ELECTRONIC DESIGN

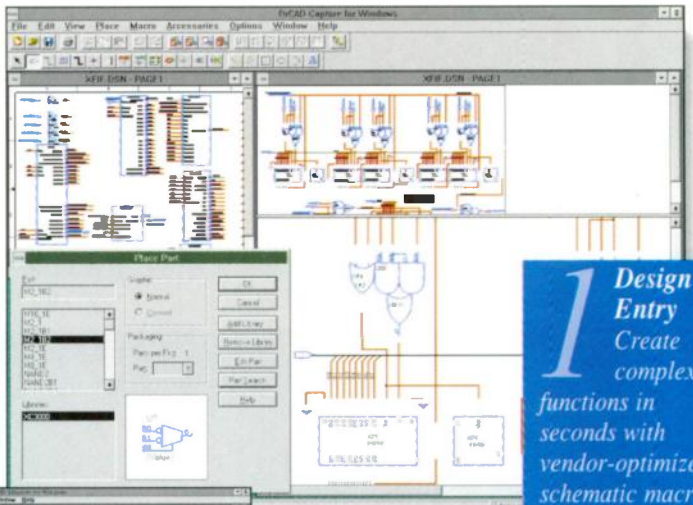
FOR ENGINEERS AND ENGINEERING MANAGERS-WORLDWIDE

A PENTON PUBLICATION $10.00

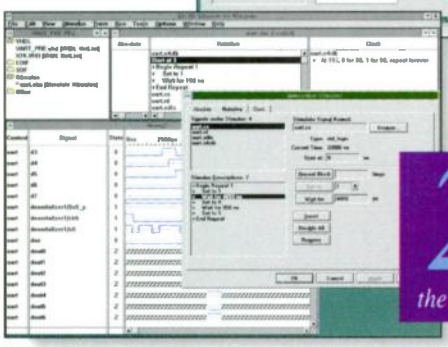
NOVEMBER 4, 1996

USB Chip Set Delivers User-Friendly Peripherals p.69

Five Steps And Your FPGAs Are Finished.



1 Design Entry *Create complex functions in seconds with vendor-optimized schematic macros and the macro recorder.*



2 Modeling *Specify stimulus in easy-to-use dialog boxes—or debug with VHDL, using the built-in editor/debugger.*

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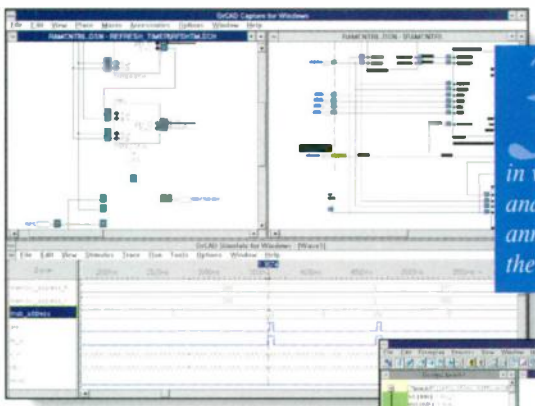
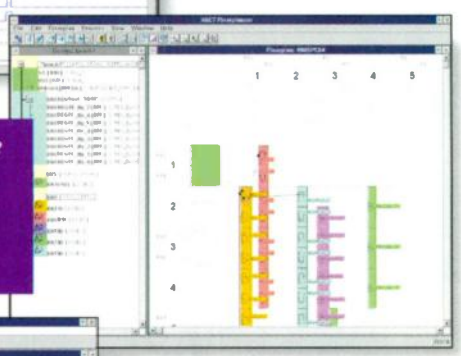
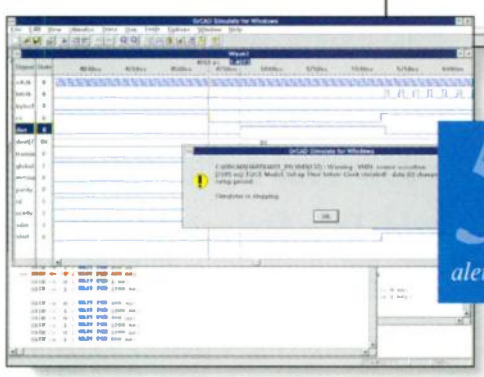


3 Functional Simulation *View results in waveform windows and see signal states annotated directly on the schematic.*



4 Place-and-Route *Press a button to create a netlist for the chosen device vendor's back-end tool.*



5 Timing Simulation *Check the corrected post-route timing in waveform windows, with automatic alert for common violations.*

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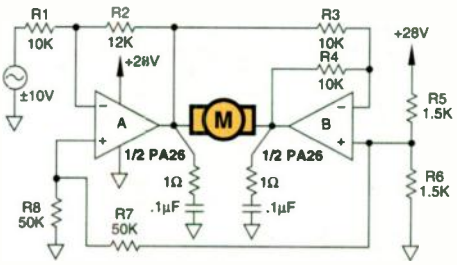
PA26	5V-40V	2.5A x 2	$-V_S$-.3V	1.8V @ 1.0A	SIP[1]	$5.75
PA25	5V-40V	2.5A x 2	$-V_S$-.3V	3V @ 2.5A	TO-3[1]	$22.85
PA21	5V-40V	2.5A x 2	$-V_S$-.3V	3V @ 2.5A	TO-3[1]	$25.15
PA21M[2]	5V-40V	2.0A x 2	$-V_S$-.3V	3.5V @ 2A	TO-3[1]	$76.75

[1] The TO-3 is a hermetic package; the SIP is a non-hermetic package
[2] "M" designates /883 certified military grade



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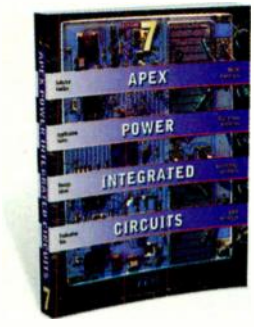

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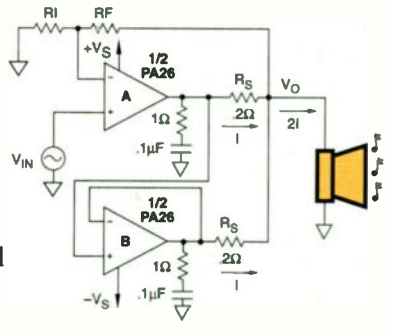

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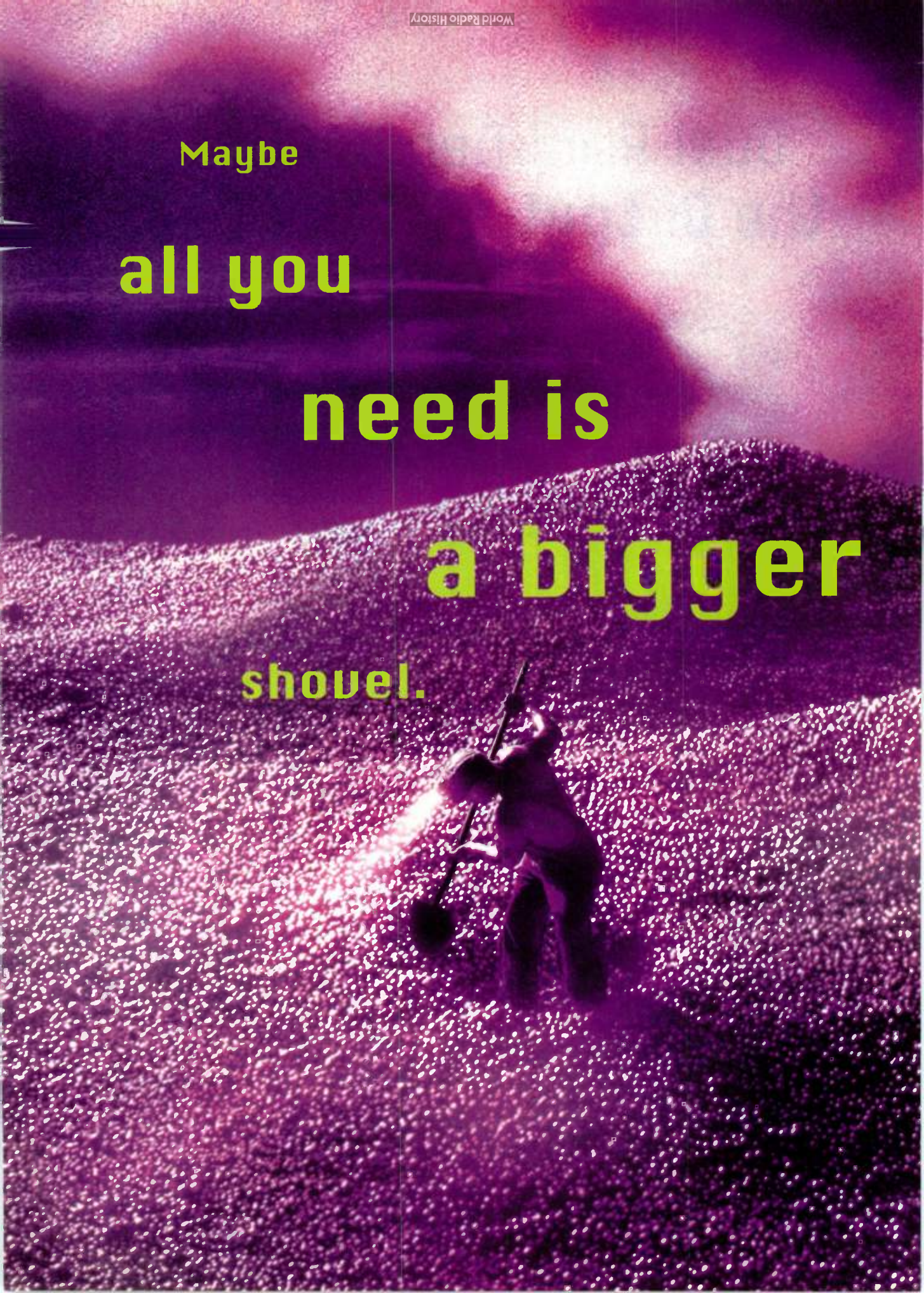
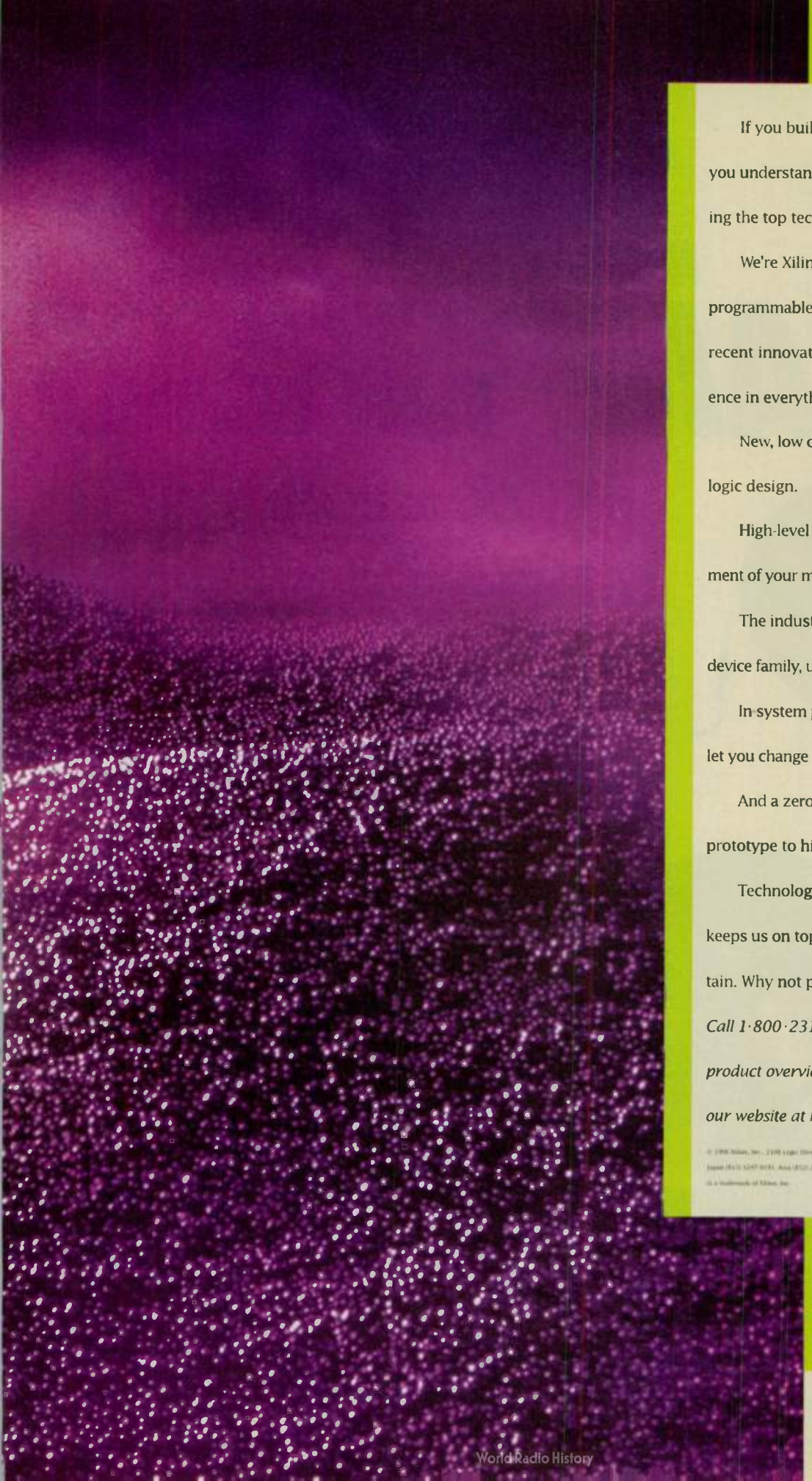
Circle No. 331 - For International





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ERA-2	DC-6000	14.9	14.0	6.0	27	1.95
ERA-2SM	DC-6000	13.1	13.0	6.0	27	2.00
ERA-3	DC-3000	20.2	11.0	4.5	23	2.10
ERA-3SM	DC-3000	19.4	11.0	4.5	23	2.15
ERA-4	DC-4000	13.9	▲19.1	5.2	▲36	4.15
ERA-4SM	DC-4000	13.9	▲19.1	5.2	▲36	4.20
ERA-5	DC-4000	19.0	▲19.6	4.0	▲36	4.15
ERA-5SM	DC-4000	19.0	▲19.4	4.0	▲36	4.20

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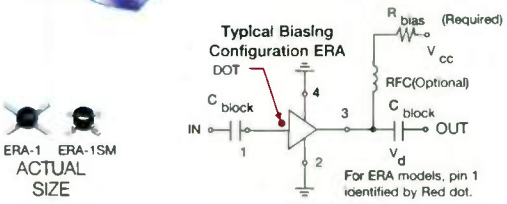
120x60	.002, .047, .068, .1 µf



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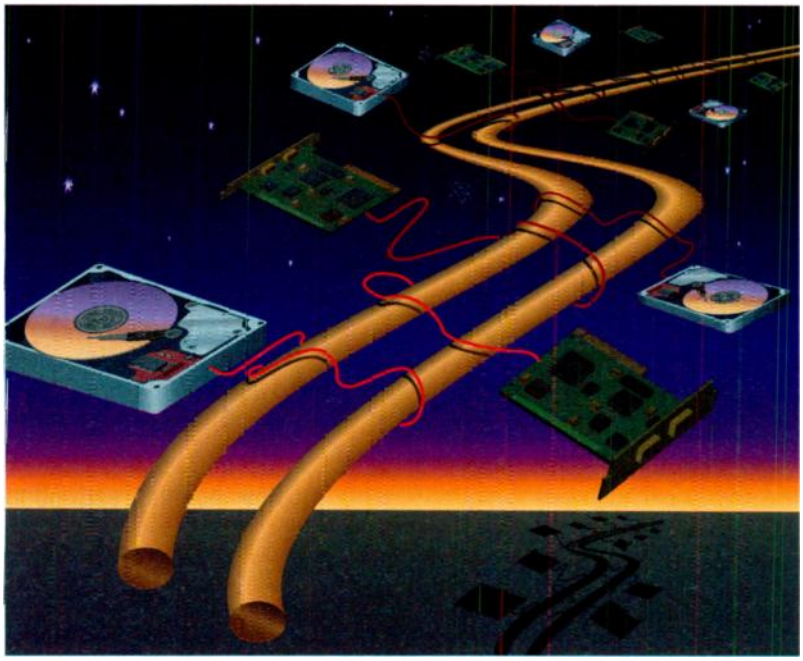
ELECTRONIC DESIGN

November 4, 1996 Volume 44, Number 23

COVER STORY



Chip Set Targets The Universal Serial Bus p. 69

USB chip set of hub, transceiver, and codec promises to make neater and smaller sealed PCs with ports for new peripherals and CD-quality audio.

