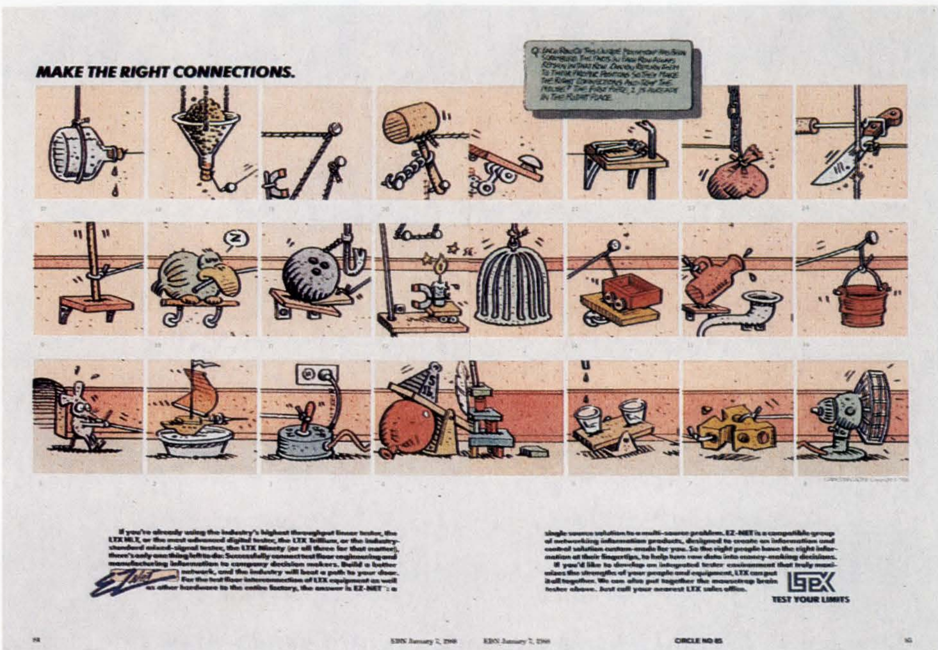
PRESENTING THE WINNING ADVERTISERS

From the EDN January 7, 1988 Issue

Here are the winning advertisements from EDN's January 7, 1988 Reader Vote Contest. Our readers analyzed and evaluated the advertisements in the issue to select the ones they judged to be the most informative, helpful and attractive. Congratulations to the advertisers and agencies who combined well-written copy and superior design to create these winning advertisements. A special thank you to the readers who took the time to participate. Here then are the outstanding performers . . .

FIRST

■ **COMPANY: LTX**
■ **AGENCY: Kelley & Wallwork**

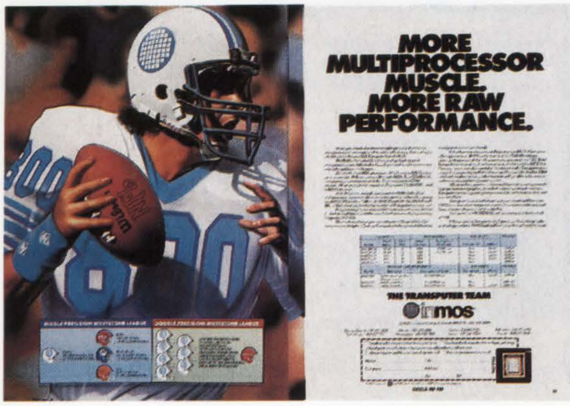


■ *"This ad made every engineer I know stop and take notice."*
Electronic Engineer, Texas Instruments

■ *"Rube Goldberg puzzle got my attention."*
Electrical Engineer, Naval Air Test Center

■ *"I spent a lot more than 30 minutes on these two pages."*
Diagnostic Engineer, Olivetti A.T.C.

■ COMPANY: Inmos
■ AGENCY: Thomas & Perkins



■ *"Football player draws interest. Text ties in well with picture."*
Chief Engineer, Beckman Instrument

■ *"Eyecatching color graphics. Table gives lots of info quickly."*
Engineer, Litton Electron Devices

■ *"Seasonal picture, good layout, concise details."*
Member Technical Staff, Advanced Micro Devices

■ COMPANY: IOtech
■ AGENCY: In-house

■ *"Describes the products very well."*
Engineering Manager, International Rectifier

■ *"Contains useful information, including prices."*
Senior Engineer, Johnson Controls Inc.

■ *"Great use of color."*
Engineer, Wilding Electronics

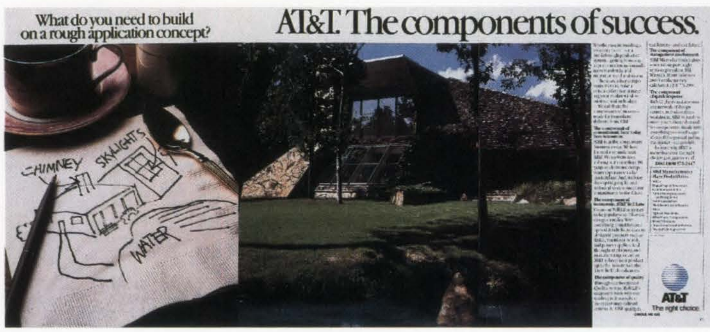
■ COMPANY: 3M Industrial Chemical Products Division
■ AGENCY: Kerker & Associates, Inc.

■ *"A very colorful, sophisticated, yet simple ad."*
Electronic Engineer, UPA Technology

■ *"Interesting design. Full of information."*
Aerospace Engineer, NASA

■ *"Full page graphics draw attention to informative product specs."*
Engineer, National Security Agency

■ COMPANY: AT&T Microelectronics
■ AGENCY: FCB/Leber Katz Partners



■ *"Allows imagination to prompt reading of entire ad."*
Engineer, General Electric

■ *"Nice concept. The house is a dream."*
Component Test Engineer, NCR

■ *"Dedicated to every engineer who has scribbled on a napkin!"*
Project Manager, IRT Corp.

■ COMPANY: Dupont Electronics
■ AGENCY: Ketchum Advertising

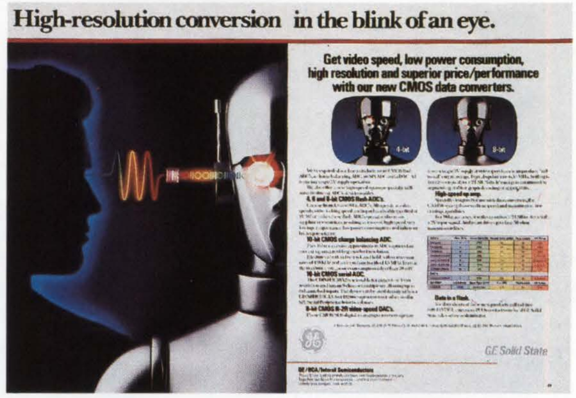
■ *"Picture caught my eye."*
Design Engineer, Hewlett-Packard

■ *"Impressive close-up."*
Software Engineer, Unisys

■ *"Sharp photograph. Good packaging."*
Chief Scientist, U.S. Army

- **COMPANY: GE Solid State**
- **AGENCY: Cappiello & Chabrowe**

- *"Impressive 4-bit vs. 8-bit comparison."*
  Engineer, Martin Marietta Electronic Systems
- *"Eyecatching and informative."*
  Engineer, Motorola Inc.
- *"The robot makes you look twice."*
  Senior Engineer, Medtronic, Inc.



- **COMPANY: Harris Semiconductor**
- **AGENCY: The Downs Group, Inc.**

- *"Photo is an attention getter."*
  Engineer, EG&G Energy Measurements
- *"This one takes the cake! Neat idea."*
  Engineer, IBM Corp.
- *"The party image makes you want to join in."*
  Design Engineer, Utica Systems

- **COMPANY: Hitachi America, Ltd. Semiconductor and IC Division**
- **AGENCY: Sutter / Martin**

- *"Refreshing to look at—informative."*
  Engineer, King Radio Corp.
- *"The painting in this ad is a truly artistic work."*
  Design Engineer, Infocom
- *"Picture complements the ad text."*
  Senior Mechanical Designer, Trebor Inc.

SECOND

■ COMPANY: Hewlett-Packard CSD
■ AGENCY: Tallant / Yates Advertising, Inc.

■ *"Good graphics. Includes prices and convenient postcard."*
Principal Engineer, Boeing Aerospace

■ *"Excellent use of vivid colors."*
Member Engineering Staff, RCA

■ *"Technically informative, with prices."*
Design Engineer, Digitech Industries Inc.

THIRD

■ COMPANY: Tektronix, Inc.
■ AGENCY: Young & Roehr

■ *"Stands out. States unique features."*
Project Engineer, Delco Electronics

■ *"Clever and informative."*
Project Engineer, Hughes Aircraft

■ *"Graphically interesting ad."*
Electronic Design Engineer, Antares Group, Inc.

- **COMPANY: Kepco, Inc.**
- **AGENCY: Zam, Kirshner, and Geller**

- *"I was looking for power supplies. Fold-out ad did it."*
  Software Manager, Teledyne Systems Co.
- *"I like the detachable ad. I can remove for future reference."*
  Senior Field Test Engineer, Bendix Oceanics Division
- *"Very well laid out with a wealth of information."*
  Engineer, Delco Systems Operations

- **COMPANY: Teradyne Industrial Consumer Division**
- **AGENCY: Ingalls, Quinn & Johnson**

- *"Very clever ad."*
  Design Engineer, Hewlett-Packard
- *"Excellent close-up photography and just enought text."*
  Member Technical Staff, Rockwell International
- *"Good graphics, good text. I can relate to the problem the product addresses."*
  Chief Engineer, EDI Inc.

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United Kingdom / Benelux: Jan Dawson, Tel: 01-6287030, Telex: 914911. **France / Italy / Spain:** Alasdair Melville. Tel: 01-6287030, Telex: 914911. **Scandinavia:** Stuart Smith, Tel: 01-6287030, Telex: 914911. **West Germany / Austria / Switzerland:** Wolfgang Richter, Tel: 49-7451-7828, Telex: (841) 765450. **Eastern Bloc:** Uwe Kretzschmar, Tel: 01-6287030, Telex: 914911. **Israel:** Igal Elan, Tel: 972-3-252967, 268020, Telex: (922) 341667. **Asia:** Ed Schrader, General Manager, Tel: 714 / 851-9422. **Taiwan:** Parson Lee, Tel: 88-6-760-6209, Telex: 29809 HORTEX. **Japan:** Kaoru Hara, Tel: (03) 366-8301, Telex: J2322609 DYNACO. **Korea:** B.K. International, Tel: 785-6665, Telex: K32487 BIZKOR.

Info Cards: Lauren Fox 203 / 328-2580. **Product Mart:** Joanne Dorian 212 / 463-6415. **Recruitment:** Roberta Renard, National Sales Manager 201 / 228-8602; Janet O. Penn, East Coast Manager 201 / 228-8610. **Reprint Orders:** Ernie Kummer 312 / 635-8800. **Direct Mail Services:** Sid Black 312 / 635-8800.

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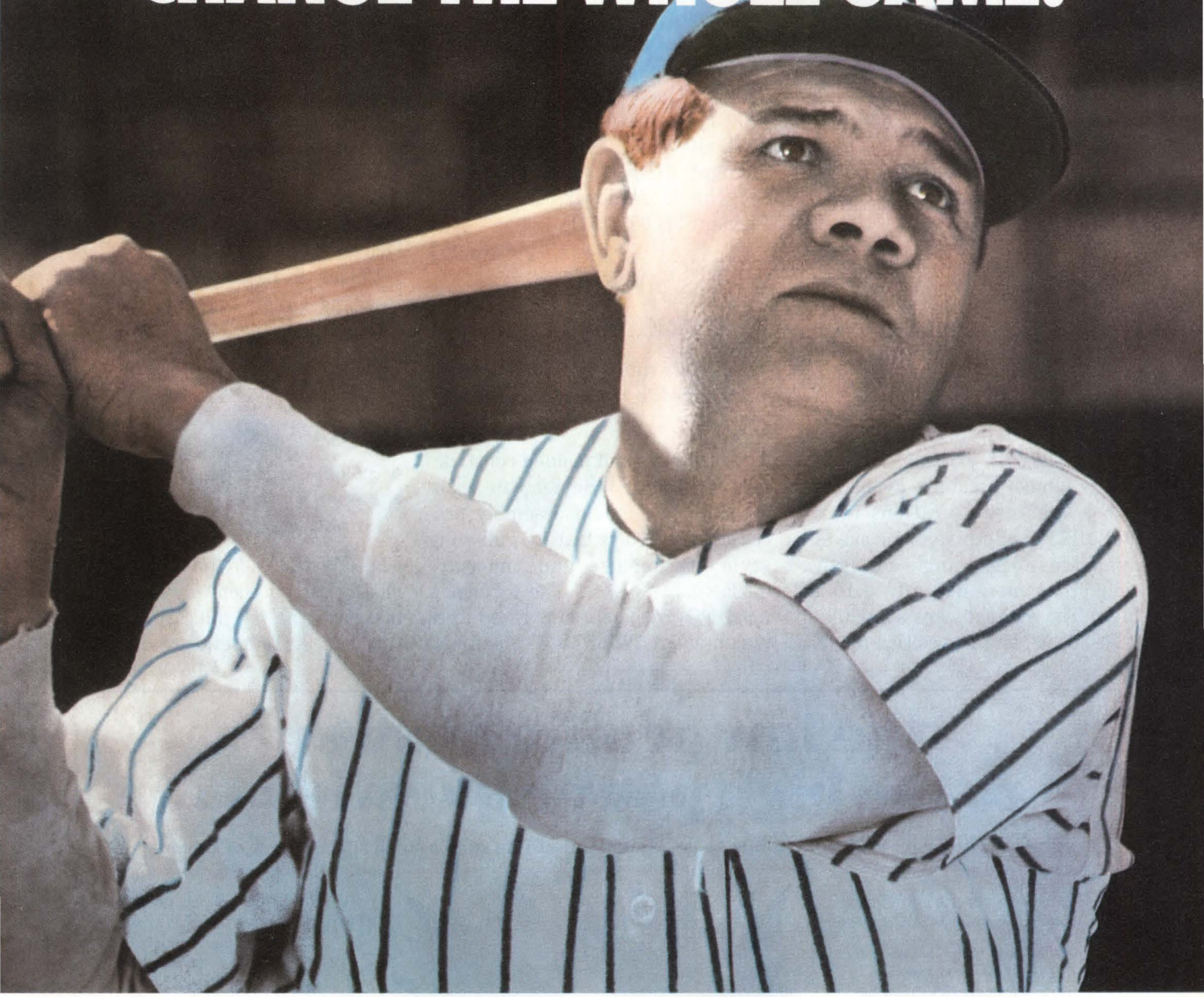
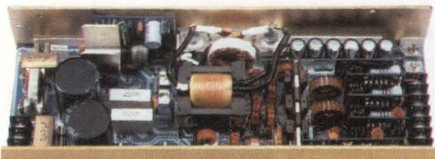
SOMETIMES A MAJOR PLAYER CAN CHANGE THE WHOLE GAME.



INTRODUCING ZENITH'S NEW STANDARD SWITCHING POWER SUPPLIES.



Now that Zenith's stepped into the batter's box, standard power supplies will never be the same. Because we've taken our expertise from years in the "custom" business, and designed a full-featured product... at a standard price. And that means significant cost savings for you!

Starting this January, Zenith will offer a complete family of medium power, off-the-shelf, switching power supplies. And our new power supplies have got all the bases covered...

- Safety. The new series meets international safety requirements of UL 478; CSA 22.2, No. 154; IEC 380; VDE 0806; VDE 0871/B; FCC PART J, CLASS B.
- Flexible. All outputs are independently isolated, mag amp regulated, and adjustable. Outputs 2 and 3 can be widely adjusted between 10 and 15.5V to meet different equipment demands – at no extra cost!

Visit us at ELECTRO '88, Booths 2433, 2435, 2437

- Tough. Exceeds 100,000 hours MTBF for durable performance.
- Reliable. Comes with 2-year warranty, fully backed by Zenith.

Output & Voltage Current Ratings

Model	Max Output Power (Watts)	Main Output		2nd Output		3rd Output		4th Output		Size (Inches)
		Volts DC (Min/Max)	Amps (Min/Max)	Volts DC (Min/Max)	Amps (Min/Max)	Volts DC (Min/Max)	Amps (Min/Max)	Volts DC (Min/Max)	Amps (Min/Max)	
ZPS-250-N	250	4.75/5.25	3.5/35.0	10.0/15.5	0.4/4.0 PK6	10.0/15.5	0.4/4.0 PK6	4.75/5.25	0.3/3.0	5.0 x 2.5 x 13
ZPS-300-N	300	4.75/5.25	4.5/45.0	10.0/15.5	0.8/8.0 PK12	10.0/15.5	0.8/8.0 PK12	4.75/5.25	0.4/4.0	5.0 x 2.5 x 13
ZPS-400-N	400	4.75/5.25	5.5/55.0	10.0/15.5	1.0/10.0 PK15	10.0/15.5	1.0/10.0 PK15	4.75/5.25	0.6/6.0	6.0 x 2.5 x 13

For optional steel cover substitute -C for -N in model number.

For more information, call

1-312-391-8700.

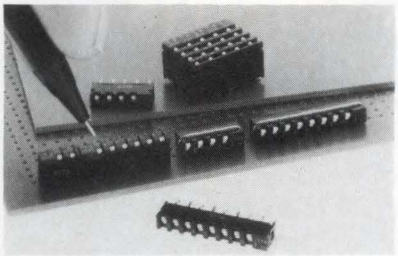
Because our new standards are going to be a big hit!

SEE US IN ZENITH BOOTH 500-502 AT THE WESCON TRADE SHOW, NOVEMBER 17TH-19TH.

ZENITH

THE QUALITY GOES IN BEFORE THE NAME GOES ON®

CIRCLE NO 74



SWITCHES

- *SIP design saves board space*
- *Lifetime specs at 1000 cycles*

Designed in a single in-line package with a common bus, switches in the S Series take up about 50% of the board space utilized by a conventional DIP switch. The units are compatible with existing SIP insertion equipment and are available in two height configurations—0.295 and 0.177 in. Both versions are also available in right-angle configurations that measure only 0.16 in. high. The switches are available in 2-, 4-, 6-, 8-, and 10-position models. They feature high-pressure, gas-tight contacts and can accommodate wave soldering and aqueous or solvent cleaning processes. The switches have a rated lifetime of 1000 cycles. An 8-position model, $1.12 (10,000).

Augat Alcoswitch, 1551 Osgood St, North Andover, MA 01845. Phone (617) 685-4371.

Circle No 402

REED RELAYS

- *Contacts rated for 5W or 5 VA*
- *Designed to withstand SMA processes*

The materials and molded construction for the JS1 Series can withstand surface-mount assembly processes. The relays feature gull-wing style terminals and measure 0.235×0.22×0.55 in. The 1 Form A (spst NO) reed switch is rated for a maximum of 5W or 5 VA. Maximum switching voltage is 100V ac or dc, and maximum switching current specs at 0.5A. Initial dielectric strength equals 250V dc min between open contacts and 1000V dc between coil and contacts. The standard coil voltages are 5, 12, 15, and 24V dc. Nominal coil power dissipation ranges from 66 to 288 mW, depending on model. $4.26 (500). Delivery, stock to 10 weeks ARO.

Potter & Brumfield Inc, 200 S Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-2276.

Circle No 403

OSCILLATOR

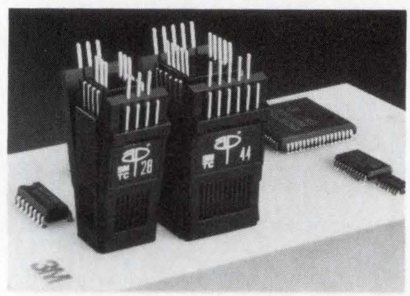
- *±0.02% initial accuracy*
- *2-ppm/°C drift (full MIL temperature range)*

The SWR200's 7.07V rms output has an initial accuracy of ±0.02% max over the full military temperature range. Temperature drift over

the same range is 2 ppm/°C max. To operate, the oscillator needs only two external frequency-setting components. Its output frequency is programmable over the range from 0.4 to 10 kHz. Stability equals 10 ppm over 1000 hours; total harmonic distortion is 0.5% at 3300 Hz. To eliminate errors due to ground drops, two separate ground pins provide accurate ground sensing. The oscillator is available in either a 14-pin DIP or a flat pack. It's screened to MIL-STD-883C requirements. DIP versions, \$86 to \$112.20 (100); flat-pack models, \$98 to \$126.09.

Thaler Corp, 10940 N Stallard Pl, Tucson, AZ 85737. Phone (602) 742-5572. TLX 825193.

Circle No 404



PLCC TEST CLIPS

- *Feature heavy-duty springs for positive contact pressure*
- *Narrow body design accommodates high-density applications*

The vendor's plastic leaded-chip-carrier (PLCC) test clips are now available in 28- and 44-pin sizes. They have an action-wedge design that allows all four sides to open simultaneously, thus providing a 1-step secure attachment to the PLCC under test. The clips also feature helical compression springs that ensure positive contact pressure, an insulating contact comb to prevent accidental short circuits, and a patented wiping action to ensure contact integrity in testing. The clips' narrow body design accommodates high-density pc-board

applications. Staggered clip contacts are located on 0.1-in. centers. Standard 0.025-in.-square contact pins accept single-row female socket connectors or wire-wrap connectors that can interface with test equipment. From $23.98 for a 28-pin clip; from $30.95 for a 44-pin clip.

3M, Electronic Products Div, Box 540, Mentor, OH 44060. Phone (800) 321-9668; in OH, (216) 354-2101.

