A CAHNERS PUBLICATION

JULY 4, 1991

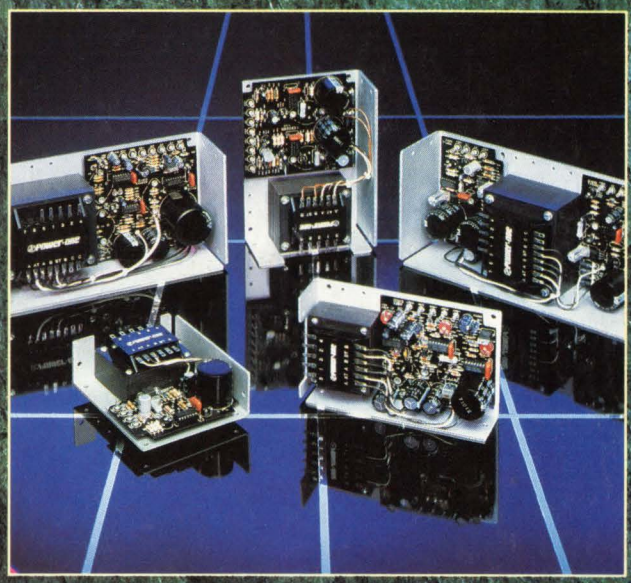
EDN®

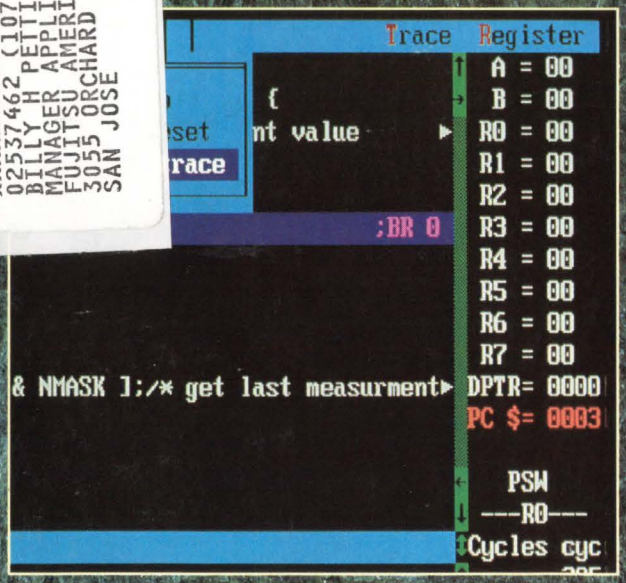
SPECIAL ISSUE—Part 1
Product Showcase No. 33

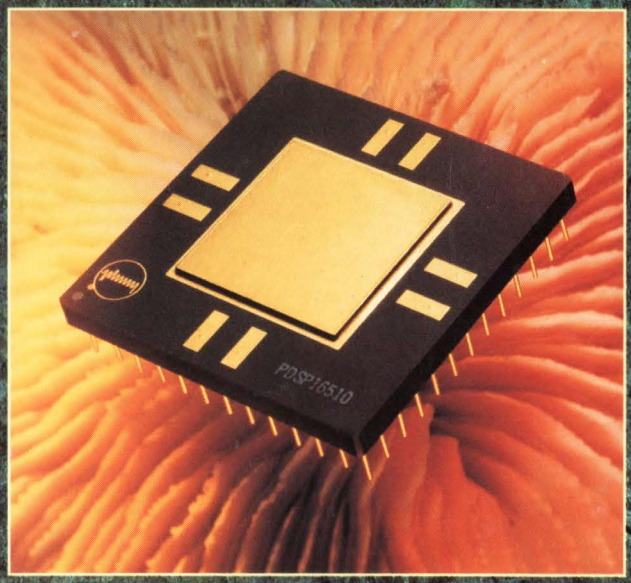
Highlighting key trends in hardware, power sources, integrated circuits and software

Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

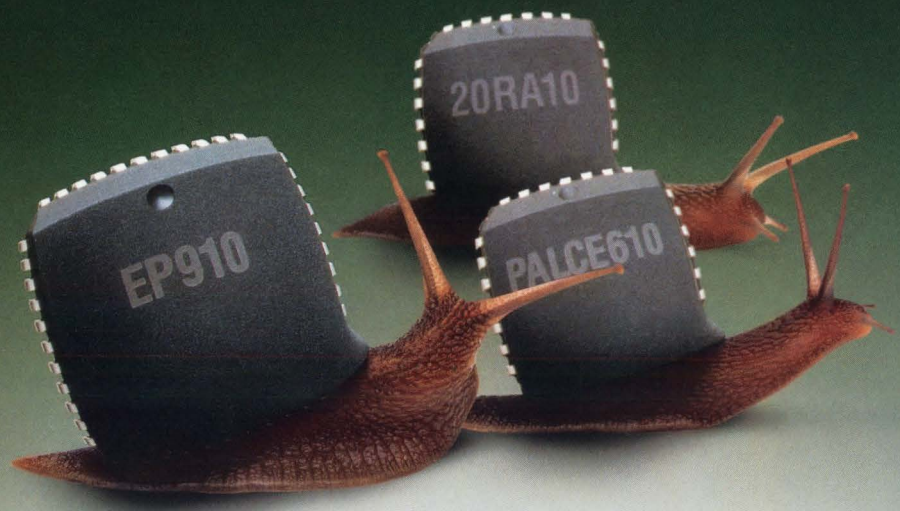






INTERNATIONAL PRODUCT SHOWCASE

A question for designers who aren't yet using high-performance µPLDs.



Why the big delay?

Ever feel like your system designs aren't quite up to speed, so to speak? It's probably not your fault. Because PLDs have typically forced designers to sacrifice performance to achieve higher integration.

PLD Performance	
PLD	t_{PD}*
Intel 85C060	10ns
PALCE610	15ns
20RA10	15ns
EP610	16ns
Intel 85C090	15ns
EP910	33ns
*Propagation Delay	

But not any more.

Now, with Intel's µPLD family of programmable logic devices, you can finally achieve the higher integration you need—with the low total propagation delay you want.

In fact, with t_{PD} figures as low as 10ns, Intel's 16-macrocell 85C060 and 24-macrocell 85C090 are, without question, the fastest integrated PLDs in the industry.

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CIRCLE NO. 1

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ALLPRO-88™ Universal Software Driven Device Programmer Supports Virtually Every Device On the Market!

Logical Devices offers you a truly pin driven "DAC-Per-Pin" programmer with electronic ground and Vcc, 4MHz clock, current mode source, high-speed programmable slew rate, and up to 10 amps of peak current on each pin.

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No copy protection in ALLPRO-88 software and updates. Buy one copy for all your units. Updates are complete and comprehensive, each version includes all supported devices.

ALLPRO-88 is supported by CUPL®, the world's most popular logic design software, with high level behavioral hardware language (CHDL), multiple PLD design, ATVG and simulation capability.

If all of this gives you an upset stomach over your Data I/O* investment, then call us for a FREE DEMO and a generous trade-in offer.

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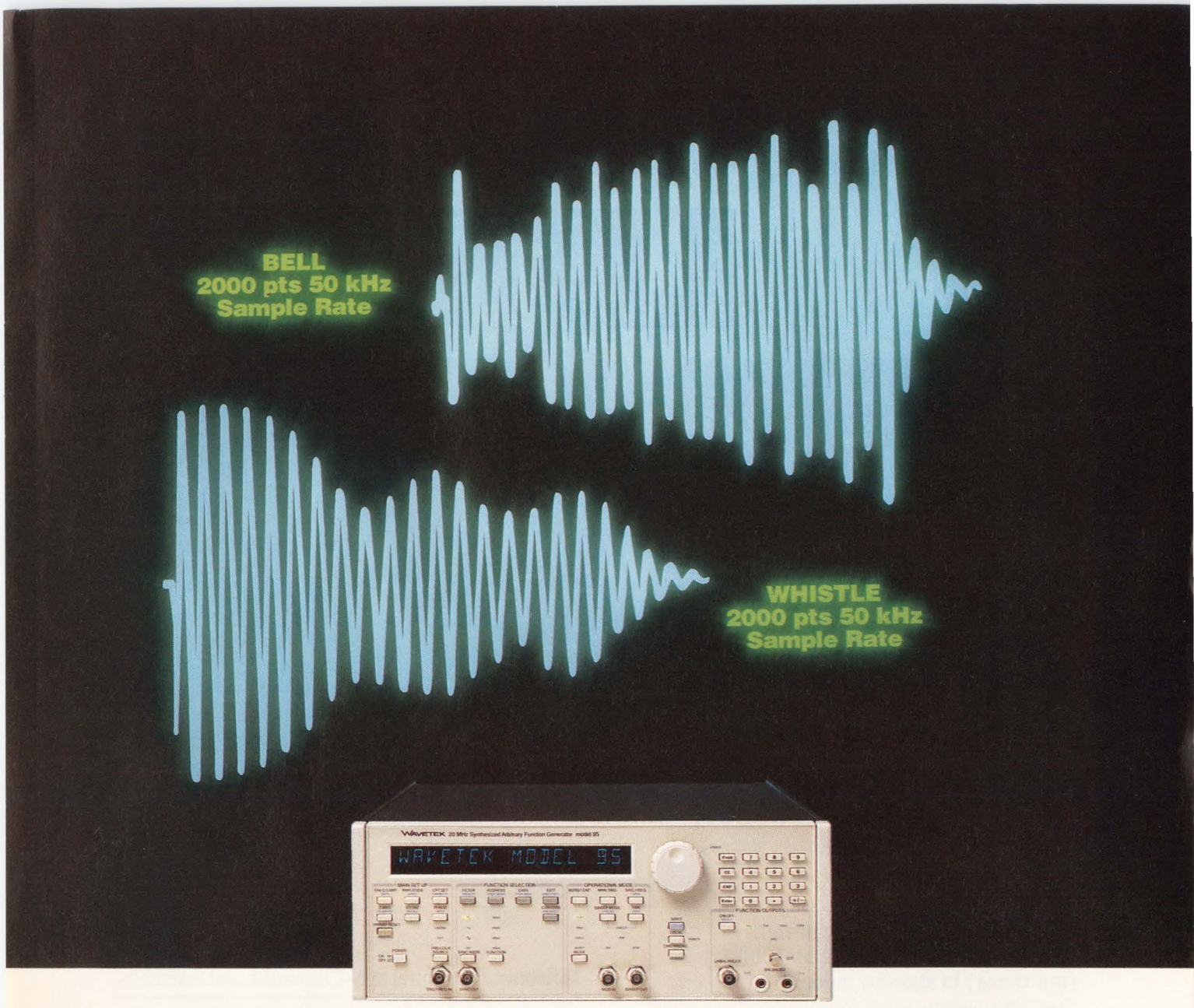
Circle No. 2



Our new function generator has all the bells and whistles.

In fact, it has any kind of waveform you can imagine. Because the Model 95 combines a high performance function generator with a powerful arbitrary generator.

As a function generator, Model 95 produces remarkably pure square waves, triangles and sines, from 1 mHz to 20 MHz with synthesized accuracy up to 0.001%. It has the power to output 15 Vp-p into 50Ω, and includes sweep, pulse and modulation modes plus four user-selectable output impedances. There's even an internal trigger generator for trigger, gate and burst.

If you'd rather be arbitrary, Model 95 gives you up to 128k of waveform memory to work with, and a sample rate of 20 MHz. Four different editing modes help you produce even the most complicated wave shapes quickly and accurately, while analog and digital filters allow you to create the purest output possible.

For information about all the other bells and whistles you'll find on the Model 95, call Wavetek San Diego, Toll Free at **1-800-874-4835** today.

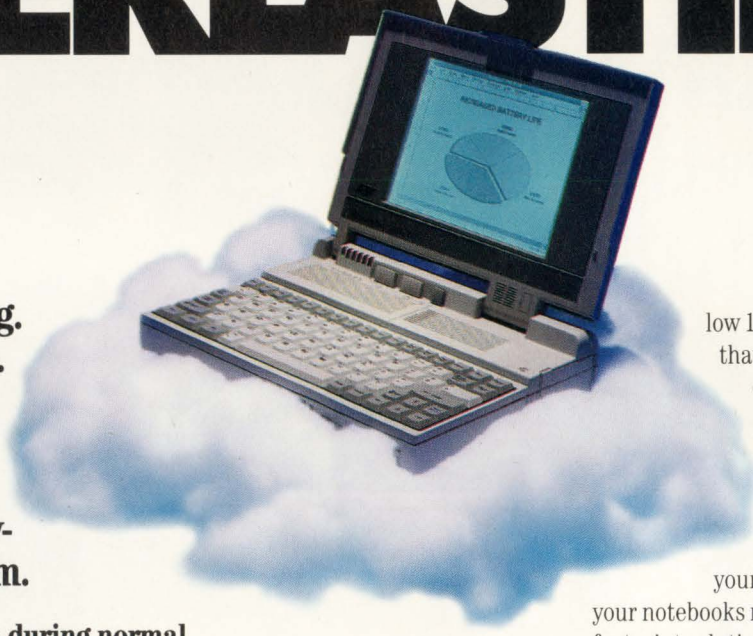
Circle #4 For Literature

Circle #5 for Demonstration

WAVETEK®

What do p-channel load switches give battery powered systems?

LIFE EVERLASTING



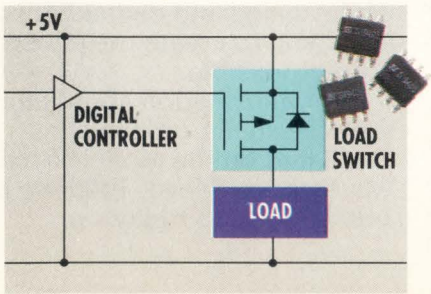
Life everlasting. Well, not quite. But it may seem that way to users of your battery-powered system.

Double battery life during normal operation! And increase it by 1000% (ten times) in standby mode!

How? With Siliconix' Si9405 load switches. Devices that let you shut down unneeded sections of your system. Now you can turn off the display, disk drive, internal FAX/modem, coprocessor, extra memory, transmitter and other analog functions when they are not in use. Then activate them instantly from your standby mode.

Added value.

This improved power management empowers your system with (almost) life everlasting. It's a compelling competitive advantage that will significantly increase your product's market share and profit margin.



LITTLE FOOT™ packaging.

The 5-V logic compatible p-channel Si9405 has an incredibly low 120-mΩ on-resistance that allows simple switching of high currents. And it comes in a space-saving LITTLE FOOT SOIC 8-pin package — assuring your portables will be truly portable, your laptops lap-size, and your notebooks notable. Other small footprint solutions are listed below.

Siliconix P-Channel & N-Channel Load Switches

Si9400DY	Single P-channel, 250 mΩ
Si9405DY	Single P-channel, 120 mΩ
Si9953DY	Dual P-channel, 2 x 250 mΩ

These SO-8 IC devices can be driven directly by 5-V logic.

Si9956DY	Dual N-channel, 2 x 100 mΩ

This SO-8 IC device is ideal for higher current loads.

SMP60N03-10L	Single N-channel TO-220, 10 mΩ

A great solution for switching between batteries..

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Siliconix

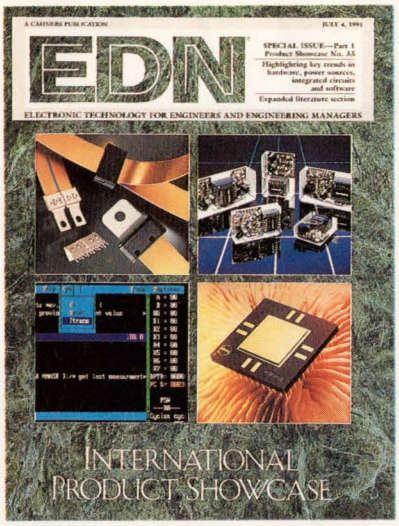
2201 Laurelwood Road, Santa Clara, CA 95056

Volume 36, Number 14

EDN Magazine Edition

July 4, 1991

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



On the cover: *Part 1 of EDN's Product Showcase No. 33 describes offerings from manufacturers of hardware and interconnect devices, integrated circuits, power sources, and software. Staff-written analyses introduce each product category and focus on high-density connectors (pg 64), neural-network ICs (pg 84), power supplies incorporating power-factor-correction ICs (pg 106), and graphical development tools for Windows 3.0 (pg 132). (Background cover photograpy by M Angelo/ Westlight; photographs courtesy AMP, Power-One, Plessey Semiconductors, and Franklin Software Inc; art direction by Ken Racicot and Cathy Madigan)*

DESIGN FEATURES

Hardware and Interconnect Devices

Integrated Circuits

INNOVATION™ Driving Electronic Technology Into The Next Century

Power Sources

Software

Continued on page 7

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The new 7.5 ns field programmable, PLD.

BiCMOS. The first BiCMOS 22V10, from the company that delivered the first CMOS 22V10. ECL core path for record-setting performance. CMOS logic outside the speed path, for low power. The speed of smaller PLDs, the convenience of the popular, flexible 22V10 and field programmable too.

Broad 22V10 PLD family and more. Cypress's 15 ns CMOS 22V10 consumes less power than any electrically erasable alternative. It's just one of a broad range of low-power CMOS PLDs. Also get 28-pin applications-tailored PLDs, and our high-capacity MAX™ PLDs too.

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The 90 Nanosecond Workout
An Exhaustive Look At High Tech Training Equipment
PAGE 2B

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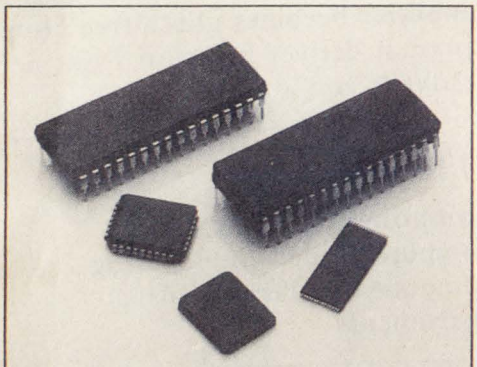
FANTASTIC FL

AMD Ships 2 PLCC Flash



How Fast Is A Flash? A Direct Comparison

Density	AMD	Fastest Competitor
256K	90ns	120ns
512K	90ns	120ns
1 Mbit	90ns	120ns
2 Mbit	90ns	150ns

SUNNYVALE — The computer industry takes a giant leap forward in performance with the help of the new Flash memory family from Advanced Micro Devices, Inc.

Flash memory is a high-density, reprogrammable, non-volatile technology that has a bright future in computation, laser printers, network and telecommunications hardware. Many military systems use Flash technology in radar and navigational applications.

Flash memory also has the potential to eliminate mechanical hard disks and the need for cumbersome batteries. These are two of the biggest and heaviest obstacles in laptop and notebook computer applications.

Today, Flash memory is the most cost effective replacement technology for UV EPROMs and EEPROMs in applications that require in-system programming. Flash memories can literally be reprogrammed in a flash — hence the name.

Standard, But With A Little More Flash

AMD's Flash memory family effectively etches in silicon the de-facto standard for this burgeoning technology that is compatible with Intel's initial Flash architecture.

Because AMD Flash memories are pin-for-pin compatible with the now standard architecture, AMD is positioned as an alternate source for design engineers and purchasing agents alike.

"Alternate source may be an inadequate term," said Jerry Sanders, chairman and CEO of Advanced Micro Devices. "Given our speed and feature set, our customers think of us as a superior resource."

Indeed, AMD's Flash memory family offers designers significant performance advantages (see chart), with speeds almost twice as fast as the nearest competitor.

Engineer Spontaneously Combusts At Meeting

Vice Pr... At Lea...

From AMD.

FOOD

Chips And Salsa

A Business Person's Guide To Silicon Valley Restaurants PAGE 7F

zette

MORNING EDITION

ASHES!

Megabit, 90ns, Memories

The AMD Flash family offers designers and purchasers many packaging options. Particularly popular is AMD's advanced 2 Megabit, PLCC part. Other packaging options include PDIP, CDIP and LCC in 256K, 512K, 1 Mbit and 2 Mbit capacities. TSOP packages will be available in the second half of this year. (LCC not currently available in 2 Mbit.)

AMD's 2 Mbit Flash memories come complete with embedded program and erase algorithms on board. These automatic algorithms speed up the design process and considerably shorten time to market. Previously, engineers were required to develop tedious and time-consuming algorithms to implement in-system reprogrammability. AMD's automatic algorithms also allow several Flash memories to be written or erased at once, without tying-up the CPU. The system is now free to perform other tasks while these operations are in progress. AMD plans to include embedded algorithms in a future release of its 1 Mbit part.

The Ultra-Violet Blues

Flash technology is particularly suited to applications requiring reprogramming in place, because these devices can be reprogrammed in seconds, and within the system.

To update the code on a UV EPROM, the part must first be removed from the system. Once removed, erasure can take up to a full 20 minutes. After reprogramming, the part is then plugged back into the system. The process can result in damage to other components, costly service calls, and headaches.

Flash memories, on the other hand, can be bulk erased in about one to two seconds, without system disassembly. Reprogramming can then be accomplished via floppy disk, over phone lines, or even ISDN

(continued)

sident To Speak

Stop the presses!

Advanced Micro Devices makes big news again—this time with an enhanced family of Flash memory devices.

That's good news for veteran and new Flash users alike.

Because our Flash devices are pin-for-pin compatible with Intel's existing Flash memory architecture, they establish the *de facto* industry standard.

Our standards, however, are a bit higher.

And so are yours.

That's why our Flash Memory family offers densities, speeds and packaging options that improve performance and save board space. For instance, our advanced 2 Mbit PLCC part with a scant 90 nanosecond delay.

You can also choose from Flash devices in 256K, 512K and 1 Mbit densities. As well as packaging options that fit your design best, including CDIP, PDIP, LCC, TSOP, and PLCC.

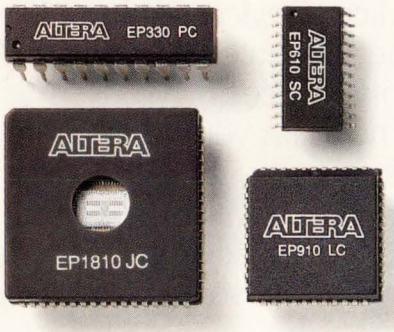
And you'll find implementation faster and easier than ever, because we've included automatic programming algorithms on all our 2 Mbit devices, and soon on our 1 Mbit parts, too. So you'll spend less time writing code, and take less time getting products to market.

To keep up to date with all the latest and greatest in Flash memory, call AMD today at **1-800-222-9323.** And start making some headlines of your own.

Advanced Micro Devices

CIRCLE NO. 6

OUR CLASSIC™ EPLDs CUT



They also cut your product costs, with prices low enough to impact your bottom line.

As for logic delays, we've cut them down to a remarkably low 12ns.

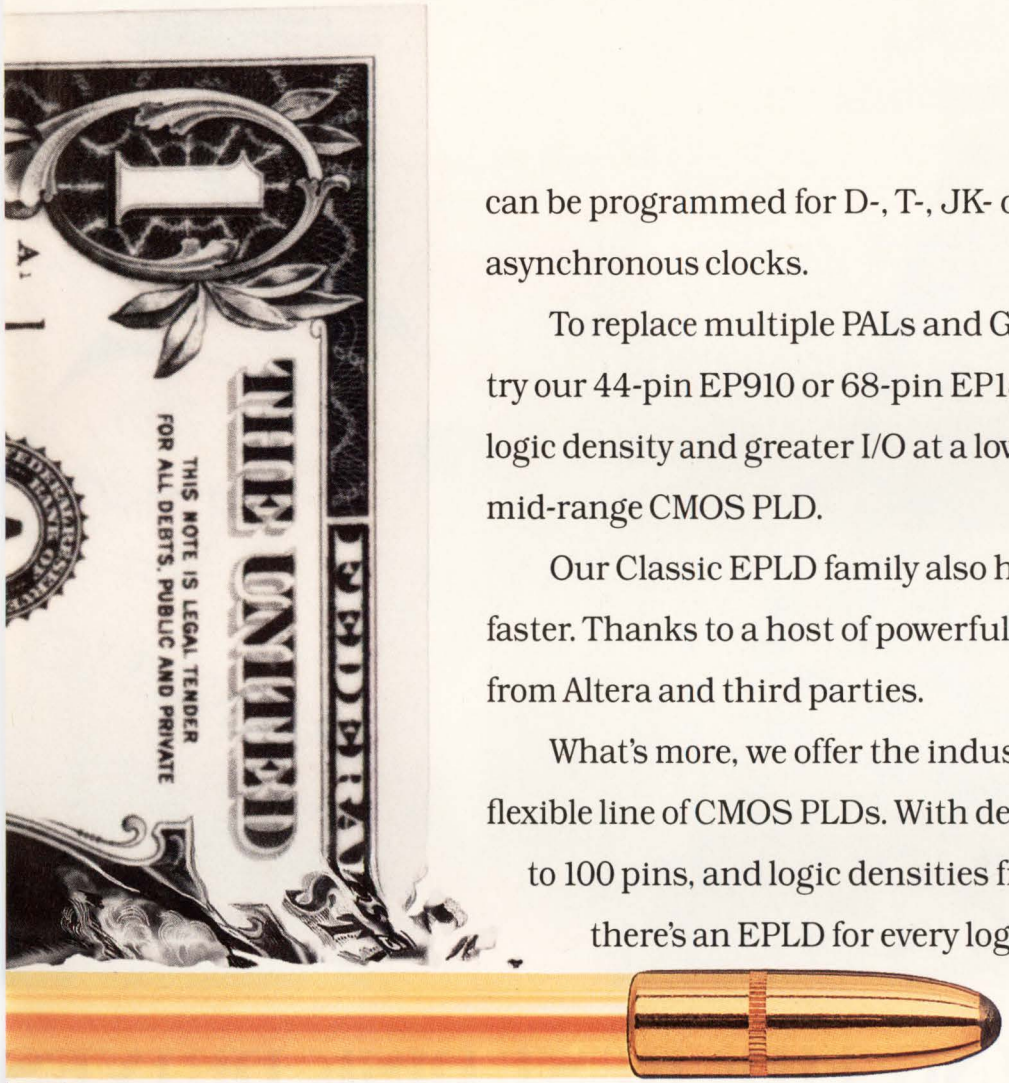
So now you can cut something from your design: PAL®s and GAL®s. Because our Classic parts give you a combination of speed, density and flexibility you won't find in other PLDs.

All of which helps you cut the time it takes to produce a superior design.

For example, our 20-pin, 8-macrocell EP330 is the perfect replacement for over 20 types of PALs and GALs. It stretches counter frequencies to 125 MHz while sipping one-fourth the power of a standard PAL. And its quiet output switching circuitry allows the EP330 to run faster in-system than a 10ns 16V8.

Our 24-pin, 16-macrocell EP610 delivers 60% more logic density than a 22V10. And unlike a 22V10, the 15ns EP610 consumes a mere 20μA in standby. And its registers

MORE THAN LOGIC DELAYS.



can be programmed for D-, T-, JK- or SR-operation or for asynchronous clocks.

To replace multiple PALs and GALs with a single chip, try our 44-pin EP910 or 68-pin EP1810. Both offer superior logic density and greater I/O at a lower cost than any other mid-range CMOS PLD.

Our Classic EPLD family also helps you get to market faster. Thanks to a host of powerful logic development tools from Altera and third parties.

What's more, we offer the industry's broadest, most flexible line of CMOS PLDs. With devices ranging from 20 to 100 pins, and logic densities from 8 to 192 macrocells, there's an EPLD for every logic design task.

So call Altera today at (408) 984-2800 for more information. And discover programmable logic that's a cut above the rest.

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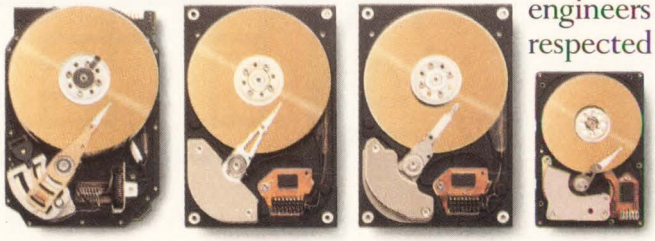

Summit 540MB *Cougar 210MB* *Jaguar 85MB* *Pancho 85MB*

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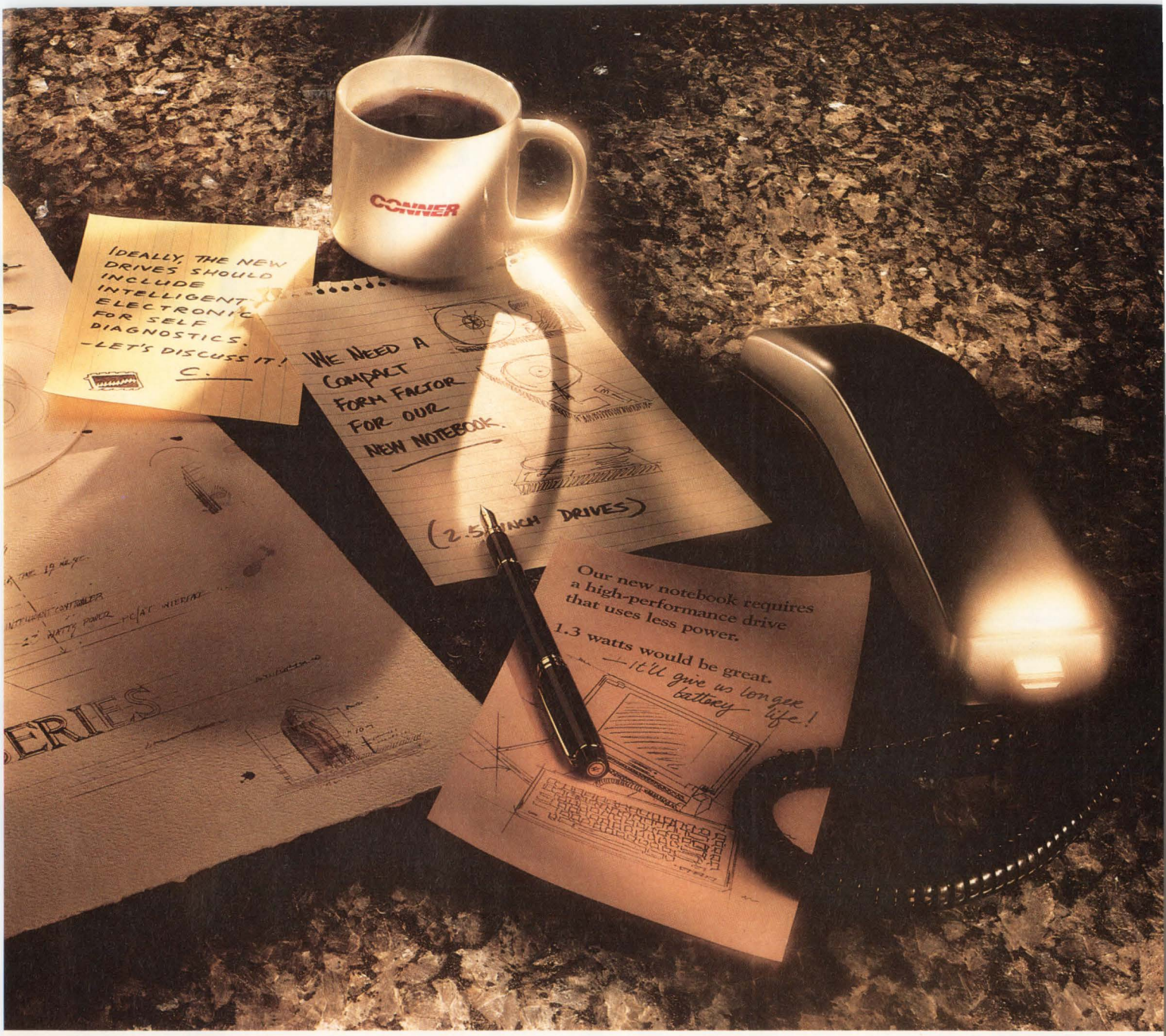

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Out of IC Deve

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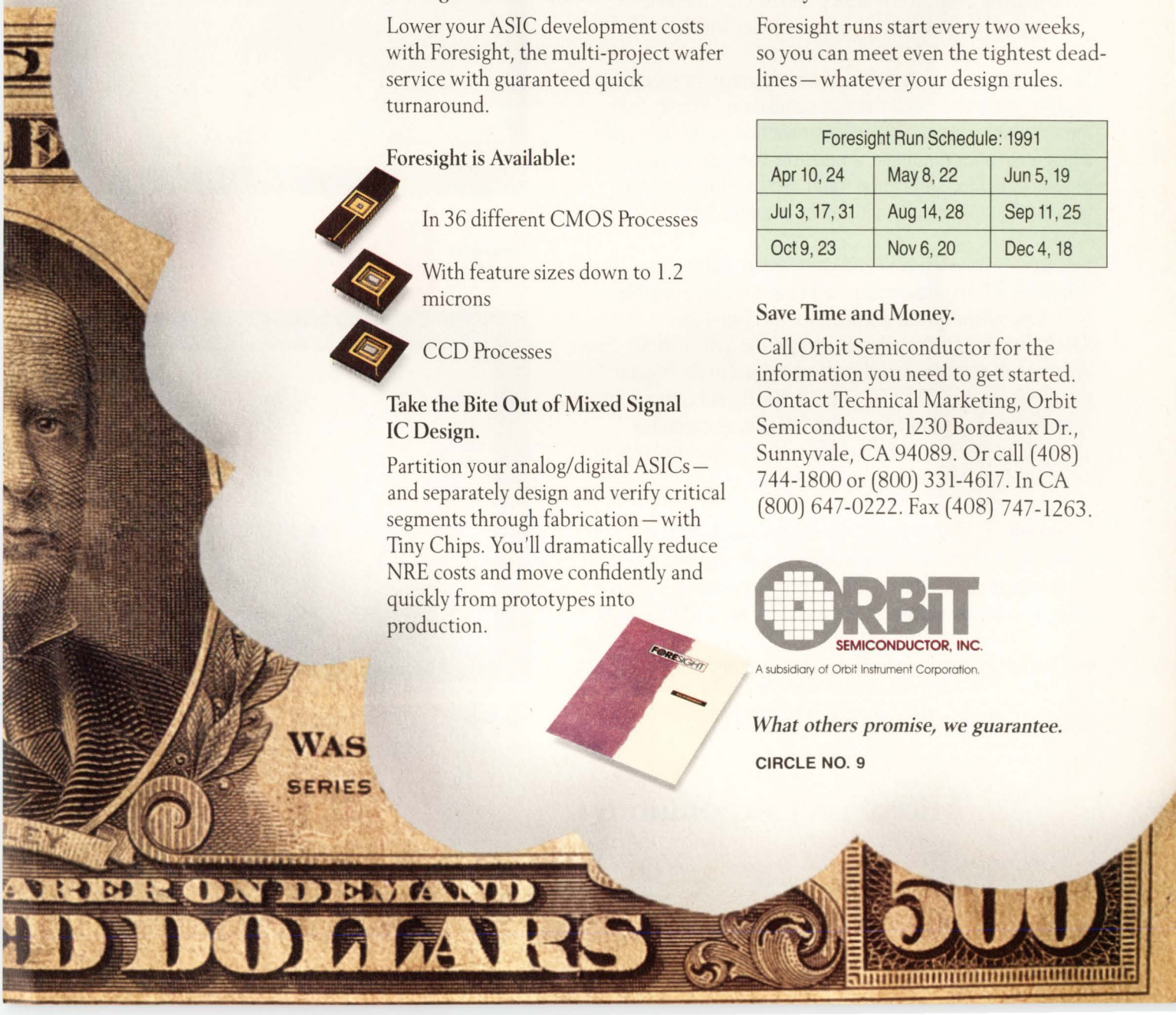

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What others promise, we guarantee.

CIRCLE NO. 9

New Schematic Capture Front End for PSpice

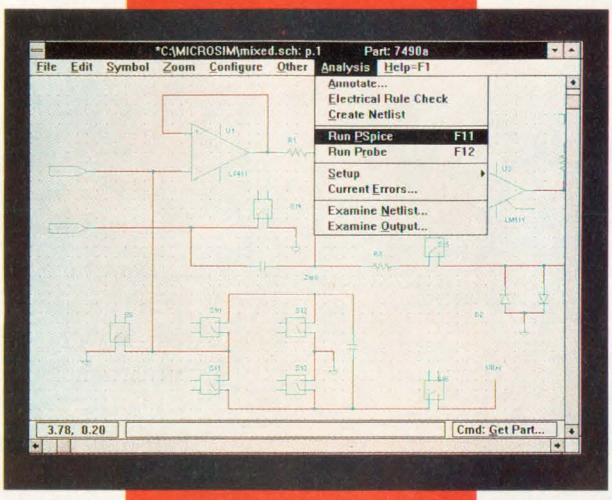
MicroSim Corporation now offers a versatile schematic capture front end, called Schematics, to our popular Circuit Analysis programs, PSpice and Probe. Schematics provides a unified system for designing and editing schematics, running analyses using PSpice, and viewing the results using Probe, all without leaving the Schematics environment. Any mix of analog and digital components can be used when defining a schematic for simulation.

Schematics provides a menu-driven interface for specifying analysis parameters and running simulations directly from the schematic display. If device simulation parameters need adjustment after running a simulation, they can be easily modified and the simulation rerun. Netlists for PSpice are generated automatically and can be examined on the screen.

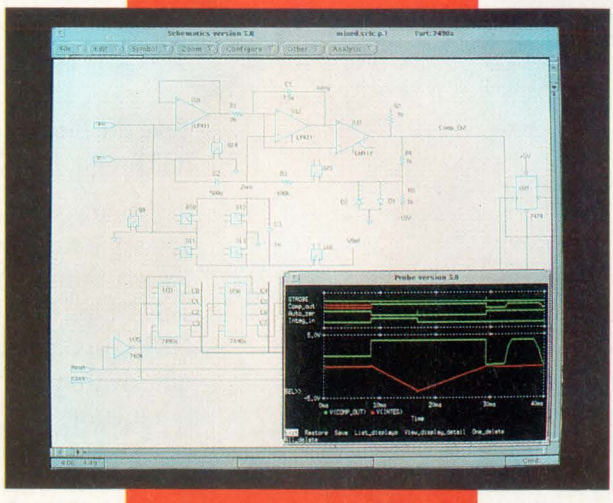
Schematics was designed and written as a native Windows 3.0 application for the PC and is also available as an OpenWindows application for the Sun-4 and SPARCstation. Both packages include the Schematics library with symbols for all parts contained in the PSpice libraries— over 3,500 analog and 1,500 digital components. An integrated symbol editor with full editing capability allows new symbols to be created and new part attributes to be defined while working on a schematic.

Schematics is sold as part of the Genesis package and comes with MicroSim Corporation's extensive customer/product support. Our expert engineering team is always on hand to answer your technical product questions.

For further information on Schematics, or any other MicroSim Corporation product, call toll free at (800) 245-3022 or FAX at (714) 455-0554.



Schematics as a Windows 3.0 application



Schematics with Probe

MicroSim Corporation

Expanding the Standard for Circuit Simulation

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CIRCLE NO. 10

NEWS BREAKS

EDITED BY SUSAN ROSE

ALGORITHM SPEEDS DISCRETE-COSINE TRANSFORM

Ricoh Corp's California Research Center has developed an efficient algorithm for calculating the discrete cosine transform (DCT) required by some image compression standards. The algorithm, called the generalized Chen transform (GCT), takes advantage of symmetries found in trigonometric functions to reduce the number of multiplication steps required in the DCT calculation. Current algorithms require about 150 multiplications to transform an 8×8 data block. The new algorithm requires only 64.

By reducing the number of multiplication steps required, the DCT can speed software implementations of DCT-based image-compression standards and can reduce the silicon area required by hardware implementations. The company will use the algorithm in its image-handling products, but is also interested in licensing the technology. Contact Ed Onstead at (408) 281-1436. Ricoh Corp, West Caldwell, NJ, (201) 882-2000, FAX (201) 882-2506.—Richard A Quinnell

COUPLER CREATES CELLULAR RJ-11 TELEPHONE JACK

The Datacell cellular-phone coupler from Zirco gives wireless freedom for the cellular-telephone network through a variety of remote data and fax applications. The coupler fits between a portable-cellular-phone's handset and base unit. It furnishes an RJ-11 jack, which is compatible with conventional telephone equipment, including data modems and fax machines. The $299.95 coupler operates at data rates to 9600 bps. Like conventional telephone connections, the actual data rate depends on the cellular connection's noise level. The company offers cables that adapt the product to a variety of cellular phones. Zirco Inc, Wheat Ridge, CO, (303) 421-2013, FAX (303) 423-8346.—Steven H Leibson

DSP CHIP HAS BUILT-IN COMPLEX MATH FUNCTIONS

Sharp Electronics Corp joined the ranks of DSP-chip vendors with its fixed-point LH9124. The $700 chip's instruction set provides for built-in, real and complex FIR-filter operations, various radix-butterfly operations, windowing, and other DSP functions. The device's instruction set also lets you program scalar and vector operations. The chip supplies four independent data buses that operate with real and complex data. You can control the buses' widths from 8 to 24 bits for each of the real and imaginary data lines. All of the buses are bidirectional. The company separates the buses into two data buses, a coefficient bus, and an acquisition bus. The chip is available in sample quantities.

The manufacturer expects to offer a $70 (sample) companion DSP address-generator chip, the LH9320, later this year. The address generator will supply 155 preset address patterns for DSP implementations of FFTs, FIR filters, FFT data separations, decimations, and circular buffers. The chip will also furnish general-purpose addressing operations. Sharp Electronics Corp, Camas, WA, (206) 834-8700, FAX (206) 834-8611.—Jon Titus

NEWS BREAKS

CHIPS SIMPLIFY ENCODER INTERFACES

Four ICs from LSI Computer Systems provide simple interfaces for optical and magnetic encoders. The $1.40 (1000) LS7083 and LS7084 derive quadrature clock signals from encoders and provide a complete interface between the encoder and an up/down counter. The chips can produce one or four clocks per quadrature cycle. The $1.60 LS7082 provides quadrature clock conversion and index support for absolute count reference. All three chips have a maximum output frequency of 16 MHz. The $5.40 LS7166 combines the functions of a quadrature clock converter with a 24-bit multimode, 20-MHz counter. The counter has an 8-bit, 3-state output bus. Both chips can produce 1, 2, or 4 clocks per quadrature cycle. LSI Computer Systems, Melville, NY, (516) 271-0400, FAX (516) 271-0405.—Doug Conner

GATE-ARRAY FAMILY ALLOWS CUSTOM-RAM ARRAY ON DIE

The LEA200K family from LSI Logic combines standard-cell and gate-array techniques to bring high-density memory to gate arrays. You define how much memory your ASIC needs, then the company develops a custom gate-array masterslice for you. You get the memory density of a standard-cell ASIC with the production benefits of a gate array. Because your logic is in the gate-array section, you can make changes to your design by changing only the metal mask.

The family uses a 0.7-μm CMOS process with either 2- or 3-layer metal. You use the 2-layer metal to save costs if your design is pad-limited, and the 3-layer metal for dense designs. The family's design library includes a variety of CISC (complex-instruction-set computer) and RISC (reduced-instruction-set computer) CPUs, system clock de-skewing circuits, and 3.3V and JTAG-scannable I/O drivers. NRE charges begin at $75,000. LSI Logic Corp, Milpitas, CA, (408) 433-8000, contact Lynn Le. —Richard A Quinnell

BLACK AND WHITE SCANNERS CAN PRODUCE FULL COLOR

The $169 Cat Color Converter from Computer Aided Technology Inc can produce a digitized image with more than 16 million colors. You give the converter all the information it needs by making three passes over a color picture with any 4-in., black-and-white or gray-scale hand scanner. Snapping your scanner into the converter's 12 × 10.5 × 1-in. scanner guide ensures scanning accuracy by holding both the scanner and the picture in proper alignment. The guide includes three built-in color filters and a light source—you use a different color filter during each scanned pass to produce the red-green-blue components of the digitized image. This conversion package includes image-processing software that combines the three filtered scans into a single color image. You can adjust the scanned image's color palette, brightness, and contrast, and then save the image as a .PCX or .TIF file for exporting into your paint, presentation, or publishing program. Computer Aided Technology Inc, Dallas, TX, (214) 350-0888, FAX (214) 904-0888, contact Jina Lee.—J D Mosley

SEMICUSTOM, SINGLE-BOARD COMPUTERS OFFER FLEXIBILITY

Ziatech's Application Specific Automation Processor is an option if you can't find the right off-the-shelf single-board computer (SBC) for your embedded control application. You can select among a list of core modules, peripheral I/O modules, and custom I/O modules for the board, instead of investing the time and money to develop a custom SBC. Because 90% of the board comprises modules from previously tested

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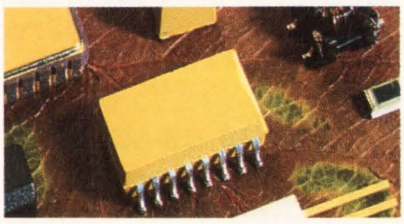

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CIRCLE NO. 11

and proven designs, the risk associated with a new design is minimized. The board is designed around the STD Bus form factor and uses a 16-MHz NEC V53 μP for 80286 performance and code compatibility. You select the RAM, PROM, Flash EPROM, counters, timers, DMA channels, peripheral I/O modules, and other features you'll need. The initial contract for development and delivery of 25 boards is $45,000. Delivery is 12 weeks, but prototyping cards let you begin software development before you have the first boards back. The semicustom product is aimed at users requiring a minimum of 500 SBCs per year. Typical costs are $500 to $800 per board. Ziatech Corp, San Luis Obispo, CA, (805) 541-0488, FAX (805) 541-5088.—Doug Conner

DEFLECTION-PROCESSOR IC SIMPLIFIES DISPLAY DESIGN

The TDA8102 deflection processor IC simplifies the design of multifrequency CRT displays by accommodating 15- to 100-kHz horizontal and 30- to 120-Hz vertical scanning frequencies. Voltage-controlled inputs control the free-running frequency, horizontal phase shift, vertical S correction, and output amplitude. Vertical S correction is independent of frequency. The IC is packaged in a 20-pin DIP and costs $3.04 (100). SGS-Thomson, Phoenix, AZ, (602) 867-6100, FAX (602) 867-6290.
—Steven H Leibson

BIT-SLICE I/O BOARD HANDLES MILITARY COMMUNICATIONS

Antares's Series 4000 VMEbus I/O processor board uses a 32-bit processor designed with 10-MHz, AMD 2901-family, bit-slice ICs. The board hosts a piggy-back module that contains the microcode, transceivers, and sequencers necessary to implement a specific communication protocol. You can buy modules that support the MIL-STD-1553 Multiplexed Avionics Bus, and the MIL-STD-1397 Naval Tactical Data Systems' type A, B, C, D, E, and F protocols. The board can act as a VMEbus master or slave, and can simulate military computers that cost more than $1 million. Delivery of the $3525 board is four weeks ARO. Antares, San Diego, CA, (619) 223-4311.
—Maury Wright

SUPERCOMPUTER PRICES TUMBLE

The C3 Series of air-cooled, Unix-based supercomputers from Convex Computer range from $350,000 (low end) to $8 million (fully loaded). The fully loaded C3800 is the first supercomputer to use GaAs chips—as many as eight 45,000-gate GaAs processors for 2G-flops peak performance. The midrange C3400 is a BiCMOS RISC (reduced-instruction-set computer) implementation of the GaAs supercomputer and has an 800M-flops performance max. Midrange prices range from $650,000 to $2 million. The low-end C3200 offers 90% of the throughput performance of a single-processor Cray Y-MP with a 200M-flops peak performance. Convex Computer Corp, Richardson, TX, (214) 497-4230, FAX (214) 497-4848, contact Donna Burke.
—J D Mosley

CONVERTER BOARD TRANSFORMS RS-232C INTO RS-485

The $75 PC-485 serial converter from Octagon Systems changes an RS-232C port into an RS-485 serial port. The resulting benefits include an extension of the RS-232C port's 50-ft range to 4000 ft and the ability to bus as many as 32 units on one multidrop network. The board measures 2.55×2.1 in. and requires 9 to 15V dc. Octagon Systems Corp, Westminster, CO, (303) 430-1500, FAX (303) 426-8126.
—Steven H Leibson

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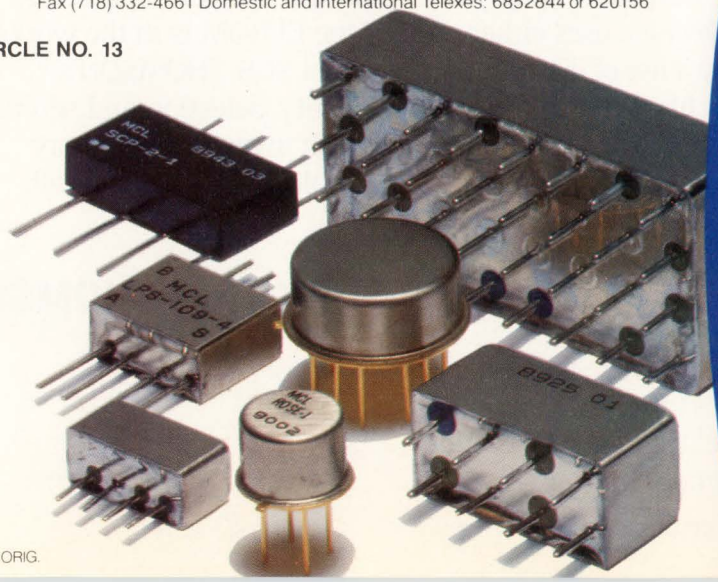

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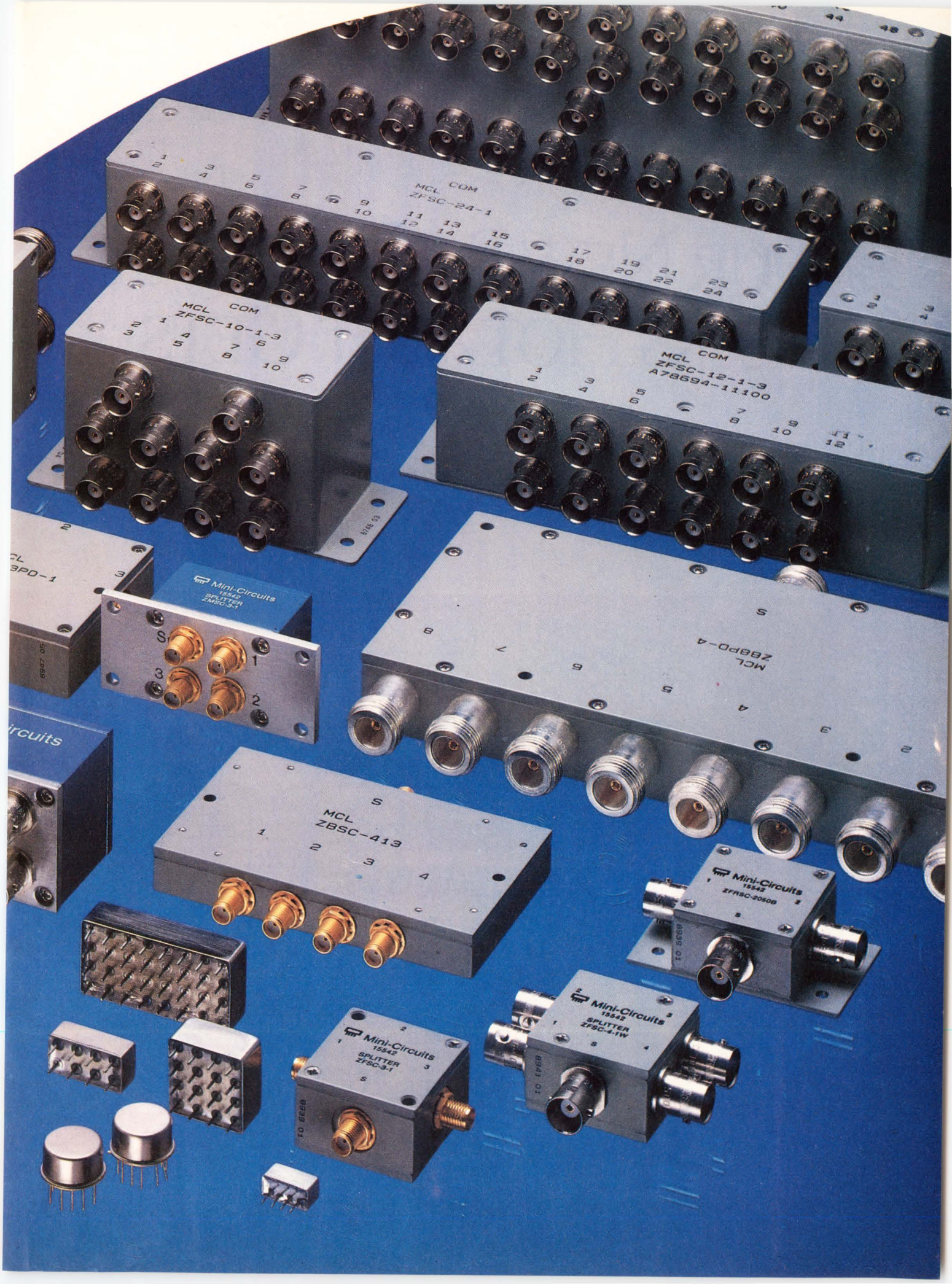
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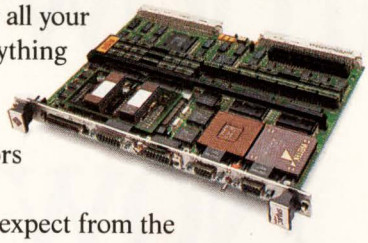

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CIRCLE NO. 14

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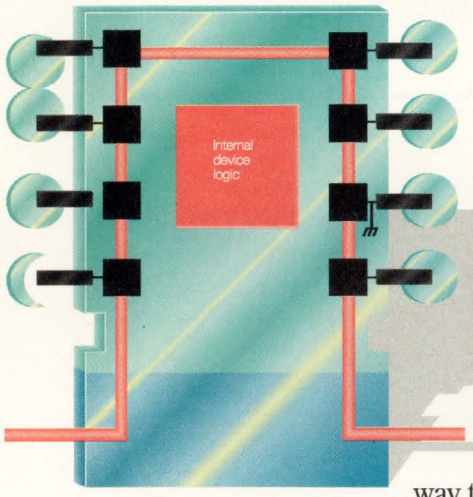

Find common manufacturing faults without test patterns libraries or physical test access with boundary-scan design and VICTORY software.

Increasing device complexity. Rising pattern development costs. High density packaging. Disappearing nodal access. These are the board test problems boundary scan was created to solve. Which is fine in theory. Only problem is there hasn't been any way to put boundary scan to the test. Until now.

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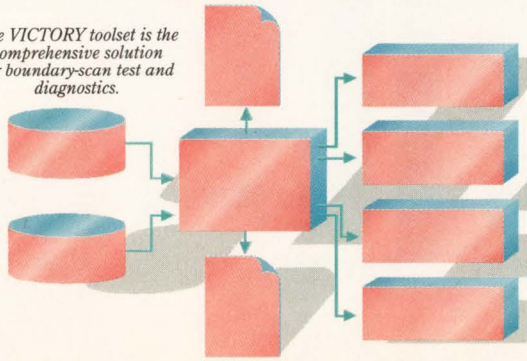
Introducing VICTORY™ from Teradyne: the only software toolset ready to help you turn boundary-scan theory into a practical advantage. From the moment your first boundary-scan device is designed in, VICTORY starts to simplify the testing of complex digital boards. And the more boundary-scan parts you have, the more time and money you save.



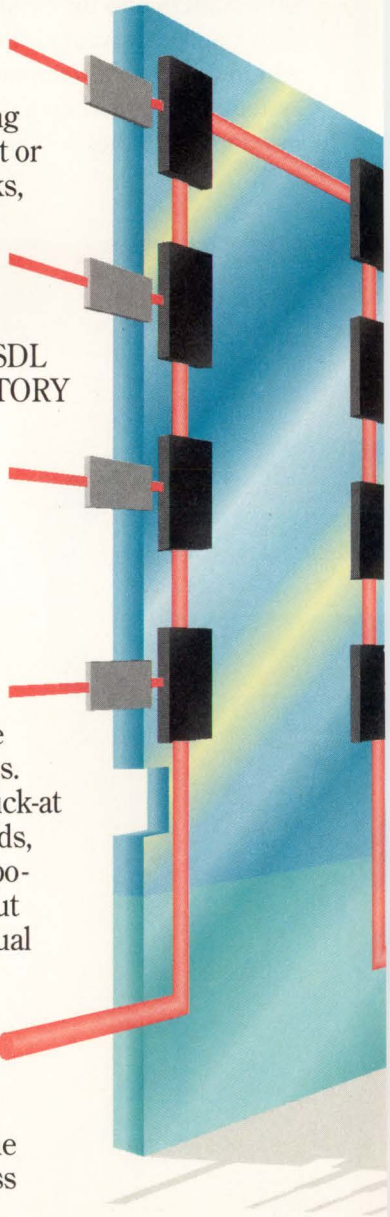
The VICTORY toolset is the comprehensive solution for boundary-scan test and diagnostics.

Delivers high fault-coverage.

Whether you're testing one boundary-scan part or boundary-scan networks, VICTORY software automatically gives you 100% pin-level fault coverage. Using the IEEE 1149.1 and BSDL standards, it takes VICTORY only a minute or two to generate test patterns. It would take a programmer days, even weeks to deliver the same fault coverage for conventional designs.

Concurrent engineering takes on new meaning when you use VICTORY's Access Analyzer to optimize board layout for testability and cost-efficiency.

Now you can find stuck-at faults, broken wire bonds, wrong or missing components – even open input pins – all without manual diagnostic probing. VICTORY's fault diagnostics clearly spell out both fault type and fault location. And that's just the manufacturing process

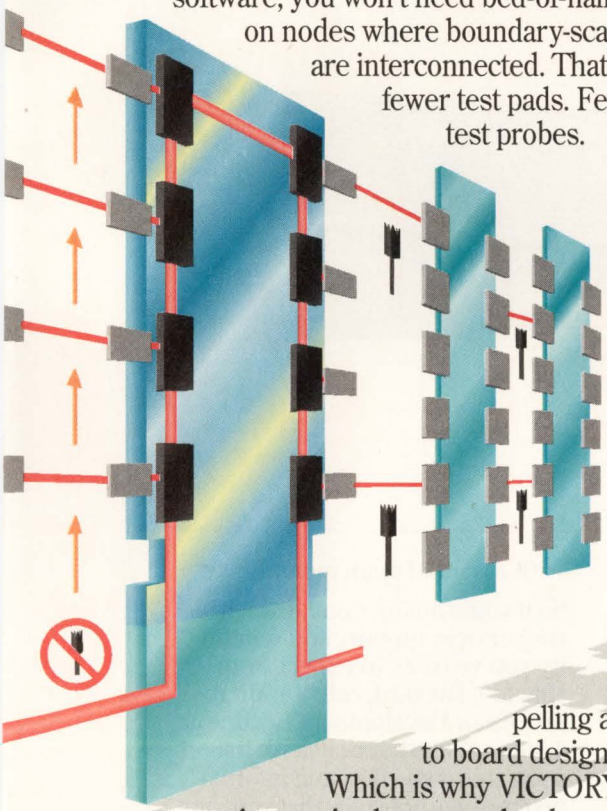


scan is a breakthrough board testing. theory.

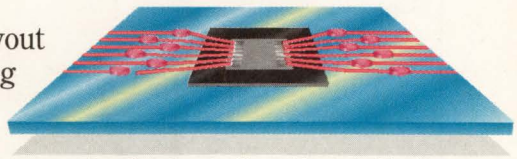
feedback you need to eliminate defects where it's most cost-effective – at the source.

Helps solve the test access problem.

With boundary-scan design and VICTORY software, you won't need bed-of-nails access on nodes where boundary-scan parts are interconnected. That means fewer test pads. Fewer test probes.



That's a compelling advantage to board designers. Which is why VICTORY's Access Analyzer was developed. With this concurrent engineering tool, designers get testability information early in the design process. They can easily see where test points are required for visibility and where they can be dropped, for optimized board layout without lowering fault coverage.