FEATURES

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ELECTRONIC DESIGN

November 4, 1996 Volume 44, Number 23

DEPARTMENTS

Jesse H. Neal Editorial Achievement

Awards: 1967 First Place Award
1968 First Place Award
1972 Certificate of Merit
1975 Two Certificates of Merit
1976 Certificate of Merit
1978 Certificate of Merit
1980 Certificate of Merit
1986 First Place Award
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COVER ART: MARGARET ENDRES

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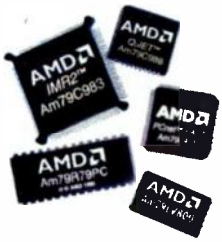

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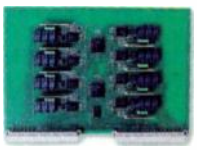

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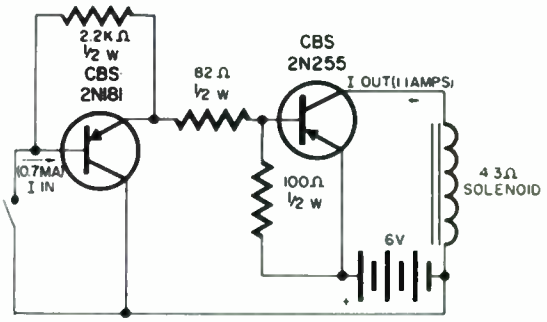
AMD

Low-Cost Power Transistors

Competitively priced with vacuum tubes, two new power transistors have been announced which are designed expressly for experimental purposes. The pnp germanium alloy junction semiconductors are hermetically sealed and each incorporates a metal mounting flange electrically connected to the collector for good heat dissipation. With a heat-sink, both the 2N255 and the 2N256, manufactured by CBS-Hytron, Danvers, Mass., are rated at 6.25 watts. The two transistors are electrically similar. The primary difference is that the 2N25 is intended for use with 6 volt power supplies and is rated at 15 v maximum, while the 2N256 is designed for 30 v maximum, utilizing a 12 v supply. Maximum ratings include 3 amps steady state dc collector current and operation from –40 to +85C. Alpha cutoff frequency is 200 kc at 25 C. Several methods of mounting are practical for amplifier circuitry. For grounded collector circuits, the transistor flange may be fastened directly to the chassis. A heat-radiator plate insulated from the chassis can be used for other circuits; if high heat dissipation is not required, the base pins support the transistor with the collector circuit lead fastened directly to the flange. The two heavy plug-in leads fit standard 9-pin miniature sockets.*(Electronic Design, November 1, 1956, p. 24)*



CBS-Hytron was one vacuum-tube manufacturer who attempted the change-over to semiconductors. But like most of the former tube makers, CBS dropped by the wayside as new, strictly semiconductor companies emerged—SS

Editorial: Common Sense is not the Answer

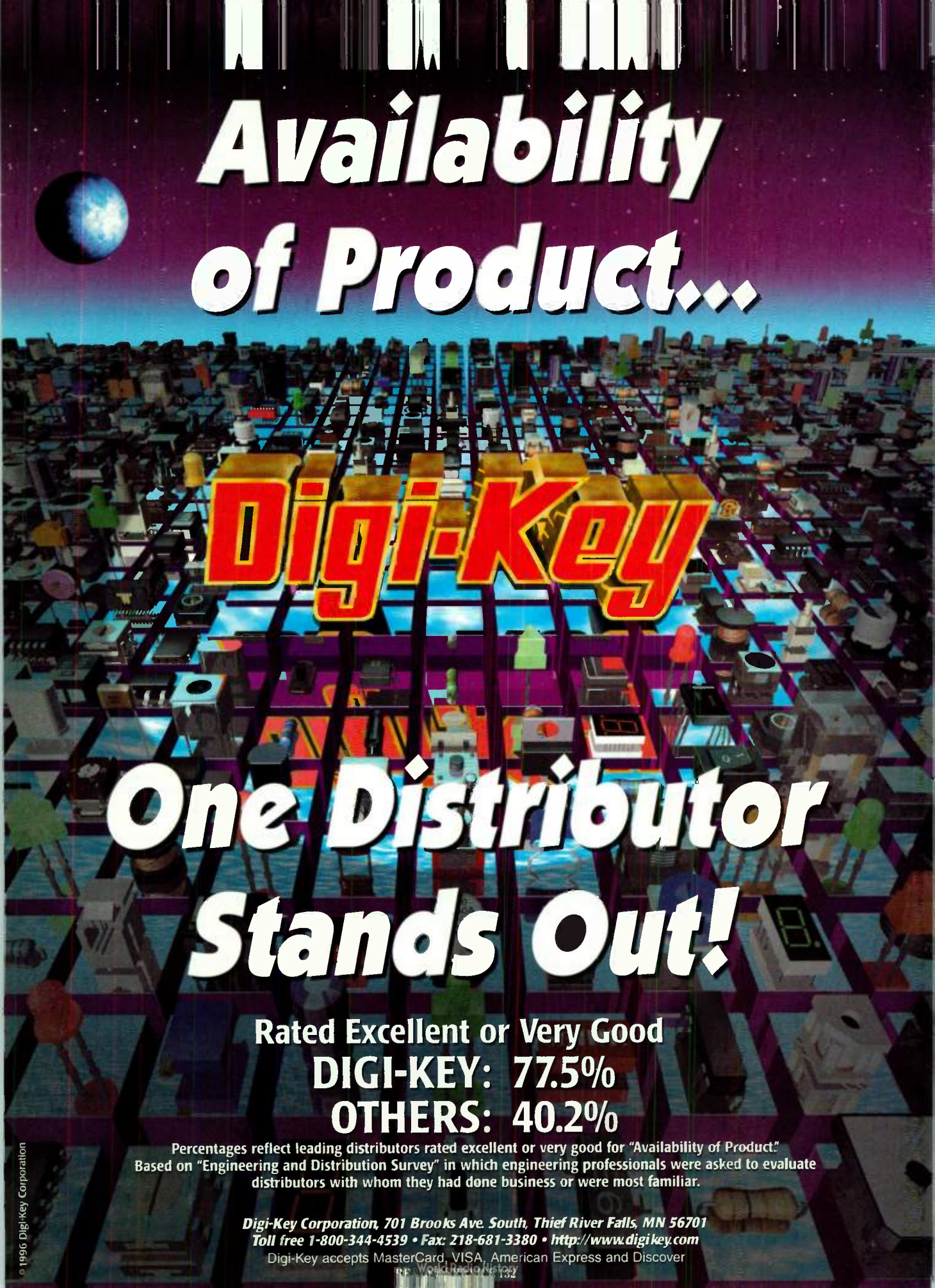
Only about five per cent of all engineers can be classed as really creative, according to a leading research director. From this small body must come the really significant ideas. Should technological superiority be the test for the survival of America, creative talent is of first order concern to us.

"Average" engineers, duly proud of being endowed with common sense, might take exception to the statement that they are not the really creative types. After all, is it not the designer's daily application of common sense that has come up with practical answers to many of our technical problems?

But just how good is the common sense approach? The revolutionary discoveries of relativity theory and quantum mechanics came about despite common sense. Length and weight changing with motion? Ridiculous. Quantum theory explains things which could not be understood on the basis of common sense views of matter held at the time. You can't predict transistor operation from every day electron flow theories. For that matter, common sense would have made the odds on the Tower of Pisa experiment astronomically high. According to scientist P.W. Bridgman, "We cannot regard man as well educated who does not intuitively recognize that common sense can't be taken for granted."

Common sense has yet to produce a simple 100 per cent reliable connector. Mr. J. Toyzer of RCA at the Radio Fall Meeting challenged us to try wholly new concepts to overcome the deficiencies of soldered joints. The engineer who discards old common-sense assumptions and comes up with a new approach could become as famous as de Forest or Einstein overnight.—JAL*(Electronic Design, November 15, 1956, p. 4)*

Managing Editor James A. Lippke raises points that are still worth thinking about. He had a long career as an engineer-editor at Electronic Design and other magazines, and is still active in the industry.—SS



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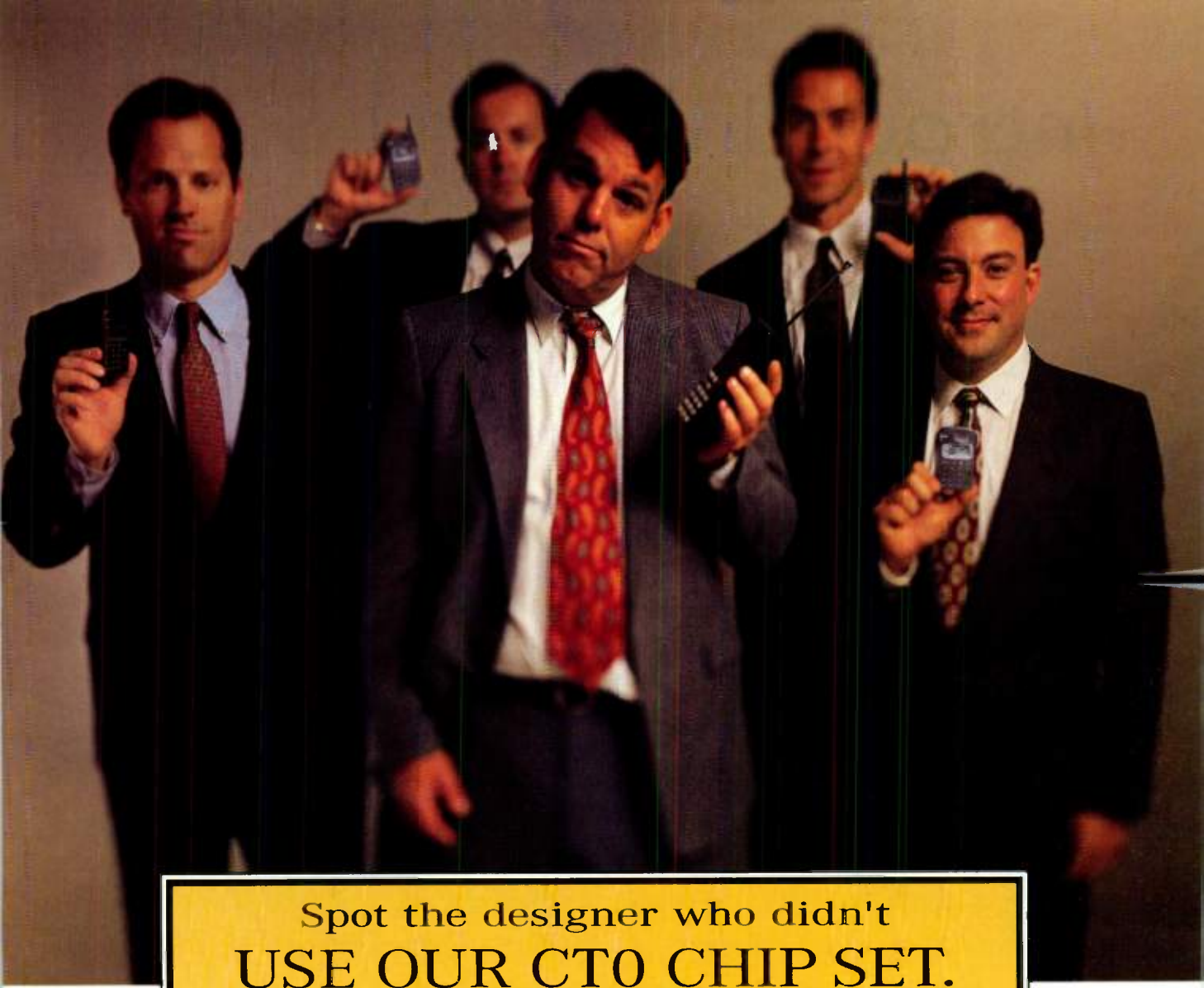

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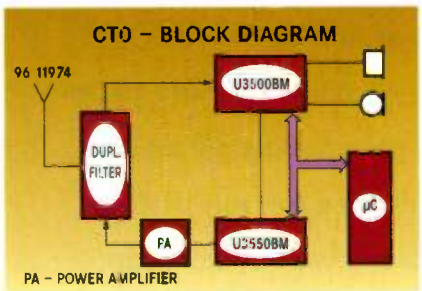

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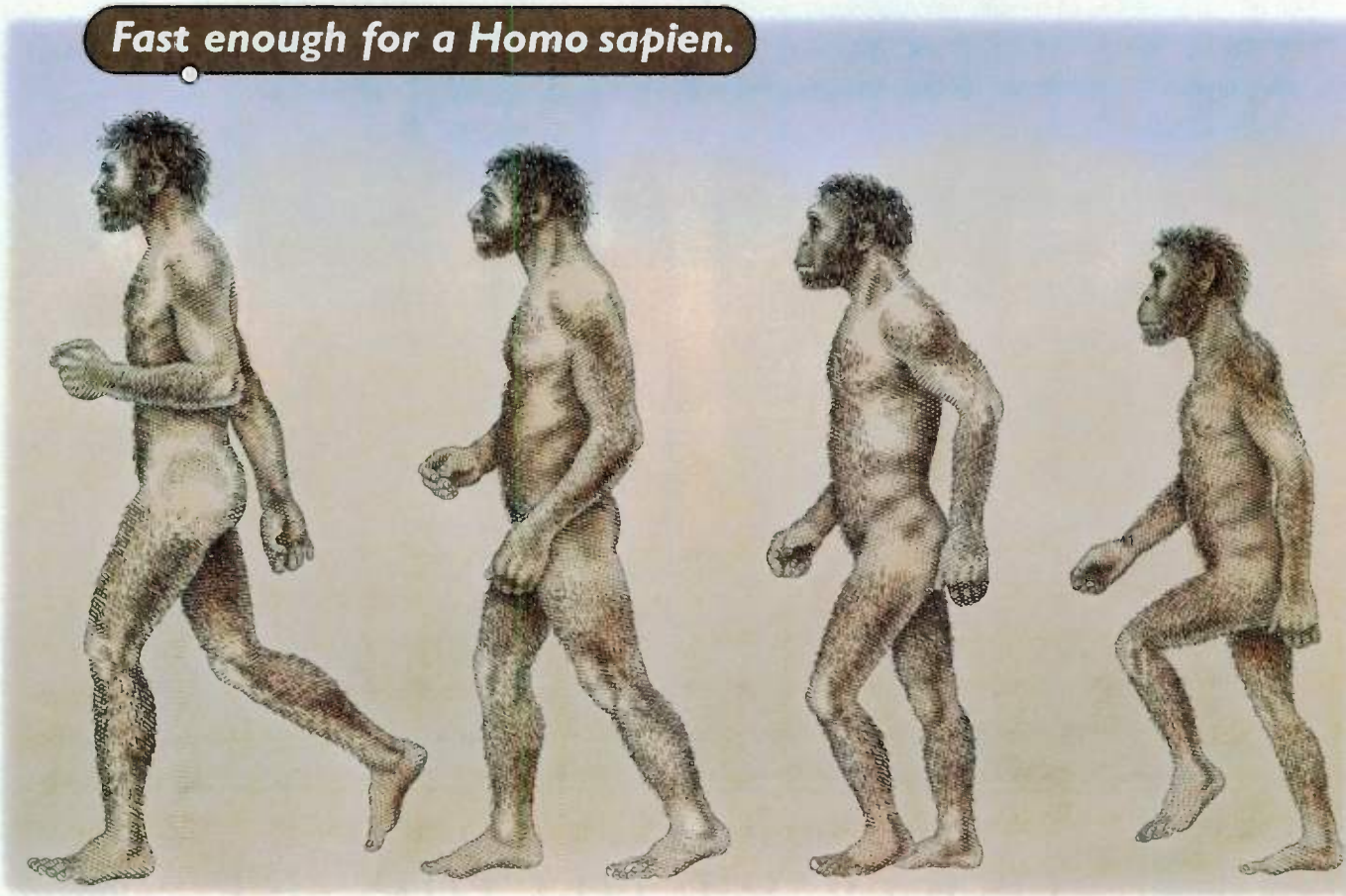

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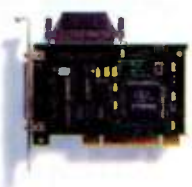

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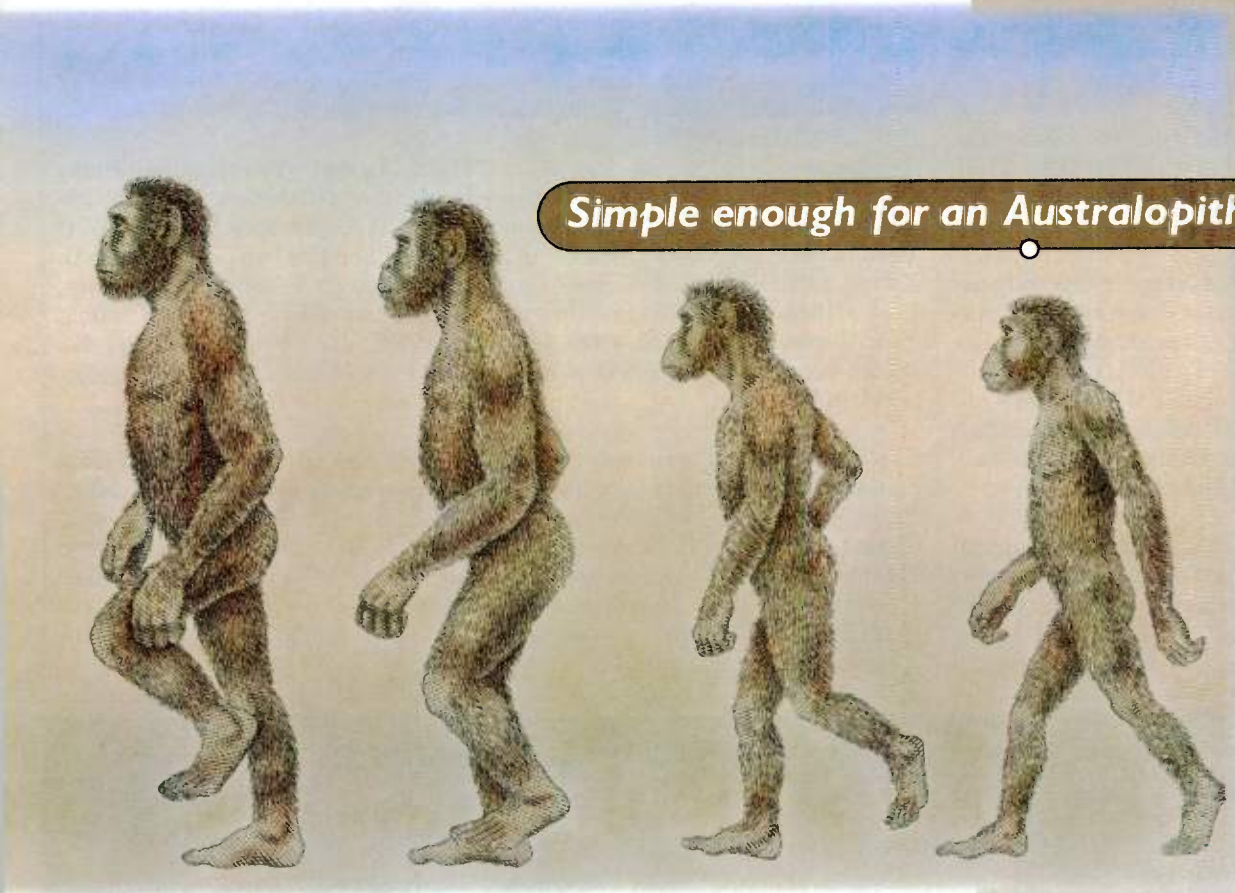

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LEOS 96, Nov. 17-22. Westin Hotel, Boston, MA. Contact Melissa K. Estrin, IEEE/LEOS, 445 Hoes Ln., Post Office Box 1331; Piscataway, New Jersey 08855-1331; (908) 562-3896; fax (908) 562-8434; e-mail: m.estrin@ieee.org.