Circle No 405

TRANSFORMERS

- *Phase shift equals 1° max*
- *Occupy <0.5-in³*

The Series 1800 isolation transformers provide high isolation with phase shifts of as little as 1° max. The units are designed to precede the input stages of hybrid synchro- or resolver-to-digital devices. Two of the units can also work with digital-to-synchro converters. The transformers occupy less than 0.5 in^3 and weigh only 0.75 oz. The family includes seven members with designations ranging from SIT/RIT1800 to SIT/RIT1840, and from RT1850 to RT1860. The SIT/RIT series and the RT1850 model are designed for frequencies from 360 to 440 Hz; the RT1860 accommodates frequencies of 47 to 440 Hz. $65 to $150. Delivery, six to eight weeks ARO.

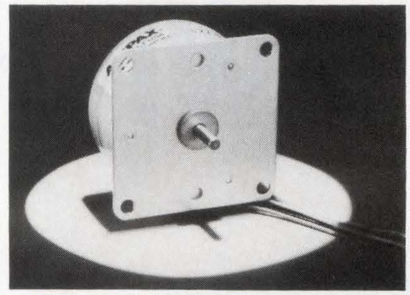
Natel Engineering Co Inc, 4550 Runway St, Simi Valley, CA 93063. Phone (805) 581-3950. TWX 910-494-1959.

Circle No 406

STEPPER MOTORS

- *±0.5° tolerance*
- *Available in unipolar or bipolar versions*

The Series L82400 permanent-magnet (PM) 42-mm stepper motors are designed to satisfy worldwide safe-

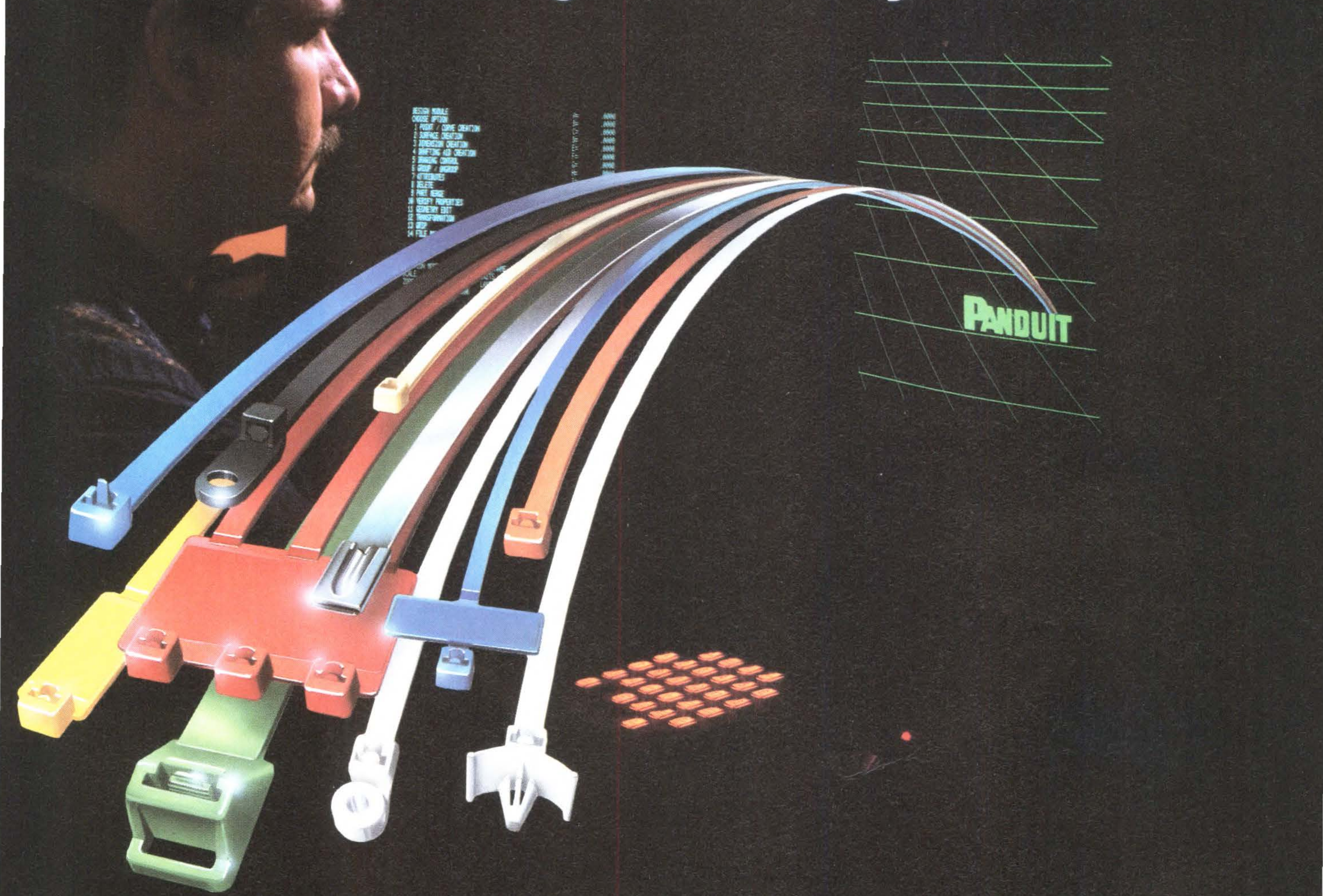


ty requirements. The holding torque specification for the PM motors ranges to 12.4 oz-in. and the step angle is 7.5°—48 steps per revolution. Noncumulative step-angle tolerance equals ±0.5°. The motors feature permanently lubricated bronze sleeve bearings. Versions are available for unipolar or bipolar operation from supply voltages of 5 or 12V dc. $7.65 (500) for bipolar version. Delivery, 4 to 12 weeks ARO.

Airpax Co, W Johnson Ave, Cheshire, CT 06410. Phone (203) 272-0301.

Circle No 407

"Designer-Friendly" Cable Ties



Five Reasons Why You Should Specify PANDUIT

1. Application Problems Solved
Choose from many materials (nylon, steel, fluoropolymers) to suit the application. Also available are mounts and accessories to complement these materials for your total package requirements. All have designed-in reliability for each environment.

2. Design Problems Solved
Specify from the widest selection of sizes, colors and styles that fit **your** design. Each is backed by more than 25 years of experience and approvals from U.L. and Mil. QPL.

3. Production Problems Solved
Select the installation tooling that meets your production needs: from hand or pneumatic powered through fully automatic—the only system that can install cable ties in less than a second. Each has design features to **lower your installed cost.**

4. Technical Problems Solved
Choose the company that provides the most experienced team in the industry, to back you all the way; from mag tapes for your CAD-CAE system (to speed specifications) to toll-free phone support before and after the sale.

5. Procurement Problems Solved
Specify the quality cable tie line and you'll get **much more**—service, delivery and support, all at competitive prices.

**For FREE SAMPLES
and Further Information Call Today**
1 (800) 777-3300
[In Chicago (312) 532-1800]
CIRCLE NO 234

PANDUIT CORP
ELECTRICAL GROUP
Tinley Park, IL 60477-0981
In Canada: Panduit (Canada) Limited

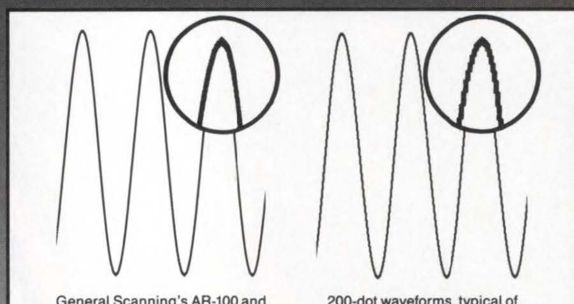
Visit PANDUIT at ELECTRO '88 Booths 342-343

An Instrument is only as Good as its Output

Will the hardcopy output of your next instrument reflect the quality, precision and capability you build into it?

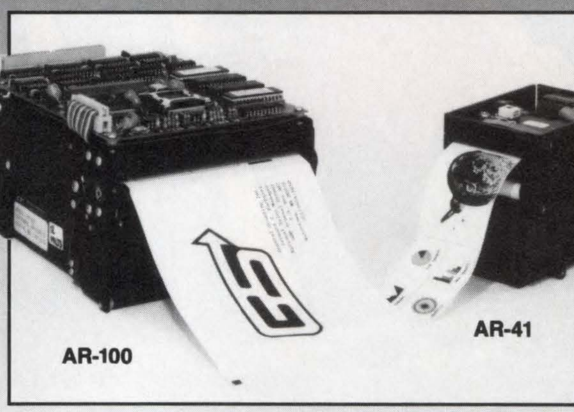
Instrument users get more than data from their printout . . . they also get a continuing impression of the overall quality and accuracy of the instrument that produces it.

Plots that can't keep pace with real-time events, that display rough, visible jaggies, that are limited in format and have noticeably lower resolution may adversely reflect on the quality of your instruments.



General Scanning's AR-100 and AR-40/41 800-dot resolution produces smooth waveforms.

200-dot waveforms, typical of most output printers, have ragged contours.

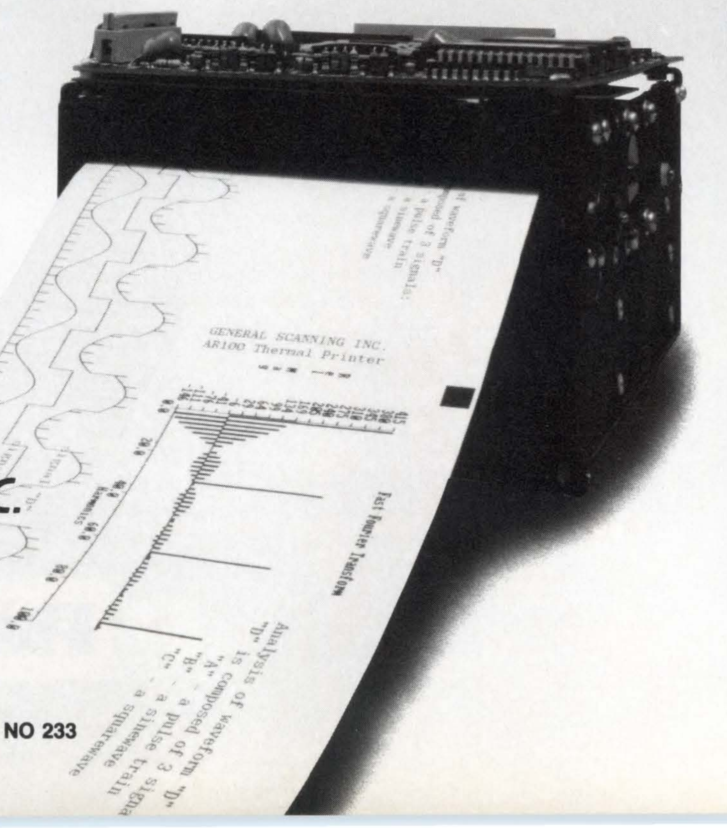


WHERE DO YOU GO FOR SMOOTH, HIGH-SPEED, HIGH-RESOLUTION RECORDING?

Only General Scanning's advanced 2 and 4 inch thermal array printer/plotters are designed specifically to produce records suitable for premium quality, precision instruments. They provide:

- Industry's highest resolution (800 dots/in) for maximum output quality.
- User-defined printing speeds from 1 mm/hr to 50 mm/sec (up to 650 characters/sec).
- Extensive character complement (246, including 96 ASCII); easy-to-add special and foreign sets for custom and international applications.
- Proprietary curve-smoothing software to enhance waveforms (real-time).
- Custom generation of background grids, special codes, X and Y orientation of alphanumerics and graphics printing, full interaction between all output modes, etc. provide total printing flexibility.
- Internal self-test routines, reducing QA and incoming inspection expenses inherent in similar products.

General Scanning, with 20 years of experience in building advanced thermal printers, is the leader in offering customers total application and engineering support.



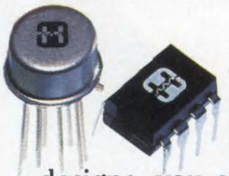
GENERAL SCANNING INC.

Charting the Path of Technology

500 Arsenal Street, Watertown, MA 02272
(617) 924-1010 Outside Mass. 800-343-1167

CIRCLE NO 233

Give your industrial controls a lift with our high-performance analog ICs.



When you put industry-proven Harris linear and data acquisition ICs into your control designs, you always come out ahead — in design time, cost, and product performance.

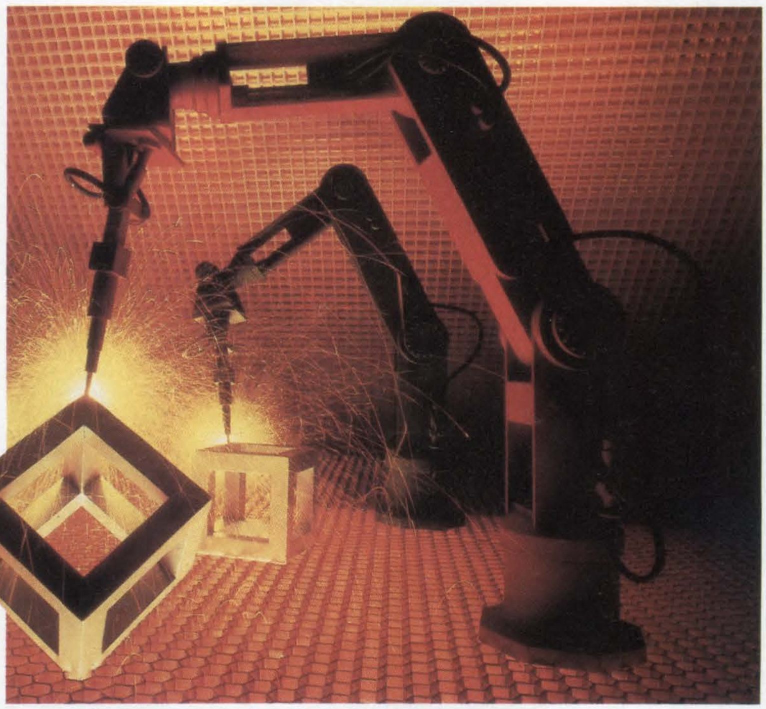
Just specify the functions you need. If it's industrial, we're in control. With a complete line of op amps — high-speed, low-power, precision or general purpose. Comparators. And analog switches.

For data acquisition, choose our A/D and D/A converters, sample-and-hold amplifiers, and analog multiplexers.

Our Dielectric Isolation (DI) process means no latch-up, plus higher speed and performance characteristics.

Get Harris into your system.

Call us at 1-800-4-HARRIS, Ext. 1810 (in Canada, 1-800-344-2444, Ext. 1810). Or write: Harris Semiconductor Products Division, P.O. Box 883, MS 53-035, Melbourne, Florida 32902-0883. We'll help handle your load.



FOR YOUR INFORMATION, OUR NAME IS

HARRIS

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

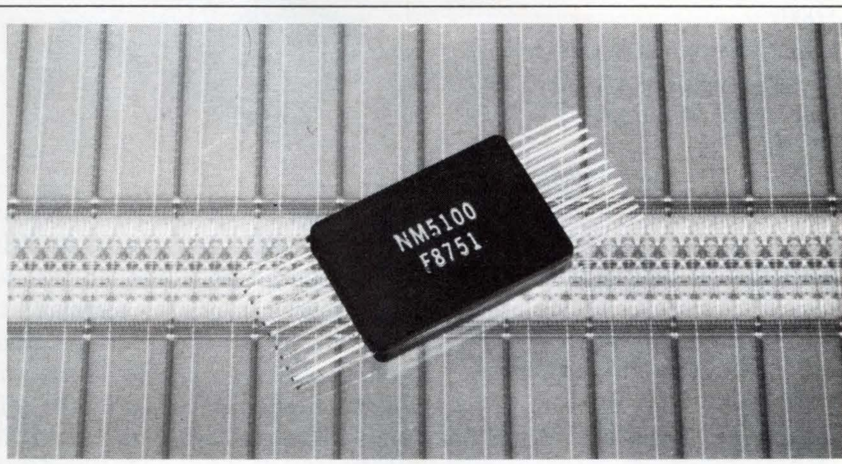
HARRIS

NEW PRODUCTS

INTEGRATED CIRCUITS

FAST STATIC RAM

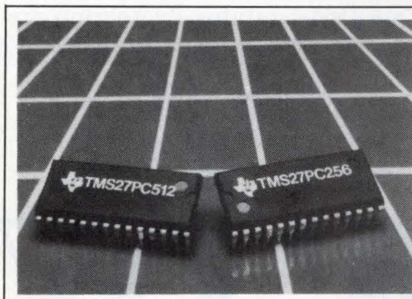
- *Available in 15- and 18-nsec speed grades*
- *10K and 100K ECL-compatible*



Organized as 262,144 words×1-bit, the NM5100 high-performance static RAM is compatible with 10K and 100K ECL I/O interfaces. The device is available in 15- and 18-nsec versions and operates from a supply voltage of −5V. The power dissipation is less than 1W. To meet the requirements of MIL-STD-883C, the device has 2000V electrostatic discharge protection. The latch-up immunity exceeds 200 mA. The device comes in either a 24-pin, 400-mil ceramic DIP or in a low-inductance 365×535-mil ceramic flatpack with a 30-mil lead pitch. 15-nsec version, $125; 18-nsec version, $96 (100).

National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 749-7400. TLX 346353.

Circle No 351



CMOS PROMs

- *One-time programmable*
- *Available in four densities*

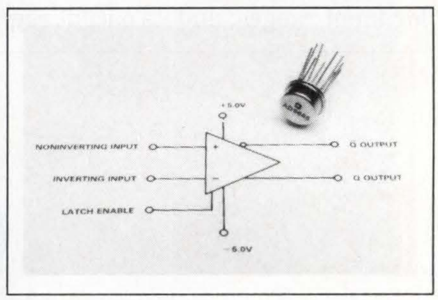
Available in 64k-, 128k-, 256k-, and 512k-byte densities, the TMS27PC64, -27PC128, -27PC256, and -27PC512 CMOS PROMs feature high-speed performance comparable to NMOS devices and provide the added benefits of lower power dissipation and improved reliability. With device speeds ranging from 150 to 200 nsec, the PROMs are designed for systems that do not require the reprogrammability of EPROMs. Because the package used for these PROMs is windowless, the PROMs offer improved data integrity when compared with windowed EPROMs. The devices feature an active power dissipation of less than 220 mW. Depending on type, from $3.16 to $6.16 (100).

Texas Instruments, Semiconductor Group, SC-800, Box 809066, Dallas, TX 74380. Phone (800) 232-3200, ext 700.

Circle No 352

TTL COMPARATOR

- *High-speed operation*
- *Complementary TTL outputs*



Featuring a 7-nsec propagation delay, the AD9686 comparator provides a latch-enable control line with a 2-nsec setup time for high-speed voltage comparisons. It can detect high-speed voltage transitions in both analog and digital systems. The device has an input-offset voltage of 2 mV max that typically drifts less than 10 μV/°C over the −55 to +125°C temperature range. Other key specifications include a 4-μA input bias current and 85-dB common-mode rejection. The comparator comes in a TO-100 metal can, a 16-pin ceramic DIP, or a 20-terminal ceramic LCC. From $3 to $16 (100).

Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565. TWX 710-394-6577.

Circle No 353

DISK CONTROLLER

- *Single-chip, floppy-disk controller*
- *Compatible with standard data formats*

The μPD72067 single-chip, floppy-disk controller is compatible with industry-standard data formats, including IBM and Sony's European Computer Manufacturers Association format. The device incorporates write compensation and system clock-generation circuitry that simplify its use. Its high bit-jitter rejection also enhances overall stability. In a plastic DIP, $10; in a PLCC surface-mount package, $11 (10,000).

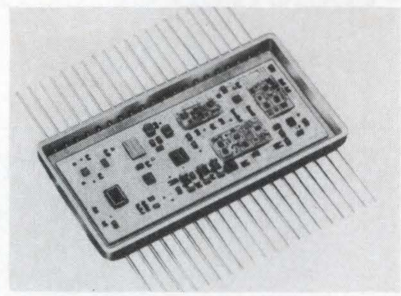
NEC Microelectronics Inc, Box 7241, Mountain View, CA 94039. Phone (415) 960-6000. TWX 910-379-6985.

Circle No 354

HYBRID 12-BIT ADC

- *Includes a track/hold amplifier*
- *Comes in a hermetic, 40-pin flat pack*

Encased in a hermetic, 40-pin flat pack for use in surface-mount applications, the ADC-00302 hybrid includes a 12-bit A/D converter, a track/hold amplifier, data registers, 3-state output buffers, and timing circuits. The IC provides nine bipolar/unipolar jumper-selectable analog input ranges, and its output reg-



isters and 3-state buffers interface to most CPUs. Because of its self-contained timing, the device requires only an encode command to start its conversion cycle. Its other characteristics include 68-dB min harmonic reduction, a 65-dB min signal-to-noise ratio, and a 0.025%-FSR (feedback shift register) max linearity error. The vendor offers MIL temperature-range versions. From $750.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 567-5600. TWX 310-685-2203.

Circle No 355

SWITCH-MODE ICs

- *Enable switch-mode supplies with output to 200W*
- *Use low-cost transformers to provide input/output isolation*

Operating on a master-slave principle, the TEA2170 and TEA2164 provide regulation and protection functions for isolated switch-mode power supplies with outputs as high as 200W. They are suited for use in low-cost power supplies for consumer products—for example, TV receivers, video recorders, and audio equipment. The devices let you isolate a supply's secondary side from the line input with a low-cost transformer. The TEA2164's ±1.5A output can directly drive power transistors at switching frequencies as high as 60 kHz. You can also synchronize the switching to an external frequency, such as the line-scan frequency of a TV set. The TEA2164 contains protection circuitry to limit the current in the power transistor and to protect the supply against repeated output overcurrent, overvoltage, and undervoltage conditions. Both devices also provide soft-start circuitry. Around $1.46 (1000).