Boundary-Scan Intelligent Diagnostics identify faults by type and location without physical probing – even on high-density SMT assemblies

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CIRCLE NO. 15

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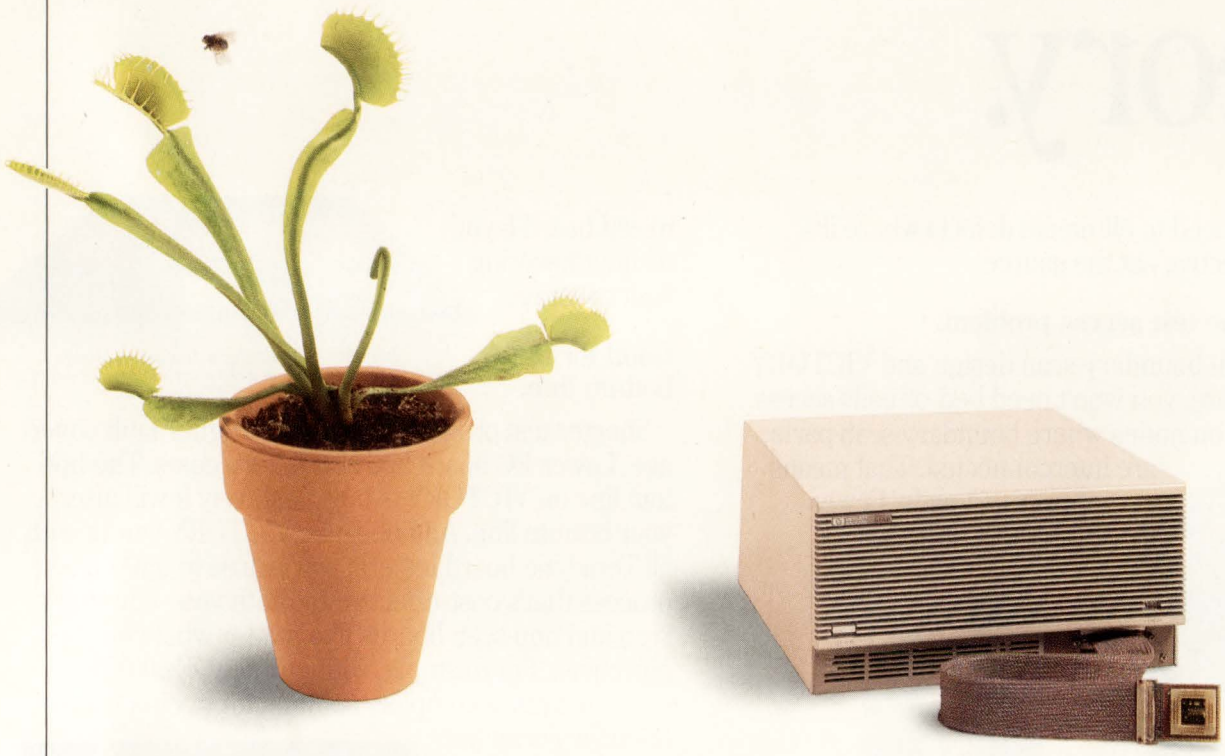

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CIRCLE NO. 16

SIGNALS & NOISE

Send ideas for math and science in action

Thanks to Jon Titus for devoting some space to math education (EDN, April 11, 1991, pg 41). I run an after-school science and math program for the Boys' and Girls' Club of San Diego. I recently started making up fill-in-the-blank handouts of famous proofs and problems, such as the sum of the integers from 1 to 100 and the Pythagorean Theorem. I have students from age 5 through 18 in the same room at the same time. Surprisingly, the handouts are very popular, and I need more ideas. I'd appreciate your readers' suggestions for simple, lucid examples of mathematics and science in action.

Ed Vogel
San Diego, CA

(Ed Note: Readers, mail or fax your ideas and suggestions to Signals & Noise, and EDN will forward them to Ed Vogel. We'll also put them on EDN's computer bulletin-board system (BBS). You can reach our BBS at (617) 558-4241 with modem settings 300/1200/2400, 8,N,1.)

Instrumentation amplifiers revisited

In the Special Report on Instrumentation amplifiers (EDN, March 14, 1991, pg 82), I was disappointed to see the 4-resistor differential amplifier referred to as an "instrumentation amplifier." In the measurements engineering field, the term has been traditionally reserved for the true 3-amplifier (or 2-amplifier, with some contortions) instrumentation amplifier. The 2-buffer and differential-amplifier configuration and its variants, whether monolithic or discrete, are different animals and belong in a class by themselves.

Doug Conner does briefly mention the difference in input impedances, but this fact isn't emphasized enough. The true instrumentation amplifier has *infinite* input impedance, whereas the input impedance of the 4-resistor amplifier is that of the input resistors. If large gains are required, they are usually quite low in order to keep the value of the feedback resistor reasonable. Thus, any network (filters, voltage dividers, etc) connected to such an amplifier will be altered by its input impedance, and some networks, such as low-frequency "washout" filters, may not even be realizable.

The paragraph on software scaling (pg 86) is confusing. It somehow leaves the impression that scaling can be magically performed without exact knowledge of the signal-path gain. Precise knowledge of the transducer and path gains are required for correct software scaling.

Gilbert C Willems
Head, Technology Dept
Naval Biodynamics Laboratory
New Orleans, LA

(Ed Note: An instrumentation amplifier accepts a differential input, multiples it by a gain, and provides a single-ended output. The definition of an instrumentation amplifier doesn't depend on the implementation. For a particular application, a single operational amplifier with four resistors may not be inappropriate because of its low performance. On the other hand, if a single amplifier design does meet your design specifications, it will save money and will be the correct choice.

It's true the single amplifier with four resistors typically has a low input resistance. Some transducers have low output voltages and a low output impedance, making them suitable for use with an instrumentation amplifier having low input impedance. As always, it's up the the engineer designing the circuit to make the appropriate component decisions to meet the required performance.

The article didn't mention the details of software scaling. The designer needs to know either the gain of the signal path or be able to apply a reference signal for software scaling.)

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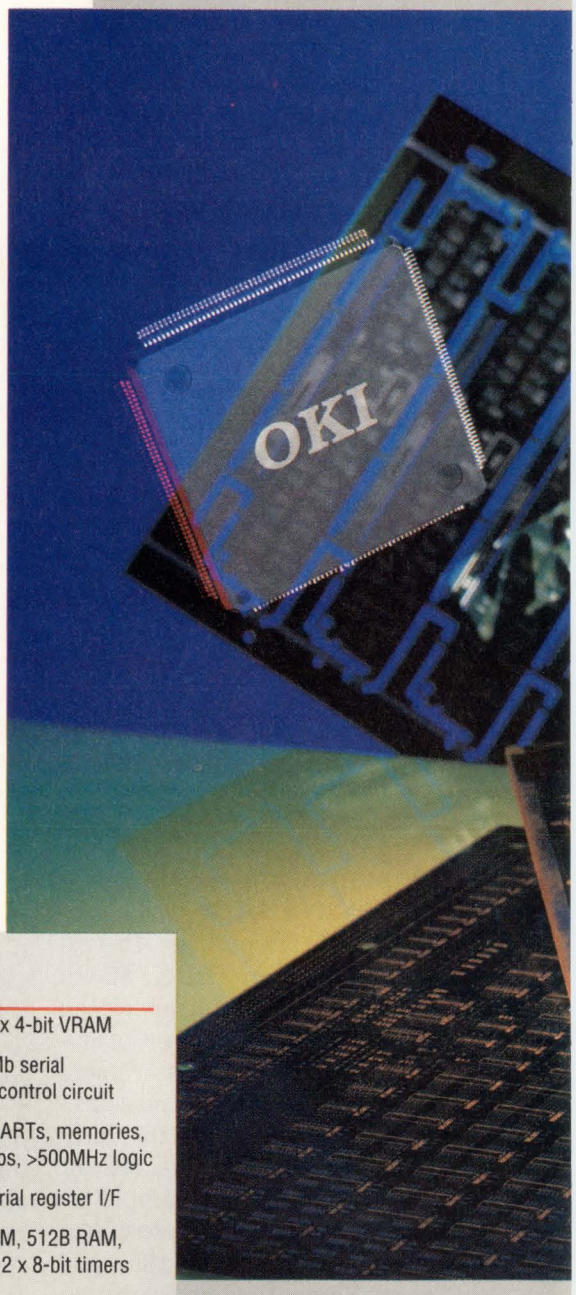

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MSM6388	Solid-state recorder/IM serial register I/F
MSM67620	16-bit MCU with 16KB ROM, 512B RAM, 56 I/Os, 3 x 16-bit timers, 2 x 8-bit timers

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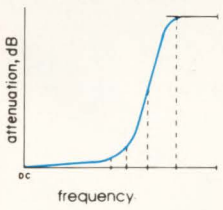
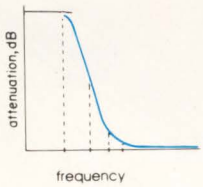
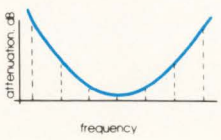


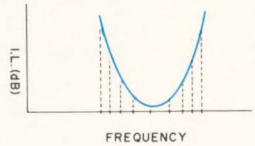
HIGH PASS



BANDPASS



NARROWBAND IF



low pass dc to 1200MHz

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

high pass dc to 2500MHz

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

bandpass 20 to 70MHz

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

narrowband IF

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

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CIRCLE NO. 26

ASK EDN

EDITED BY JULIE ANNE SCHOFIELD

Noise interferes with heartbeat signals

I am interested in learning techniques to decouple a noisy IBM power supply from my circuit cards. These cards plug into the bus to let me work with very small signals, such as EKG heartbeats and recording-studio-quality signals. Using op amps and trying to process signals in the millivolt and microvolt range, I get a lot of common-mode noise fed in by the power supply. Also, as programs execute, the noise increases, so I need a way to make the 5, 12, −5, and −12V power supplies clean while the data fly all over the place.

As you've probably guessed, I've tried a range of capacitors, resistors, and inductors without success. I suspect that besides the noise I can see on a 20-MHz scope, even more noise exists outside this band.

John Bercik
Covox
Eugene, OR

We suggest you start by looking in EDN's Technical Article Database, an annual or semiannual compilation of technical articles that have appeared in EDN and other technical magazines. Read all the articles you can on grounding and other standard practices. You can also check out the mechanical design of purpose-built instrument cards, such as those for VXI systems.

More than one young start-up ran into the laws of physics trying to make plug-in instruments for personal computers. The first Apples had no ground at all. One old-line instrument company bought a line of PC instruments and had to redesign them to be electrically safe and clean.

You should also study the catalogs and application notes published by the top analog IC companies. Analog Devices, Burr-Brown, Linear Technology, National Semiconductor, and too many more to mention here, have talented, experienced analog designers who have spent endless hours at the bench and on their word processors trying to make such practices available to engineers.

You should also contact oscilloscope companies. There's a 99% chance that, through improper probing techniques, you're causing as much noise as you're curing. Senior Editor Charles H Small says that every analog-IC application engineer he talked to while researching an article on sensitive scope measurements told him that when their customers thought they were having low-level noise problems, those customers were really measuring their instruments' noise, not that of their circuits.

Would-be PLD programmer gets cold shoulder

I'm trying to develop a small universal PLD (programmable logic device) programmer. Being an electrical-engineering student, I thought that developing my own programmer would be better than paying the exorbitant prices of some programmers. At the same time, I'd learn a lot about these programmers. Nevertheless, I've found that most manufacturers' data books don't have any references at all on how to program their devices—unlike the way you can find out how to program an EPROM from, say, a Texas Instruments' MOS Memory Databook.

When I phoned companies regarding this lack of information, I was told that the programming algorithm varies, depending on the specific device. I was given the cold shoulder when I asked if they could send me a copy of the algorithm. Some of the manufacturers said the algorithms to program their devices are proprietary, and they don't give it out!

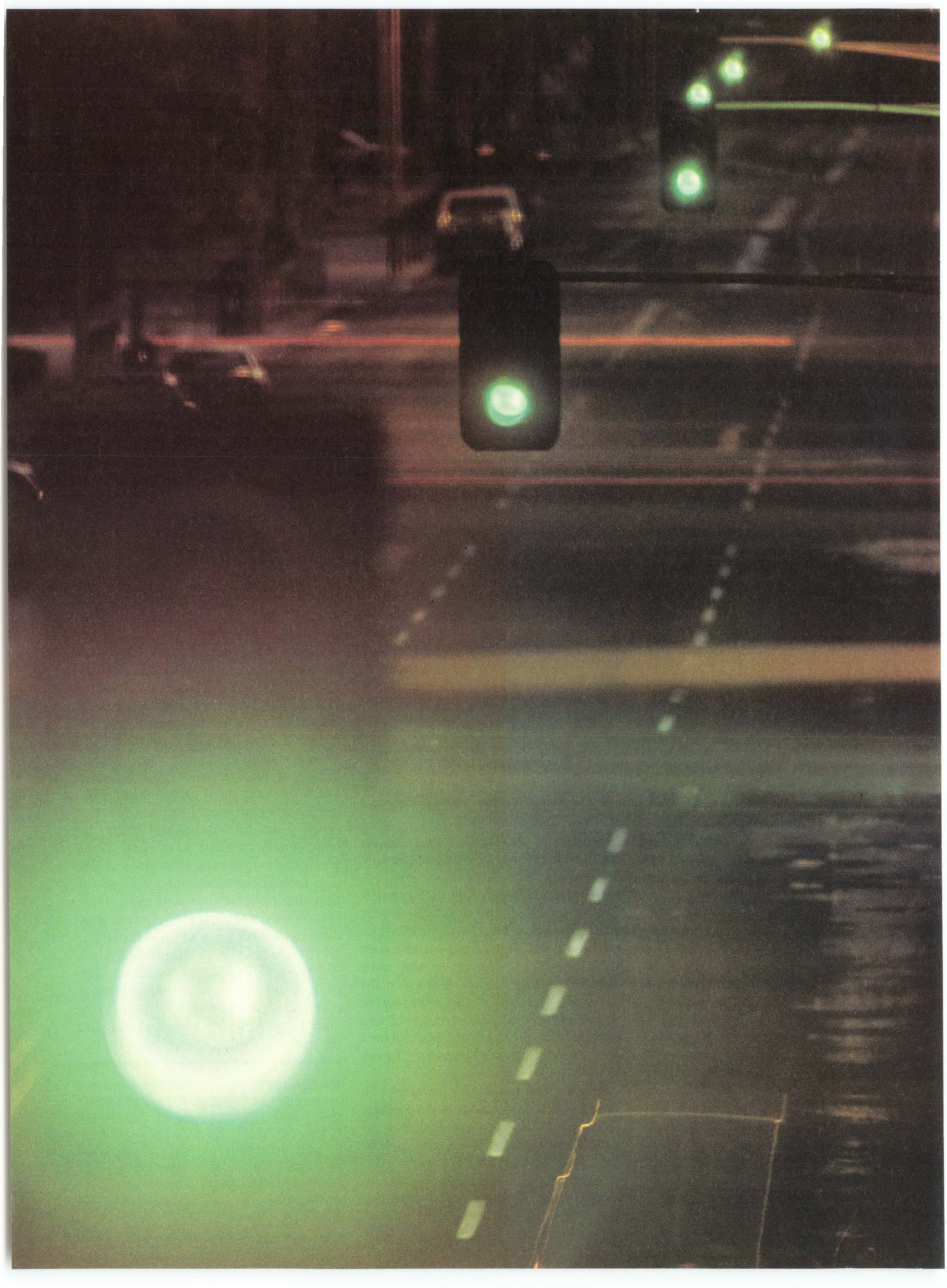
What's the matter? I thought the idea behind data books was to make available to the general designer all the information he or she would need to use a manufacturer's ICs. Programming a PLA shouldn't be much different from programming an EPROM or a microcontroller. I'd hand out a trophy to Cypress Semiconductor, which puts the information about its EPLDs right in the devices' data books. Is there any way, other than being a "big company," to find out those programming algorithms and be able to develop a PLD programmer? Cypress's information was useful, but it doesn't cover the great majority of PLDs out there.

Javier Alexis Perez
Boston University
Boston, MA

Senior Editor Charles H Small reports that Mike Holley at Data I/O (Redmond, WA), a company that has programmed a device or two, says keeping up with changes in programming algorithms is just too big a headache to be done in catalogs and data sheets. Holley reports that Data I/O is in constant communication with all programmable-device manufacturers because the manufacturers' algorithms change constantly. Sometimes, Mike says, the companies change their processes for one reason or another. Sometimes, the characteristics of the devices change for no known reason.

Charles has been keeping informal track of companies that get into the device-programmer business. In the seven years he has been at EDN, he has seen more than 30 of them come and go. He guesses that the companies look at the electronics needed for a device programmer and say, "Hey, this looks pretty simple." Later, they discover the true cost of supporting all the changes in programming algorithms and go out of business. So, even if you design your own programmer and it works fine now, tomorrow your programmer could start blowing up parts or failing to program them.

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



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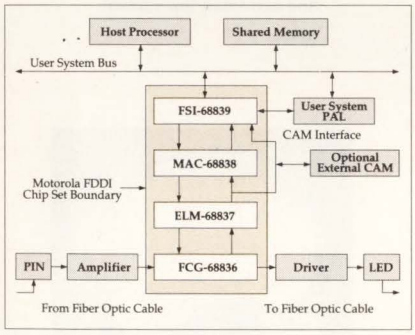

Led by the FDDI System Interface chip, it speeds data through the system at up to 200 Mbytes/second via two 32-bit ports. While 8 Kbytes of on-chip RAM provide more than 80 microseconds of bus latency. Freeing up your host for other system tasks.

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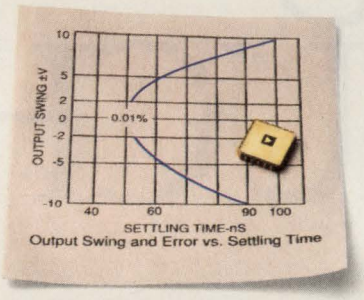
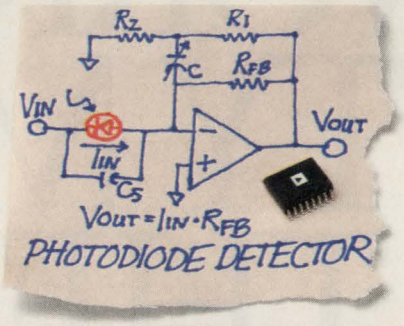


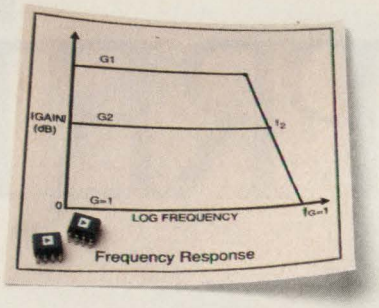
Precision

With the AD840, AD841 and AD842, there's no need to trade speed for accuracy. All three settle to 0.01% within 100 ns (840/842) and 110 ns (841) – critical in data acquisition and instrumentation applications – and offer low offset voltages and drifts, and fast slew rates.



FET Input

For op amps requiring low input current, the OP-42, OP-44, AD845 and AD843 are all remarkably fast – slew rates are 58, 120, 100 and 250 V/μs, respectively. In addition, they offer offset voltages of less than 1 mV and extremely low current noise.



Transimpedance Amplifiers

The OP-160, OP-260, AD844, AD846, AD9617 and AD9618 all utilize a current feedback architecture to achieve slew rates from 450 to 2000 V/μs without compromising stability – even in hostile environments. Other benefits include low power dissipation and high unity-gain bandwidth.

If whatever it is you're trying to do involves high-speed op amps, Analog Devices is the company to call. With our current products and new introductions, we have the broadest line of high-speed op amps available. A line that gives you the right combination of speed, precision, noise and price. So chances are, we've got exactly what you need for

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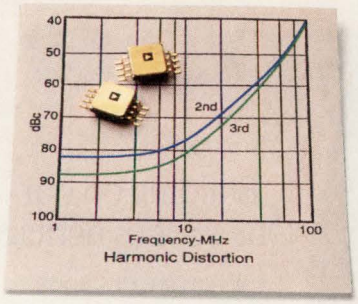
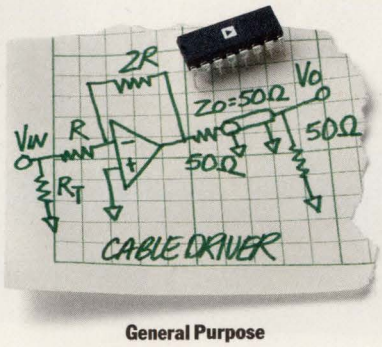


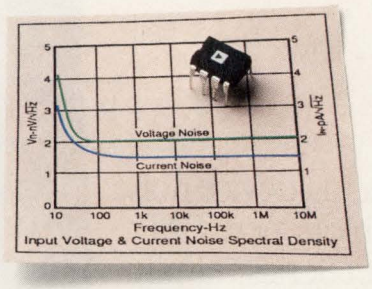
Buffers

If you're looking for extremely low distortion buffers, look at the specs of the AD9620 and AD9630 – distortion at 20 MHz: −73 dBc and −66 dBc, respectively; fast settling time: less than 8ns to 0.02%; and extremely low noise: 2.2 nV/$\sqrt{\text{Hz}}$.



General Purpose

With the right combination of speed, precision, power dissipation and high output drive capability, the AD827, AD829, AD847, AD848, AD849 and OP-64 are ideal general purpose solutions. And they're ideally priced solutions – most singles are under $3, and duals are under $5.



Low Noise

It used to be you had to choose between speed or low noise. But with the AD829, you get both. It features voltage noise of 2 nV/$\sqrt{\text{Hz}}$ and current noise of 1.5 pA/$\sqrt{\text{Hz}}$ with a 50 MHz unity-gain bandwidth. Those specs, combined with the low price of $2.95/100s, make it ideal for both audio and video applications.

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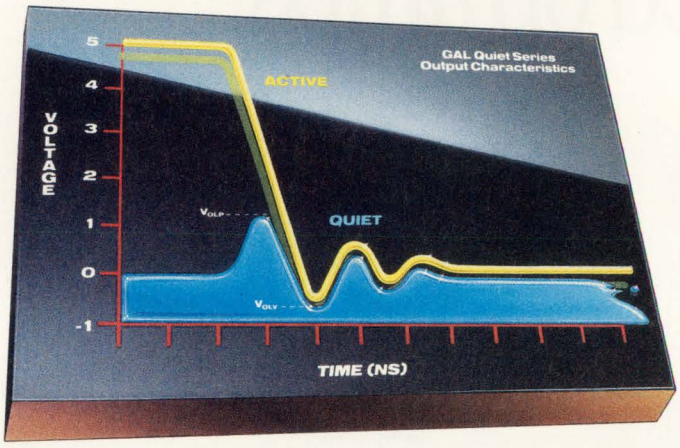

Silencing device noise with our new GAL® Quiet Series™ family.

The tide of events for CMOS-based logic is sure to change course with the introduction of our new GAL Quiet Series devices. Because now you can design in high-speed logic devices without having to design out noise.

Through our advanced proprietary circuitry, we keep noise to a bare minimum. Our GTO™ (Graduated Turn-on Output) circuit, which retards the output buffers, results in smoother edge rates, diminished output undershoot, and greatly reduced ground bounce (V_{OLP} max of 1.5V).

What's more, these devices utilize unique ground and power buses, which effectively isolate inputs from output noise and improve dynamic threshold.

	V_{OLP}	V_{OLV}	V_{ILD}*	V_{IHD}**
National	1.18	−.62	1.40	1.78
Competitor A	2.06	−.66	1.10	1.83
Competitor B	1.58	−.66	1.39	1.62
Competitor C	1.46	−1.08	1.09	1.56

*V_{ILD}—Dynamic Input threshold low **V_{IHD}—Dynamic Input threshold high

Minimizing system noise.

Not only will our high-speed GAL QS devices improve your system performance, they'll reduce your overall system noise. And that means extraneous noises like Electromagnetic Interference (EMI), crosstalk, and ringing, the effects of which often result in false clocking.

Delivering higher speeds at 1/2 and 1/4 the power.

What more would you want in a GAL device other than high speed and low noise? Our answer is less. That's why we offer reduced-power versions of our 15ns devices. Which means now you can get half- and quarter-power GAL devices —in either 20- or 24-pin DIP and PLCC packages —that draw a max I_{CC} of 90mA and 55mA respectively at 15MHz.

Building on our Quiet Series heritage.

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Information: Explosion and fallout

Most of us agree that we're experiencing an explosion of information. Photocopiers are ubiquitous, facsimile machines are a necessity, and almost any desktop personal computer can serve as a communication link with worldwide services and databases. The fruits of these devices yield an increasing flow of information. Along with the explosion of information comes the inevitable "fallout," or problems that such a free flow of information introduces. Here are some examples worth considering:

A US Senate proposal would require that telephone and computer companies give the government the keys to all scrambled communications. Even if this measure passes through Congress as part of the bill it's attached to, the proposal wouldn't be legally binding. However, it opens avenues for invasion of privacy. Many companies routinely use the Data Encryption Standard (DES) to encrypt and decrypt sensitive information. However, some people think this standard, which arose from the National Bureau of Standards in 1977, contains a "back door" through which agencies such as the National Security Agency can decrypt communications.

Earlier this year, several amateur-radio operators were cited by the Federal Communications Commission for violating FCC regulations that prohibit ham operators from transmitting commercial messages or information. In this case, a station originated a digital message that was sent to many packet-radio repeaters and then retransmitted to other packet stations throughout the USA. The short message urged support for a nonprofit group. Because each ham operator is responsible for every message that his or her station originates or "repeats," the FCC took action against many hams. Should such operators really be held responsible for the hundreds of thousands of bytes of data that their stations pass on to other operators?

In 1990, a group of computer hackers tapped into a Bell South computer and made a copy of a memo regarding upgrading and billing for 911 emergency phone systems. A grand jury indicted the hackers, who were charged with interstate transfer of stolen property worth more than $5000. (Bell South put a $79,449 value on the memo.) One of the hackers published an on-line newsletter, *Phrack*, which was seized, along with the hacker's disks, computer system, and subscription lists. These actions raise important questions. Can you steal a document when all you do is make a copy of it? (Recently, a British court ruled that making a copy of a document isn't the same as stealing it.) Are works published in electronic form subject to Constitutional protection?

As transferring information from place to place becomes easier, and as we increase our dependence on those paths of communications, we need to re-examine how we continue to protect our rights and how we assume new responsibilities. Unfortunately, new technologies often outstrip our ability to regulate them. Surely FCC regulations for ham operators didn't envision a station being able to communicate millions of bits of data to other stations in the course of a day. So, should we even attempt to regulate the flow of information, or must we protect ourselves as best we can? Obviously, the information age raises a lot of questions. As technical people who are involved with and depend on communications technology, we're in a unique position to make our ideas known. Now's the time to let us—and others—know what you're thinking.

Jon Titus
Editor

Send me your comments via FAX at (617) 558-4470, or on the EDN Bulletin Board System at (617) 558-4241 300/1200/2400, 8, N, 1.

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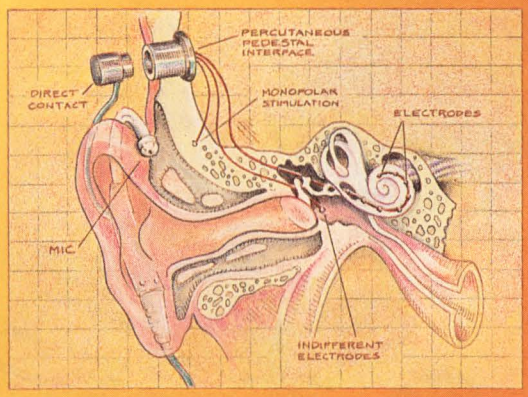
CIRCLE NO. 28

We call it a FET Array.

She'd call it a Miracle.



Hammer. Anvil. Stirrup. Drum. Simple names for the complex natural "hardware" that allows us to hear. If it's injured—or congenitally defective—the deafness that occurs can't always be helped by conventional hearing aid.

A *cochlear implant* bypasses the damage, delivering filtered and processed analog signals directly to electrodes implanted deep in the inner ear. These signals stimulate the audio nerves in a natural way, allowing—in most cases—the deaf to hear.

The variety of applications for our new *RFA120* never ceases to amaze us. But then, a linear array that combines *both* bipolar *and* JFET gain blocks can provide some pretty versatile characteristics:

RFA120 FET Array
Operating Range: ±5V to ±15V
Input Offset Voltage: 5 mV typ.
Input Bias Current: 30 pA typ.
Gain Bandwidth Product: 3.0 MHz typ.
Slew Rate (Gain = +1): 8 V/μs

The RFA120 is a low power device that's ideal for signal conditioning applications. One of our favorites also takes advantage of its small size.

It's a *cochlear implant system* that bypasses injured or congenitally defective "hardware" in the ear canal. The system converts audio signals to analog signals, routing them deep into the inner ear to stimulate the natural audio nerves that are "hardwired" to the brain.

We're committed to analog technology.

And we're committed to helping you develop creative, cost effective solutions.

Our *Win-Win* program is a good example. It lets you get to market quickly with a semicustom array, then shift to full custom as sales increase. It's fast, flexible and makes good business sense because it eliminates the risk of going full custom before you're really ready.

If you'd like more information on our analog arrays, give us a call at **1-800-722-7074**. We'll send you our new brochure.

Raytheon Company. Semiconductor Division.
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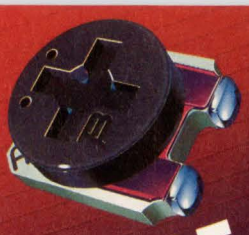
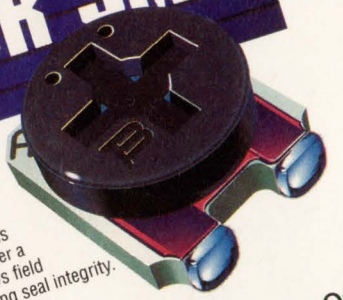
Where quality starts with fundamentals

CIRCLE NO. 29

THE MULTIPLE CHOICE ANSWER FOR SMD TRIMMERS

BOURNS





New! New! New! 4mm Sealed 5-Turn

The all process compatible Bourns® Model 3374 is the first elastomer sealed chip-style device to offer a minimum 5-turn seal life. The Model 3374 allows field adjust capability after soldering while maintaining seal integrity.

Size	4.9mmL x 4.0mmW x 2.0mmH
Contact Resistance Variation	3% max.
Resistance Range	10 ohms to 2 megohms ± 20%
Temperature Coefficient	±100ppm/°C
Seal Life	5 cycles
Rotational Life	100 cycles

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4mm Sealed Multiturn

The only way to get multiturn trimming precision in a 4mm surface mount potentiometer is with the new Bourns Trimpot® Model 3224 12-turn sealed trimmer. Dynamite specs. Rugged construction.

Size	4.6mmL x 4.8mmW x 3.7mmH
Contact Resistance Variation	1% max.
Resistance Range	10 ohms-2 megohms, ±10%
Temperature Coefficient	±100ppm/°C
Rotational Life	200 cycles

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4mm Open-Frame Single-Turn

With a cost-effective chip style design, the Model 3304 features a cross-slot rotor that is ideal for automatic assembly and adjustment techniques.

Size	4.8mmL x 3.8mmW x 2.4mmH
Contact Resistance Variation	5% max.
Resistance Range	10 ohms-2 megohms, ±25%
Temperature Coefficient	±200ppm/°C
Rotational Life	20 cycles

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3mm Open-Frame Single-Turn

The Model 3363 is the industry's smallest 3mm design meeting both EIA and EIAJ footprint standards. With a film-coated resistor, it can be either wave or reflow soldered.

Size	3.6mmL x 3.0mmW x 1.3mmH
Resistance Range	100 ohms-1 megohm, ±25%
Rotational Life	20 cycles
Contact Resistance Variation	5% max.
Temperature Coefficient	±250ppm/°C

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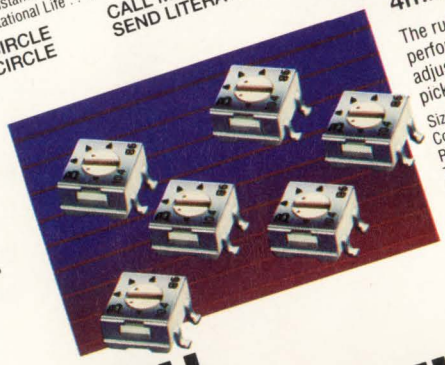

4mm Sealed Single-Turn

The rugged Model 3314 trimmer is ideal for reliable performance in harsh environments. Top and side adjust styles provide excellent compatibility with pick-and-place assembly techniques.

Size	4.5mmSq x 2.55mmH
Contact Resistance Variation	1% max.
Resistance Range	10 ohms-2 megohms, ±20%
Temperature Coefficient	±100ppm/°C
Rotational Life	100 cycles

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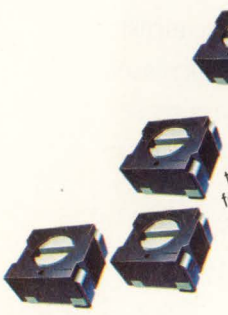

3mm Sealed Single-Turn

Another size barrier has been broken with the Bourns® Model 3313 trimmer which features 3mm size, a protective seal and solid construction.

Size	3.5mmL x 3.2mmW x 2.2mmH
Contact Resistance Variation	2% max.
Resistance Range	10 ohms to 2 megohms ± 20%
Temperature Coefficient	≤100 ohms ±150ppm/°C >100 ohms ±100ppm/°C
Rotational Life	100 cycles

CIRCLE CALL ME
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Trimmer Processability Guidelines

Model	Packaging	Sealed/Open	Soldering
3224	7 In. Reel	Sealed	Wave & Reflow
3304	7 In. Reel & 13 In. Reel	Open	Reflow Only
3313	7 In. Reel & 13 In. Reel	Sealed	Wave & Reflow
3314	7 In. Reel & 13 In. Reel	Sealed	Wave & Reflow
3363	7 In. Reel	Open	Wave & Reflow
3374	7 In. Reel & 13 In. Reel	Sealed	Wave & Reflow

Call Me Circle #30

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For a FREE BROCHURE and the telephone number of your nearest sales office providing technical assistance.

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BOURNS TRIMPOT

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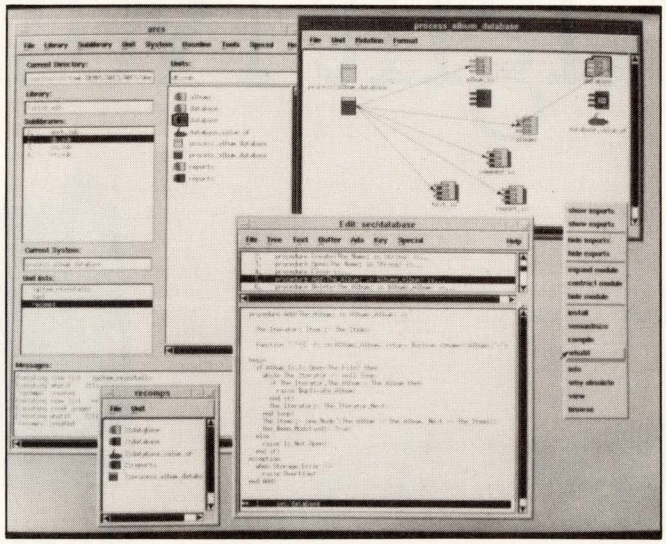
Send Literature Circle #31

Motif-based Ada development system targets Sun and other RISC workstations

The RISCAda software-development environment includes an Ada compiler and integrates a suite of development tools under the control of OSF/Motif. On a workstation, different windows can display an editor, a debugger, a network manager, and configuration-management tools. Initially, the system will run on Sun SPARC-based workstations, but the company also plans to port the software to other RISC-based systems.



***The Motif-based integrated Ada development system**, RISC-Ada, includes configuration-management tools and a system browser that traces dependencies between code modules.*

The Ada compiler included in the development system can compile 1667 lines of code per minute in optimized mode and 2465 lines per minute with no optimization. The system can automatically perform global optimization across all modules in a large application program, including the Ada runtime package. Furthermore, the software system automatically eliminates any subprograms not required for a particular application, thereby reducing the size of the final executable program file.

The suite of development tools that accompanies the compiler, called the Arcs 2.0 toolbox, includes a graphical system browser. The browser shows the structure and dependencies of an Ada program, and also dependencies on C-or assembly-language modules. The browser uses diagram structures defined by software guru Grady Booch in 1983. Icons in the diagram distinguish between specifications, bodies, units, and subunits. The browser and other toolbox features allow a team of programmers to work on large Ada applications.

The Arcs 2.0 includes a language-sensitive editor that performs syntax and semantic checking. The editor's semantic completion service displays all possible completions after the first few characters of a procedure, function, or package name have been typed. A library manager allows programmers to examine and modify program libraries and sublibraries.

The RISCAda package also includes a set of testing tools. For example, the Adatracer package has a source-level debugger and a graphics-based profiler. You can debug code at the source level in one window and view an analysis of the debugged data the profiler displays in another window.

The SPARC version of RISCAda also features a set of bindings to industry standards. For example, the Xview binding allows you to develop Open-Look applications although RISCAda is Motif based. The company offers optional bindings to Sybase and Oracle database packages, and to X-Window and Motif standards. The package includes Posix bindings, and you can purchase the company's Teleuse package that lets you automatically generate programs compatible with the X-Window standard and OSF/Motif.

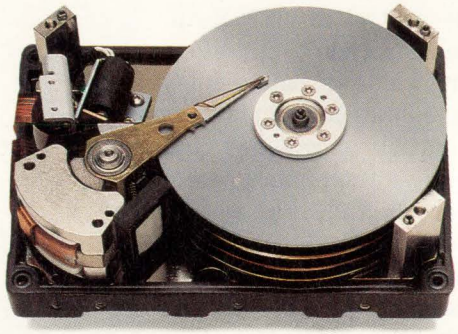
You can perform cross-development activities under RISCAda using the Triad family of products. The company supports the Motorola 68000 and 88000 μP families, Intel 80386 and 80960 μPs, and MIL-STD-1750A-compatible processors.

Depending on the specific configuration, the SPARC version of RISCAda costs from $6000 to $12,000 per workstation or server. The Teleuse graphical-user-interface generator costs $2000, and bindings to the database packages cost $895. The X-Window and OSF/Motif bindings sell for $2500. The company provides customer support directly.—***Maury Wright***

Telesoft, 5959 Cornerstone Ct W, San Diego, CA 92121. Phone (619) 457-2700. FAX (619) 452-1334. TLX 855300.

Circle No. 727

The Right Specs. Right Now.



Maxtor LXT-340

See for yourself. The Maxtor 340MB (formatted) 3.5-inch LXT-340 drive, a field-proven design, is available for shipment right now, in volume.

Proven design delivers unbeatable performance including a sequential data transfer rate that is 20% faster than the comparable 331MB Seagate ST1400.

Essential components are common in *all* drives within the LXT family. This commonality provides easy migration upwards or downwards making future qualifications for other family members happen quickly and efficiently.

Call and ask about our LXT family of high-performance, 3.5-inch AT and SCSI drives with capacities from 213MB to 535MB. Because right now can't be soon enough. **Call your nearest Authorized Maxtor Distributor.**

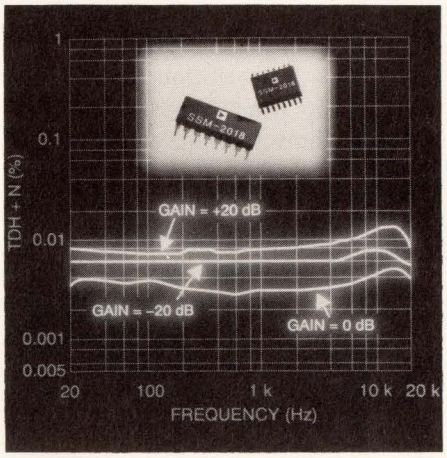
3.5 Inch Disk Drive Comparison Criteria	Maxtor LXT	Seagate ST14xx
Shipping 300MB Class in Volume	Yes	No
Full Range of Capacities from 213MB to 535MB	Yes	No
Commonality in Family for Components and Manufacturing	Yes	No

We Drive Harder.

Maxtor®

VCA features 118-dB range and ≤0.025% distortion

The SSM-2018 is, according to the company, the industry's highest performance voltage-controlled amplifier (VCA) in monolithic form. Supporting this contention is the VCA's dynamic range of 108 dB in class-A mode and 118 dB in class-AB mode, equivalent to 18-bit and ≈20-bit resolution, respectively. In its class-A mode with gains of ±20 dB, the VCA has a maximum THD of 0.025% over the 20-Hz to 20-kHz audio band. In its class-AB mode under the same conditions, THD is 0.04%.



***Able to operate in either class-A or class-AB mode**, the SSM-2018 voltage-controlled amplifier exhibits low THD+N over the 20-Hz to 20-kHz audio range.*

The classic tradeoff designers face is that a class-A device offers lower distortion, and a class-AB device provides a better signal-to-noise ratio. The advantage of this VCA over other devices is that it allows you to choose between either class of operation. A single external resistor programs the VCA's internal gain core for the desired operation. You can ascertain from the previous specifications that little difference in THD exists between the two classes.

Key to the device's ability to operate in either mode is an architecture that the company calls an operational-amplifier voltage-controlled element (OVCE). This architecture provides differential inputs and outputs that can operate in either the voltage or current domain. Conceptually, the differential-output OVCE uses various forms of feedback to create a range of functional configurations, including those suitable for preamplifiers, amplifiers, mixers, equalizers, and compressors.

The OVCE consists of three basic sections: the input differential pair and compensation network; a programmable current splitter that generates the bias current for the gain core; and the 4-transistor gain core, which is essentially a dual 2-quadrant multiplier. Easing design-in, the VCA contains a high-impedance input control port and an output op amp to eliminate the need for any external active components.

In addition to its low distortion, the VCA also features a 140-dB gain range, a 10V/μsec slew rate, 14-nV/$\sqrt{\text{Hz}}$ input voltage noise and a 12-MHz gain-bandwidth product. The SSM-2018 is available in 16-pin DIP and SOIC packages with operation guaranteed over the industrial temperature range of −40°C to +85°C. In a 16-pin SOIC, the device costs $3.25 (100).

—Dave Pryce

Analog Devices, Precision Monolithics Div, 1500 Space Park Dr, Santa Clara, CA 95052. Phone (408) 562-7513.

Circle No. 724

Spreadsheet-like interface replaces tedium of HDL code writing

If you can't write VHDL (VHSIC Hardware Description Language), maybe you can "Hum" a few bars. Rather than forcing you to write textual VHDL code, Hum uses a spreadsheet paradigm that allows you to describe the behavior of your circuit by entering Boolean-like descriptions in a matrix. The software then maps the spreadsheet description into behavioral VHDL.

After providing the software with a list of the model's I/O, which the software uses to generate a VHDL entity, you enter a spreadsheet-like table. This table consists of control, object, and a potentially infinite series of state columns. You place WHEN, IF, AND, OR, and DO operators in the control column to control the flow of events. You use the object column to list the signals or variables that result from or influence the operation of your model. Finally, the state columns contain the seven fixed signal states (RISES, FALLS, LOW, HIGH, CHANGES, X, Z), which cause operations to occur.

Pop-up menus prompt you for the proper input to each column in **Fig 1**; you can create your own data types simply by typing in your enumeration values. The object-column menu presents all I/O pins as potential objects. Unlike VHDL, which demands strict adherence to type consistency, Hum allows you to mix data types; the software creates data-conversion functions as needed.

The software also takes care of the assignment of signals and variables; variables can't exchange information between multiple WHEN blocks (equivalent to VHDL processes) or external models as signals can. After you've developed your models, the software compiles your tabular design into an intermediate format. You then compile the intermediate format into VHDL, which you can simulate using a third-party simulator.

To visualize the simulation of the VHDL code, conceptually "watch" the simulator enter each column at a WHEN operator and evaluate the values of the variables left to right across the row. When the simulator finds a true condition, the simulator executes the remainder of that column, unless a CONTINUE, BREAK, or RETURN statement redirects control. Therefore, most of the time, one column represents one time step.

Although Hum presents a more intuitive and easier-to-use front end for VHDL-based design than textual entry, the method is currently used only for simulation. The software doesn't support generics or packages but does use aliases and labeled DO loops, so you may have to massage or modify the VHDL output to allow synthesis. Although the software declares variables and signals of type integer, it doesn't put bounds on the integer. This failing will choke logic synthesizers but is relatively easy for you to correct.

The software's documentation isn't comprehensive; instead, it's conversationally written to walk you through the specification and generation of a very simple VHDL model of a J-K flip-flop. The draft copy of the documentation also promises a discussion of how to add timing to your models without actually delivering on that promise.

The software does support timing

PROCESS	sn54109a											
WHEN	sd_	LOW	HIGH	LOW	X		HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
AND	rd_	HIGH	LOW	LOW		X	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
AND	cp_						RISES	RISES	RISES	RISES	RISES	RISES
AND	j_						HIGH	LOW	HIGH	LOW	X	
AND	k_						LOW	LOW	HIGH	HIGH		X
>	q_	HIGH	LOW	HIGH	X	HIGH	q_	LOW	HIGH	q	X	X
>	q_	LOW	HIGH	HIGH	X	HIGH	q	HIGH	LOW	q_	X	X
>												

Fig 1—You can describe the operation of a J-K flip-flop *in a 13×7 matrix. You read the matrix by starting at the control and object columns, reading across to the appropriate state column, and then down that column. For example, WHEN sd_ is LOW AND rd_ is HIGH, THEN q is HIGH and q_ is LOW.*

Z I L O G

Introducing Zilog's Smart Access Controller... Z180 intelligence and SCC communications together in one package.

Don't throw away your old software.

The Z80 family continues to be the most popular group of intelligent peripheral controllers on the market. With good reason. It's a tribute to our Superintegration™ technology and the performance of the controllers themselves. And since each new product in the family, like the SAC,™ is based on the same Z80/180 code you'll be able to migrate your existing software easily and effectively. We don't have to tell you how important that is.

Here's a list of the fast-growing family of Z80-based intelligent peripheral controllers. It's a list that's not likely to stop expanding any time soon... stay tuned.

INTELLIGENT PERIPHERAL CONTROLLERS

	System				Serial			Timers		Parallel	
	CPU	OSC	MMU	RAM	DMA	USART	UART	C/S	CTC	C/T	PIA	PIO
Z84C01	✓	✓							✓		✓	✓
Z84C50	✓	✓		✓		✓			✓			
Z84C90	✓						✓	✓		✓		
Z80180	✓	✓	✓		✓		✓			✓		
Z80280	✓	✓	✓	✓	✓		✓			✓		
Z84013/C13	✓	✓					✓			✓		✓
Z84015/C15	✓	✓								✓	✓	
Z84011/C11	✓	✓								✓	✓	✓
Z80181	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓

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

High integration. High performance. Smart communicator.

The Superintegration™ SAC Controller packs the popular high performance Z180 architecture into a new cell suitable for many datacom and peripheral control applications. You get the SCC single-channel communication cell with two additional UARTS, a 4 x 8-bit counter timer (CTC) *and* onboard 16-bit I/O. The SAC Controller runs at 10 MHz and drives fast serial communications at 2.5 Mbits/sec. With the reduced 3 cycles per instruction, the SAC Controller gives you Z80® code performance 25% faster. That makes the SAC Controller the highest performance, low power embedded controller around.

The best cost/performance of any embedded controller out there.

Whatever your application — data communications, modems, FAXs, printers, terminals, industrial controls — the SAC Controller combination gives you the best cost/performance ratio. Everything you need for your system is on the chip. The SAC Controller brings you all the advantages of Zilog's Superintegration technology. Off-the-shelf and backed by our solid reputation for quality and reliability.

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CIRCLE NO. 33

UPDATE

via transport and inertial delays that you place by adding "@"<time> for transport delays and " "<time> for inertial delays. You can also use variables and expressions.

To its credit, the company includes partial copies of more complex models with the software for you to use as examples of coding style and the power of the tools. These examples include AMD29000 and Intel 8085 microprocessors.

The company assumes that users of the tool will be more interested in correctly specifying their designs than in the resulting VHDL code. As a result, the software puts both the entity and architecture descriptions into a single file. This procedure simplifies file management at the expense of making what-if analysis a bit more tricky.

The SPARC or VAX X-Window version of the software costs $12,000. A $3500 IBM PC version sacrifices the multiwindowing capability that's useful for displaying multiple tables and internally created waveform graphs.

The company has specified two future revisions of the code. One revision includes an option to create VHDL that you can synthesize. This option, however, will result in larger files that will make VHDL less simulation efficient. The other revision will allow you to copy the necessary timing information right from the data book.

—Michael C Markowitz

Lewis Systems Inc, 1915 Peters Rd, Suite 113, Irving, TX 75061. Phone (214) 438-2177.

Circle No. 737

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NKK introduces the surface mount G3T with patented STC contacts, gull-wing terminals. VPS or infrared reflow solderable.

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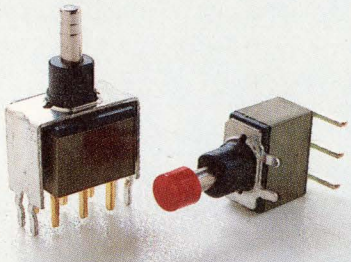


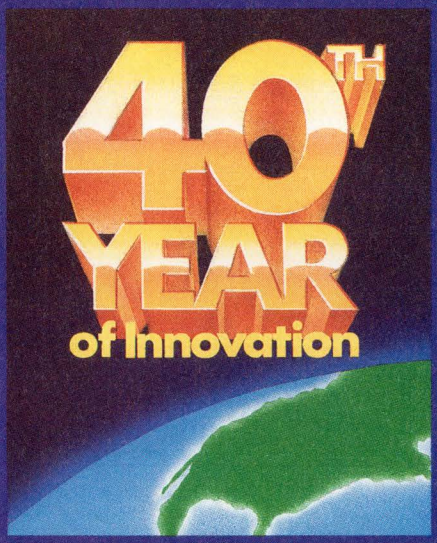
Washable M2B subminiature pushbuttons feature very-light-touch, snap-acting contacts. Straight, right angle, vertical PC terminals.

ULTRA-MINI

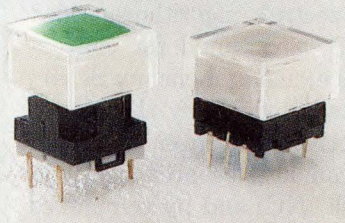
New ND switch is half the size of ordinary binary coded DIP rotaries. Washable and universal footprint pattern.

LEGENDARY

New compact, industrial-grade NB snap-in LED pushbutton with split legend up to 4 ways. Built-in resistor. Numerous options.

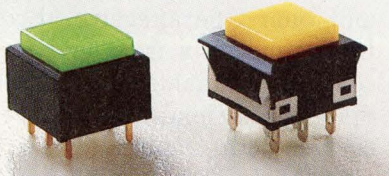


WORTH A MILLION



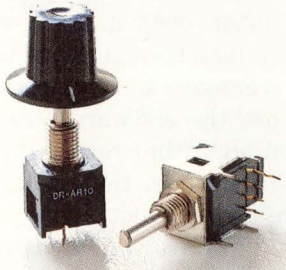
Million operations from unique LED illuminated JB keypad switch. Red, green or yellow LED options.

DOUBLE DUTY



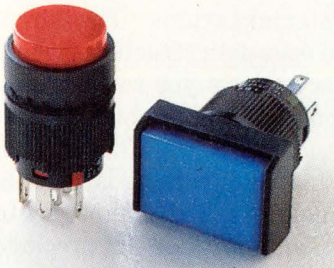
Logic-level for PCB or power rating for snap-in panel mounting, from very low-profile UB pushbuttons with full-face LED illumination.

TURNING POINT



Washable Binary Coded DIP rotary DR-A switch can be PC or panel mounted. Crisp operation. Right angle or straight terminals.

100,000 CHOICES



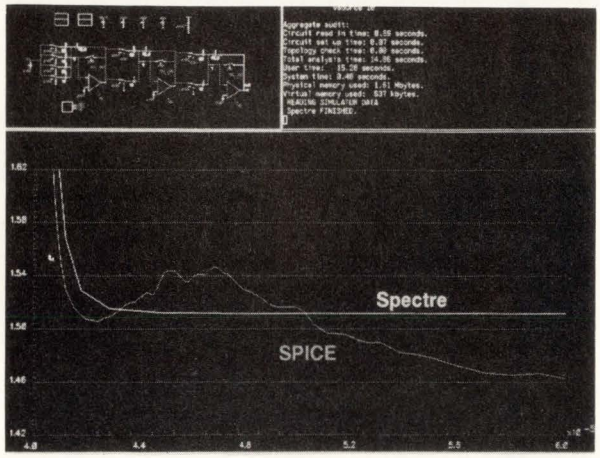
YB pushbutton yields literally 100,000+ part numbers with variations in mounting, illumination, circuitry and color.

Spice-based tools speed chip and board analysis

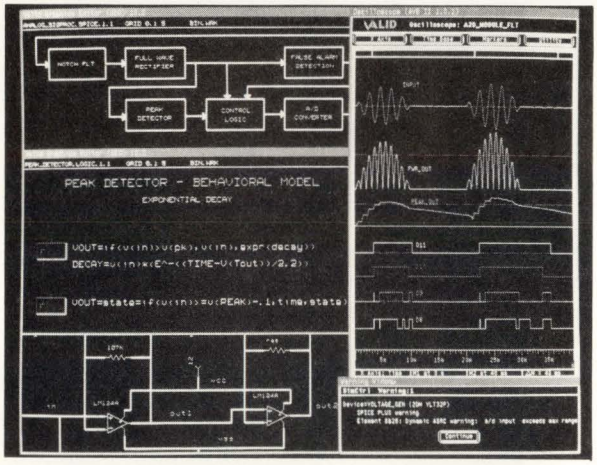
Analog designers have a love-hate relationship with Spice. They generally love its accuracy but curse its speed, its capacity, its inability to converge, and its unfriendly interface. Two Spice-based tools take on some of these problems to improve Spice's utility.

At the chip level, Spectre from Cadence Design Systems is a circuit simulator that uses modified Spice-based algorithms to improve convergence. Spice-based simulators use an iterative analysis to zero in on voltage and current levels. Too often, on large circuits or circuits with many nonlinear elements, these analyses diverge.

Spectre's algorithms, coded in C, are tuned for convergence, using benchmark circuits provided by the Microelectronics Center of North Carolina (Research Triangle Park, NC) and by companies associated with Cadence's Analog Alliance Partners. Tuning the simulator to converge on these circuits improves their benchmark performance.



Charge-conserving device models *allow Spectre to produce more accurate results than Spice.*



Evaluate multiple-level circuit representations *using Profile graphical and textual entry to the Analog Workbench II Spice-simulator.*

Using the C language yields more efficient memory utilization than Fortran-based Spice implementations. The simulator also uses data structures whose efficiency allows you to simulate large circuits in half the memory of other versions of Spice. The company has simulated circuits as large as 53,000 transistors and claims no fundamental limitation to preclude the simulator from running larger circuits.

Three enhancements provide the circuit simulator with higher simulation speed than Spice. First, the simulator uses a more efficient sparse-matrix algorithm to calculate voltages and currents. Then, because the software uses a node-based algorithm rather than a device-based one, the simulator performs fewer calculations. Finally, the simulator uses automatic time-step control to minimize calculations when circuit voltages and currents are stable.

The simulator accepts C-language user-compiled models. It also uses standard Spice models and input files so you can upgrade to Spectre from other Spice simulators, though proprietary models created in other third-party Spice derivatives may not run without modification. Among the models included are the Gummel and Poon BJT (bi polar junction transistor) model, five MOSFET models (MOS1, MOS2, MOS3, BSIM1, and BSIM2), a GaAs MESFET model, and standard diode models.

The simulator runs on most workstations and is integrated in the vendor's Analog Artist design framework. As a result, you can use the simulator to design and analyze analog circuits as you create them. However, you can't use the simulator on mixed-signal designs yet; it has not yet been coupled to any digital simulators.

Cadence isn't calling Spectre an upgrade; both users and nonusers of its current Spice-derivative simulator pay the $30,000 single-user licensing fee.

Another Spice-based tool addresses simulation from the system and board perspective. Profile, from Valid, is a front end for the company's Analog Workbench II Spice-based simulation tool. Profile enables both graphical and textual entry of structural- and behavioral-level circuit descriptions.

Where Spice has classically been a text-based simulator, this front end allows you to build circuit mod-

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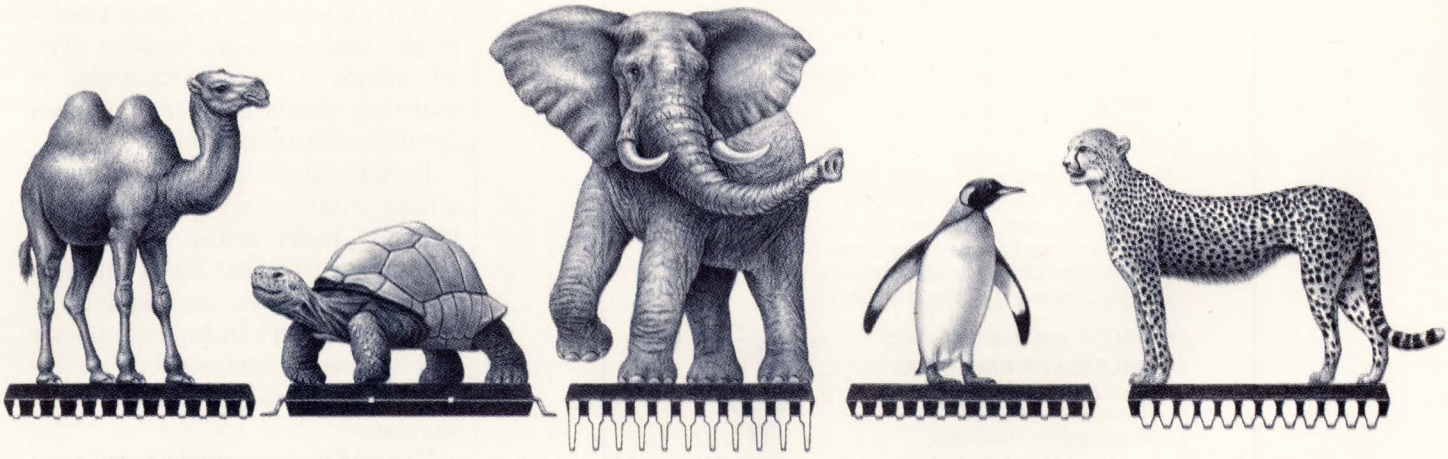

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	CXK581100TM	100/120	TSOP (normal)	L/LL	B/X	Now
	CXK581100YM	100/120	TSOP (reverse)	L/LL	B/X	Now
	CXK581001P	70/85	DIP 600mil	L/LL		Now
	CXK581001M	70/85	SOP 525mil	L/LL		Now
	CXK581020SP	35/45/55	SDIP 400mil			Now
	CXK581020J	35/45/55	SOJ 400mil			Now
128Kx9	CXK77910J	17/20	SOJ 400mil		Sync ASM	3/Q '91
256Kx4	CXK541000J	25/30/35	SOJ 400mil			3/Q '91

L = Low LL = Low,Low B = 3 Volt X = Extended Temperature

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UPDATE

els from block diagrams that include such components as PLLs, differentiators, oscillators, and gain blocks. Although this front end also accepts standard Spice netlists, the components it accepts can be behavioral-level models, which contain differential equations, Laplace transforms, and basic arithmetics. The advantage of these components is that they simulate faster than more detailed structural models.

Because the simulation software allows distributed processing of multiple tasks across a network, certain multiprocess tasks can utilize excess processing capability. Such tasks don't include simple dc and transient analysis but do include statistical and parametric simulation.

The software expands Spice's capabilities and minimizes convergence problems by incorporating modeling extensions to Spice. Profile models can include such effects as hysteresis, memory, and conditional branching. The models also let you eliminate discontinuities in nonlinear models using piecewise-linear functions. As an example, a model can use the function $y = 1/x$, where $x \leq -0.1V$ and $x \geq 0.1V$; it can close the discontinuity with the function $y = x$, for $-0.1V > x < 0.1V$.

The language allows modeling of electromechanical devices such as motors, solenoids, and sensors. You can also build mixed-signal analog/digital models. An option to the company's $12,000 Analog Workbench II simulation and analysis tools, Profile costs $15,000 and runs on Sun, DEC, and IBM workstations.—***Michael C Markowitz***

Cadence Design Systems Inc, 555 River Oaks Pkwy, San Jose, CA 95134. Phone (408) 943-1234. FAX (408) 943-0513.

Circle No. 725

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- *Impedance matched*
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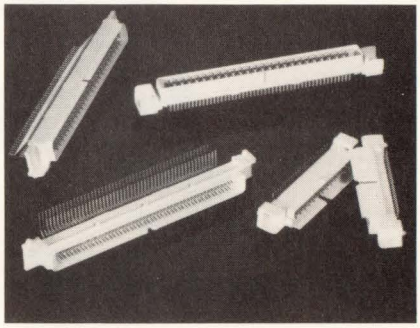

.050" Pitch Hermaphroditic Connectors eliminate the need for separate male and female parts

- *Feature .050" centers*
- *50 Ω impedance matched*

Meritec introduces a new concept in board-to-board interconnects–CP50™ Hermaphroditic Connectors. Each mating half is identical in configuration, eliminating the need for separate male and female parts. Close pitch .050" centers minimize board space requirements. The 50 Ω, impedance matched connectors feature precision, high strength molded terminations for reliability in critical applications and are designed to meet IR or vapor phase reflow requirements. Contact tails come in SMT and through hole configurations, straight and right angle.