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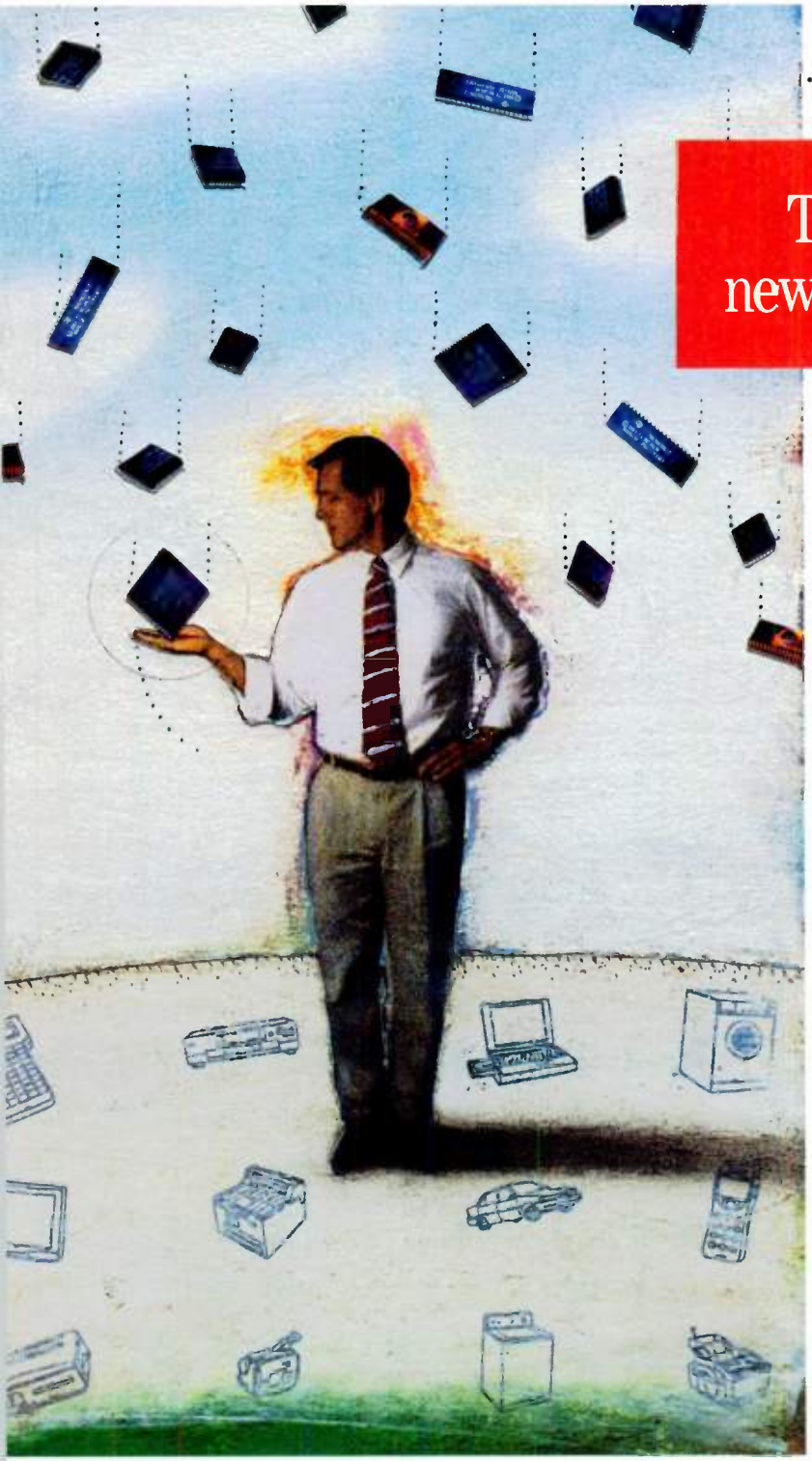

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GPS Revisited

My September 3 editorial titled "GPS and I" attracted quite a bit more attention than I ever expected. As an avid but relatively inexperienced hiker who does not want to find himself lost, I had written it mostly to warn against the folly of blindly trusting in technology as a substitute for knowledge and thought. The subject seemed to me to be only slightly more controversial than the proverbial motherhood and apple pie, so you can imagine my surprise when a flurry of e-mail messages popped up in my mailbox. Some were supportive, but others varied from polite attempts to correct my misconceptions about Global Positioning System (GPS) technology to flames that intimated I was either an idiot or insane.

I must admit that there were a few incorrect statements in the editorial, the two most significant being that "inexpensive" GPS receivers cost in the $300 to $500 range (they cost less than $200) and that it can take as long as 15 minutes to provide an accurate reading (that's true only in the most extreme cases; a couple of minutes is the norm). This was bad information and I apologize for not researching the subject more thoroughly.

But as it turns out, there are some potentially serious problems with GPS. This is according to another of my correspondents, none other than Bob Pease, our resident iconoclastic columnist and staff scientist at National Semiconductor.

Bob is an avid hiker, so this is a subject near and dear to his heart. He was kind enough to send me a sheaf of correspondence he has been conducting with other engineers much more knowledgeable about GPS than me. The most significant problem has to do with the turning of the century in about four years. The calendar in GPS receivers will rollover, but they will rollover at midnight, August 21-22, 1999. That marks the end of the GPS 1024-week count that began in 1980. At that time, many GPS receivers will claim that it is January 6, 1980, when the original count began. To correct this problem, the firmware in many GPS receivers will have to be changed.

Another problem has more to do with the user than it does with GPS. Pease says that you have to set the GPS receiver to the Datum that matches your map. Most U.S. Geological Survey maps use North American Datum 1927 (NAD27), but his receiver's default Datum was WSG84. When Pease reset the Datum to NAD27, the receiver gave him readings within 50 yards of where he really was—instead of being 200 yards off.

It just goes to show that even though the original editorial was wrong on a few points, its message was right on target. *jshandle@class.org*

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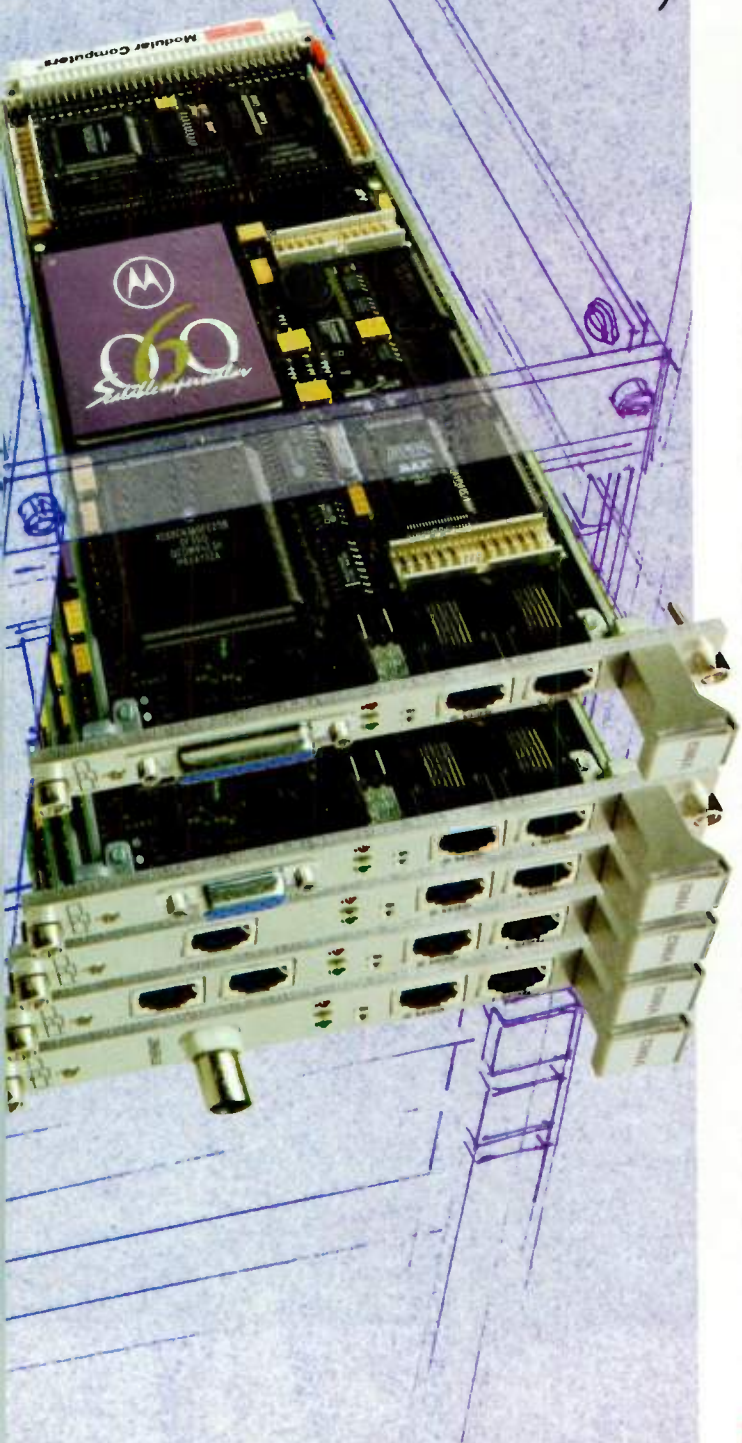

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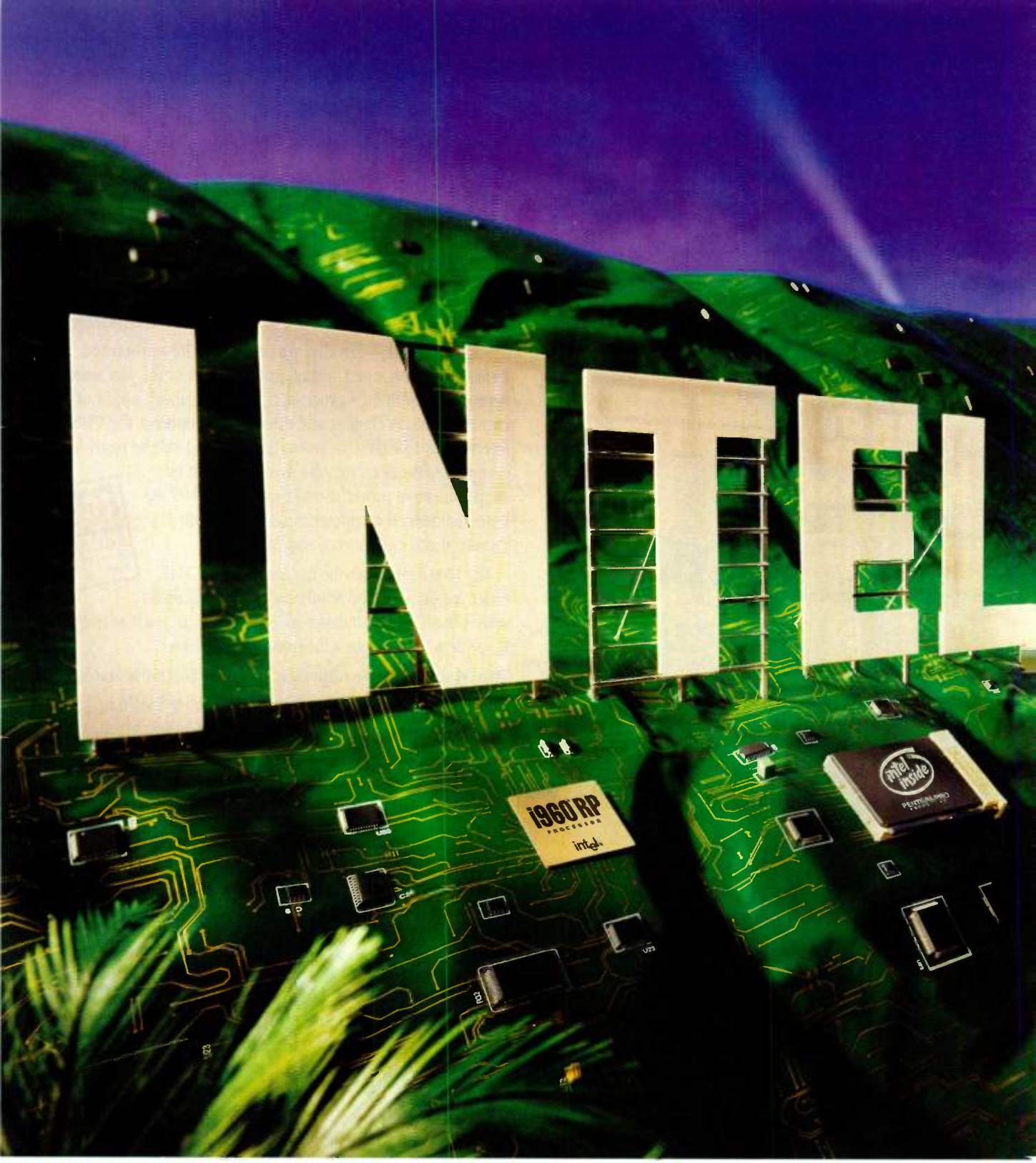

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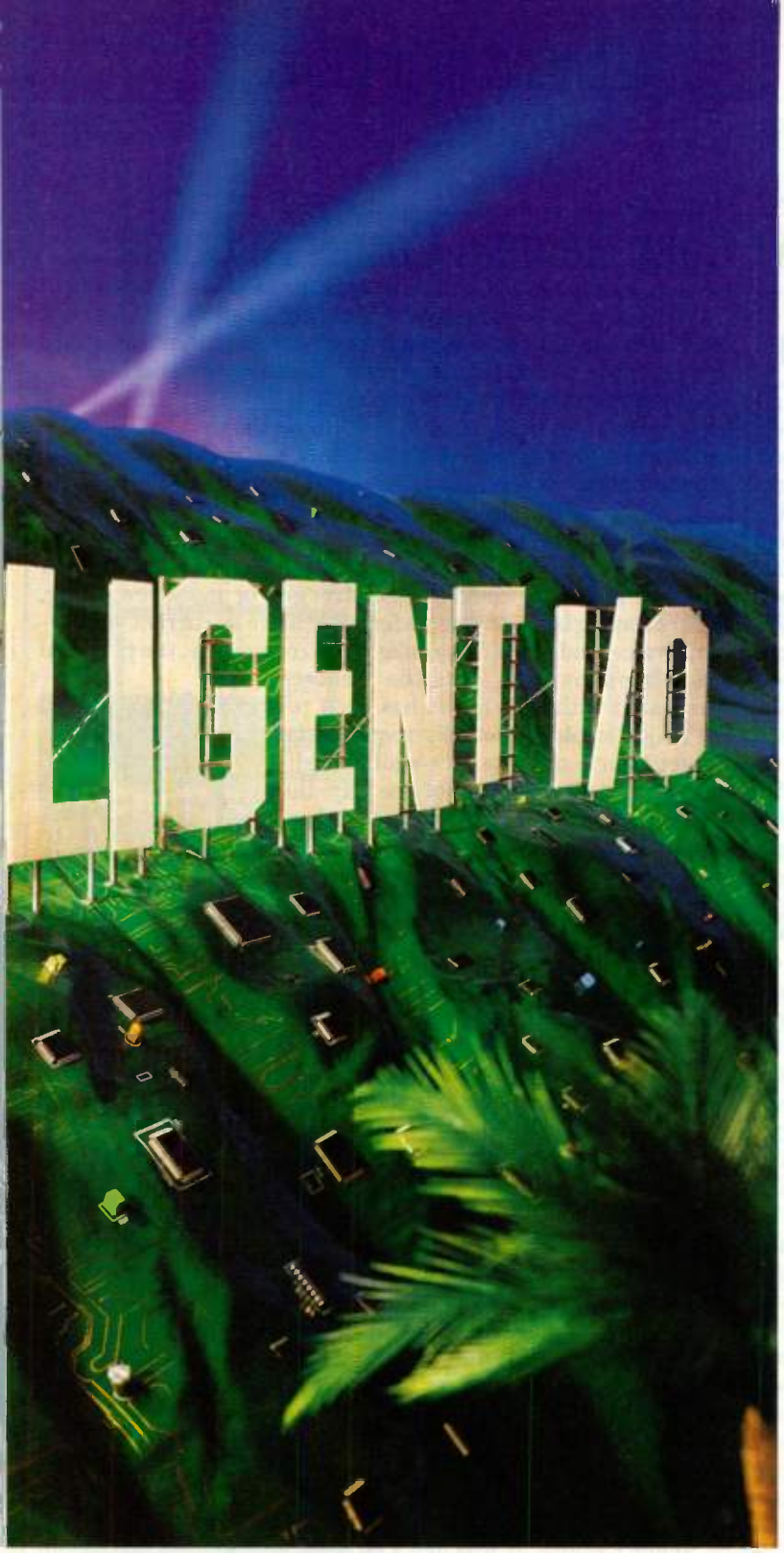