SGS-Thomson Microelectronics, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 356

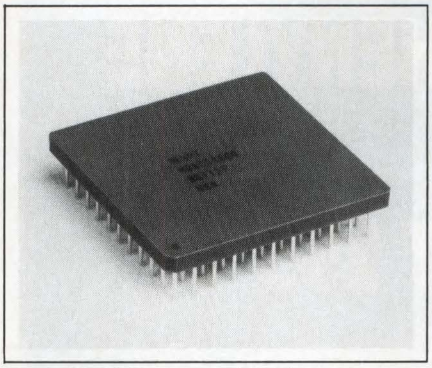
SGS-Thomson Microelectronics, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 357

MULTIPLEXED DAC

- *250-MHz, 8-bit performance*
- *Five TTL/CMOS-compatible input buses*

The HDAC51600 250-MHz, 8-bit multiplexed D/A converter has five



TTL/CMOS-compatible input buses. It simplifies system designs that combine high-speed analog inputs with TTL or CMOS logic. Included on chip are a voltage reference, data latches, timing and control logic, a 5:1 multiplexer, and a video DAC. Synchronization, blank, bright, and force-high controls are available. The device also provides a clock output for system-memory control. When used with CMOS memory, the converter creates a high-speed system that provides cost- and power-savings, compared with designs that use discrete video DACs and ECL memories. The device's linearity is guaranteed to ±½ LSB, and the slew rate is 525 V/µsec min. The outputs of the device can drive either 50 or 75Ω loads. In a 46-pin pin-grid array, $98.75 (100).

Honeywell Inc, Signal Processing Technologies, 1150 E Cheyenne Mountain Blvd, Colorado Springs, CO 80906. Phone (719) 540-1000.

Circle No 358

REGISTER FILE IC

- *Provides three ports*
- *Features 20-MHz read/write capability*

The TMC3220 three-port register file is a specialized memory IC that features one write and two independent read ports. The IC features 20-MHz, asynchronous read/write capability. You may use it as a scratchpad memory with 32-bit floating-point products such as the TMC3200 floating-point arithmetic unit, the TMC3201 floating-point multiplier, and the TMC3210 floating-point divider. Fully TTL compatible, the device operates from a 48-nsec clock and uses just 30 mA max of current when operating in the commercial temperature range. It comes in a 48-pin ceramic DIP. Commercial-grade version, \$29; military-grade version, \$61 (1000).

TRW, LSI Products Div, Box 2472, La Jolla, CA 92038. Phone (619) 457-1000.

Circle No 359

PREAMPLIFIER

- *Dual-channel preamplifier for Inductosyns*
- *Internally matched gain resistors*

The IPA-15805 preamplifier raises the low-level output of an Inductosyn to 2V rms, thus providing the needed drive for an Inductosyn-to-digital converter. The hybrid features high gain, together with matched gain and matched phase. You can use the device without trimming, or for maximum circuit accuracy, you can trim it externally for both gain and phase. Available in a small, 18-pin hermetically sealed package, the device has an operating temperature range of −55 to 125°C. \$148. Delivery, stock to 90 days.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 567-5600. TWX 310-685-2203.

Circle No 360

INTEGRATED CIRCUITS

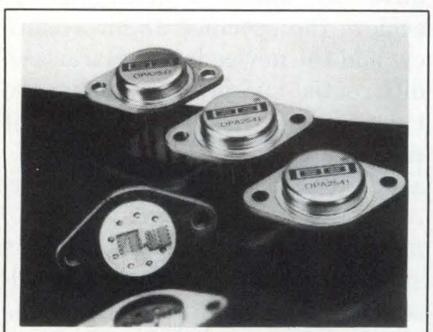
12-BIT ADC

- *2-MHz throughput*
- *Operates from ±15V and 5V supplies*

The completely shielded, integrated ZAD1202 module is a 12-bit sampling A/D converter that minimizes the number of converters needed in multichannel digitizing systems. It has a 2-MHz throughput, which includes the S/H operation and the A/D conversion. The harmonic distortion is −74 dB from dc to 500 kHz, and −68 dB from 500 kHz to 1 MHz. The device's S/N ratio is −70 dB min at 100 kHz, and its relative accuracy is ±¾ LSB max. The gain and offset of the module is adjustable. $449 (100).

Analog Solutions, 85 W Tasman Dr, San Jose, CA 95134. Phone (408) 433-1900.

Circle No 361



DUAL-POWER OP AMP

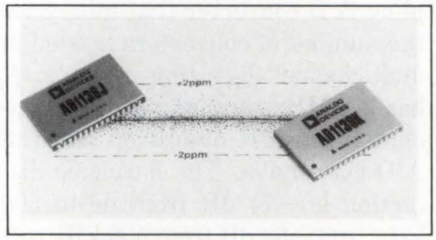
- *Output currents to 5A*
- *Power supplies to ±40V*

Containing two monolithic power-amplifier chips, the OPA2541 op amp can deliver 5A continuous from ±10 to ±40V supplies.

The offset voltage is ±1 mV max, and the bias current is 50 pA max. The open-loop gain is 96 dB, and the slew rate is 6V/μsec min. The device has FET inputs, and its class A/B output stage minimizes crossover distortion. The TO-3 package is electrically isolated for direct mounting on a heat sink. The device is available in three performance grades and two temperature ranges. From $28.95 (100).

Burr-Brown, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491.

Circle No 362



HYBRID DAC

- *Adustment-free 18-bit accuracy*
- *±½-LSB differential and integral nonlinearity*

The AD1139 D/A converter has voltage- and current-output data latches, an internal reference, an output amplifier, and application resistors for output ranging. You don't have to make adjustments to achieve the specified 18-bit accuracy, and the device has a guaranteed differential and integral nonlinearity of ±½ LSB. Voltage output ranges are 0 to 5V, 0 to 10V, ± 5, and ±10V. You can also select current outputs of −1 mA and ±0.5 mA. The settling time is 6 μsec for a single LSB change, and the full-scale settling time is 40 μsec. The device's high-stability internal reference is available through a built-in buffer for use as an external reference. Data bits are presented to the DAC via a single 18-bit bank of parallel, 5V CMOS-compatible latches, which ease the interface to processor buses. The device requires 5V and ±15V supplies. It

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Call toll-free, 800-443-7364 ext. 23

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

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Three Dual Flip-Flops	Two Synch 4-Bit Binary Up-Down Counters	One Octal Transparent Latch 3-State
Two 3- to 8- Line Decoder Demultiplexers*	Two Octal Buffer Line Driver 3-State*	One Octal D-Type Flip-Flop 3-State*
	Two Octal BUS Transceiver 3-State*	One Octal Transparent Latch 3-State(Inverting)
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*Standard Military Drawings available

† FAST is a trademark of Fairchild Semiconductor Corp.

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Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565. TWX 710-394-6577.

Circle No 363

FIFO REGISTERS

- *Has 16-word×4-bit silicon gate CMOS device*
- *40-MHz data-rate capability*

Except for their capacities, the 74HC/HCT40105 16-word×4-bit and the 74HC/HCT7030 64-word×9-bit FIFO registers are functionally identical. The devices feature a 40-MHz typ burst-in/burst-out data rate without flags, and a very low power consumption (essentially zero in the idle mode). Other features include independent shift-in/shift-out controls and input-ready and output-ready status indicators. The FIFOs are cascadable in depth and expandable in word width; they can operate at 30 MHz typ with flags. 74HC/HCT40105, $2.85; 74HC/HCT7030, $35 (100).

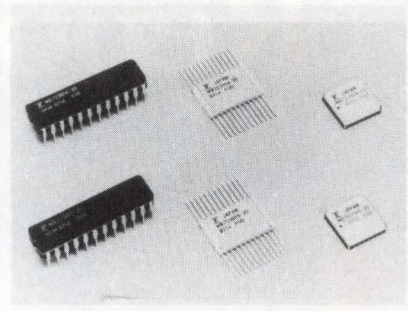
Signetics, Box 3409, Sunnyvale, CA 94088. Phone (408) 991-2000.

Circle No 364

FAST PROMs

- *Registered outputs*
- *20-nsec clock-access times*

Organized as 8-bit-wide devices, the MB7226, MB7232, and MB7238 PROMs provide 4-, 8-, and 16-bit-wide storage capacities, respectively. The built-in register of these devices latches the output data, eliminating the need for an external register. Each of the three PROMs features a 20-nsec access time; 25-nsec versions are also available. You



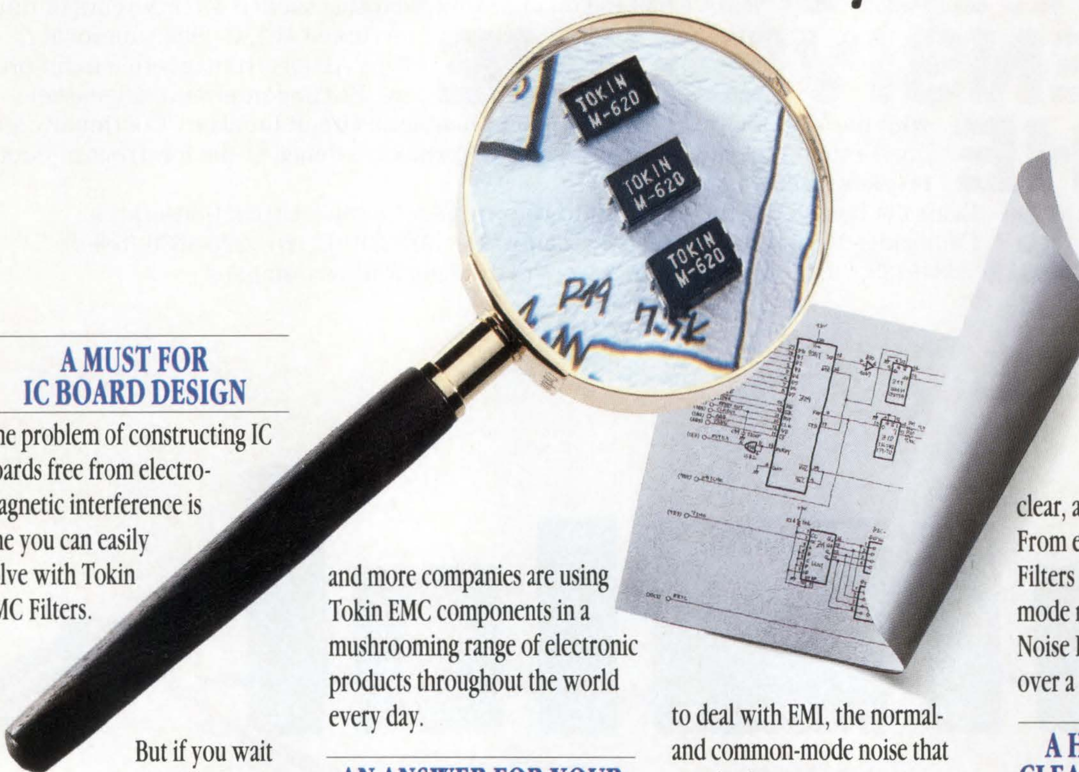
can program the register's initial contents to any 8-bit value when programming the rest of the PROM's contents. The PROMs are TTL compatible and operate from a 5V supply. The package options include a 24-pin ceramic DIP, a 24-pin ceramic flatpack, and a 28-pin LCC. From $5.25 to $17.

Fujitsu Microelectronics Inc, 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 562-1000.

Circle No 365

50th Anniversary

Eliminate the noise from your design.



A MUST FOR IC BOARD DESIGN

The problem of constructing IC boards free from electromagnetic interference is one you can easily solve with Tokin EMC Filters.

But if you wait until you've started designing the board, it's already too late; it's something you need to consider *before* you begin. The Tokin EMC Chip Filters above are a good example. By including them in the IC design from the start, the designer can create an IC board that enables the end user to enjoy the full, unrestricted potential of the board's performance. That's why more and more companies are using Tokin EMC components in a mushrooming range of electronic products throughout the world every day.

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Digital electronics are changing the shape of the world we live in, in more ways than one. And to deal with EMI, the normal- and common-mode noise that attacks data communications terminals and digital equipment, Tokin has come to the rescue with an incomparable lineup of EMC data line filters that deliver clear, accurate data transmission. From easy-to-mount EMC Chip Filters for normal- and common-mode noise absorption, to DIP Noise Filters for high impedance over a wide frequency range.

Specifications (DIP Noise Filters)

Model	Circuit	Rated Current per Line (mA)
D-03C/ D-03C1	8 circuits; Common-mode	100
D-05N1	8 circuits; Normal-mode	100
D-07C1	8 circuits; Common-mode	300
D-08C2	4 circuits; Common-mode	2,300
D-08C2A	4 circuits; Common-mode	500
D-16C	4 circuits; Common-mode	100
D-20C	8 circuits; Common-mode	500
D-40C	3 circuits; Common-mode	300
D-42C	5 circuits; Common-mode	300
D-45C	8 circuits; Common-mode	300
D-47C	10 circuits; Common-mode	300
D-55C	5 circuits; Common-mode	300
D-58C	8 circuits; Common-mode	300

Specifications (EMC Chip Filters)

Model	Circuit	Frequency Range (MHz)	Impedance (Ω)	Rated Current (mA)
M608	1 circuit; Common-mode	5~200	≧300 (at 100MHz)	100
M614	1 circuit; Common-mode	5~100	≧700 (at 50MHz)	100
M620	1 circuit; Common-mode	5~50	≧1,000 (at 30MHz)	100
M720N	20 circuits; Normal-mode	50~300	≧50 (at 200MHz)	50

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CIRCLE NO 230

CAE & SOFTWARE DEVELOPMENT TOOLS

DISK MAINTENANCE

- *Works with two hard-disk drives*
- *Works with both MFM and RLL controllers*

Disk Technician+ runs on the IBM PC, PC/XT, PC/AT, and compatibles. The disk-maintenance software package provides automated daily, weekly, and monthly testing procedures that prevent failures and recover data from damaged sectors on both hard and floppy disks. The program works with both MFM and RLL controllers, and with PC/AT 1.2M-byte floppy-disk drives. You can use one or two hard drives. The program reads from and writes to every individual bit in the hard-disk partition under test, using proprietary algorithms that can detect marginal bits, predict potential failures, and correct these failures if they occur. The package provides two formatting procedures: a nondestructive formatter for PC/AT-type machines, with adjustable interleaving to maximize system speed; and a destructive, low-level formatter with adjustable interleaving for PC/XTs, PC/ATs, and compatibles. You can retain or ignore the disk-manufacturer's bad-track table, and can add bad track or sectors at any time, nondestructively. The package also includes the SafePark memory-resident program, which automatically moves the heads to a safe zone if there is no hard-disk activity for a user-specified period within 1 to 15 sec. $129.95

Prime Solutions, 1940 Garnet Ave, San Diego, CA 92109. Phone (619) 274-5000.

Circle No 410

SPECTROSCOPY TOOL

- *Automates the acquisition and analysis of spectroscopy data*
- *Handles ultraviolet, visible, infrared, and other data*

The Spectrochart-PC software package automates the acquisition and analysis of spectroscopic data. Using the vendor's Adalab-PC data-acquisition board and an IBM PC or compatible, you can record and analyze voltage signals from the recorder output of any type of spectrometer, including those that operate with ultraviolet, visible, or infrared radiation as well as those that work with fluorescence, reflectance, atomic emission, or atomic absorbtion. You can analyze as many as 100 standard or unknown samples in any sequence. The program will record a single value for each sample, or, for kinetic studies, will provide each with multiple, timed values. The graphics routines can plot multiple samples, kinetic curves, or spectra in windows to 640×200 pixels max. You can select the position, size, background color, X and Y scale factors, and labels for each graph. You can display the value of a point by moving the cursor along the curve to that point. $595.

Interactive Microware Inc, Box 139, State College, PA 16804. Phone (814) 238-8294.

Circle No 411

CAE FOR MAC

- *Provides schematic entry, layout, and routing modules*
- *Can translate Gerber files to PostScript format*

The EDS-I electronic-design software system runs on the Apple Macintosh II. The schematic-capture module lets you generate schematics, using both standard and user-defined component libraries, and automatically produces a net list and a parts list. The layout module can handle pc-boards as large as 32×32 in. and provides zoom and pan features, auto-tooling extraction, multilayer editing, and Gerber photoplotting files. The autorouting module accepts the net list and parts list as input, lets you define routing parameters and options as well as keep-out areas, and lists unfinished nets. The Gerber translator module lets you convert Gerber files created by other systems into the electronic design software's internal format, or Gerber files produced by the software into PostScript files for use by high-resolution graphics printers in the Linotronics 300/500 series so that you can check the photoplot drawings before committing them to film. You do not have to order all the modules, but rather, can select just those that you need. Full system, around $1500.

Vamp, 6753 Selma Ave, Los Angeles, CA 90028. Phone (213) 466-5533. TWX 650-262-3069.

Circle No 412

CASE TOOLS

- *Help you document and examine multiple-module C programs*
- *Run on IBM PCs under MS-DOS*

The C Documenter and C Scan utilities for the IBM PC and compatibles ease the task of documenting and examining programs written in the C programming language. Where such programs are subdivided into separate subsystems, C Documenter generates a set of four reports containing cross-reference information, such as which modules or functions are called by other modules or functions. You can use the reports to define the interface between two program subsystems, which is advantageous when differ-

ent programmmers are writing the subsystems. When you examine your programs, C Scan lets you use symbolic names to locate and display portions of code, regardless of the source-code file in which they're contained. By keeping a record of your program's files, C Scan lists the type of items in the program, such as functions, global variables, structures, and union members; upon your selection of an item, C Scan displays all items of that type in your program and lets you locate them. You can obtain the utilities separately or as part of the C Dev cross-development tool set, which also includes a C cross compiler, a mimic simulator, and a crossassembler. C Scan, £195; C Documenter, £195; C Dev, about £2000.

Real Time Systems Ltd, Viking House, Nelson St, Douglas, Isle of Man, UK. Phone (0624) 26021. TLX 94011289.

Circle No 413

REAL-TIME OS

- *Operates with minimal hardware configuration*
- *Provides many real-time tasks and features*

The UniFlex/RT multiuser, multitasking operating system for VME Bus systems based on the 68020 processor is now available for Apple's Macintosh II computer. The real-time features include fast message exchanges, a named enqueue/dequeue mechanism, shared data pages and text segments, and other facilities needed by real-time systems. The OS runs on a minimal Macintosh II computer that has at least 1M byte of main memory, 20M bytes of disk storage space free, and the 68851 memory-management chip. If you have a larger hard disk, you can partition the disk so that you can use the Mac OS as well as UniFlex/RT. The system comes with the utilities that you'll need for real-time, assembly-language software development, including a relocating macroassembler, a linking loader, a library generator, a symbolic debugger, and file- and system-maintenance programs. You can also obtain such options as a System V-compatible C compiler, X-Windows, a screen editor, and a text processor. $750.

Technical Systems Consultants Inc, 111 Providence Rd, Chapel Hill, NC 27514. Phone (919) 493-1451. TWX 510-920-0540.

Circle No 414

CROSS COMPILER

- *Generates efficient code for 8051 family of µCs*
- *Supports internal bit operations*

AVPAS51 version 3.0 is an optimizing Pascal cross compiler for the 8051 family of µCs. The language is a dialect of Pascal that is closely matched to the architecture of the

8051 family and that can use all 8051 memory spaces. When you're writing programs for enhanced µCs such as the 8052, you can also use the upper 128 bytes of on-chip memory to store variables. The compiler lets you declare individual subroutines as static, which reduces code size and improves execution speed. According to the vendor, the code is efficient enough that you should not need to rewrite time-dependent routines in assembly language. The compiler does not support a few Pascal features, such as real-number arithmetic, but it does support the interrupt handling, special-function registers, and internal bit operations of the 8051. The compiler runs on the IBM PC and compatibles. Compiler, $495; with AVMAC macroassembler, $795.

Avocet Systems Inc, Box 490, Rockport, ME 04856. Phone (207) 236-9055.