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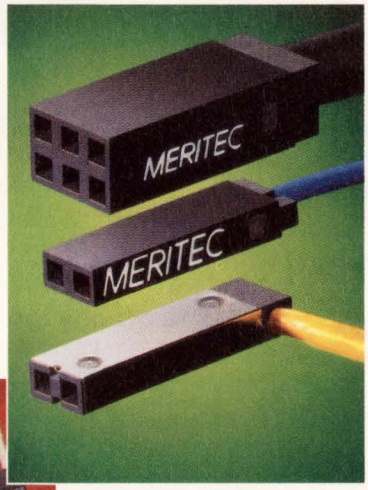

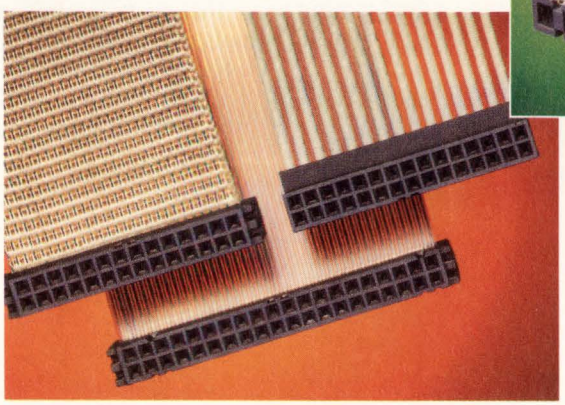

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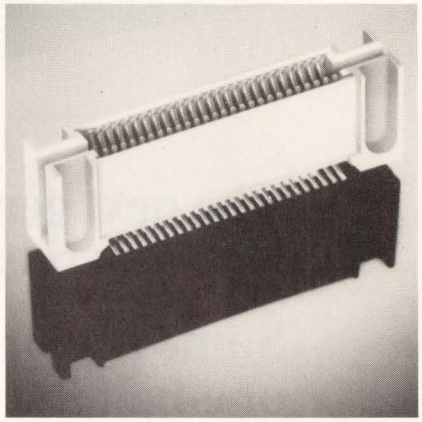

Card Edge Connectors with .050" centers are available in SMT and through hole configurations

Meritec's CP50™ Card-Edge Connectors are designed with .050" centers to minimize board space requirements. The 50 Ω, impedance matched connectors are ideal for high density board-to-board applications. The connectors are designed to meet IR or vapor phase reflow requirements. Through hole and SMT contact tail configurations are available. Precision, high strength molded terminations provide reliability in critical applications.

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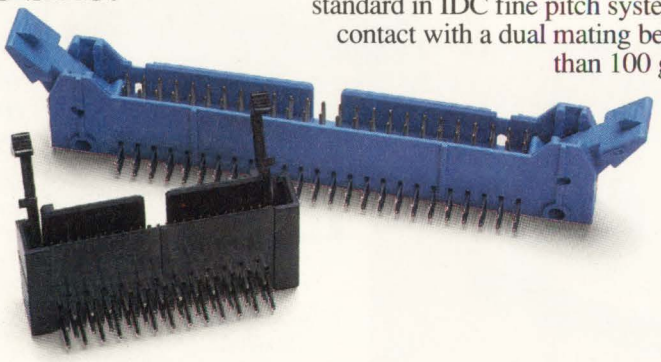

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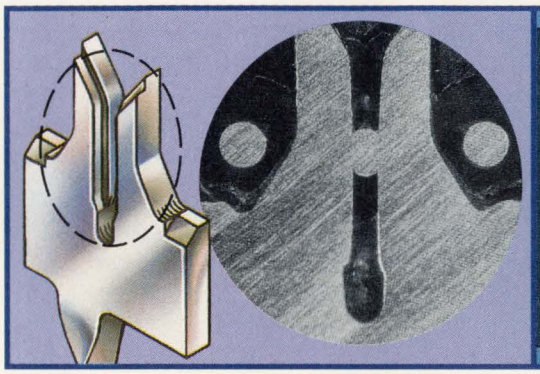
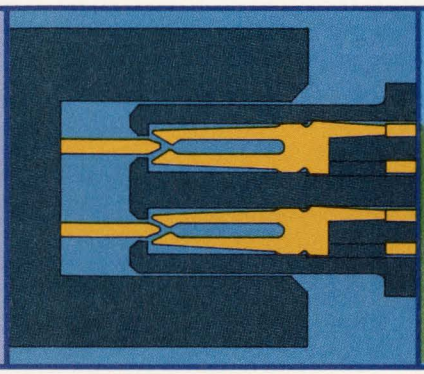
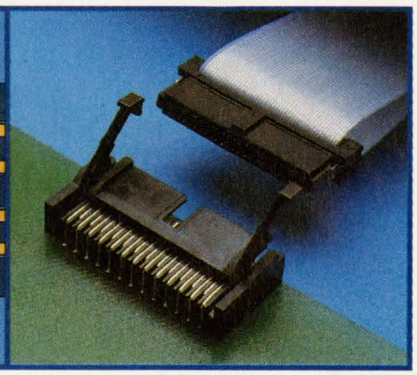


Contact-to-Conductor Relationship – Thomas & Betts' "coined-slot" contacts are designed to position the terminated conductors within a specified region for maximum conductivity and reliability.



Precision Lead-In Design – assures that repeated connect/disconnect functions are consistently smooth and without pin damage.



Our Own Vertical Eject Design – saves board real estate and ensures positive locking and easy disengagement of header from mating socket without stress to cable, contacts, or solder joints.

and high performance materials are combined to ensure excellent system integrity and maximum reliability.

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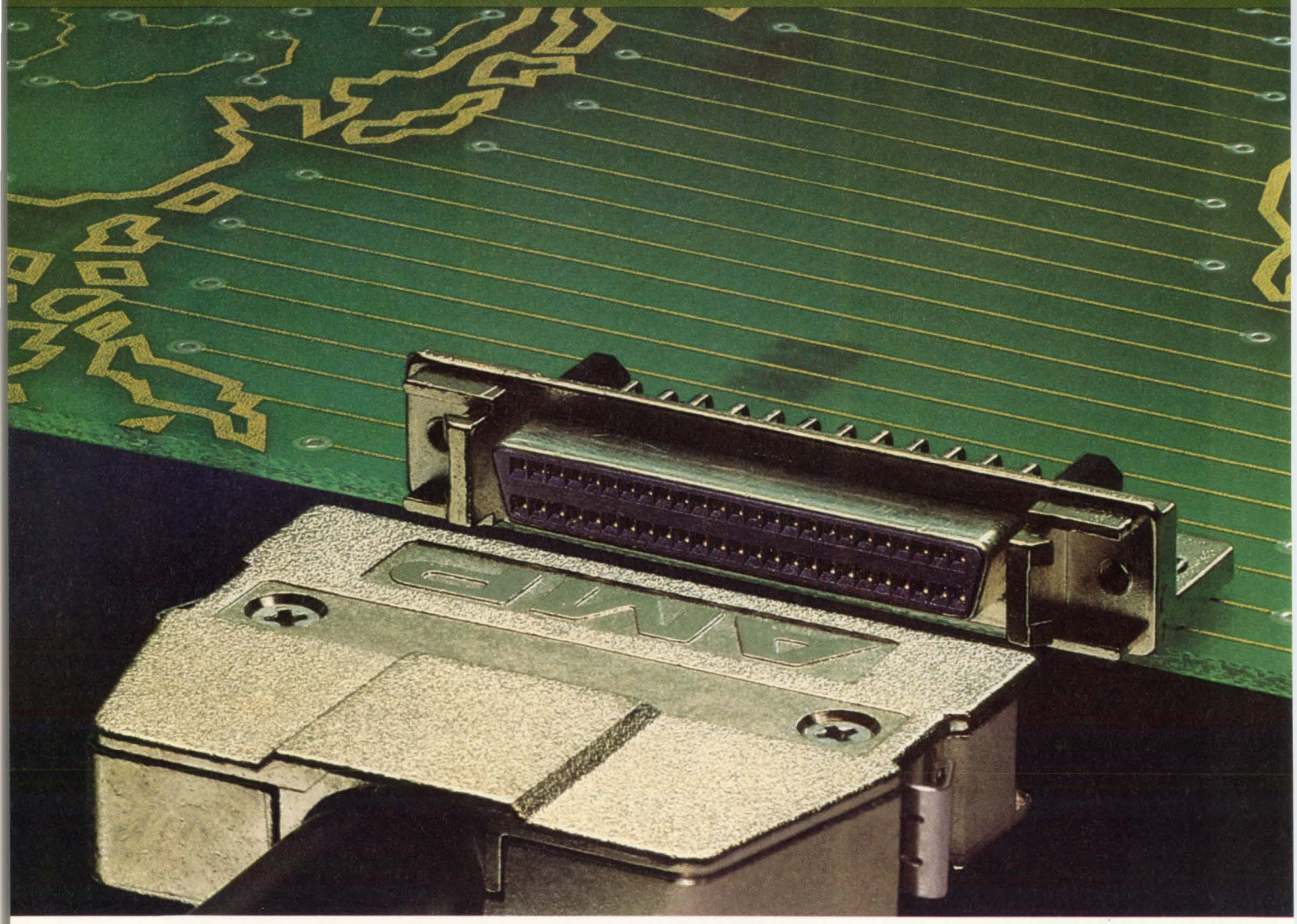

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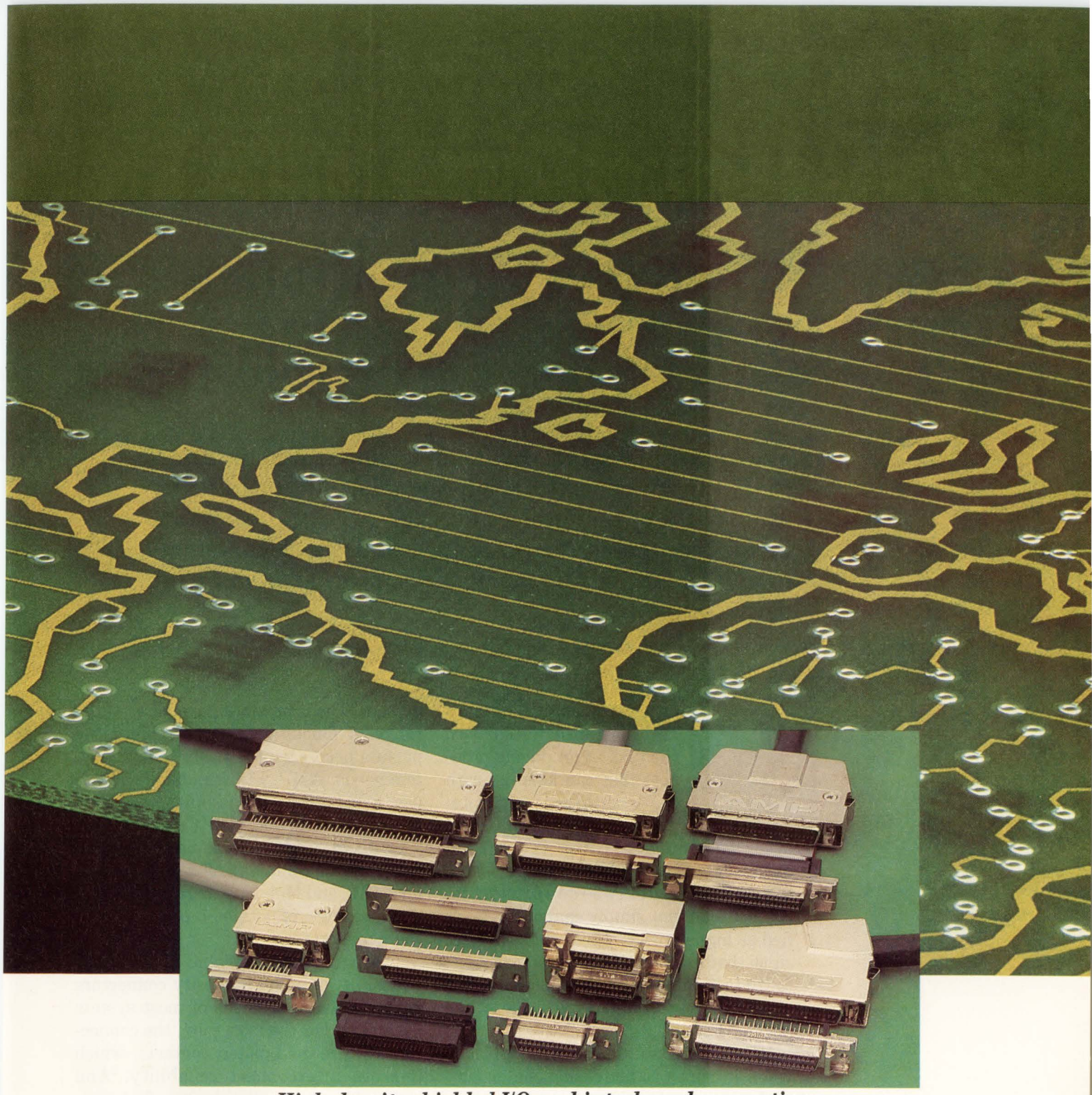

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AMP

CIRCLE NO. 41

High-density connectors solve tough pc-board interconnect problems

The high signal speeds and tight packing densities found in today's active components would be of little value without the interconnect technology to support them. Fortunately, novel connector designs let system designers take advantage of the improvements in today's components.

Tom Ormond, Senior Editor

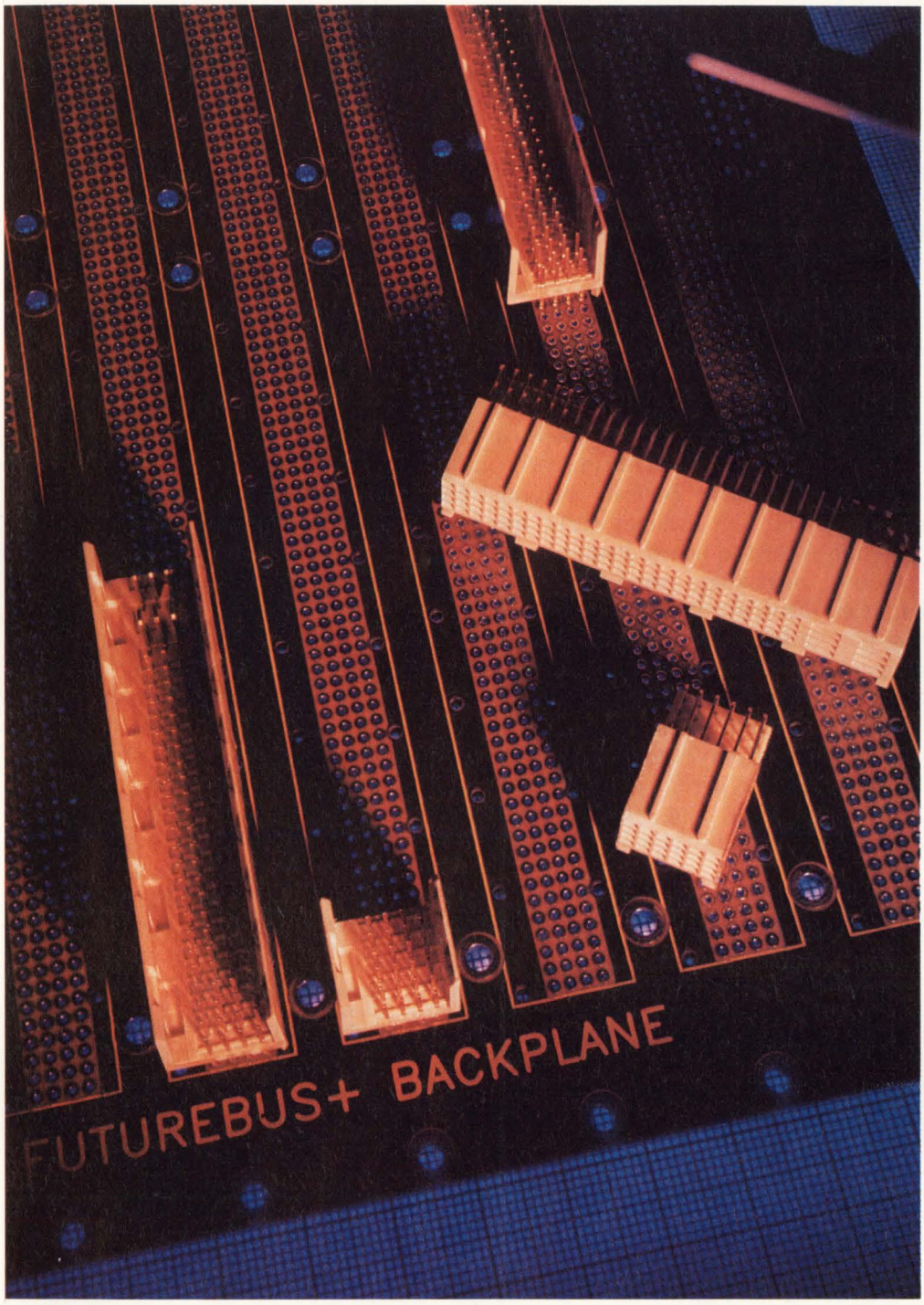
Connector manufacturers are constantly faced with the task of producing products that can keep up with the performance and integration advances in ICs and other components. Given the I/O requirements typically found on pc boards today, the classical two-row, 0.1×0.1-in. contact footprint simply cannot be classified as high density. Those connector designs that have retained a 0.1-in. contact-to-contact pitch usually employ four or more rows of contacts to achieve the needed I/O density.

Vendors have some design options when it comes to increasing pin density in their connectors. In one scheme, they can stuff the same number of contacts in a smaller housing by using different pin configurations. They can, for example, leave the row-to-row spacing at 0.1 in. and use a contact-to-contact spacing of 0.05 in. or less. Another option is to maintain a 100-mil contact-to-contact spacing, but reduce the row-to-row pitch. Finally, the vendor can simply reduce both the row-to-row and contact-to-contact pitch.

Table 1 lists some of the key parameters for selecting high-density connectors. The companies have all used the range of pinout options to achieve the pinouts necessary to satisfy today's system needs. AMP, Fujitsu, and Teradyne use a 0.1×0.05-in. pinout grid. Hypertronics, DuPont, and Cinch use the 0.1×0.1-in. grid, but also use more than two rows of contacts. AT&T, ITT Cannon, JST, and Molex use hard metric contact spacings of either 1 or 2 mm for their connectors.

The pin counts available in **Table 1**'s partial listing of high-density connectors should satisfy the needs of most system designers. For the most part, the connectors feature gold-plated contacts, which improve interconnect reliability. And most of the connector designs feature a wiping-action type contact mating.

However, connector manufacturers cannot arbitrarily continue to reduce contact spacings. There are a number of considerations they must address, such as maintaining signal integrity and minimizing the effect of insertion force. For example, as vendors try to cram more and more pins into smaller spaces, the pins must get smaller and the force necessary to insert the connector must increase. Zero-insertion-force technology is one way to minimize problems associated



Based on stackable modules that can provide either 24 signal contacts, 8 power-blade contacts, or a single cavity for a high-power, fiberoptic, or coaxial insert, ITT Cannon's Tempus 2-mm interconnect system is very flexible.

with increasing forces. Since signal integrity is so critical at high speeds, Augat, AMP, and Teradyne place clean signal transmission at the top of their design-goal lists.

Augat's solution for the problem of interconnecting high-speed signals is the electronic invisible interconnect, a device that uses controlled-impedance MicroStrip or stripline design technology. The unit is a compression, surface-mount, single-piece connector that routes signals from a mother board to a perpendicularly mounted daughter board. All signals pass through a short length of flexible circuit mounted within the connector's housing.

In standard electronic invisible interconnect connectors, the flexible circuit has a 50Ω characteristic impedance; however, Augat will customize the impedance of the circuit to fit your needs. A contact assembly routes the signals from the mother board to the flexible circuit and then on to the daughter board. The flexible circuit features a ground plane.

To be truly international players in the connector market of the future, vendors will have to go hard metric with pinouts.

Therefore, there is no need to dedicate any connector pins to ground points and thereby degrade connector density. The propagation delay for each signal line measures 30 psec, ±10%. The attenuation and signal skew parameters are 0.025 dB max and 10 psec max, respectively.

Each electronic invisible interconnect connector consists of 160-pin modules that you can stack to create larger devices. The unit's sequenced-mating feature lets you insert a daughter card during power-up. As you insert the card, the ground pins contact first. Power-pin contact follows, and then the signal pins mate. A 0.05-in. wiping action occurs during the signal-pin mating sequence. Part of the connector—a protective locking and aligning cover—resides on the daughter board. The cover properly positions the daughter board and the mother board's main connector. The card-mating action wipes the daughter board's contacts across spring-loaded contacts to ensure low-resistance connections.

Using borrowed technology

The AMP Micro-Strip connectors utilize the same Micro-Strip techniques used extensively in pc boards to control transmissions. The line includes three models: a board-to-board stacking connector, right-angle connectors that connect boards perpendicularly to one another, and a cable-to-board unit designed for system interconnect applications.

Transmission characteristics in the Micro-Strip connectors are controlled by adjusting dimensions, spacing, and dielectric properties. The units have a controlled impedance of 50Ω, ±10%, which minimizes impedance-related discontinuities during the sending and receiving of fast-risetime digital data pulses. Crosstalk is limited to less than 4% at 1 nsec. Connector design provides a lower inductance ground return that results in minimal voltage drops between grounds while signals are being switched simultaneously. This lower inductance makes dedicated signal and ground pins unnecessary. The connectors feature 40 signal pins and two ground-bus segments per linear inch.

Ground-bus segments are designed in increments of 20 signal pins, and each segment is approximately 0.5 in. long. This design lets users tailor the Micro-Strip connector to fit a specific application. In applications that require impedance control for the entire connector, you

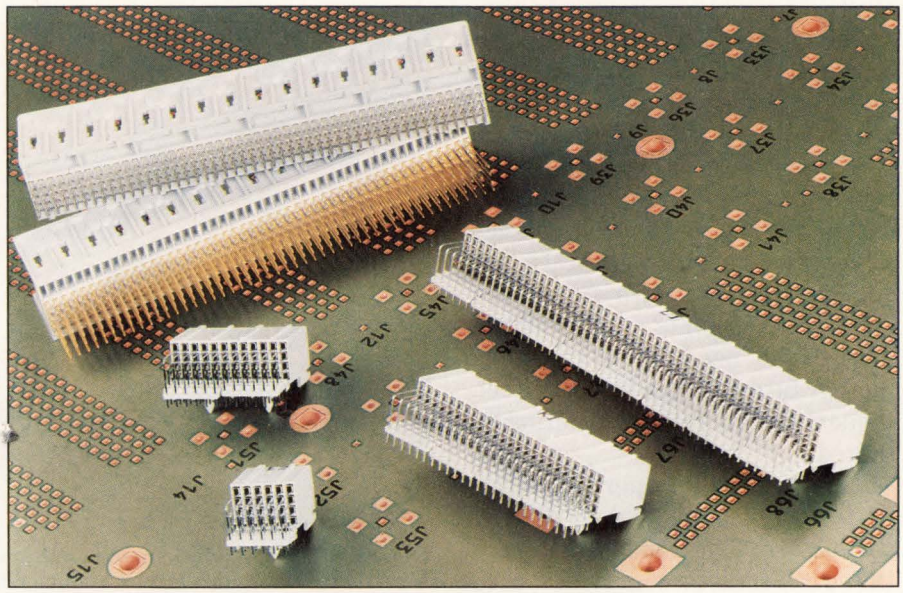
Table 1—Representative parameters for high-density pc-board connectors

Company	Model	Number of contacts	Contact spacing (in.)	Contact current (A)	Contact plating	Lifetime (cycles)	Operating range (°C)	Price
AMP	Micro-Strip	20 to 240	0.05×0.1	0.5 for signal 5 for bus	Gold	50	−55 to +125	$0.15 to $0.21/ mated line (OEM qty)
AT&T	Metral	456	0.079×0.079	1	Gold	200	−55 to +125	$0.08/mated line
Augat	EIL	160 to 960	0.050×0.050	0.5/2[1]	Gold	100	−55 to +105	$0.60 to $0.80/ signal (1000)
Beta Phase	MS4-025-312-D-LTF	312 pairs	0.025	0.5	Gold	500	−65 to +125	$0.10 to $0.20/ pair
Cinch	CIC[2]	106	0.1×0.1	4	Gold	25,000	−55 to +125	$75 (10,000)
DuPont	HPC	40 to 600	0.1×0.1	1	Gold	Not specified	−65 to +105	$0.09 to $0.18/ mated line
Fujitsu	FCN790	10 to 40	0.05×0.1	1	Gold	500	−55 to +105	$1.67 (1000) for a 20-contact unit
Hirose	FX1	144, 192, 216	0.05	0.5	Selective gold	500	−55 to +85	$16/mated pair
Hypertronics	KA/254	48 to 490	0.1×0.1	3 to 5	Gold	100,000	−55 to +125	$36 to $250 (1000)
ITT Cannon	Tempus	24 to 192	0.079×0.079	1	Gold	250	−55 to +125	$0.08/mated pair
J S T Corp	FPZ	7 to 25	0.039	0.5	Tin-lead	100	−25 to +85	$0.40 to $0.60/ line (OEM qty)
Molex	FFC/FPC	30	0.039×0.025	1/0.5	Tin	30	−20 to +85	$0.01/line (OEM qty)
Teradyne	VHSICon UHD	38 to 396	0.1×0.05	2	Gold	500	−55 to +105	$0.50 to $11/ mated line[3]

Notes: 1. Ratings for flex circuit/contact pin.
2. Controlled Impedance Connector.
3. For connector portion of system only.

can use the pc board's ground line as a common interconnect point for the individual ground bus segments in the connector. However, if transmission protection is only required in part of the connector, you can use the remaining contacts to perform other functions, such as low-speed control-line interconnection or low power distribution between boards.

All three versions of the MicroStrip connector are similar in design—a row of contacts is located on each side of a separable ground bus positioned in the center of each connector. When the connector halves mate, the ground connection is carried from one pc board to a second pc board by a metal ground bus. This eliminates the need to use signal contacts for the grounding function.



A modular system based on 2-mm centers, AT&T's Metral interconnects feature a basic building block that is 12 mm long and 4 rows wide. The modules are available in 4×6, 4×12, 4×24, and 4×48 sizes and are designed to stack end-to-end on a card edge or backplane without loss of positions.

Interconnects go GI

Teradyne's VHSICon UHD is a complete backplane interconnection system designed primarily for advanced VHSIC-based military/avionic applications. The system includes a controlled-impedance, multilayer, pc-type backplane (KS1050 Series) and a UHD connector system, which consists of a backplane segment and a daughter-board segment. The backplane half of the connector mounts via solderless, compliant, press-fit contacts. The bare pc backplane can contain as many as 30 layers.

Featuring connectors that measure 5.44×0.58 in., the VHSICon UHD conforms to the dimensions of SEM (Standard Electrical Module) format E. The connectors employ a miniature version of the tuning-fork and blade contact system. This contact technology, used in airborne, shipboard, and ground-based applications for many years, is qualified to MIL-C-28859, MIL-C-28754, MIL-A-28870, and WS6157. The daughter board and backplane connectors feature 10 modular sections; each section contains 40 tuning-fork or blade contacts. This modularity eases field repair. The modular insulator concept lets you easily construct connector patterns that are longer or shorter than the SEM format and incorporate fiber-optic or coaxial contacts to meet future system needs.

Featuring 396 contacts in a 5.44-in.-long housing, VHSICon UHD connectors from Teradyne accommodate high-density military/avionics applications.

Daughter-board connectors are available in two versions: with flexible-circuit terminations (FM1050) or rigid terminations (M1050) at the connector/daughter-board interface. In both cases, the terminations are attached to each side of the daughter board using surface-mount techniques. The blade contact is also identical in both versions—only the terminating end that attaches to the module is different.

Running traces significant distances to reach a backplane can degrade system performance. Cinch gets around this problem by doing away with the backplane interconnect concept.

Cinapse, Cinch Connector's interconnect technology, eliminates traditional backplane wiring techniques in high-speed systems. The technology can significantly reduce propagation delays by shortening interconnect paths between components.

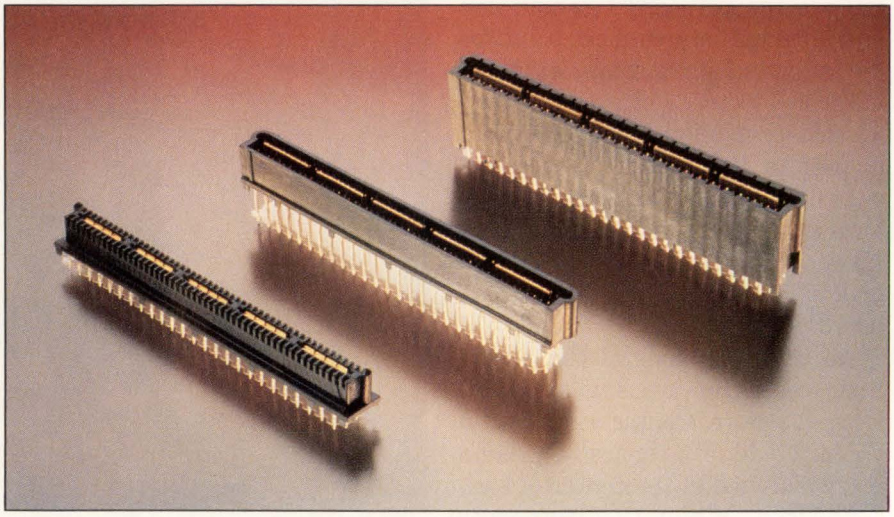
The interconnect technology uses resilient, cylindrical wads of wire, known as button contacts, which are positioned in a dielectric substrate and interposed between the items that must be connected. You can position these button contacts anywhere on the substrate and achieve a direct interconnect between components or pc boards. There's no need for conventional mother-board/daughter-board techniques, and there's no soldering required.

The physical properties of the button contacts make them efficient conductors. The random nature of the wire structure provides a redundant contact at the interface surface, creating a high-pressure connection. In addition, button contacts provide a wiping action when compressed, ensuring reliable electric contact.

Currently, the company can manufacture these boards with as many as 625 connections/in.^{2} The button contacts are available in diameters of 0.04 in. for use on 0.075-in. min centers and 0.02 in. for use on 0.04-in. min centers. The boards can use buttons in various materials to satisfy different environmental conditions. Materials include copper/silver for temperatures as high as 85°C, beryllium/copper for temperatures as high as 105°C, molybdenum for temperatures as high as 125°C, and copper/nickel/tin for temperatures as high as 200°C. The buttons are also available with either gold or other plating.

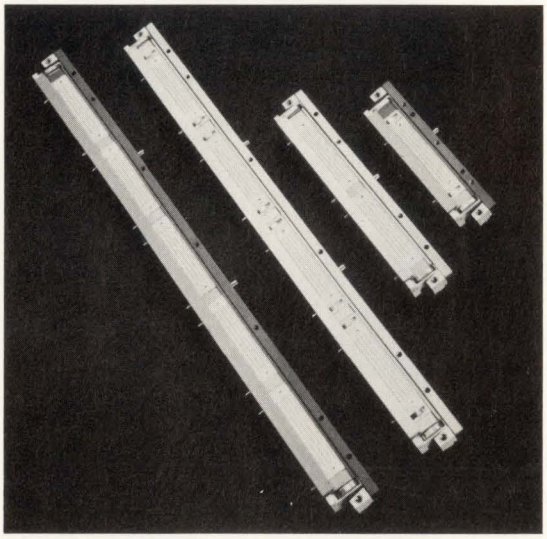
Once the signal-integrity issue is resolved, the designer must address the problem of insertion force. You can eliminate the problem by carefully considering the mechanical aspects of the connectors.

Shape memory alloy (SMA) metals have a physical structure that, through the application of heat, can be unlocked, rearranged, and programmed to take on new shapes. About 20 alloys have shape-memory properties, but only a few—copper zinc aluminum, copper zinc nickel, and nickel titanium—are practical for commercial applications. The nickel titanium alloys are the most promising because they offer the best overall performance. They have good memory capacity, they resist corrosion and cracking, and they are lightweight and elastic.



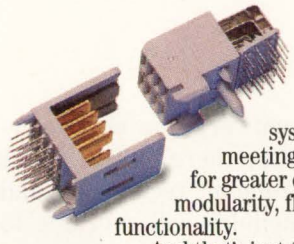
Capable of passing subnanosecond pulses with minimal noise and distortion, AMP's Micro-Strip connectors feature a contact design that presents a flat metal surface facing a ground plane. This design results in a controlled impedance transmission path.

Beta Phase offers a line of pc-board connectors that use this nickel titanium alloy. These connectors offer a combination of impedance-matched high-density contacts, zero-insertion force (ZIF), and high contact force. They allow you to make ZIF connections on three edges of a pc board. In addition, you can remotely or locally ac-



Offering signal densities of 80 contacts/in., Augat's electronic invisible interconnect connectors are impedance matched to the daughter card and the backplane through a flexible printed circuit.

METRAL*. The New Universal Interconnection System From Du Pont.



METRAL is the next generation interconnect system that's meeting today's need for greater density, modularity, flexibility, and functionality.

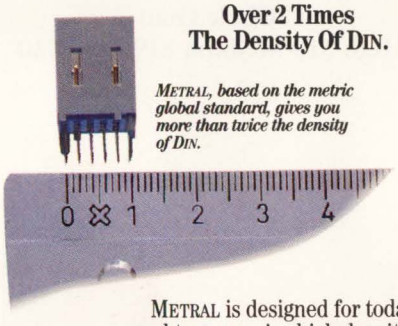
And that's just the beginning.

METRAL cuts costs by shortening the design cycle. It reduces risk by being flexible enough to allow for design changes. And METRAL is universal enough to use in electronic packaging designs from modems to mainframes.

With all these advantages, it's no wonder METRAL was selected by IEEE as the interconnection standard for Futurebus+.

Over 2 Times The Density Of DIN.

METRAL, based on the metric global standard, gives you more than twice the density of DIN.



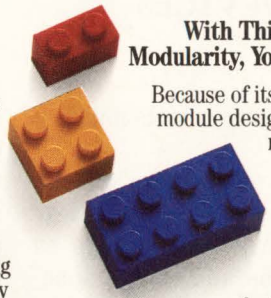
METRAL is designed for today's —and tomorrow's—high density requirements.

METRAL connectors are based on a 2.0 millimeter grid and provide up to 456 signal positions on a double Eurocard. Which means, in the same amount of space, METRAL packs more than twice the position density of DIN 41612.

Cost-effective density like that makes METRAL indispensable if you want the most value possible from real estate.

In other words, the more functions you pack on a board, the more you need METRAL.

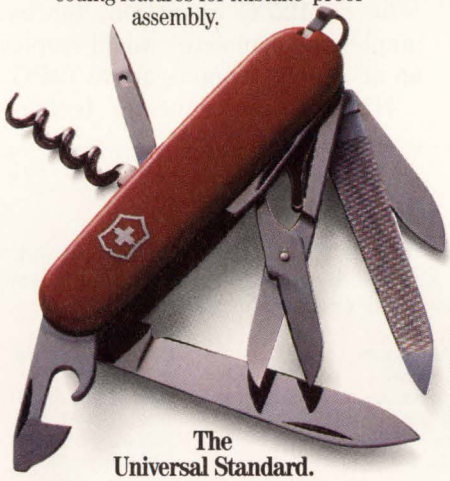
With This Much Modularity, You Can't Lose.



Because of its uniform module design, METRAL is remarkably adaptable. You design the connectors around the board, instead of designing the board around the connectors.

Based on a 4x6 position building block, METRAL offers configurations of 24, 48, 96 and 192 contact positions. And the connectors are stackable end-to-end without position loss. You can use the same footprint for signal and power modules. If you don't need a module, the space can be used for something else.

METRAL also has keying and coding features for mistake-proof assembly.



The Universal Standard.

METRAL affords designers limitless creativity by standardizing the configuration of the connectors. You can standardize across your entire product line—whether data processing, telecommunications or instrumentation.

What's more, since METRAL connectors can be qualified as a system, you can reduce approval time.

METRAL already meets the metric global standard.

METRAL is available in signal, power, coax, IDC, round cable, and male and female versions. With surface mount and other board-to-board connectors on the way.

METRAL Does It All.

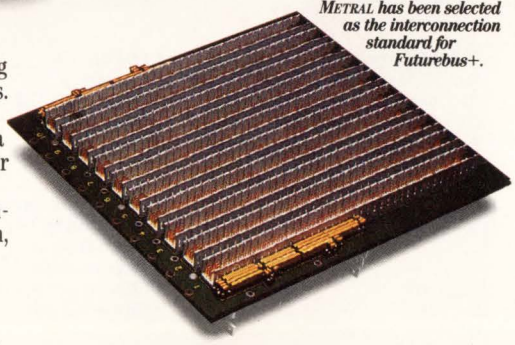
METRAL is multifunctional enough to expand as your needs—or the needs of the market—change. It is the first connector system that lets you design daughter cards for through-hole or surface mount without redesigning the backpanel system.

METRAL is available in signal, power, coax, IDC, round cable and male and female solder-to-board versions. And shielded cable connectors, surface mount, fiber optic, press-fit and high speed board-to-board connectors are on the way.

Make The Move To METRAL.

Call **1-800-237-4357** for more information about the one connector system that meets your needs today—and tomorrow—for more density, modularity and flexibility. METRAL.

METRAL has been selected as the interconnection standard for Futurebus+.



*METRAL is a trademark of the Du Pont Company for its family of electronic connectors.

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tuate the devices electrically—there's no need to physically access the connector. The connector can also function as a card guide and stiffener, providing good mechanical support for the board.

The connectors consist of three basic parts: a shape-memory element, a closing spring, and flexible-film circuitry that includes the contact pattern and a built-in heater. When you trigger the heater, the shape-memory element moves toward its original flat shape, engaging and opening the contact-closing spring. After inserting the board, you remove power from the heater. The shape-memory element closes, engaging the contacts with high normal forces—100g/contact in a typical connector. The polyimide-film flexible circuitry meets military standards.

Beta Phase's connectors offer a number of features. The use of flexible circuitry makes it possible to mix trace widths and center spacings to accommodate signal, power, and grounding needs. The connectors are also compatible with surface-mount technology. Because plastic molded bodies are not required for strength or support, each connector's profile, size, and weight are low. The use of shape-memory alloys also makes it easy to tailor the connectors for specific applications. In an application involving −55 to 125°C operation, for example, the connector would employ an alloy that triggers above 125°C.

Historically, connector technology has shown very slow change cycles. However, there's little doubt that surface-mount technology and multichip modules will continue to put the pressure on when it comes to higher I/O density. To meet the needs of the future, connector vendors may have to abandon today's design techniques to provide interconnects that will not introduce signal degradation.

EDN

Article Interest Quotient
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High 518 Medium 519 Low 520

For more information . . .

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

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Allentown, PA 18103
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FAX (215) 778-4106
Margaret Fourounjian
(908) 771-2645
Circle No. 657

Augat Inc
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Attleboro, MA 02703
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FAX (508) 222-0693
Circle No. 658

Beta Phase Inc
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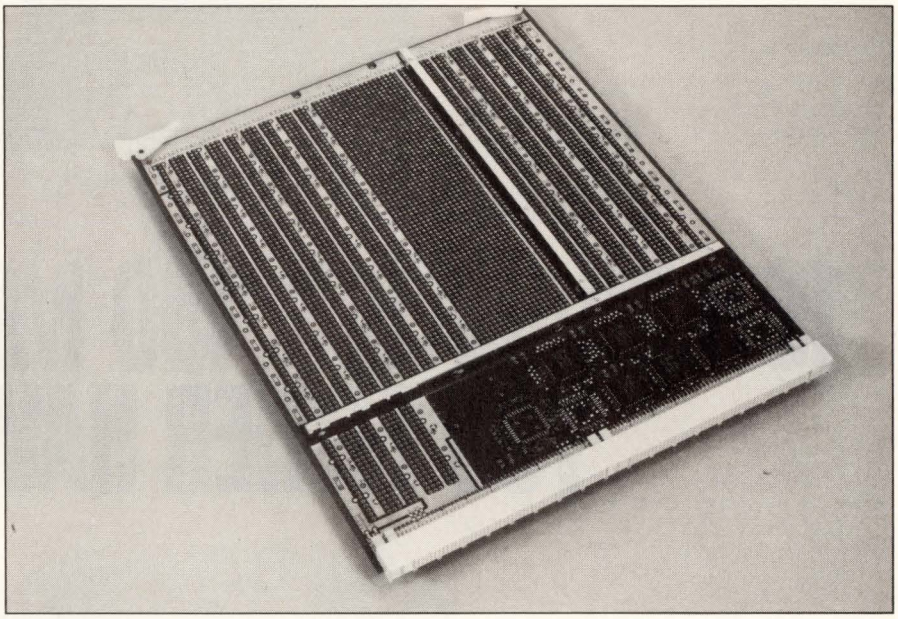
Futurebus + wire-wrap boards conform to hard metric standards

The 031-128 and 031-129 multilayer wire-wrap boards are for prototyping Futurebus+ systems. The 12SU × 300-mm boards conform to the hard metric standards of the Futurebus+ specification. The boards have a bus interface section that contains premounted arbitration, data, and handshake transceivers from National Semiconductor.

The 031-128 and 031-129 boards have transceivers for 64-bit and 128-bit bus communications, respectively. The transceivers are packaged in 9-bit plastic quad flatpacks. The maximum line length on the boards is 2.3 cm, and the typical stub length is 1.4 cm. The boards use the Futurebus+ 2-mm bus connector and have five wire-wrappable signal layers. You can order the board in wire-wrap pin lengths for two or three wraps and in a choice of platings. The 031-128 with all-gold pins for two wraps costs $1742.65.



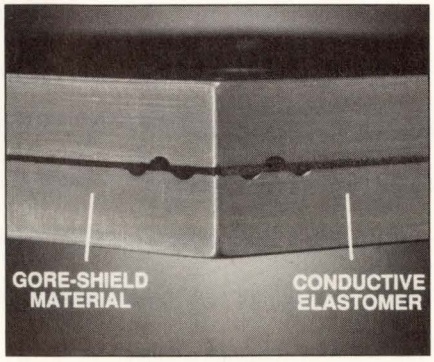
Hybricon Corp, 12 Willow Rd, Ayer, MA 01432. Phone (508) 772-5422. FAX (508) 772-2963.

Circle No. 734

Gasket material provides EMI shield and environmental seal

Gore-Shield gasket material provides a high shield against EMI and RFI while maintaining an environmental seal. The expanded polytetrafluoroethylene (PTFE) material provides more than than 80 dB of shielding, and the shielding remains constant under vibration. The material provides 100-dB electric-field suppression at 100 kHz and 80 dB of suppression at 18 GHz. Plane-wave shielding is greater than 80 dB at 1 to 18 GHz. Volume resistivity is 0.5 Ω × cm.

The material has passed the deep-space outgassing test in accordance with the NASA specification ASTM-E-595-84. The material operates at −266 to +260°C and is soft and pliable, allowing you to form it around corners and place it on irregular surfaces.



The gasket material comes in thicknesses of 0.005 to 0.25 in. and widths of 0.125 to 24 in. The material is available in sheets, strips, and die-cut sheets, with or without conductive adhesive backing. Prices for form-in-place strips start at $156 for a 50-ft roll.

W L Gore & Associates Inc, 2401 Singerly Rd, Box 1220, Elkton, MD 21922. Phone (301) 398-6400.

Circle No. 728

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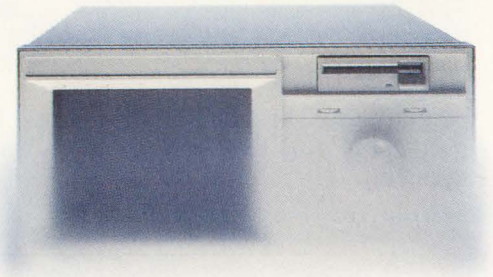

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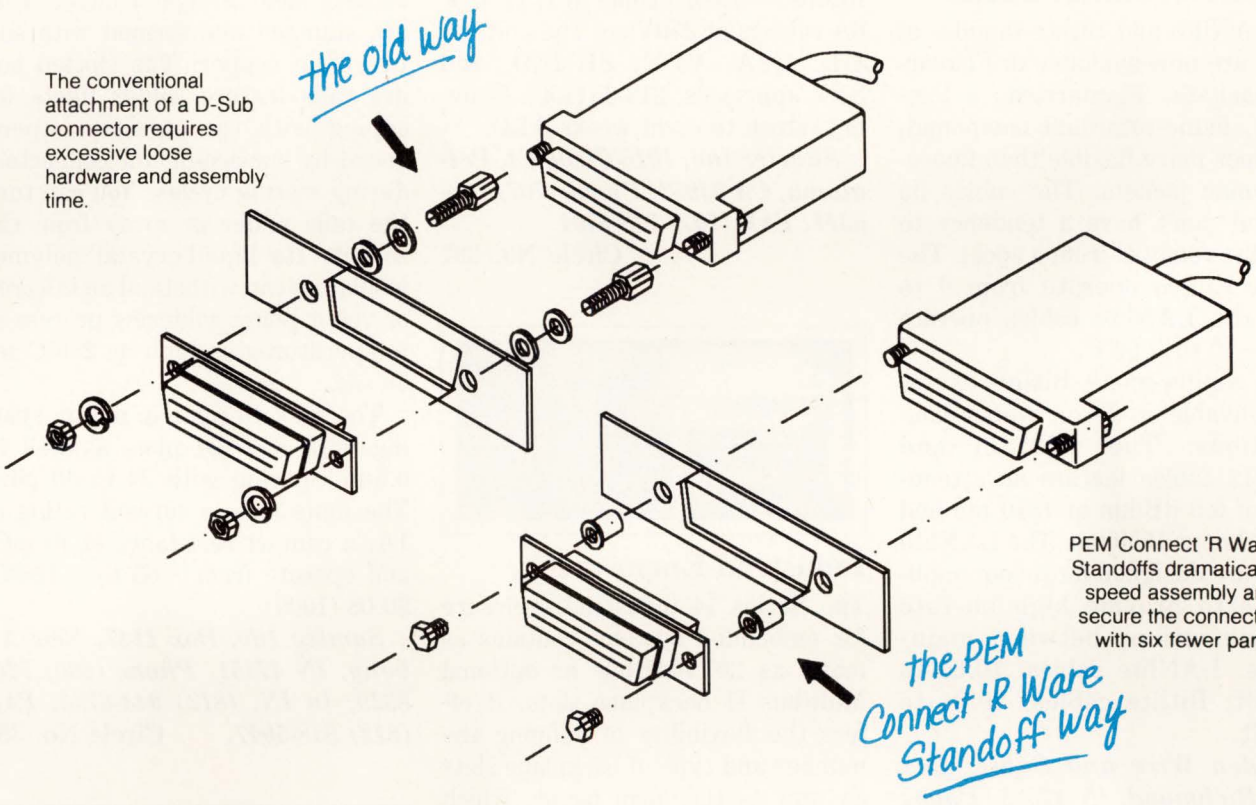

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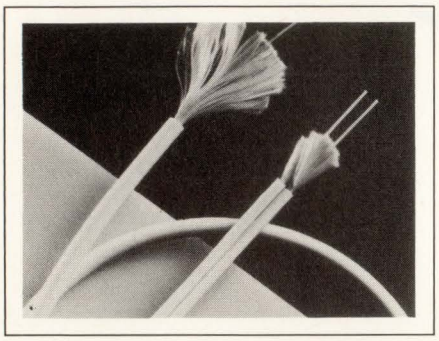
Hardware and Interconnect Devices

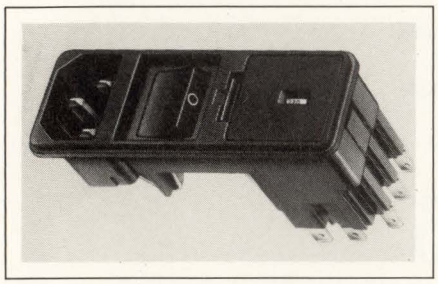


Flamarrest-Jacket Cables

The LANlite and Bitlite families of cables are now available in Flamarrest jackets. Flamarrest, a low-smoke, flame-retardant compound, is 5 times more flexible than fluorocopolymer jackets. The cables lie flat and don't have a tendency to coil after removal from a spool. The Bitlite cables operate from 0 to 75°C; the LANlite cables operate from −10 to +50°C.

The single-mode Bitlite cables are available in 1- or 2-fiber constructions. The #221811 and #221812 cables feature an attenuation of 0.5 dB/km at 1310 nm and 0.4 dB/km at 1550 nm. The LANlite cables are designed for indoor applications to provide high bit-rate communications between mainframes. LANlite cables, $0.65 to $0.72/ft; Bitlite cables, $0.21 to $0.62/ft.

Belden Wire and Cable, Box 1980, Richmond, IN 47375. Phone (317) 983-5200 **Circle No. 380**

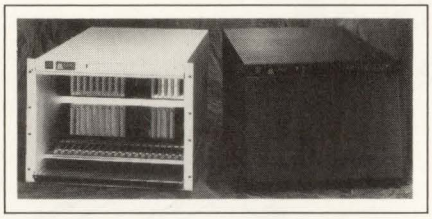


Power-Entry Module

The KG power-entry module contains a series-parallel voltage selector. Instead of connecting or disconnecting a jumper wire inside the equipment, you can split or combine dual primary windings using the voltage selector in the power-entry module. The unit solves complex wiring requirements for switching power supplies.

Models are available for snap-in or flange mounting. The 2-pole switch has an in-rush current of 35A and comes lighted or unlighted. The fuse holder holds one or two fuses in a shock-safe fuse drawer. RFI-filtered versions come in 1, 2, 4, or 6A ratings at 250V ac. The unit has UL, CSA, VDE, SEMKO, and SEV approvals. $13.35 (100). Delivery, stock to eight weeks ARO.

Shurter Inc, 1016 Clegg Ct, Petaluma, CA 94952. Phone (707) 778-6311. FAX (707) 778-6401. **Circle No. 381**

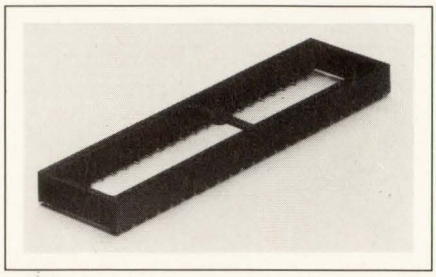


Industrial Enclosure

The Series 14 industrial enclosure for embedded systems contains as many as 20 VMEbus or optional Multibus II backplane slots. It offers the flexibility of defining the number and type of backplane slots as well as the form factor, which can be single-height, double-height, or a combination of both. Power supplies range from 140 to 700W.

The enclosure comes with two fans, which provide 140 cfm of air flow; as an option, you can add two fans that generate as much as 400 cfm of air flow. Integrated floppy-disk drives have mounting and wire harnesses that let you configure the enclosure into a turnkey system. You can easily remove the power-supply subsystem as a complete unit via a rear access. From $2000.

Matrix Corp, 1203 New Hope Rd, Raleigh, NC 27610. Phone (919) 231-8000. FAX (919) 231-8001. **Circle No. 382**

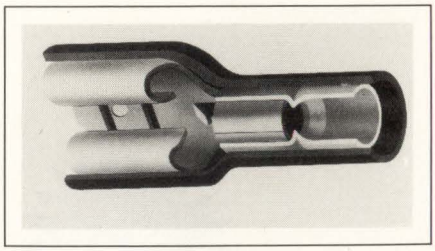


Surface-Mount DIP Sockets

The ICF Series surface-mount DIP sockets have 3-finger contacts that are stamped and formed with soft beryllium copper. The slotted solder tails feature solder fillets for coping with the stresses experienced by surface-mount connectors during mating cycles. You can turn the tails under or away from the socket. Its liquid-crystal polymer insulators can withstand an infrared or vapor-phase soldering process at temperatures as high as 230°C for 30 sec.

The sockets come in 0.3-in. spacing with 8 to 24 pins, as well as 0.6-in. spacing with 24 to 40 pins. The units have a current rating of 1A, a contact resistance of 10 mΩ, and operate from −65 to +125°C. $0.08 (1000).

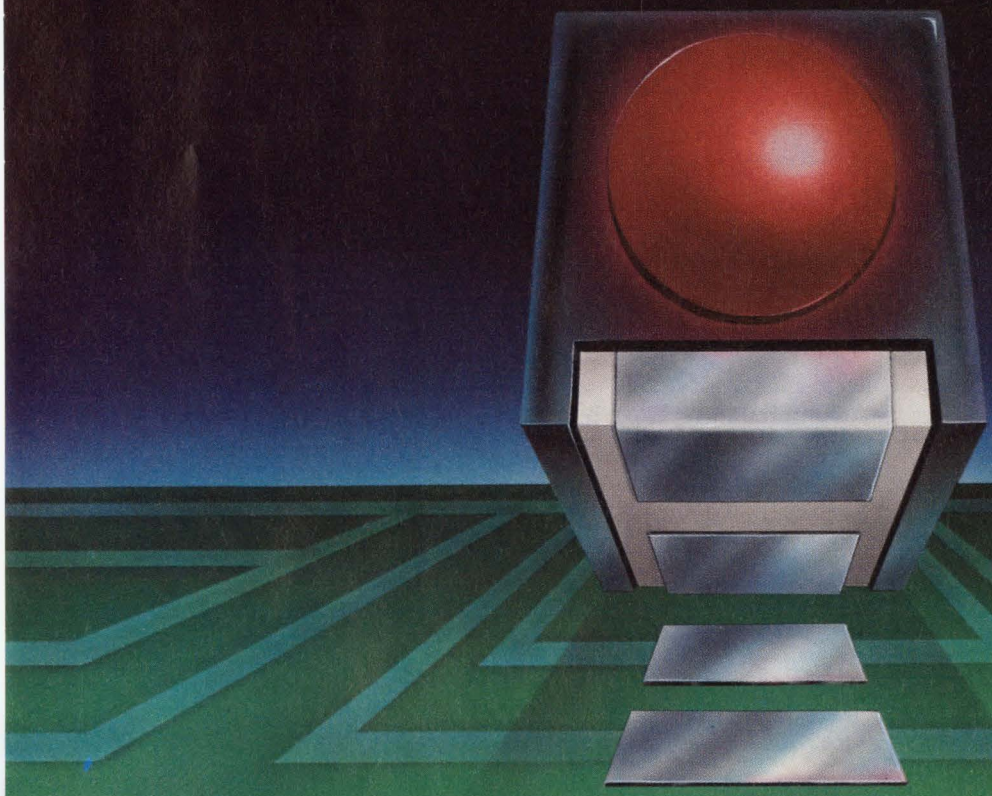
Samtec Inc, Box 1147, New Albany, IN 47151. Phone (800) 726-8329; in IN, (812) 944-6733. FAX (812) 948-5047. **Circle No. 383**



Quick Disconnects

The Avikrimp insulated quick disconnects provide a secure metal-support sleeve. They fulfill the double-crimp requirements of TUV, VDE, and other DIN specifications. In addition to their TUV license, they have passed TUV/VDE testing. The units feature molded-nylon insulating housing and a funnel en-

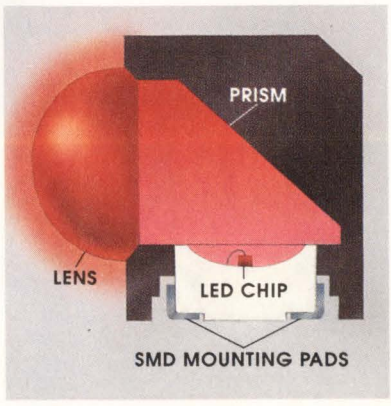
BEND THE LIGHT, NOT THE LEADS.



INTRODUCING PRISM CBI℠
THE FIRST TRUE SURFACE MOUNTABLE LED INDICATOR.

The new surface mount CBI from Dialight is another breakthrough idea whose time has come. Instead of bending the leads on a through-hole version to make it look like a surface mount device, Dialight uses a patented high transmission prism and clear lens to bend the light from an upwards-facing surface mount LED. This approach offers a uniform illumination of the lens over a wide viewing angle. Finally, a truly leadless indicator developed for reflow-soldering and compatible with a wide variety of pick and place equipment.

The PRISM CBI is available in T-3/4 (1mm), T-1 (3mm) and T-1 3/4 (5mm) lens sizes. This unique product is offered in package sizes of 0.130 x 0.098 x 0.138 for the T-3/4, 0.240 x 0.185 x 0.200 for the T-1 and 0.250 x 0.245 x 0.282 for the T-1 3/4 size.



The introduction of the PRISM CBI means there is one less component on the board that has to be through-hole mounted because now a reliable surface mount version exists. Using this approach, an extremely high "post-process" reliability rate can be achieved.

Available in red, yellow or green, packaged in ESD-shielded tape on EIA standard 7" or 13" reels, the PRISM CBI is ready for a whole spectrum of demanding SMD applications.

For more information, contact:
Dialight Corp., 1913 Atlantic Ave.,
Manasquan, NJ 08736; Tel.: (908) 223-9400
Fax: (908) 223-8788.

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CIRCLE NO. 47

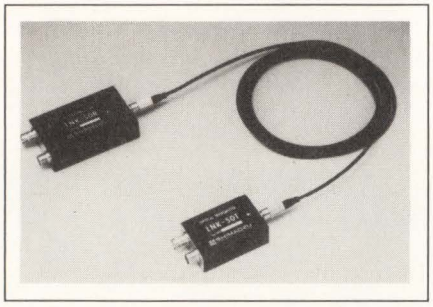
try that leads to a stress-relieved barrel having deep wire-grip serrations. The units are available for #10 to #22 AWG wire sizes, as well as hand crimping. They also come on Mylar tape for automatic crimping equipment. Loose pieces, from $110; tape-mounted parts, from $125 (1000).

Molex-Etc Inc, 4820 Park Blvd, Pinellas Park, FL 34665. Phone (800) 237-8905; in FL, (813) 541-4651. FAX (813) 541-4505.

Circle No. 384

Optical Video Link

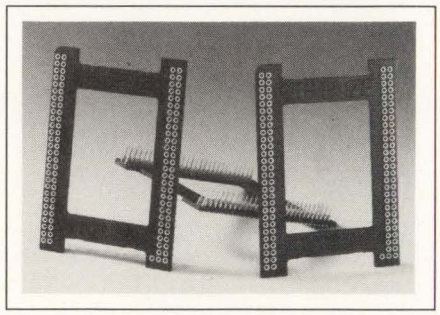
The LNK-50 device consists of an optical transmitter and receiver module, and an optical fiber cable. Depending on the quality of the fiber cable, it can transmit color video signals as far as 3 km. Both the modules and the cable have shielding for EMI and RFI. Built-in



automatic gain control keeps the signal levels constant without readjustment.

The unit requires a 12V dc power supply and drives a nominal 1V p-p into video equipment having a 75Ω input impedance. Other specifications include a 30-Hz to 8-MHz transmission bandwidth; a 42-dB S/N ratio; an unbalanced 75Ω input and output impedance; a differential gain less than 8%; and a differential phase less than 5°. The standard optical fiber is GI 50/125 fused-quartz fiber. $995.

Soltec Corp, Sol Vista Park, 12977 Arroyo St, San Fernando, CA 91340. Phone (800) 423-2344; in CA, (818) 365-0800. FAX (818) 365-7839. **Circle No. 385**



Turbocache 486 Socket

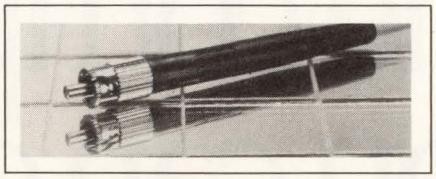
Developed specifically for Intel's Turbocache 486 module, the Microcache socket is molded from high-temperature thermoplastic and has 113 pins. Two different contact versions accommodate either lead variation on the Turbocache module—

0.025-in. square-post or 0.020-in. round leaded modules. Both variations use 6-finger contacts, which ensure positive retention and minimize insertion and extraction forces. The screw machine contacts come in a variety of platings and are nonsolder wicking. Square-post socket, $9.79; round socket, $3.89 (1000).

McKenzie Technology, 44370 Old Warm Springs Blvd, Fremont, CA 94538. Phone (415) 651-2700. FAX (415) 651-1020. TWX 910-240-6355. **Circle No. 386**

Fiber-Optic Connector

The Mini-BNC multimode fiber-optic connector conforms to IBM's 8210 fiber-optic network specifications. You can polish its stainless-steel, radius-tipped ferrule for low back reflection. The connector's 3-μm fiber-hole tolerance results in



an average connector loss of 0.21 dB for 62.5/125-μm multimode fiber. Mating durability tests, which conform to FOTP-21 specifications, record incremental losses of <0.2 dB for 500 connector insertions. The connector is available for both 125- and 140-μm multimode clad fibers. Maximum cable size for proper termination is 1.5-mm outside diameter for the fiber buffer and 3.2-mm outside diameter for the cable jacket. Preterminated cable assemblies, a polishing tool, and an installation kit are also available. $10.95.