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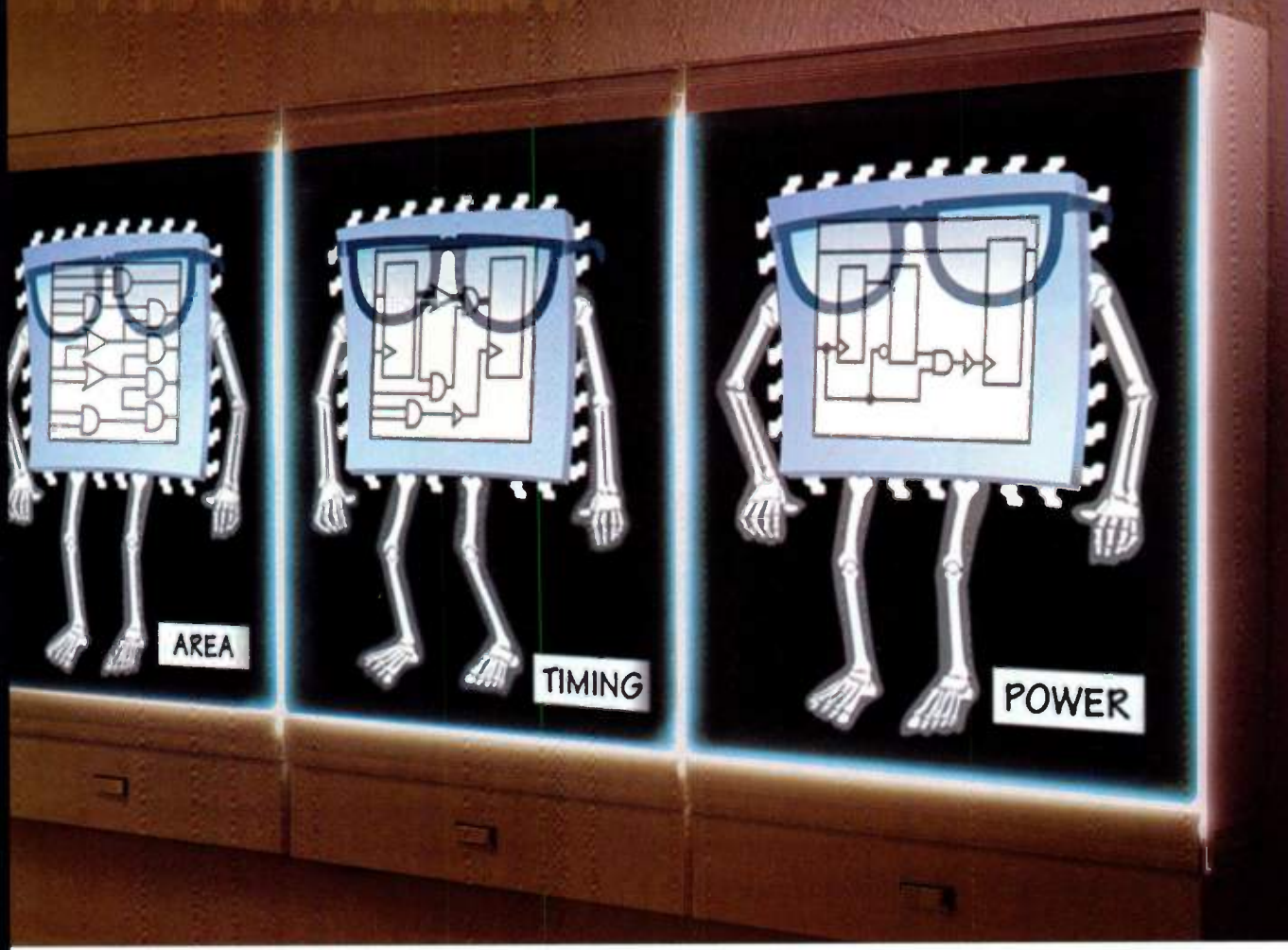

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Blue-Purple Laser Emits 417-nm-Wavelength Beam

An important step was taken toward realizing a laser that offers the short-wavelength, high-power, and continuous-wave operation required for future DVD technologies. A blue-purple semiconductor laser that emits a pulsed laser beam with a wavelength of 417 nm at room temperature is the culmination of work done by researchers at Toshiba Corp., Tokyo, Japan. The prototype laser (5-A threshold current, 20-V operating voltage) uses a gallium-nitride compound as its basic material because the researchers felt that the III-V material is more suitable for producing a stable, short-wavelength laser beam than other materials, such as the II-VI compound zinc selenide. Two breakthroughs brought about the laser-emission development. The first involved successful fabrication of very thin layers of GaN-compound crystals in a multi-quantum-well structure. Basically, the layer's fineness determines how easily a laser beam can be emitted. The second breakthrough was using dry etching to cleave the GaN crystal grown on the C-face sapphire substrate to assure a smooth surface. The only drawbacks are that dry etching is more expensive and requires more manufacturing processes than typical cleaving procedures; however, it will become more practical when the lasers are commercialized. Contact Toshiba at (03) 3457-2105; fax (03) 3456-4776. *RE*

CCD Image Sensor Consists Of Over 60 Million Pixels

A team made up of researchers and semiconductor process engineers at Philips, Eindhoven, The Netherlands, constructed the largest CCD image sensor array (imager) to date. A form of true "wafer-scale" integration, the imager contains over 60,000,000 12-μm pixels. The imager takes up over 9000 mm^2, virtually filling the 6-in.-diameter wafer used by the process. The array was made possible thanks to advances contributed by the team's process engineers. For instance, they developed a technique that joins small CCD imager arrays of 1 million pixels to form the large arrays. Images from the ultimate large array aren't appreciably distorted by the fabrication technique. At present, the largest array possible on a 6-in. wafer would contain 63 million (9000 by 7000) pixels. However, using the same masks, smaller arrays can be located in the periphery of the wafer around the large array. The modular technique works because of the redundant nature of a typical CCD array's architecture. Initially aimed at telescopes (most of which have replaced film with similar large CCD imagers), the modular technology may find its way into medical and photographic applications. *FG*

TIA Standards Target Cellular Mobile Service

A series of four American National Standards (ANS) aimed to ensure compatibility between cellular mobile stations and corresponding systems were published by the Telephone Industry Association (TIA), Arlington, Va. The key standard, TIA/EIA-627, homes in on the aforementioned compatibility. Compatibility is defined to mean that any mobile station can place and receive calls in any cellular system. Consequently, all cellular systems are able to place and receive calls with any mobile station, and, in a subscriber's home system, all call placement must be automatic. Furthermore, it's preferable that call placement be automatic when a mobile station is in roam status. The other three standards (-628, -629, and -635) are more or less extensions from TIA/EIA-627, each of which having to fall within the compatibility parameters of that standard. The EIA-628 deals with the mobile station, the EIA-629 concentrates on the cellular switch and cell-control equipment, and the EIA-635 gives details for the full-rate speech codec. The codec is intended to be used at both dual-mode mobile stations and at compatible base stations in the cellular service. For copies of the documents, call Global Engineering Documents at (800) 854-7179. For information regarding the TIA, visit their web site at http://www.tiaonline.org. *RE*

Power-Component Standards Spur U.S. Navy Grant

In a move to save cost and energy, the Office of Naval Research awarded over $1 million in grants to a consortium of three universities to develop an approach for standardizing power-electronics components. Research centers at Virginia Polytechnic Institute and State University, the leader of the group, North Carolina State University, and the University of Wisconsin will partake in the effort. Their goal is to create lightweight, customized, energy- and cost-efficient power-electronics building blocks (PEBBs). PEBBs are standardized forms of power-electronics components, such as semiconductor materials, circuits, controls, sensors, and actuators. Specifically, the U.S. Navy wants to use

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NEW UNDERSTANDING OF PHOSPHOR LIGHT GENERATION TO ENABLE THE DEVELOPMENT OF PHOSPHOR FEDS

Until now, very little was known about the mechanism that enables crystalline materials called phosphors to emit light. This lack of information, while not preventing phosphors from being successfully utilized in television CRTs, made it quite difficult to find ways to overcome the current performance limitations on phosphors that are used in field-emission displays (FEDs). Consequently, it was nearly impossible to eliminate the characteristic demands for high voltage, high power, and high density that are associated with phosphors.

Scientists from Sandia National Laboratories, Albuquerque, N.M., recently found evidence to suggest that the phosphor's own surface chemistry may hold the key to unlocking the mystery. They discovered this while examining the process by which green light is emitted from a zinc-oxide compound. Careful observation of the zinc-oxide revealed surface defects consisting of missing oxygen atoms *(Fig. 1)*.

When the material was energized via a mild current to produce light, it became apparent to the scientists that the emitted light originated with the single electrons remaining in the previously noted surface defects. Consequently, Sandia's scientists were able to determine that the amount of light emitted was dependent on the material's surface defects and not on its overall thickness, as was previously thought. In addition, they also learned that by changing the surface chemistry of the material, its luminescence could be increased.

Funded by a $1 million, 3-year grant from the U.S. Department of Defense's Advanced Research Projects Agency (DARPA), this important work has a number of widespread implications for the display industry. Primarily, since it enables a method of increasing luminous efficiency without increasing display weight, it can be targeted toward more portable display applications.

Today, many of these portable applications are being addressed with liquid-crystal display (LCD) alternatives. However, these LCD devices are hampered by obstacles so performance-critical that the display industry has been frantically searching for other viable solutions.

For example, LCDs have limited viewing angles and screens that can easily go blank in direct sunlight environments or in environments subject to rapidly changing temperatures. And due to the inherent nature of the LCD's construction, the display must be entirely backlit. This is a virtual sinkhole for battery power.

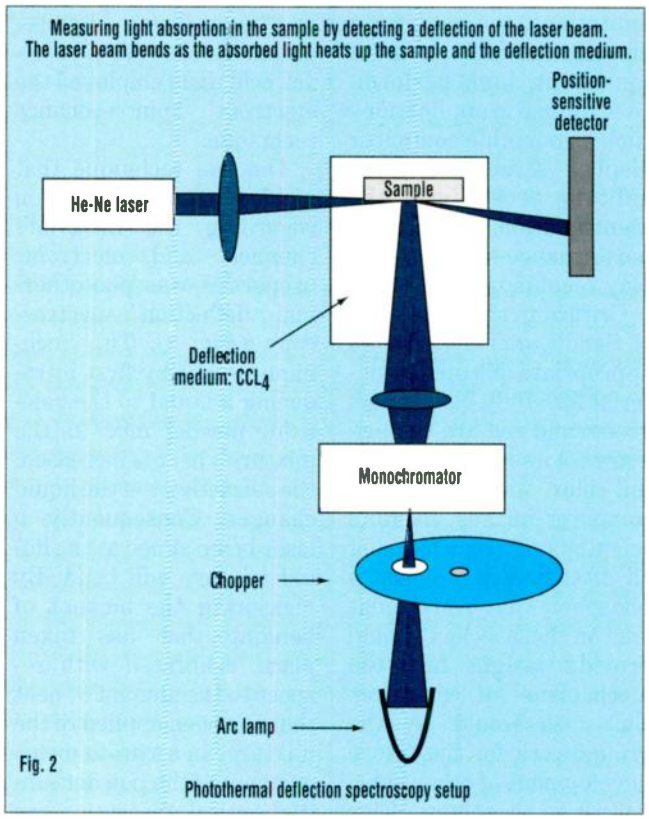

Fig. 2 Photothermal deflection spectroscopy setup

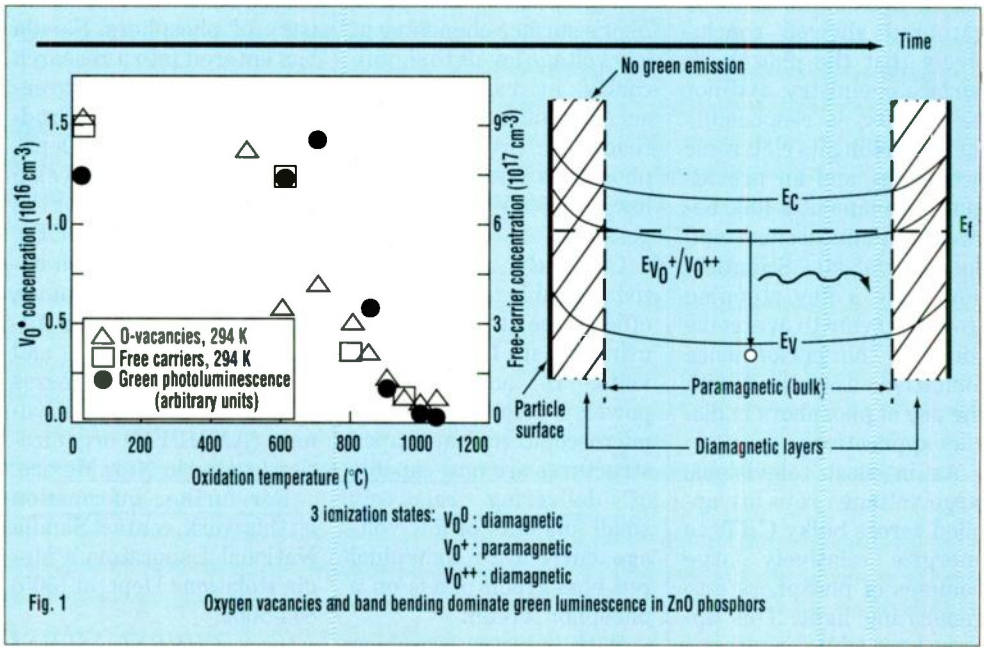

Fig. 1 Oxygen vacancies and band bending dominate green luminescence in ZnO phosphors

While many advances in conventional LCD technology have sought to address these performance limitations, the need for a display that's capable of consistent, high performance for use in applications such as portable computer display screens for the military necessitates the identification of a more performance-suited display technology.

Critical to the work done at Sandia was choosing an appropriate phosphor material for study. Since blue, green, and red are the primary colors needed to form full-color television and computer images, Sandia's scientists felt that focusing all of their attention on a phosphor that could emit one of these colors would provide insight into the mechanism of emission. This also would lay the groundwork for the future development of other light-emitting phosphors. Zinc oxide, a green-like light-emitting phosphor, was chosen for its simple, two component lattice as opposed to the more conventional three- to five-component lattice. As Sandia scientist David Tallant explains, "Zinc oxide does not quite have the right chromaticity—it doesn't look naturally green, like green grass. But the color can be balanced. It also can be used in monochrome displays. We used that material to tune up a method to study other phosphors."

To assist in its study of the zinc-oxide phosphor, Sandia leveraged the extensive educational and research experience of its scientists with a number of key spectroscopy techniques. Using a technique known as cathodoluminescence, scientists observed light emission from the zinc oxide while it was being bombarded by electrons at a variety of voltages. To observe the emission of light in even-finer detail—atomic-level detail to be exact, scientists employed the electron spin-resonance technique.

The one technique that yielded crucial information regarding the material's chemical and electronic properties was photothermal deflection spectroscopy *(Fig. 2)*. This technique works by first introducing a liquid to the zinc-oxide powder mix. As the mixture's heat is increased, the refractivity of the liquid changes. Consequently, a laser beam aimed at the liquid mixture will bend. By measuring the amount of bending that has taken place, calibrated with respect to the amount of heat that has been applied to the mixture, an accurate measurement of the powder's initial optical absorption can be obtained. Measurements of the amount of light absorbed at different wavelengths also can be ascertained using this technique *(Fig. 3)*.

The information that was gathered showed conclusively that the phosphor's surface chemistry, and not its density, is responsible for controlling its electronic properties, and for providing a fundamental link between luminescence and specific defects. Scientists now have a key stepping stone in trying to overcome some of the performance limitations associated with the use of phosphors in display applications.

As in most televisions, large voltage drops are applied across bulky CRTs to energize relatively large volumes of phosphors into generating light. This approach typically requires a high voltage, on the order of 25 kV. And when incoming energy drops below 5 kV, the efficiency of light generated degenerates significantly. Both are unacceptable if the phosphor FED is to be utilized in battery-powered portable type applications.

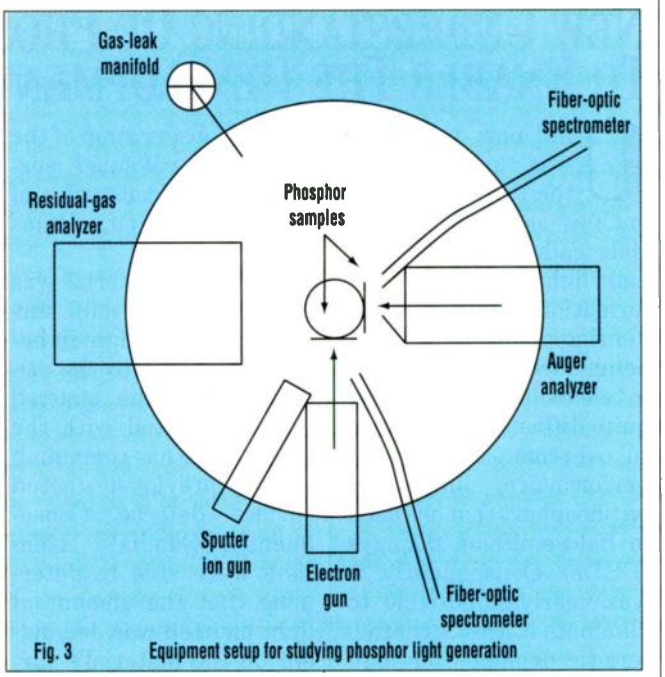

Fig. 3 Equipment setup for studying phosphor light generation

Using the information obtained from studying zinc oxide, these limitations can be easily overcome through manipulation of the phosphor's surface chemistry at low voltage levels to significantly increase performance. Sandia's Scientists already are predicting that phosphors operating at as low as 0.5 kV will now be possible.