Circle No 415

IEEE-488 SOFTWARE

- *Lets you write IEEE-488 control programs in C or Pascal*
- *Runs under the OS-9/68k operating system*

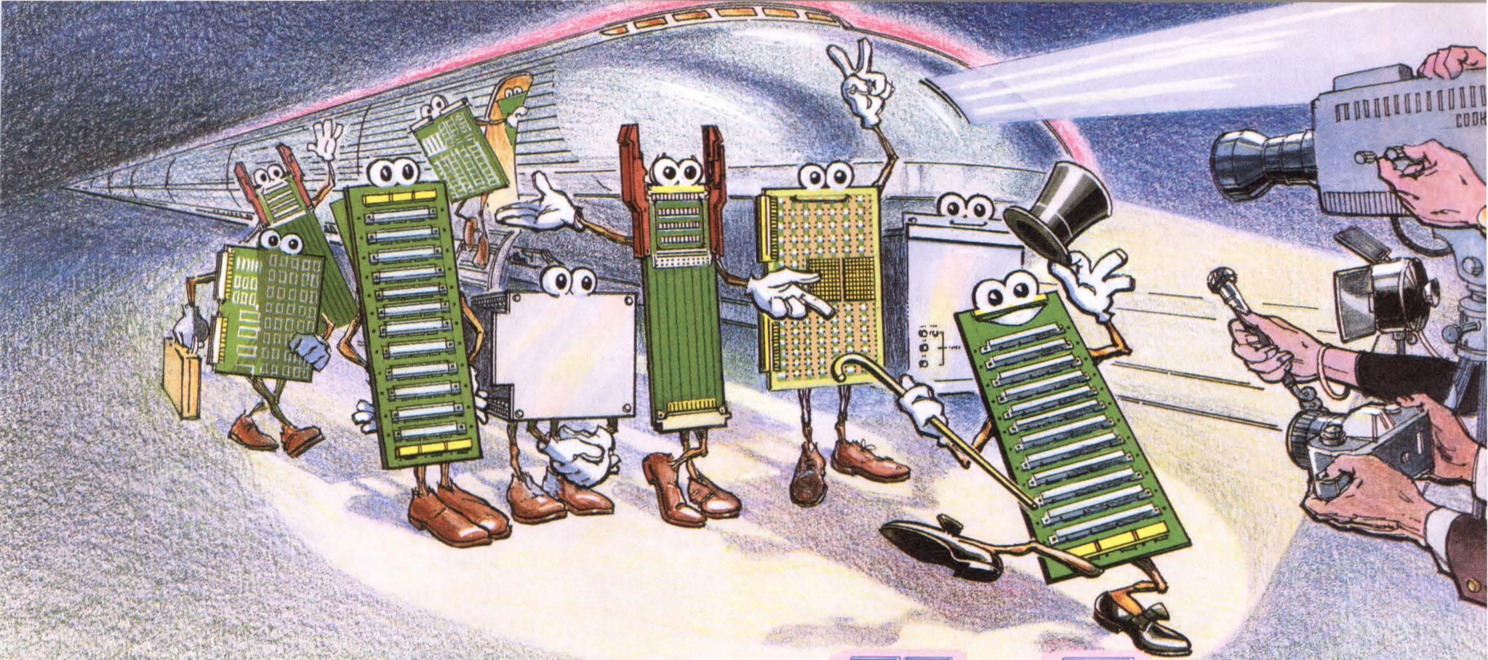
This IEEE-488 management software package allows a VME Bus computer system to control an IEEE-488 instrumentation bus. It lets you implement IEEE-488 talker, listener, and system-controller functions. The software comprises an IEEE-488 manager and an IEEE-488 device driver that run under the OS-9/68k operating system and that permit you to write application programs in C or Pascal. Running as a background task, the manager configures and initializes the IEEE-488 bus and arbitrates all communication between the IEEE-488 device driver software and the application program. To execute an IEEE-488 bus operation, the application program passes a command parameter block—specifying the device name and address, the action required, and the source and destination of transferred data—via the manager to the device driver. A device descriptor provides the driver with information about the addressed device's IEEE-488 capabilities. The manager also includes a time-out monitor to detect excessive delay in an instrument's response. The software package further includes sample device descriptors, a menu-driven system test program, and sample application programs. $750.

Compcontrol bv, Stratumsedijk 31, 5600 AD Eindhoven, The Netherlands. Phone (040) 124955. TLX 51603.

Circle No 416

Compcontrol Inc, 15466 Los Gatos Blvd, Suite 109-365, Los Gatos, CA 95032. Phone (408) 356-3817. TWX 510-601-2895.

Circle No 417



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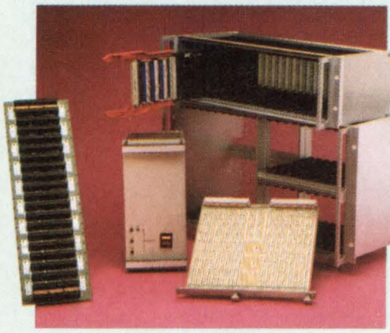

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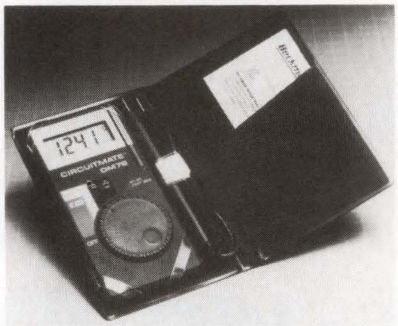


MINIATURE DMM

- *Is credit-card size*
- *Costs $29.95, including test leads*

The Circuitmate DM78 credit-card-size 3½-digit autoranging DMM features readings that range from 200 mV to 400V dc, 2 to 400V ac, and 200Ω to 20 MΩ. The error in dc voltage measurements equals ±0.7% of reading. The unit includes a carrying case, manual, and test leads. It features input impedance in excess of 1000 mΩ; ac overload protection to 700V rms; and a case that withstands 2 kV ac without arcing. The unit provides a low-voltage dc range as well as low- and high-resistance ranges. $29.95.

Beckman Industrial Corp, 3883 Ruffin Rd, San Diego, CA 92123. Phone (619) 495-3240.

Circle No 421

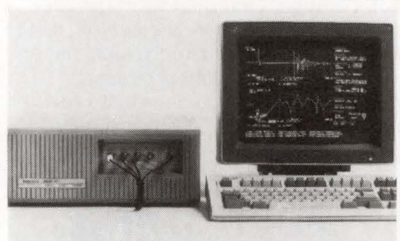
LOGIC ANALYZER

- *Captures 10M bits×64 channels*
- *Acquires 16-channel data at 200 MHz*

Without multiplexing, the K450M logic analyzer system can capture as many as 10 million, 64-bit-wide data frames at speeds as high as 50 MHz. From the front panel, you can reconfigure it to capture 40 million, 16-bit-wide data frames at speeds as high as 200 MHz. Another member of the series, the K450B, can record 80-bit-wide data frames. Each system includes an analyzer, an IBM PC/AT-compatible computer, and a multimegaword memory with either 2.5M bits or 10M bits/channel. The vendor also offers the 80386 MAP (microprocessor analysis package), an 80386 μP disassembler that also supports the 80287 and 80387 coprocessors. Analyzer, $165,000; disassembler, $2495. Delivery, 90 days and eight weeks ARO, respectively.

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

Circle No 422



FOURIER ANALYZER

- *Has two 20-kHz bandwidth channels*
- *Averages spectra in real time at 10 kHz*

The standard 23-lb 2630 Fourier analyzer comes with two channels, but you can also obtain a four-channel version. The analyzer samples all channels simultaneously and provides 20-kHz bandwidth on each channel, with 75-dB dynamic range. The unit connects to the RS-232C port of an IBM PC or compatible computer equipped with an IBM EGA or compatible card. The analyzer's capabilities include computation of transfer functions, power spectra, coherence, impulse response, and cross spectra. It performs real-time spectral averaging of data gathered at a 10-kHz rate.

Now benchpress 400 MHz. Easy.

Arium introduces The Tool for your bench. The 400 MHz logic analyzer at a price you can handle as easily as the ML4400 handles multiple pods simultaneously . . . starting at $4995.

Arium does it again.

We just redefined high-end logic analyzers in terms of low-end cost. With the 8/16/32-bit ML4400, you can combine up to four independent-clock cards (user-selectable) to get 16 channels at 400 MHz, 64 channels at 100 MHz (synchronous), or 160 at 50 MHz (synchronous). That means you can now handle full-speed 68030s or 80386s, as well as 68020s and 8086s. And, uniquely, up to four different microprocessors, simultaneously. That's speed our competition can't catch up with. Now for ease of use.

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Why Arium? How can Arium be the first to put this much low-cost power on your bench? Because we've always been first, ever since we redefined performance/price logic analyzers with our ML4100. When will the competition catch up with the performance/price of our new ML4400? Don't hold your breath.

For more data on the new ML4400, as well as on our family of Arium 8/16/32-bit logic analyzers at prices as low as $2495, contact ARIUM CORPORATION, 1931 Wright Circle, Anaheim, CA 92806-6052. Telephone 800/TO-ARIUM (800/862-7486), (714/978-9531 in CA).

ARIUM CORPORATION

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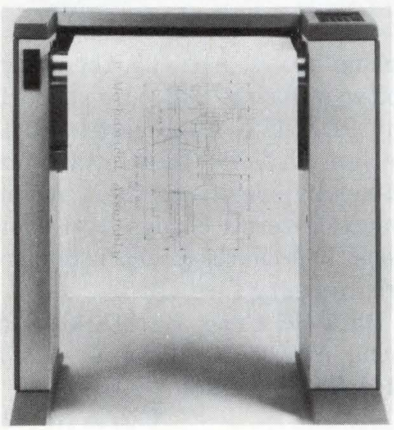
See us at ELECTRO, Booths 2356-2358

CIRCLE NO 76

The control program, which runs on the PC, allows screen dumps to plotters and to dot-matrix or laser printers. $9950.

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

Circle No 420



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- *Handle 24- and 36-in.-wide media*
- *Plot 200 points/in. at 1 in./sec*

Series 8500 electrostatic, monochrome printers plot 200 points/in. at 1 in/sec. The 8524 plots on 24-in.-wide media; the 8536 uses 36-in.-wide media. The units accept data in HPGL (Hewlett-Packard Graphics Language) 906/907 formats. The vendor claims that the printers are three to four times more reliable than earlier units because their parts counts are 30% lower. The units' rasterizers, which convert vectors to raster-scan data, can accept an unlimited number of vectors. A full-page buffer stores the last page printed, enabling you to rapidly obtain multiple copies of a drawing. The units can produce D-size copies at 1.67 copies/min. Their RS-232C ports accept vector data at 38,400 bps. 8524, $19,900; 8536, $24,900.

Versatec, 2710 Walsh Ave, Santa Clara, CA 95051. Phone (800) 538-6477; in CA, (800) 341-6060. TWX 910-338-0243.

Circle No 451

LCR ANALYZER

- *Measures C, leakage, ESR, and D/A of capacitors*
- *Measures L, ringing, and leakage of inductors*

The portable LC77 auto-Z meter analyzes inductors, capacitors, and resistors. It makes the following capacitor measurements: capacitance (C), leakage (shunt resistance), dielectric absorption (D/A), and equivalent series resistance (ESR). On inductors, it measures inductance (L), leakage resistance, and ringing. The meter counts the number of times that the voltage across a coil oscillates or rings following an interruption in current through the coil; the resulting total is related to the coil's Q (quality factor). The meter measures C from 1 pf to 19.99f, leakage current from 10 nA to 19.99 mA, ESR from 0.1 to 1990Ω, D/A from 1 to 100% of impressed voltage, L from 0.1 μH to 19.99H, and resistance from 50Ω to 999 MΩ. It can also test some active devices, such as SCRs and triacs. $1895.

Sencore, 3200 Sencore Dr, Sioux Falls, SD 57107. Phone (800) 843-3338; in SD, (605) 339-0100.

Circle No 423

RTD SIMULATOR

- *Simulates 2-, 3-, and 4-wire thermometers*
- *Covers −200 to +850°C*

The handheld, battery-powered RTD-700 can measure and simulate 2-, 3-, and 4-wire resistance temperature detectors (RTDs), or resistance thermometers. The unit operates in either Celsius or Fahrenheit mode, covers the temperature range from −200 to +850°C, and offers four digits of resolution, with simulation accuracy of ±0.1% of setting and readout accuracy of ±(0.1%+0.1Ω). The unit uses an industry-accepted test-current value of 1 mA to minimize the effects of self-heating of the detector. $725.

General Resistance Co, Box 185, North Branford, CT 06471. Phone (203) 481-5721.

Circle No 424

CONTROLLER ADAPTER

- *Supports programmable bus-controller IC*
- *Works with vendor's universal programming system*

The 303A-PLX LogicPak adapter works with the vendor's 29B universal programming system to program and test PLX Technology Corp's PLX 448 high-drive-current programmable bus controller. The PLX 448 meets VME Bus, Multibus I, and Multibus II specifications,

among others. Abel 3.0, the design software for the 29B, also supports the PLX 448. Abel allows you to design PLX 448-based state machines by specifying their performance in terms of high-level equations. It produces JEDEC-standard programming files. $495.

Data I/O Corp, Box 97046, Redmond, WA 98073. Phone (206) 881-6444. TLX 152167.

Circle No 425

ANALYZER

- *Monitors, emulates, and analyzes high-speed data links*
- *Suits development and testing of ISDN terminal equipment*

The DA-20 data-communications analyzer can capture and analyze data streams operating in full duplex mode at data rates as high as 72k bps. You can also use it to analyze the 192k-bps data on the S_0 interface of ISDN networks. Interchangeable EPROMs that plug into the instrument allow you to implement any data-communications protocol or procedure. The analyzer features two RX channels and one TX channel, allowing you to monitor, emulate, and statistically analyze data links. Data and programs are stored on 45M-byte tape streamer cartridges; you can thus build a library of instrument setups and results. You don't need a knowledge of high-level programming languages to program the instrument. You set it up via a simple menu-driven editor and soft-key controls. You can select transmission parameters manually or use the analyzer's autoconfigure mode, and you can store setup information either in nonvolatile RAM or on tape. The analyzer has an integral printer. Around $15,000.

Wandel & Goltermann, Postfach 1262, 7412 Eningen u A, West Germany. Phone (07121) 860. TLX 729833.

Circle No 426

Wandel & Goltermann Inc, 1030 Swabia Ct, Research Triangle Park, NC 27709. Phone (919) 941-5730. TLX 810-621-0002.

Circle No 427

LOGIC ANALYZER

- *Analyzes software performance at 50-MHz in real time*
- *Excludes irrelevant data from analysis*

The DT3750XA can study the performance of your software in real time at 50 MHz with no limits on the duration of the examination. The unit—which you can obtain with as many as 256 channels, configured in 16-channel increments—has logic-analysis capabilities that let you qualify the data it will consider and exclude irrelevant information. To avoid loss of data, a pair of 4k-word buffers store the acquired intelligence. While one buffer is filling, the other transmits its contents to a host computer via a high-speed interface. The state-machine triggering has 16 levels, with four test conditions per level. $13,000 to $90,000.

HiLevel Technology Inc, 31 Technology Dr, Irvine, CA 92718. Phone (714) 727-2100. TLX 655316.

Circle No 428

DMM

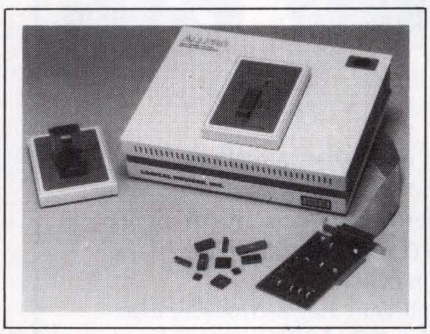
- *Performs six measurement types and resolves 5½ digits*
- *Incorporates 8-channel scanner*

The half-rack-width Model 199 DMM incorporates an 8-channel scanner and measures dc and ac voltage, dc and ac current, resis-

tance, and dB, with 5½-digit precision. The instrument is also available optionally without the scanner; if you purchase a unit without the scanner and later decide to obtain the scanner, you can add it yourself. The unit offers sensitivity of 1 μV, 1 mΩ, and 100 nA. It can take 150 readings/sec with 4½-digit resolution and, for one year after calibration, can measure dc voltages within an error rating of ±(0.007% of reading +2 counts). The scanner performs 40 measurements/sec, offers 2- or 4-pole switching, and introduces <1 μV of thermal offset. $995 to $1395.

Keithley Instruments Inc, 28775 Aurora Rd, Cleveland, OH 44139. Phone (216) 248-0400. TLX 985469.

Circle No 429



DEVICE PROGRAMMER

- *Programs PLDs, μPs, PROMs, and sequencers*
- *Software libraries support more than 1200 devices*

The AllPro/28 programmer handles 28-pin PLDs, EPLDs, μPs, EPROMs, EEPROMs, and programmable sequencers. You can upgrade the unit to handle 40-pin devices by adding pin-driver cards. This retrofit converts the unit into the vendor's AllPro/40. You need an IBM PC, PC/AT, or compatible computer to host the programmer.

The vendor will offer an interface card for IBM's PS/2 series in April 1988. The host computer runs the vendor's LogiPro support software, whose device library includes more than 1200 ICs. $2795.

Logical Devices Inc, 1321 NW 65th Pl, Fort Lauderdale, FL 33309. Phone (305) 974-0975. TLX 383142.

Circle No 430

BUS ANALYZER

- *On single I/O card for IBM PC/AT, PC/XT, or compatible*
- *Captures 8000 bus states in real time*

The BusTrak microsystem-bus analyzer performs many functions usually associated with logic analyzers, code debuggers, and PC testers. It is housed on a single I/O card that plugs into an IBM PC/AT, PC/XT, or compatible computer. The unit can capture 8000 80-bit-wide data frames in real time. You can set breakpoint conditions such as reads, writes, DMA requests, CPU bus cycles, DMA bus cycles, address or data ranges, or data-bus, I/O, or memory accesses. You attach the unit by plugging it in; there are no probes or clips. Its software can automatically scan acquired data and search for conditions that you define. $1495; demonstration diskette, free.

Applied Physics Inc, 1291-E Cumberland Ave, W Lafayette, IN 47906. Phone (317) 497-1718.

Circle No 431

DMM

- *Performs 18 types of measurements*
- *Permits 4½- or 5½-digit resolution*

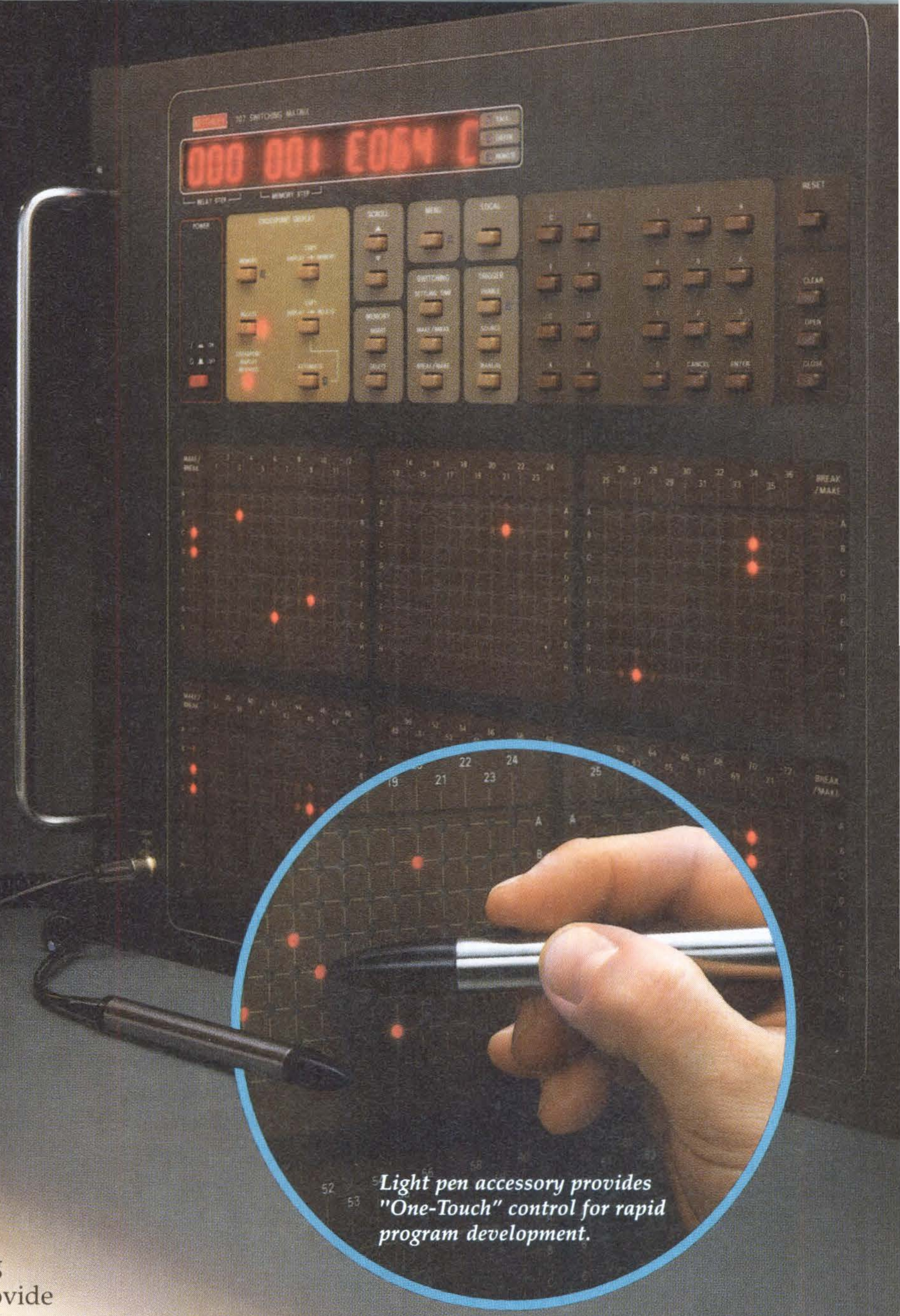
The PM2525 digital multimeter makes 18 kinds of measurements. It measures ac and dc voltage, ac and dc current, two- and four-wire resistance, capacitance, frequency, time, temperature, and decible level; it also checks continuity. The meter allows you to select a readout resolution of 4½ or 5½ digits; it provides five voltage, seven current, and eight resistance ranges. Its maximum resolution is 1 μV, 100 pA, 10 mΩ, and 1 pF, and its ac measurement bandwidth extends to 100 kHz. $795.

John Fluke Mfg Co, Box C9090, Everett, WA 98206. Phone (800) 426-0361; in WA, (206) 347-6100. TLX 185102.

Circle No 432

Superior Semiconductor Test Performance

Matrix Switching Solutions for your ATE

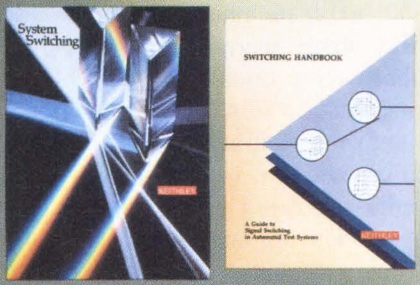


Light pen accessory provides "One-Touch" control for rapid program development.

Look to the leader in low-current performance to meet your semiconductor test needs. The new Model 707 Switching Matrix includes two sub-picoamp and two high frequency CV matrix switching paths. Four additional triaxial inputs provide signal paths with performance to 20pA. Mix general purpose and coaxial matrix cards to switch an entire spectrum of signals from 5μV to 200V, DC to 30MHz, in configurations up to 2880 relay crosspoints (8x360).

Integrate the Model 707 into your system quickly and easily, with preassembled cables and standard connecting hardware. General purpose, semiconductor, and coaxial switching cards are automatically interconnected through the analog backplanes, and are easily removed for maintenance.