Ofti, 2 Lyberty Way, Westford, MA 01886. Phone (508) 692-6606. FAX (508) 692-6620.

Circle No. 387

Self-Clinching Standoffs

You can use the DSOS Connector Ware standoffs for mounting D-sub connectors. The self-clinching standoffs replace much of the loose hardware associated with D-sub connector attachments. When installed, the standoffs become permanently fixed to the chassis to prevent them from dropping into the electronic circuitry. They come in 303 stainless steel in #4-40 and M3 threaded sizes. You install the standoffs from the rear of a panel, which can be 0.037 to 0.25 in. deep. The standoffs go into a punched or drilled hole and mount flush with the panel. The flush mount eases the installation of RFI and EMI gaskets. $0.10 each.

Penn Engineering & Manufacturing Corp, Box 1000, Danboro, PA 18916. Phone (800) 237-4736; in PA, (215) 766-8853. FAX (215) 766-0143. **Circle No. 388**

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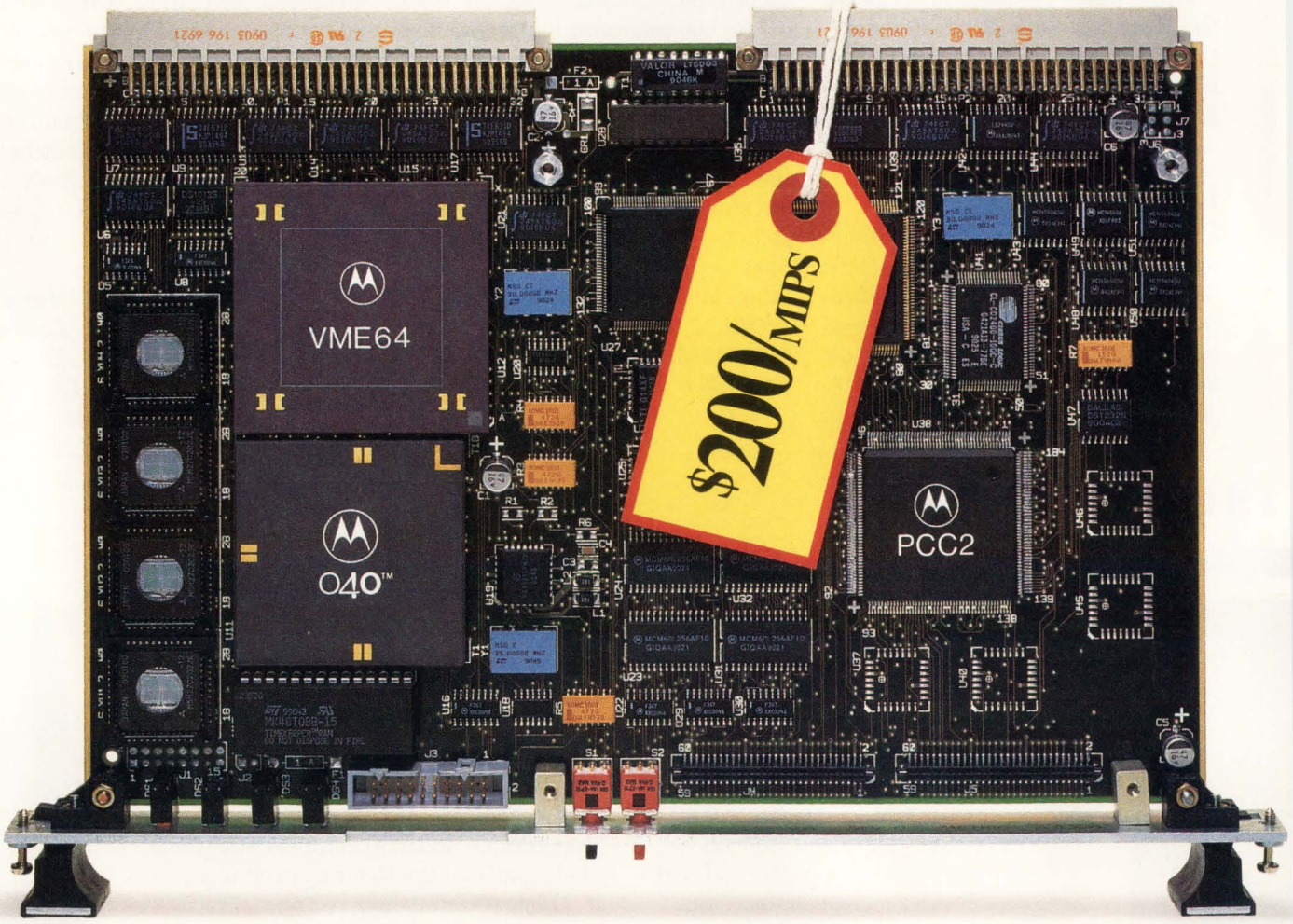

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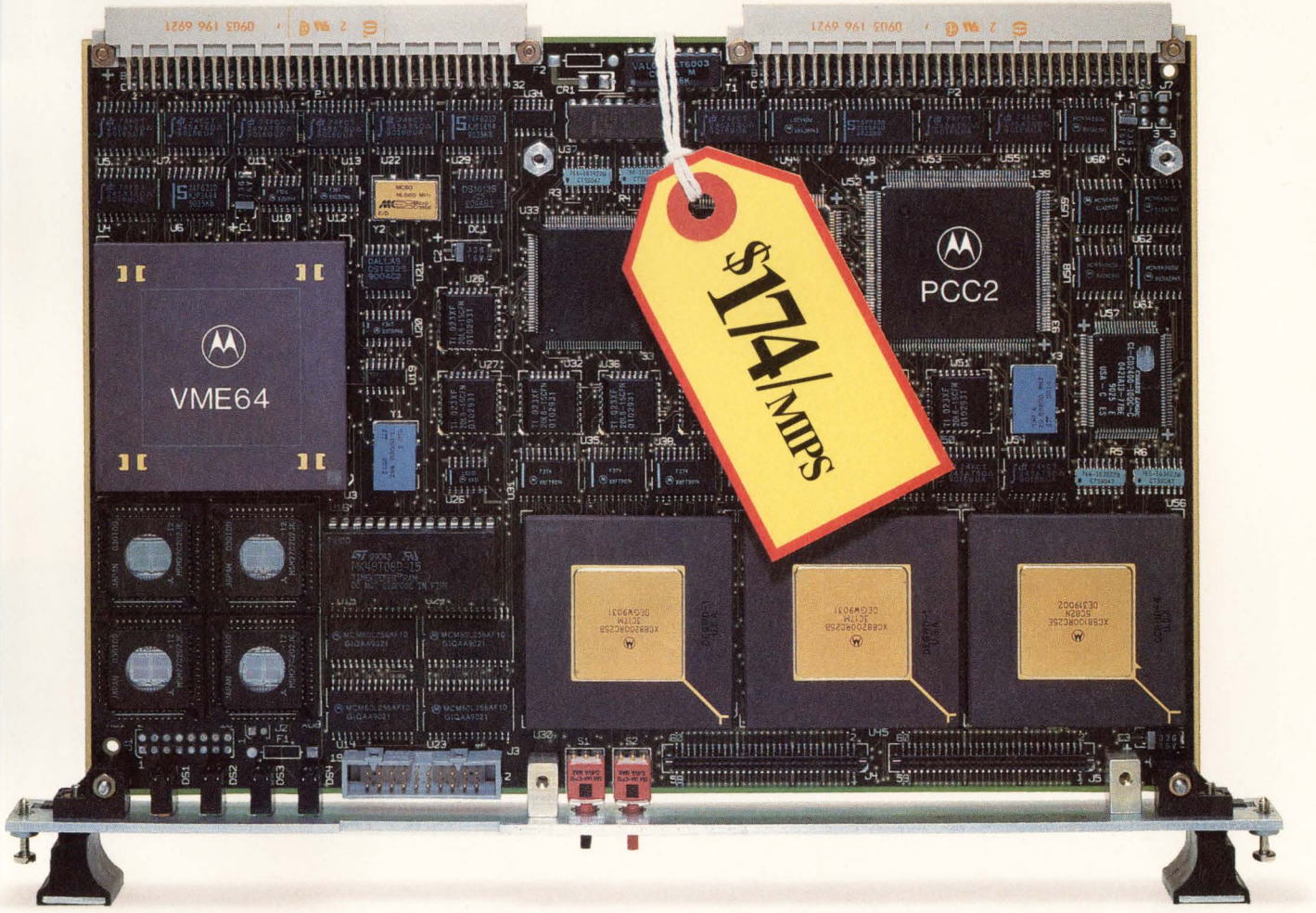

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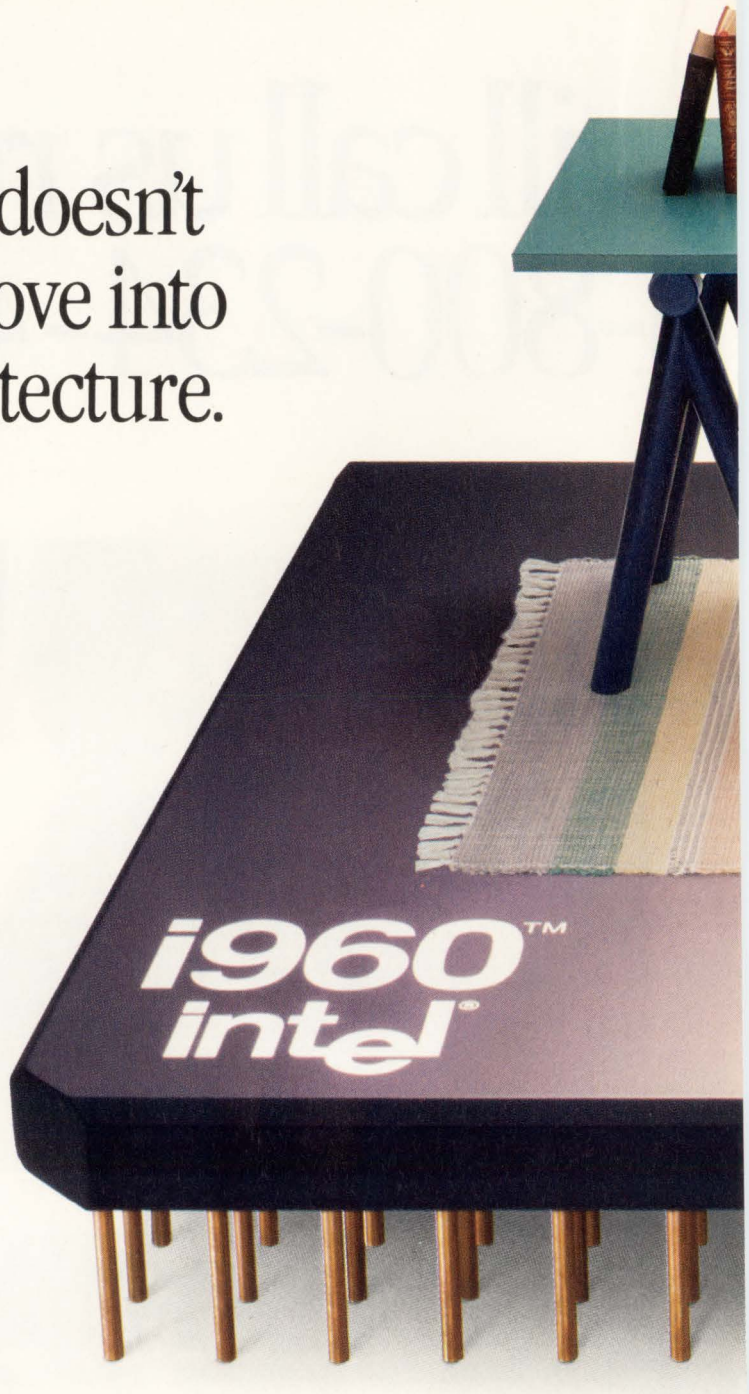

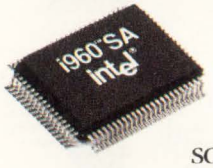

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CIRCLE NO. 50

Neural-network IC architectures define suitable applications

Neural-network technology offers promise in embedded applications, such as vibration control and image recognition. The varied architectures of neural-network ICs, however, limit the type of embedded applications any of the individual ICs best suit.

Maury Wright, Regional Editor

Neural networks excel in applications such as character recognition, financial analysis, bomb detection, target classification, and just about anything else that requires pattern recognition on input data. Further, neural-network ICs promise to make cost-effective and physically small neural-based products possible. Only two companies currently ship such ICs, however, and two more will offer chips shortly. The ICs differ so greatly in architecture that you must match your application to the best architecture rather than comparing features of the ICs.

Neural networks, like the human brain, operate based on experience gained from a set of training data. Neural networks don't require development of software algorithms or rules. Therefore, development cycles for neural-based products can be relatively short, providing that you have a suitable set of training data. Neural networks can also detect key data patterns that a programmer may never recognize as important.

By nature, neural networks employ an array of interconnected neurons to solve problems in a parallel manner. The parallel architecture allows neural networks to quickly handle pattern-recognition problems that traditional digital computers solve by sequentially comparing sets of data. (For more background information on neural networks, see **Refs 1, 2,** and **3.**)

You can test the applicability of neural networks to a design problem by using a software simulator. A number of companies offer simulator programs for personal computers and workstations at prices ranging from approximately $200 to $10,000. You can also purchase hardware accelerators to increase simulation speed (**Ref 1** includes information on simulators and hardware accelerators).

General-purpose computers and simulators, however, often fail to meet the size or cost constraints of designs that must be deployed in the real world. Some simulator vendors offer methods that let you generate dedicated code for traditional μPs, and the code generated uses neural-network algorithms. You may find that simulating a neural network on a μP in an embedded design works for simple neural-network topologies. But ICs that specifically implement neural networks provide the greatest performance for embedded applications.

Briefly consider the architectures of

The 64-neuron, electrically trainable, analog neural-network (ETANN) IC from Intel targets embedded applications. You can develop such applications using software simulators and an IBM PC-compatible development system.

available and soon-to-be available neural-network ICs. Intel leads the way with the 80170NX ETANN (electrically trainable, analog neural-network) IC. The ETANN chip includes 64 neurons and 10,240 synaptic weights. The chip is based on the company's floating-gate memory-cell technology used in EEPROM ICs.

The ETANN IC, as the name implies, uses analog circuits to multiply inputs times stored weights, sum the inputs to a neuron, and perform the sigmoid function on each neuron. **Fig 1** depicts the architecture of the IC. You preprogram the synaptic weights in a manner similar to programming an EEPROM.

You can use the reset and feedback control signals to set up the ETANN IC in different neural-network topologies. The simplest operation provides 64 input and 10 bias vectors and 64 analog-signal outputs. You can expand the inputs to 128 vectors in place of on-chip feedback. And, you can implement a 2-layer feed-forward neural network on a single ETANN IC using two operating cycles.

IC takes bit-slice approach

The Micro Devices division of Chip Supply offers the MD1220 NBS (neural-bit-slice) IC, which is completely digital in nature. **Fig 2** shows the architecture of the MD1220. The IC includes eight neurons, each consisting of a digital processing element that can perform 16-bit multiply-accumulate operations. The IC accepts 256 16-bit synaptic inputs and reads 16-bit weight values from external memory.

Designers of the MD1220 faced trade-offs between pin count and chip setup time because of the 16-bit inputs. Therefore, the circuitry that surrounds the MD1220 must load the chip inputs in a time-multiplexed fashion. Once set up, however, the neurons perform in parallel.

The MD1220 was the first neural-

Simple application characteristics such as analog or digital inputs can help determine if an IC suits your needs.

network IC available, but its future is not entirely certain. The engineers that developed the IC at Micro Devices no longer work for the company, but all now work at nearby startup American Neuralogix. Micro Devices plans to continue to offer the MD1220 IC and a $595 evaluation kit for IBM PC-compatible computers. The kit demonstrates neural networks by balancing a "broom stick."

Paul Basehore, vice president of engineering at American Neuralogix and formerly general manager of Micro Devices, has plans to ship a neural-network IC by the fourth quarter of 1991. Called the NLX420 Neural-Processor Slice, the IC will employ an architecture similar to the MD1220's, but with improvements such as 32-bit multiply-accumulate capability and support for an unlimited number of inputs.

Another company, Neural Semiconductor, should ship a neural-network IC this summer. The company had announced a 2-chip implementation of its technology last year but never got the chip to market. The NUSU32 will include 32 neurons, 32 inputs, and an array of 1024 weights. Neural Semiconductor uses digital circuits to perform multiply-accumulate operations, but does not use traditional multipliers. The logic model in **Fig 3** demonstrates the way the company uses pulse arithmetic to multiply an input by a weight and sum it with other inputs at the wire-OR stage.

Inputs can guide choice

Your potential embedded neural-network application should guide you toward one of these technologies. For example, the Intel ETANN IC accepts analog inputs directly from real-world sensors and typically requires a minimum of signal conditioning. If the inputs in your application are digital, however, you will require a lot of data converters to connect to the 64 analog inputs on the ETANN IC.

The ETANN IC also has built-in weight storage. You can program the IC permanently, or you can design support circuitry that allows field updates. The ETANN IC also requires a minimum of support circuits for embedded applications. The IC doesn't require μP control for setup, and the analog outputs can drive CMOS or TTL logic.

The Micro Devices NBS IC requires digital inputs, a μP to control loading and operation of the chip, and external memory for weight storage. The MD1220 actually simulates a neural network, albeit with a parallel architecture. The μP control provides the opportunity to handle applications that require continuous training simply.

The Neural Semiconductor NUSU32 falls between the other two devices. You need a μP to control the IC. The IC will directly accept digital inputs and some properly conditioned analog inputs. The IC directly implements a neural network because there is a local processing element at each weight.

The NUSU32 doesn't perform analog multiplication and addition, but has a silicon-efficient way to do these operations digitally. The NUSU32 stores weights essentially in static RAM (SRAM) on chip. The design uses 40 transistors to store a weight with the equivalent of 8 bits of dynamic range and to implement the math functions. Furthermore, the company claims its technology will allow it to build mask-programmed ROM-based ICs requiring only five transistors per weight.

Ultimately, you match your application to an IC architecture based on price vs performance. Expect this task to be doubly difficult in the case of neural-network ICs. You can't really guess what the different ICs might cost next year because you really don't know how

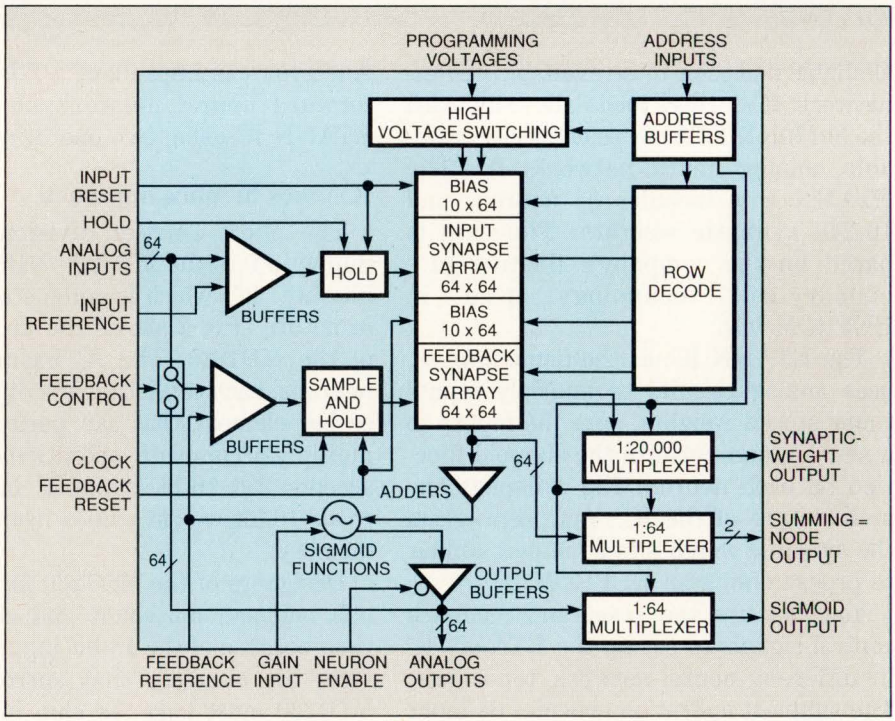

Fig 1—Based on floating-gate EEPROM technology, Intel's ETANN IC can store weights in memory cells. The chip uses analog circuits to perform multiply-accumulate operations.

much success the companies will have selling the ICs and, therefore, increasing volume and lowering prices.

Based on software simulation, you should define a set of network specifications including number of layers, number of neurons in each layer, and number of inputs and outputs. All of the ICs can be cascaded to add neurons to any layer and to increase the number of layers. You can simply determine how well your network topology maps into ICs offered by Intel or Neural Semiconductor. Both technologies directly implement neurons; therefore, you can estimate the number of ICs necessary to hold your design.

IC simulates large network

Micro Devices' MD1220, however, gives you the option of making a single chip simulate a large network. The controlling μP handles storage of the values of signals in intermediate layers. Therefore, you realize less performance than an implementation that applies one neuron for every neuron in the network model.

So consider the following figures with care. Intel sells the ETANN IC for $940. The $11,000 development system is a virtual necessity unless you want to build a system to handle training and device programming yourself. Intel will also develop evaluation samples of programmed parts for customers based on simulations. This fall the company plans to offer a multichip prototyping board with a wire-wrap area. The prototype board will cost $9750.

You can buy Micro Devices' MD1220 ICs for $50; expect American Neuralogix to sell its NLX420 for about the same price. You can experiment with the ICs using low-cost μPs.

Neural Semiconductor expects to sell samples of its chip for $500. The company offers a simulator that costs $500 and includes activation functions that accurately mimic the operation of its ICs. It also plans a prototype board, and you can control the NUSU32 with a standard μP.

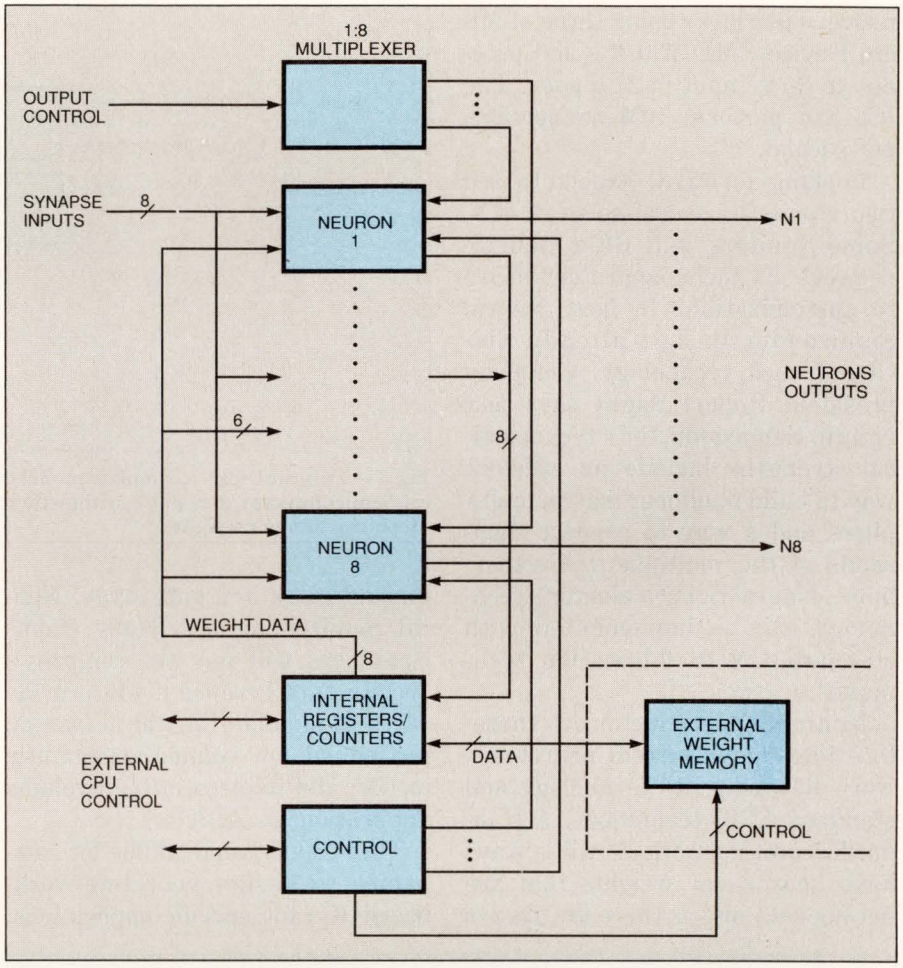

Fig 2—Eight neurons and 256 synaptic inputs make up the MD1220 neural-bit slice from Micro Devices. Via μP control, you can simulate large networks with a single IC, or you can cascade ICs and dedicate a neuron to every neuron in your model.

The Intel ETANN IC offers (by a wide margin) the fastest neural performance. The IC performs 2 billion multiply-accumulate operations per second—also referred to as connections per second. Furthermore, the IC doesn't slow down on large networks, you just use more ICs. But, because the IC has 64 neurons, a single IC can perform tasks such as optical character recognition.

The Neural Semiconductor NUSU32 can perform 2 billion connections per second, but the accuracy the IC offers decreases as you increase speed. The company prefers to rate throughput as 100,000 patterns per second. Like Intel's ETANN, the speed of the NUSU32 doesn't slow on large networks—the number of chips required increases. Yet some simulator vendors quote the spec connections per second. And in the case of a simulation, the connections-per-second spec can mislead you because it doesn't reflect the real performance of a large network.

You can implement a 3-layer feed-forward network with eight

neurons per layer using three of Micro Devices' MD1220 ICs and process an 8-bit input in 21.6 μsec. The ICs can perform 10M connections per second.

Looking forward, expect to see two trends in neural-network ICs. Some vendors will offer neural-network IC technologies conducive to customization. In fact, Neural Semiconductor has already discussed such technology. Company president Robert Bagby says that Neural Semiconductor's technological strengths include an efficient way to build nonlinear matrix multipliers and a way to connect thousands of the multipliers. Furthermore, Neural Semiconductor's technology can be implemented with standard CMOS fabrication techniques.

Neural Semiconductor can therefore implement custom neural-network ICs using its technology and standard ASIC techniques. A standard neural-network IC will always have neurons or weights that are not needed, just as there are always unused gates in a gate array. Neural Semiconductor's Bagby claims customers will buy the company's architecture because it will provide ways to simulate neural networks, implement low-volume applications in ICs, and implement high-volume applications in ASICs.

The second trend will be for companies to design neural-network-based ICs for specific applications. An example of the trend can be found in Adaptive Solutions' plan to build a neural-network compute server that will use a custom neural-network IC. The IC, called the N64000, includes 64 digital signal processors and measures slightly more than 1 in.^{2} Each processing node includes a 16-bit ALU, a hardware multiplier, and a 4k-byte array of SRAM for weight storage. The system Adaptive Solutions plans will use four of the ICs, cost $55,000, and be available late this year.

Adaptive developed the IC with the help of Inova Microelectronics Inc (Santa Clara, CA). Inova had planned to sell the IC as a merchant product, but recently filed for bankruptcy. Adaptive has hired the Inova engineers that worked on the project and will finish development of the chip. Currently, however, the company hasn't formulated plans to sell the device to other companies.

Finally, semiconductor industry stalwarts such as Fujitsu, Hitachi, and Mitsubishi have demonstrated neural-network ICs destined for specific applications. Motorola and Texas Instruments have also shown interest in the technology. And a number of companies have work un-

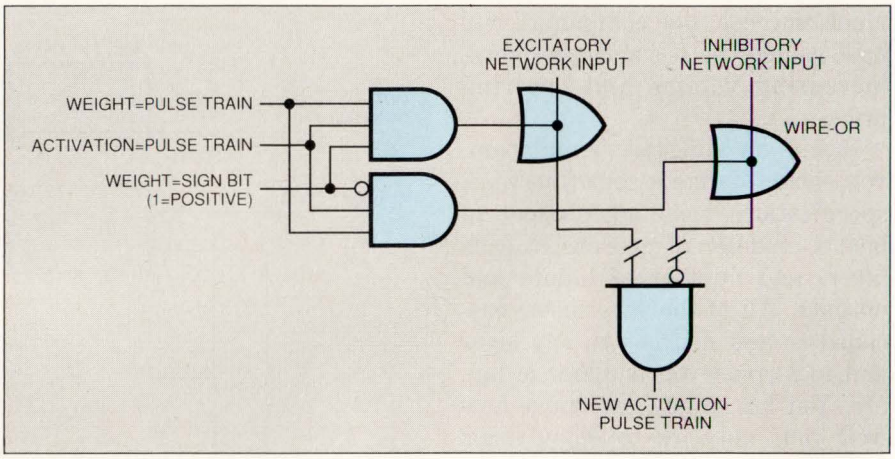

Fig 3—This multiply-accumulate model demonstrates how the NUSU32 IC from Neural Semiconductor uses pulse arithmetic to implement neural weights with less than 10 transistors per weight.

For more information . . .

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

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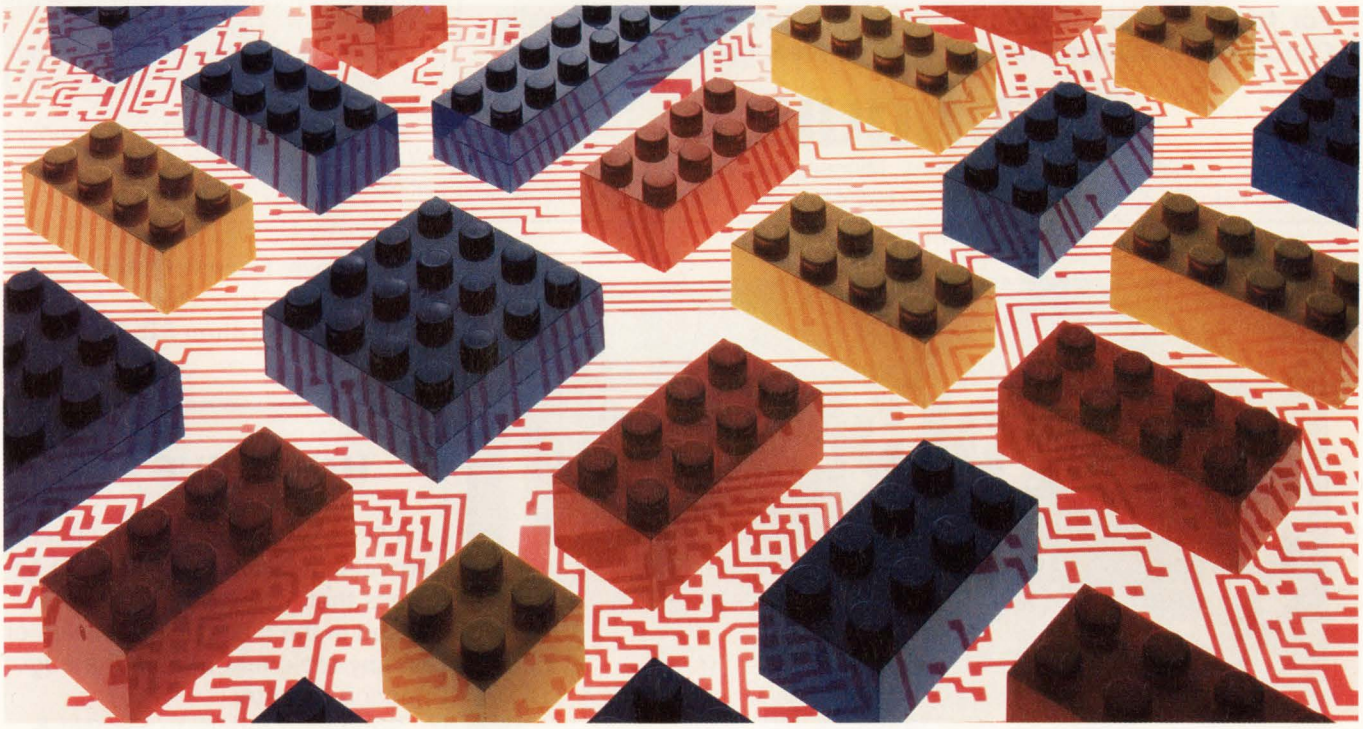

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der way to develop neural-network ICs for Defense Advanced Research Projects Agency contracts. You can therefore expect to hear about a number of new ICs in the next year. The newsletter *Neural Networks Today* (**Ref 4**) provides monthly updates on many of these IC projects. EDN

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1. Wright, Maury, "Neural networks tackle real-world problems," *EDN*, November 8, 1990, pg 79.
2. Stanley, Jeannette, "Introduction to Neural Networks," California Scientific Software, Grass Valley, CA.
3. Caudill, Maureen and Charles Butler, *Naturally Intelligent Systems*, MIT Press, Cambridge, MA.
4. *Neural Networks Today*, Frontline Strategies, Vancouver, WA, (206) 892-5880.

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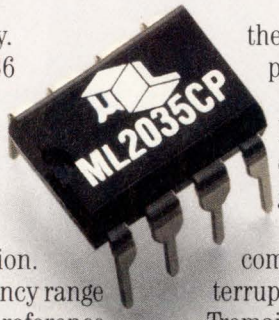


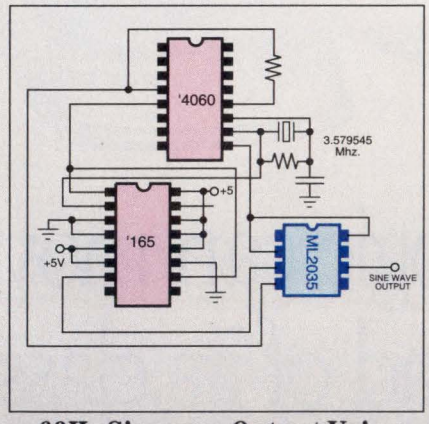
Absolute error gain over the frequency range is better than ±.1dB. And the frequency reference of the sinewave output is derived from either an external crystal or clock input.

The ML2035 is housed in an 8-pin DIP while the full featured ML2036 is available in a 14-pin DIP or 16-pin SOIC.

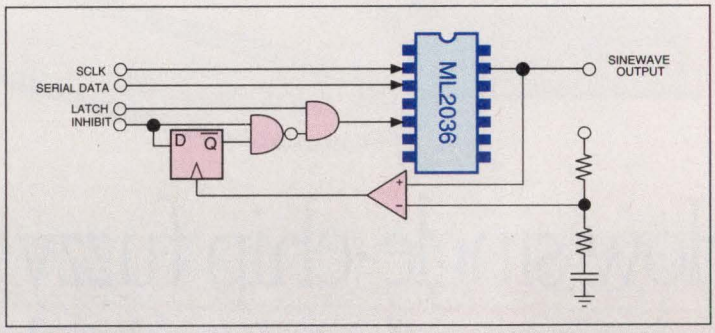
At prices starting at $5.95,* the low-cost ML2035 and ML2036 are the perfect single chip solutions to efficient, precise sinewave generation.

So whether your application is in telecommunications, modems, motor control, uninterruptible power supplies, or any other, call Al Tremain at (408) 433-5200. Or write to Micro Linear, Dept. SWG, 2092 Concourse Drive, San Jose, CA 95131.

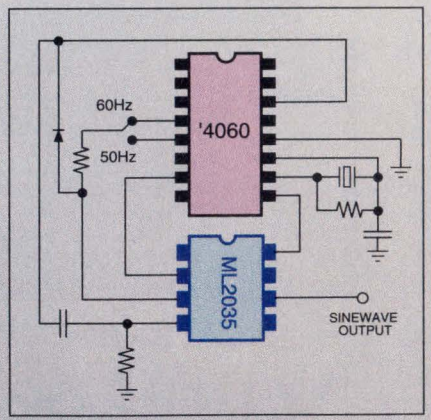
And ask for your copy of our 1991 Data Book, too.



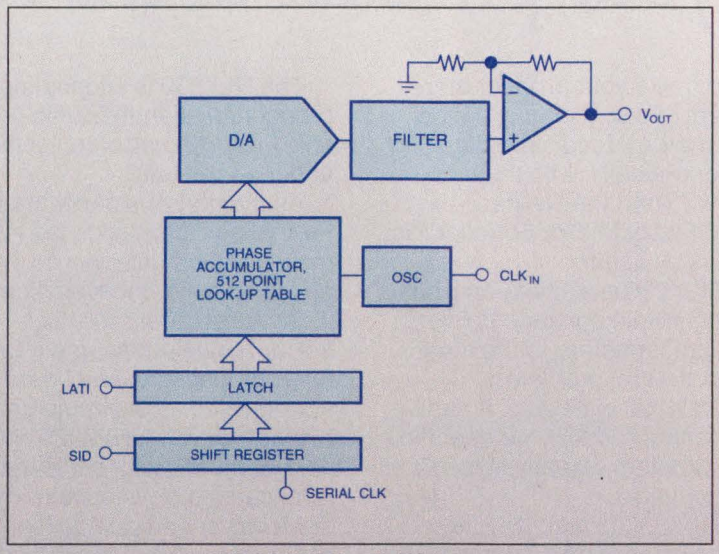
60Hz Sinewave Output Using NTSC Color Burst Crystal



Generating Precise Phase Controlled Sinewaves



Generating Fixed 50Hz and 60Hz Sinewaves



ML2035 Block Diagram

Micro Linear

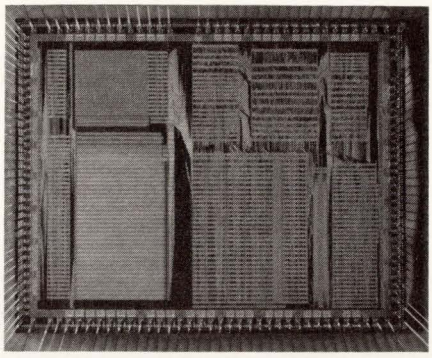
CIRCLE NO. 56

*Based on lots of 100.

Low-transistor-count 32-bit μP chip seeks embedded systems

The Hyperstone E1 μP, an 85,000-transistor chip, operates at a burst rate of 25 MIPS at 25 MHz. It requires no external cache and directly controls external dynamic RAM (DRAM) chips.

The E1 chip offers an address space of 4G bytes, and it has separate memory and I/O addresses. The chip supplies 19 global and 64 local 32-bit registers. Programs can directly address as many as 16 global and 16 local registers. You can also reconfigure the registers in a variable-length stack, using from 2 to 16 frames. Most of the chip's instructions are 16 bits long, although complex instructions can consume as many as 48 bits. High throughput results from a combination of pipelined load instructions, an internal 2-stage decode/



execute pipeline, and a look-ahead instruction cache.

The company expects the chip's $150 price to drop to less than $50 (10,000) by the end of 1991. A development board, which provides an E1 CPU, 1M byte of DRAM, 256k bytes of EPROM, and an RS-232C I/O port, is available for $1699. You can load instructions and data into the development board through the computer's serial I/O port. A PC-compatible assembler costs $350, and a debugger costs $400.

In addition to selling the chip itself, the company has licensed nonexclusive rights to the chip to Zilog. Zilog will offer the μP chip alone and as a core for embedded applications in its Superintegration ASIC program.

Hyperstone Electronics, GmbH, Robert-Bosch-Strasse 11, D-7750 Konstanz, Germany. Phone 07531-67789. FAX 07531-51725.

Circle No. 729

Zilog Inc, 210 Hacienda Ave, Campbell, CA 95008. Phone (408) 370-8000. FAX (408) 370-8056.

Circle No. 730

Voice-storage chip supplies nonvolatile analog memory

The ISD-1016 voice-storage chip requires neither an A/D nor a D/A converter because it relies on analog memory. The device operates from a 5V power supply, and it requires few external passive components and no external crystal or clock signal. Distortion measures about 2%.

Nonvolatile memory cells, using a proprietary CMOS/EEPROM technology, store charge in random-access memory. Thus, the chip requires no backup power supply to maintain its analog information—the chip draws 10 μA of standby current only to supply power to additional circuitry.

The ISD-1016 stores as much as 16 sec of speech, and you can cascade as many of the chips as you need to extend a message's length. Because the chip uses a RAM structure, you can access portions of a message or divide the 16-sec interval into subintervals (eg, several shorter messages). To record a message, you connect a microphone directly to the chip. The chip's output drives a small speaker, although you might want to add an external audio-amplifier IC for some applications. You can order the voice-storage chip in a 28-pin DIP or in a 28-pin plastic leadless chip carrier.

The chip can deal with all types of analog information, not just speech or music. For example, it can store test waveforms, sample analog signals, store correlation data, and hold filter coefficients. The chips cost $16 (1000).

Information Storage Devices Inc, 2332B Walsh Ave, Bldg G, Santa Clara, CA 95051. Phone (408) 562-9550. FAX (408) 562-9559.

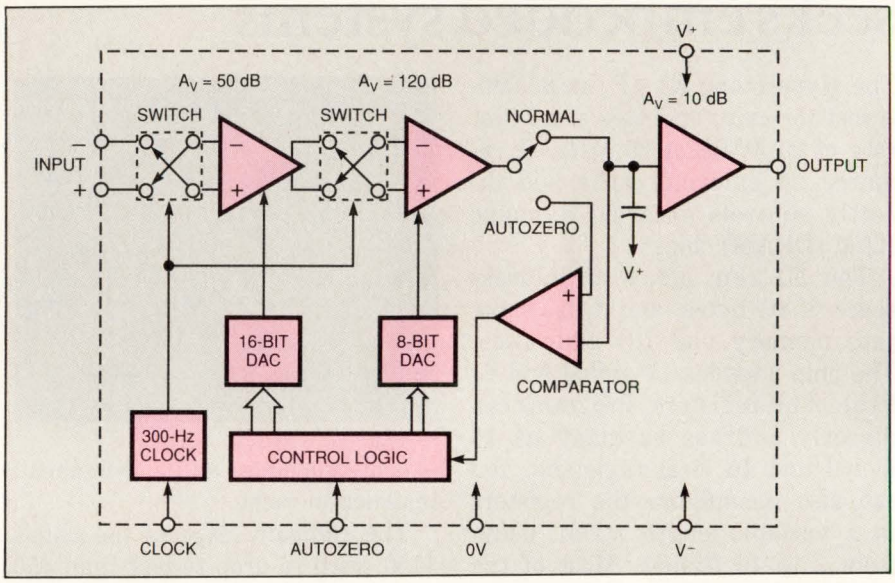
Circle No. 731

Low-drift op amps incorporate switching input stage and loop

Max425 and Max426 CMOS op amps ($9.50 (100) in 8-pin plastic DIPs) equal or surpass the low-drift performance characteristics of bipolar and chopper input alternatives. The maximum specifications for input-offset voltage are V_{io} of 5 μV, V_{io} TC of 0.05 μV/°C, and input bias current (I_B) of 200 pA. V_{io} noise in a 0.1- to 10-Hz bandwidth is typically 0.25 μV p-p, which represents a fivefold improvement on similar specs for the best chopper amps.

Both amps have 140-dB min open-loop voltage gain and common-mode and power-supply rejection ratios of 120 dB min. Internal compensation yields gain-bandwidth products of 350 kHz and 15 MHz for the Max425 and Max426, respectively.

The op amps achieve low-drift performance by using two independent and programmable on-chip nulling techniques. The first is an autozero loop, and the second is a commutating input stage.



You have a choice of programming either, neither, or both nulling methods for operation. The choices have performance tradeoffs, however. If you don't program the commutating switch, you won't cancel any 1/f noise. In addition, without implementing an occasional cycle of autozero-loop operation, the op amps' output signal may exhibit an increasing level of 300-Hz ripple.

Maxim Integrated Products, 120 San Gabriel Dr, Sunnyvale, CA 94086. Phone (408) 737-7600. FAX (408) 737-7194. **Circle No. 732**

FPGA features 3000 equivalent gates and 15-nsec logic propagation delay

The pASIC 8x12 is a field-programmable gate-array (FPGA) based on metal-to-metal antifuses that allow you to program the part with a 10V signal. The device, offering 96 macrocells in a 68-pin package, contains the equivalent of 3000 gates. Each macrocell includes six AND gates, three multiplexers, and a scannable flip-flop. The flip-flop is configurable, serving as a D, JK, T, or RS type.

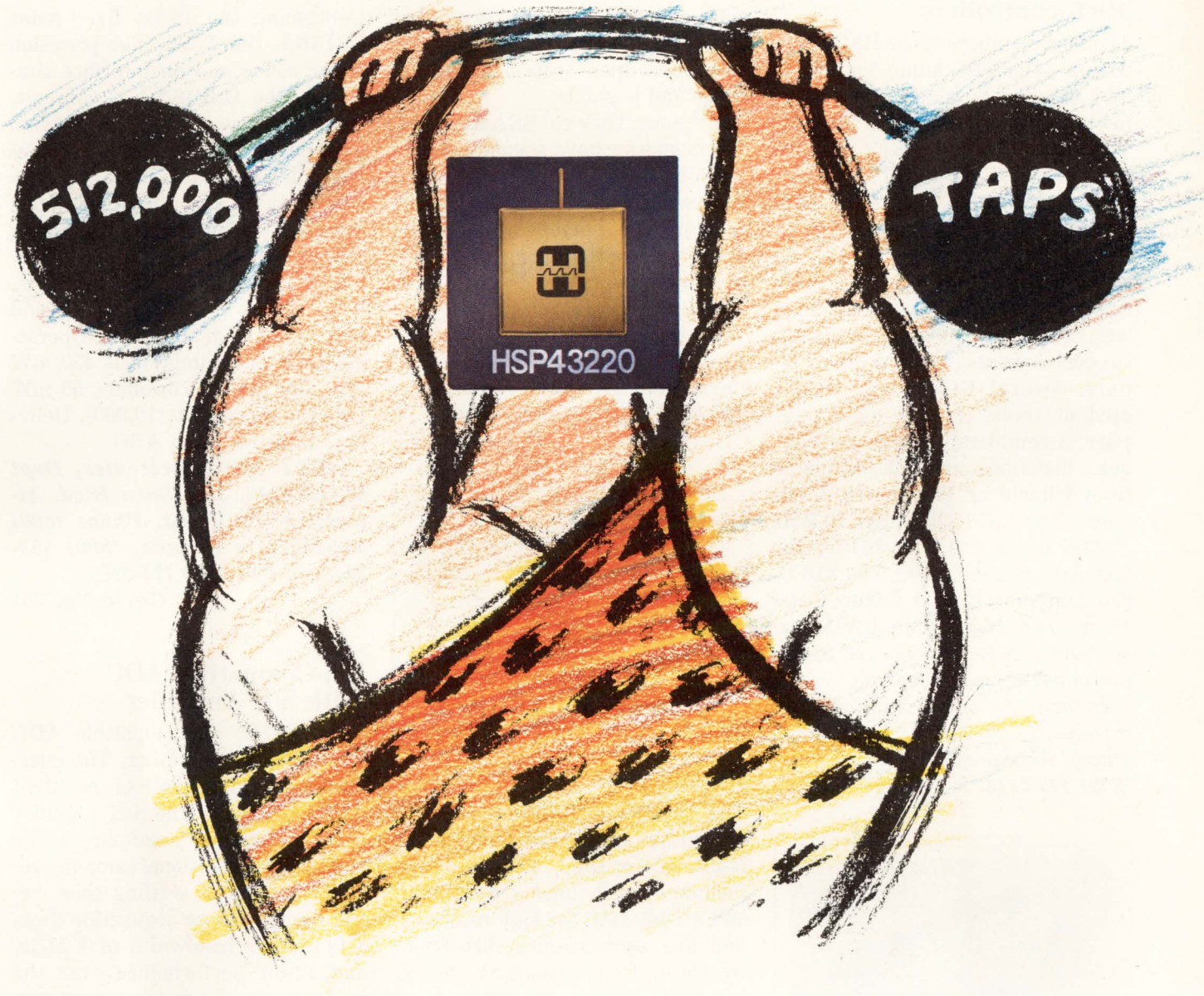
The manufacturer offers a library of more than 200 predesigned functions that fit within a macrocell. These functions include gate elements with as many as 14 input terms, AND-OR logic blocks, multiplexers, and latches.

The <200Ω metal-to-metal fuses allow the device to offer a 15-nsec input-to-output propagation delay through combinatorial logic. The internal circuitry is even faster, allowing you to build, for example, an 8-bit counter that operates at 100 MHz.

The pASIC Development Toolkit includes schematic capture, function and timing simulation, place-and-route, physical viewer/editor, delay simulation, and automatic test-vector-generation software. The tool kit also includes a programming station with RS232 interconnect cables and an antistatic wrist strap. The software and programming station require a PC running Windows 3.0.

The pASIC 8x12 will be available in sample quantities within twelve weeks; the device costs $75 (1000). The tool kit is available now for $3995.

Quicklogic Corp, 2933 Bunker Hill Lane, Santa Clara, CA 95054. Phone (408) 987-2000. FAX (408) 987-2012. **Circle No. 733**

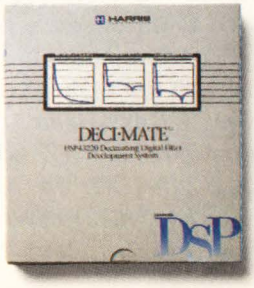


The world's most powerful digital filter on a single chip.

The new Harris HSP43220 DDF (Decimating Digital Filter) packs more power into a single-chip digital filter than ever before. With features like programmable decimation to over 16,000, and up to 512,000 equivalent taps, it's a powerhouse of performance.

Decimation:	Up to 16,384
Tap Length:	Up to 512,000
Out-of-band Attenuation:	96 dB
Sample Rate:	Up to 33 MHz
Data Width:	16 bits
Coefficient Width:	20 bits

And despite its incredible power, our DECI-MATE™ software makes designing filters with the Harris DDF incredibly easy.



Want to know more? That's easy, too. Just call 1-800-4-HARRIS, ext. 1220. And find out more about our complete line of industry-leading ICs for digital signal processing applications.

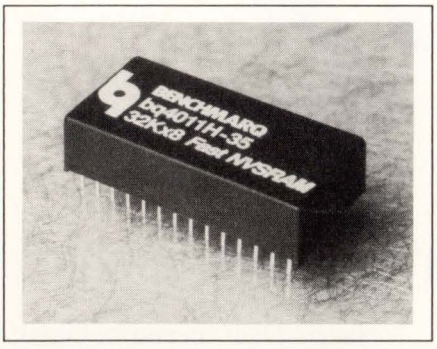
HARRIS SEMICONDUCTOR

*DECI-MATE is a trademark of Harris Corporation.

Configurable Microcontrollers

The four members of the H8/300 microcontroller (μC) family feature an 8-bit external bus and a 16-bit internal bus, although the ALU is 8 bits. You can configure the μCs' internal registers as 16 8-bit or 8 16-bit registers. Despite its 8-bit ALU, both 8- and 16-bit adds and subtracts execute in one instruction cycle (two clock cycles). At 10 MHz, these add/subtract instructions execute in 200 nsec. Hardware and software support include two real-time kernels, several C-language development tools, a fuzzy-logic compiler, assemblers, simulator/debuggers, librarians, and ICEs available from Hitachi or third-party developers. The <$10 (OEM qty), 10-MHz H8/310 features a 1-bit I/O pin for fast data transmission. The $15 to $25 high-end H8/350 features one 19-bit, two 16-bit, two PWM, and six 8-bit timers that you can configure under software control.

Hitachi America, Semiconductor and IC Div, 2000 Sierra Point Pkwy, Brisbane, CA 94005. Phone (800) 448-2244. **Circle No. 351**



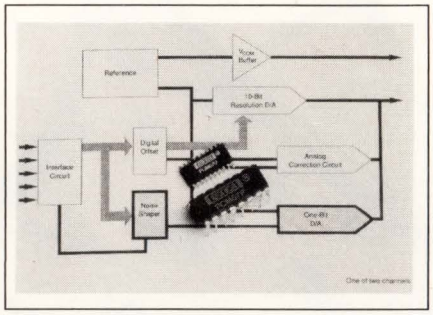
Nonvolatile Static RAMs

The bq4011H and bq4011HY battery-backed, nonvolatile 32k×8-bit static RAMs (SRAMs) have access times as fast as 35 nsec. Packaged in 600-mil DIPs, the circuitry includes power monitoring and control logic as well as a lithium power cell. If the module's supply falls out of tolerance—10% for the 4011HY, 5% for the 4011H—the control circuits write-protect the RAM contents and switch to battery power to preserve data. Write protection continues until system power returns and is stable.

Because they're SRAM based, the memories have standard timing specifications and offer unlimited read/write cycles. According to the vendor, the battery can protect data for more than 10 years without system power. In 28-pin DIPs, $60.30 (100).

Benchmarq Microelectronics Inc, 2611 Westgrove Dr, Suite 101, Carrollton, TX 75006. Phone (214) 407-0011. FAX (214) 407-9845.

Circle No. 352



18-Bit Audio DAC

The PCM67 dual 18-bit BiCMOS monolithic audio DAC combines an R-2R ladder DAC, a digital offset technique with analog correction, and a 1-bit DAC for high resolution and low zero-crossing distortion. Operating from a single 5V supply, the DAC features a THD+N of −92 dB at 0 dB, an idle-channel S/N ratio of 110 dB (20 Hz to 20 kHz, A-weighted), and a dynamic range in excess of 108 dB.

The DAC's level linearity at 90 dB is ±1 dB. Specified for a 352.8-kHz sampling rate, the DAC allows 8× oversampling of the audio spectrum on each channel. The device is available in a 16-pin DIP or a 20-pin SOIC. $19.50 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (800) 548-6132; in AZ, (602) 746-1111. FAX (602) 889-1510.

Circle No. 353

V.32 Modem Chip Set

Containing the 16-bit fixed-point DSP16A, the T7525 high-precision linear codec and an interface controller, the DSP16A-V32 chip set, compose a low-power, V.32 modem data pump. The DSP chip receives and transmits data, performs echo cancellation, and offers automode capability to select the fastest data rate possible. The chip set implements V.32 9600 baud, V.22bis, V.22, V.21, V.23, Bell 212A, and Bell 103 modem standards. Operating power consumption is 450 mW typ, and the set consumes 50 mW powered down. $70 (10,000). Delivery, 12 to 14 weeks ARO.

AT&T Microelectronics, Dept 52AL300240, 555 Union Blvd, Allentown, PA 18103. Phone (800) 553-2447; in Canada, (800) 553-2448; in PA, (908) 771-2788.

Circle No. 354

Pin-Compatible ADC With S/H Amplifier

The AD1674 pin-compatible ADC includes a S/H amplifier. The guaranteed conversion rate of the 12-bit ADC is 10 μsec. The S/H amplifier performs secondary sampling at the output. This additional sampling reduces hold-mode settling time, resulting in a 1-μsec acquisition time, a full-power bandwidth of 1 MHz, and 12-bit performance over the −55 to +125°C temperature range. The monolithic ADC also features a 10V reference, a clock, and 3-state output buffers.

The device's dc specifications include an integral nonlinearity of ±1/2 LSB and no missing codes at 12 bits. The converter has a minimum signal-to-noise and distortion ratio of 70 dB, a maximum THD of −82 dB, and a maximum intermodulation distortion of −80 dB. Power-supply requirements are either 5 and ±12V or 5 and ±15V. Bus access time is 75 nsec typ, 150 nsec max. The device uses laser-trimmed scaling and offset resistors

Harris puts all the most popular modulation techniques into one DSP chip.

The new Harris HSP45116 NCOM (Numerically Controlled Oscillator-Modulator) puts all the most popular digital modulation techniques on a single DSP chip. Including QAM, FM, AM, FSK, PSK, and complex down-conversion.

Sample rate: Up to 33 MHz
Frequency control: 32 bits
Phase control: 16 bits
Data input: 16-bit complex

So if you're still doing modulation the old analog way, it's time to change. Because with the NCOM in your design, there's no analog drift, just pure digital accuracy.

Plus, with the NCOM's microprocessor compatible interface, and its complex MAC, digital modulation is as easy as designing with one chip.

Want to know more? That's easy, too. Just call 1-800-4-HARRIS, Ext. 1213. Today.

Spurious freq. components: <-90 dB
Tuning resolution: 0.008 Hz

And find out more about our complete line of industry-leading ICs for digital signal processing applications.

HARRIS SEMICONDUCTOR

CIRCLE NO. 58

to provide four calibrated input ranges: 0 to 10V, 0 to 20V, ±5V, and ±10V. The converters come in 28-pin plastic DIPs and SOICs and 28-pin ceramic DIPs. $18 (100).

Analog Devices Inc, 181 Ballardvale St, Wilmington, MA 01887. Phone (617) 937-1428. FAX (617) 326-8703. **Circle No. 355**

16-Bit Color Palettes

The SC11485, SC11487, and SC11489 16-bit color palettes provide as many as 65,536 colors in support of the XGA (extended graphics adapter) standard. The devices are downward compatible with the 15-bit, 32,768-color Targa format and 8-bit, 256-color VGA modes. Operating as fast as 80 MHz and working with VGA and Super VGA video controllers, the color palettes provide 1024×768-pixel resolution and flicker-free, 70-Hz noninterlaced refresh-rate video boards.

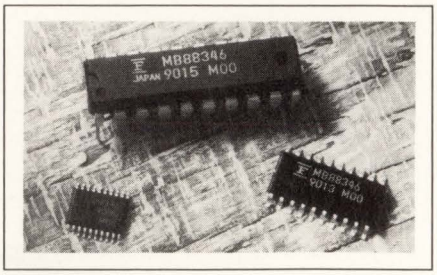
The SC11485 offers three 6-bit DACs. The SC11487 adds 15 overlay registers, which eliminate the need for software to overlay cursors, grids, and menus. The SC11489 uses three 8-bit DACs. The palettes come in 50-, 66-, and 80-MHz speed grades. $10 to $18 (10,000).

Sierra Semiconductor, 2075 N Capitol Ave, San Jose, CA 95132. Phone (408) 263-9300. FAX (408) 263-3337. TLX 384467.

Circle No. 356

8-Bit DAC

The MB88346 device is a 12-channel, 8-bit DAC. An internal op amp buffers each output channel to drive 400-µA loads at throughput rates as high as 16.7 kHz. Conversion is via an R-2R ladder. Each channel



of the DAC accepts 2.5-MHz serial data. This data is loaded into internal data latches before the device converts the digital information into analog dc voltages in 60-µsec settling time. The DAC provides a serial data output that allows you to cascade devices. In 20-pin DIPs and SOJs (small outline J-lead) plastic flatpacks, $4.50 (1000).

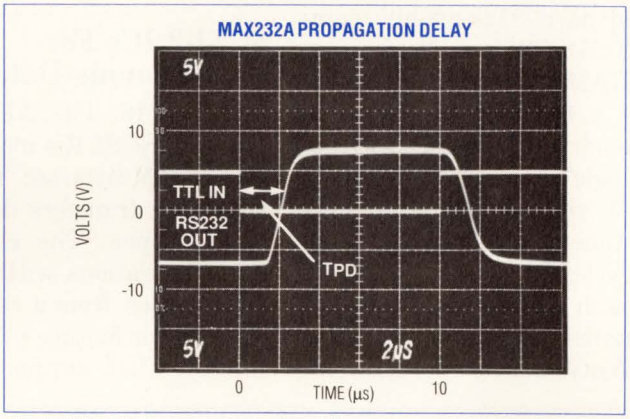
Fujitsu Microelectronics Inc, Integrated Circuits Div, 3545 N First St, San Jose, CA 95134. Phone (800) 642-7616; in CA, (408) 922-9000. FAX (408) 432-9044.

Circle No. 357

GET +5V RS-232 AT 116kBITS/SEC—GUARANTEED!

New Transceivers Use Small 0.1μF Capacitors

Push the limits of +5V RS-232 with Maxim's new family of 116kBits/sec dual transceivers. The MAX222/232A/233A/242/243 typically run at data rates of 200kBits/sec and these limits are achieved while driving real loads (2500pF and 3k). They operate with only 0.1μF charge pump capacitors, making them ideal for small, low power systems. Maxim's new MAX233A operates on a single +5V supply with no external capacitors and the MAX243 lets you swap between 2-wire (Xon/Xoff) and 4-wire (CTS/RTS) interfaces without changing cables or adding jumpers.

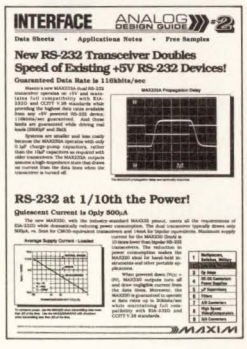


The MAX232A improves propagation delay and symmetry.