Currently, these scientists are able to benchmark efficiencies at low voltages using a mere few thousand volts. In addition, less power is required because microscopic conical-shaped structures are now capable of delivering relatively small amounts of low-voltage current to individual red-blue-green pixels on a phosphor screen.

With industry searching for high-performance, low-voltage, low-power display options, the development of an optimized phosphor FED may be just the answer they have been looking for.

In addition to a home in military display applications, phosphor FEDs are expected to find use in commercial laptop computers and portable TVs.

As an offshoot of the research on the surface chemistry of phosphors, Sandia has entered into a research and development agreement with Motorola's Product Development Dept., Phoenix, Ariz., to develop improved phosphors for the company's flat-panel FEDs. The R&D effort, which began this past September, will be overseen by the Advanced Materials and Manufacturing Processes for Economic Competitiveness (AMMPEC) organization located in New Mexico.

For further information on this work, contact Sandia National Laboratory's Media Relations Dept. at (505) 844-8066.

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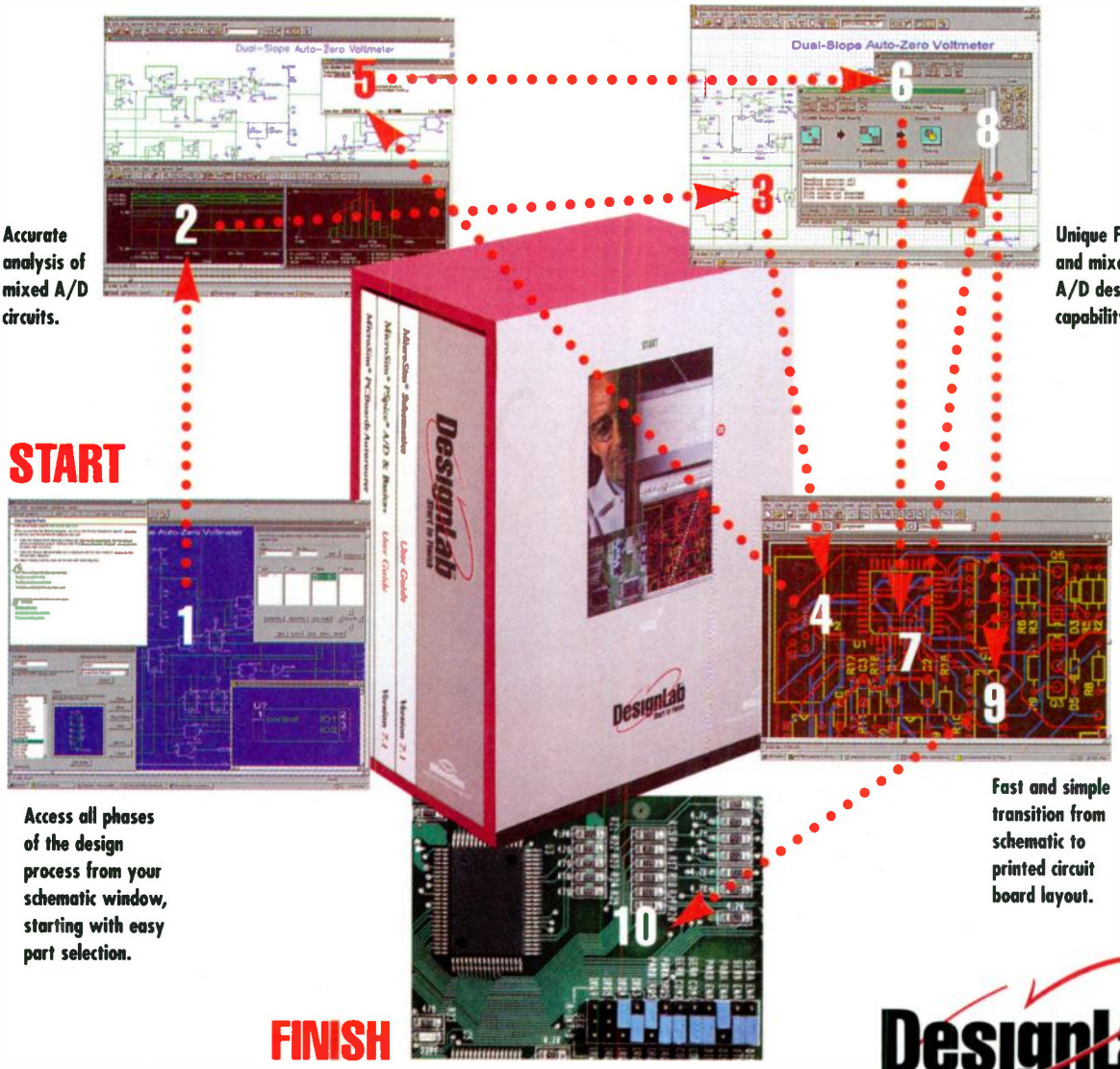

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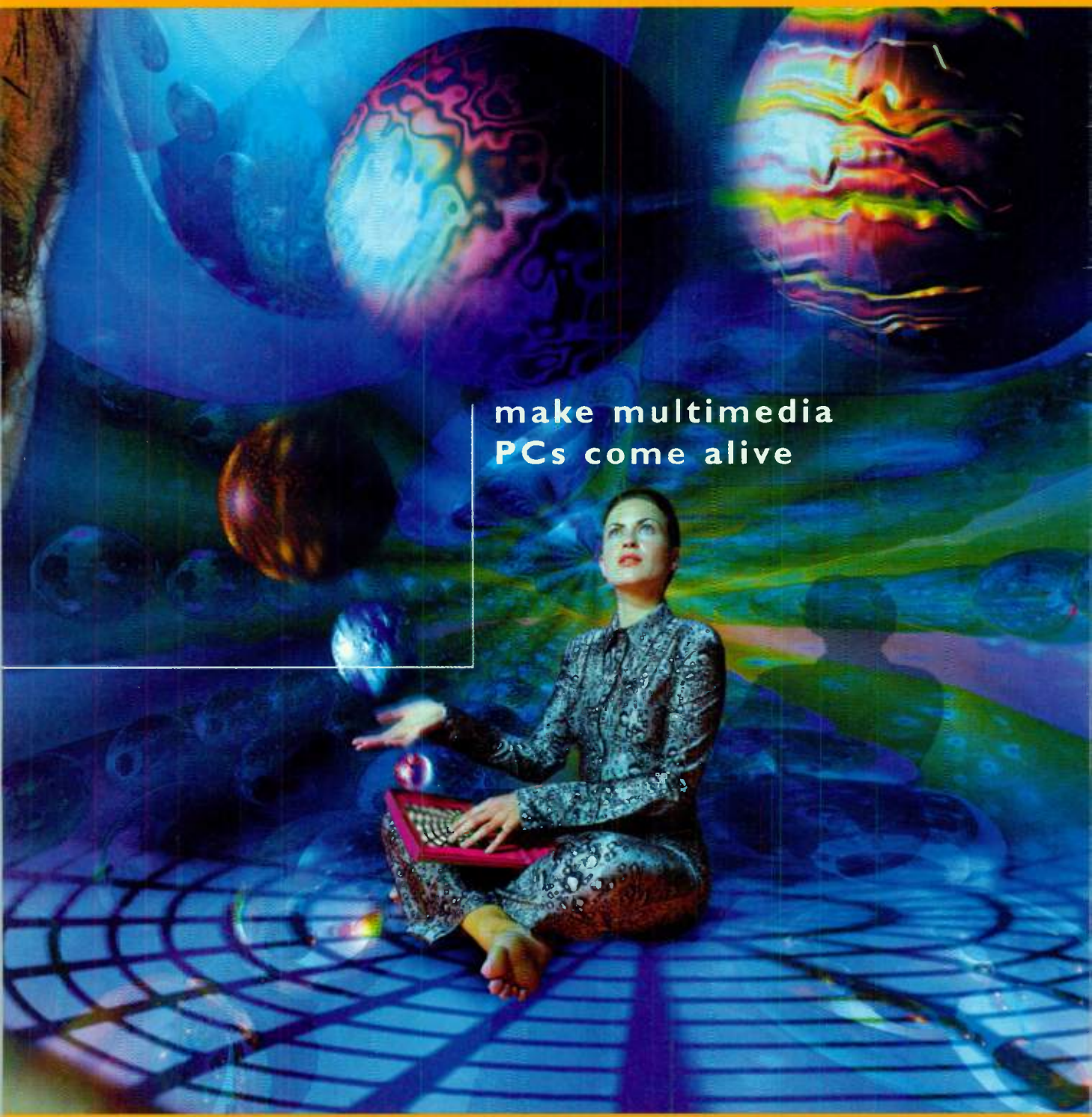

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UNIQUE ANALOG ARCHITECTURE CREATES FAST 1.2-GSAMPLE/S 6-BIT FLASH ADC WITH WIDE BANDWIDTH OF 1.4 GHz

A major advance over previous flash converters is evident in the input circuit arrangements of the SPT7760 analog-to-digital converter (ADC) from Signal Processing Technologies Inc., Colorado Springs, Colo. Included between the reference ladder and the input comparators are 64 input preamplifiers *(see the figure)*. These not only reduce the clock transient kickback to the input and reference ladder due to a low ac Beta, but also reduce the effect of the dynamic state of the input signal on the latching characteristics of the input comparators. Sample rates are guaranteed to be 1 Gsamples/s, with 1.2 Gsamples/s typical. The converter's full-power analog bandwidth is better than 1.4 GHz.

The ADC's input preamplifiers not only serve as buffers, they also stabilize the input capacitance (at less than 8 pF with an input resistance of typically 50 kΩ) so that it remains constant over different input ranges of both voltage and frequency, and less slew-rate distortion is induced. Unlike previous flash converters, this makes the part easier to drive, eliminating the need for external track-and-hold amplifiers in most applications.

The preamplifiers also add a gain of two to the input signal so that each comparator has a wider overdrive or "threshold" range to trip into or out of the active state. This sensitivity increase reduces the errors that could otherwise be output due to metastable states; such errors are to the ±1/2-LSB level.

Two analog input pins are provided—which are tied together internally—and either one may be used for analog input sense, with the other used for input force. This arrangement is convenient for testing the source to check that there is sufficient drive capability. The pins can also be tied together externally and driven from the same source.

With an input frequency of 250 MHz, the ADC's spurious-free dynamic range is 45 dB, the signal-to-noise + distortion ratio is 34 dB, and the total harmonic distortion is 40 dB. The converter's input slew rate is 5 V/ns and the acquisition time is typically 250 ps.

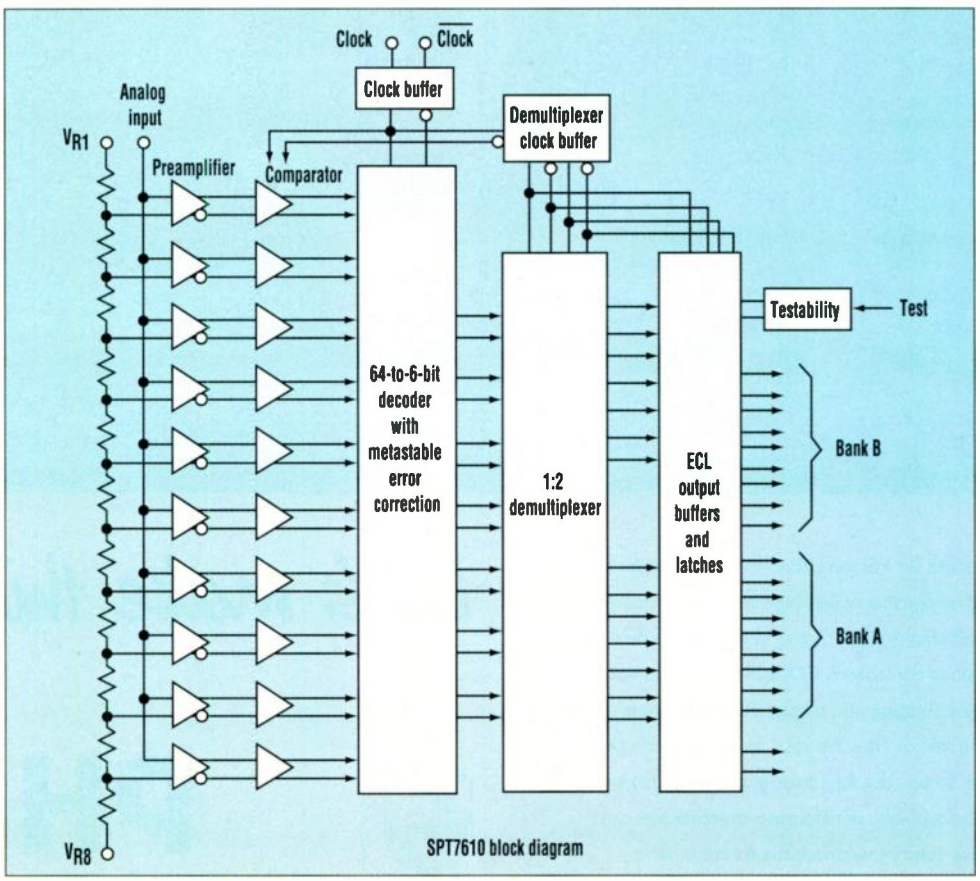
Current-mode logic is used throughout the converter to give true differential analog and digital data paths from the input preamplifiers through to the output buffers. This technology results in the achievement of good common-mode rejection of noise while reducing potential missing codes (no missing codes are guaranteed).

The analog circuitry also is laid out carefully to reduce potential signature errors with such a complex structure. When pulled down to –2 V, the full ECL swing can be obtained into 50 Ω with the output drive capability that exists. When pulled down to –5.2 V, the outputs can drive 130-Ω to 1-kΩ loads. Differential receivers on the outputs of the data-ready lines are recommended to ensure the proper output rise and fall times.

While the power-supply line needed for the converter is –5.2 V, there are two external voltage references applied to the internal reference ladder. The top reference is typically 0 V or is connected to the analog ground.

Top force and sense pins are internally connected together to reduce the voltage drop across the parasitic line resistance. The bottom reference is typically –1 V. There are bottom force and sense pins, again connected together internally to reduce the voltage drop across the parasitic line resistance.

Integral non-linearity errors over temperature can be controlled by three addi-



SPT7610 block diagram

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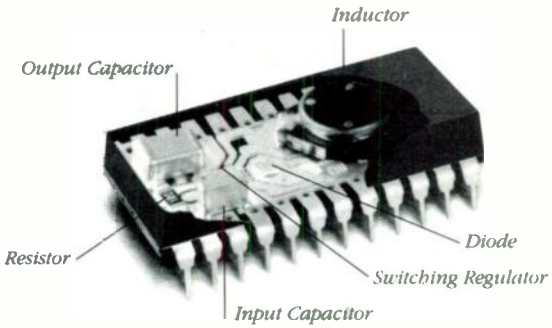
THE LM2825 DC-DC CONVERTER DELIVERS UNSURPASSED INTEGRATION AND RELIABILITY AT A SUBSTANTIAL COST SAVINGS.



[2X Actual size]

As the industry's first and only complete step-down DC-DC converter in a 24-pin DIP, the **LM2825** represents a huge breakthrough for power conversion designs. All thanks to our continuing innovation in advanced packaging technology.

But what makes the LM2825 even more amazing is its reliability. In fact, recent benchmark studies calculated it to be a whopping 20,000,000 hours MTBF. That's 2,283.1 years, for those of you who don't have a calculator handy.

The newest member of our SIMPLE SWITCHER® family, the LM2825 integrates a 1A switching regulator, an inductor, a Schottky diode, and input and output capacitors in a single 24-pin DIP.

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tional reference taps that are brought out at, typically, –0.25 V (3/4 tap), –0.5 V (mid-point tap), and –0.75 V (1/4 tap). The mid-point tap is normally driven by an op amp to ensure temperature-stable operation, or it can be bypassed in limited temperature-range applications. The 1/4 and 3/4 taps can be driven by op amps to adjust linearity or can be bypassed for noise suppression. As noted, the top reference is normally tied to analog ground, while the bottom reference can be driven by an op amp.

It is recommended that the clock input be driven differentially (on the Clock and $\overline{\text{Clock}}$ signals) to improve noise immunity and to reduce aperture jitter (specified at a typical 2 ps). Using other than 50% duty cycle on the clock may produce unacceptable second harmonics. All the logic levels are compatible with both 10K ECL or 100K ECL.

The digital outputs are split into two banks of 6-bit words plus an overrange bit with a format that can be straight binary, inverted binary, two's complement, or inverted two's complement. Two control pins are provided to enable that choice to be made. The banks are in opposite phases. The banks also are alternately updated at one-half the clock speed with an offset in the clock divider always ensuring that the A output bank will be the first with data after the ADC is powered on.

A special test-mode function is supported that overrides the internal-data output latch stage and exercises the digital outputs in an alternating dual-sequence test pattern. The user can test the digital interface logic downstream of the converter with a known digital test-pattern set. Only the digital-output stage is involved with the test output and, when concluded by taking the test pin low, the converter will resume the output of valid data.