Relay status is continually displayed on the 707's front panel. And the interactive Programming Light Pen accessory reduces program development time by eliminating keystrokes. Store up to 100 configurations in the 707's built-in, non-volatile memory for instant recall or fast triggered relay sequences.



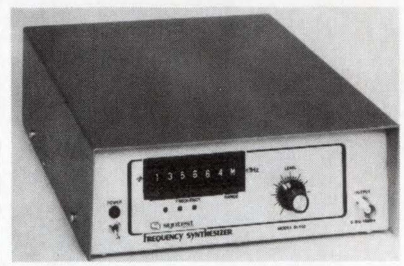
Technical support literature and our Applications staff will help you select the appropriate system configuration.

To get the complete story on Keithley switching, call **1-800-552-1115.**

The Model 707 Switching Matrix

KEITHLEY

CIRCLE NO 245



SYNTHESIZER

- *Generates 0.1 Hz to 16 MHz with 5½-digit resolution*
- *Optional oscillator provides 1 ppm stability*

The Model SI-102 frequency synthesizer provides 5½ digits of resolution and covers 0.1 Hz to 16 MHz. When operating at 1 Hz and below, the unit provides a resolution of 10 μHz; when running at 1 kHz and above, it offers 100-Hz resolution. You can choose between two reference oscillators: The standard one is stable within ±10 ppm, from 0 to 50°C; the optional reference is stable to ±1 ppm. The half-rack-width instrument consumes 8W from a 50- or 60-Hz, 115 or 230V ac line. The vendor also offers BCD-programmability as an option. $681.

Syntest Corp, 40 Locke Dr, Marlboro, MA 01752. Phone (617) 481-7827.

Circle No 433

ATE

- *Combines functional and in-circuit testing*
- *Available with either 128 or 256 functional test channels*

The System-730BT board-test system provides high-performance, 15-MHz functional testing, together with 10-MHz, in-circuit testing. You can dynamically switch between the two test techniques to optimize fault location strategies. Using the 15-MHz functional test channels around the edge of the board under test, you can detect device-interaction faults even on VLSI-based boards. Each functional test channel is backed by a 4k×4-bit RAM, which you can reconfigure to a 16k×1-bit RAM to handle long bit streams. All the channels are deskewed to eliminate propogation delay differences, and each channel offers 12 separate drive formats and measurement modes, including signature analysis. The system is available in either 128- or 256-channel forms and is suitable for high-speed cluster testing. It includes a timing generator in which the functional channels can apply algorithmic patterns, perform word recognition for triggering purposes, and provide both high- and low-frequency clock output functions. Around $280,000.

Schlumberger Technologies, ATE Div, Ferndown Industrial Estate, Wimborne, Dorset BH21 7PP, UK. Phone (0202) 893535. TLX 41436.

Circle No 434

Schlumberger Technologies, ATE Div, 1801 Technology Drive, San Jose, CA 95110. Phone (408) 998-0123.

Circle No 435

SIGNAL GENERATOR

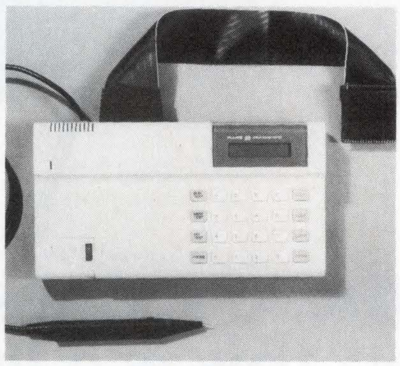
- *Provides phase noise of −130 dBc at 500 MHz*
- *Shows actual power-level at DUT despite cable losses*

The HP 8657A synthesized signal generator covers the 100-kHz-to-1.04-GHz range. When running at 500 MHz, its phase noise is −130 dBc; when operating at 1 GHz, its phase noise equals −124 dBc. The residual FM is <4 Hz. In combination, these characteristics allow you to use the unit to test selectivity of radios carrying −90-dB selectivity specs. The unit incorporates an electronic attenuator that, according to the vendor, sets new standards for

reliability; its estimated MTBF is 500 years. The generator provides a dc-FM mode with <10 Hz/hour drift, and an amplitude-offset mode. It also has 100 storage registers for production-line use. $7900. Delivery, eight weeks ARO.

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

Circle No 436



μP BOARD TESTER

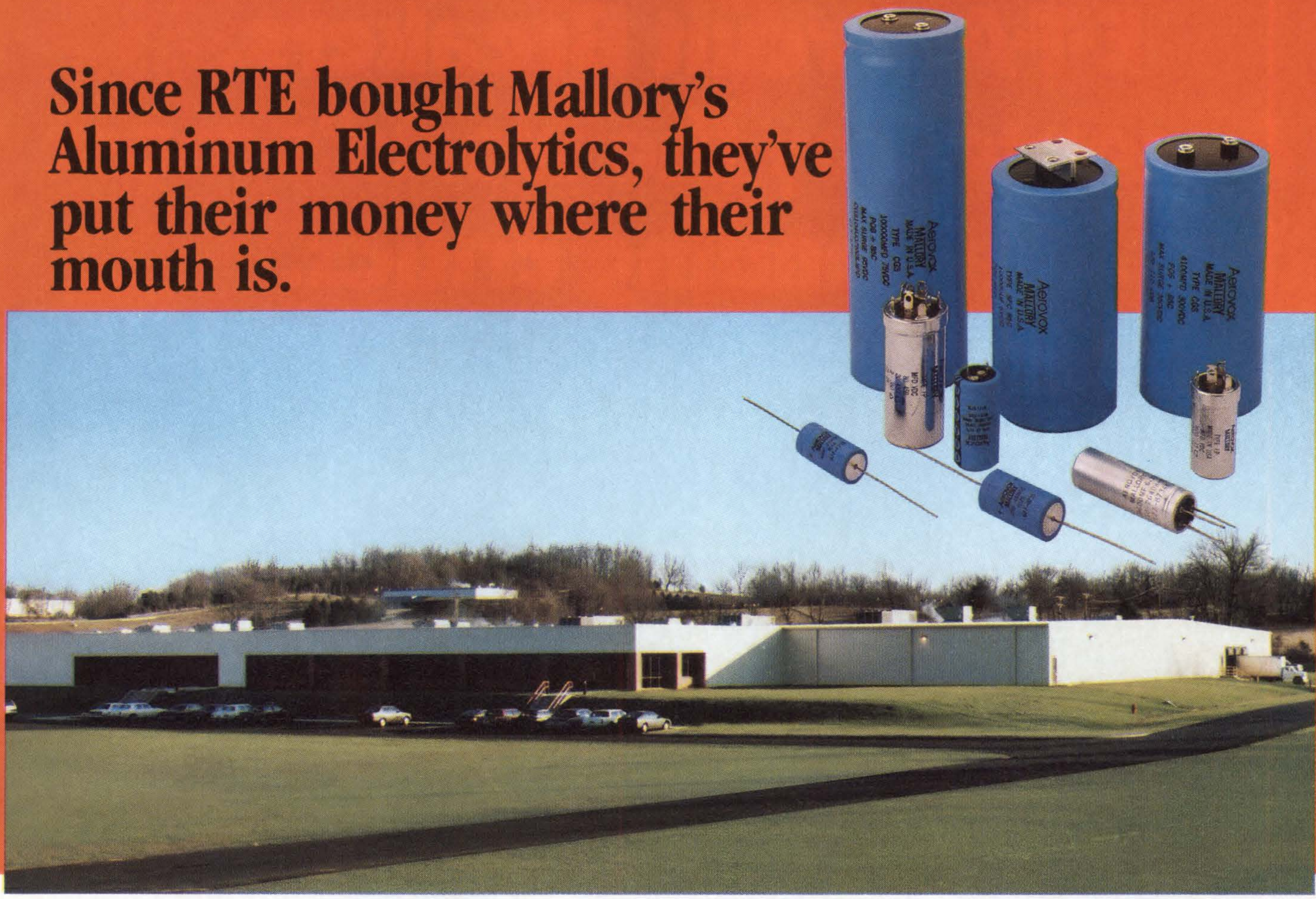
- *Clips onto boards with soldered-in μPs*
- *Tests circuits by overdriving bus and control lines*

You use the 90 Series stand-alone tester for troubleshooting pc boards that employ Z-80, 8085, and 6809 μPs. Because the tester clips onto boards under test, it can accommodate boards with soldered-in processor chips. Instead of emulating the processor, it "steals" processor cycles and overdrives the control and bus lines to test ancillary circuits, an arrangement that permits the unit under test to continue running while the tester executes diagnostic routines. Sixteen preprogrammed routines reside in the tester. The tester includes a 2-line×16-character LCD display and a 24-key keypad. You can also control it remotely via an RS-232C port. $1395.

John Fluke Mfg Co, Box C9090, Everett, WA 98206. Phone (800) 426-0361; in WA, (206) 347-6100. TLX 185102.

Circle No 437

Since RTE bought Mallory's Aluminum Electrolytics, they've put their money where their mouth is.



Announcing the latest, largest investment in this dynamic product line: our new Aerovox M plant – over 50% bigger & just across the street!

When RTE bought Mallory's aluminum electrolytic capacitor line last year, priority #1 was to retain the quality and respect this fine product line already enjoyed by retaining the same facility and skilled work force. However, they immediately began building for a bigger future with new management appointments plus major improvements like key equipment upgrades, in-house CAD-assisted engineering, and a computerized order entry/customer service system. Also, field sales was assigned to the service-driven rep and distributor organization of Aerovox Inc., another RTE company and a world-leader in AC capacitors.

But for the ambitious future RTE envisioned for this vital product line, we needed more room — fast! Available land across the street from the original Mallory plant allowed us to build — then move — without losing production or a single skilled worker!

Our new plant has been shipping product for over two months, with improvements in yields and quality already evident. So now our big news is about completing another giant step on our way to becoming #1 in aluminum electrolytics. For your next cap requirement, call your Aerovox rep or us, and see for yourself what a difference a full commitment to excellence can make in a product line that was outstanding to begin with!

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CIRCLE NO 243

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In fact, SAFT is the power behind this century's most innovative developments in electro-chemical energy systems. Our diverse experience includes military requirements as well as complex industrial applications, such as communications, instrumentation, metering, medical and business electronics.

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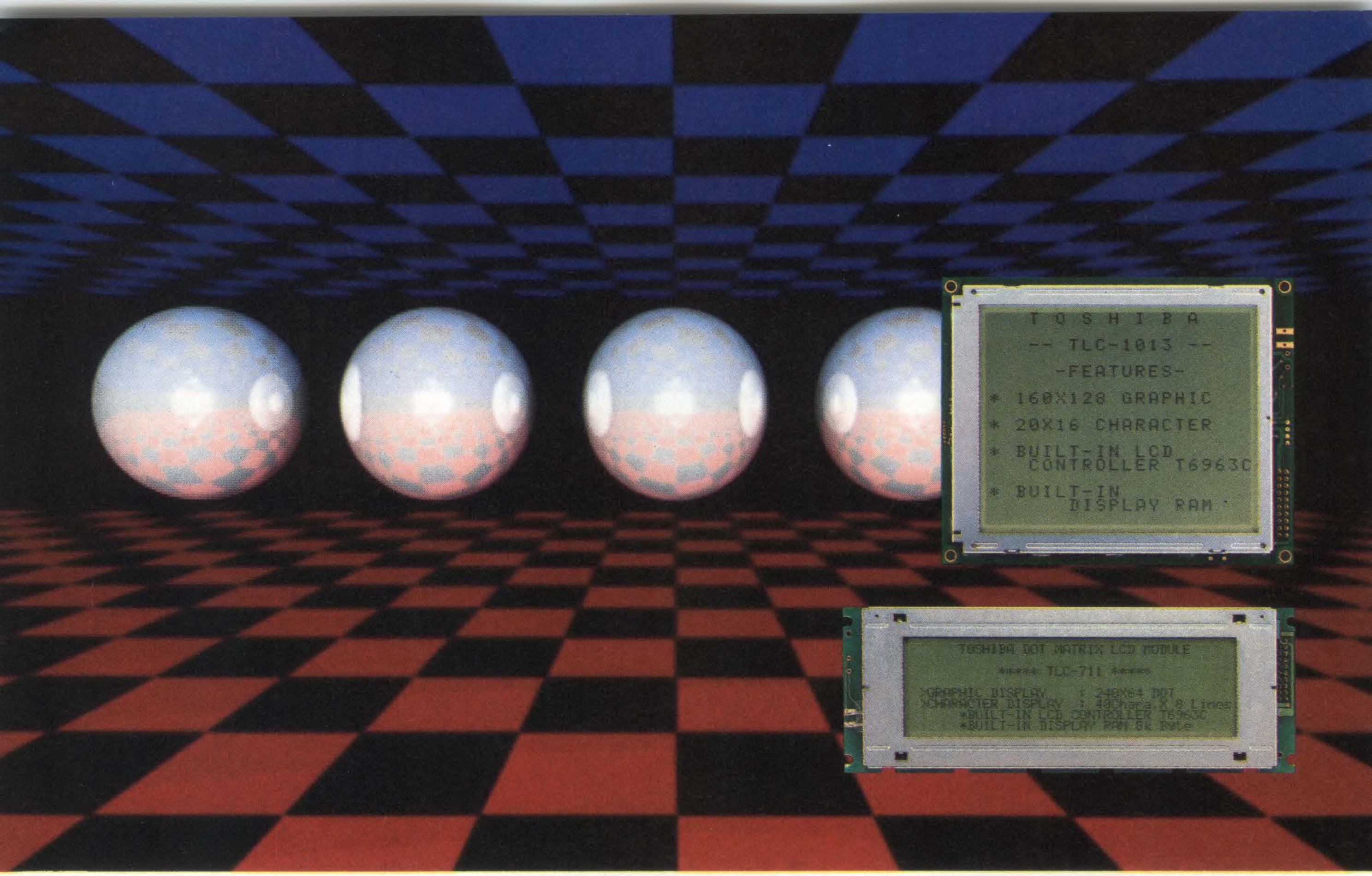
Contact Applications Engineering at SAFT America Inc., Portable Battery Division, 711 Industrial Blvd., Valdosta, GA 31601, Phone: 912-247-2331. Or contact SAFT America Inc., Lithium Battery Division, 107 Beaver Ct., Cockeysville, MD 21030, Phone: 301-771-3200.

SAFT

MORE POWER TO YOU.

CIRCLE NO 241

CGE



A Wide Lineup Builds Quality and Reliability

From small to large sizes, from character to graphic displays, Toshiba has a wide lineup of LCDs with high quality and superior readability. The employment of H-TN offers you easier reading. And built-in controllers enable easy operation. There's even a module that accepts an EL backlight. So when you look for an LCD — look for Toshiba.

Character Display Type with Built-in Controller

High character height and easy-to-read display.
Easy-to-use design thanks to high contrast TN.

Model name	Number of characters	Outline dimensions (mm)
TLC-671	16 × 1	80.0 × 36.0 × 12.0
TLC-241	16 × 1	80.0 × 36.0 × 12.0
TLC-491	16 × 2	80.0 × 36.0 × 12.0
TLC-731	16 × 4	87.0 × 60.0 × 12.0
TLC-501	20 × 2	116.0 × 37.0 × 12.5
TLC-721	20 × 4	98.0 × 60.0 × 12.0
TLC-691	24 × 1	126.0 × 36.0 × 12.0
TLC-771	24 × 2	118.0 × 36.0 × 12.0
TLC-601	40 × 1	182.0 × 33.5 × 13.0
TLC-591	40 × 2	182.0 × 33.5 × 13.0
TLC-1001	40 × 4	221.0 × 76.0 × 12.5

Graphic Display Type with Built-in Controller

Clear display thanks to high contrast TN.
Easy-to-use C/G, RAM and ROM built-in types.

Model name	Number of dots	Outline dimensions (mm)	Controller
TLC-1021	120 × 64	85.0 × 70.0 × 20.0	T6963C
TLC-682	160 × 64	125.0 × 50.0 × 18.0	T6963C
TLC-711A	240 × 64	180.0 × 65.0 × 12.0	T6963C
TLC-1013	160 × 128	129.0 × 104.5 × 14.0	T6963C
TLC-1091	240 × 128	241.0 × 125.3 × 12.0	T6963C
TLC-1101	160 × 32	140.0 × 40.0 × 12.0	T6963C

*We provide many options.
*We can meet the need for customized products.

Graphic Display Type

Clear display through employment of high contrast TN.
Capable of displaying large-size letters and special letters.

Model name	Number of dots	Outline dimensions (mm)	Controller
TLC-612	640 × 32	320.0 × 48.0 × 14.0	(T6963C)
TLC-761	640 × 64	320.0 × 47.0 × 14.0	(T6963C)
TLC-341AK	128 × 128	93.2 × 86.6 × 12.0	(T6963C)
TLC-531A	128 × 128	132.2 × 111.0 × 13.0	(T7755)
TLC-972	480 × 128	274.0 × 114.4 × 20.0	(T7755)

( ): Recommended controller ICs.

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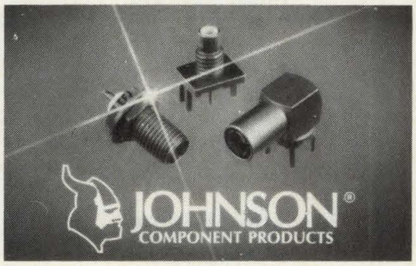

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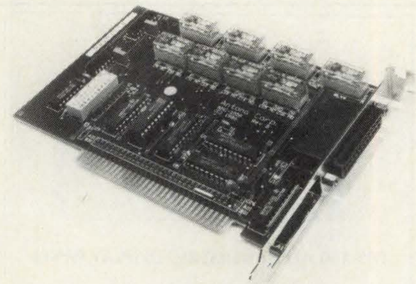


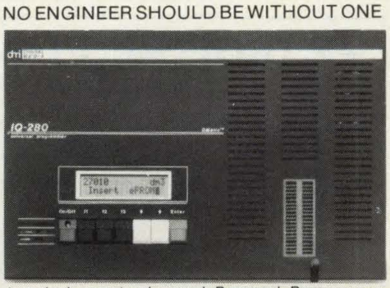
RELAY CARD FOR THE IBM PC

The ANC-1008 provides the IBM PC with 8 discrete relays to control up to 115 VAC/1 Amp. Each relay provides a normally open/closed output, and sites for "snubber" capacitors. A 9-element LED array displays card status. Programming can be performed directly in BASIC. Unit pricing is $149.00.

Antona Corporation
1643 1/2 Westwood Blvd., L.A., CA 90024
(213) 473-8995

CIRCLE NO 327

NO ENGINEER SHOULD BE WITHOUT ONE



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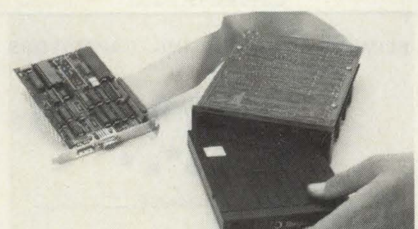

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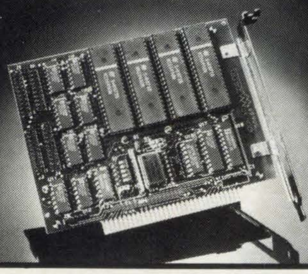

SEALEVEL

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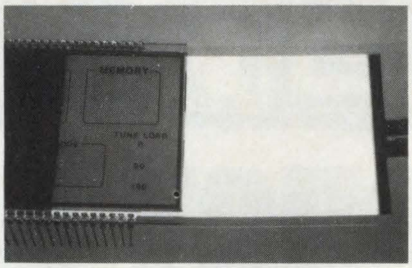

EL LCD BACKLIGHTING.

To backlight or not to backlight? With BKL's EL lamps, the answer is simple, inexpensive and fast! BKL's extremely thin (.012" to .018") quality lamps are made from Kard-O-Lite, a patented electroluminescent material that's easily die-cut to any size, any shape. For the fastest turnaround in the industry, at a drastically reduced cost, call Dean Smith, 215-277-2910.