Pick a High-Speed Dual Transceiver for Your Application

Part Number	Guaranteed kb/sec	External Caps (μF)	Supply Current No Load (mA) max	Shutdown & Three-State	Features	Price*
MAX222	116	0.1	10	Yes	**MAX232A + 10μA Shutdown Mode**	$2.65
MAX232A	116	0.1	10	No	**Guaranteed 116kbits/sec Data Rate**	$2.65
MAX233A	116	none	10	No	**MAX232A with no External Capacitors**	$4.21
MAX242	116	0.1	10	Yes	**MAX222 + Receivers Active in Shutdown**	$2.65
MAX243	116	0.1	10	No	**Simplifies Cabling–No Jumpers**	$2.65

* 1000-up FOB USA, suggested resale



FREE Interface Design Guide

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MAXIM

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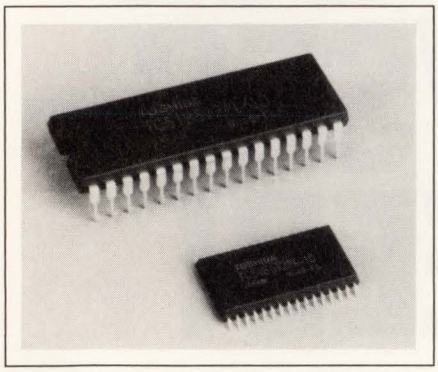


Pseudostatic RAM

Organized as a 512k×8-bit memory, the TC518512 is a 4M-bit pseudostatic RAM (PSRAM). The memory uses a 1-transistor dynamic-RAM memory cell and CMOS peripheral logic to internally generate its refresh signals. The chip uses internal timers to generate its 2k refresh cycles/32 msec. The memory comes in 70-, 80-, and 100-nsec speed grades. The 70-nsec device draws 385 mW during operation; refresh current is 200 μA for all speed grades. Available in 32-pin 600-mil DIPs and 32-pin 525-mil SOPs (small outline packages), the memories use JEDEC standard SRAM pinouts for compatibility. Three speed grades, $34 to $37.50 (100). Delivery, 8 to 12 weeks ARO.

Toshiba America Electronic Components Inc, 9775 Toledo Way, Irvine, CA 92718. Phone (714) 455-2000. **Circle No. 358**

SCSI-2 ICs For Synchronous Data Transfers

The Fas216, Fas226, and Fas236 family of SCSI ICs includes support for the 10M-byte/sec "fast" synchronous data transfers defined by the SCSI-2 spec. The chips perform SCSI operations without requiring intervention from a controlling μP. These chips feature a 24-bit transfer counter that supports long data transfers. (Older ICs incorporated a 16-bit counter.) The upper 8 bits of the counter reveal a part-unique ID code when read after NOP (no operation) commands.

The ICs' dedicated DMA channel links the SCSI bus with buffer memory. The three ICs support single-ended and differential transceiver options. The Fas216 supports single-ended applications. The Fas226 supports differential applications but requires external transceivers. Both the Fas216 and Fas226 come in 84-pin plastic leaded chip carriers. The Fas236 comes in a 100-pin quad flatpack and includes support for single-ended or differential applications. Fas216 and Fas226, $18.75; Fas236, $21 (1000).

Emulex Corp, 3545 Harbor Blvd, Costa Mesa, CA 92626. Phone (714) 662-5600.

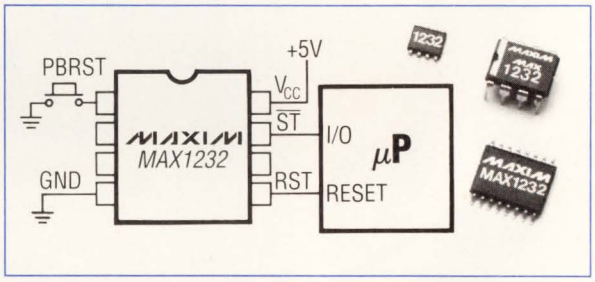
Circle No. 359

A SOLE SOURCED 1232 COULD SHUT DOWN YOUR μP!

Spec A MAX1232 And Save $$, Space & Power

Maxim's new MAX1232 μP supervisory circuit provides you with an enhanced second source for the DS1232. The MAX1232 saves you power and board area, *at a reduction in cost.* The MAX1232's 50μA supply current is 1/10th that of the DS1232. And the new MAX1232 is available in a space saving 8-pin surface mount package in addition to the standard 16-pin SOIC and 8-pin DIP packages.

- **Improved Second Source to DS1232**
- **Reduced Supply Current – 50μA!**
- **Also Available in 8-pin Mini DIP and SOIC Packages**



Pick The Right μP Supervisor For Your Design

Maxim also offers the MAX690 and MAX700 families of microprocessor supervisory circuits which feature power-on reset, backup battery switchover, watchdog timing, CMOS RAM write protection, power fail or low battery monitoring, and manual reset.

FUNCTIONS	MAX 1232	MAX690	MAX691	MAX693	MAX694	MAX696	MAX697	MAX699	MAX700	MAX701
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Variable Power-Up/Down Reset						✔	✔		✔	
Battery Backup Switching		✔	✔	✔	✔	✔				
Watchdog Timer	✔	✔	✔	✔	✔	✔	✔	✔		
Programmable Watchdog Period	✔		✔	✔		✔	✔			
Power Fail Warning		✔	✔	✔	✔	✔	✔			
Write Protect			✔	✔			✔			
Reset Threshold (V)	4.5/4.75	4.75	4.75	4.50	4.75	>1.3	>1.3	4.75	4.75	4.75
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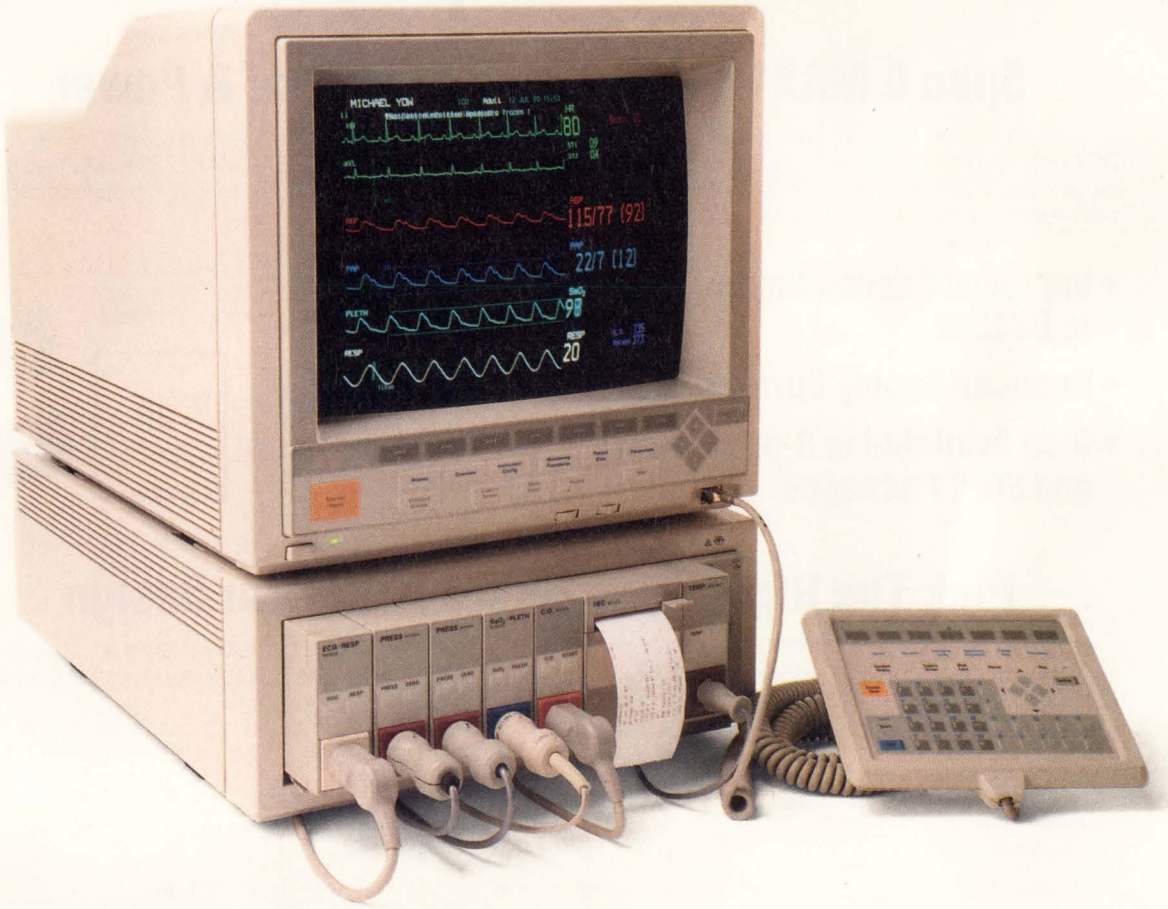

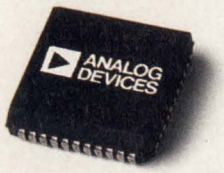

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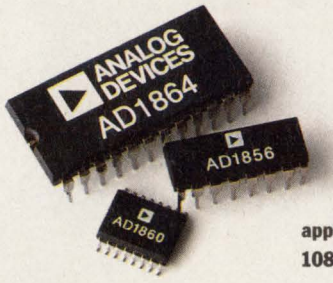

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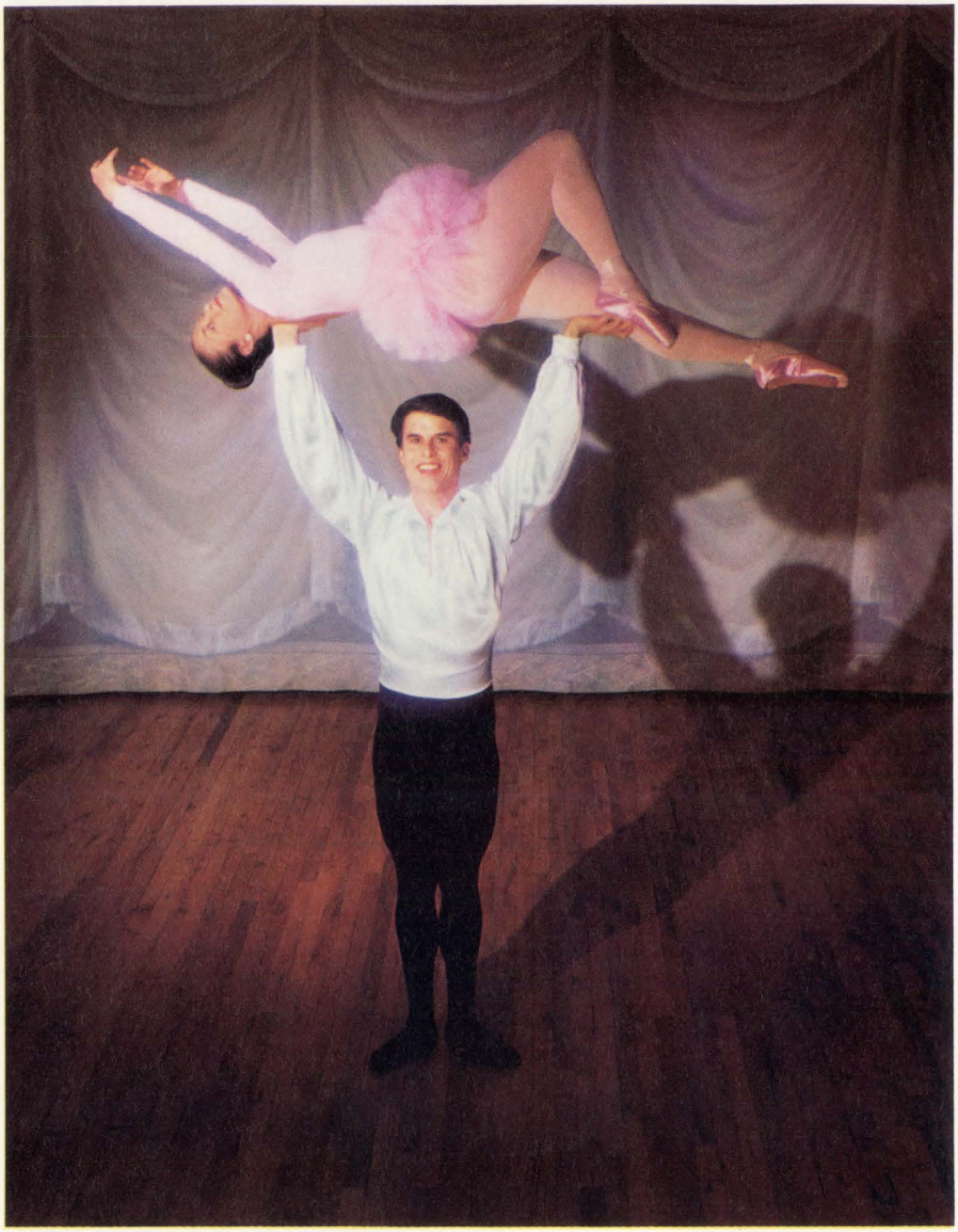

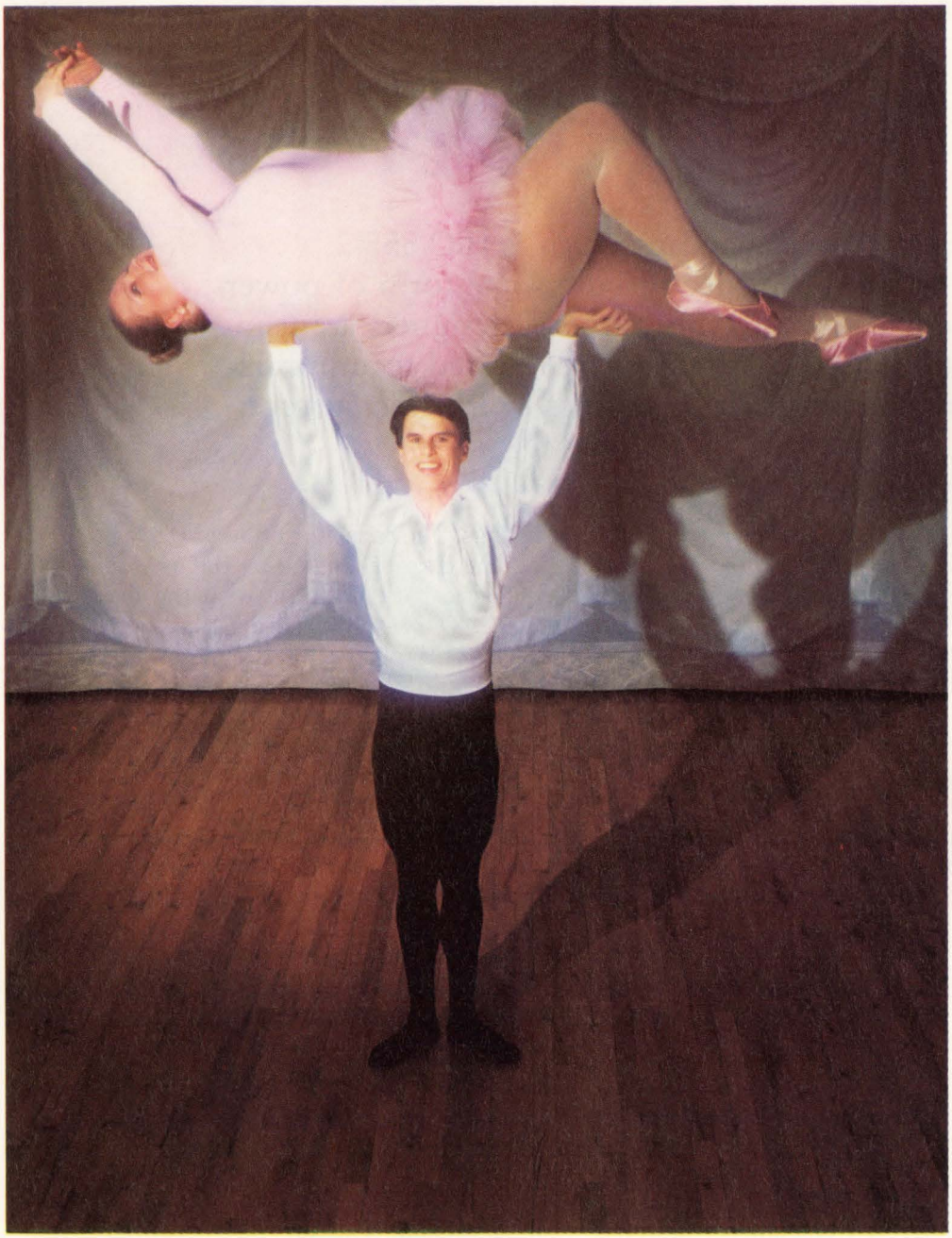

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Specialized ICs correct power factor in switching supplies

To meet upcoming standards, such as IEC 555-2, power supplies will need to use some form of power-factor correction. To this purpose, designers are using integrated circuits specifically dedicated to minimizing the percentage of harmonics in the line current.

Dave Pryce, Associate Editor

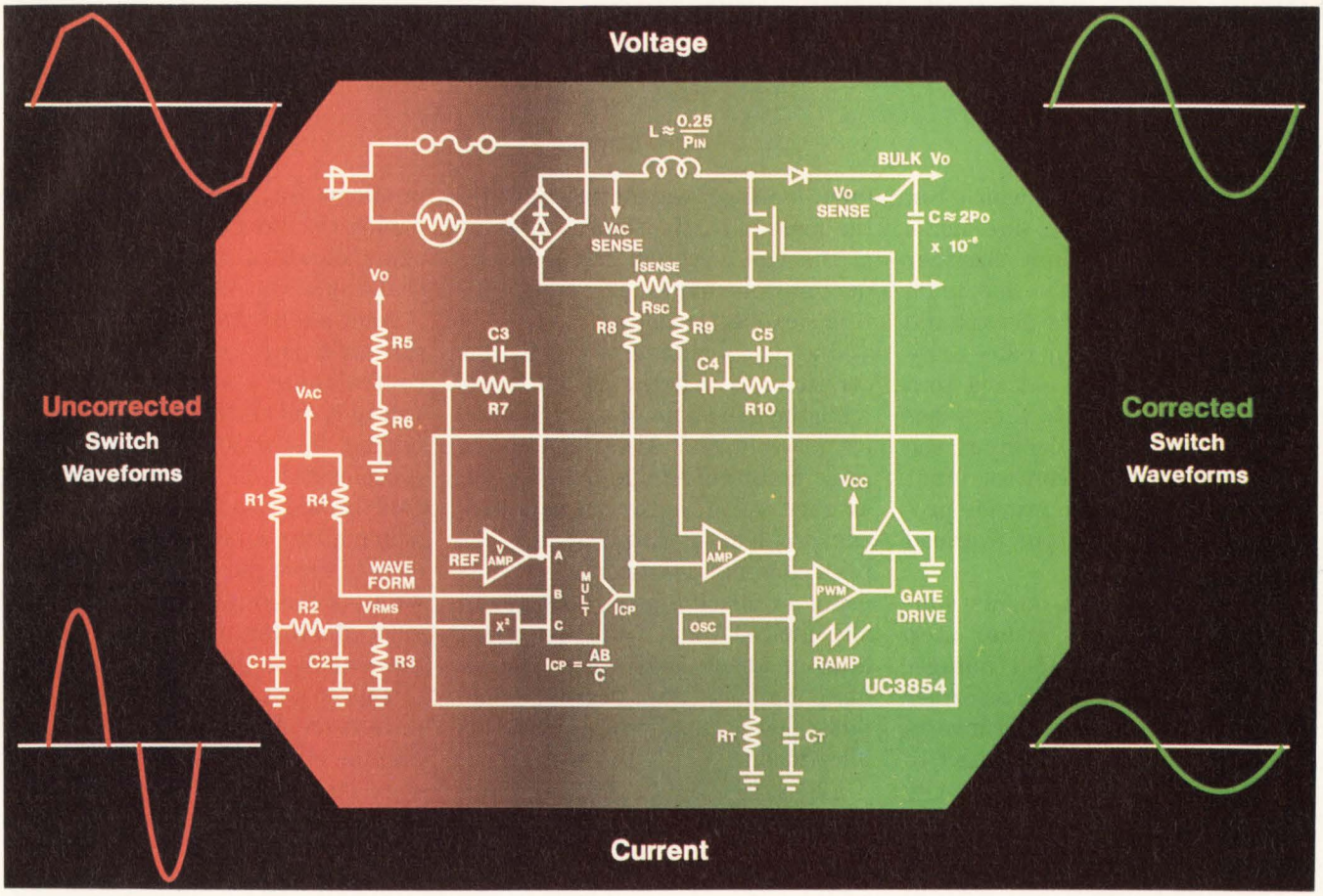
As the need for power-factor correction in today's power supplies intensifies, several vendors of integrated circuits have introduced devices that perform this function. Compared with the passive methods traditionally used in such applications as electric motors, active power-factor correction in electronic power supplies is much more complex. Before discussing the complexities of active correction, it's worth reviewing the basic definition of power factor.

Power factor (PF) is the ratio of the real power (measured in watts) to the apparent power (measured in volt-amperes). For sinusoidal line voltages, PF equals the cosine of the phase angle between the voltage applied to a load and the current passing through the load. In the ideal case, when voltage and current are exactly in phase, PF is unity (1). In most uncorrected equipment, however, power factors of 0.6 to 0.8 are common.

When electric motors accounted for the major part of the load serviced by electric utilities, power-factor problems were easy to correct. Because motors are essentially inductive elements, you simply added an appropriate value of capacitance in parallel with the motor windings. The capacitor brought the lagging line current created by the motor's inductance back in phase with the line voltage. The result was a near-zero displacement angle between current and voltage and a power factor close to unity—usually about 0.95 using the capacitors then available.

With myriad electronic power supplies now in use in computers and home-entertainment equipment, power-factor correction requires a much more complex solution. Although linear supplies for laboratory applications generally use transformer coupling and sometimes use choke-input filters, most of today's power supplies are switching supplies. These high-efficiency supplies work directly from the ac line using bridge-configured line rectifiers and a capacitor-input filter (**Fig 1a**).

As shown in **Fig 1b**, these circuits draw current in a way that is certainly not sinusoidal. The full-wave rectifier charges the capacitor with pulses of current that occur only at the peak of each half cycle of the ac line voltage. The result is a severely distorted ac input current that generates multiple harmonic currents. It's these harmonics, rather than the displacement angle, that cause most of the reduction in power factor.



Power-factor-correction circuits such as the UC3854 from Unitrode restore the input current waveform to a sinusoidal shape.

Because they don't deliver any power to the load, harmonics serve no useful purpose. Harmonics do, however, contribute to the total line loss, add to the current drain from the line, and dictate the need for higher-capacity wiring.

IEC specification 555-2 reinforces the need for some form of active power-factor correction in today's off-line supplies. Scheduled for implementation in Europe starting in 1992, IEC 555-2 provides harmonic-current limits for four groups of equipment: Class A, for balanced 3-phase equipment; Class B, for portable tools; Class C, for lighting equipment; and Class D, for equipment having an input current with a "special waveshape." In effect, the Class-D specification (**Table 1**) places strict limits on the allowable harmonic currents for two groups of power supplies: those that consume less than 300W of ac power and those that consume 300W or more. Europe isn't the only market that has strict power-factor-correction standards. MIL-STD-1399 specifies allowable harmonic levels for supplies in American military equipment.

Essentially, a power-factor circuit is a preregulator that uses circuitry similar to that used in a conventional switch-mode regulator. The difference is that the power-factor preregulator restores the input current to a near-sinusoidal state with an appropriate rms value that complements the line voltage; the conventional regulator only deals with the regulation of the output voltage. Like the conventional regulator, the power-factor regulator can use any one of three basic converter topologies, namely: buck, boost, and flyback (buck-boost). Each of these topologies (**Fig 2**) has distinctive characteristics.

The step-down buck converter (**Fig 2a**), for example, has major limitations. In order to regulate, the output voltage of a buck converter must be less than its minimum input voltage. Because there's a break in the input current when the input voltage falls below the output voltage, the buck converter cannot provide optimal power-factor correction. However, a buck converter may be satisfactory for low-output-voltage applications having moderate power-factor requirements.

Of major concern in a buck regulator

Using today's integrated circuits, switching power supplies can obtain power factors of 0.99 or better.

is its chopped current, which can generate considerable line noise that is difficult to filter. Another disadvantage is that the maximum input voltage appears across the switch, and its base (or gate) drive usually requires level shifting to a floating reference. However, because the switch is at the input, the buck converter can control input surge current and also provide protection against an output overload or short circuit.

The flyback (buck-boost) converter **(Fig 2c)** can either step down or step up the input voltage. In a circuit that isn't transformer coupled, a flyback converter inverts the output polarity with respect to the input. Advantages of the flyback converter include its adaptability to transformer coupling and its ability to accommodate current limiting and overload protection. Moreover, by controlling the switch on-time, you can—to some extent—make the input current follow the input voltage waveform. But, for the most part, the sinusoidal shape of the input voltage across the inductor determines the input current's average value.

One disadvantage of the flyback converter is that the switch has to withstand the sum of the input and output voltages. Also, because the peak input current is 2 to 4× the average value, noise can be a serious problem. Because of the high peak currents, power-factor circuits using a flyback topology are generally limited to a maximum power level of about 150W. Fluorescent-lamp ballasts and personal-computer power supplies are typical applications.

Probably the most popular topology for a power-factor preregulator is the boost converter **(Fig 2b)**, which steps up the input voltage. Because the continuous-boost converter does not chop the input current, and because the inductor itself acts as a line filter, RFI and EMI problems are greatly reduced. Also, having the inductor in the input circuit makes it easy to implement current-mode control.

Another advantage of the boost converter is its ability to maintain control over the complete input voltage waveform, thereby minimizing distortion—an important consideration in power-factor control. In addition, the switch's common-emitter configuration makes it easy to drive the base of the switch with ground-referenced control signals. Moreover, the voltage across the switch is limited to the value of the output voltage. Because its peak current tends to be much less than in other topologies, the boost converter is particularly effective for use in high-power supplies. The major disadvantage of the boost converter is its inability to easily provide short-circuit protection.

Choosing a topology is not necessarily easy. You need to understand the allowable tradeoffs for your par-

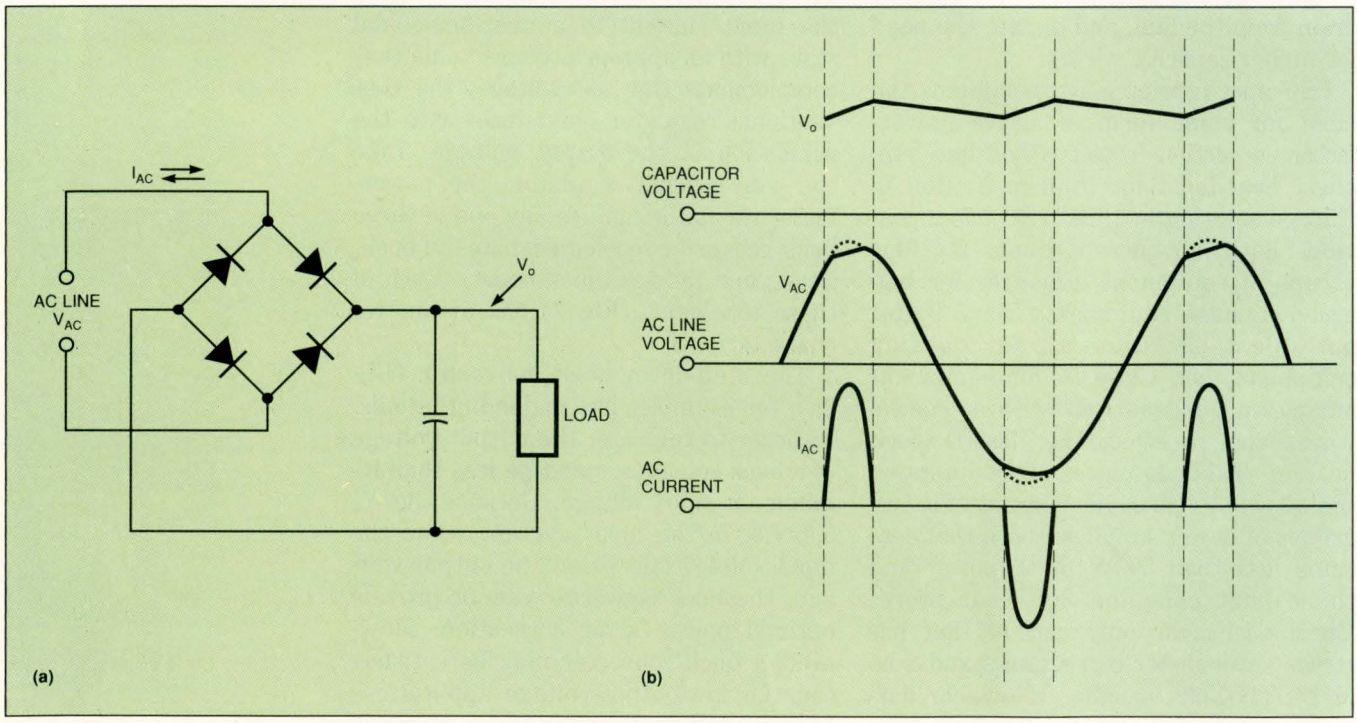


Fig 1—Power supplies using bridge-configured line rectifiers and a capacitor-input filter (a), draw current in a nonsinusoidal way (b). The full-wave rectifier charges the capacitor with pulses of current that occur only at the peak of each half cycle of the ac line voltage.

ticular application. In the case of a low-voltage supply that doesn't require the highest possible power factor, a buck converter may satisfy your needs. For power levels of 150W or less in designs where noise is not a major concern, a flyback converter may be just the ticket. For many high-power applications, however, particularly those that also demand superior power-factor control, a boost converter will probably be your best choice.

Complicating these choices are the differing characteristics of the available controller chips. Although most power-factor chips use either a boost or flyback topology, the specific operating modes of these chips vary. Of the few controller models available, the majority operate at a fixed frequency, and the remainder operate at a variable frequency. Because of potential stability problems, variable-frequency controllers tend to work best with a fixed load and a limited input range. But don't take this dictum too literally—there are always exceptions.

Chips also vary as to how they sense and control the input current. You can choose among voltage mode, average-current mode, peak-current mode, and hysteretic current mode. Chips that rely on peak-current detection need slope (ramp) compensation to correct for the difference in peak-to-average current as a function of pulse width. Such compensation is a compromise based on the expected line and load variations and can degrade performance at high line inputs and low power levels.

Before deciding on the use of a particular chip, look carefully at the data sheets and application information. Although you probably will find a suitable chip for your application, choosing the chip will not be simple.

Recognizing the existing and impending needs to provide a practical solution to the problem of active power-factor correction, several vendors of integrated circuits have introduced devices specifically dedicated to the task. Among these vendors are Cherry Semiconductor, Micro Linear, Silicon General, and Unitrode. As you might expect, all of these vendors have extensive experience in the power-conversion field.

Unitrode states its case for accep-

Table 1—IEC 555-2 Class-D specs

Harmonic order (n)	Maximum permissible harmonic current: Relative limits (ma/W)	Maximum permissible harmonic current: Absolute limits (A)
Odd harmonics		
3	3.6	1.08
5	2.0	0.60
7	1.5	0.45
9	1.0	0.30
11 to 39	0.6 (11/n)	0.18 (11/n)
Even harmonics		
2	1.0	0.30
4	0.5	0.15

Notes:
1. Class-D specifications apply to equipment operating from a single-phase 220V ac line with a waveshape such as that exhibited by the input current to a rectifier with a capacitive input filter.
2. The **absolute limits** apply to equipment with a power consumption of 300W or more and will be in effect in 1992. The **relative limits** apply to equipment with a power consumption of less than 300W and will be in effect in 1994.

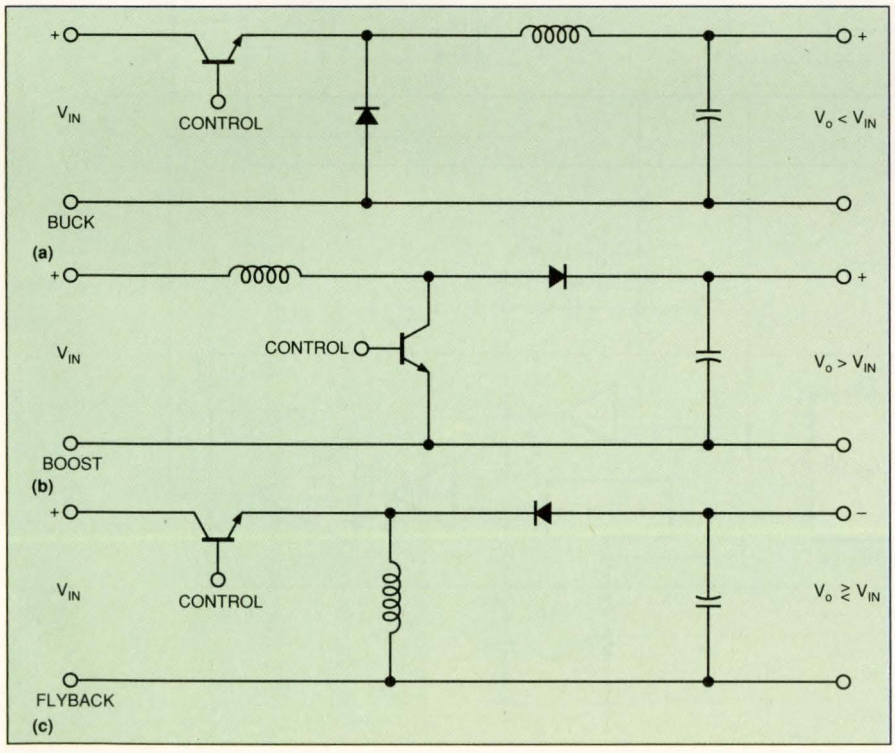


Fig 2—The three basic topologies used for power-factor correction are buck, boost, and flyback (buck-boost).

tance with its UC3854, priced at $3.59 (1000). This sophisticated chip uses average-current control, so it can accurately maintain sinusoidal line current without resorting to slope compensation. Used in a boost topology, the chip provides power factors to 0.99 and limits line-current distortion to less than 5%. The chip operates in systems with line voltages of 75 to 275V and line frequencies of 50 to 400 Hz. When compared with other power-factor controllers, the UC3854's higher reference voltage (7.5V) and higher oscillator output (5V) can offer advantages in high-power supplies, which typically exhibit high noise.

The chip includes a voltage amplifier, a low-offset analog multiplier, a current amplifier, a fixed-frequency PWM, an oscillator, and a 1A totem-pole MOSFET gate driver. Also included is a 7.5V voltage reference, an enable comparator, and an overcurrent comparator. Based on the detailed application circuit in Unitrode's data sheet, the greatly simplified circuit in **Fig 3** illustrates the UC3854's basic operation.

As shown, the circuit uses both a current loop and a voltage loop for control. The current loop samples the output waveform of the bridge rectifier through resistor R_7, which converts the voltage to a current waveform at pin 6 of the UC3854. This input acts as a reference for the multiplier. To implement feed-forward line regulation, resistors R_6, R_8, and R_9, together with capacitors C_3 and C_4, develop a dc voltage at pin 8 that is proportional to the rms value of the line voltage. The chip squares this dc voltage and applies it to the multiplier. To complete the voltage loop, resistors R_1 and R_2 provide a sample of the output voltage and apply it to the input of the voltage amplifier at pin 11. The output of the voltage amplifier goes to the multiplier.

The output of the multiplier is a current that is equal to the product of the voltage amplifier output and the input line voltage, divided by the square of the rms line voltage ($I_M = AB/C$). Acting as a control signal to the preregulator, I_M has an instantaneous value that follows the shape of the input voltage, and an average value that is inversely proportional to its rms value. Resistor R_3 converts I_M to a voltage, which the current amplifier then uses to force an equivalent voltage across R_S, the line-current sensing resistor.

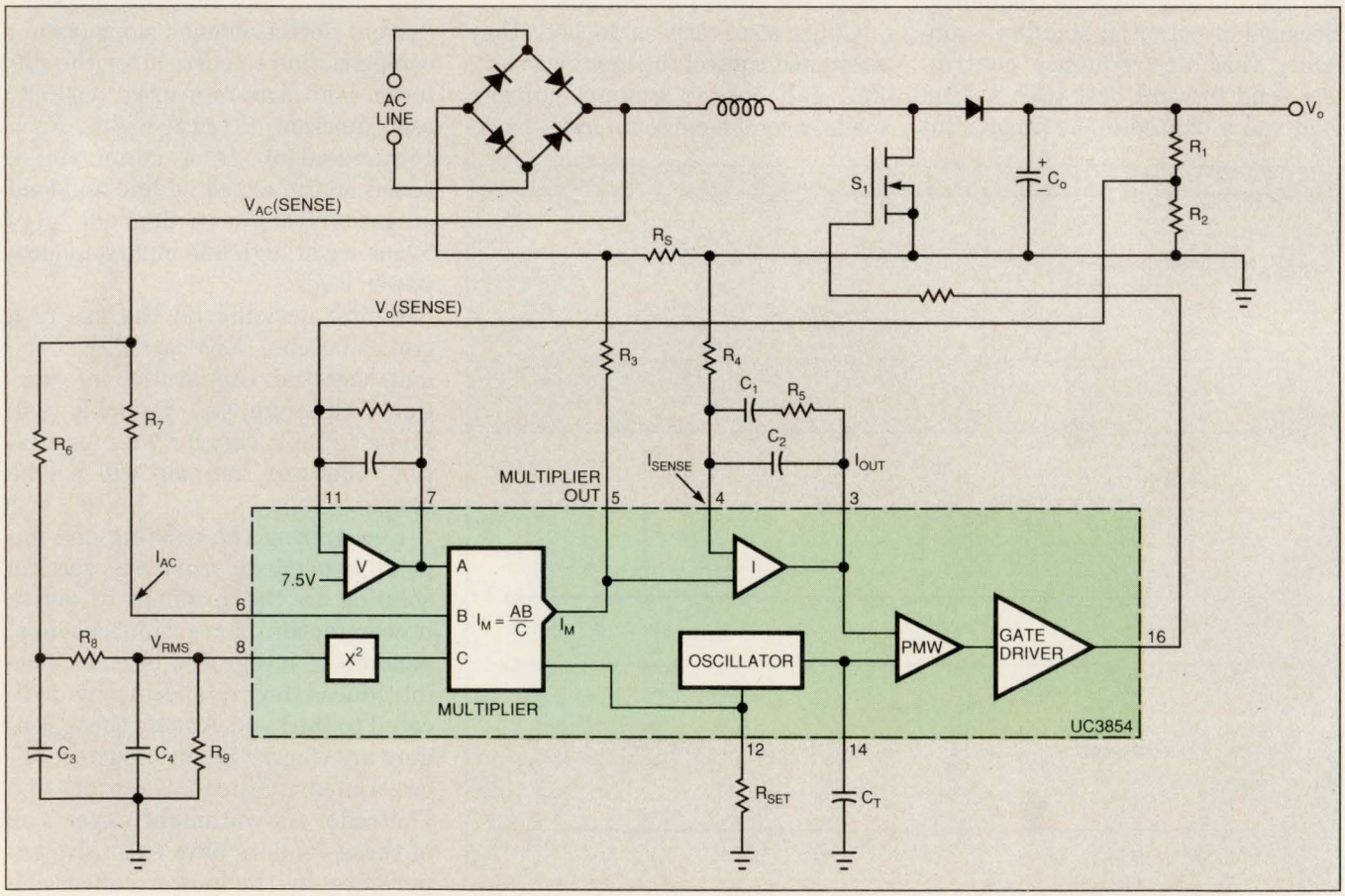


Fig 3—Typical of many of the power-factor-correction circuits is the UC3854 from Unitrode. Shown here in simplified form, the circuit contains both a current loop and a voltage loop.

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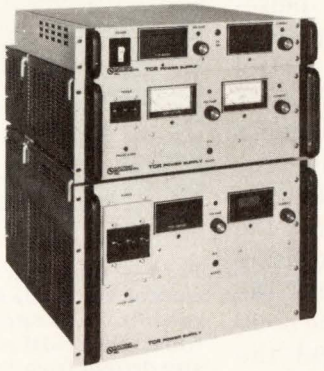

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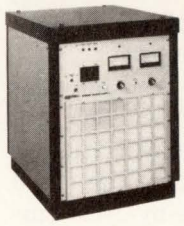

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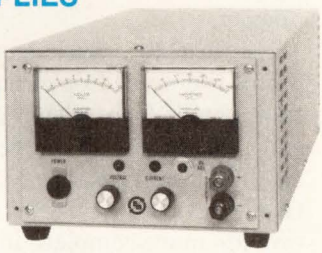

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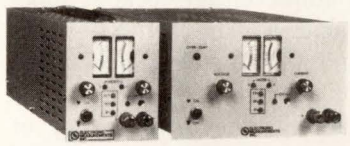

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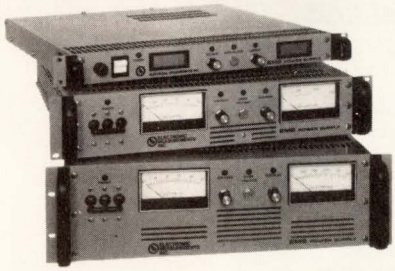

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The current amplifier provides the gain for the current loop, which controls the action of the pulse-width modulator (PWM). In turn, the PWM and gate driver control the on-off action of the MOSFET power switch, S_1, to force the input line current to follow the programmed value. The UC3854 implements average-current control; the compensation network comprising R_4, R_5, C_1, and C_2 performs the averaging. R_{SET} programs the oscillator-charging current and the maximum output of the multiplier. C_T sets the PWM oscillator frequency.

For brevity, much has been left out of the preceding circuit description, particularly with regard to the soft-start and enable functions. Unitrode's Application Note U-125 (**Ref 1**) and the UC3854 data sheet provide more complete information.

Taking a slightly different approach to active power-factor correction, Cherry Semiconductor accomplishes essentially the same results as Unitrode. Like the Unitrode chip, Cherry's CS-3810 uses a boost topology, but instead of average-current control, the Cherry chip uses hysteretic current-mode control. To implement this technique, a sinusoidal refere nce and an offset derived from the reference generate a hysteresis band (**Fig 4**). Turning the power transistor on and off causes the current to ramp up and down. The switching occurs when the current reaches the bounds of the hysteresis band. The average value of the waveform determines the inductor current.

In addition to the hysteretic current-mode, you can use the chip in constant off-time applications. Other features of the $2.54 (1000) CS-3810 include feedforward of the input voltage, undervoltage lockout, a shutdown comparator for fault conditions, and a ±1A source-sink output driver.

Probably the leading supplier of power-factor-correction chips, at least in terms of the variety of its products, is Micro Linear Corp, which offers three different chips. The $2.85 ML4812 is for use in a current-mode boost regulator at power levels of 75 to 2000W. Typical applications include computer systems that require optimum power-factor correction. The $1.80 ML4813 is for use in a voltage-mode flyback regulator at power levels below 150W. **Table 2** summarizes the typical characteristics of the two devices.

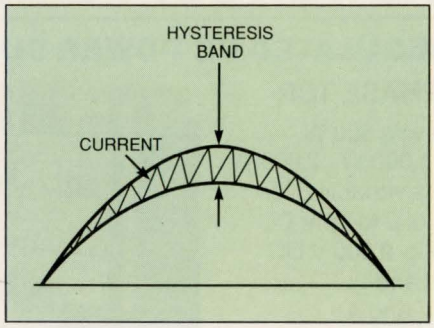

Fig 4—Using hysteretic current-mode control, the CS-3810 from Cherry Semiconductor generates a hysteresis band from a sinusoidal reference and an offset also derived from the reference. The average value of the waveform determines the inductor current.

The third chip offered by Micro Linear is the ML4819, which combines a boost-mode power-factor circuit similar to the ML4812 with a conventional PWM controller circuit. You can use the PWM section for either current- or voltage-mode control for a second-stage converter. **Fig 5** is a simplified diagram of the individual functions. Combining the two circuits in a single device minimizes component count and saves space. Because both circuits share the same oscillator, synchronization is inherent. Moreover, a large oscillator amplitude of 4.3V maximizes noise immunity.

The power-factor section uses peak-current sensing, and the programmable slope compensation is common to both sections. The PWM section includes cycle-by-cycle current limiting as well as duty-cycle limiting (for single-ended converters). Both sections feature individual 1A totem-pole output drivers, but the undervoltage lockout function is shared. The ML4819 costs $3.40, and all three chips are priced for 1000s quantities.

Completing this brief survey of power-factor controllers is the $1.30

Table 2—A comparison of boost and buck-boost preregulators

	Continuous boost	Discontinuous buck-boost
Output voltage	$V_{OUT} > V_{IN}$	Independent of V_{IN}
Input current	Continuous	Discontinuous
Output current	Discontinuous	Discontinuous
Control	Simple current mode	Simple voltage mode
Peak current (150W)	2A	9A
Transformer isolation	Not possible	Easy
Rectifier needs	Fast	Moderate
V_{MAX} on pwr switch	V_{OUT}	$V_{OUT} + V_{IN}$ (peak)
Surge current limit	Difficult	Inherent
Input transient absorption	Inherent	Tran-zorb required
Input line filter	Minimal	Complex π network
Usable power levels	75W to > 2000W	< 150W
Controller	ML4812	ML4813

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(1000) SG3561 from Silicon General, the company that developed the first integrated PWM controller some 15 years ago. Optimized for electronic-ballast applications, the chip allows a discontinuous mode of operation over the entire range of line and load variations. This capability is particularly important in ballast applications where the nonlinear nature of the lamp could affect the stability of the preregulator. In addition to its use as a power-factor controller, you can use the chip in conventional switched-mode converters.

Although power-factor correction requires the addition of several active and passive components, which add to the cost of the supply, the power-factor controllers are relatively inexpensive. In 1000-piece lots, even the most complex controller ICs are available for about $3.60 apiece. Whatever the total cost, power-factor-controlled supplies will become the norm, heeding IEC 555-2 and other standards.

Because of the predictive schedule for enforcement of IEC 555-2 regulations, designers must add power-factor correction to their power supplies if they expect their companies to sell into the European market next year. Although only military applications dictate the present U.S. requirements for power-factor correction, this picture could change in the future as more efficient use of power is mandated. Clearly, however, vendors of integrated circuits are answering the need with chips that suit a variety of applications. EDN

For more information . . .

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

Cherry Semiconductor
2000 S County Trail
East Greenwich, RI 02818
(401) 885-3600
Circle No. 669

Silicon General
11861 Western Ave
Garden Grove, CA 92641
(714) 898-8121
Circle No. 671

Unitrode Integrated Circuits
7 Continental Blvd
Merrimack, NH 03054
(603) 424-2410
Circle No. 672

Micro Linear
2092 Concourse Dr
San Jose, CA 95131
(408) 433-5200
Circle No. 670

References

1. de Sa e Silva, Claudio, "Power Factor Correction With The UC3854," *Unitrode*, Application Note U-125.
2. Cardinale, Vince, "Techniques for improving power factor," *Powertechnics*, April 1990, pg 33.
3. Swager, Anne Watson, "Power-supply IC controls both PWM and power-factor correction," *EDN*, December 6, 1990, pg 57.
4. Mammano, Bob, and Lloyd Dixon, "Choose the Optimum Topology for High Power Factor Supplies," *PCIM*, March 1991, pg 8.
5. Strassberg, Dan, Power-factor-corrected switching power supplies," *EDN*, April 11, 1991, pg 90.

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

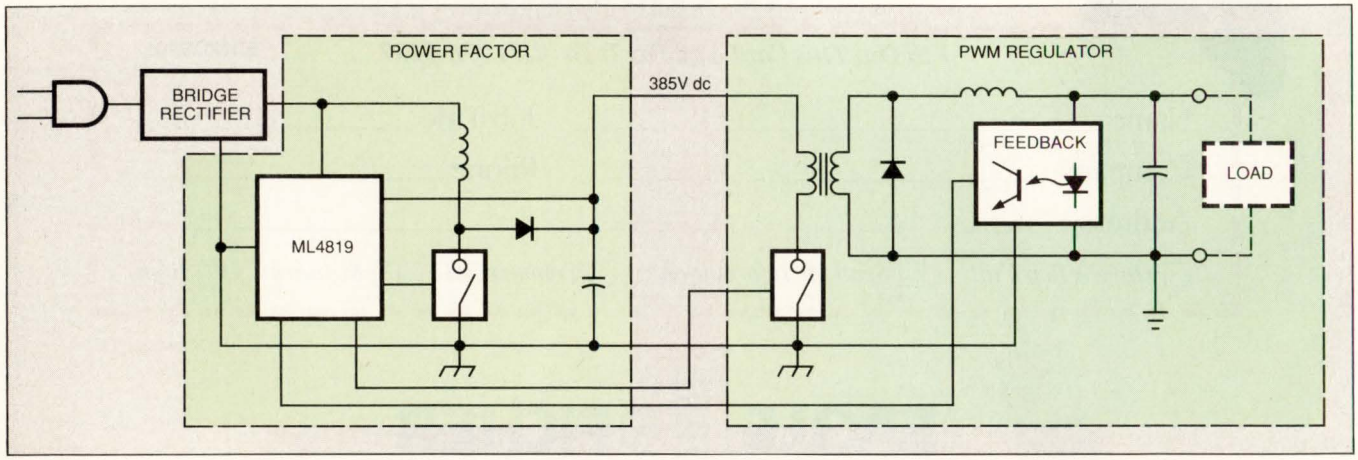
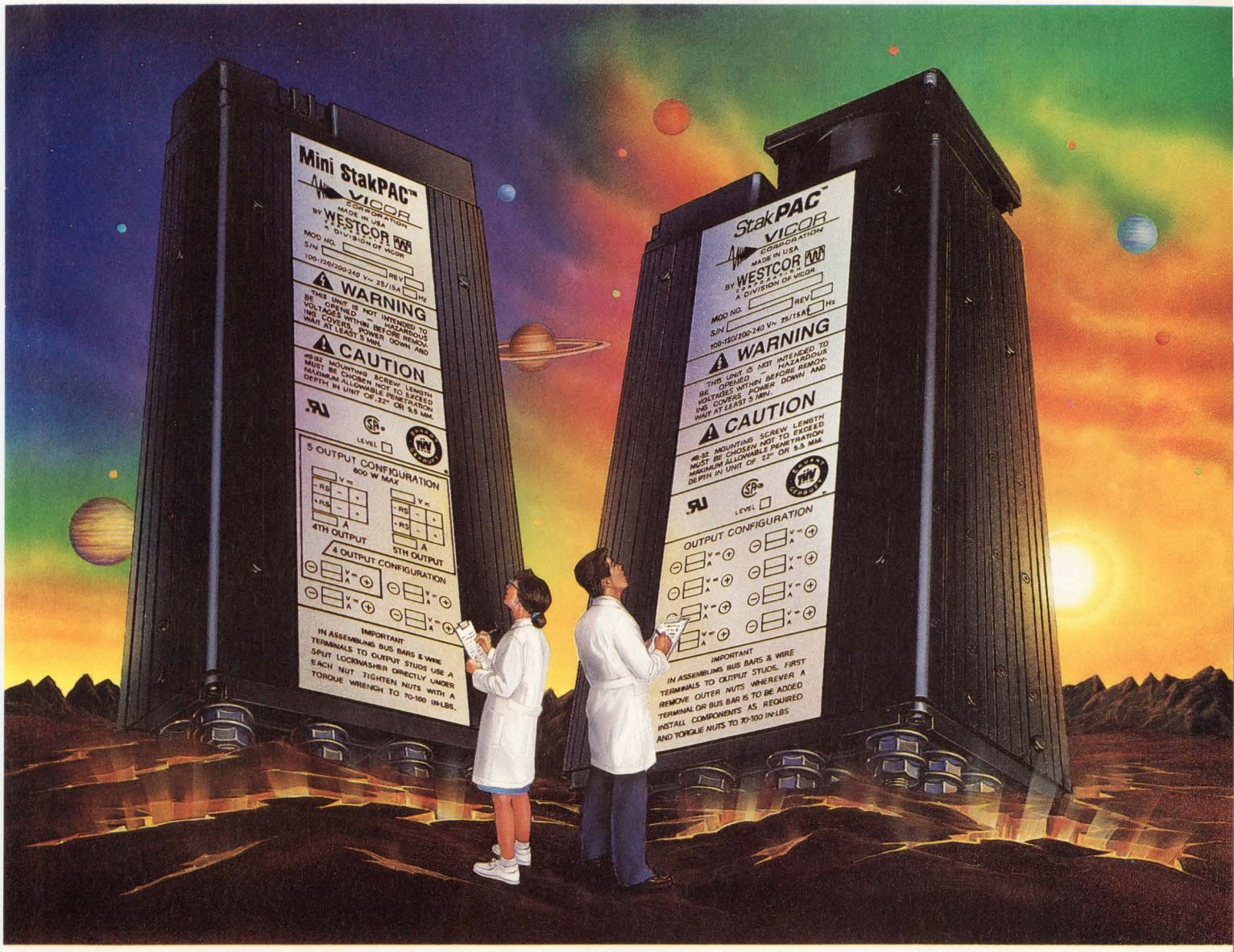


Fig 5—Combining PWM and power-factor controllers, the ML4819 from Micro Linear needs fewer components than other implementations.

Power Revelation



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DC MINI	800W	up to 5	5 Ranges 18-76 VDC	2.5 x 4.3 x 12.2

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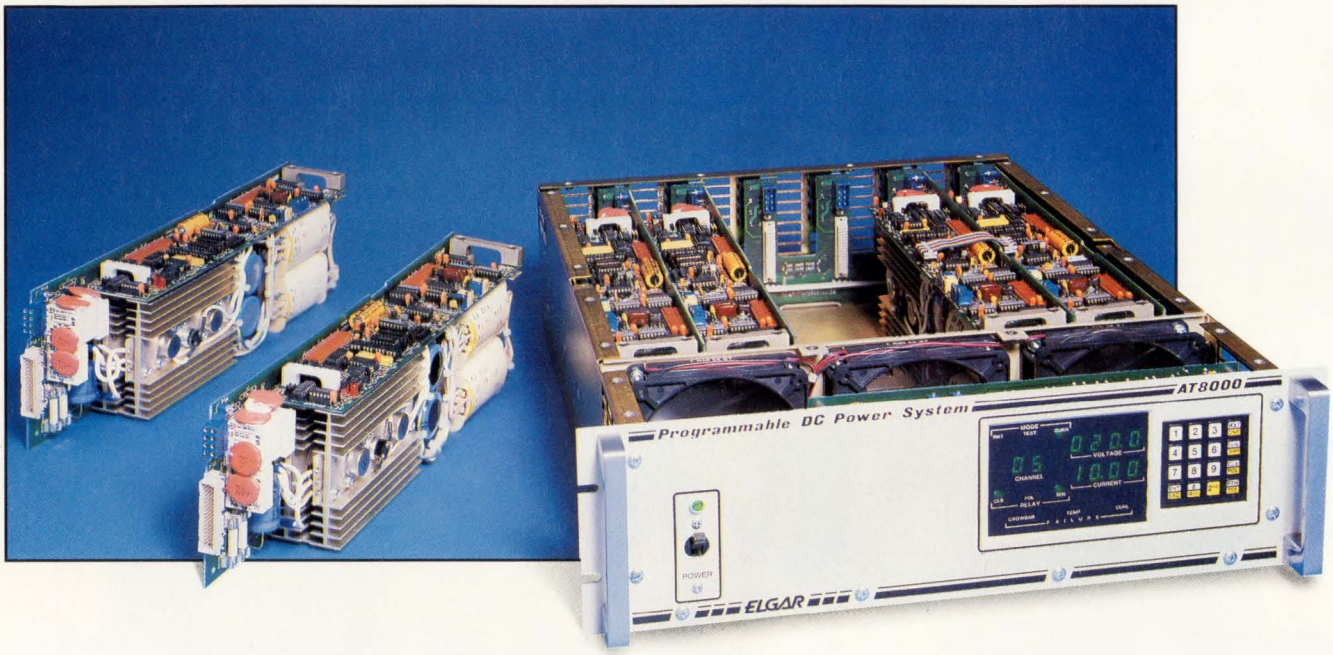

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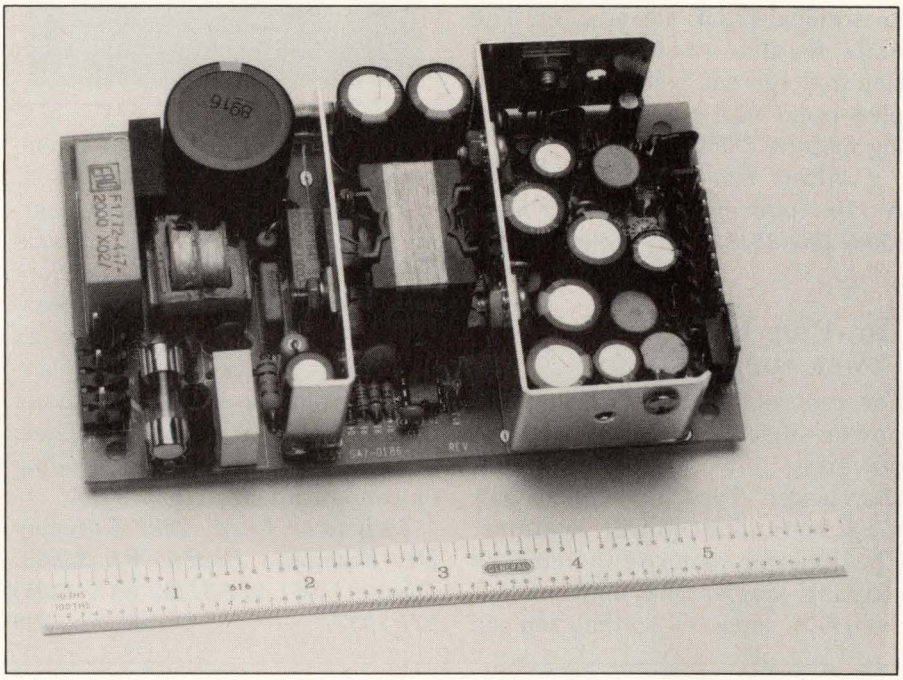
Switching power supplies accept worldwide voltages

The US 50 series of 40 to 70W switching power supplies accepts input voltages ranging from 90 to 264V ac, at 47 to 440 Hz. The supplies measure 5×3×1.2 in. Boasting an efficiency of 70%, the supplies come in single-, dual-, triple-, and quad-output versions. The supplies feature line regulation of ±0.2% and load regulation of ±3%. Output ripple and noise is 25 mV rms, 50 mV p-p for the primary output, and 0.5% rms, 1% p-p for the auxiliary outputs. The supplies have current limiting set at 120% of maximum output.



The supplies have Molex connectors; they conform to FCC Class-A specs and are UL, CSA, and TUV approved. One low-leakage version meets UL544 medical requirements. All models run at full-rated power and minimal air flow. You can also use them with convection cooling at reduced power levels. The manufacturer can customize each model with the output-voltage and current combinations that your applications require. The supplies cost $50.

Digital Power Corp, 41920 Christy St, Fremont, CA 94538. Phone (415) 657-2635. FAX (415) 657-6634. **Circle No. 735**

DC/DC converters' dual sections provide completely isolated outputs

The K Triple series of 55W dc/dc converters have two separate power sections: one being a 5V (5A) section and the other being either a ±12V (1.25A) or a ±15V (1.0A) section. The two individual power sources within each converter develop isolated, regulated outputs. The power sections operate in antiphase to each other to reduce both ripple-current stress on input components and reflected input ripple.

The converters are 90% efficient and have 2:1 input-voltage ranges, double-shielded pot-core transformers, and toroidal magnetics. The converters' cases are 0.4 in. thick. Transient-voltage-suppressor diodes protect the inputs and outputs from overvoltages. The outputs feature pulse-by-pulse current limiting.

The cases measure 3.5×5.5×0.9 in. Line and load regulation is 0.8%, and output noise is 20 mV p-p. Voltage stability is 0.3%/1000 hours. Input-to-output voltage isolation is 500V, and the converters' operating temperature is −40 to +90°C. The converters cost $150.50 (100).

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (800) 542-3355; in CA, (415) 932-3911. FAX (415) 932-6017.

Circle No. 736

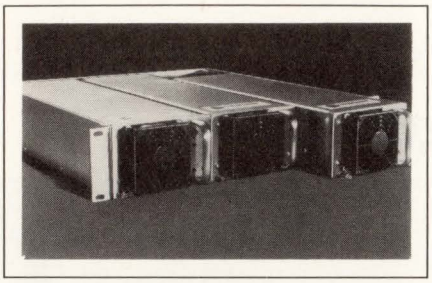
Programmable Linear Supplies

You can program the PD series linear power supplies with a 10-turn pot, an external control voltage, or an optional IEEE-488 adapter. The units feature overvoltage protection and current limiting. The supplies come with either LED or analog meters. $895 to $1550.