Major applications of the converter should be in digital oscilloscopes, radar systems, electronic-warfare systems and electronic counter-measure systems, microwave modems, and direct RF downconversion systems in digital communications.

The 3-W SPT7610 ADC is available in a 44-lead cerquad package (14 by 14 mm) and is priced around $295 each.

For more information, contact Signal Processing Technologies at 800-643-3SPT (3778).

PAUL McGOLDRICK

IN TACKLING NEW PACKAGING CHALLENGES, TWO COMPANIES ARE BETTER THAN ONE IN DEVELOPING A 2-W TSOP-6

The stakes in developing new packaging are an increasing concern for the semiconductor industry. If a company decides to try it alone, it takes a risk on the acceptance of the packaging. On the other hand, if a company follows a standard pattern, it may not be doing justice to the product. Motorola and Temic have found another way: a joint development sharing the risks, with the results registered with JEDEC.

AVAILABLE POWER FETs IN THE TSOP-6 PACKAGE

Motorola part #	Temic part #	Breakdown voltage	Device type	R_{DS} (on) @ V_{gs} = ±10 V	R_{DS} (on) @ V_{gs} = ±4.5 V	R_{DS} (on) @ V_{gs} = ±2.5 V	I_D (A) @ 4.5 V
MGSF3454V/X	SI3454V/X	30 V	n-channel	0.065 Ω	0.095 W	□	3.4 A
MGSF3455V/X	SI3455V/X	-30 V	p-channel	0.100 Ω	0.190 Ω	—	2.5 A
MGSF3442V/X	SI3442V/X	20 V	n-channel	—	0.070 Ω	0.095 Ω	4.0 A
MGSF3441V/X	SI3441V/X	-20 V	p-channel	—	0.900 Ω	0.135 Ω	3.3 A

The new package is the TSOP-6 *(Fig. 1)*. At 25°C, the package can dissipate up to 2 W of power.

The small package's development is due largely to the necessity of placing power MOSFETs in portable electronic systems that no longer have the space for existing devices. The devices that are being fabricated in these packages have very low on-resistances as low as 0.065 Ω, and high current ratings of up to 4.2 A of current.

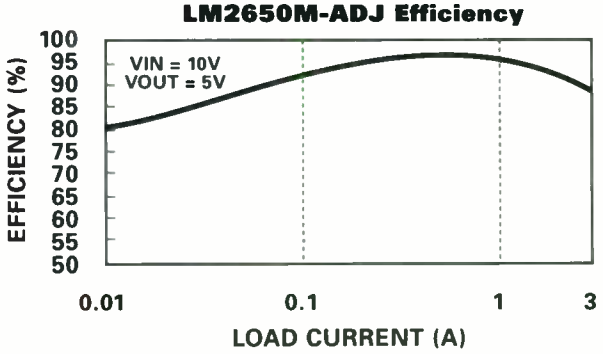
The package's footprint is identical to the SC-59 package, except for a lower profile and a higher power rating. With a double-sourcing of products, Motorola and Temic hope that the package becomes an industry standard. The two companies have agreed on compatible pinouts, power ratings, and package outlines and dimensions *(Fig. 2)*. And, even though the actual MOSFET processes used are their own, both Motorola and Temic have released products with identical specifications and similar numbering.

The development of smaller packages is also due to other factors. These include the move to surface-mount technology, the continuing lowering of on-resistance values, and the resultant fall in power-dissipation levels per unit of current. With a suitable path designed for heat to escape, high levels of currents can be switched in a smaller-size package.

The first surface-mount package, the SO-8, showed the practicality of a smaller-

>96% EFFICIENT 3A BATTERY SWITCHER.

A SINGLE-CHIP SOLUTION WITH NO EXTERNAL FETs. ANOTHER INDUSTRY MILESTONE FROM NATIONAL.



For the first time, there's a 3A step-down battery switcher that can deliver over 96% efficiency—at substantial cost-savings. It's National's new **LM2650.**

Thanks to its synchronous architecture, this DC-to-DC converter can decrease power consumption and increase battery life in portable applications. Since the LM2650 has integrated FETs on a single chip, it can also save valuable board space. And its automatic sleep mode enables it to retain its high efficiency in light load conditions.

To meet a variety of portable applications, the LM2650 has a wide input voltage range, from 4 to 18V. Its built-in protection features include thermal shutdown and current limit. And it's from National, so it will never be in short supply.

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size package. This package later was developed into the TSSOP 8 package. Now, it's the TSOP-6—a six-leaded, 1-mm-thick package with a total height of just 1.1 mm. The package and leads occupy an area of just 2.75 by 3.10 mm.

A visual comparison shows the new package with overlays of the earlier ones *(Fig. 3)*. The TSOP-6 package has less than one-half the width of the SO-8 package.

The same copper frame design that has been used in the earlier packages also is used in the TSOP-6 package. The thermal path runs from the die, through the die-attach, into the copper lead frame, then out the drain leads.

The largest area is used for the drain leads, which use four of the six pins. The short leads, in combination with this large drain area, keep the thermal impedance low for this size of package.

The thermal rating (junction-to-ambient) indicated on the data sheets of R_{JA} = 62.5°C/W, with a part mounted on a 1-in.^{2} piece of 0.062-in.-thick FR4-type pc board.

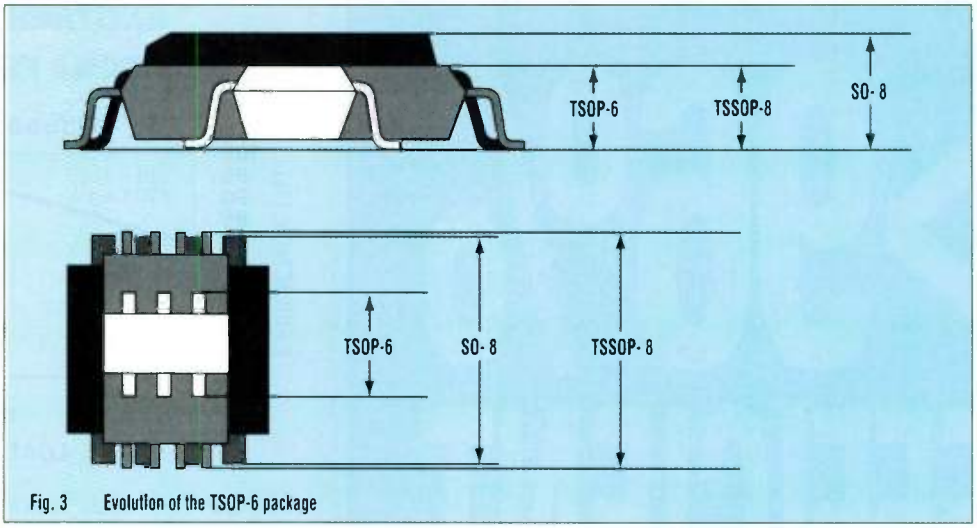


Fig. 3 Evolution of the TSOP-6 package

The rating represents a compromise between single-layer and multilayer boards, with more copper on its single side than the average single-layer board. It is a reasonable approximation of multilayer boards that have a central power plane.

The junction is heated with a known amount of power for a known amount of time. The junction temperature is measured immediately after heating using the temperature coefficient of the forward voltage of the internal diode. This measurement is repeated for various time periods ranging from 5 ms out to several hundreds of seconds, thus providing the data to generate the transient thermal impedance curves from the junction to the ambient.

Each TSOP-6 package is available in two different versions with different thermal ratings, depending on their lead-frame materials used. The best thermal performance is obtained with a copper lead frame. Those parts are given a "V" suffix. The 0.5-W-rated parts use an alloy 42 lead frame and are given an "X" suffix.

The parts have the same electrical impedance characteristics, but the "X"-rated devices are specified at lower current levels to compensate for their increased thermal resistance values.

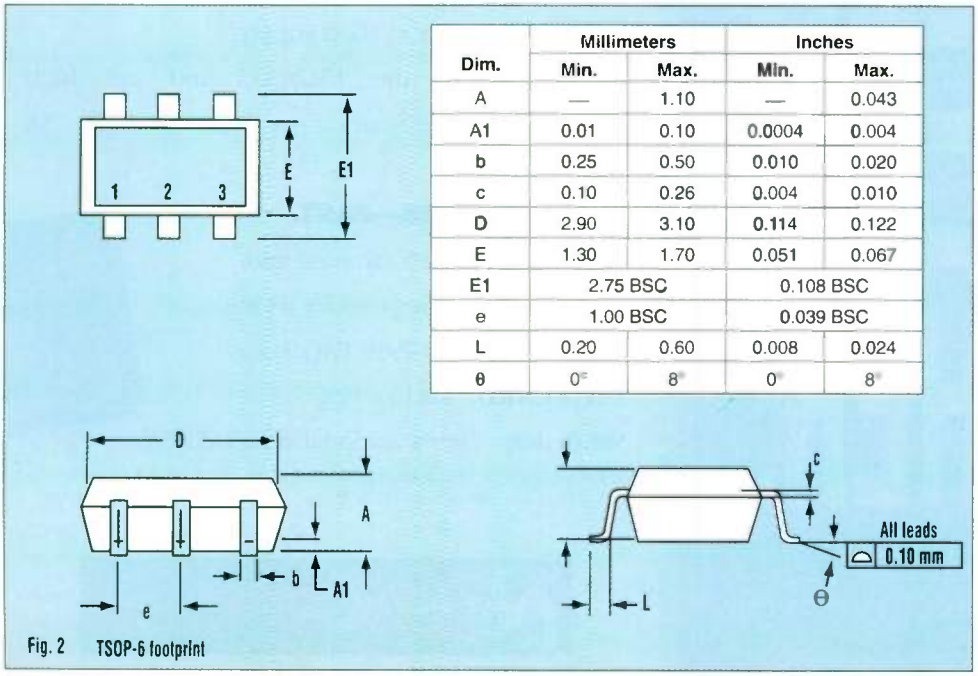
Samples of the Motorola and Temic parts are available now. A range of parts is being offered as power FETs from both companies *(see the table on the previous page)*.

Further parts using the package will follow. Temic Semiconductors and Motorola's Semiconductor Product Sector also have indicated they both will be looking aggressively at the next generation of packaging together.

Information is available from Temic by calling (800) 554-5565 or by faxing at (408) 567-8995.

Information is available from Motorola by calling Mike McKean at (602) 244-4773 or faxing him at (602) 244-5406.

PAUL McGOLDRICK



Dim.	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	—	1.10	—	0.043
A1	0.01	0.10	0.0004	0.004
b	0.25	0.50	0.010	0.020
c	0.10	0.26	0.004	0.010
D	2.90	3.10	0.114	0.122
E	1.30	1.70	0.051	0.067
E1	2.75 BSC		0.108 BSC	
e	1.00 BSC		0.039 BSC	
L	0.20	0.60	0.008	0.024
θ	0°	8°	0°	8°

Fig. 2 TSOP-6 footprint

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Quiescent Current (typ@0mA)	65µA	180µA
Quiescent Current (typ@100mA)	600µA	5000µA

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Electronica '96 Shows Off The Latest Products

The World's Largest Components Fair Includes The Newest Analog, Digital, And Mixed-Signal ICs, As Well As Other Active And Passive Components And Subsystems.

ALFRED VOLLMER

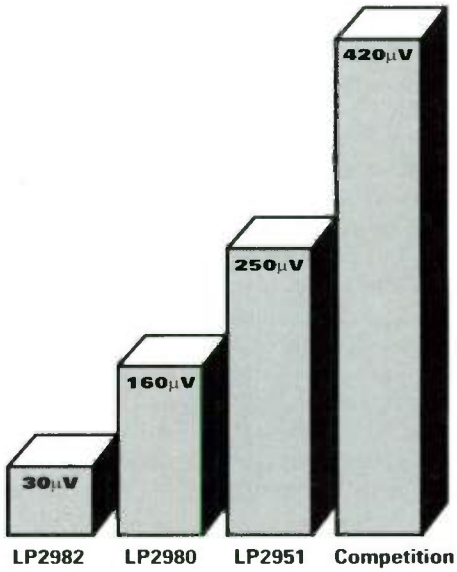
There is no doubt about it. The Electronica fair is by far the biggest components show in the world. It takes place every other year in Munich, Germany, with this year's show to be held on Nov. 12-15. Even though the 2800+ exhibiting companies (about 80 companies are still on the waiting list) from about 50 countries wanted to keep their Electronica news under wraps, *Electronic Design* was able to catch some of the highlights in advance.

The show will be divided into eight product segments. Sector A, "Microchip products," features application-oriented standard ICs (ASSPs), as well as ICs for data conversion, microprocessors, logic circuits, and memory periphery. Section B, "Circuit boards and other subsystems," showcases just about every kind of subsystem from plug-in and pc boards up to hybrid modules. In sector C, "Discrete semiconductor components," visitors will find diodes, displays, sensors, transistors, power units, and optoelectronic semiconductors. Sector D, "Other discrete components," includes vacuum tubes and passive components (e.g. capacitors, resistors, filters, crystals, and oscillators). Sector E, "System supply," is dedicated to EMC and ESD systems, power supplies, and enclosures. "Electromechanical components,", sector F, includes connectors, relays, unmounted pc boards, and switches. I/O devices will be located in sector G, "Systems periphery." This sector also covers image-recognition, image-processing, display, and servo products. Finally, sector H, "EDA," houses electronic design automation and laboratory measurement systems.

1. FUTURE CAN CONTROLLERS will make use of Motorola's HC08AZ and HC08AB microcontrollers in Swedish Volvo cars. The chips include flash memory.

HEAR NO EVIL. TINY REGULATORS WITH 30µV OUTPUT NOISE.

THE NEW LP2982, THE WORLD'S SMALLEST, QUIETEST MICRO POWER REGULATOR, EXTENDS BATTERY LIFE.



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The LP2982's output noise spec of 30µV is several times lower than other popular regulators on the market.

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The main focus of most exhibitors will be on multimedia, automotive, consumer, and communications applications. In contrast to the booths of yesteryear, when exhibitors still showed their components neatly arranged all in a row, today's booths show complete solutions. One of these solutions addresses multimedia. Philips Semiconductors, for example, will give the first public demonstration of the TM-1 chip, the first in the TriMedia family. It will be used in a live video demonstration over normal telephone lines.

TriMedia has been designed specifically as a coprocessor to cope with the processing-intensive environment of multimedia. It's designed to handle advanced concurrent audio, video, graphics, and communications. A company spokesman says that the product will achieve "significantly better performance than the main CPU can deliver on its own." And, for certain applications such as set-top boxes, TriMedia can be used by itself. TriMedia is a fully-programmable digital signal processor that uses very long instruction words (VLIW), allowing a higher degree of parallel processing than ordinary designs. It can achieve a performance of 3 billion operations/s and can be programmed in C. Philips Semiconductors also will be launching the first in a series of software modules for the TriMedia family that includes H.324 for videophone applications, MPEG 1 decoding, and AC3 six-channel audio for DVB and MPEG-2 audio.

One area where Philips claims to be pioneering with several "firsts" is the universal serial bus (USB). Philips' exhibits for this application segment will include the first soft control of a monitor over USB, a working prototype of a USB audio digital-to-analog converter (DAC), the first standalone USB hub, the first working USB speaker, and the first monitor with an integrated USB hub *(see "Chip Set Targets The Universal Serial Bus," p. 69)*. A USB demonstration computer will be shown with a number of products including a USB hub, a USB audio DAC, and USB digital speakers. In addition, Philips will launch some ICs for IEEE 1394 or Firewire bus at Electronica.

Philips also will provide show attendees with a preview of its next generation of graphics controller ICs to be launched next year. The Dutch manufacturer will show the chips' 3D capabilities with 64-bit performance and resolutions of up to 1600 by 1200 pixels. Another major segment within the huge arena of multimedia is digital media. Here, Philips will demonstrate some of the company's latest developments with a digital versatile disk (DVD) player, the successor to the CD, and a digital video broadcasting (DVB) set-top box.

SGS-Thomson Microelectronics also plans to focus on digital entertainment products. The French-Italian company will display a set-top box solution, containing its own chip set as well as products for DVD MPEG and PAL/NTSC encoder devices. Although it is not officially confirmed,

SGS-Thomson plans to show a low-cost PC based on its dedicated 486 core. This ST486DX core is being used in conjunction with a standard-cell technology and a library of functions to build a powerful, yet cost-effective PC entertainment system. Currently, the system is a two-chip solution, but it can be integrated into a single-chip 486 PC. The single-chip 486 includes the 486DX2/4 core, a UMA chip set, an SVGA graphics engine, a DRAM controller, a PAL/NTSC encoder, and an MPEG-2 decoder. This solution is intended to be used as the basis of a home PC-based entertainment center, or a multimedia home system (MHS), currently being designed by Sichuan Ding Tian Microelectronics of China.

In the microcontroller category, SGS-Thomson's seven new members of the ST62 MCU family also will be on display. These devices extend the product range to sub-dollar SOP16 levels, while offering on-chip 8-bit multi-channel analog-to-digital conversion. According to Thibault Brunet, senior marketing engineer for microcontrollers at SGS, the least-expensive ROM version of an ST16 controller will be available "well below $0.65," in very large quantities. All ST62 family devices are available in OTP packages as well as in ROM and EPROM versions.

IN CONTRAST TO THE BOOTHS OF YESTERYEAR, WHEN EXHIBITORS STILL SHOWED THEIR COMPONENTS NEATLY ARRANGED ALL IN A ROW, TODAY'S BOOTHS SHOW COMPLETE SOLUTIONS.