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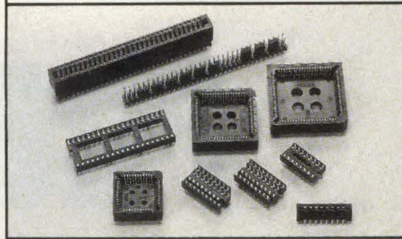

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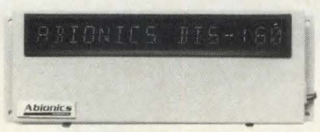

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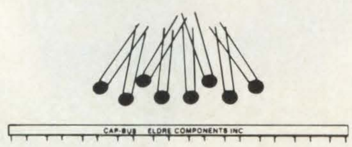

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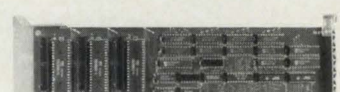

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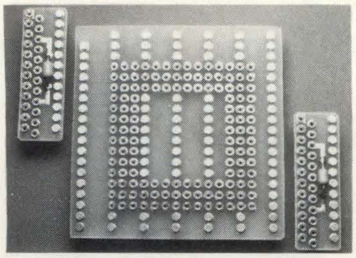

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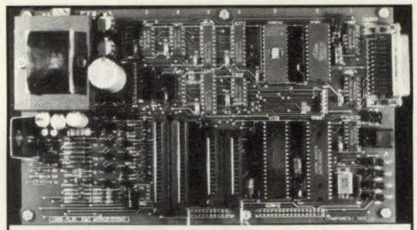

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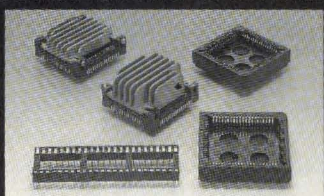

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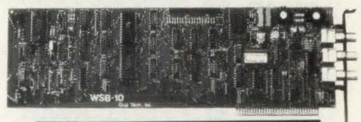

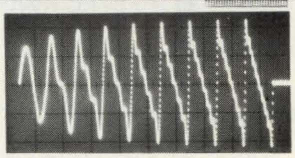

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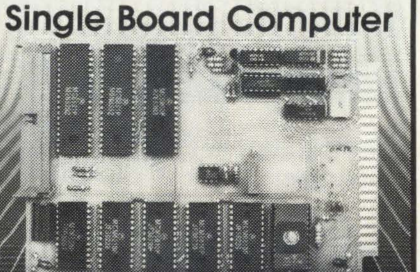

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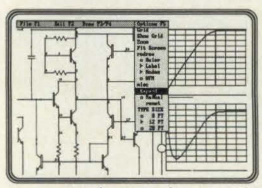

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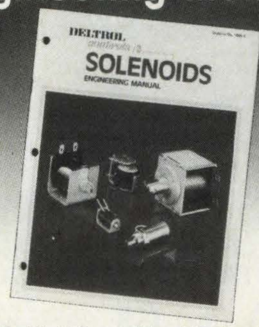

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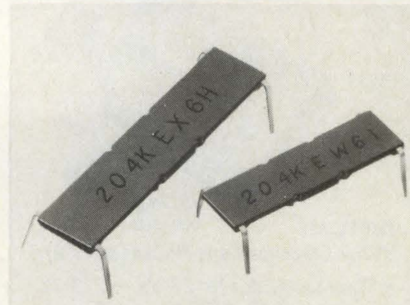

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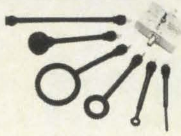

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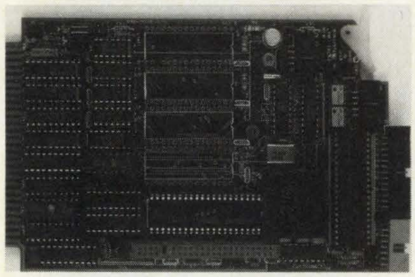

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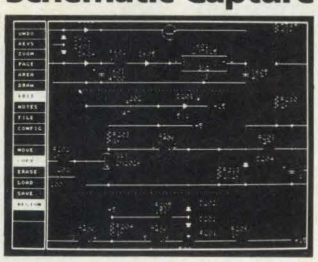

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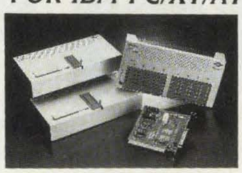

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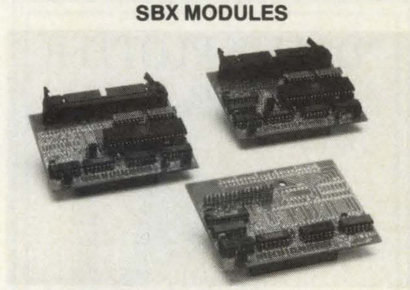

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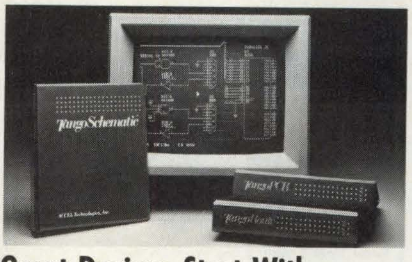

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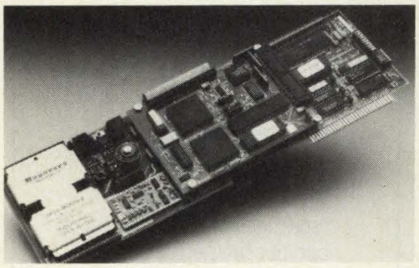

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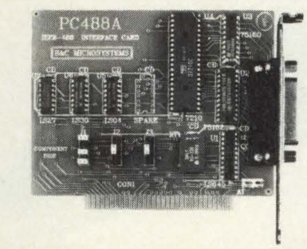

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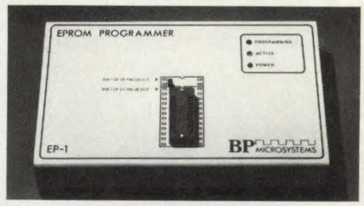

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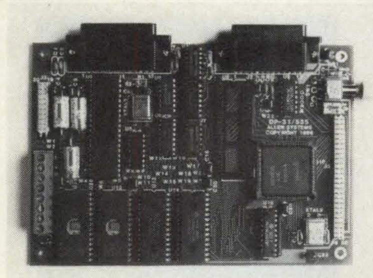

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The CP-196 is based on the high-end 80C196 microcontroller on a chip. The board supports up to 60K bytes of EPROM / RAM, 8 channel ten-bit A/D converter, 4 eight-bit parallel ports, 3RS-232/RS-422 buffered serial ports, 3 time / counters, and is fully CMOS. We also feature boards based on the 8051, 8096, and 68HC11. Available as bare boards or assembled and tested. EPROM resident System Monitors and BASIC interpreters are also available.

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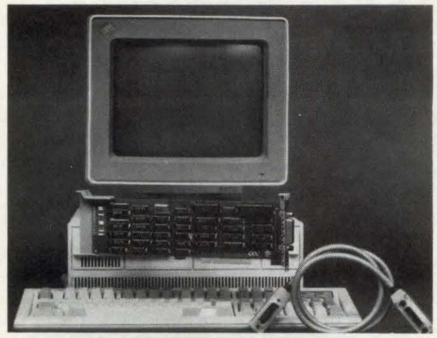
CIRCLE NO 786



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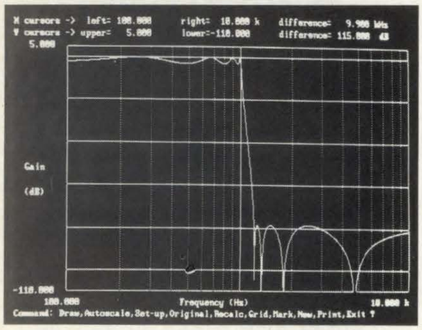

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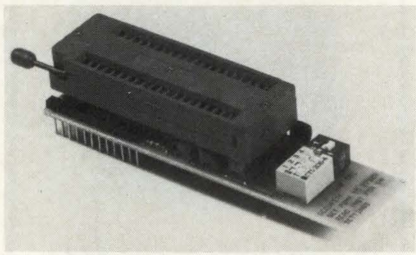

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The UPA87C51 converts general purpose programmers into 8751/C751 programmers. Select 2732A on your programmer, plug in the UPA, and you have an 8751/87C51 programmer. With the UPA87C51 you can also program the 8751 and 87C51 security bits and the 87C51 encryption array. It's very simple and VERY cost effective.

Price $125 including UPS ground shipping. Adapters are also available for the 63701V0, 63705V0, and 8751 and are priced at $65-$95.

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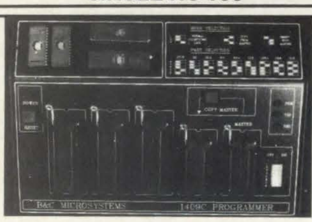

UNIVERSAL E(E)PROM PROGRAMMER $495 (Kits from $165)

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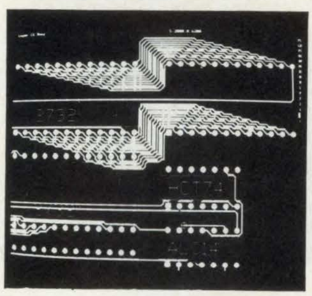

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AutoPCB is a professional quality, PC/AT-based PCB design system integrated with AutoCAD. It features schematic capture, interactive part placement and route editing, and a powerful autorouter that uses artificial intelligence techniques to identify optimal routing patterns, as shown above, as part of the routing process. All layers of multilayer boards are routed simultaneously. Post processors for photoplotters and drill tapes are available. A large, 4500 component part library lets you start designing boards immediately. Complete PCB design systems are priced from $1995 to $4295.

PRO. LIB, INC., 624 E. Evelyn Ave., Sunnyvale, CA 94086
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CIRCLE NO 792

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MICRO/Q capacitors can be retrofitted to solve noise problems on existing boards. Because MICRO/Q caps share mounting holes with existing IC pins no board redesign is required. Effective decoupling becomes a matter of adding one insertion step. **Rogers Corp.,** 2400 S. Roosevelt St., Tempe, AZ 85282. 602/967-0624

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VME:AT

ELTEC's new VMEbus module VME-AT closes the gap that IBM left open in industrial control.

- Fully IBM AT-03 compatible VMEbus CPU module
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- Fully VMEbus Master Slave Interface (D16 : A24)
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- On-board EGA Bios
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- IBM PC bus available on separate connector for test and debugging
- Runs MS-DOS, PC-DOS and OS/2
- Multiprocessor software available between OS9 based realtime CPU's and the VME-AT running under MS-DOS

Eltec's new VME-AT CPU module builds the bridge between PC Software and Industrial VME hardware. Software that has been written under MS-DOS or OS/2 will run on the VME-AT without modification. Due to its dual ported RAM and special semaphore registers, the VME-AT is particular well suited for multiprocessor applications.

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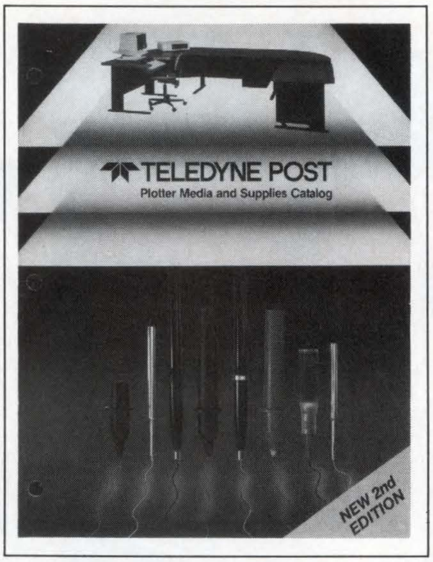


Publication lists plotter media and supplies

This 52-pg, 4-color catalog deals with the vendor's selection of plotter media from bonds and vellums to polyester drafting films and custom-printed forms. It contains a new section of business graphics films designed for use with plotters and nonimpact printers. It also describes HP plotters: HP DraftPro of personal CAD systems and the DraftMaster designed for a shared-resource environment. The publication provides photographs and specifications for plotter supplies including pens, inks, and adapters. A pen/media compatibility chart as well as a plotter-pen, trouble-shooting guide are also included.

Teledyne Post, 700 E Northwest Hwy, Des Plaines, IL 60016.

Circle No 438

Newsletter to cover impact of superconductivity

SuperConductor World Report (SCWR) is a newsletter covering developments in superconductivity. It focuses on the interests of business executives, strategic planners, investment analysts, and product engineers all over the world. Therefore, rather than handle superconductivity as a scientific phenomenon, SCWR will concentrate on the technology's economic and industrial uses, as well as its social and political implications. The second issue, for example, presents articles on investments, futures, government funding, and market strategy. Annual subscription, $385.

Empire Communications Group, 23 Empire Dr, St Paul, MN 55103.

INQUIRE DIRECT

Folder introduces absorption material

This introductory packet includes a folder and a sample of Poron products, the vendor's high-density cellular urethanes. It describes five simple tests that you can conduct right at your desk. The tests demonstrate energy absorption, resistance to impression, self-healing after puncture, resiliency, and resistance to long-term compression set.

Rogers Corp, 1 Technology Dr, Rogers, CT 06263.

Circle No 440

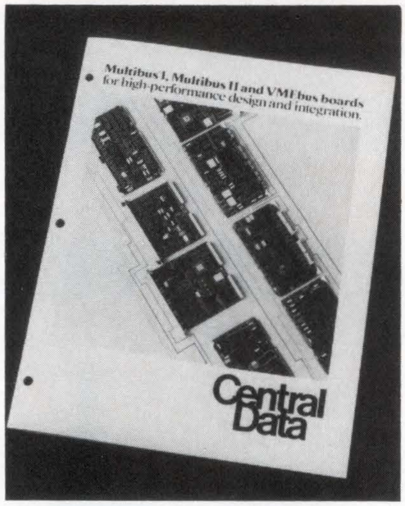
Two ways to design antenna systems

The 6-pg technical bulletin *Celwave Opens the Door to 900 MHz Trunking* explains two practicable methods of designing and equipping 10-channel, 900-MHz antenna systems. These methods include the

use of combiners, receiver multicouplers, duplexers, antennas, and cable.

Celwave RF, Div of Radio Frequency Systems Inc, Route 79, Marlboro, NJ 07746.

Circle No 441



Multibus I and II boards cataloged

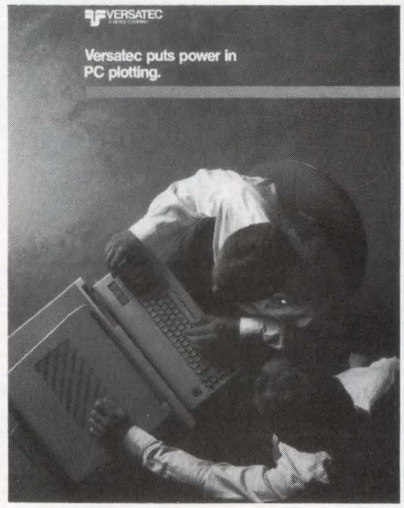
This 35-pg catalog covers a complete line of Multibus I boards and accessories, and four new Multibus II products. It contains photographs, descriptions, and specifications for more than 30 Multibus I, Multibus II, and VME Bus board-level products. It describes a Multibus II communications controller, a SCSI and floppy controller, an SBX single-board computer, and an intelligent prototype board.

Central Data Corp, 1602 Newton Dr, Champaign, Il 61821.

Circle No 442

How to connect plotters to personal computers

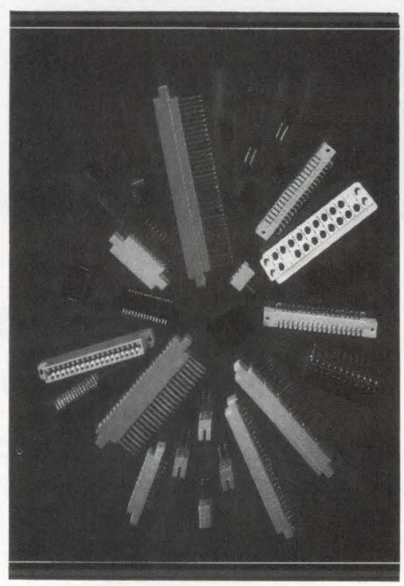
The 4-color brochure, *Versatec puts power in personal-computer plotting,* tells you how to receive hard copy information on your IBM PC or compatible, or your Macintosh personal computer. Its diagrams show the configurations, including software, interface or rasterizer, and plotter. Besides discussing the ad-



vantages of using electrostatic and thermal transfer plotters, the folder also contains a product table to help you select the right plotter for speed, size, and high-quality output.

Versatec, 2710 Walsh Ave, Santa Clara, CA 95051.

Circle No 443

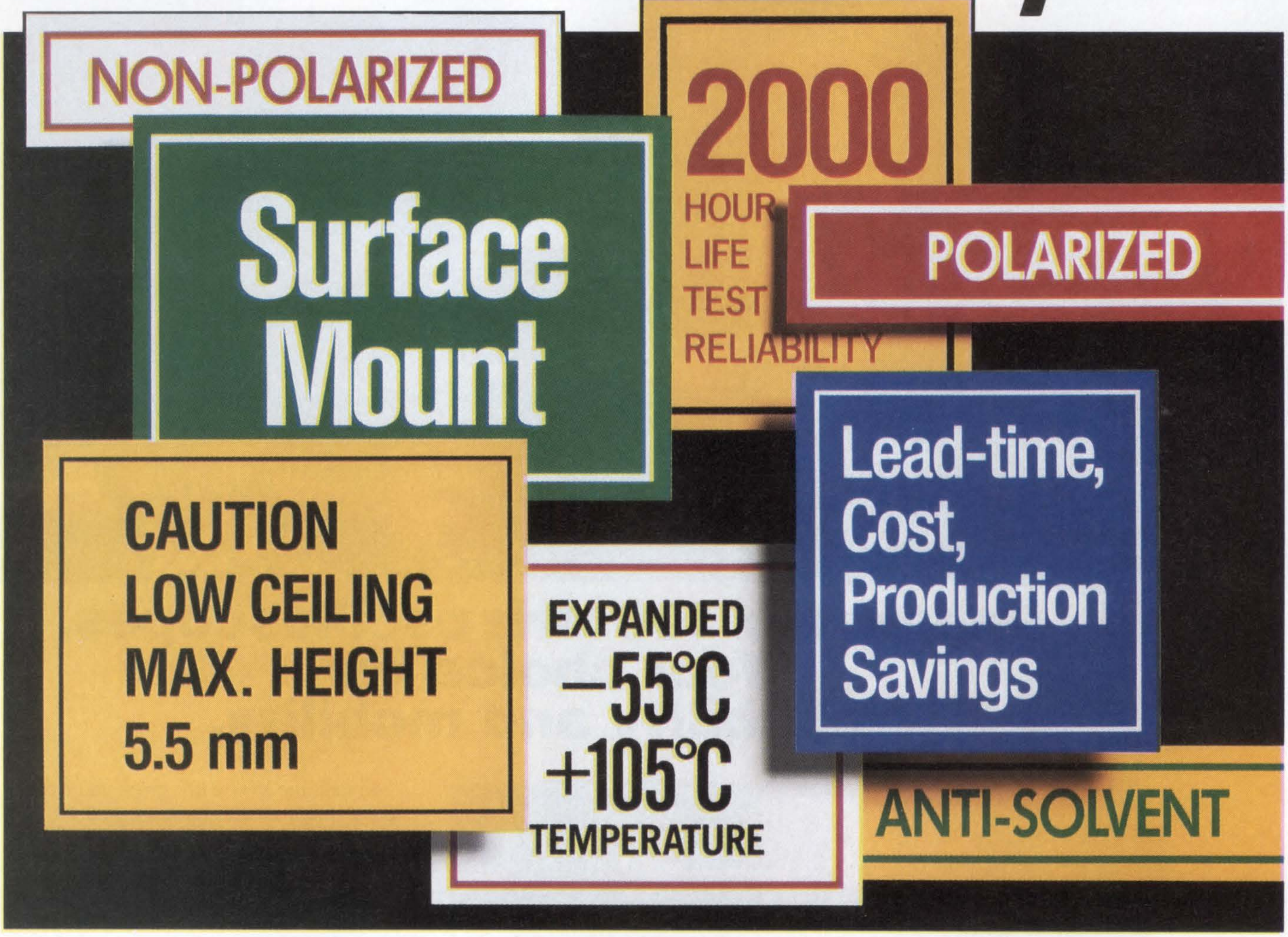


Booklet features card-edge connectors

The 36-pg catalog *Card Edge Connectors* focuses on the vendor's card-edge-connector series that come on 0.05- to 0.336-in. contact centers with wire-wrap, dip-solder, solder-eye, and right-angle terminations. The descriptions of the 56 connector

Continued on pg 344

Aluminum Electrolytics



All signs point to Nichicon surface mount electrolytics.

In surface mount capacitors, success breeds success.

And with four new surface mount electrolytic capacitor series ready to help your products meet their marketing window—on budget, all signs now point to Nichicon.

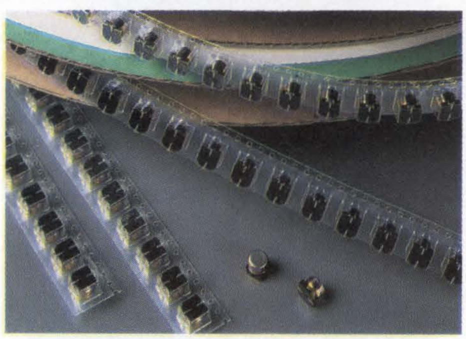
Save time. Save space. Save money.

Who isn't under pressure these days to reduce costs?

Well now you can, without sacrificing performance, when you design your new products or replace comparable tantalum capacitors with one of our new surface mount electrolytics.

More Nichicon advantages.

Your real bottom line though is still capacitor performance. And with four tantalum equivalent Nichicon surface mount electrolytic capacitor series to choose from, your chances of finding your capacitor choice are better than ever.



SERIES	FEATURE
UP	Non-polarized/ −40°C∼+85°C 6.3∼50V/0.1∼47μF
WX	2,000 hour life/5.5mm max. ht. 4∼50V/0.1∼220μF
UT	−55°C∼+105°C 4∼50V/0.1∼100μF
MX	2,000 hour life/6.3mm max. ht. 4∼50V/0.1∼220μF

Of course, each series is carrier-taped and reeled and features Nichicon's anti-solvent design.

For your free Nichicon Surface Mount Electrolytic Capacitor data sheet or more information, call one of our customer service representatives at (312) 843-7500. Or, call your local Nichicon representative or distributor.

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One good idea after another.

CIRCLE NO 36

series incorporate specifications, dimensional drawings, and photographs.

Methode Electronics Inc, Connector Div, 7447 W Wilson Ave, Chicago, IL 60656.