Contact East, 335 Willow St, North Andover, MA 01845. Phone (508) 682-9844. **Circle No. 389**

Hot-Plug Redundant Power Supplies

You can replace T Series hot-plug power-supply modules without powering down the system that they power. Thus the supplies suit $n+1$ redundant-power systems. The T Series comprise the maker's existing single- and multi-output switchers repacked so that you can



plug and unplug them from a company-standard power backplane.

The supplies have current sharing on all outputs and built-in isolation diodes. A mechanical interlock turns the supplies on and off. Standard backplanes accept one to six supplies per backplane. The backplanes mount in standard 3½-in.- or 7-in.-high, 19-in. racks. Supplies, $409 (100); backplanes, depending on configuration, $115 to $515.

Unipower Corp, 2981 Gateway Dr, Pompano Beach, FL 33069. Phone (305) 974-2442. FAX (305) 971-1837. **Circle No. 390**

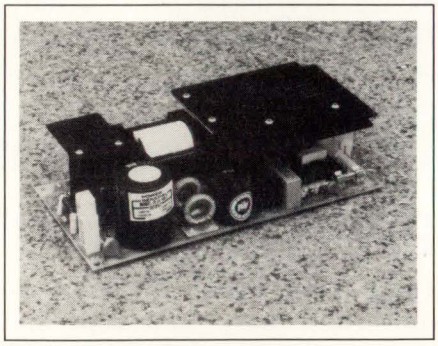
Quad-Output Switcher With Powerful Auxiliaries

The SQM225 quad-output switcher suits applications that require high-power auxiliary outputs for disk drives but minimal main-output power. The switcher's main output supplies 5V at 30A. The first auxiliary output supplies 12, 15, or 24V at 10A (12A pk); the other two auxiliary outputs produce 5, 12, 15, or 24V at 7.5A.

Standard features include international-voltage inputs of 90 to 132/180 to 264V ac, 47 to 440 Hz, overcurrent and overvoltage protection, and 3750V ac isolation. The built-in line filtering meets FCC Level B and VDE 0871 Level A. The supplies meet VDE, IEC, US, BS, and CSA safety standards. SQM225, $228 (100). Delivery, 12 weeks ARO.

Switching Systems International, 500 Porter Way, Placentia, CA 92670. Phone (714) 996-0909. FAX (714) 996-2753.

Circle No. 391



Quad-Output 100W Switching Supplies

The Flu4-100 series 100W switching supplies offer a 5V main output and combinations of ±5, ±12, ±15, and +24V dc. The calculated MBTF is 165,000 hours min using MID-STD 217E. All models meet UL, CSA, and TUV safety and EMI specs. The units' auxiliary outputs will operate at no load. Efficiency is 65% min. Line regulation is 0.2% for the primary output and 0.5% for auxiliary outputs. Load regulation is 1%,

and output ripple and noise is 1% max. The units measure 4×8×2.2 in. and operate over a temperature range of 0 to 70°C with convection cooling. $159.

Power General, 152 Will Dr, Canton, MA 02021. Phone (617) 828-6216. FAX (617) 828-3215.

Circle No. 392

Ultrawide Input DC/DC Converters

The SIW series of 15 and 30W dc/dc converters have a 4:1 input-voltage range and 85% efficiency. The series accepts either 9 to 36V dc or 20 to 72V dc. The units come in single-, double-, or triple-output versions. All versions come in 3.0×2.56×0.04-in. cases and have standard pinouts.

The units have LC input filters and 6-sided shielding. They offer protection against overtemperature, input surges, short circuits, and reversed polarity. SIW series, $100 (25).

Wall Industries Inc, 5 Watson Brook Rd, Exeter, NH 03833. Phone (603) 778-2300.

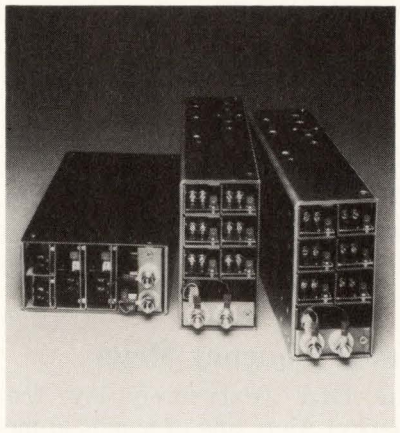
Circle No. 393

Supplies For DC And Ringing Current

The rack-mounted 1200W PS-19 accepts plug-in power supplies that develop either dc or ringing current. The dc supplies develop either ±24V dc at 20A or −48V dc at 12A. The ringing-current generators accept either 24 or 48V dc and develop 90 to 105V ac, 200 mA at 20 Hz. The dc supplies have power-factor-correcting circuitry.

The units accept 95 to 132V ac at 47 to 63 Hz. Applications include channel banks, fiber-optic equipment, and PBX systems. $1200 to $1500.

Power Conversion Products Inc, Box 380, Crystal Lake, IL 60014. Phone (815) 459-9100. FAX (800) 526-2524. **Circle No. 394**



VMEbus, VXIbus, And Futurebus Supplies

The VM series switching power supplies suit VMEbus, VXIbus, and Futurebus systems. The models supply 400 to 1500W and have one to seven outputs per package. Supplies have built-in cooling fans. Units meet FCC, UL, CSA, EN, and VDE specs. $382 to $1152 (100). Delivery, two to six weeks ARO.

Deltron Inc, Box 1369, North Wales, PA 19454. Phone (215) 699-9261. FAX (215) 699-2310.

Circle No. 395

Screw-Terminal DC/DC Converters

These single- and dual-output dc/dc converters have screw terminals instead of common solder pins. Outputs range from 5V at 2.5A to 28V at 500 mA. The converters have a voltage-trim adjustment, and they accept inputs ranging from 5 to 28V. Load regulation specifies ±0.1%, line regulation is ±0.02%, and ripple is 1.5 mV rms. The units have an input filter and 6-sided shielding. $119 to $135.

Acopian, Box 638, Easton, PA 18044. Phone (800) 523-9478; in PA, (215) 258-5441.

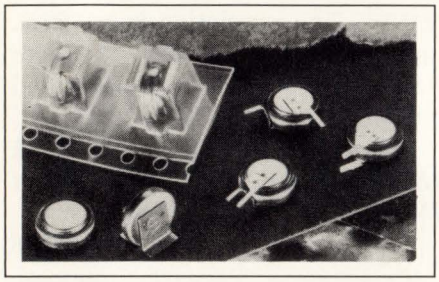
Circle No. 396

Power Sources

43W Switching Power Supplies

The 43W GLS series switching power supplies accept input voltages ranging from 90 to 250V ac at 47 to 400 Hz. Outputs are 5, 12, 15, or 24V dc. Output regulation is ±3%. All models exhibit 75% efficiency min and are burned-in at 48°C. The supplies meet UL, CSA, TUV, VDE, and FCC specs. $85.

Sola, 1717 Busse Rd, Elk Grove Village, IL 60007. Phone (800) 289-7652; in IL, (708) 439-2800. FAX (800) 626-6269. **Circle No. 397**



Rechargeable Lithium Cell

The Model AL series batteries are rechargeable 3V lithium cells. They use an electrically conductive polymer as a cathode, a lithium alloy as as anode, and an organic compound as an electrolyte. The coin cells will withstand 1000 charge/discharge cycles and operate from −10 to +60°C. $2.25 (1000).

Seiko Instruments USA Inc, 2990 W Lomita Blvd, Torrance, CA 90505. Phone (213) 517-7700. FAX (213) 517-7709. **Circle No. 406**

Space-Saving Screw-Mounted Supplies

Series M power supplies suit applications served by plug-in power supplies. This series, however, does not plug directly into a wall socket. Instead, the supplies come with tabs for screw mounting and a single standard plug for power. Consequently, the supplies do not cover both outlets of a standard wall socket. The series comes in three sizes and has 60VA ac/ac models, unregulated 40W ac/dc models, and 15W regulated ac/dc models. $5 to $25. Delivery for production quantities, 10 to 12 weeks ARO.

Multiproducts International, 250 Lackawanna Ave, West Paterson, NJ 07424. Phone (201) 890-1344. FAX (201) 890-1677. TLX 219289. **Circle No. 398**

Low-Frequency Meter

The ELF (extremely low frequency) Alert line of handheld meters measures low-frequency magnetic fields generated by power lines, CRTs, home appliances, etc. The units measure magnetic-field strength from 1 to 2000 mG over the frequency spectrum of 30 to 300 Hz. Model 30P, $99; model 30S, which has NIST calibration, $139.

Teslatronics, 1 Progress Blvd, Suite 25, Alachua, FL 32615. Phone (904) 462-2010.

Circle No. 399

Wide-Input 20W DC/DC Converters

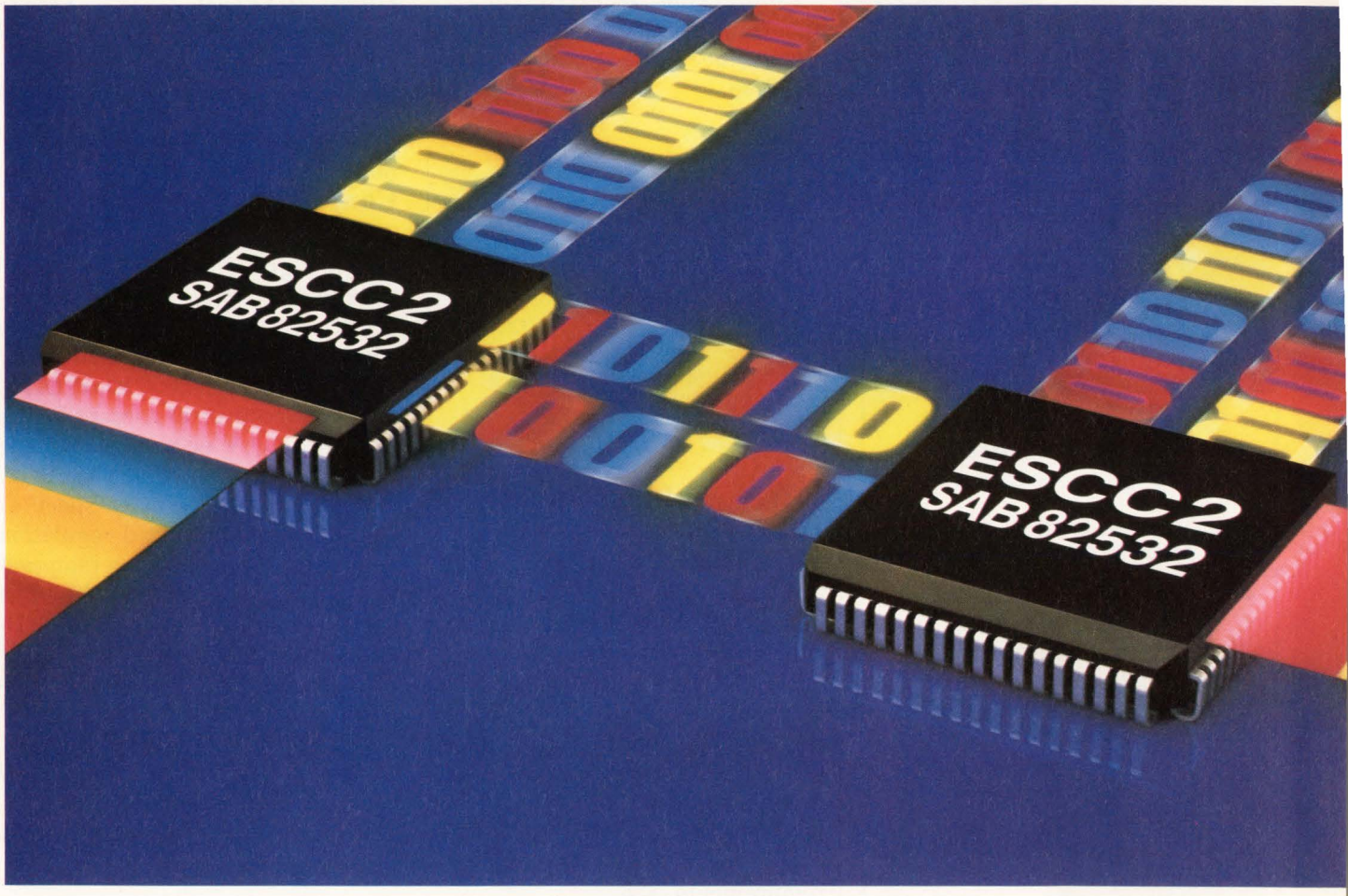
The XWR series 20W dc/dc converters have 84% efficiency typ. The converters' packages measure 2×2×0.45 in. Input-voltage ranges are 4.6 to 13.2V, 9 to 18V, and 18 to 72V dc. Single- and dual-output models are available in 3.3, 5, 12, 15, ±5, ±12, and ±15V dc. All units have a trim pin. The converters have overvoltage, surge, overcurrent, and overtemperature protection. $120 each.

Datel Inc, 11 Cabot Blvd, Mansfield, MA 02048. Phone (508) 339-3000. FAX (508) 339-6356. TLX 174388. **Circle No. 400**

Wide-Input 8W DC/DC Converters

The 800 series single-, dual-, and triple-output 8W dc/dc converters have a 2:1 input-voltage range. The converters' shielded packages measure 2×1×0.375 in. The con-

SIEMENS



Communications Genius

With the development of the new Enhanced Serial Communication Controller (ESCC2), Siemens has demonstrated a new genius in high-speed multi-protocolling.

The ESCC2 (SAB82532) offers an extraordinary range of protocol options at a high-speed transfer rate of up to 10 Mbit/sec in synchronous mode. Supporting X.25 LAPB, ISDN, LAPD, HDLC, SDLC, and both ASYNC and BISYNC, the ESCC2 offers outstanding capabilities for a wide variety of applications. And it is as adaptable as it is powerful. The ESCC2's flexible 8/16-bit bus interface allows it to easily adapt to either Intel or Motorola microprocessors. Plus, it provides direct 8/16-bit accessibility to all registers, as well as DMA and both vectoring and non-vectoring interrupt modes. This ensures efficient data transfer to and from host system memory, for fast, accurate and reliable multi-protocolling.

For superior performance and flexibility, the ESCC2 features clock recovery up to 4 Mbit/sec, storage capability of 64 bytes in each of its four on-chip FIFOs and four encoding schemes: NRZ, NRZI, FMx and Manchester. In addition, it offers user-programmable features such as 16/32-bit CRC, time slot assignment, and an 8-bit parallel port. The result is an excellent CMOS device with only 40 mW power consumption for all kinds of multi-protocol applications.

For more information on the ESCC2, or to find out how you can receive your inexpensive PC-based evaluation kit (EASY532), call 800-456-9229, or write:
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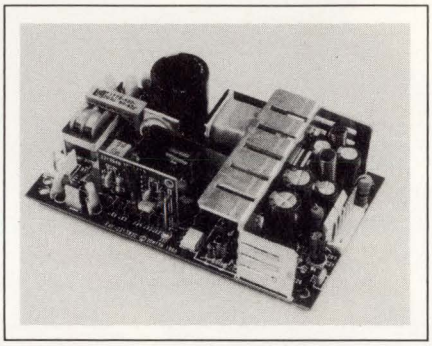
Power Sources

verters will operate without derating as high as 75°C. Load regulation is ±1.0%, and line regulation is ±0.5%. Ripple and noise measures 1% p-p, and input-to-output isolation is 1000V dc. $66 (100).

Conversion Devices Inc, 15 Jonathan Dr, Brockton, MA 02401. Phone (508) 559-0880. FAX (508) 559-9288. **Circle No. 401**



45W Wide-Input-Range Power Supply

The ZPS-45 45W switching power supply accepts 85 to 265V ac; the unit measures 3×5×1.25 in. The supply's outputs specify 5V at 5A, 12V at 2A, and −12V at 0.7A. The unit can supply 40W with convection cooling, and 45W with forced air. The company calculates this commercial unit's MBTF at 200,000 hours, using MIL-HDBK 217E. The supply meets UL, CSA, and VDE requirements. $55.

Zenith Components, 1000 N Milwaukee, Glenview, IL 60025. Phone (708) 391-7733. FAX (708) 391-7078. **Circle No. 402**

Power-Factor-Corrected 1000W Switching Supply

The Max 1000 series 1000W switching supplies have power-factor correction and accept 90 to 264V ac. The open-frame supplies' power factor measures 0.99, and efficiency is 75% min. Thus the supplies can operate from standard ac receptacles and draw less than 12A, per UL, TUV, and CSA regulations. The units measure 8×12×3.38 in. Models are available with and without built-in cooling fans. Quad-output models are available. The units meet VDE0871 and FCC Class A EMI specs. $1150.

Todd Products Corp, 50 Emjay Blvd, Brentwood, NY 11717. Phone (800) 223-8633; in NY, (516) 231-3366. FAX (516) 231-3473. **Circle No. 403**

30W MIL-Spec DC/DC Converters

The MTR series 30W aerospace/military-grade dc/dc converters' package occupies 2.5 in.^{2} of pc-board area and is 0.5-in. high. The converters have a MIL-KDBK-217 MTBF rating of 95,000 hours (AIT, 80°C). The converters accept inputs from 16 to 40V dc and offer single or dual outputs at 5, 12, 15, ±12, or ±15V dc. Efficiency specifies 80% min. Line and load regulation is 0.1% typ, and operating temperature runs from −55 to +125°C. The converters comply with MIL-STD-461 CEO3 noise limits and MIL-STD-704A CS06 transient-suppression standards. $362 (100).

Interpoint Corp, Box 97005, Redmond, WA 98073. Phone (206) 882-3100. FAX (206) 882-1990. **Circle No. 404**

Universal-Input 43W Switcher

The UO series 43W switching power supplies accept 90 to 270V ac at 47 to 440 Hz. The supplies exhibit 75% min efficiency and operate over 0 to 70°C. All models have overvoltage and short-circuit protection. $38 (100). Delivery, four to six weeks ARO.

Total Power International Inc, 418 Bridge St, Lowell, MA 01850. Phone (508) 453-7272. FAX (508) 453-7395. TLX 948617. **Circle No. 405**

V SERIES
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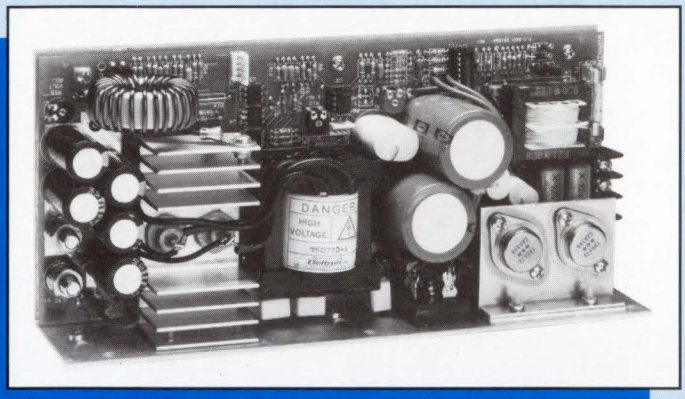

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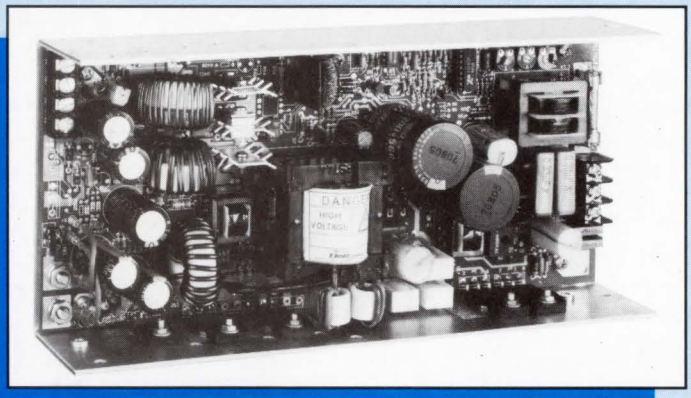
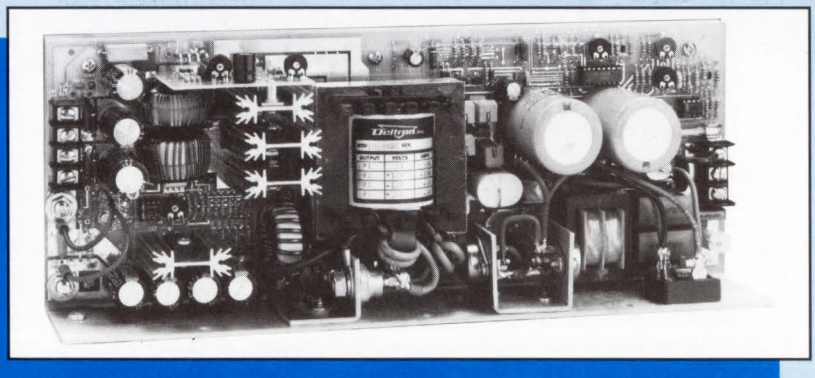
- Time tested design



Low Power Quads

- 200 - 325 watts
- All regulated units
- High power auxiliaries



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- Industry workhorse

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V-102 5/91

SPECIFICATIONS

OUTPUTS
See table of models.

INPUT
90-132 VAC or 180-264 VAC, 47-440 Hz.
Consult factory for 400 Hz. operation.

INPUT SURGE
17A peak from cold start for models up to 250 watts or less, 68A for other models, from nominal 110 or 220 VAC.

LINE REGULATION
±0.1% for line change from nominal to min. or max. rating with 20% min. load on the measured output.
±0.05% with post regulator and no min. load. Singles to no load.

LOAD REGULATION

+5V main/singles	±0.2%
−5V aux.	±3%
±12V aux.	±2%
±15V aux.	±2%
+24V aux.	±1.5%

Post Regulated Outputs
VP models—±0.5%
Option 32—±0.05%

for load change from 60% to 20% or 100% max. rating. With post regulator to no load. Singles to no load.

CROSS REGULATION
±0.2% for load change on the main +5V output from 75% to 50% or 100% max. rating with 20% min. load on the measured output. ±0.05% with post regulator and no min. load. Not applicable to singles.

CENTERING

+5V main/singles	±5% trim adj.
1st and 2nd aux.	±5% trim adj. tracking
3rd aux.: −5V	±3%
+12V	±2%
+24V	±1%

with all outputs loaded to 50% max. ratings and output #2 set precisely at its rated value. With post regulator—±3% trim adj.

RIPPLE & NOISE
1% or 100 mv, pk.-pk., 20 MHz. bandwidth.

REMOTE SENSING
On +5V main/singles which are fully isolated from all auxiliaries.

HOLDUP TIME
20 milliseconds after loss of nominal AC power.

EFFICIENCY
80% typ.

OVERVOLTAGE PROTECTION
Standard on main output/singles. Optional on auxiliaries.

OPERATING TEMPERATURE
0-50°C under the tabulated conditions.
Derate 2.5%/°C above 50°C to 70°C.

Models	Forced Air
V225, VP200, V250, V270, V360	30 CFM
V600, V601, V325, VP300, V300, V400, V500, V501	60 CFM

REDUNDANT OPERATION
Singles option provides for current sharing and redundant parallel operation. No isolation diodes are needed. Output good signal is provided.

TEMPERATURE COEFFICIENT

+5V main/singles	±0.02%/°C
Auxiliaries	±0.05%/°C
With post regulator	±0.02%/°C

OVERLOAD
Outputs short circuit protected by current foldback with automatic recovery. Post regulators have individual current foldback protection.

REVERSE VOLTAGE PROTECTION
All outputs are protected up to load ratings.

SAFETY
Units meet UL 1950, CSA 22.2 No. 220, CSA bulletin 1402C, EN 60 950, DIN VDE 0805/05.90.

LEAKAGE CURRENT
0.75 ma. at 115 VAC, 60 Hz. input.

SPACING
8 mm primary to secondary.
4 mm primary to grounded circuits.

DIELECTRIC WITHSTAND
3750 VRMS input to ground.
3750 VRMS input to output.
700 VDC output to ground.

EMISSIONS
Units meet FCC 20780 Part 15 Class A and VDE 0871/6.78 Class A for conducted emissions. Compliance with Class B limits by use of additional external filter.

AC UNDERVOLTAGE
Proprietary proportional drive and low voltage lockout protects against damage for undervoltage operation.

SOFT START
Units have soft start feature to protect critical components.

DYNAMIC RESPONSE
Peak transient less than ±2% or ±200 mv for step load change from 75% to 50% or 100% max. ratings.

RECOVERY TIME
Less than 400 microseconds on main/singles output.
Less than 50 microseconds on post regulated auxiliaries.

INHIBIT
Optional TTL logic inhibit input.

THERMAL SHUTDOWN
Optional circuit cuts off supply in case of local over temperature. Unit resets automatically if excess temperature abates.

POWER FAIL MONITOR
Optional monitor provides a TTL signal 2 ms. min. prior to loss of output power with outputs fully loaded from 100VAC/200VAC line loss.

SHOCK
MIL-STD 810-D Method 516.3, Procedure III.

VIBRATION
MIL-STD 810-D Method 514.3, Category 1, Procedure I.

COVER
Optional cover for safety and EMI.

POST REGULATOR
Optional for output #4 on V300, V400, V500, V600 models. VP models have post regulators on all auxiliaries.

Specifications subject to change without notice.

OPTIONS – *To order, replace XX in model numbers with sum of Option Codes desired.*

Code	Description
00	None
01	OVP protects all auxiliaries. Not for singles.
02	Power Fail Monitor
04	Thermal Shutdown
08	Cover. Fan placed for comparable flow as in uncovered units.
16	Logic Inhibit
32	Post Regulator, −5V@4A, +12V@3A, or +24V@2A. Not for singles, V225 or V325.
01	Redundant Sharing for singles.

V SERIES MODELS and RATINGS

V SINGLES Model	Output	Max Power
V120AXX	5V/25A	120W
V120BXX	12V/10A	
V120CXX	15V/8A	
V120DXX	24V/5A	
V180AXX	5V/36A	180W
V180BXX	12V/15A	
V180CXX	15V/12A	
V180DXX	24V/7.5A	
V250AXX	5V/50A	250W
V250BXX	12V/21A	
V250CXX	15V/17A	
V250DXX	24V/11A	
V270AXX	5V/54A	270W
V270BXX	12V/22A	
V270CXX	15V/18A	
V270DXX	24V/12A	

Model	Output	Max Power
V360AXX	5V/72A	360W
V360BXX	12V/30A	
V360CXX	15V/24A	
V360DXX	24V/15A	
V501AXX	5V/100A	500W
V501BXX	12V/42A	
V501CXX	15V/33A	
V501DXX	24V/21A	
V601AXX	5V/120A	600W
V601BXX	12V/50A	
V601CXX	15V/40A	
V601DXX	24V/25A	

(Non-standard voltages, e.g. 2V, 3.3V, 28V and 48V available on custom order.)

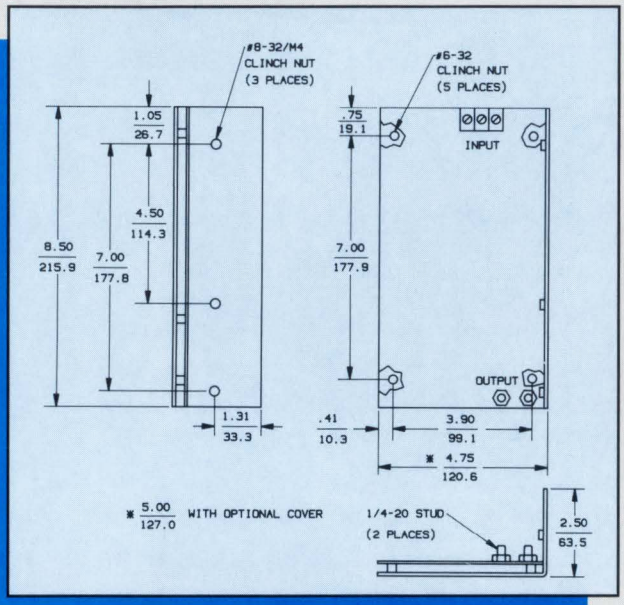
V QUADS Model	Output 1	Output 2	Output 3	Output 4	Max Power
V300AXX	5V/40A	+12V/4A	−12V/4A	−5V/3A	300W
V300BXX	5V/40A	+12V/4A	−12V/4A	+24V/3(5)A	
V300CXX	5V/40A	+15V/4A	−15V/4A	−5V/3A	
V300DXX	5V/40A	+15V/4A	−15V/4A	+24V/3(5)A	
V300EXX	5V/40A	+12V/4A	−12V/4A	+12V/3(5)A	
V400AXX	5V/50A	+12V/8A	−12V/8A	−5V/4A	400W
V400BXX	5V/50A	+12V/8A	−12V/8A	+24V/4(6)A	
V400CXX	5V/50A	+15V/8A	−15V/8A	−5V/4A	
V400DXX	5V/50A	+15V/8A	−15V/8A	+24V/4(6)A	
V400EXX	5V/50A	+12V/8A	−12V/8A	+12V/4(6)A	
V500AXX	5V/60A	+12V/10A	−12V/10A	−5V/5A	500W
V500BXX	5V/60A	+12V/10A	−12V/10A	+24V/5(8)A	
V500CXX	5V/60A	+15V/10A	−15V/10A	−5V/5A	
V500DXX	5V/60A	+15V/10A	−15V/10A	+24V/5(8)A	
V500EXX	5V/60A	+12V/10A	−12V/10A	+12V/5(8)A	
V600AXX	5V/80A	+12V/10(20)A	−12V/10A	−5V/5A	600W
V600BXX	5V/80A	+12V/10A	−12V/10A	+24V/5(10)A	
V600CXX	5V/80A	+15V/10(20)A	−15V/10A	−5V/5A	
V600DXX	5V/80A	+15V/10A	−15V/10A	+24V/5(10)A	
V600EXX	5V/80A	+12V/10(20)A	−12V/10A	+12V/5A	
V225AXX	5V/30A	+12V/6(12)A	−12V/4A	−5V/4A	225W
V225BXX	5V/30A	+12V/6A	−12V/4A	+24V/4(8)A	
V225CXX	5V/30A	+15V/6(12)A	−15V/4A	−5V/4A	
V225DXX	5V/30A	+15V/6A	−15V/4A	+24V/4(8)A	
V225EXX	5V/30A	+12V/6(12)A	−12V/4A	+12V/4A	
V325AXX	5V/45A	+12V/8(16)A	−12V/6A	−5V/4A	325W
V325BXX	5V/45A	+12V/8A	−12V/6A	+24V/4(8)A	
V325CXX	5V/45A	+15V/8(16)A	−15V/6A	−5V/4A	
V325DXX	5V/45A	+15V/8A	−15V/6A	+24V/4(8)A	
V325EXX	5V/45A	+12V/8(16)A	−12V/6A	+12V/4A	
VP200AXX	5V/30A	+12V/5A	−12V/1.5A	−5V/1.5A	200W
VP200BXX	5V/30A	+12V/5A	−12V/1.5A	+24V/1.5A	
VP200CXX	5V/30A	+15V/5A	−15V/1.5A	−5V/1.5A	
VP200DXX	5V/30A	+15V/5A	−15V/1.5A	+24V/1.5A	
VP200EXX	5V/30A	+12V/5A	−12V/1.5A	+12V/1.5A	
VP300AXX	5V/45A	+12V/7.5A	−12V/3A	−5V/3A	300W
VP300BXX	5V/45A	+12V/7.5A	−12V/3A	+24V/3A	
VP300CXX	5V/45A	+15V/7.5A	−15V/3A	−5V/3A	
VP300DXX	5V/45A	+15V/7.5A	−15V/3A	+24V/3A	
VP300EXX	5V/45A	+12V/7.5A	−12V/3A	+12V/3A	

NOTES

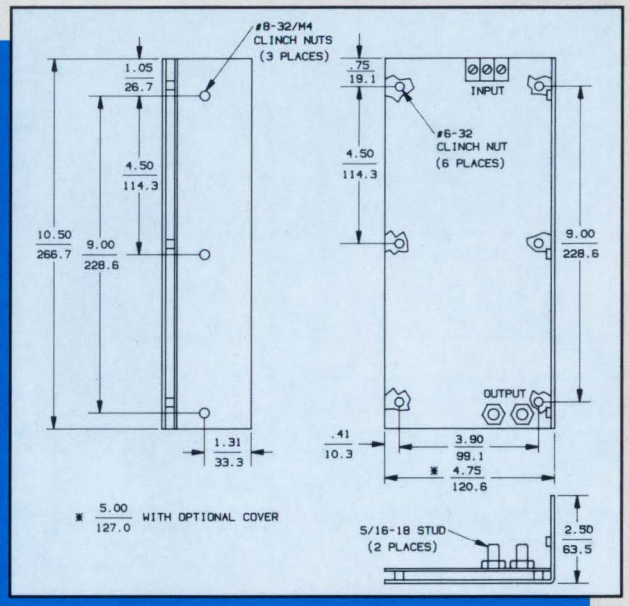
1. *VP models have post regulators on all auxiliaries. Specifications are guaranteed to no load on auxiliaries.*
2. *Numbers in parentheses ( ) are peak ratings for short duration service such as motor starting.*
3. *Output 1 is floating and can be either polarity.*
4. *Quads require 10% of maximum power distributed among auxiliary outputs for optimum performance.*
5. *Outputs can operate to no load with slight increase in specifications.*

DIMENSIONS inches / mm

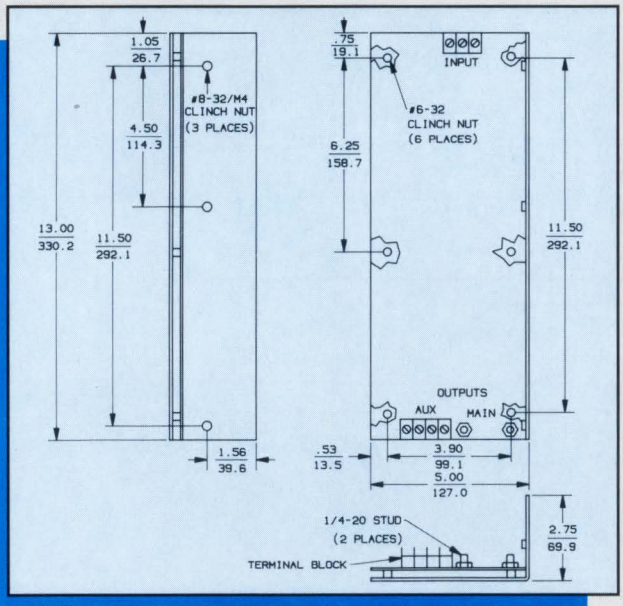
SERIES V120, V180, V250



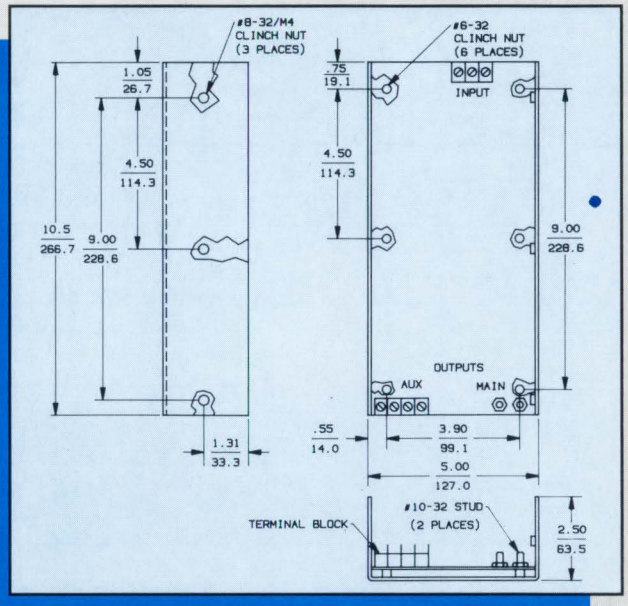
SERIES V270, V360, V501, V601



SERIES V300, V400, V500, V600



SERIES V225, V325, VP200, VP300



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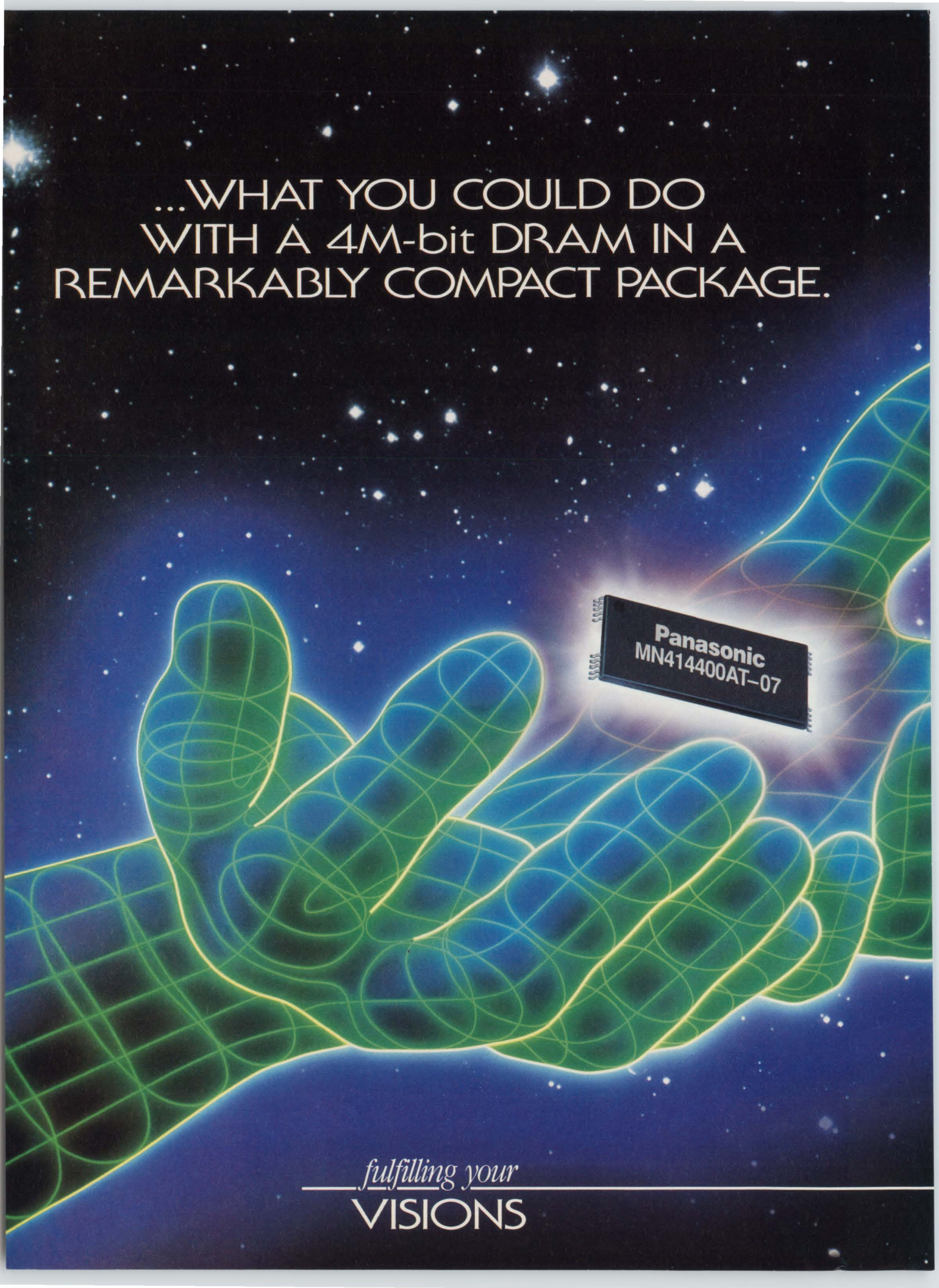
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Development tools accelerate Windows-3.0 software development

With sales approaching 4 million units in less than one year, Microsoft Windows 3.0 has rocketed into personal-computing history. Although riding the tail of this shooting star may initially appear overwhelming, a number of companies offer tools to help you make your application software soar within Windows' graphical user interface.

J D Mosley, Regional Editor

Regardless of your opinion about the merits of Microsoft Windows 3.0, its current popularity undeniably offers a highly lucrative platform for software development. The present demand for Windows programmers is, understandably, very great, but the current supply is modest. For engineers moving to Windows programming, the downside to the potential windfall is having to learn how to code for yet another operating environment.

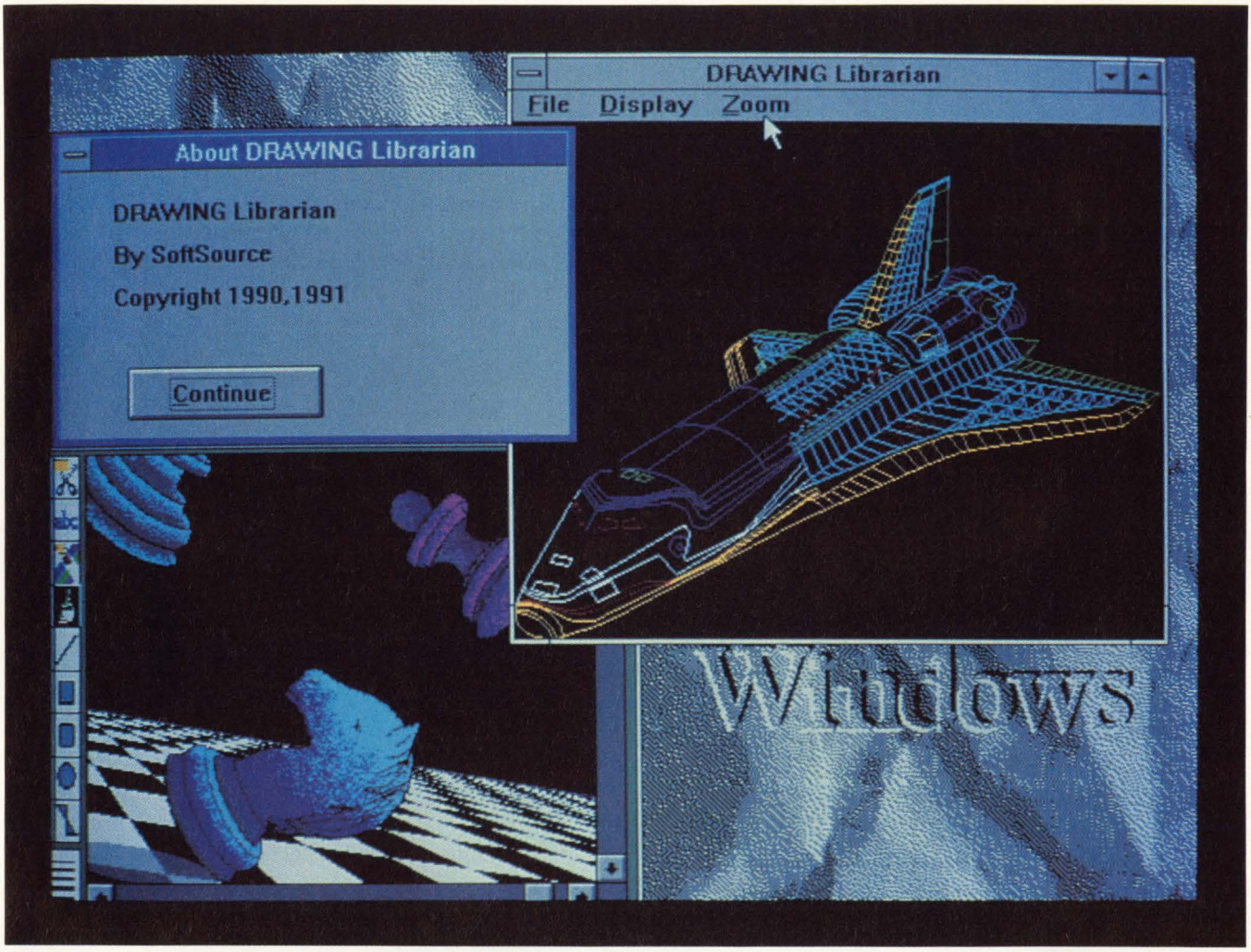
Despite its simplified graphical user interface (GUI), Windows is notorious for having a complex programming method. For example, just to make the words "Hello, Windows!" appear on a CRT, you have to type four screens of code comprising three different files. Programming for Windows is not a task for the meek. But many companies are working on making the transition to Windows programming much less painless.

Since Microsoft developed Windows, you might expect the company's Windows Software Development Kit (SDK) to be the ultimate development tool for Windows. The SDK probably is the most powerful, but it isn't the easiest tool kit to use. Because Windows is such a complex environment, programmers who are unaccustomed to writing for graphical interfaces may find the SDK itself overwhelming.

The $500 SDK includes a Codeview debugger, resource-editing tools, source-code examples, optimization tools, and on-line documentation. You also get a two-volume reference manual, a programming guide, a manual that describes all of the SDK tools, and an IBM Common-User Access (CUA) Style Guide.

Using the SDK is a multiple-step process. First you use a programming language such as C or assembler to create source files that contain your application's functions. You then use the SDK resource editors to create resource files that contain the application's visual elements. Next you must compile, assemble, and link the source files. Then you merge and compile the resource files. Finally, you add the compiled resource file to the executable file to produce the completed Windows application.

To help aspiring programmers become



Utilities can help you link DOS applications with Windows. Drawing Librarian from Softsource lets you cut and paste AutoCAD drawings into your Windows applications.

proficient in writing Windows applications, Microsoft conducts training classes at one of three facilities collectively named Microsoft University (MSU). These facilities are located in Bellevue, WA, Boston, MA, and Washington, DC.

If you already know how to program in C, you can sign-up at MSU for an introductory, hands-on Windows Programming Environment course. The course lasts five days and costs $1500. Microsoft also offers this course on five videotapes for $2995. You can call MSU at (206) 828-1507 to request a free evaluation kit, which includes an introductory tape.

After you've completed the introductory course—or have six months of SDK usage under your belt—you can register for MSU's Microsoft Windows—Advanced Topics course, which provides an in-depth look at the SDK's advanced features. This course also lasts five days and costs $1500. MSU has added a four-day, $1200 course called Sales Engineer. The course provides trouble-shooting training for employees of companies that develop Windows applications.

For further support, you can subscribe to an electronic bulletin board called Microsoft Online. Through the bulletin board, you can submit questions to an SDK support engineer who will research and answer them. The annual subscription fee also includes access to a database of technical information for all of Microsoft's products, a software library of code examples and technical specs, a bulletin board for exchanging ideas and information, and an electronic-mail service that links you with other Online subscribers. Despite these support measures, it usually takes months to become proficient in writing application programs using the SDK.

Fortunately, Windows is now in its third incarnation, and a number of programming tools do exist that can make your coding task speedy and almost painless. Of course, the price you pay for

Just to make the words "Hello, Windows!" appear on a CRT you will have to type four screens of code comprising three different files.

such simplification is degraded program performance, speed, and flexibility. But if your goal is to get your product to market quickly, you may consider these penalties a reasonable tradeoff.

Even if you want to code your application in C to maximize its functionality, you can still use one of the commercially available tool kits to speed you through the graphical prototyping aspects of GUI building.

Let's go Windows shopping!

Any logical discussion of Windows 3.0 development tool kits must begin with a look at Asymetrix's Toolbook, the program whose runtime module and Daybook demo application is included with each copy of Windows 3.0. Perhaps even more impressive than this marketing coup is the fact that Asymetrix has already revised Toolbook, and is now selling version 1.5, whereas some competitors are still struggling to get their initial offering to market. You can buy this program for $395 or upgrade from version 1.0 for $75.

Toolbook 1.5 displays screen pages 30 to 40% faster than the original version because it now draws objects directly to the CRT. And for smoother and more realistic animation, Toolbook can now build objects offscreen for rapid and continuous display. Asymetrix asserts that searching 100 fields to find a text string in the last field is now 28 times faster in version 1.5. Entering text into fields is 15 to 40% faster, scrolling a 5000-character field is about three times faster, and selecting text lines in a field is more than 10 times faster.

Toolbook uses an object-oriented programming language called Openscript to control the behavior of objects you create with the included drawing tools. Although you can generate Openscript applications by writing scripts from scratch, Toolbook comes with an array of predefined software objects that you can quickly copy, manipulate, and modify. Version 1.5 also provides context-sensitive help, an Openscript tutorial, and an author's guide to building applications.

Furthermore, Toolbook simplifies your development task by building in certain behaviors to every object you create. For example, when you designate an object as a button, it automatically has the ability to flash and to display a centered caption; every object designated as a field can scroll text.

Each page of your application can contain 64k bytes of data defining

Table 1—Tool kits for building Windows 3.0 applications

Manufacturer	Program name	Price	Description/features
Asymetrix	Toolbook 1.5	$395	New version increases the speed of page-drawing, searching, and text operations as much as 28×.
	Toolbook Author's Resource Kit	$450	License to distribute royalty-free copies of Runtime Toolbook; Script Remover; Booklook.
Blue Sky	Windowsmaker	$795	Generates C code; simplifies task of porting existing C or Mac applications to Windows 3.0.
CaseWorks	Case: W	$995	Generates character-level edit masks and calls for data validation; produces C code.
CNS	C++/Views	$495	Object-oriented development platform based on C++.
Echelon Development	Windowcraft	$295	Hypercard-like application tool kit.
Knowledge Garden	Knowledgepro Windows	$695	Object-oriented, event-driven, message-based hierarchical language for Windows development.
Matesys	Objectscript Professional	$495	Menu-based Windows programming via a superset of Basic; C version sells for $899.
Microsoft	Windows Software Development Kit	$500	Debugger, resource-editing, and optimization tools, source-code examples, on-line documentation.
Protoview	Protoview	$695	Dynamic Link Library of objects and screen management/painting tools with C-code generator.
Raindrop	Software Engineer	$249.95	Lisp-based, lexically-scoped interpreter; on-line help; interactive object inspector.
Softbridge	Bridge Tool Kit	$695	Translates task-related keystrokes into development code; data sharing between DOS and Windows.
Spinnaker	Plus	$495	Hypercard-like object-oriented programming environment; runtime package costs an extra $495.
Whitewater Group	Actor 3.1	$495	"Friendlier" version of original object-oriented development language and tools.
Within Technologies	Realizer	$399	Superset of Basic for application development; with Windows objects and visual form designer.

Making Windows crystal clear

Even if you plan to write your application with a development tool kit, to build a program that will function well in this GUI environment you will need a basic understanding of how Windows 3.0 works. Windows programs are event-driven rather than sequential, and this fact alone demands that you renovate your approach to code design.

Microsoft's authorized guide to writing applications for Windows 3.0 is a 944-page volume entitled *Programming Windows* by Charles Petzold. In its text, you'll find a thorough discussion of the Graphics Device Interface (GDI) and how Windows handles data exchanges and links.

The GDI handles output drivers for video displays, printers, and plotters. This interface therefore acts as a buffer between your application and the vast assortment of raster and vector output devices that are currently available for PCs. The GDI also determines whether your hardware contains graphics coprocessing capabilities or if the GDI itself must provide the necessary calculations to produce figures such as polygons and curves.

You can execute a group of GDI functions by creating a Windows metafile. The metafile describes a picture as a collection of GDI calls encoded in binary form. In this way, you can create descriptions of images that take up less disk space and memory than actual bitmapped images.

Metafiles also offer greater device independence than bitmapped images can. As a result, metafiles provide a way to share pictures among applications via Windows' clipboard. The clipboard transfers data between programs, and although you ordinarily wouldn't transfer the metafile itself via the clipboard, you can use the clipboard to transfer metafile pictures, bitmapped images, text, and spreadsheet data.

Notably, you can't add anything to the existing contents of the clipboard. But as a Windows programmer, you can *set* the clipboard data several times and in different formats before closing the clipboard. In this way, you hold the clipboard open so you can combine graphics and text with distinctive fonts within the same clipboard contents.

However, you must remember that the clipboard's data stays in memory until it is replaced by other data. As a result, this data reduces the amount of memory available for your applications. To alleviate this waste of memory, Petzold recommends a technique called *delayed rendering*.

With delayed rendering, your application empties the clipboard, sets the clipboard data with a null parameter, and thus establishes "ownership" of the clipboard. When another application requests your program's data, your program can then replace the null parameter with the actual data handle—a 16-bit number that refers to the image you want to load into the clipboard.

Be a dynamic programmer

Besides the clipboard, Windows 3.0 uses two other interprocess communication mechanisms: Dynamic Data Exchange (DDE) and Dynamic Link Library (DLL.) The DDE is a messaging system for communication between a client and a server program.

The server has access to data that the client wants to obtain, so the client must initiate the DDE "conversation" by broadcasting a message to all the Windows programs that are running. If a server has the requested data and responds, the conversation begins.

Several conversations can occur simultaneously, each contained within a separate window. So, a single server can supply data to several clients, and a single client can receive data from several servers. One program can even be a server and a client at the same time. However, each conversation is between only one client and one server.

On the other hand, a Dynamic Link Library is a file that contains functions or resources that other programs and DLLs can call upon at run time to perform certain tasks. By concentrating functions used by many programs into a single library, you can reduce disk space requirements and simplify your programming task.

However, a DLL does not receive messages. Instead, at run time, as a program calls one of the DLL's functions or resources, a process called *dynamic linking* occurs, and the C compiler generates assembly-language code for a far call and address translations for that call.

The GDI, is one of three DLLs that comprise Windows 3.0. The other two basic DLLs are called KERNEL and USER. KERNEL handles program loading and execution, memory management, and scheduling tasks. USER provides the user interface and windowing functions.

Although it may seem intimidating at first, Windows can provide an exciting opportunity for you to expand your programming skills. Regardless of whether you rely on a point-and-click tool kit or tough-it-out with the SDK and C, become comfortable with the components and functionality of Windows 3.0 before you begin developing your first application. You will greatly improve your program's capabilities and marketability.

The SDK is probably the most powerful set of tools for Windows application development, but its complexity is notorious.

objects, scripts, and properties. You can mix objects and scripts on a page, and you can make each script as large as 60k bytes. The script editor now has multiple-level undo and search-and-replace capabilities.

You can paste bitmaps and graphics as large as 64k bytes into Toolbook via the Windows clipboard, or import larger graphic files by using the Openscript *importGraphic* command. You can now print Toolbook pages in color and at full printer resolution, scaling large pages to fit the paper size specified for your printer. Version 1.5 also includes Windows-to-Openscript message translation, a utility for creating standard Windows dialog boxes for use in Toolbook applications, a slide show builder, a clip-art collection, and a hypermedia application.

In addition, Toolbook gives you menu commands for developing or altering an application's user interface. And because a run-time version of Toolbook comes with each copy of Windows 3.0, you completely side-step issues such as the payment of run-time royalties to Asymetrix or the possibility of Windows-related memory-management or screen-imaging conflicts.

If you're interested in selling your Toolbook-based application, you'll probably want to order the Toolbook Author's Resource Kit (ARK). Besides providing screen-design guidelines and a master copy of Runtime Toolbook, you also receive an application called Script Remover that removes the text from your application's scripts so that end users can't copy or read your source code.

The ARK also includes Booklook, an application that simplifies the task of editing object properties. And you can list your application free of charge in Asymetrix's Catalog of Books and Consultants. Selected developers will even have an opportunity to showcase their products at tradeshows and conferences. The ARK costs $450 and includes access to an electronic bulletin board reserved for Toolbook developers. An ARK upgrade from version 1.0 costs $75. For an additional $495, you can consult for one year with your own designated Toolbook support engineer.

At least one company is offering productivity enhancement utilities for Toolbook authors and developers. Syndetic Management Systems sells a $125 program called R-Spy, which lets you directly access and control variables and properties associated with any Toolbook object via a pop-up control panel. R-Spy lets you create and modify user-defined stacks or arrays, copy properties from one object to another, view and modify any script, and navigate anywhere in an object's hierarchy.

Syndetic's $135 R-Script lets you view a cross-referenced list that identifies where handlers and variables occur in a script. You can also use R-Script to compare any script to a list of defined system variables, thus avoiding potential variable-declaration problems. Syndetic is offering a $50 discount, for a limited time, if you order either product.

Try some expert software

If you aren't interested in the extensive support structure offered to Toolbook developers, and instead are looking for a development tool kit with richer support for Windows objects, you may want to try Knowledgepro Windows from The Knowledge Garden. This $695 application development system is not limited by the 64k boundaries established by Toolbook. The Knowl-

Table 2—Windows 3.0 programming languages

Manufacturer	Program name	Price	Description/features
Borland	C++ 2.0	$495	A dual C and C++ compiler for both DOS and Windows programs; precompilable headers.
	Turbo Pascal for Windows	$249	Build applications without the SDK; create, edit, compile, and run programs from within Windows.
Digitalk	Smalltalk/V Windows	$500	Objecti-oriented programming platform for Windows.
Gold Hill	GCLisp Developer 4.0	$1995	Lisp development platform that runs under Windows 3.0 and supports DDE.
Microsoft	C 6.0	$495	Now available bundled with the SDK; ANSI G-compliant compiler.
	Visual Basic	$199	Graphical application-development package derived from QuickBasic; includes icon library and editor.
Multiscope	Modula-2 Development System	$249	Modula-2 development platform for Windows and DOS with editor, debugger, and utilities.
Watcom	C 8.0 Professional Edition	$495	16-bit C compiler for Windows 3.0, DOS, and OS/2.
	C/386	$1295	32-bit C compiler for developing and debugging Windows applications.
Zortech	C++	$199.95	16-bit C compiler for Windows; compiles directly from C++ into object code.
	C++ Developer's Edition 2.1	$450	32-bit C compiler for developing and debugging Windows applications.

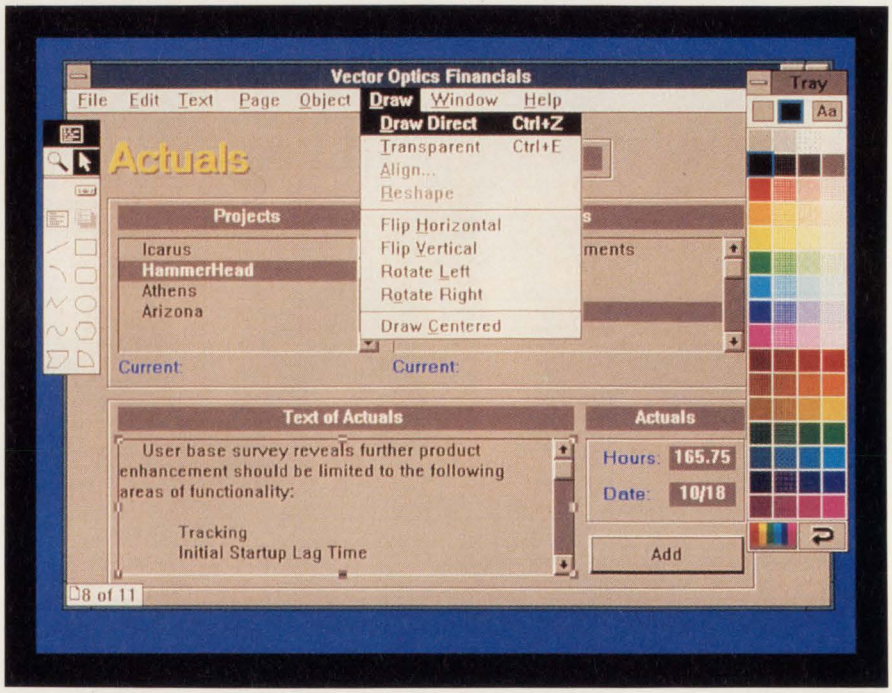
Table 3—Useful programs and utilities for Windows 3.0 application development

Manufacturer	Program name	Price	Description/features
Abacus	Becker Tools	$79.95	File- and data-management utilities such as undelete and disk formatting.
Application Techniques	Pizazz Plus	$149	Screen-printing utility for Windows 3.0; supports color printers.
	Pictureeze	$149	Graphics file converter and image enhancer lets you rotate, mirror, and flip color or b/w images.
Borland	Objectvision for Windows	$99.95	Tool kit for developing database front ends.
Cognos	Powerplay 2.0	$850	GUI database front end and analysis tool.
Dariana Technology	Winsleuth	$149	System diagnostic utilities for Windows 3.0; includes file viewer and network analyzer.
Delrina Technology	Perform Pro	$495	Tool kit for developing database front ends.
Drover Technologies	Toolbox for Windows	$295	200-function Data Link Library for SDK, Toolbook and SQL Windows; source-code option costs $885.
GUI Computer	3-in-1	$99	Low-cost development tool for C; C++ version costs $159.
HDC Computer	Fileapps	$129.95	Pop-up utilities let you undelete, encrypt, search for, and transfer files from within Windows.
	Icon Designer	$59.95	Pop-up utility lets you create, use, and store icons from within Windows.
	Windows Express	$99.95	Menuing system associates applications and documents in "folders."
Heizer Software	Convertit!	$99.95	Converts Hypercard stacks into Toolbook books.
Horizon Technologies	DDELib	$295	Application Program Interface provides DDE-compliance for your Windows software.
	DDEWatch	$85	DDE-monitoring utility; also supports file logging.
Intersoft	Windows Application Programming Environment	$195	Library functions for window creation and registration, menus, and dialog boxes.
	Winhelp	$199	On-line help system for programmers.
Magna Carta Software	C Windows Toolkit	$99.95	200-function user-interface C library; supports virtual screens and overlapping windows.
Microsoft	Windows Libraries for OS/2 Development Kit	$150	Provides tools for converting a Windows 3.0 application to run on the OS/2 operating system.
	Windows Device Development Kit	$500	Tools for developing, testing, debugging, and modifying device drivers for Windows 3.0.
Moon Valley Software	Zip Manager	$21.95	Windows version of PKZIP file-compression programs; also supports .ARC and .LZH formats.
Okna Corp	Desktop Set	$149	Productivity utilities including calendar, calculator, phone book, and dialer.
Protoview	Protogen	$199	Interactive menu-design and field validation; interactive DDE support.
Raima	db_Vista III Developers Edition	$195	Database engine for C and Windows; compatible with Toolbook and Actor.
Revolution Software	VGA Dimmer	$35.95	Screen-blanking utility.
Rosesoft	Prokey for Windows	$99	Automates keystroke and mouse sequences for script-building; includes event scheduler.
Roykore	ABC Flowcharter for Windows	$295	Flowcharting tool for documenting Windows procedures.
Sage Software	Control Pak/W	$595	Package of six predefined, reusable, and modifiable control objects; includes C source code.
Softsource	Drawing Librarian-Windows	$150	Utility for importing AutoCAD .DWG and .DXF drawings into Windows 3.0 applications.
Stirling Group	Dbxshield	$595	Dialog-box code generator for Windows that uses an interface engine and library.
	Demoshield	$495	Creates visual demos of Windows applications.
	Log Shield	$395	Session recording and playback library; linkable to applications for self-running demos.
	Tbxshield	$295	Library of toolbox objects that you can add to applications.
Synappsys	Wincomm	$149	Produces communication scripts and front ends for data-transfer applications.
Syndetic	R-Script	$135	Cross-references variable and handler locations in toolbook scripts.
	R-Spy	$125	Pop-up control panel for editing the scripts, variables, and properties of Toolbook objects.
Ventanaworks	Skylight	$99.50	Menu-building utility for Windows; lets you display any .BMP file anywhere on the screen.
Whitewater Group	Objectgraphics	$445	Library of object-oriented graphics.
	Resource Toolkit for Windows	$195	Create, edit, and manage resources such as dialog boxes, cursors, icons, and bitmaps.
	Wintrieve	$395	Data file management tool; interfaces with C- or Actor-based programs; unlimited indexing.
Xian	Winpro/3	$895	GUI generator for C programs; requires SDK and Windows-compatible C compiler.
XVT Software	Extensible Virtual Toolkit for Windows 3.0	$795	Library provides a standard programming interface; libraries for other GUIs are also available.