Thanks to a range of development tools and starter kits which fully conform to the European Community's "Electro Magnetic Compatibility" directives, designing with an ST62 can be quite effective. One of the most interesting design tools to be demonstrated at Electronica is the ST6-Realizer, a Windows-based graphical software development system. It allows the generation of self-documenting ST62 application code. This tool offers features such as automatic initialization after reset, automatic MCU configuration of I/O registers, RAM location/initialization, and ROM location. It also features automatic peripheral management of the ADC, EEPROM, timer, watchdog, and bit-to-bit operations on the I/O ports. Using the ST6-Realizer means programming the microcontroller from a graphical user interface without having to worry about any assembly line or C code. According to Brunet, auto bodies are the second biggest applica-

tion of the ST62; only the display market uses more of these devices.

Speaking of the automotive market, SGS also plans to show prototype products for integrated solutions containing GPS, navigation and radio functions, as well as a version of its ST20 controller for GPS applications. For car-navigation and fleet-management systems, Philips has released a complete 5.1-in. LCD monitor. The monitor includes housing, loudspeaker, infrared receiver, and a CVBS (composite video blanking signal) input according to PAL and NTSC standards. Philips also plans to launch its next generation of car immobilizer key technology, becoming the first company to use a cryptographic transponder embedded in the ignition key. This usage provides a much higher level of security for auto owners, since the key and the car both possess a cryptographically random number (initially generated by the car), and access is granted only if the key produces the same number. Data are exchanged by RF between the key and the car. According to Philips, it is impossible to deduce the hidden cryptographic code sequence that is used in the cipher process from this data flow.

Aiming to replace the heavy copper wire harnesses within a car with a simple twisted-pair cable plus a power line running around the car, Philips will put a major focus on its CAN (Car Area Network) bus technology. All of a car's electrical control operations such as power-train management, seat adjustment, mirror adjustment, door locking, and ABS braking can be handled via this bus. For its new PCA82C252 CAN bus transceiver, to be displayed at Electronica, Philips has developed a special fault-tolerant technology that enables the bus to keep operating even if one of the wires is cut or shorted. This feature provides a higher level of safety than the copper wire technique.

While Intel is the only major semiconductor company that won't be at Electronica, its major competitor, Motorola, will put significant emphasis on exhibiting products for consumer, computing, and automotive applications. Motorola's latest microcontroller families, dubbed 68HC08AZ and 68HC08AB, were designed in East Kilbride, Scotland, and Munich, Germany, in close cooperation with Sweden's Volvo Car Corp. According to Jim Stuart, technical marketing manager of Motorola's Customer-Specified Integrated Circuits Division, the HC08AZ0 is the basis of future CAN-based multiplex systems in future Volvo cars *(Fig. 1)*. At the outset, there will be eight different versions available: 16-kbyte, 24-kbyte, 32-kbyte, and ROMless, all of which can be shipped with or without CAN interfaces. Versions with up to 60 kbytes of memory will be available in the fourth quarter of 1998. Devices with flash memories are currently in development. Motorola also will exhibit its MC68HC08 serial programmer for the CAN controllers *(Fig. 2)*.

A major part of these controllers is the CAN module dubbed msCAN08, which was jointly developed by Mo-

torola and Volvo. This protocol controller is fully compatible with CAN2.0a and CAN2.0b, and has five buffers for intermediate storage of data. According to Jim Stuart, technical marketing and applications manager at Motorola's European Customer Specified Integrated Circuit Division, msCAN08 will not go into applications such as power-train, engine management, ABS, or navigation where high-performance MCUs (e.g. 16-bit and 32-bit MCUs) are needed. "We are offering low-cost MCUs with CAN for car-body systems like doors, locks, seats, immobilizers, as well as safety systems like airbags, and also comfort/entertainment systems like climate control or car audio," says Stuart. While the power-train CAN network requires data rates of almost 1 Mbits/s, the body electronics only need a data-transmission speed between 50 and 100 kbits/s, making the CAN functionality suitable for 8-bit microcontrollers. Stuart adds, "It is the world's first 8-bit flash-based MCU with a CAN module onboard, which is specifically optimized for real-time operations." As Stuart points out, without networking, there are about 2000 connections in a car for 2000 functions. With networking, there will be only 1000 connections for 4000 functions.

In Europe, CAN has been established as the de facto standard in automotive networks. Stuart is quite confident that the CAN protocol will become a lot more popular in the U.S. as well, even though J1850 is currently the favorite protocol for U.S. car manufacturers. With its HC08 controller, which is about five times as powerful as an HC05 controller, Motorola shows an entirely new, scalable CAN implementation. The CAN controller's message buffer arrangement enhances CAN bus loading by using three transmit and two receive buffers. Furthermore, it offers a guaranteed maximum latency for CAN messages. A priority register at each transmit buffer allows designers to implement different scheduling schemes: MCAN style, priority-based, or package. Message filtering is employed to relieve the CPU of intervention. It is configurable for one level at 32 bits, two levels at 16 bits, or four levels at 8 bits.

Within the components portion of Electronica, show topics such as consumer electronics and telecommunications also will be among the hot topics. For example, it is highly probable that Siemens Semiconductors will display its Chinatext IC for the first time ever. This IC is a teletext implementation suitable for handling Mandarin Chinese characters. The Chinese characters are compressed and stored in the memory onboard the teletext chip.

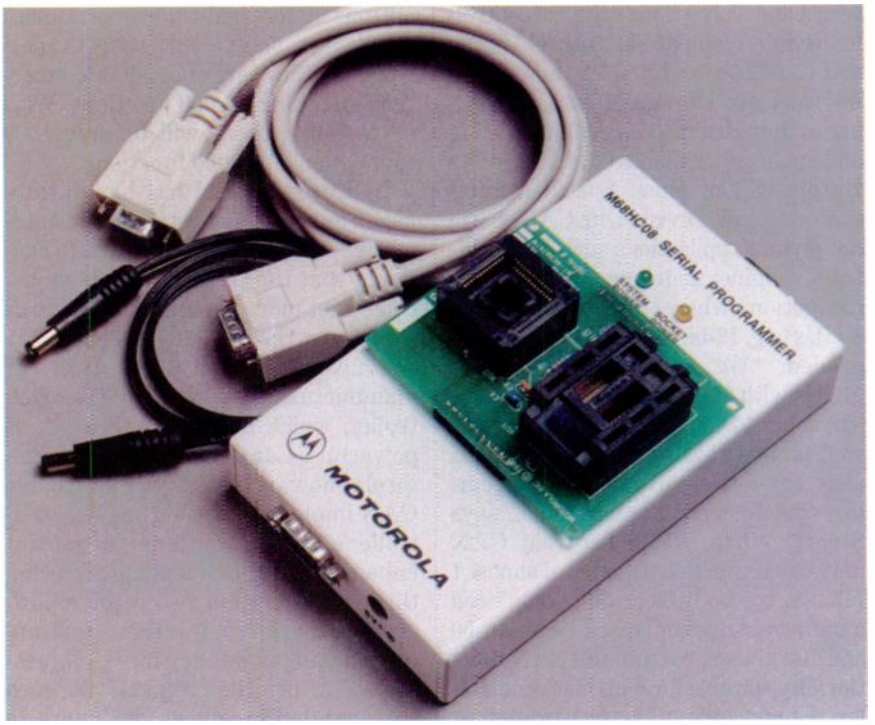
In the telecommunications area, Siemens will present two new products: A communication controller, DSCC4 and a multichannel HDLC controller, MUNICH32X. The PEB 20534 DSCC4 is a DMA-supported serial communications controller with four serial channels. Essentially, it is a double ESCC2 (SAB 82532) Version 3.1 with a DMA controller and several

add-ons. It provides four independent serial multiprotocol communications controllers, a 33-MHz/32-bit PCI bus master/slave interface with integrated DMA controllers, an integrated Local Bus Interface (LBI) (for connection to other peripherals that do not have a PCI bus interface with DMA capability), an SSC interface, and an IOM-2 interface.

Each of the four serial communication channels contains an independent baud-rate generator, DPLL, and programmable protocol hardware (HDLC, bisync, and asynchronous and character-oriented PPP). Data rates of up to 2 Mbits/s (DPLL and async), 10 Mbits/s (HDLC), and 52 Mbits/s (HDLC transparent and extended transparent mode) are supported. According to Gerhard Zehethofer, marketing manager for network ICs at Siemens' Semiconductor Group, the channels also can handle a large set of layer-2 protocol functions independently of the host CPU.

Typical applications for the DSCC4 are LAN-WAN internetworking systems such as routers, switches, and trunk cards. However, the device also supports interfaces such as V.35, ISDN basic-rate (S/T), or asynchronous dialup services. In addition to the bit-oriented functions such as bit stuffing, CRC check, and flag and address recognition, which are supported by a wide range of HDLC controllers, the DSCC4's serial communications controller also provides a higher degree of procedural support. In "auto-mode" the controller processes the information transfer and the handshaking procedure (I and S frames of the HDLC protocol) autonomously. On the other hand, the window size is limited to 1, which is sufficient for many applications.

Siemens' new MUNICH32X (PEB20321) is an enhanced version of the multichannel network interface controller for HDLC, the MUNICH32. The new version now contains a 33-MHz/32-bit PCI bus master/slave interface with integrated DMA controllers, as well as symmetrical receive and transmit buffer descriptor formats for faster switching. Providing for connections to other peripherals that do not have a PCI bus interface with DMA capability, a local bus interface (LBI) was integrated as well. Furthermore, the new device has an SSC interface and an IOM-2 interface. MUNICH32X is able to handle up to 32 full-duplex serial PCM channels. It performs layer-2 HDLC formatting/deformatting or V.110 or X.30 protocols up to a network data rate of 38.4 kbits/s, as well as transparent transmission for the DMI modes 0, 1, and 2.



2. THIS SERIAL PROGRAMMER from Motorola, the M68HC08, can be used to program CAN controllers.

Siemens, along with Motorola and SGS-Thomson, will dedicate a part of their exhibition space to ChipCard applications. For example, Siemens will show a combination card demonstration. A combination card is a ChipCard which is able to communicate either with contacts or without (using inductive coupling in the contactless case). The ChipCard that will be shown basically incorporates three elements: a microcontroller for data interchange via the contacts, the interface for contactless data transmission, and an EEPROM. While Siemens is contributing the technology for the contact-based card, a "MIFARE" technology is being used for the interface for the contactless data interchange. MIFARE was invented by Mikron GmbH of Austria.

Electronica visitors not only will be able to see products or solutions, they also will be able to discuss new process technologies. Austria's Mikro Systeme (AMS), for example, will announce the availability of a new family of mixed-signal CMOS processes dubbed CBT, CBY, and CBZ, which are suited for ASIC solutions operating at voltages up to 50 V. The 2-µm, double-metal, single-polysilicon basic CBT process was primarily developed for ASICs incorporating complex digital parts with high-speed and high-density elements operating in a high-voltage environment. The CBY process is a double-metal, double-polysilicon version for the integration of linear capacitors. The CBZ process is a double-metal, double-polysilicon high-resistive polysilicon process for linear-resistance applications requiring a minimum of silicon area. The maximum toggle rate of the processes is 100 MHz, while the gate delay is 2 ns and the D-flip-flop delay is 10 ns. □

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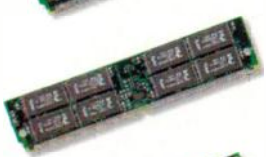

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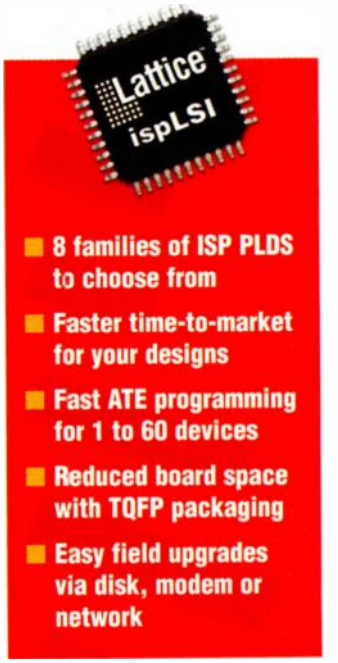

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READER SERVICE 107

Fall Comdex Takes The Wraps Off PC-Related Technologies

Available Solutions Run The Gamut Of Hardware And Software, From Notebooks And Desktops Through Audio And Video To Peripherals And Interfaces.

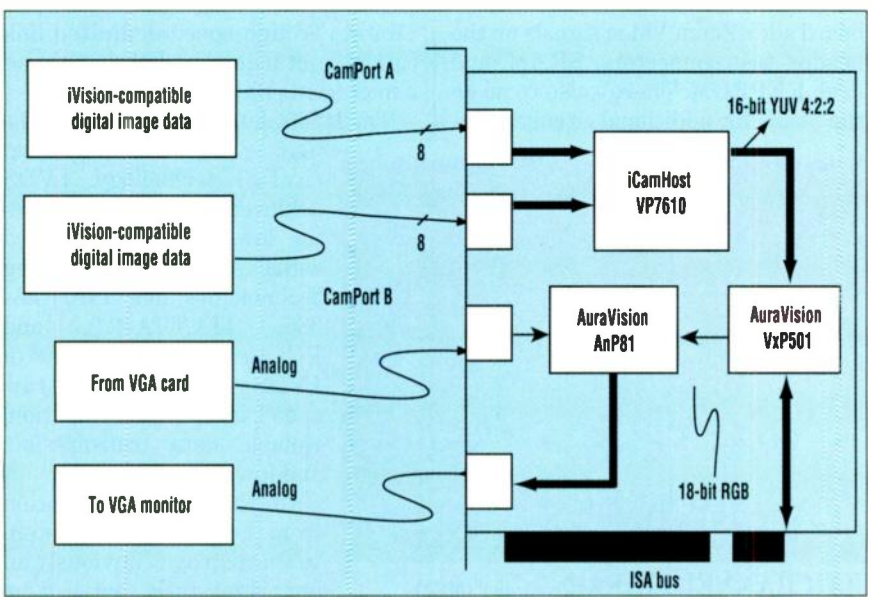
RICHARD NASS

As has been the case in previous years, this year's Fall Comdex trade show blends together all types of PC-related technologies, both in hardware and software. Fall Comdex takes place on Nov. 18-22, in Las Vegas, Nev. Some of the items attendees will see include video-conferencing solutions using MPEG technology, IEEE 1394 (Firewire) hardware, displays, hard-disk drives and related components, tape drives, notebook computers, and PDAs and their associated software.

On the video-conferencing front, AuraVision Corp. and Silicon Vision Inc., both in Fremont, Calif., have teamed up to develop a video-capture reference design that supports Silicon Vision's iVision digital camera standard. With the reference design, called the pcVision, OEMs can develop a video-capture solution that sends video data from the camera to a PC's ISA or PCI bus *(Fig. 1)*. The result is a system for video conferencing, video communication, or security applications.

The pcVision reference design combines AuraVision's VxP501 video processor and AnP81 video digital-to-analog converter (DAC) with Silicon Vision's iCamHost digital-video-camera interface chip. The design lets OEMs build video-capture add-in cards that are compatible with existing PC graphics subsystems.

Unlike traditional analog cameras, where all the controls are fixed and embedded into the camera, the iVision digital camera lets the PC application control such camera functions as frame rate, aperture correction, and light balancing. As a result, a lower-cost camera can be employed without sacrificing video quality. The iCam camera that ships with the reference design offers a resolution of 512 by 492 pixels.



1. THE PCVISION REFERENCE design is built with a digital-video- camera interface chip from Silicon Vision, and a video processor and video DAC from AuraVision. The end result is a board for video conferencing, video communication, or security applications.

AuraVision also is responsible for a reference design that supplies a cost-effective MPEG-2 playback and video-capture system. In this endeavor, AuraVision teamed with Odeum, Milpitas, Calif. Called the Fly Fisher, the design lets OEMs develop sophisticated MPEG-2 video systems for PCs and set-top boxes for a bill of materials cost of under $100.

The Fly Fisher is built with Odeum's HDM8212 MPEG-2 audio-video decoder and AuraVision's VxP524 video stream processor. PCs built with the Fly Fisher can handle some of the more demanding video applications, including digital-video broadcasts based on

the MPEG-2 video-compression standard, as well as live video. In addition, boards that incorporate Odeum's HDM8111 MPEG-2 video and Dolby AC-3 audio decoders let end users employ DVD playback with both MPEG-2 and AC-3 audio.

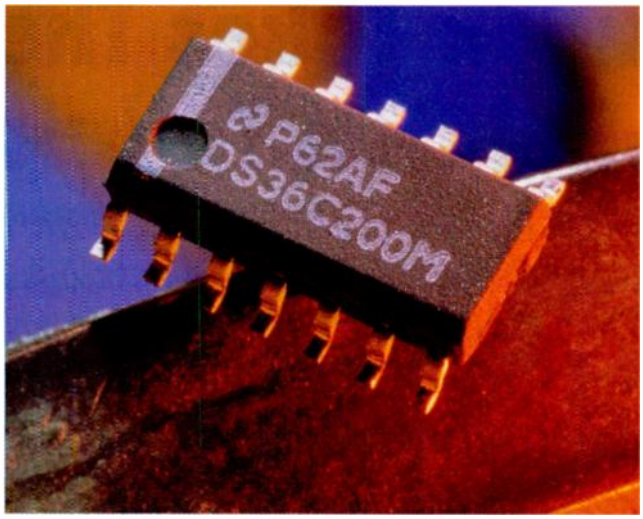
The HDM8111 is a single-chip DVD decoder with a program demultiplexer, subpicture decoder, S/PDIF formatter, microSparc RISC engine, and graphics-overlay capabilities. The VxP524 supplies both PCI master and slave modes, with burst-cycle support. In the master burst mode, the chip enables real-time video capture and playback without any bus or DRAM bottlenecks when EDO DRAM is employed. The VxP524 also performs two-dimensional interpolated scaling, dual-level polyphase filtering, cropping, color adjustment, and color-space conversion with full 24-bit resolution.