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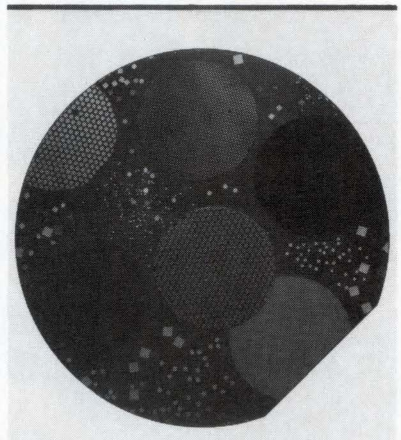


diode chips

Brochure deals with diodes

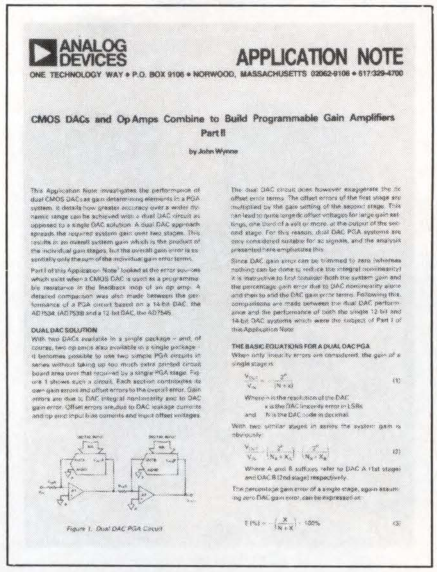
The 12-pg brochure *Diode Chips* outlines unencapsulated die and surveys die geometries, types, and metallizations. Specific chips are available through the level equivalent of the Joint Army-Navy Specification. Devices offered in chip form include zener diodes, rectifiers, transient suppressors, and temperature-compensated chips.

Microsemi Corp, 2830 S Fairview St, Santa Ana, CA 92704.

Circle No 445

How to build programmable gain amplifiers

The 12-pg application note, *CMOS DACs and Op Amps Combine to Build Programmable Gain Amplifiers, Part II* examines the performance of dual-CMOS DACs as gain-determining elements in a programmable-gain-amplifier (PGA) system. It discusses how you can achieve greater accuracy over a wide dynamic range, using a dual-DAC circuit. Some of the subjects in the note include basic equations for



ANALOG DEVICES

APPLICATION NOTE

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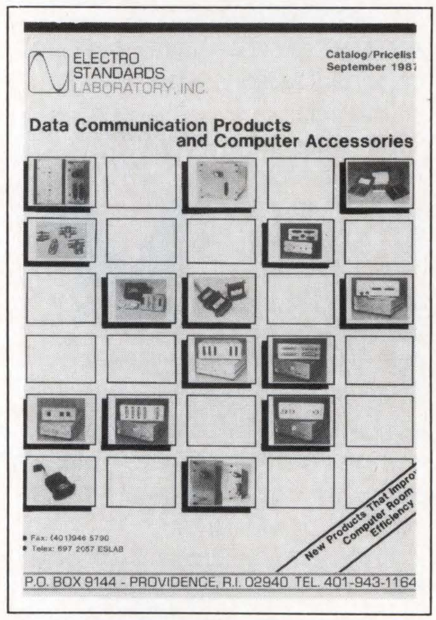
CMOS DACs and Op Amps Combine to Build Programmable Gain Amplifiers
Part II

by John Wynne

a dual-DAC PGA, comparing errors, small-signal bandwidth, and dynamic gain errors. Equations, circuit diagrams, and tables illustrate the text.

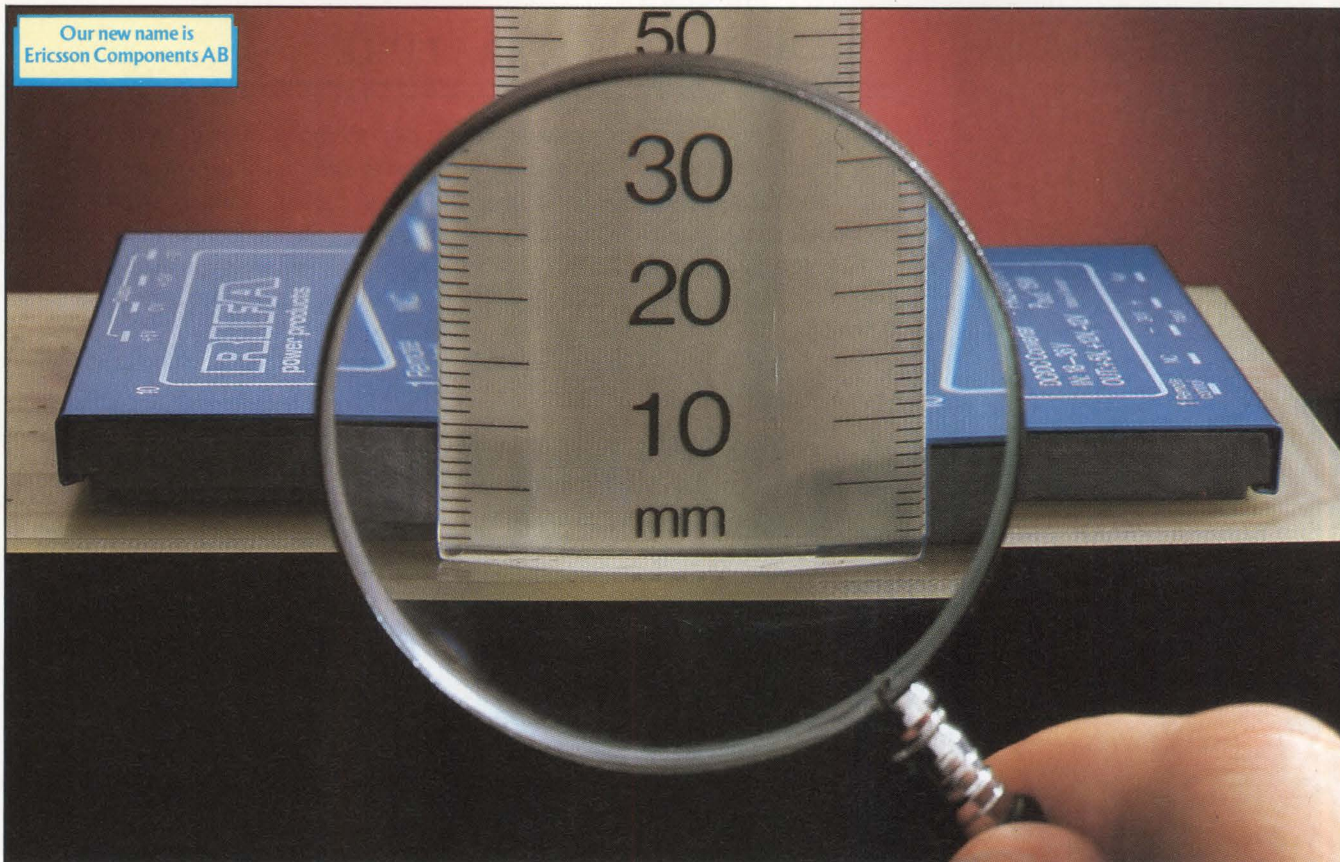
Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021.

Circle No 446



Computer and datacomm products categorized

This product catalog can help you plan a new network installation, or maintain or expand existing networks. It contains the vendor's line of RS-232C breakout boxes; cable adapters; line drivers; modem elimi-



High performance power, in a low profile package

Ericsson's new triple output, 15 Watt DC/DC converter is only 8·5mm high with In-Card™ mounting!

When you need high performance and a low profile in a DC/DC converter, Ericsson's new 15W PKC series has the answer.

The PKC's advanced mechanical design offers two mounting options, Using conventional "On-Card" pcb mounting results in a height of 0·42" (10·7mm).

Where profile is critical our In-Card™ mounting provides the unique capability of recessing the supply into the pcb providing a height of 0·33" (8·5mm)!

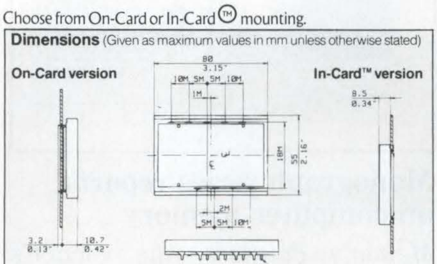
Allowing inputs of 24V (18-36V) and 48V (36-72V) the PKC series provides 5, 12 and 15V dc outputs in single, dual and triple output configurations. A high reliability magnetic feed back loop ensures that all outputs are regulated to within 2·5%. Each model is fully isolated to 500V dc and all outputs are overvoltage protected.

Advanced technology, including the use of highly automated surface mount manufacturing and 300kHz switching frequency results in the PKC's exceptional MTBF of over 200 years.

SMD components are assembled onto a thick film ceramic substrate to give excellent thermal characteristics. As a result, efficiency is 85% and the unit operates without derating over the temperature range of −45°C to +85°C!

The PKC takes up no more pcb space than a credit card.

Choose from On-Card or In-Card™ mounting.



No extra components, filters or heatsinks are required to meet VDE, FCC or CISPR regulations with respect to RFI specifications or high temperature environments.

Paralleling units for higher output requirements or redundancy configurations is easily accomplished by a simple connection.

To find out more about the world's most advanced 15W DC/DC converter, contact Ericsson today.

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nators; surge protectors; computer and printer switches; data, bulk-data, and personal-computer cables; and twin-axial interface products.

Electro Standards Laboratory Inc, Box 9144, Providence, RI 02940.

Circle No 447

How to find video digital signals with an MCP scope

The application note *See Digital Controlled Video Signals and Make Precision Timing Measurements Using the 2467 Portable Scope (38W-6797)* explores a wide range of measurement techniques from basic video to digital/frame-rate timing. It reports on the measurement of pulses as narrow as 50 nsec and explains how you can see them in full detail on a microchannel-plate CRT scope. The note provides several illustrations of this waveform-viewing feature.

Tektronix Inc, Box 1700, Beaverton, OR 97077.

Circle No 448


MEMORY
POINTERS 3
A SERIES OF MONOGRAPHS ON COMPUTER MEMORY—PUBLISHED BY CLEARPOINT
The Workstation Wars
... a Memory Perspective
New from Clearpoint
Apollo DN4000 Compatible Memory
PCs? Real Contenders?
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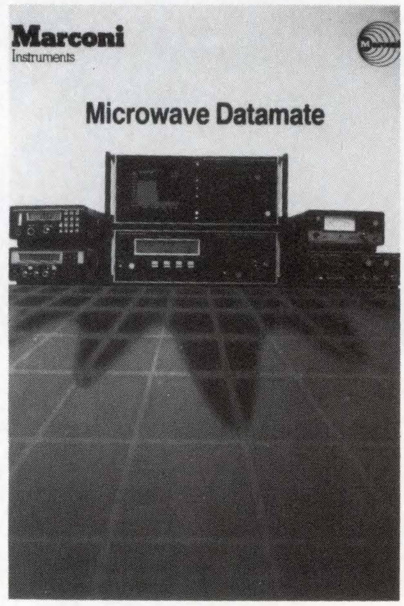
PCs

Monograph series reports on computer memory

Memory Pointers, the vendor's newsletter, analyzes current technical developments in the add-in computer-memory market and analyzes the various computer memory offerings of Apollo, Sun, Hewlett-Packard and others. It provides regular features such as a question and answer column and a new-product section.

Clearpoint Inc, 99 South St, Hopkinton, MA 01748.

Circle No 449



Reference for microwave and RF engineers

The 61-pg brochure *Microwave Datamate* deals with topics such as microwave applications by frequency, waveguide parameters, connections, transmission lines, power measurement, and scalar network analyzers. Following the first section on general information is an explanation of satellite and terrestrial telecommunications systems. Another section examines waveguide parameters and has a waveguide data chart. Among the subjects highlighted in the final section are IEEE-488 programming, a status and message-exchange overview, S-parameters and transformations, and scattering parameter relationships.

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401.

Circle No 450

0 to 60 in 5 seconds

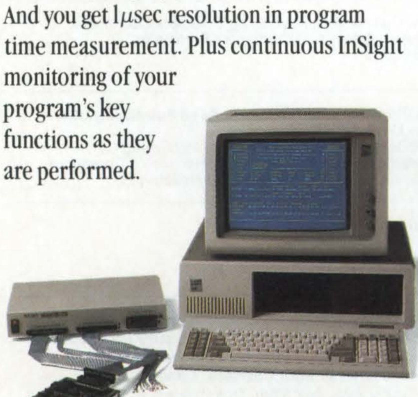
with new UniLab 8620 analyzer-emulator.

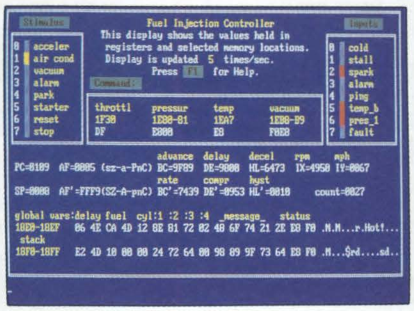
■ 64Kbytes from hard disk in 5 seconds. That's moving. But today you've got to be fast just to stay in the race for better microprocessor designs.

■ The secret is a new, high-speed parallel interface: the Orion bus. Which zips data between your PC/AT and the 8620 analyzer-emulator, breaking the RS-232 bottleneck.

■ The 8620 with O-bus gives you complete program diagnosis — and solutions — in real time. For more than 150 different microprocessors. Using **the same command set** environment.

■ A generous 2730 trace-cycle buffer with selective filtering lets you cut through the clutter and display just the traces you wish. And you get 1μsec resolution in program time measurement. Plus continuous InSight monitoring of your program's key functions as they are performed.



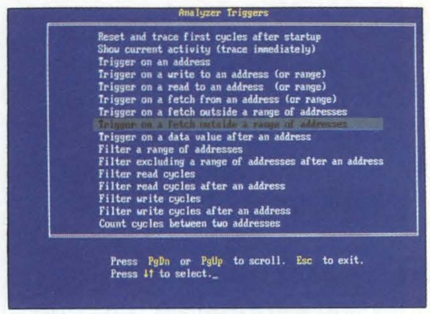


InSight Display. InSight blends analyzer-emulator techniques to give you continuous, real time monitoring of key processor functions. And still services user interrupts. It displays changing register contents, I/O lines, ports, user-defined memory windows. With your own labels.

■ On top of that, you get UniLab's trademark ability to debug by symptom, not just by breakpoint and single step. And, to help you complete the job on time, on the spot, a stimulus generator and EPROM programmer are included.

■ Ease of use, another Orion trademark, is also built in. So you have all the familiar features and formats you're used to working with. It doesn't matter if your project is a single chip controller or complex 16-bit microprocessor, the 8620 is the top price/performance analyzer-emulator that does it all. At just $4380. With processor Personality Paks typically $550 each.

■ UniLab 8620. Fast-lane debugging that gets you to market quicker.



Analyzer Triggers. Commonly used triggers can be selected quickly from a list of standard and user-defined triggers.

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In CA: 415/361-8883

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Computer Integrated Instrumentation

CIRCLE NO 96

EDN's CHARTER

EDN is written for professionals in the electronics industry who design, or manage the design of, products ranging from circuits to systems.

EDN provides accurate, detailed, and useful information about new technologies, products, and design techniques.

EDN covers new and developing technologies to inform its readers of practical design matters that will be of concern to them at once or in the near future.

EDN covers new products
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- that have technical data specified in enough detail to permit practical application
- for which accurate price information is available.

EDN provides specific "how to" design information that our readers can use immediately. From time to time, EDN's technical editors undertake special "hands-on" projects that demonstrate our commitment to readers' needs for useful information.

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CIRCLE NO 94

IEEE database service encourages entrepreneurial urges

Deborah Asbrand, *Associate Editor*

The latest addition to the IEEE's résumé-database service matches independent consultants with potential corporate clients. The IEEE intends the database to serve both members who maintain their own consulting practices and those who are retired but desire part-time work. But it also has a third—much larger—group in mind: industry-employed members who would like to try consulting.

The database is part of the IEEE's effort in recent years to lend more support to its members' entrepreneurial urges. One reason the organization formed the new résumé service, called the Self-Employed Engineers Registry (SEER), was to give business-minded members an outlet for making contacts and undertaking independent assignments without having to give up full-time corporate employment first.

SEER is based on the success of the Professional Engineering Employment Registry, known as PEER. The PEER service contains the résumés of job-seeking engineers and scientists from 30 technical societies. The database has more than 300 clients, who access the system through terminals installed in their own facilities. PEER began operating in 1984. Since then, it has become one of the most successful of the computerized résumé services.

But there are important differences between SEER and PEER. In the PEER files, individuals' names don't appear on the résumés. A company identifies candidates who interest them by using code numbers, which are assigned to the résumés by Career Technologies Corp, the Andover, MA, business that maintains the service. Career Technologies then contacts the individuals that a company has expressed interest in.

SEER, on the other hand, is not confidential. Individuals' names appear on the résumés that employers review. SEER still acts as an intermediary in the notification process, however: Employers who access the database contact SEER about a consultant they're interested in, and SEER then contacts the individual. Because of SEER's nonconfidentiality, the IEEE encourages engineers who plan to moonlight as consultants to obtain their employer's approval first.

Another difference between SEER and PEER is the format in which the participating engineers and scientists present their professional qualifications. Companies typically hire consultants who have the necessary experience in very specific technical areas. As a result, consultants' résumés often contain long passages of technical information. SEER allows its participants to abandon the traditional résumé structure and instead describe their engineering experience in detail.

Companies access SEER for a variety of reasons, according to Joe Stacey, president of Career Technologies. In many instances, employers need additional design assistance but can't afford to hire permanent, full-time technical professionals. Companies also hire independent consultants for short-term projects that don't warrant a full-time employee. Some corporate consulting needs are more unusual: Stacey says one company recently searched the database for an engineer to testify as an expert witness in a lawsuit.

Since SEER began operation (in September 1987), several hundred consultants have contributed résumés to the database. Stacey estimates that two dozen employers have used the service to date, and he says that although the level of interest in SEER will never equal that of PEER, he believes the market for SEER is sizable, particularly as the database grows. "More candidates result in more companies interested in using the service," he says.

Among the strongest supporters of SEER is Richard Backe, former chairman of the IEEE's Employment Assistance Committee and an active Region 2 member. Backe says that although the IEEE hasn't surveyed its members' opinions about starting businesses of their own, anecdotal evidence suggests that interest is strong. "There's been a hue and cry from people to gain some independence and try things from an entrepreneurial standpoint," he says.

The number of full-time consultants within the IEEE's ranks is small, only 5%. Yet Backe says that independent consultants constitute 10 to 15% of other professional societies' memberships. He hopes that SEER will give more IEEE members the opportunity to explore the idea of running their own consulting practices. "I hope that it lights a light for people who are interested in doing this kind of work." To provide further encouragement, the IEEE now sponsors a committee on entrepreneurship whose charter is to scout new sources of support and information for members who are considering starting small businesses.

The IEEE hopes that response to SEER will move along the same lines as it has to PEER, which, despite a slow start, now seems well established. The 1985 IEEE Member Opinion Survey, conducted one year after PEER's inception, turned up few respondents who had used the PEER service, and those surveyed exhibited mixed feelings about continuing it. In the last four years, however, PEER has remained active in a field in which many similar services have failed. The IEEE hopes that the 1988 member survey, due to be released this summer, will show steady support for the résumé database.

The IEEE is optimistic about the future of such services and is now working on a third addition to its roster. The Graduate Engineer Employment Registry, designed for use by students, is scheduled for introduction next year. **EDN**

How to participate in SEER

IEEE members interested in participating in SEER need to include a registration form along with their résumés. To obtain a registration blank, write to Career Technologies Corp, SEER Service Center, 138 Old River Rd, Andover, MA 01810, or phone the company at (617) 683-0098. (Members interested in contributing to PEER should follow the same procedure.)

SEER also puts priority assignments on line. Modem owners can access these assignments by calling the On-Line Network at (617) 263-3857, pressing the Return key, and entering the password *SEER*.