Windows programs are event-driven rather than sequential, and this fact alone demands that you renovate your approach to code design.

edgepro language is an object-oriented, event-driven, message-based language that you use to create text files called knowledge bases.

Each knowledge base contains at least one *topic*—a collection of commands and functions. Topics perform tasks, describe object behaviors, or service hypertext requests. By linking topics you can create hyper-region topics that can open additional windows, display text, or pop-up message or dialog boxes. In addition, you can use Knowledgepro to create hierarchical classes of topics that derive their attributes from other base topics. You can use Knowledgepro to create independent executable applications, but you'll have to bundle a copy of the free runtime module for others to run them.



Significantly increasing speed over the original version, Toolbook 1.5 from Asymetrix can search 100 text fields 28 times faster than version 1.0.

Keep it simple

Objectscript Professional from Matesys Corp is probably the easiest to use of all the object-oriented tool kits. This program offers approximately 50 built-in commands nestled in drop-down screen menus. By selecting commands with your mouse, you can create an application without writing a script or even a single line of code.

However, you sacrifice flexibility for Objectscript's simplification of effort. The drawing facilities are limited, and the object menu lacks important items such as scrollbars. However, the impressive assortment of sample programs provided with this tool kit do provide a solid basis for understanding the kit's capabilities.

Objectscript's language is a superset of Basic, and you can purchase a $495 version of Objectscript that is compatible with Microsoft's Quick Basic. The C version sells for $899. An $899 companion product called Objectview lets you build Windows-based graphical user interfaces (GUIs) for database applications.

Actor is yet another development platform for Windows 3.0. However, Actor is closer to being a true object-oriented programming language than an intermediary tool kit. As a result, Actor has gained a reputation as a high-level package for serious programmers—neophytes who aren't comfortable with such concepts as polymorphism, encapsulation, and inheritance would probably be happier with some other tool.

To address this perception, the Whitewater Group has announced Actor 3.1, a version that they claim is "friendlier" than the original. The price has also dropped from $895 to $495. Whether these changes will provide sufficient incentive to overcome its prior reputation remains to be seen.

Another development environment called Software Engineer, from Raindrop Software, uses Lisp as its programming basis. Software Engineer contains a lexically scoped Lisp interpreter, a Lisp-aware text editor, on-line help, and an interactive object inspector.

Priced at $249.95, Software Engineer's main strength lies in its ability to support Dynamic Data Exchange (DDE) at a higher level than Microsoft's Windows Software Development Kit. In addition, this program is all you need to create Windows 3.0 applications—you don't have to buy the SDK or any additional interpreters. If you are comfortable programming in Lisp, this program would certainly provide one of the least expensive ways to write Windows applications.

Simplify your Windows

Meanwhile, other Windows development tool kits such as Blue Sky Software's Windowsmaker Professional and Caseworks' Case:W actually promise point-and-click simplicity for Windows 3.0 application development. The primary basis for this claim seems to lie in

For more information . . .

For more information on the Windows 3.0 development software discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

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FAX (616) 698-0325
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10 Lomar Park Dr
Pepperell, MA 01463
(508) 433-8464
Circle No. 679

Asymetrix Corp
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Bellevue, WA 98004
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in WA, (206) 637-1500
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N2L 3X2 Canada
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in IL, (708) 328-3800
FAX (708) 328-9386
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Within Technologies Inc
Laurel Corporate Center
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the fact that neither program uses an object-oriented language, thus relieving you of any need to learn a new language before learning to use the tools.

Windowsmaker Professional not only provides an interactive development platform, it also simplifies the task of porting your existing C-based DOS or Apple Macintosh programs to Windows. Because Windowsmaker generates C source code, you can use Windowsmaker to build a Windows user interface and then add your existing C program. During code regeneration, your existing code remains unaltered.

Unlike other development tool kits, Windowsmaker requires both the Microsoft Software Development Kit (SDK) and a Microsoft C compiler. So, its $995 price tag isn't the only monetary investment you'll make to use this package. However, the manufacturer does provide a 30-day money-back guarantee, and you'll pay no runtime royalties when you distribute your finished application.

Case:W also generates C code and also requires you to purchase the SDK. But Case:W maintains a file of all the prototype data accumulated as you develop your Windows application. This data file eases the task of porting your program to the IBM OS/2 Program Manager because you can use the file with Caseworks' Case:PM development tool kit.

Case:W also validates data in your edit fields, automatically generating character-level edit masks and calls to your field-level data-validation routines. Case:W also lets you toggle your screen between a *build* view used to construct an interface and a *test* view that lets you animate the interface without generating the program. In this way, you can see exactly how your interface will function after Case:W generates the code. Case:W sells for $795, and Case:PM for C retails for $1995.

Unfortunately, deciding among all these object-oriented, menu-driven, and conventional tool kits is similar to buying a pair of shoes—until you wear them around, you won't know whether you've found a comfortable fit or merely an attractive-looking source of pain. Unless you've had an opportunity to experiment with a tool kit at a tradeshow or seminar, it may be wise to look for companies that advertise a money-back guarantee.

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Reference

1. Petzold, Charles, *Programming Windows*, Microsoft Press, Redmond, WA, 1990.

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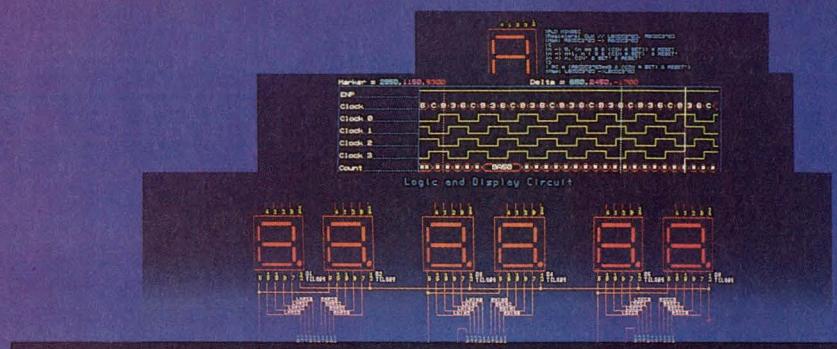

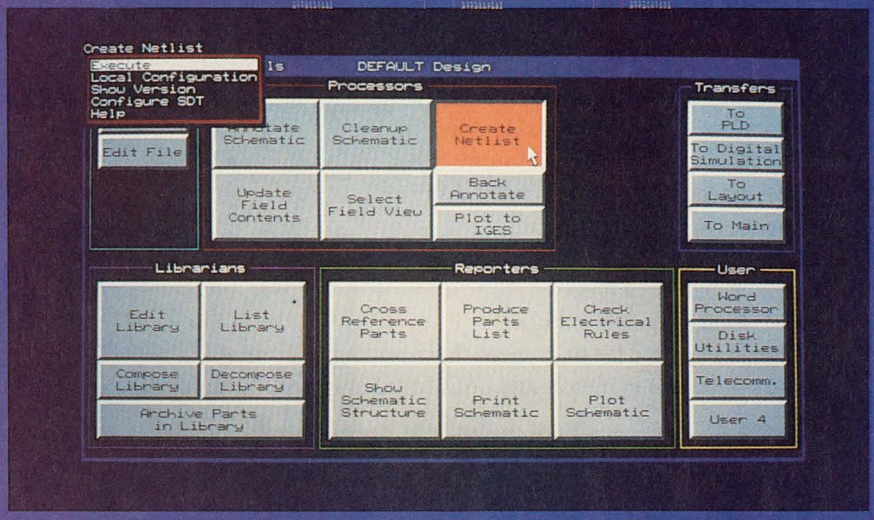

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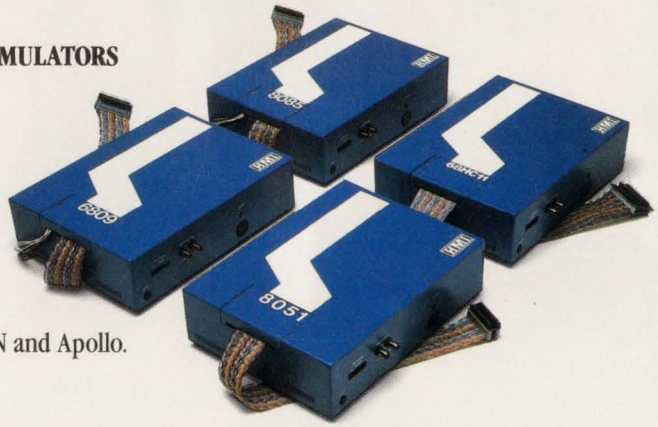
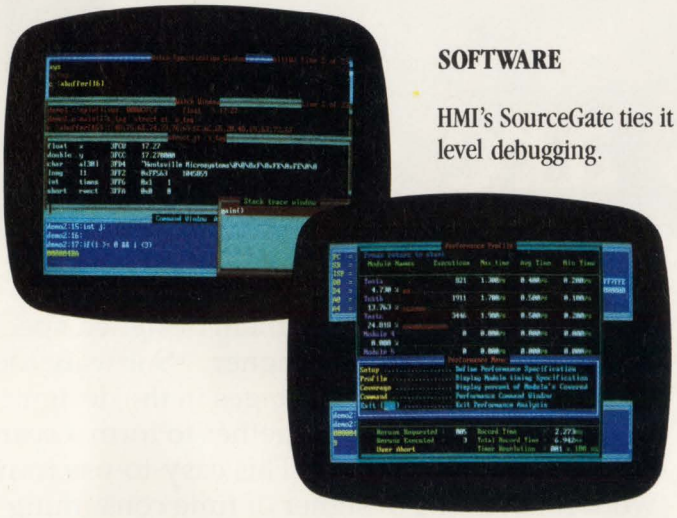
EMULATORS





SOFTWARE

HMI's SourceGate ties it all together, so emulator features aren't sacrificed to gain source-level debugging.

HMI SourceGate® Features:

- Custom window configuration determined by user.
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Performance Analysis Features:

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If you are looking for one development system that does it all, call (205) 881-6005, or write to Huntsville Microsystems Inc., 3322 South Memorial Parkway, Huntsville, AL 35801.

AVAILABLE EMULATORS

68000	68302	8051 Family
68008	68332	DS5000
68010	68340	8096/80196 Family
68020	6809/6809E	8085
68030	68HC11 including F1 and D3	64180/Z180
	68HC001	Z80

IBM is reg. T.M. International Business Machines, Inc. UNIX is reg. T.M., Bell Laboratories, Inc.

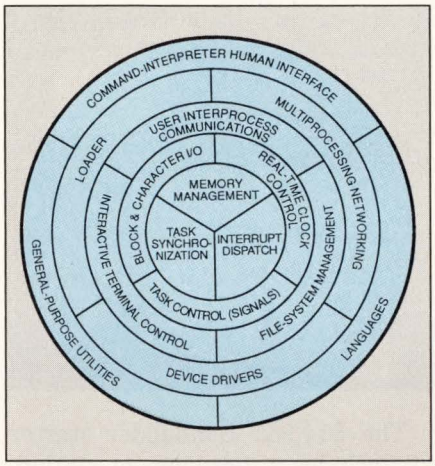
HMI

Real-time Unix-like operating system implements Posix 1003.4 extensions

Version 2.0 of the Unix-compatible Lynxos real-time operating system implements the complete set of real-time extensions specified in IEEE Posix 1003.4 (also called Posix.4). The Posix.4 standard makes possible real-time applications that can run on systems and processors from multiple vendors. Lynxos 2.0 also offers compatibility with threads, a form of lightweight tasks defined by Posix.4a.

Lynxos 2.0 provides the following features defined in Posix.4 extensions:

- Binary semaphores
- Process memory locking
- Shared memory
- Priority scheduling
- Asynchronous event notification
- High-resolution timers
- Interprocess communication
- Asynchronous I/O
- Synchronized I/O
- Contiguous real-time files.



The priority-scheduling facility provides several priority-driven scheduling policies, including first in/first out. The timers in Lynxos go far beyond Unix timers and have nsec resolution for both absolute- and relative-timing operations. Lynxos 2.0 fully supports the Posix.4a threads concept as well as the thread model implied by Ada tasking.

Although compatible with Unix and Posix.4, Lynxos is a real-time operating system developed with no Unix System Laboratories (AT&T) code. The operating system can respond to an external event in less than 450 μsec, worst case, when running on a 20-MHz 80386-based system. The specified worst-case response time includes interrupt disable, dispatch, interrupt routine execution, pre-emption disable, scheduling, context switch, and return system call.

You can buy Lynxos for a number of popular μP families including the Intel 860, 80386, and 80486; the Motorola 680X0 and 88000; and the Mips R3000 and R6000. A version for IBM PC/AT compatibles costs $1495.

Lynx Real-Time Systems Inc, 16780 Lark Ave, Los Gatos, CA 95050. Phone (408) 354-7770. FAX (408) 354-7085. **Circle No. 738**

Symbolic math package sports user interface for X Windows and Sunview

Release V of Waterloo Maple Software makes this interactive symbolic math package available for 80386-based systems, Sun workstations, and DEC RISC and Ultrix systems; it also provides many mathematical enhancements. You can now sort polynomials, and the D operator has been extended to handle partial derivatives. Meijer G, Airy Wave, and Dirac functions have been added, and improved facilities include Runge-Kutta functions for solving initial-value ordinary differential equations.

This package has grown steadily over ten years to now include more than 2000 mathematical functions. The relatively small kernel (less than 500k bytes of compiled code) performs arbitrary-precision arithmetic, polynomial manipulation, and interpretation of the Maple programming language. This language is Pascal-like, and it automatically generates procedures from expressions, aliases, and macros.

The X-Window user interface provides help and plot windows, allows editing of input expressions, and maintains a log of your Maple session. The X-Window and other user interfaces support three-dimensional graphics, such as surface plots. You can direct output to a variety of printers, including Postscript devices. The coordinate system can be cartesian, spherical, or cylindrical, and you can render surfaces as surface patches, as a wireframe plot (with optional hidden-line removal), or as a collection of plots.

Prices start at $695 for the PC/MS-DOS version for 80386/486-based systems. Other computers the software can run on include Sun, DEC, and MIPS workstations, IBM System/370 mainframes, and Cray supercomputers.

Maple, 160 Columbia St W, Waterloo, Ontario N2L 3L3, Canada. Phone (519) 747-2373. FAX (519) 747-5284. **Circle No. 739**

Local-operating-network developer's kit creates distributed control systems

A local operating network (LON) consists of a collection of nodes that interact with their physical environment and with each other. Each node has sufficient processing power to handle internode communications and control I/O functions. The nodes communicate over a variety of media, including optical, RF, and power-line carriers, using a common message-based protocol.

The core of each node is the Neuron IC. In addition to timers and I/O ports, each IC has three CPUs: one to control internode communications hardware, one to handle message processing, and one to handle the local control functions. The IC has built-in firmware for communications and message processing; you supply control software.

The $14,965 Lonbuilder starter kit includes a development station, two Neuron emulators, a software compiler, and a debugger. You use a PC to control as many as four development stations.

The development station has two built-in nodes and can accommodate six more. Nodes communicate through the station's backplane. You can also add transceiver cards to communicate through RF, twisted-pair, or power-line links, allowing you to test your network with various media.

The built-in nodes handle network management and provide a protocol analyzer. Network-management capabilities include configuring nodes, downloading node software through the network, and controlling individual nodes. The protocol analyzer allows you to monitor communications between nodes and measure performance statistics.

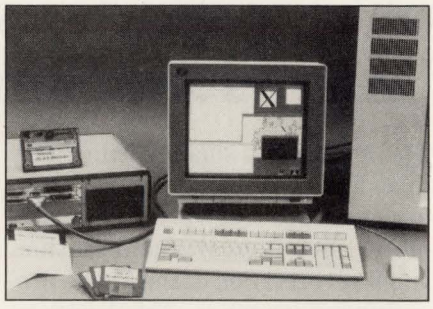
Echelon, 4015 Miranda Ave, Palo Alto, CA 94304. Phone (415) 855-7400. FAX (415) 856-6153.

Circle No. 740

X-Window package provides user interface for embedded real-time applications

OS-9 real-time operating-system users can add X-Window-based graphical user interfaces to their 68000-based embedded systems. The OS-9/X-Window software package from Microware Systems provides a complete X-Window client implementation. You can use the software in OS-9-resident development environments and Unix- or MS-DOS-based cross-development applications. The X-Window implementation is compatible with various networked X-Window servers, and the company offers embedded X-Server support for OS-9 and specific graphics boards.

The package complies with X-Window version 11 release 4 from MIT and supports the MIT Tab window manager. The company expects to add an OSF Motif window manager to the package in the third quarter.



The X-Window development libraries include Xlib (X-window library), Xt (X tool kit intrinsics library), Xaw (X athena widgets library), Xmu (X miscellaneous utilities library), and Xdmcp (X display manager control protocol library). Runtime client programs enable programmers to perform system-level functions, such as initializing and starting up the X-Window package or opening terminal-emulation windows.

The package provides X-Window-server support for OS-9 systems using MMI-250 graphics board from Vigra Inc (San Diego, CA). The package also includes sample X-Window-server source code that users can port to other boards.

The price is $995 for the full X-Window client development package and $195 for a runtime version. Source code for the client development package costs $15,000; the server source code package costs $150.

Microware Systems Corp, 1900 NW 114th St, Des Moines, IA 50322. Phone (515) 224-1929. FAX (515) 224-1352. **Circle No. 741**

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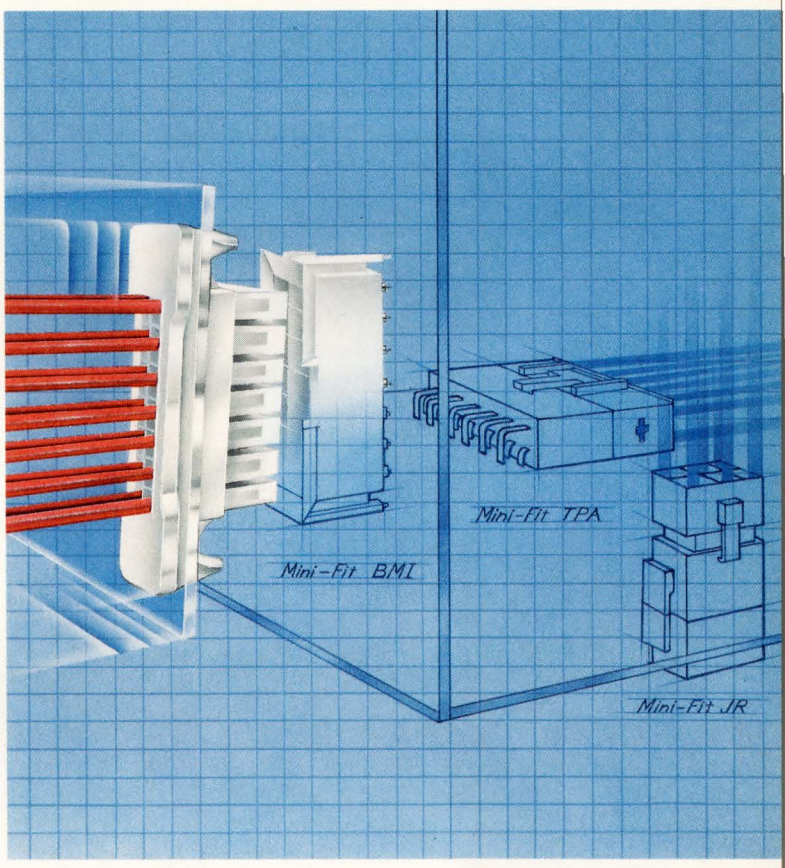

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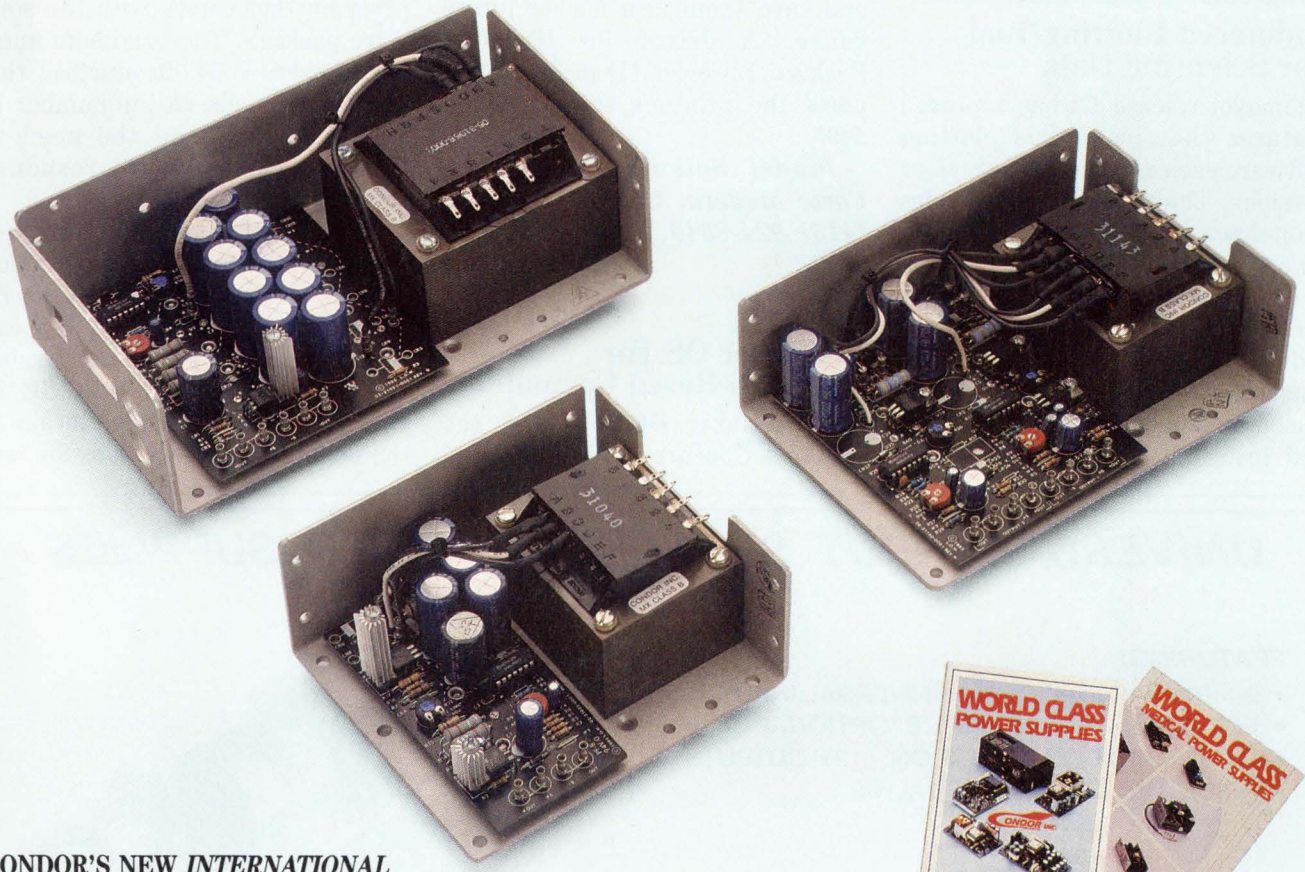

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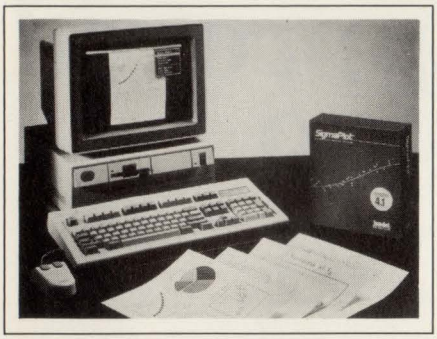

Enhanced Plotting Tool For Scientific Data

Sigmaplot release 4.1 has improved features that make this plotting software easier to use than previous versions. The new version provides drop-down menus, which stay down when you click on them with a mouse, and an information bar at the bottom of the screen, which provides information on the options you select. A dynamic memory system uses smaller memory overlays and brings into memory only the needed items. As a result, this version needs 40k bytes less memory than previous versions and can run concurrently with TSR programs such as Novell network drivers.

The program automatically takes advantage of expanded or extended memory. You can define graph attributes, such as type of plot, line thickness, colors, and font choice, and save them in a file for future reuse. A driver for Hewlett-Packard Laserjet III printers supports the printer's scalable fonts. $495.

Jandel Scientific, Box 996, Corte Madera, CA 94925. Phone (415) 924-8640. FAX (415) 924-2850. **Circle No. 360**

Multiuser OS For 80386/486-Based Computers

DR Multiuser DOS replaces the vendor's Concurrent DOS 386 and incorporates technology from that product and from DR DOS version 5.0. This operating system lets a single 386SX-, 386-, or 486-based computer host multiple DOS applications as well as multiple, multitasking users linked to the host through a standard serial port. User stations may be dumb terminals or PCs running the emulation program that comes with the software package. The maximum number of users is 64. In practice, this number depends on the number of available ports and the need to maintain an adequate response time.

Disk caching speeds disk accesses, and a dynamic idle-detection system ensures that idle tasks do not tie up the processor. You can accommodate three users by using the standard COM1 and COM2 ports, or 10 users with the aid of the default menu selections for sev-

The secret to better Ethernet is NICE. And simple.

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FUJITSU MICROELECTRONICS, INC., Advanced Products Division. 77 Rio Robles, San Jose, CA 95134-1807.

eral 8-port plug-in cards. The package comes with drivers for 8- and 16-port intelligent cards and can support drivers for cards that have as many as 64 ports. $695.

Digital Research Inc, Box DRI, Monterey, CA 93942. Phone (408) 649-3896. FAX (408) 646-6248.
Circle No. 361

FFT Subroutine Library

Most FFT packages require you to use one of 16 data-set sizes, each of which is a power of 2. This restriction often forces you to truncate your test arrays or add bogus data, leading to inconsistency in your results. Prime Factor FFT is a library of FFT subroutines that makes available 815 data-set sizes with as many as 64,600 points in 1-D data. The library also allows rectangular dimensions in which m is not equal to n. This facility allows for 664,225 data-set size combinations.

The library supports floating-point double-precision numbers (10 bytes) as well as 2-, 4-, and 8-byte integers. The library includes routines for amplitude and phase calculations, Hamming and Hanning windows, and complex forward and inverse FFT in one and two dimensions. To obtain maximum performance, the routines include automatic math-coprocessor detection and the enhanced features of the 80387 coprocessor and 80486 processor. $295. Upgrade for current users, $99.

Alligator Technologies, Box 9706, Fountain Valley, CA 92708. Phone (714) 850-9984. FAX (714) 850-9987. **Circle No. 362**

Ada Development System For CASE Tools

VADS APSE version 1.1 integrates the Verdix Ada Development System with commercially available CASE tools, such as Atherton Technology's Software Backplane, Cadre's Teamwork, and IDE's Software through Pictures. The system allows software development, requirements tracking, and design-data management across heterogeneous nodes of a network. It also provides configuration management and version control while controlling the work flow. The tools include a self-hosted Ada compiler,

C&C Computers and Communications

CB-C7

High Integration Level Cell-Based ASIC Technology

Systems on Silicon

Fast Turnaround Options

Advanced CAD-Enviroment

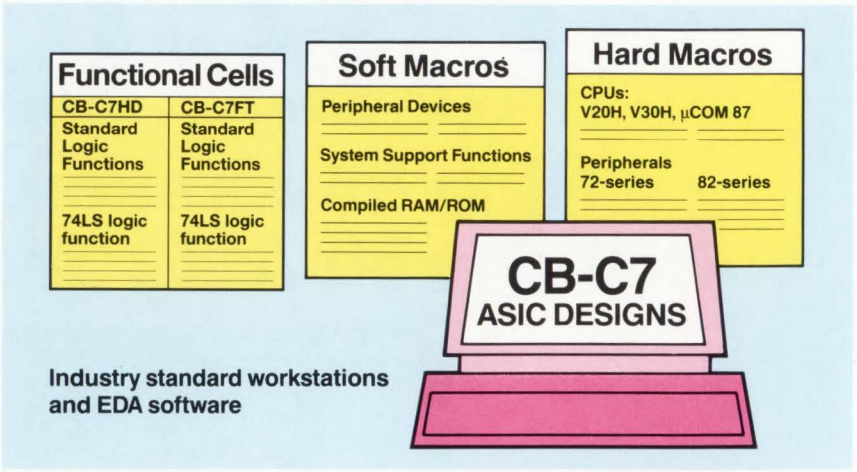
NEC

NEC CB-C7 Cell-Based ASICs - Single-Chip Solutions to System Problems

Putting intelligent systems on silicon has never been so easy. Using NEC's CB-C7 advanced CMOS ASIC technology you can integrate all your system elements – such as microprocessor or microcontroller cores, RAM, ROM, intelligent peripherals and analog I/O – into a single-chip solution. And it won't cost you a fortune in new design tools, because NEC CB-C7 ASICs can be designed using industry standard hardware platforms and EDA software – hardware and software you probably already have.

NEC's CB-C7 cell-based ASIC technology gives you other advantages as well. The sub-micron CMOS process used to implement it not only allows CB-C7 to achieve the high level of integration required for systems-on-silicon, it also provides you with 0.44 nsec gate delays and ultra-low power consumption.

To make things even better, NEC offers you two routes to finished silicon. If you require a fast turnaround, we can implement user-defined logic in your design as a sea-of-gates gate array. Alternatively, if you are aiming for minimum chip cost, we can produce the entire ASIC as a standard-cell solution.



Mega function block Libraries - key to system integration

NEC's CB-C7 megafunction block-libraries cover all your likely integration requirements – from the simple logic elements which glue your system together, right up to the high-level functions which provide your designs with on-chip intelligence.

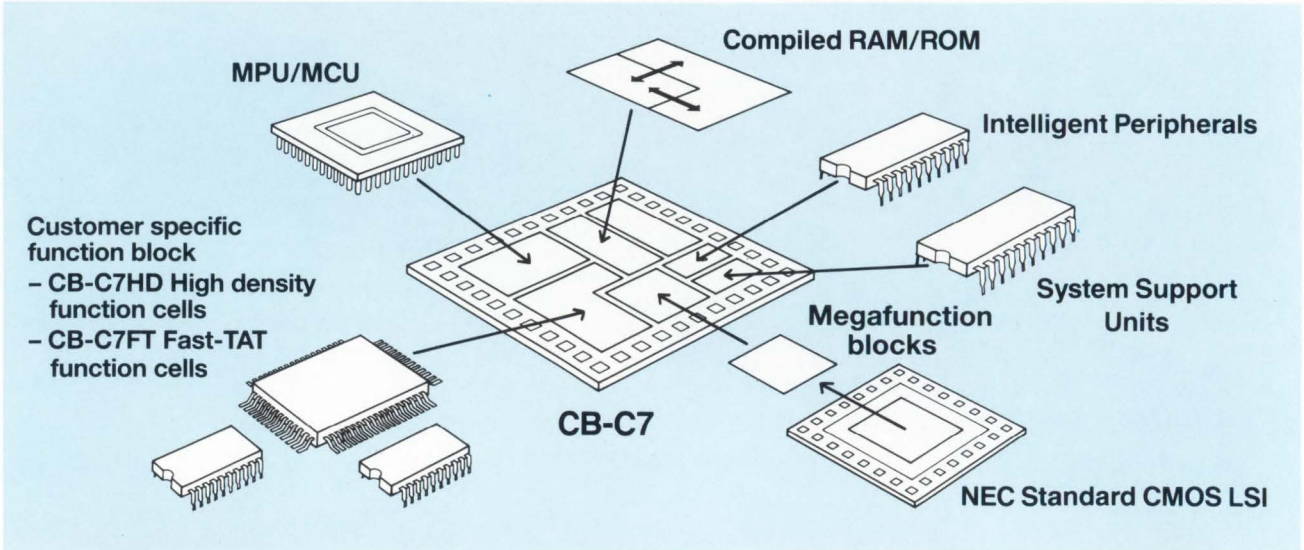
For example, the library of megafunction blocks contains cores of our µCOM87, V20H and V30H microprocessors, plus intelligent peripheral functions such as those provided by NEC's 72-series and 82-series standard peripheral devices. And because most of these megafunction blocks are hard macros, derived directly from the chip layouts of our standard parts, they have fully characterized timing parameters and can be tested with the standard part test vectors.

Our hard macros are complemented by an extensive range of soft macros to provide additional peripheral device and system support functions, and by a library of over 300 standard logic functions availaible for both silicon realization approaches, the 'High-density' (CB-C7HD) and the 'Fast TAT'-option (CB-C7FT). And of course, all our RAM and ROM blocks can be compiled to exactly match your system requirements.

Sub-micron CMOS - high speed, low power

CB-C7 ASICs utilize an advanced CMOS process technology which features 0.8µm gate lengths. This technology achieves internal gate delays of only 0.44 nsec and power gate delays of 0.34 nsec (fan-out = 2, wire length = 2mm)

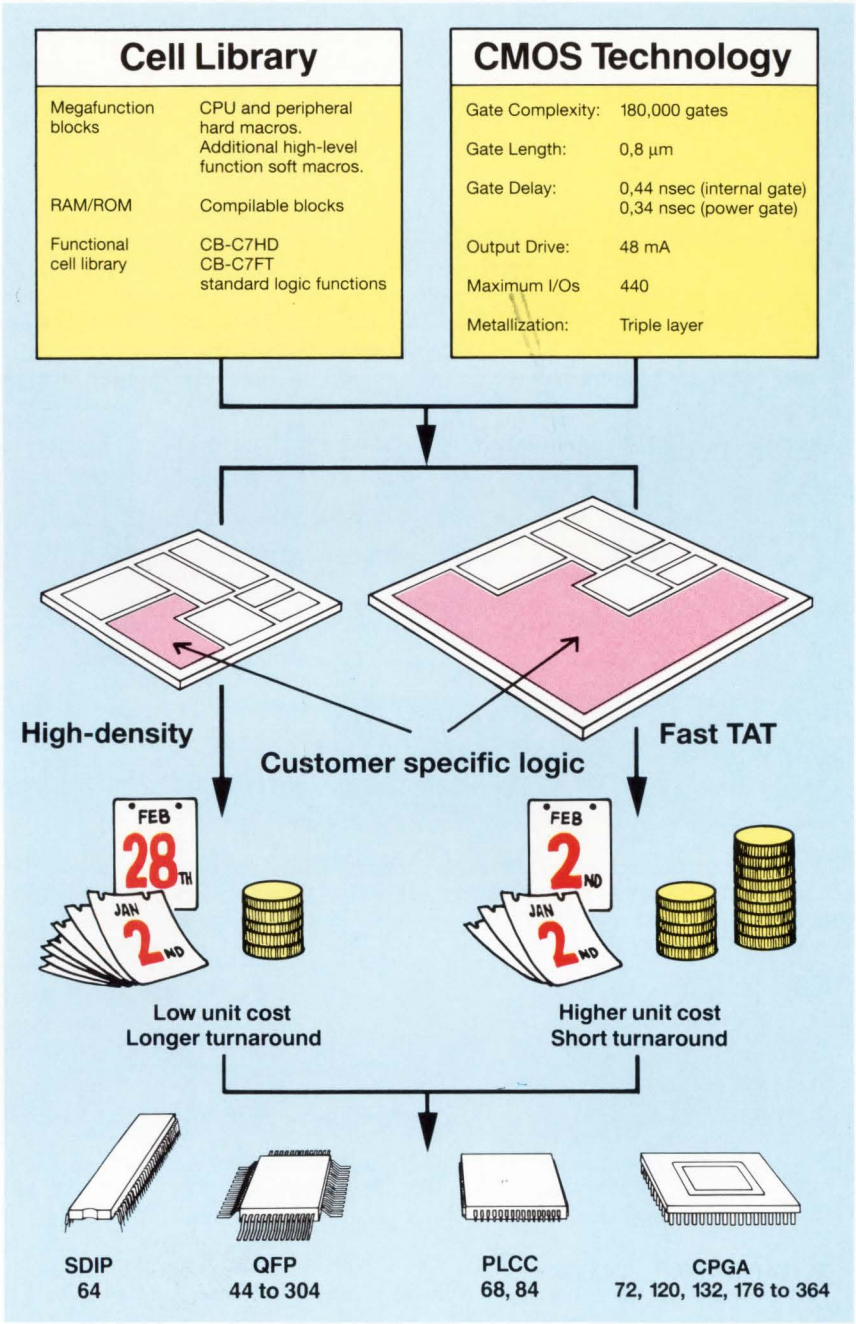
The high silicon utilization of the process allows us to achieve integration levels of over 180,000 usable 2-input NAND-gate equivalents per chip – more than sufficient to put high-performance systems into single-chip solutions. And although CB-C7 ASICs consume very little power – only 6.5 µW/gate/MHz – their 48-mA drive capability allows them to deliver power when it's needed.



Solving Cost/Turnaround Trade-offs

Fast turnaround and low unit price are often conflicting requirements when it comes to implementing your ASIC designs – the first suggesting the use of a gate array solution, and the second dictating a standard cell approach. NEC's CB-C7 ASIC technology solves these cost/turnaround trade-offs – with combined gate-array/standard-cell solutions for fast turnaround, and full standard-cell implementations for low unit cost.

Whichever option you choose, the hard-macro, megafunction block and RAM/ROM blocks in your design will be floor-planned onto the chip in much the same way. If you need finished silicon in less than a month, we will then implement your customer specific logic in a 'sea of gates' gate array, laid down around these cells. Alternatively, if you are aiming for minimum piece price, we will implement the entire ASIC as a standard cell design – using sophisticated cell optimization algorithms to ensure we achieve minimum chip area.



High Performance ASICs and Packages

Both the fast turnaround and low unit cost versions of CB-C7 ASICs feature the same high performance - so there are no compromises with either solution.

To match this performance, we have an equally impressive range of packages in which to house them. You can choose between conventional plastic DIPs, quad flat-packs, PLCCs and high pin-count plastic or ceramic pin-grid arrays. NEC's state-of-the-art packaging technology provides CB-C7 ASICs with maximum protection from their environment, ensuring their long-term reliability.

OpenCAD – flexibility in design

NEC OpenCAD gives you maximum freedom in the CB-C7 design process. Freedom to perform schematic capture using popular EDA software such as DAZIX, Mentor, Valid and VIEWlogic, on industry standard workstations from DEC, HP-Apollo, IBM and SUN.

After schematic capture, your design is completed by compiling RAM/ROM blocks and optimizing user-defined logic. It is then floor-planned using ChipPlan, simulated with System Hilo or Verilog, and placed and routed using Cell-3 Ensemble. After post-layout simulation and design-rule checks, we pass pattern generation data to one of our wafer fabrication facilities in Japan, the USA or Europe.

To simplify your design task, logic optimization, simulation, and chip layout are normally carried out by a NEC ASIC design center on their SUN or DEC workstations. Providing access to NEC's Unified Design Environment – a suite of ASIC design tools which operate under DEC PowerFrame system management software – these workstations ensure a simple user interface and smooth data flow from one design process to the next.

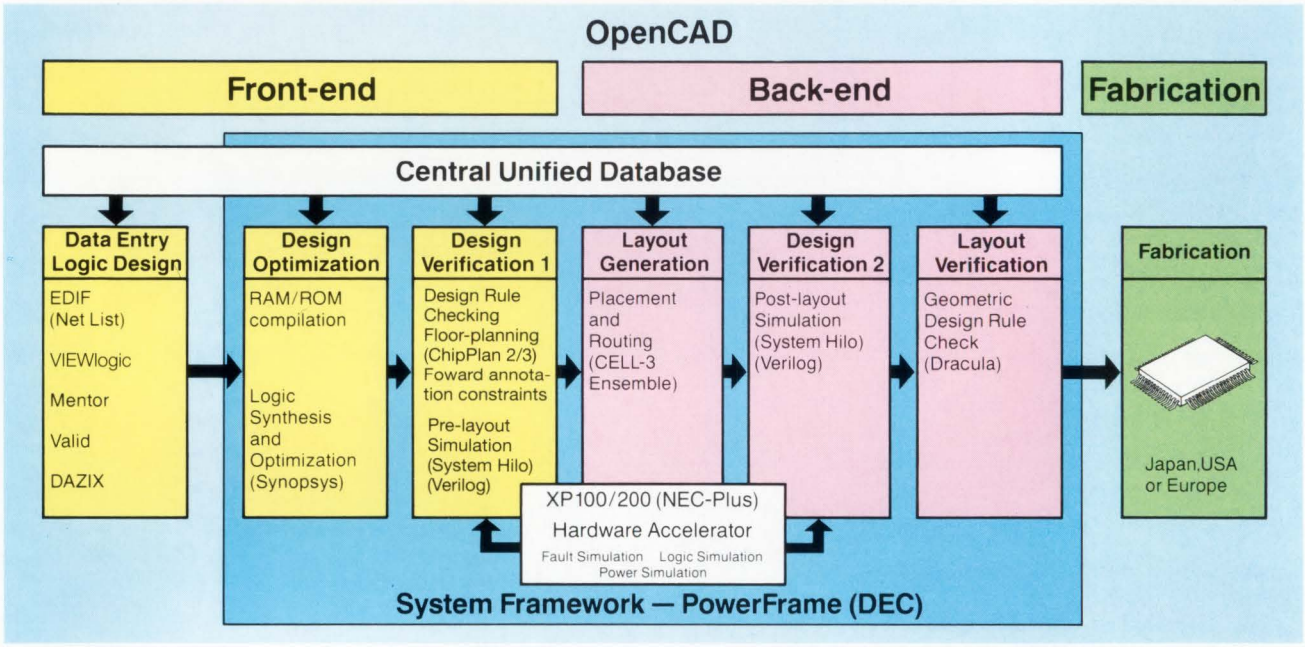
However, OpenCAD also gives you the flexibility to install part or all of the NEC Unified Design Environment on your own system, so that you can perform as much, or as little, of the CB-C7 design process as you choose.

NEC Unified Design Environment - A Framework for Right-First-Time Designs

To handle the complexity of CB-C7 ASICs, and that of our next generation of ASIC technologies, we have taken some of the best ASIC design packages in the industry – such as VIEWlogic schematic capture software, Synopsys HDL compilers and logic synthesizers, Genrad System Hilo, and Cadence simulation, layout and routing software – and integrated them into the NEC Unified Design Environment.

At the heart of this design system lies the NEC Central Unified ASIC Database – a technology independent database which allows us to automatically generate new simulation models as new process technologies are introduced.

So with NEC, you not only get ahead, you stay ahead.



Wherever you are in the world, there is a NEC design center close enough to support you in CB-C7 ASIC design. If you are already using industry standard workstations and EDA software to design ASICs, you probably have all the hardware and software design tools you will need. Simply install the CB-C7 ASIC libraries, and you can start on a CB-C7 design tomorrow.

Interested ...? Then phone your local NEC office today.

For fast answers, call us at:

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The FS700 LORAN-C frequency standard

10 MHz cesium stability

$4950

Cesium long term stability at a fraction of the cost

Better long-term stability than rubidium

Not dependent on ionosphere position changes, unlike WWV

Complete northern hemisphere coverage, unlike GPS.

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

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

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

FS700: The optimum frequency management system

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CIRCLE NO. 86

Chapter 13 functions, and a window-oriented source-level debugger. The tools support register variables, command history, and command editing. $7895 per user.

Verdix Corp, Sullyfield Business Park, 14130-A Sullyfield Circle, Chantilly, VA 22021. Phone (703) 378-7600. **Circle No. 363**

Image-Compression Software And Accelerator

Picture Packer is an image-compression subsystem for 80286-, 80386-, and 80486-based IBM PCs and compatibles. The subsystem consists of software and an optional half-size accelerator board. The software-only version runs under

MS DOS 3.0 and later versions or Windows 3.0. It compresses full-color and gray-scale images using the proposed JPEG implementation standards and achieves compression ratios as high as 30:1. The software works with Targa, TIFF, PCX, and GIF file formats, and is compatible with existing desktop-publishing, presentation, animation, and word-processing programs. You can activate a memory-resident utility from within an application program to read a compressed file.

The accelerator board is based on Texas Instruments' 320C25 DSP chip and makes image compression and decompression as much as five times faster than the software-only version. You can select 30:1 lossy compression or 5:1 no-loss compression. The lossy compression retains adequate image quality for noncritical applications; the 5:1 no-loss compression retains all pixel data needed for medical and scientific analysis. Picture Packer software, $79; accelerator card, $595.

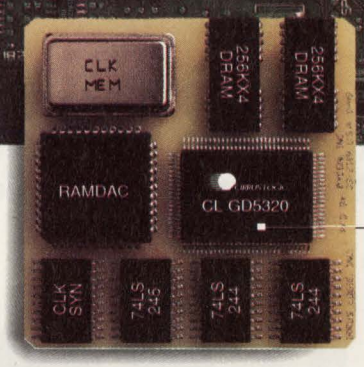
Video & Image Compression Corp, 21311 Hawthorne Blvd, Suite 235, Torrance, CA 90503. Phone (213) 792-1659. FAX (213) 543-2117. **Circle No. 364**

X-Window Servers

Xoftware X11R4 servers, which are based on X-Window System version 11 release 4, let you turn Unix and DOS PCs that have TMS340-based graphics accelerators into high-resolution X workstations and X terminals, respectively. The servers are 100% backward compatible

VGA Get On Board.

Introducing VGA that fits your motherboard and your budget.



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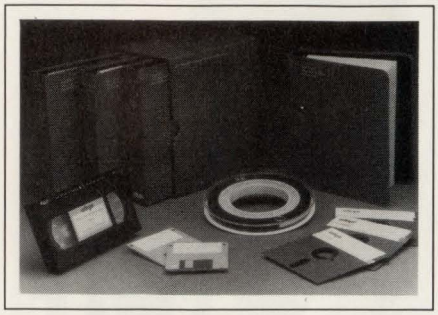
with the vendor's X11R3 server and support all major windowing environments, including Motif, Open Look, and DECwindows. Proprietary enhancements optimize available X-server memory, boost performance, and improve overall system integrity.

The vendor has implemented the MIT Shape extension, which lets user applications create nonrectangular windows, and memory-paging extensions, which allow local regeneration of pixmaps. In addition to the X11R4 fonts bundled with the servers, you can obtain more than 200 supplemental X11R4 fonts by returning the product-registration card. Xoftware for PC Unix, $595; Xoftware for TIGA/DOS, $495.

AGE, 8765 Aero Dr, Suite 226, San Diego, CA 92123. Phone (619) 565-7373. FAX (619) 565-7460.

Circle No. 365



Ada Compiler For 386 LynxOS

The Alsys Ada Software Development System now runs on IBM PS/2 Model 80, Compaq Deskpro 386, and selected 386-based compatibles under LynxOS, a real-time Posix-compliant operating system. The package includes the Ada compiler with high- and low-level optimizers; a binder; a multilibrary system with family, library, and unit managers; the Adaexec run-time executive; Adaworld, the interface common to all Alsys compilers; standard Ada packages; and an ISO-standard math library.

Other tools that come with the package are Adaprobe, a source-level debugger; Adaxref, a cross-reference generator; Adamake, an automatic recompilation utility; and Adareformat, a source-code standardization tool. The compiler implements Ada tasks as lightweight Posix threads, thereby allowing the LynxOS scheduler to maintain priority relationships across multiple application programs. The multilibrary system provides safe, efficient sharing of Ada libraries and lets you adapt the Ada library structure to your project. $7500.

Alsys, 67 S Bedford St, Burlington, MA 01803. Phone (617) 270-0030. FAX (617) 270-6882.

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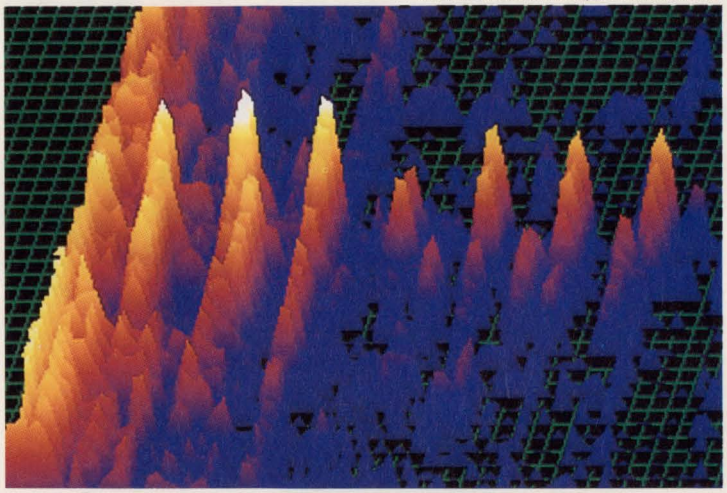
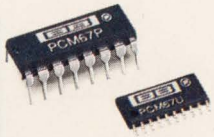
Some Notes About Digital Audio DACs

Mac DSP is a trademark of Spectral Innovations Inc.



Three seconds of a horn instrumental from a score of classical music.



Tops!

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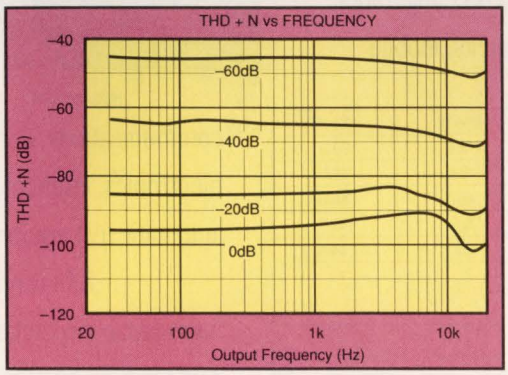
A Close Second

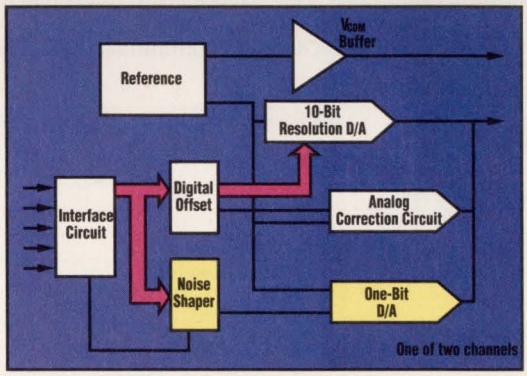
Our dual BiCMOS PCM67 D/A converter delivers high performance at low cost for your medium and low-end systems. A novel architecture combines the best features of "one-bit" and multibit designs for high SNR and glitch-free operation. It works from a single +5V supply, ideal for portable CD and DAT players.

SPECIFICATIONS	PCM63	PCM67
Resolution	20-bits	18-bits
THD+N, Max	–96dB	–92dB
SNR, Min	116dB	110dB
Dynamic Range	108dB	108dB
Gain Error	±1%	±3%
Power Dissipation	225mW	75mW
Oversampling	16X	8X
Channels	Single	Dual
Price*	$12.23	$13.97

PCM63's ultra-low distortion over the audio bandwidth.▼



PCM67 features the best of multibit and one-bit designs. ▼



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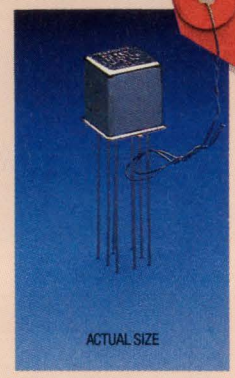

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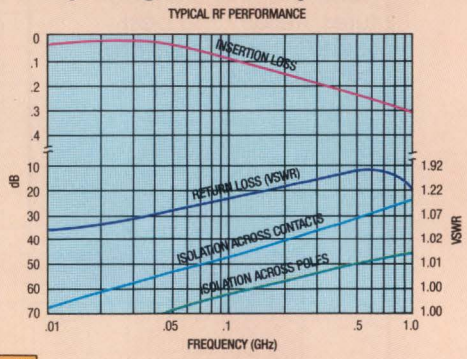

DETAILED ELECTRICAL SPECIFICATIONS (@ 25°C)

GENERIC PART NUMBERS		172-5	172-12	172-26
Coil Voltage (VDC)	Nom.	5.0	12.0	26.5
	Max.	5.8	16.0	32.0
Coil Resistance (ohms ± 20%)		64	400	1600
Pick-up Voltage (VDC, Max.) Pulse Operation		3.8	9.0	18.0
Coil Operating Power at Nominal Voltage (Milliwatts)		405	360	440
Contact Load Ratings (DC)	Resistive: 1 Amp/28VDC Inductive: 200 mA/28VDC (320mH) Lamp: 100 mA/28VDC			
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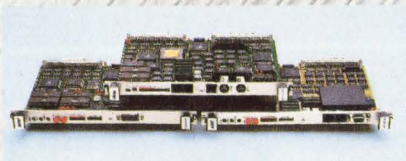

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DESIGN IDEAS

EDITED BY CHARLES H SMALL

Ordinary DMM measures high resistances

Alfred E Hess
Consultant, Boulder, CO

Using a simple technique, you can extend the resistance-measurement range of your 3½-digit DMM from the usual 19.99 MΩ to 40 GΩ. Thus, you could measure, for example, the leakage resistances of transformers, motor windings, and capacitors.

For a 19.99-MΩ DMM range, select a stable 20-MΩ resistor whose value is slightly below nominal, say 19.99 MΩ. Simple math tells you that an unknown high resistance, R_X, is

$$R_X = R_P \times R_{PX}/(R_P - R_{PX}),$$

where R_P is the high-value parallel resistor and R_{PX} is the measured value of R_P in parallel with R_X. An even easier way to determine the value of R_X is by using the graph in **Fig 1.**

A handy mounting tip is to connect the high-value resistor across the setscrews of a dual banana plug. Insert the dual banana plug into your DMM's terminals and your leads into the banana plug.

EDN BBS /DL_SIG #982 EDN

To Vote For This Design, Circle No. 747

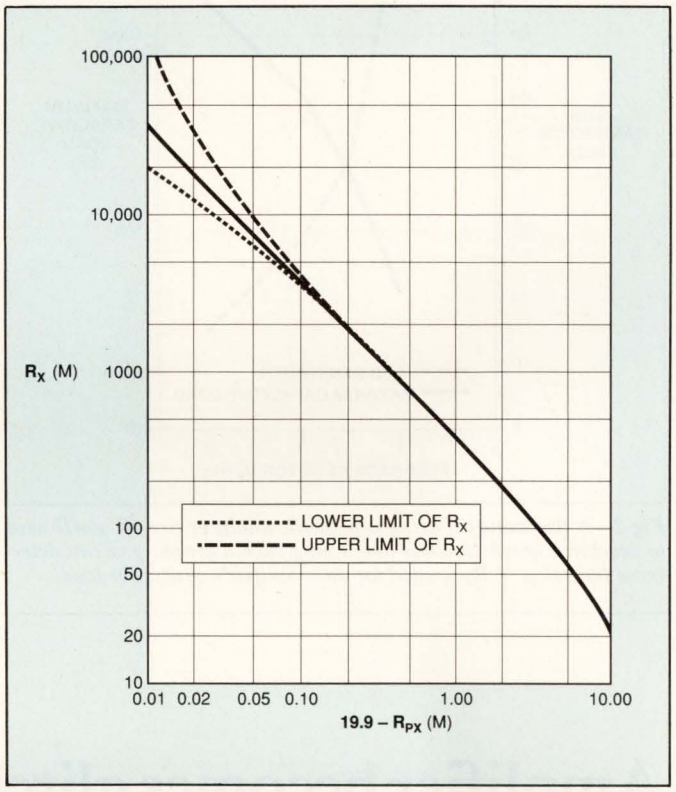


Fig 1—Using this chart and a high-value parallel resistor, *you can measure resistances far beyond the range of your DMM.*

Increased feedback stabilizes amp

William A Gross
Linear Technology Corp, Milpitas, CA

Contrary to popular thought, you *can* optimize current-feedback amplifiers to drive capacitive loads. The usual method for using a current-feedback amplifier to drive a capacitive load isolates the load with a resistor in series with the amplifier's output. The disadvantage of this method is that the finite output resistance will cause errors unless the load's resistance is well defined.

A better solution involves only the amplifier's feedback resistors (**Fig 1**). Because the feedback resistors determine the amplifier's compensation, you can select the optimal value for these feedback resistors for almost any capacitive load.

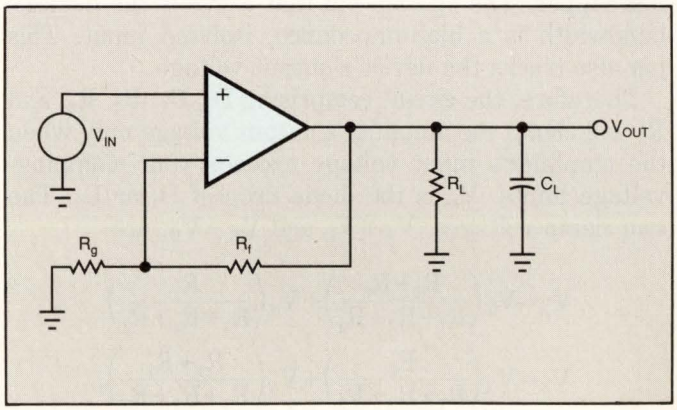


Fig 1—By adjusting the value of R_F, *the feedback resistor that determines a current-feedback amplifier's bandwidth, you can optimize your circuit to drive almost any capacitive load.*

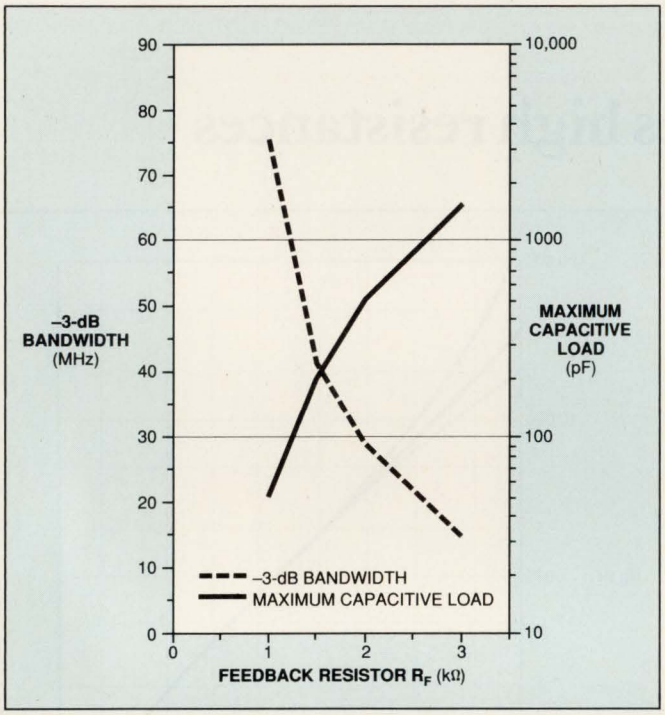


***Fig 2—A few minutes using a network analyzer** are all you'll need to develop a graph like this one. Using such a graph, you can determine the value of R_F needed for an amplifier's capacitive load.*

Feedback-resistor R_F sets the amplifier's bandwidth. Increasing R_F reduces the amplifier's bandwidth, significantly improving the amplifier's ability to drive capacitive loads. Feedback-resistor R_G sets the amplifier's gain.

You cannot get the data necessary to calculate alternate values for R_F from most data sheets. However, a few minutes at the bench with a network analyzer will generate the data you need to make a graph of the value of the feedback resistor vs the amount of capacitive load the amplifier can drive (**Fig 2**).

Start with the recommended data-sheet value for feedback-resistor R_F and measure the amplifier's frequency response without any capacitive load. Note the bandwidth and then add capacitive loading until the response peaks by about 5 dB. Record this value of capacitance; it is the maximum amount for that feedback resistor. Then increase the value of the feedback resistor and repeat the procedure until you develop a graph like the one in **Fig 2.**

EDN BBS /DI_SIG #979 EDN

To Vote For This Design, Circle No. 748

Amplifier becomes glitch-free clipper

Timothy F Darling
MariPro/SAIC, Goleta, CA

Adding a simple clamping circuit (**Fig 1**) to a Harris 2620 high-speed op amp produces a glitch-free amplifier/clipper. The op-amp pin that controls the device's bandwidth is a high-impedance, isolated input. This pin also tracks the device's output voltage.

Therefore, the circuit comprising D_1, D_2, R_1, R_2, and R_3 will clamp the amplifier's output voltage only when the amplifier's input voltage exceeds your clamping-voltage limits. V_D is the diode drop of D_1 or D_2. The two clamp voltages, $V_A + V_D$ and $V_B - V_D$, are

$$V_A = V_X\left(\frac{R_2+R_3}{R_1+R_2+R_3}\right)+V_Y\left(\frac{R_1}{R_1+R_2+R_3}\right)$$

$$V_B = V_X\left(\frac{R_3}{R_1+R_2+R_3}\right)+V_Y\left(\frac{R_1+R_2}{R_1+R_2+R_3}\right),$$

where V_X and V_Y are the clamping circuit's bias voltages. Choosing R_1 lets you determine the val-

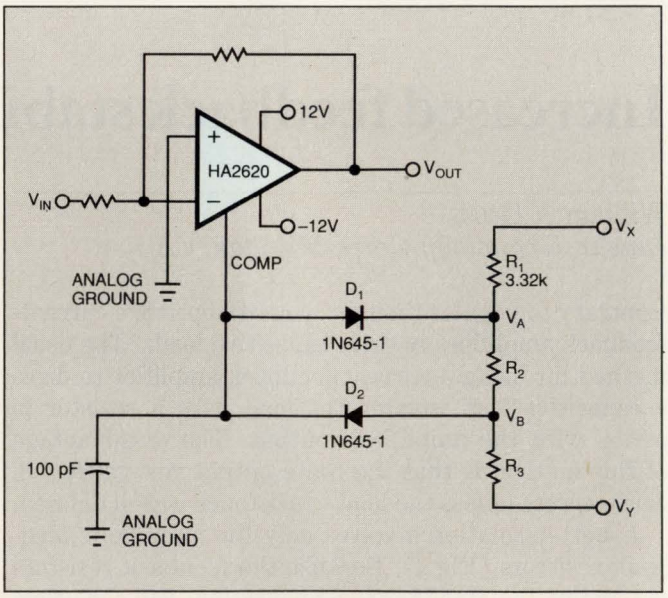


***Fig 1—By putting the 2620 op amp's** isolated bandwidth-control (COMP) pin to a novel use, the resistor-diode clamping network transforms the amplifier into an amplifier/clipper.*

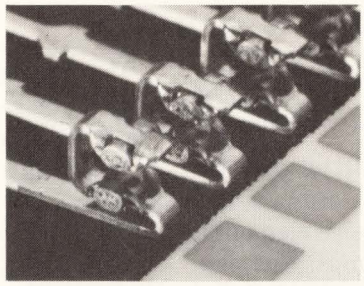
TAKE EXPENSIVE REWORK OUT OF CIRCUITS ASSEMBLY

...and improve product reliability

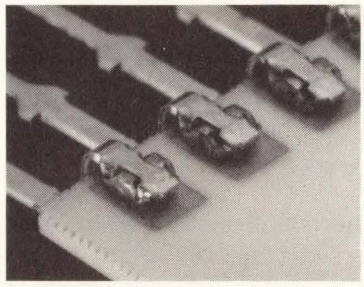
When you use NAS solder and flux bearing edge clips, rework is virtually eliminated. Steps that yield high rates of rejects in other circuits assembly methods — solder paste, dipping and board clean-up — are replaced by simple, one-step lead attachment and reflow operations that consistently produce 100% solderability. Also, NAS clips can be bonded to conductor pads without raising the temperature of pre-populated boards to reflow levels and causing damage to existing connections. Most — or all — of the inspection procedures required by other methods are unnecessary, and expensive rework becomes a thing of the past.

Preforms on edge clip terminals contain precisely the right amounts of the proper solder and flux for each application, and the exclusive NAS "Claw" grip holds each preform. This unique grip design provides direct contact between solder and conductor pads, a beneficial wiping action as clips are attached, and positive control of solder flow.

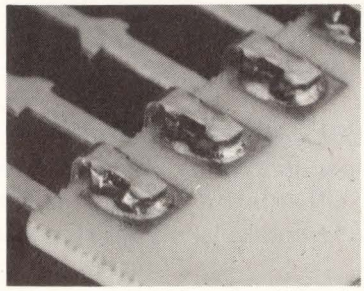
The simple, efficient method of applying NAS solder and flux bearing edge clips:



Direct contact between solder preforms and conductor pads produces a beneficial wiping action as clips are attached, either manually or with a lead attachment machine.



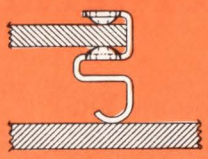
Interference fit holds clips firmly in position for reflow. Top and bottom preforms are reflowed in one operation using any method that raises temperatures to reflow levels.



Precise amounts of the right solder and the shape of the "Claw" grip provide control of solder flow without a solder stop. This assures perfect mechanical and electrical bonding without wicking or bridging.

Unretouched Macro Photography

A single reflow operation for top and bottom preforms — using any method that raises temperatures to reflow levels — produces perfect solder joints every time.



With no specialized labor skills to acquire and very little capital investment, you can quickly and easily convert to the NAS solder and flux bearing edge clip method. The immediate result will be a faster, far less costly circuits assembly process, and more reliable, better performing products.

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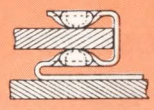

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CIRCLE NO. 95

ues of R_2 and R_3. Try a value for R_1 around 3 kΩ.

One example of this circuit had clamping voltages of ±3.7V and exhibited THD below −75 dB for a sinusoidal, 30-kHz input signal. When the input signal increased beyond the ±3.7V clamping voltages, the clipper symmetrically clamped the output voltage with no glitches in the waveform.

EDN BBS /DI_SIG #983 EDN

To Vote For This Design, Circle No. 749

Program derives function from netlist

Henry Yiu
Consultant, Claremont, CA

The Quick C program Xfunc computes an ac transfer function from a circuit's netlist. The input netlist, which resembles a Spice netlist, can contain passive elements, linear dependent sources, and ideal op amps. The program's output is an s-domain transfer function in symbolic format.

The program and accompanying documentation, including the source code, are too long to reproduce here; you can obtain these files from the EDN BBS's DI Special Interest Group (617-558-4241,300/1200/2400,8,N,1—from Main System Menu, enter (s)ig, <s/di_sig >, rk980). **EDN BBS /DI_SIG #980** EDN

To Vote For This Design, Circle No. 750

FEEDBACK AND AMPLIFICATION

Keep your boss from worrying

When your current project exhausts all normal design time plus allowable extra time, here are some tips to overcome management worries.

Blame problems on

- Oscillation—High or low frequency, parasitic, load, layout, or heat related. Or, blame computer simulation that showed no stability problems.
- Feedback—Everything was working until you closed the loop. A complex pole for compensation may be required.
- Noise—Call attention to crosstalk that you could not have checked at the prototype stage. Note sagely that the problem is probably either intrinsic or extrinsic. Point out that adding optoisolators or shielding will take time.
- Jitter—Blame jitter on components, terminations, transmission lines, speed, interfaces—or just cite jitter without offering explanation.
- Heat—Blaming inadequate heat sinking or airflow is a good idea. "Typical drift" is a good excuse, too.
- Layout—If you did not do the board layout, then place the blame on mistakes in the ground plane, ground loops, etc. If using a multilayer board, buy more time by maintaining that mistakes in a hidden layer make a completely new layout necessary.
- Delivery—The samples and prototypes arrived late.

If these suggestions do not work, don't give up. Try glitches, overshoot or undershoot, static charges, threshold, hysteresis, and power-supply problems (only if you did not design the power supply, of course). Then ask for the most expensive test instruments, computers, and software packages available. Failing all else, demand that management rewrite your project's specifications because the specs are obviously too tight. Finally, let the software department develop workarounds for your hardware problems.

Constantin Buta
Product Development Engineer
Pulse Instruments
1234 Francisco St
Torrance, CA 90502
(213) 693-2192

EDN is proud to pass along to its faithful readers what are probably the most useful ideas ever presented in the Design Ideas section. We are also considering distributing the previous tips to graduating engineers because we suspect that their professors neglected to cover this vital component of a professional engineer's armamentarium.

Charles H Small and Anne Watson Swager
Design Ideas Editors

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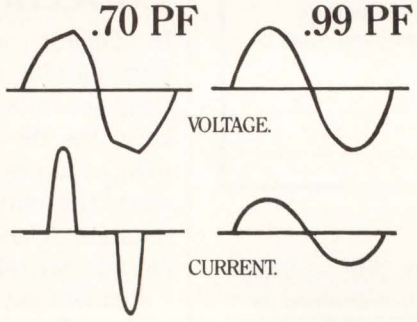

WIth .70 PF, current is drawn as narrow spikes during a short period of each half cycle. Power available from the line is cut by about 30%. In addition, harmonics generated by the excessive peak current produce substantial power line noise and distortion.

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CIRCLE NO. 96

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ISSUE WINNER

The winning Design Idea for the April 11, 1991 issue is entitled "Pause detector adapts to signal," submitted by Tibor Szep and Andras Pomozi of Technical University of Budapest (Budapest, Hungary).

Your vote determines this issue's winner. All designs published win $100 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.

FEEDBACK AND AMPLIFICATION

Reader chews prose

After reading "A/D board hooks to IBM PC printer port" by Bob and Mark Underwood (EDN, February 18, 1991, pg 184), which was a Design Idea for the MAX171 A/D converter, I reflected on my own experience with the device and was moved to compose this limerick:

Missing Codes

There once was a MAX171 chip,
That could make our design really zip.
But after eight months of waiting,
Thinking soon we would be creating,
We were told the chip would never ship!

I am amused to find that a Maxim employee submitted a design for the MAX171 A/D converter after we were told of the chip's ultimate demise because of yield problems.

Brett M Jackson, Design Engineer
Beckman Instruments Inc
90 Boroline Rd
Allendale, NJ 07401
(201) 818-8900

Maxim replies that rumors of the death of the MAX171 are greatly exaggerated. The company says that building the chip involves a novel assembly technique. Some glitches in the process caused the company to suspend production temporarily. They assure us that the problems are now ironed out and that you can once again get the device.

Charles H Small and Anne Watson Swager
Design Ideas Editors

Corrections

In "Digital correlator defeats noise," (EDN, May 9, 1991, pg 176), counter A clocks on a high-to-low transition, not on a low-to-high transition as shown. Similarly, the flip-flop clocks on a low-to-high transition. Also, counters A and B are synchronous counters. Thus when the output of counter B goes high, resets of counters A and B occur on the next clock transition, not immediately.

Readers have pointed out that if the AND gate and counter B go high simultaneously, the J-K flip-flop will not reset. You can cover this extremely rare eventuality by adding a D flip-flop, with the flip-flop's input connected to counter B's output, and the D flip-flop's output going to the J-K flip-flop's reset.

John D Charlton
42936 Cinema Ave
Lancaster, CA 93534-6231
(805) 942-4814

EDN

LINEAR TECHNOLOGY

DESIGN NOTES

DC-DC Converters for Portable Computers – Design Note 52

Steve Pietkiewicz
Jim Williams

Portable computers require simple and efficient converters for +5V power and display driving. A regulated 5V supply can be generated from two "AA" cells using the circuit shown in Figure 1. U1, an LT1073-5 micropower DC-DC converter, is arranged as a step-up, or "boost" converter. The 5V output, monitored by U1's SENSE pin, is internally divided down and compared to a 212mV reference voltage inside the device. U1's oscillator turns on when the output drops below 5V, cycling the switch on and off at a 19kHz rate. This action alternately causes current to build up in L1, then dump into C1 through D1, increasing the output voltage. When the output reaches 5V, the oscillator turns off. The gated oscillator provides the mechanism to keep the output at a constant 5V. R1 invokes the current limit feature of the LT1073, limiting peak switch current to 1A. U1 limits switch current by turning off the switch when the current reaches the programmed limit set by R1. Switch "on" time, therefore, decreases as V_{IN} is increased. Switch "off" time is not affected. This scheme keeps peak switch current constant over the entire input voltage range, allowing maximum energy transfer to occur at low battery voltage without exceeding L1's maximum current rating at high battery voltage.

The circuit delivers 5V at 150mA from an input range of 3.5V to 2.0V. Efficiency measures 80% at 3.0V, decreasing to 70% at 2.0V for load currents in the 15mA to 150mA range. Output ripple measures 170mVp-p and no-load quiescent current is just 135µA.

A –24V LCD bias generator is shown in Figure 2. In this circuit U1 is an LT1173 micropower DC-DC converter. The 3V input is converted to +24V by U1's switch, L1, D1, and C1. The switch pin (SW1) then drives a charge pump composed of C2, C3, D2, and D3 to generate –24V. Line regulation is less than 0.2% from 3.3V to 2.0V inputs. Load regulation, although it suffers somewhat since the –24V output is not directly regulated, measures 2% from a 1mA to 7mA load. The circuit will deliver 7mA from a 2.0V input at 73% efficiency.

If greater output power is required, Figure 2's circuit can be driven from a +5V source. R1 should be changed to

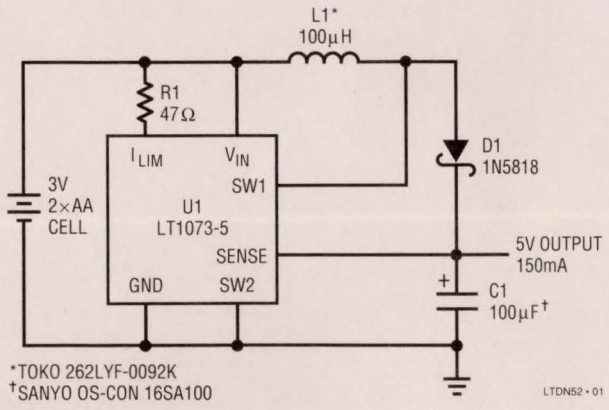


Figure 1. Two "AA" Cell to 5V Step-Up Converter Delivers 150mA

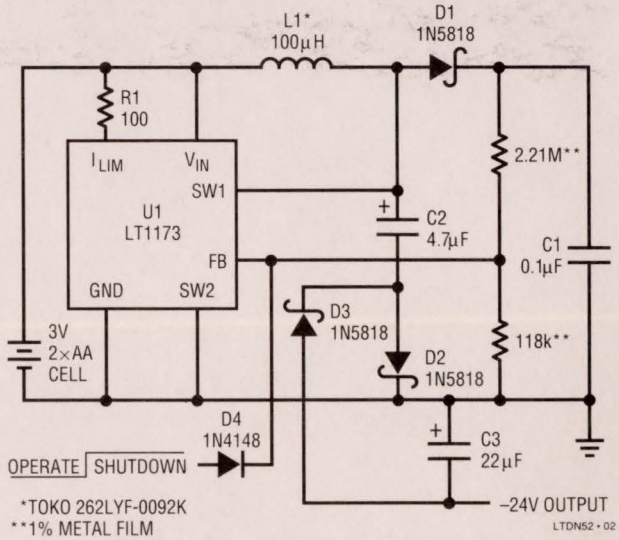


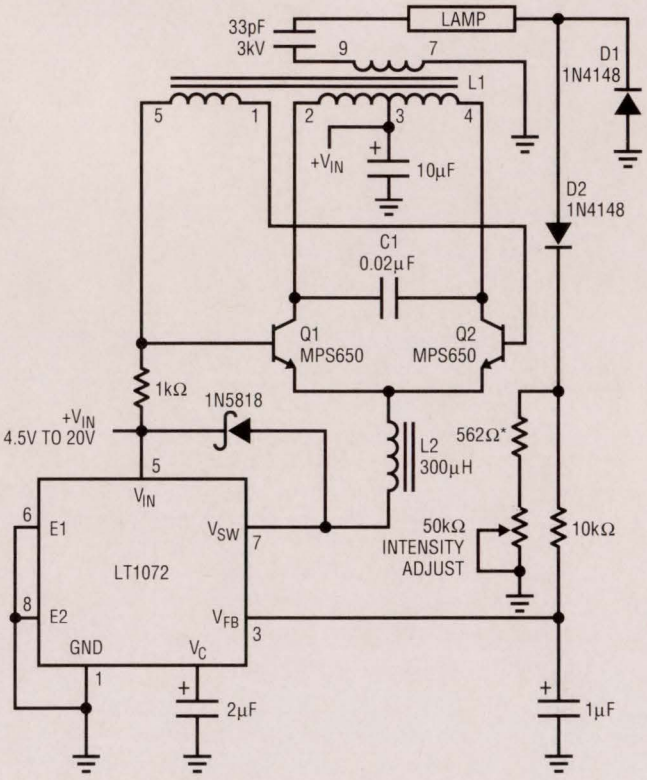
Figure 2. DC to DC Converter Generates –24V from 3V or 5V

47Ω and C3 to 47μF. With a 5V input, 40mA is available at 75% efficiency. Shutdown is accomplished by bringing the anode of D4 to a logic high, forcing the feedback pin of U1 to go above the internal reference voltage of 1.25V. Shutdown current is 110μA from the input source and 36μA from the shutdown signal.

Current generation portables require back lit LCD displays using cold cathode fluorescent lamps (CCFLs). Figure 3 provides 78% efficiency with full control over lamp brightness. 82% efficiency is possible if the LT1072 is driven from a low voltage (e.g. 3V-5V) source. Additional benefits include a 4.5V to 20V supply range and low radiated power due to sine wave based operation.

L1 and the transistors comprise a current driven Royer class converter which oscillates at a frequency primarily set by L1's characteristics and the 0.02μF capacitor. LT1072 driven L2 sets the magnitude of the Q1-Q2 tail current, and hence L1's drive level. The 1N5818 diode maintains current flow when the LT1072 is off.

The 0.02μF capacitor combines wth L1's characteristics to produce sine wave voltage drive at the Q1 and Q2 collectors. L1 furnishes voltage step-up, and about 1400Vp-p appears at its secondary. Current flows through the 33pF capacitor into the lamp. On negative waveform cycles the lamp's current is steered to ground via D1. Positive waveform cycles are directed, via D2, to the ground referred 562Ω-50k potentiometer chain. The positive half-sine appearing across these resistors represents 1/2 the lamp current. This signal is filtered by the 10k-1μF pair and presented to the LT1072's feedback pin. This connection closes a control loop which regulates lamp current. The 2μF capacitor at the LT1072's V_C pin provides stable loop compensation. The loop forces the LT1072 to switch-mode modulate L2's average current to whatever value is required to maintain a constant current in the lamp. The constant current's value, and hence lamp intensity, may be varied with the potentiometer. The constant current drive allows full 0-100% intensity control with no lamp dead zones or "pop-on" at low intensities. Additionally, lamp life is enhanced because current cannot increase as the lamp ages. Detailed information on this circuit appears in LTC Application Note 45, "Measurement and Control Circuit Collection."



C1 = MUST BE A LOW LOSS CAPACITOR.
METALIZED POLYCARB
WIMA FPK 2 (GERMAN) RECOMMENDED.

L1 = SUMIDA 6345-020 OR COILTRONIX CTX110092-1.
PIN NUMBERS SHOWN FOR COILTRONIX UNIT

L2 = COILTRONIX CTX300-4

* = 1% FILM RESISTOR

DO NOT SUBSTITUTE COMPONENTS

LTDN52 • 03

Figure 3. Cold Cathode Fluorescent Lamp Power Supply

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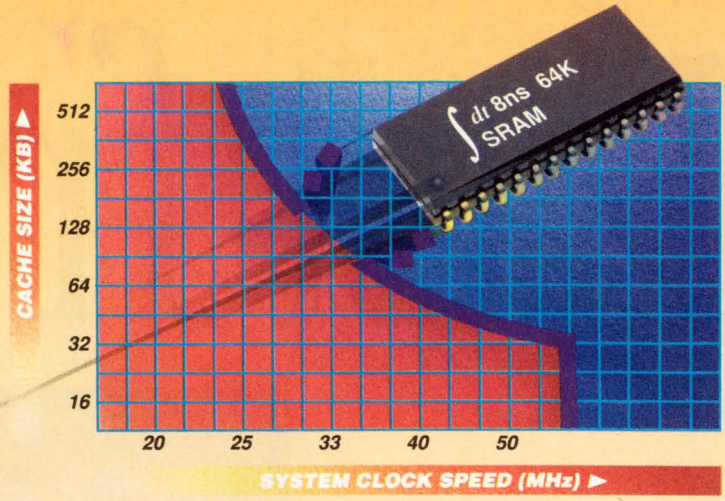

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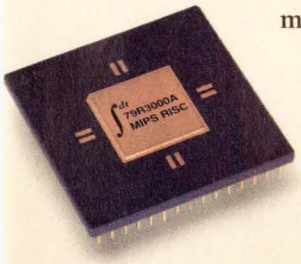

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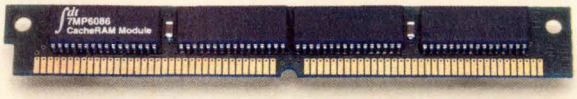

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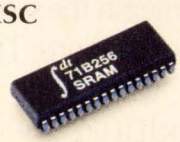

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Powerex, Hillis St, Youngwood, PA 15697. **Circle No. 375**

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Superior Electric, 383 Middle St, Bristol, CT 06010.

Circle No. 376

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ACL Inc, 1960 E Devon Ave, Elk Grove Village, IL 60007.

Circle No. 377

Booklet Of Popular Switches

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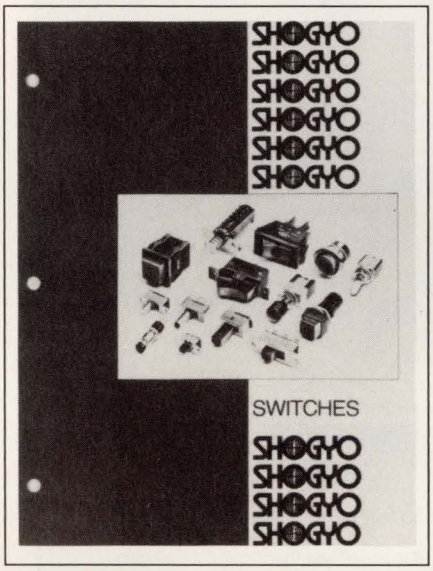
EAO Switch Corp, 198 Pepe's Farm Rd, Milford, CT 06460.

Circle No. 378



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Shogyo International Corp, 287 Northern Blvd, Great Neck, NY 11021. **Circle No. 379**

LITERATURE: CAE

App Note Explains Emulation System

This application brief examines the vendor's installation and utilization of the RPM Emulation System; its title is *Rockwell NTSD: ASIC Design Productivity Improvements.* The focus is on ASIC hardware emulation. "Sneakernet," an excerpted version of this study, is also available.

Quickturn Systems Inc, 325 E Middlefield Rd, Mountain View, CA 94043. **Circle No. 742**

Handbook Examines World Of 3-D AutoCAD

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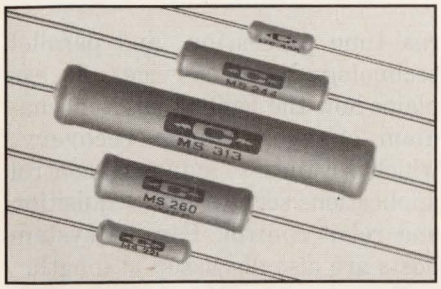

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For Type MS data, circle number 98

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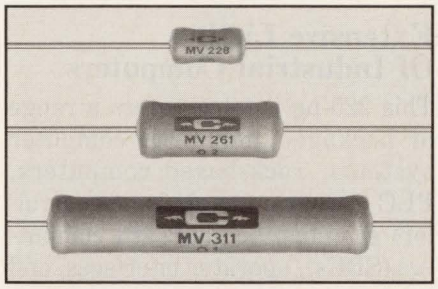

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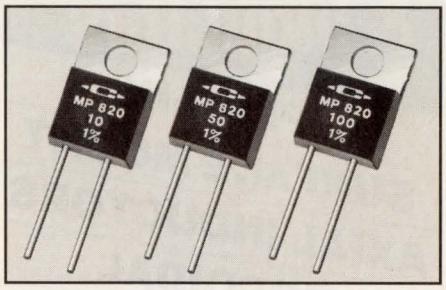

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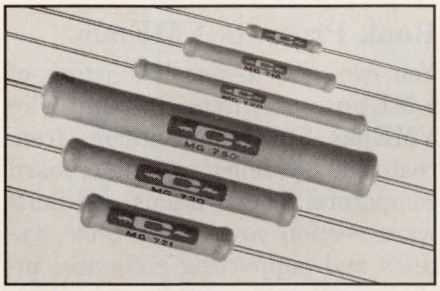

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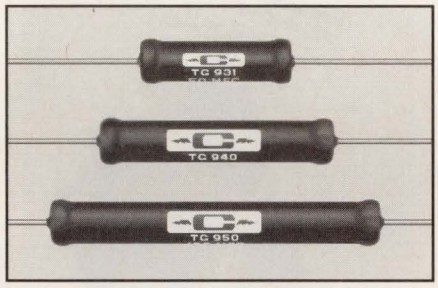

TC of 25 ppm/°C, -55°C to +125°C

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For Type TG data, circle number 102

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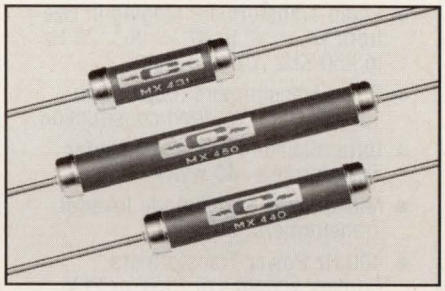

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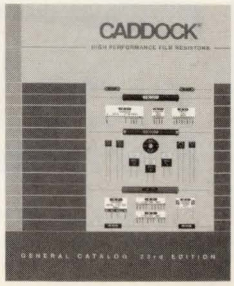

L121.119

LITERATURE:
COMPUTERS & PERIPHERALS

Extensive Listing Of Industrial Computers

This 225-pg catalog covers a range of packaged industrial computer systems, rack-based computers, PLC (programmable-logic-controller) systems, single-board computers (SBCs), operator interfaces, and cards for mass storage, communications, and I/O interfaces. The book is divided into product groups and provides product features and specifications, as well as application notes and software products. In addition to other SBCs, new products include the 386SX/AT, which is software-compatible with the IBM PC/AT. An entire section covers the IPLC, an integrated PLC that uses 80C286 processors.

Pro-Log Corp, 2555 Garden Rd, Monterey, CA 93940.

Circle No. 371

Newsletter And Brochure Keep Up On Parallelism

Parsytec News, a quarterly newsletter reports on innovations in Transputer-based parallel processing. *Parallel Products* is a tutorial catalog for 1991. The 4-pg News provides updates on applications and products. It also provides how-to information and explains how design choices are made. The 48-pg, 4-color catalog has sections on number-crunching systems, industrial real-time processing, and parallel technology-based services. It explains how the Unilink reset mechanism ensures failure recovery, which is critical to industrial-control applications such as data acquisition and robot control. Parallel system hosts are also discussed at length.

Parsytec Inc, Bldg 9, Unit 60/61, 245 W Roosevelt Rd, West Chicago, IL 60185. **Circle No. 372**

How To Solve Monitoring And Control Problems

These application notes explain how to use the Series 4000 Smart I/O Processor System for monitoring and control. The book's four sections deal with wireline systems; telephone communications systems; radio communications systems, and questions and answers. The appendix presents the Series 4000 product line.

Acromag, Box 437, Wixom, MI 48393. **Circle No. 373**

Book Presents VMEbus

You can find a detailed listing of VMEbus products in the The VMEbus Full-Line Catalog, from real-time systems to single-board computers. The Systems and Software section covers real-time systems and supporting software, including Vxworks, OS-9, and pSOS. The Board-Level section contains 32-bit processors, expansion modules, memory modules, and a selection of I/O boards. Two overview sections introduce the vendor's line of rugged products and mention products currently in development. The section on Packaging and Accessories presents backplanes, peripherals, and a Fanpack cooling system. A general-information section explains custom products and consulting services.

Matrix Corp, 1203 New Hope Rd, Raleigh, NC 27610.

Circle No. 374

Type TN Lab Grade Low TC Precision Resistors

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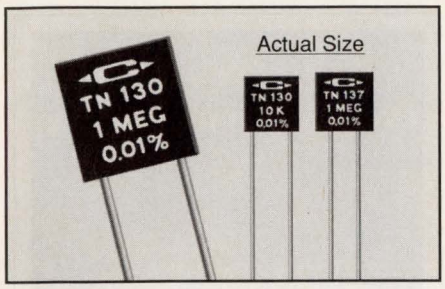

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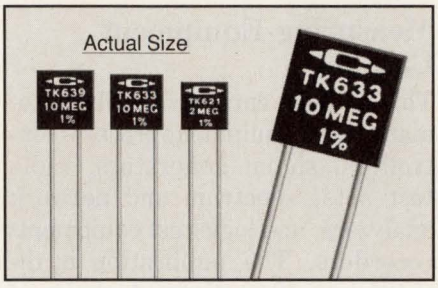
For Type TN data, circle number 105

Type TK Low TC Precision Radial-Lead Film Resistors



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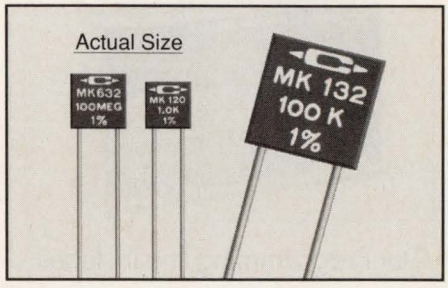
For Type TK data, circle number 106

Type MK Precision Power Radial-Lead Film Resistors



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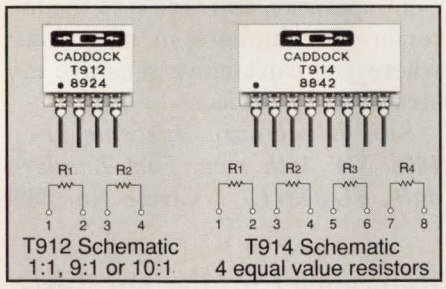

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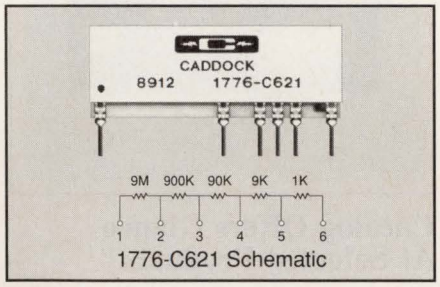

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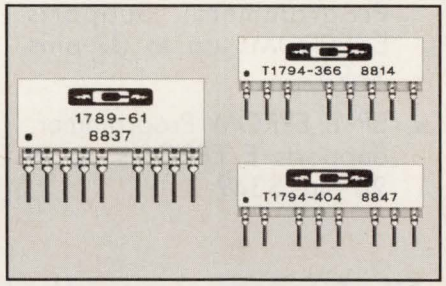

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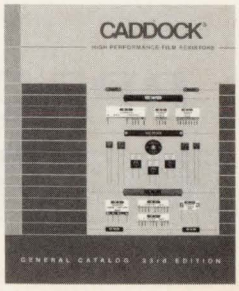


LITERATURE: INSTRUMENTS

Measuring-Equipment Catalog

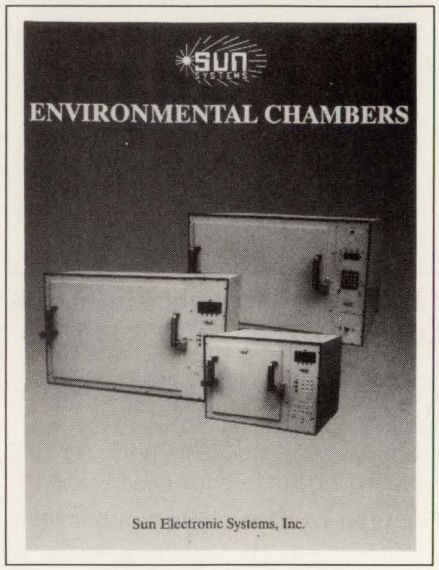
This 572-pg catalog details automatic test equipment/process controllers, signal generators, radio test sets, spectrum and network analyzers, and logic test equipment/recorders. The publication is divided into 13 sections. A choice of peripheral measurement devices appears in the appendix.

Rohde & Schwarz, 8000 Munchen 80, Muhldorfstr 15, Germany. **Circle No. 367**

Catalog Offers Glance At Selected Products

The 164-pg 1991 Contact East catalog features thousands of instruments and tools for assembling, testing, and repairing electronic equipment. The catalog is divided into the following categories: power supplies, oscilloscopes, DMMs, static protection products, ozone-safe cleaners, magnifiers, inspection equipment, and workbenches. Also included are information sections for custom tool kits, telecommunications and datacommunications testers, precision hand tools, electronic adhesives, and wire and cable aids.

Contact East, 335 Willow St, North Andover, MA 01845. **Circle No. 368**



Index And Reference To Environmental Chambers

The EC Series reference is an 8-pg guide to the vendor's environmental test equipment. The handbook discusses specs and products for a variety of applications. Six new products listed in this guide provide various options and a range of standard features, including cost-efficient operation and access to the interior of chambers in situations where you can't move sensitive instruments or devices.

Sun Electronic Systems Inc, 1601 NW 38th Ave, Fort Lauderdale, FL 33311. **Circle No. 369**

Reference Catalog For Test-And-Measurement Products

This 32-pg guide book catalogs power systems and components for commercial, industrial, and military applications. It covers ac and dc programmable power sources, plug-in oscillators, on-line uninterruptible power systems, and high-isolation transformers. The catalog offers cross-reference tables and new-product listings, such as digitally modulated ac power systems and electronic dc load modules.

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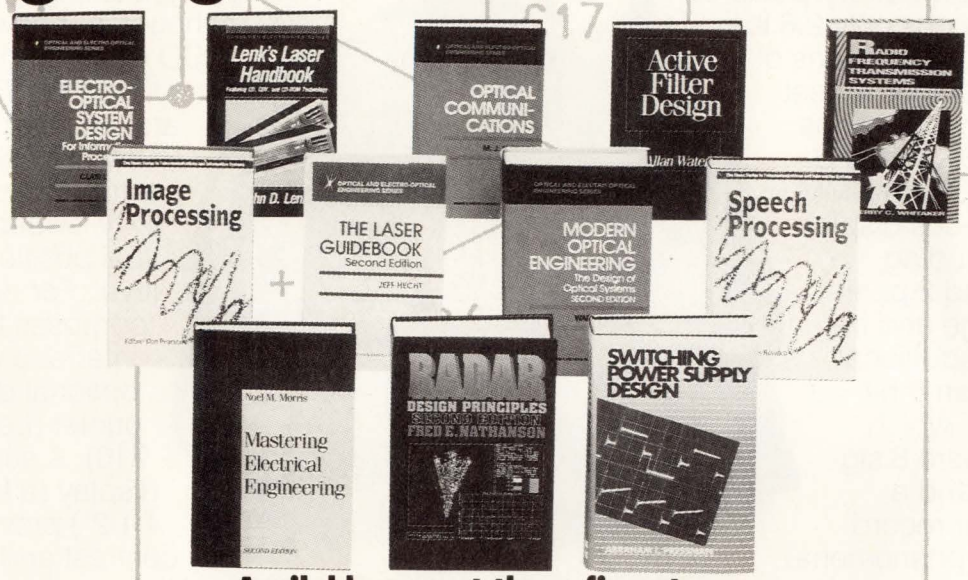

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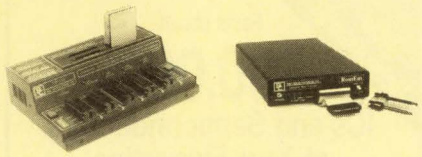

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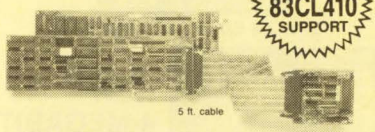

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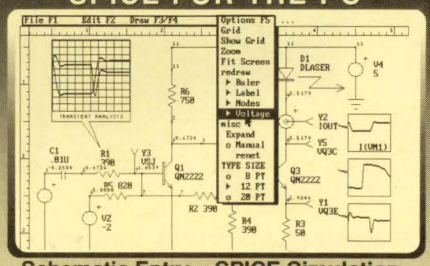

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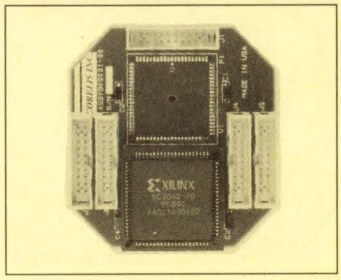

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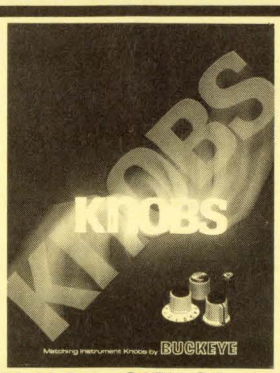

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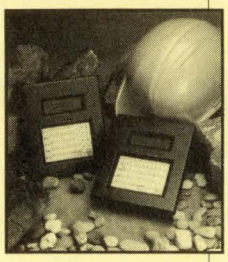

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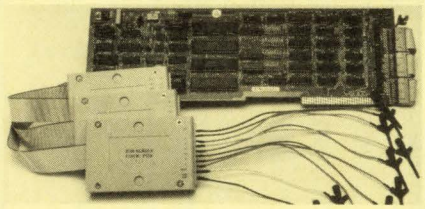

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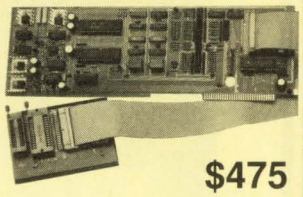

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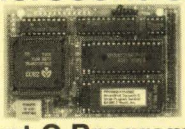

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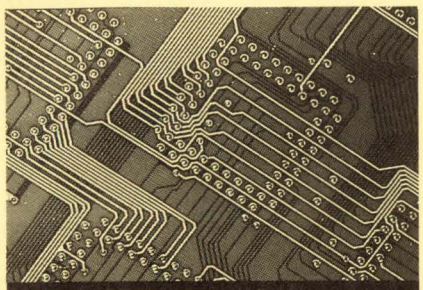

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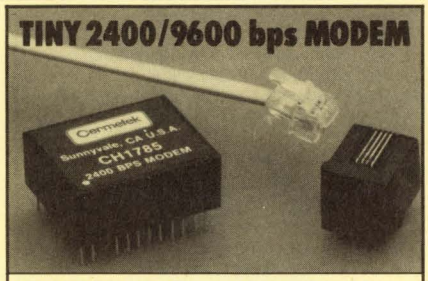

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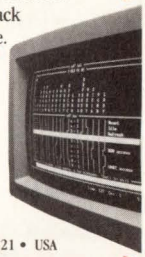

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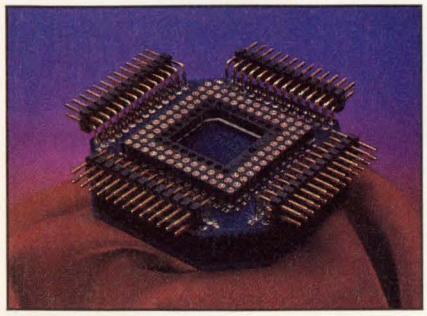

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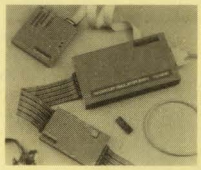

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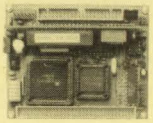

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News Edition	Aug. 8	July 19	CAE, Datacom**
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News Edition	Aug. 22	Aug. 2	Peripherals/Components, Test & Measurement**, Regional Profile: Idaho, Colorado, Utah**
Magazine Edition	Sept. 2	Aug. 8	ASICs Special Issue, Semicustom ICs • CAE, Packaging • ICs & Semiconductors Data Converters
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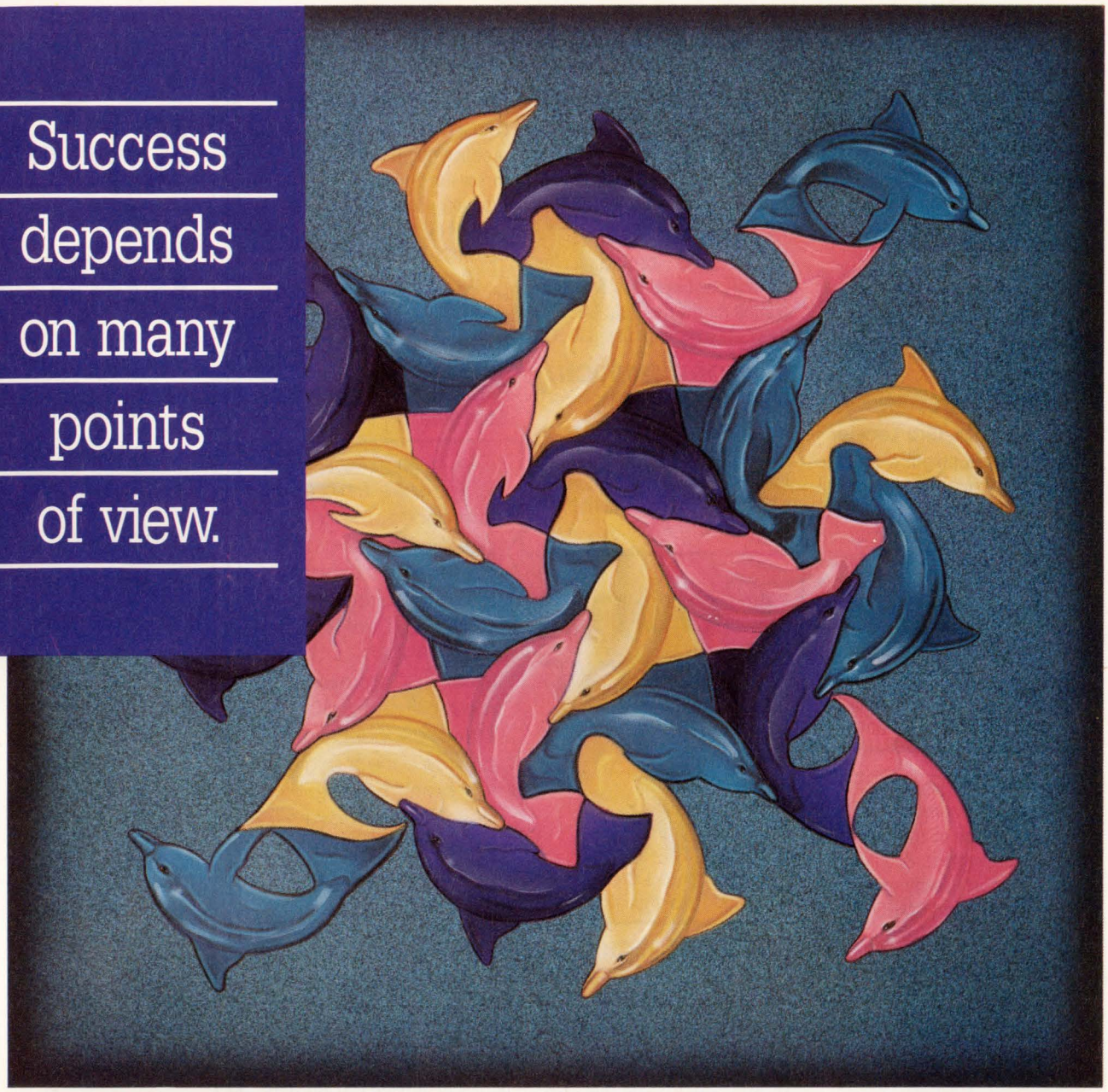

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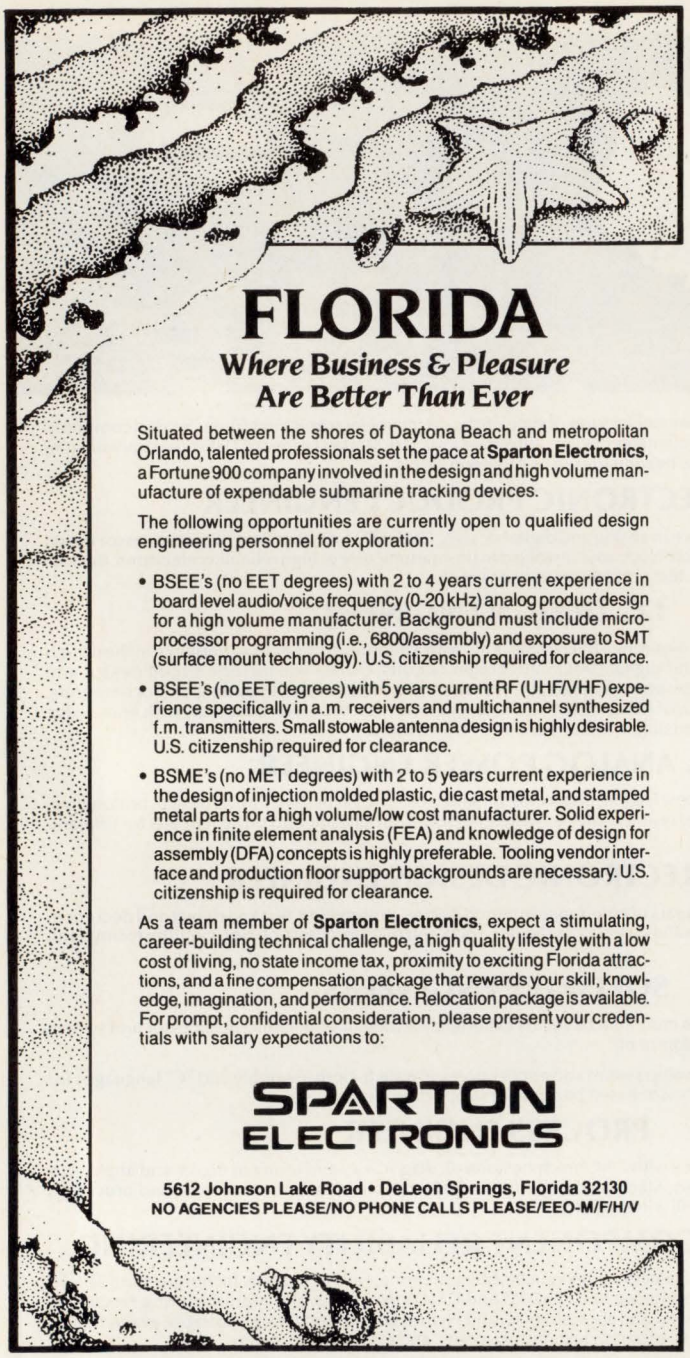

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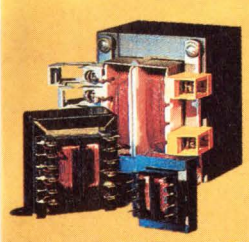

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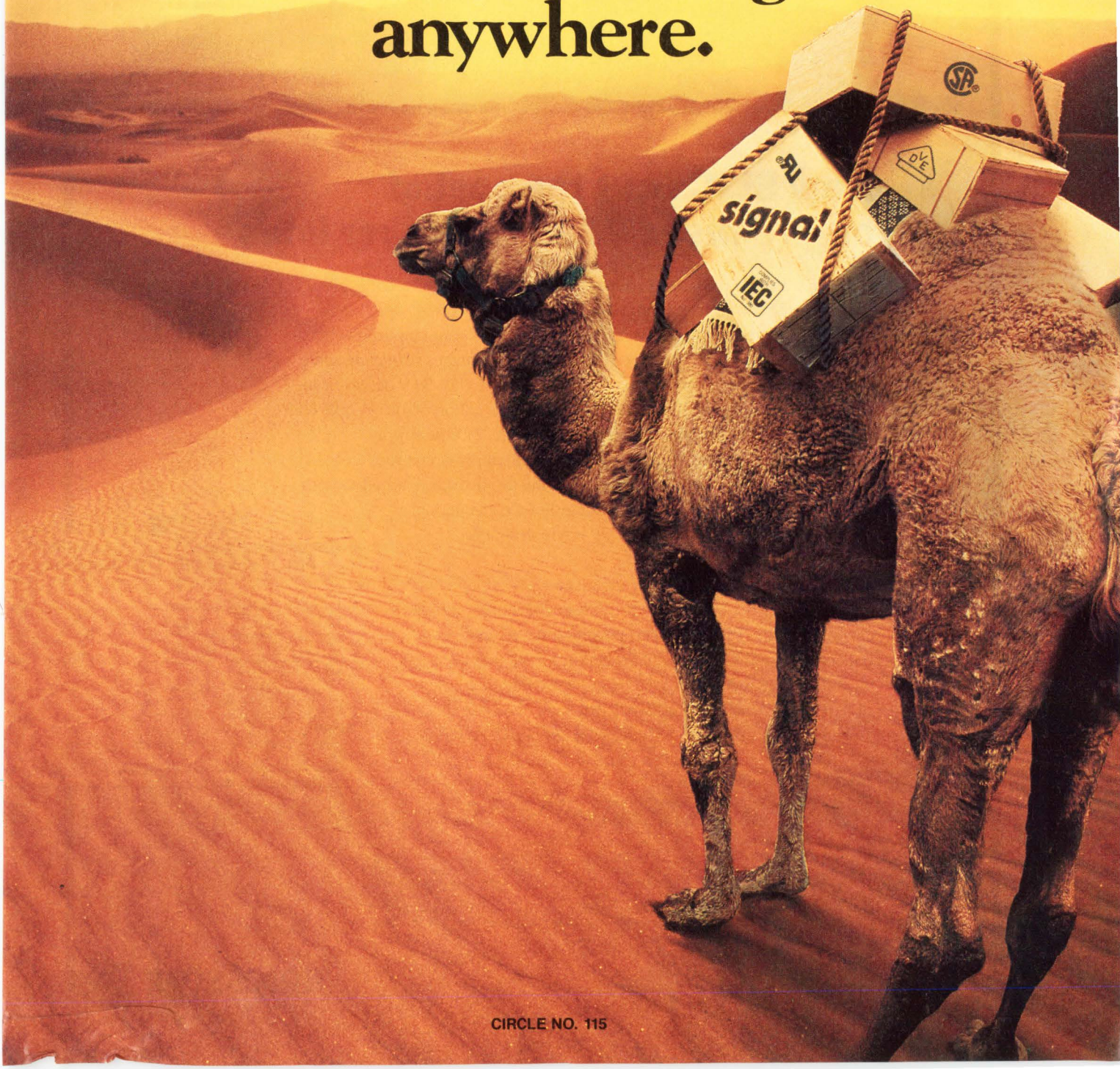

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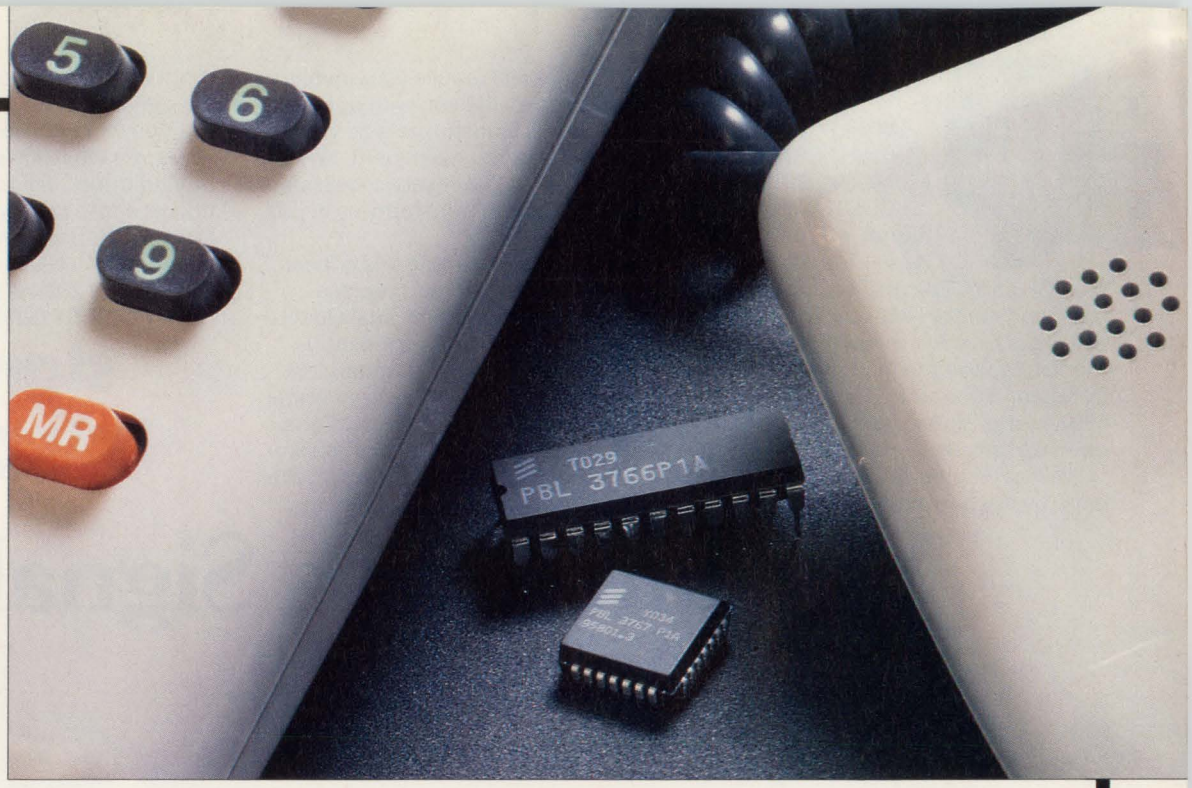

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Both come in a choice of 22-pin plastic DIP or 28-pin PLCC packages with compliant 'j' leads.

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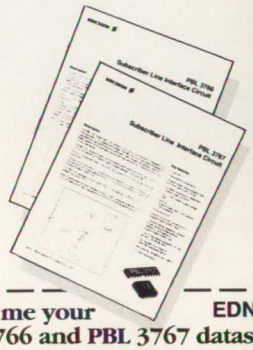

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Freq. Range(MHz)	10-3000		10-2500	
Insert. Loss (dB)	typ.	max.	typ.	max.
10-100MHz	1.3	1.9	1.3	1.7
100-1500MHz	1.1	1.9	1.1	1.7
1500-3000MHz	1.8	2.7	1.8	2.5
Isolation(dB)	typ.	min.	typ.	min.
10-100MHz	60	40	60	40
100-1500MHz	40	28	40	30
1500-3000MHz	35	22	35	22
1dB Compression(dBm)	typ.	min.	typ.	min.
10-100MHz	17	6	17	6
100-1500MHz	27	19	27	19
1500-3000MHz	30	28	30	28
VSWR(ON)	typ.	max.	typ.	max.
	1.3	1.6	1.3	1.6
Switching Time (μsec) (from 50% TTL to 90% RF)	typ. 2.0	max. 4.0	typ. 2.0	max. 4.0
Oper. Temp.(°C)	-55 to +100		-55 to +100	
Stor. Temp.(°C)	-55 to +100		-55 to +100	
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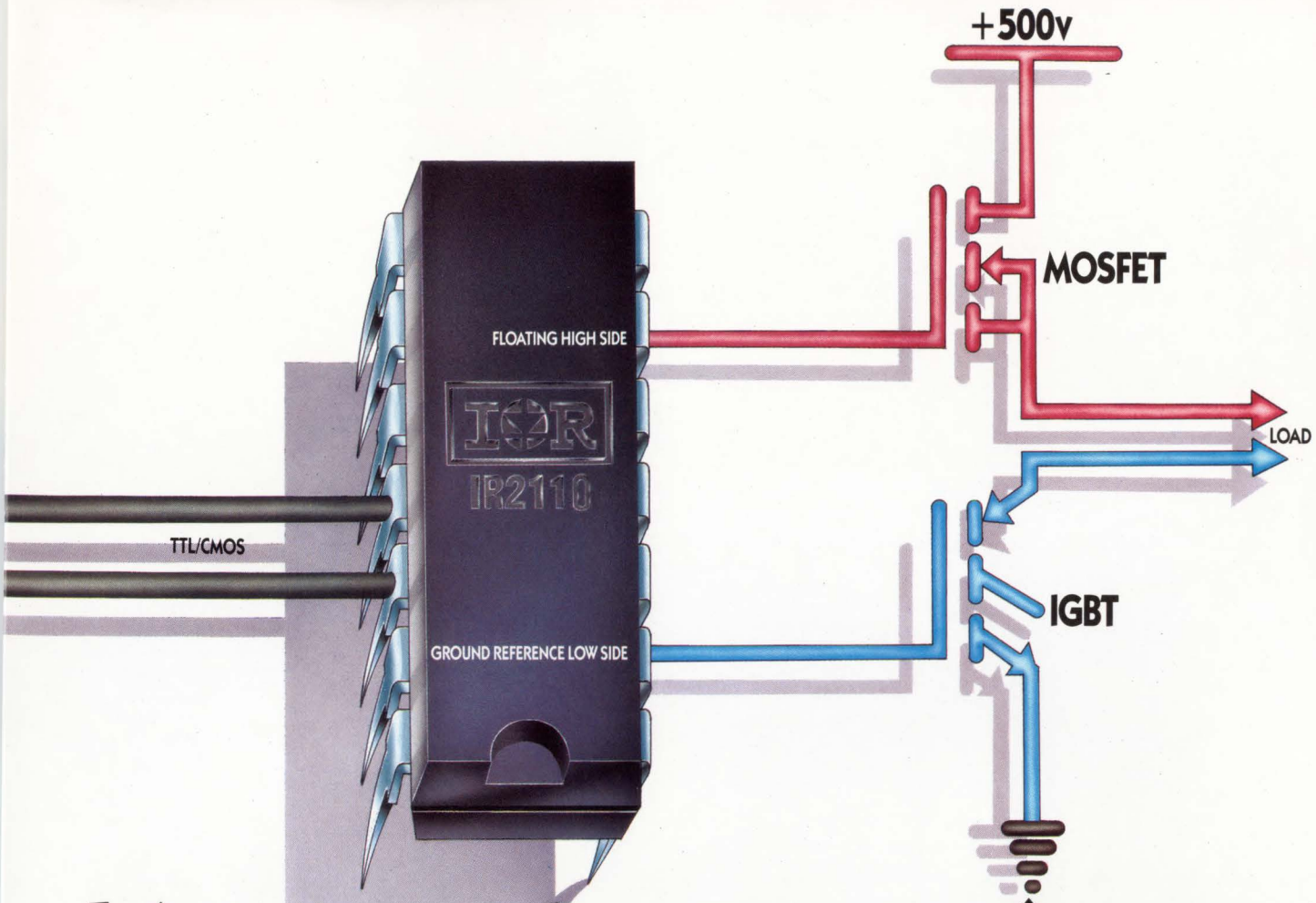

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