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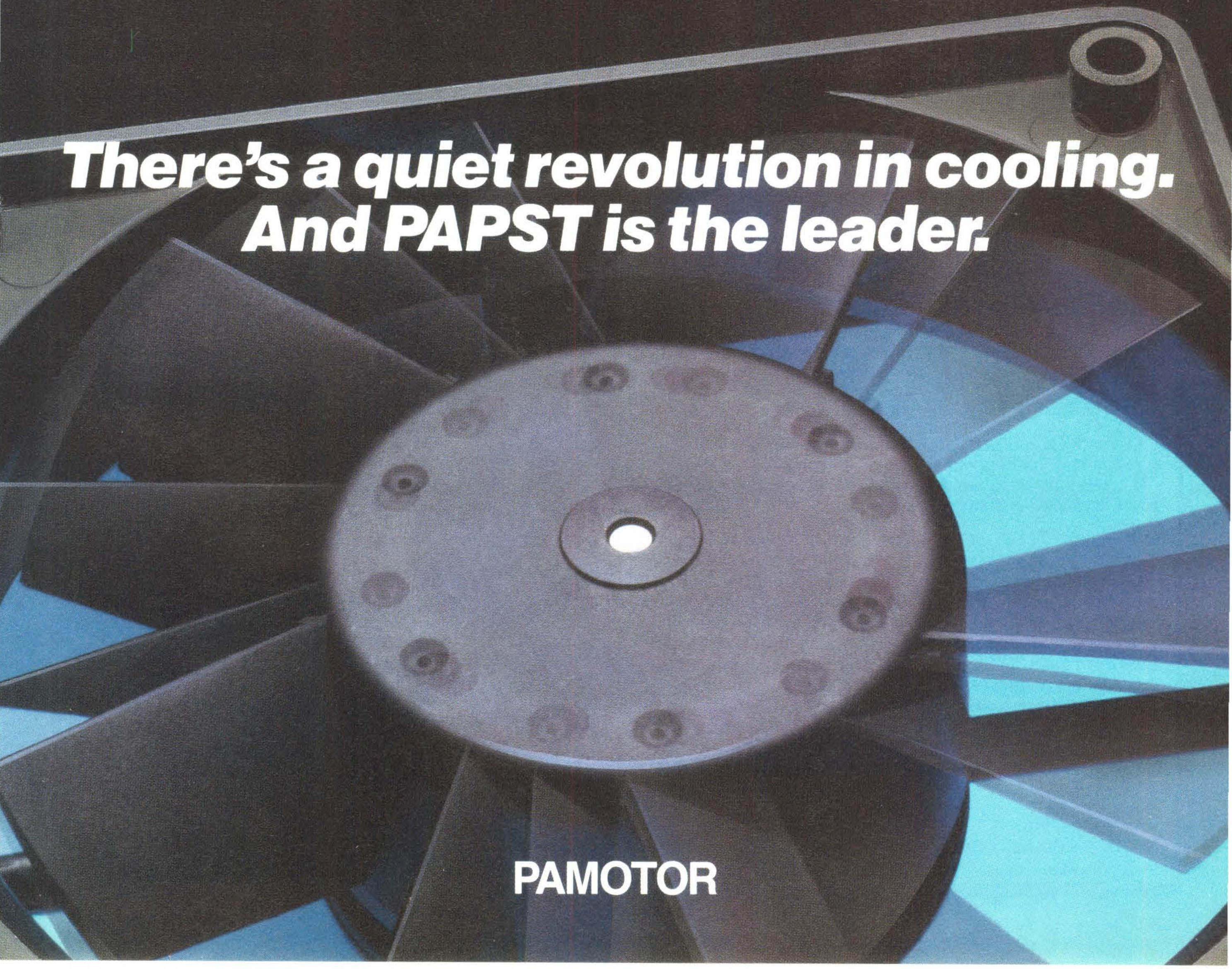

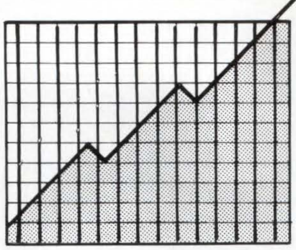

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1988 Editorial Calendar and Planning Guide

EDN

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN News
May 26	May 5	CAE, Software, Sensors/Transducers	Closing: Apr. 28 Mailing: May 19
June 9	May 19	CAE, Analog ICs, Test & Measurement	Closing: May 29 Mailing: June 16
June 23	June 2	Data Communications, DSP, Components	
July 7	June 14	Product Showcase—Vol. I, Power Sources, Software	Closing: June 23 Mailing: July 14
July 21	June 30	Product Showcase—Vol. II, CAE, Test & Measurement	
Aug. 4	July 14	Sensors & Transducers, Analog ICs, Graphics	Closing: July 21 Mailing: Aug. 11
Aug. 18	July 28	Military Electronics Special Issue, Displays, Military ICs	
Sept. 1	Aug. 11	Instruments, Op Amps, Computers & Peripherals	Closing: Sept. 1 Mailing: Sept. 22
Sept. 15	Aug. 25	Data Acquisition, Data Communications, Digital ICs	
Sept. 29	Sept. 8	DSP, Grahics, Optoelectronics	
Oct. 13	Sept. 22	Test & Measurement Special Issue, Instruments, Computers & Peripherals	Closing: Sept. 29 Mailing: Oct. 20
Oct. 27	Oct. 6	CAE, Computers & Peripherals, Integrated Circuits, Wescon '88 Show Preview	
Nov. 10	Oct. 20	Programmable Logic Devices, Integrated Circuits, Test & Measurements, Wescon '88 Show Issue	Closing: Oct. 27 Mailing: Nov. 17
Nov. 24	Nov. 3	Microprocessor Technology Directory Graphics, CAE	
Dec. 8	Nov. 16	Product Showcase—Vol. I, Power Sources, Software	Closing: Nov. 21 Mailing: Dec. 15
Dec. 22	Dec. 1	Product Showcase—Vol. II, Computers & Peripherals, Test & Measurement	

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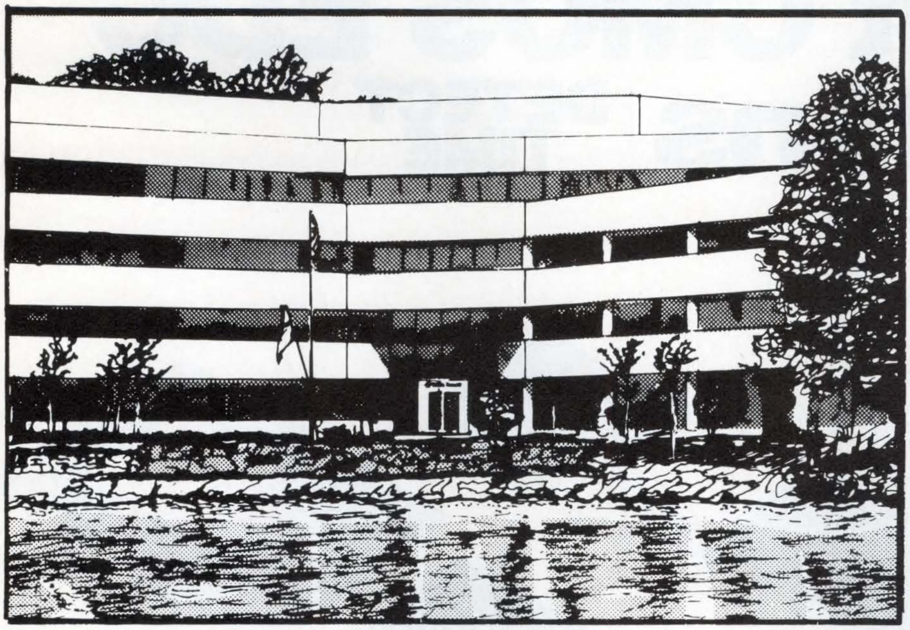

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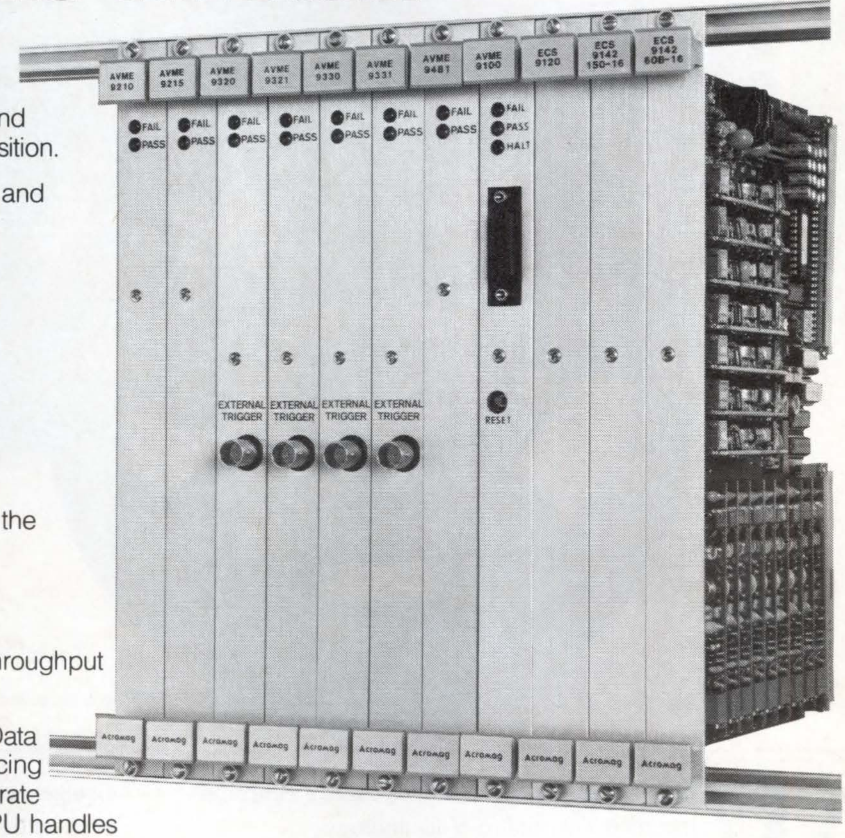

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Analog Out	8 out	±10V, Vout 4-20mA, Iout	12 Bit D/A, 6 μ sec Vout, 25 μ sec Iout, throughput	AVME9210 AVME 9215
Data Acq. Controller	16D/32SE in, opt.	±10V	14 Bit A/D, 256 in, scans, linearizes, limit checks	AVME9100 AVME9110
Subsystem Expanders	16D/32SE in	±10V	High level expander	ECS9120
	16D in	±10V	Filtered inputs	ECS9121
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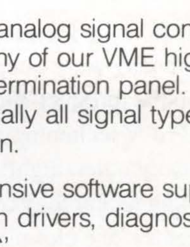

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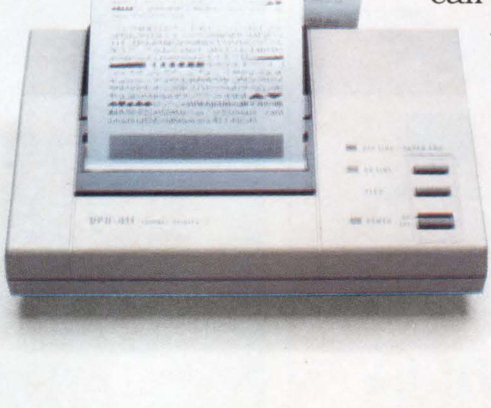

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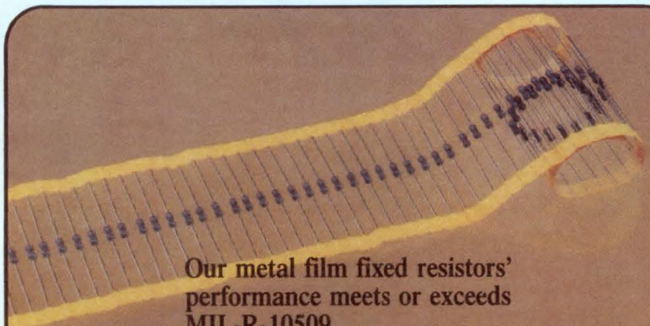

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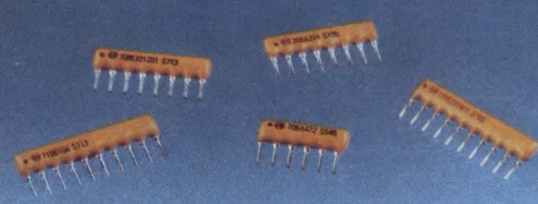

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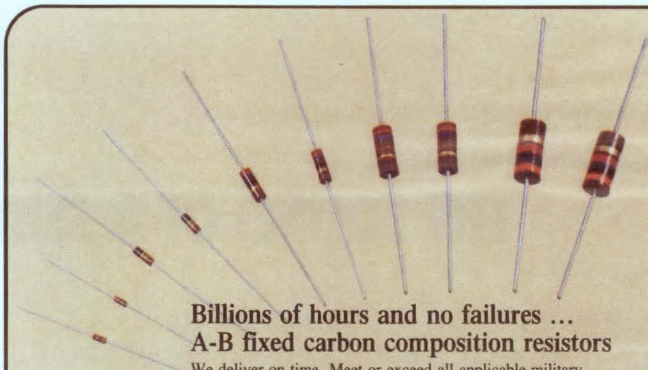

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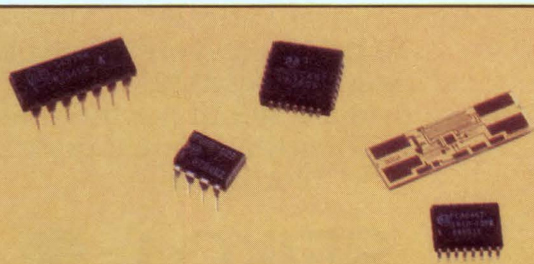

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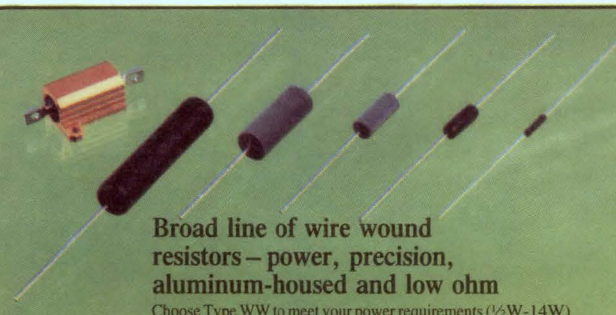

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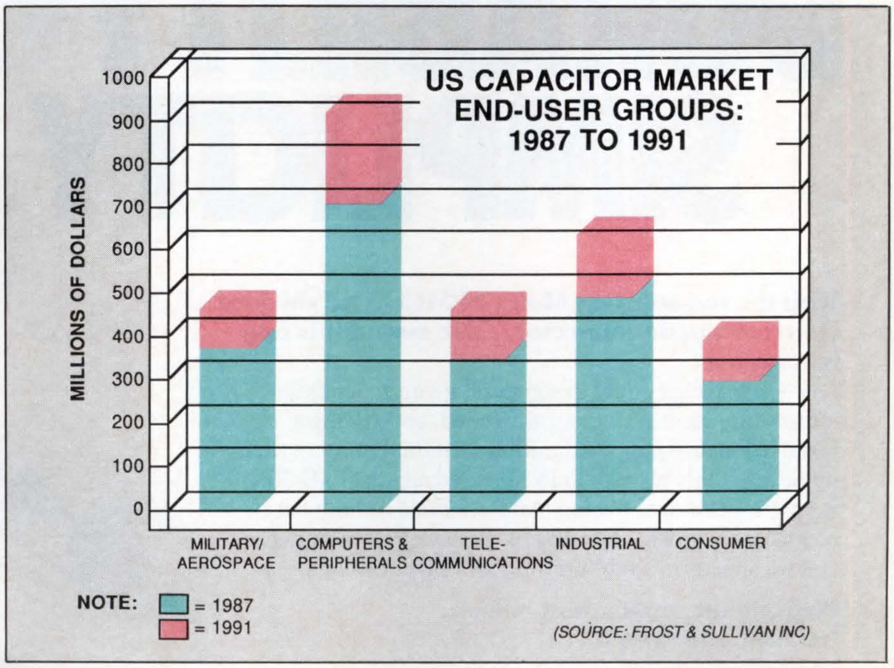
CIRCLE NO 248

LOOKING AHEAD

EDITED BY CYNTHIA B RETTIG

US capacitor sales are on the way up



Capacitor sales, which are closely linked to the health of the computer-and-peripherals markets, have suffered markedly as a result of the slump in the market for PCs. An OEM build-up caused a 27% rise in the dollar value of the capacitor market in 1984, only to be followed by a 30% decrease in capacitor demand in 1985. Now, however, the capacitor market is recovering, according to Frost & Sullivan. The New York market-research firm predicts 6.1% growth in sales dollar value and 9.4% growth in unit sales by 1991. The sale of 26.8 billion capacitors in 1991 will gross $2.9 billion—partly as a result of decreased prices stemming from the large volume of OEM accounts.

Sales in 1987 are estimated to have been worth $2.2 billion, which constitutes a 5.6% increase over the previous year's figure; 1987 unit sales are calculated to have been approximately 18.6 billion, 9% greater than 1986 unit sales.

The capacitor market is divisible into five principal OEM end-user categories: computers and peripherals, industrial, military/aerospace, telecommunications, and consumer. The computers-and-peripherals segment generated 31.1% of the dollar value of the 1986 market and is expected to account for nearly one-third of capacitor demand through 1991. Industrial sales, the next largest segment, will represent approximately 22% of the market through the forecast period. Demand for capacitors among military/aerospace OEMs is expected to grow quite slowly and to decline from 17.3% of the market in 1986 to 16.3% in 1991. The telecommunications sector will steadily consume just over 16% of the capacitor market, whereas consumer OEMs will increase their level of demand to 13.3% by 1991.

An examination of the capacitor market in terms of suppliers reveals that the top five suppliers claim 46% of the total US market, and the top ten, 62%. This situation is expected to persist, leaving the rest of the market to some 200 smaller suppliers. However, smaller suppliers who specialize in custom design should see their opportunities grow over the next few years. Product quality and the ability to offer just-in-time delivery should also prove advantageous for some suppliers, as will flexible operations.

Miniaturization and surface-mount technology will constitute significant factors across the entire market. Although surface-mount technology currently accounts for only about 12% of the US market, in Japan, it already claims 35%. By 1990, 50% of US products are expected to employ SMT.

LAN market to grow at 20% rate through '91

According to Arthur D Little Decision Resources (Cambridge, MA), the US market for local-area networks should grow from $520 million in 1986 to $1.3 billion in 1991, which translates into a 20% annual growth rate for the domestic market. Although all application areas will expand during this period, office applications will continue to constitute the largest segment, claiming about 41% of the LAN market by 1991. Factory and medical applications, however, should both grow more quickly—at annual rates of 58% and 35%, respectively, over the next few years. In general, prices are expected to decline about 3%.

Key issues for LAN suppliers vary from one application area to another, but, as is often the case today, interconnectivity emerges as a primary concern; the ability of LANs to cross the technical borders between various types of equipment is crucial to vendors, third-party vendors, and users alike. Joint ventures and consolidation to offer specialized products will serve as major avenues to growth for US LAN businesses; distribution techniques, relationships with value-added resellers, the availability of total systems, and software quality will also prove important factors.

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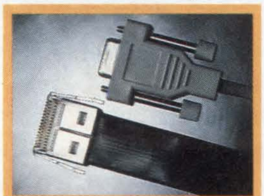

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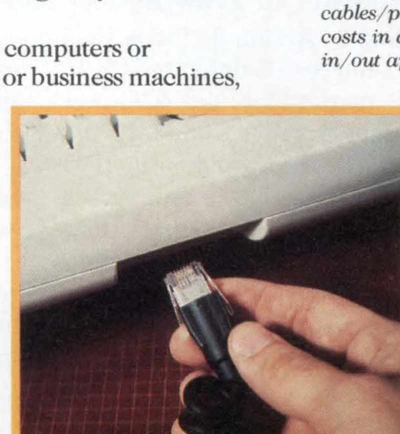

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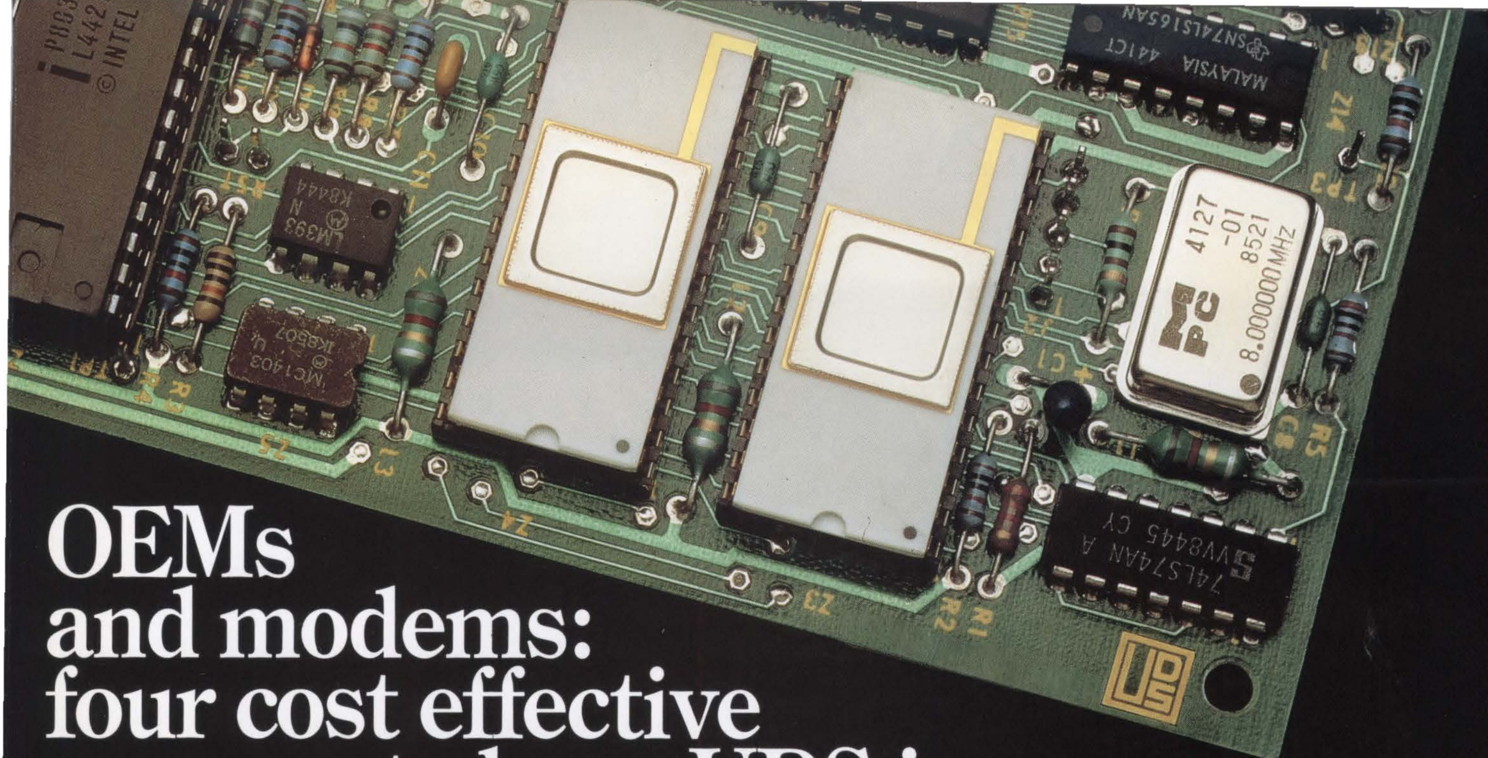

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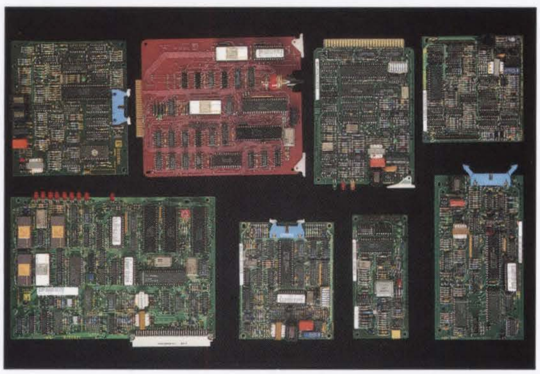

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