Software that's bundled with the Fly Fisher supports Microsoft's Media Player, ActiveMovie, and DirectX video enablers. Also bundled are a video-port-manager (VPM) client and provider. To create, encode, edit, and playback video data on an intranet, users can take advantage of the IntraVideo MPEG PAK. The package includes the Producer, a user-friendly authoring tool which captures and compresses video according to the MPEG format. The IntraVideo MPEG PAK is designed for use with most popular multimedia and video servers, including those from DEC, Hewlett-Packard, Oracle, Silicon Graphics, and Sun Microsystems.

One of the biggest questions hanging over the IEEE 1394 specification is which applications will take advantage of the 400-Mbit/s serial bandwidth to an external device. The aforementioned video-related technologies offer the type of fit that's being touted by the 1394 hardware developers.

One such developer is Texas Instruments Inc., Dallas, Texas. TI offers a family of reference design kits to help build feature-rich, value boards with the company's PCILynx and 200-Mbit/s PHY, a 100-Mbit/s PCI card, a backplane card, and a peripheral kit for easy prototyping. Each of the kits contains an evaluation board, a 1394 cable, schematics, and a programmer's guide.

The value board, built with the PCILynx and a 200-Mbit/s PHY, features a serial EEPROM, a power circuit (needed to drive unpowered external peripherals), Windows 95 drivers, a 1394 bus manager, and transaction-layer software. The feature-rich board adds Zoom Video signals on the header, test connectors, SRAM, and flash EEPROM. There's also room on the board for additional circuitry, letting board designers customize the card.



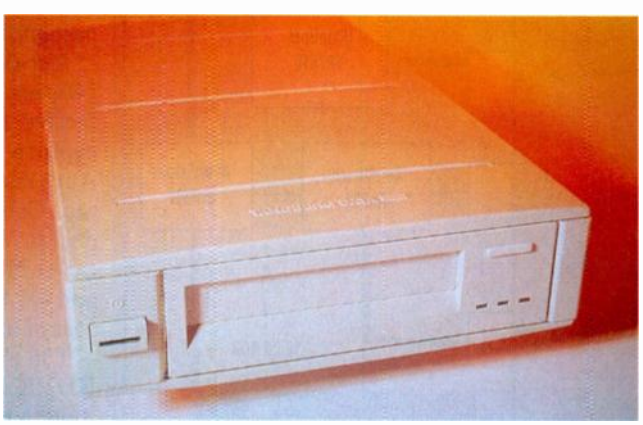
2. APPLICATIONS that require low power and data rates in excess of 100 Mbits/s, such as IEEE 1394, are candidates for the DS36C200, low-swing dual bidirectional transceiver designed by National Semiconductor Corp.

The 100-Mbit/s PCI card employs the PCI bus for communications with a link-layer controller and a three-port 1394 physical-layer device. The kit comes with Windows 95 and Windows 3.1 sample software that allows developers to examine and modify the link-layer controller's registers. The backplane card features three link-layer controllers connected to a backplane, and 100- and 200-Mbit/s cable ports. It includes sample C-code software to transmit and receive data packets. The card is controlled by a TMS320C52 DSP chip. Finally, the peripheral kit is an ISA board with a PC/104 expansion connector and an RS-232 interface.

The DS36C200, designed by National Semiconductor Corp., Santa Clara, Calif., is a low-swing dual bidirectional transceiver that's suited for applications requiring high data rates and low power, such as IEEE 1394 *(Fig. 2)*. Primary applications for the chip include the interface between digital-satellite-service (DSS) set-top boxes and digital VHS devices, camcorders, compact-disk players, and digital television. Such applications require data rates in excess of 100 Mbits/s. A high-speed dedicated link can be built using the DS36C200 and a microcontroller.

The DS36C200 is based on low-voltage differential-signaling (LVDS) technology. LVDS achieves high data rates using lower signal levels and signal swings than existing technologies like TIA/EIA-385, TIA/EIA-422, and PECL. The strong points of LVDS include a high raw speed, low power dissipation, reliable data transmission, and low noise emission.

Getting the information from the graphics subsystem to the display is obviously an important task that can be burdened by high-quality video or high-end graphics. Just as important however,



3. MULTICHANNEL LINEAR recording (MLR) technology is the backbone of the MLR1 tape drive from Tandberg Data Inc. In the compressed mode, it stores up to 26 Gbytes of data on a quarter-inch cartridge.

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deploying a high-quality monitor. Smile International Inc., Costa Mesa, Calif., has developed a pair of monitors using an NEC Cromaclear CRT. At 15 and 17 in., respectively, the CB6536SL and CB6736SL displays offer a 0.25-mm dot pitch. Both offer 1280 by 1024 pixels at a 60-Hz refresh rate.

The Cromaclear CRT's electron gun shoots electron beams through a slotted shadow-mask screen to a striped phosphor screen. The illuminated phosphors appear elliptical in shape compared to the round phosphors used in traditional displays. The CRT groups the illuminated phosphors into separate bundles of three in a vertical alignment. The result is improved color saturation, focus, and contrast.

Power-management software ships with the Smile displays. They also come bundled with power and video cables, manuals, and an ergonomic tilt-and-swivel base.

Aimed directly at imaging, multimedia, and video-conferencing applications is a series of high-resolution monitors from Nokia Display Products Inc., Sausalito, Calif. The 17- and 21-in. monitors ship with integrated audio capabilities including a subwoofer, an adjustable color CCD camera, and a directional microphone.

At the high end is the Nokia 447K, which is Windows 95 plug-and-play compatible. It is built with a Trinitron display and offers intuitive on-screen controls for both audio and video. The resolution runs up to 1600 by 1200 pixels at a refresh rate of 72 Hz with a 0.25-mm aperture grill. A proprietary FullScreen technology lets the user expand the usable viewing area by 10% to reduce eye strain.

Not do be outdone by their monitor-producing competitors, Compaq Computer Corp., Houston, Texas, has developed its own family of monitors, dubbed the Performance line. The 15-in. model, the P50, is built with a flat square multiple-scan CRT and an Invar shadow mask. The 0.28-mm dot pitch can be viewed at resolutions up to 1280 by 1024 pixels at a refresh rate of 60 Hz. The design features concealed cable management for the most effective space utilization. On-screen display is used for all controls except contrast and brightness, which are handled by analog dials.

The P70, manufactured with a Trinitron CRT, is the 17-in. version of the Performance line. With a dot pitch of 0.26 mm, it can display resolutions up to 1600 by 1200 pixels at a refresh rate of 65 Hz. Advanced on-screen controls are provided. A 15-in. Value line display, the V50, is also available.

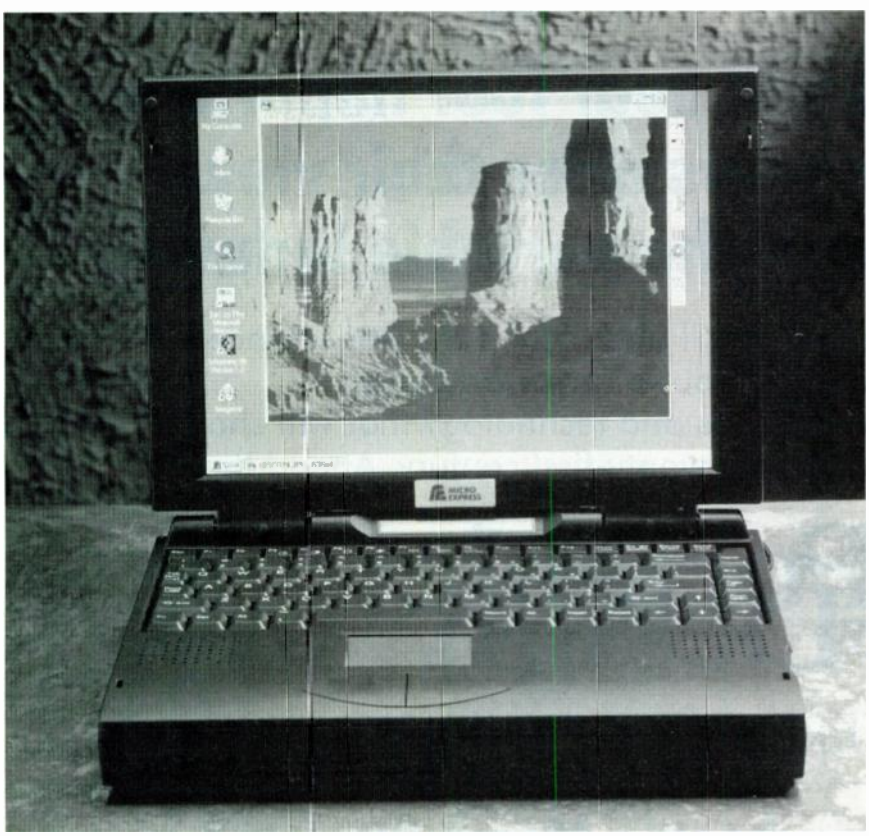
Where To Keep It All

With the vast amount of data coming into today's PCs, users need a place to store all the information. For this reason, Hitachi America Ltd., Brisbane, Calif., designed the DK224A-14 2.5-in. hard-disk drive. With a height of just 12.7 mm, the drive employs magnetoresistive (MR) heads, a partial-response maximum likelihood (PRML) read channel, and ID-less sector formatting to achieve a 1.44-Gbyte capacity on three platters.

The DK224A-14 is driven by a 32-bit, 20-MHz RISC processor which reduces IDE command overhead by more than 50%. The result is an average seek time of 12 ms, and a transfer rate of 16.6 Mbytes/s through the ATA-2 (Enhanced IDE) interface. The rotational speed is 4464 rpm. Reliability is improved using the Self Monitoring Analysis and Reporting Technology (SMART). The drive is rated for an MTBF of 300,000 hours. The power requirements are 0.9 A at spin-up, 0.22 A in the idle mode, and 0.055 A in the sleep mode.

To get an even higher data rate, Hitachi offers a series of drives with an Ultra SCSI interface. Capacities run up to 9.1 Gbytes with a 9-ms average seek time. The DK318H-91 is 1-in. high, in a 3.5-in. form factor. Spinning at 7200 rpm, the drive employs ten platters, each with an areal density of over 800 Mbits/in.^{2}. MR heads and PRML read channels push the drive to the highest performance.

To help propel the higher disk-drive capacities, Lucent Technologies' Microelectronics Group, Berkeley Heights, N.J., has developed a second-generation CMOS PRML read-channel chip. The all-CMOS design helps lower the drive's overall power consumption. The device, designated the MS131, encodes and decodes user and



4. BUILT WITH A 133-MHZ Pentium processor and a 12.1-in. active-matrix display, the NP133A notebook computer is suited for presentations. Other features include 16 Mbytes of DRAM, 256 kbytes of secondary cache, a 1.3-Gbyte disk drive, a 6X CD-ROM drive, 16-bit sound capabilities, dual stereo speakers, and a 28.8-kbit/s fax-modem.

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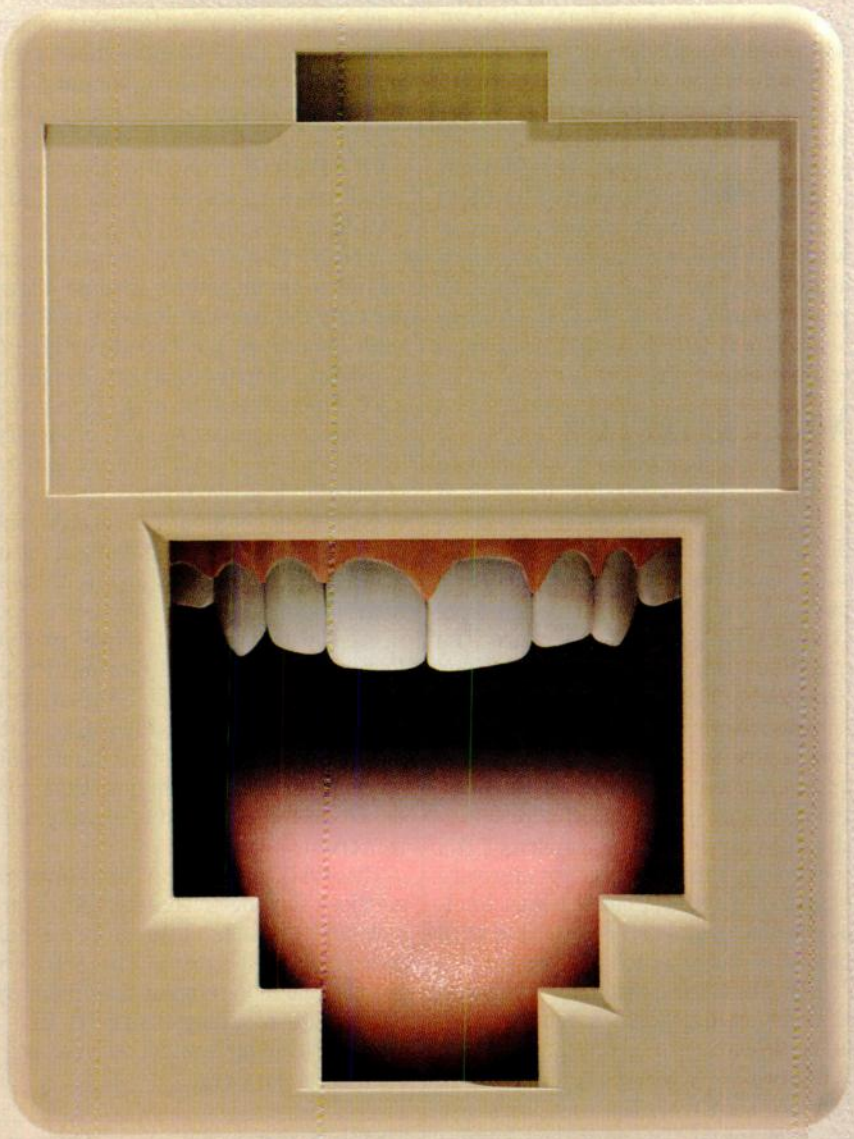

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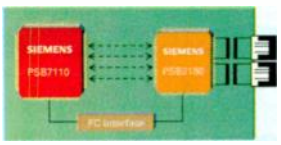

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READER SERVICE 192

servo data stored on the drive's platters. Aimed at high-end drives, the IC operates with MR heads.

To help simplify drive design, the MS131 read-channel chip employs a quality monitor whose output supplies a performance indicator based on the difference between the actual data and an ideal read signal. While helping to optimize the read channel, this data helps to map bad sectors.

The MS131 balances analog and digital circuitry to minimize the power draw. Running from a 5-V supply, the part can handle data rates up to 165 Mbits/s. At full speed, the part consumes less than 860 mW in the read mode. In the sleep mode, the part consumes under 5 mW. The SMART disk-failure prediction is supported.

Nonlinear aspects of MR head response are compensated for by the MS131's adaptive circuitry. The chip also detects and compensates for thermal asperities that could result in data loss. The thermal asperities occur when the head strikes debris, generating heat and causing a shift in the read-channel's input baseline voltage level. The MS131 detects this shift and compensates for it.

No Space? Try Tape

While the disk drive is one place to store the ever-increasing amounts of data, tape drives are also in the spotlight. For example, the MLR1 tape solution stores up to 26 Gbytes compressed, on one quarter-inch cartridge *(Fig. 3)*. According to the manufacturer, Tandberg Data Inc., Simi Valley, Calif., Multi-channel Linear Recording (MLR) technology offers a five-fold increase in capacity and performance over existing quarter-inch tape products. In addition to the 13-Gbyte native capacity, the technology offers a data-transfer rate of up to 3 Mbytes/s. The MLR technology is also backward-compatible with previous quarter-inch products.

The MLR1 is suited for high-end PC servers and workstations running under Netware, Unix, Windows NT, Windows 95, Windows 3.1, and DOS. Drivers ship with the unit for these environments. In addition, single-server support is supplied for Solaris and AIX. Another piece of software that ships with the drive is Direct Tape Access, which lets users access the tape drive just as they would access a hard-disk drive.

The MLR1 tape drive employs RLL data encoding and MR heads for higher data densities. The number of tracks on the tape has been increased from 42 to 144. Simultaneously, servo tracking is implemented to prevent overwriting of adjacent tracks.

Power In Tiny Packages

While most industry observers are aware that the functionality of notebook computers is increasing at a rate near their desktop counterparts, the NP133A from Micro Express, Irvine, Calif., is living proof. The platform, which is suited for presentations, is built with a 133-MHz Pentium microprocessor, a 12.1-in. active-matrix display, 16 Mbytes of main memory, and 256 kbytes of secondary cache. It also includes a 1.3-Gbyte hard-disk drive, a 6X CD-ROM drive, 16-bit sound capabilities, dual stereo speakers, and a 28.8-kbit/s fax-modem *(Fig. 4)*.

The NP133A's IRDA-compatible infrared communications module allows for easy file transfer. External peripherals connect to the Type II or III PC Card slot. There's also a port to connect a VGA monitor. On-board flash memory lets users upgrade the system's BIOS. The standard NiMH battery can be charged in just two hours.

Notebook computers aren't the only portable devices getting a lot of attention. The market for digital cellular telephones and services is expected to more than triple in five years. To address that market, Phoenix Technologies Ltd., Santa Clara, Calif., has developed PicoPAL, software that supplies system functionality for smart telephones that are based on the Geos 3.0 operating system from Geoworks.

PicoPAL offers the fundamental services for power control, data storage, and expandability, all in a small memory-size footprint. The software lets the telephone employ flash memory like a solid-state hard-disk drive. □

Richard Nass' e-mail address is: richnass@class.org.

How Valuable?	Circle
Highly	540
Moderately	541
Slightly	542

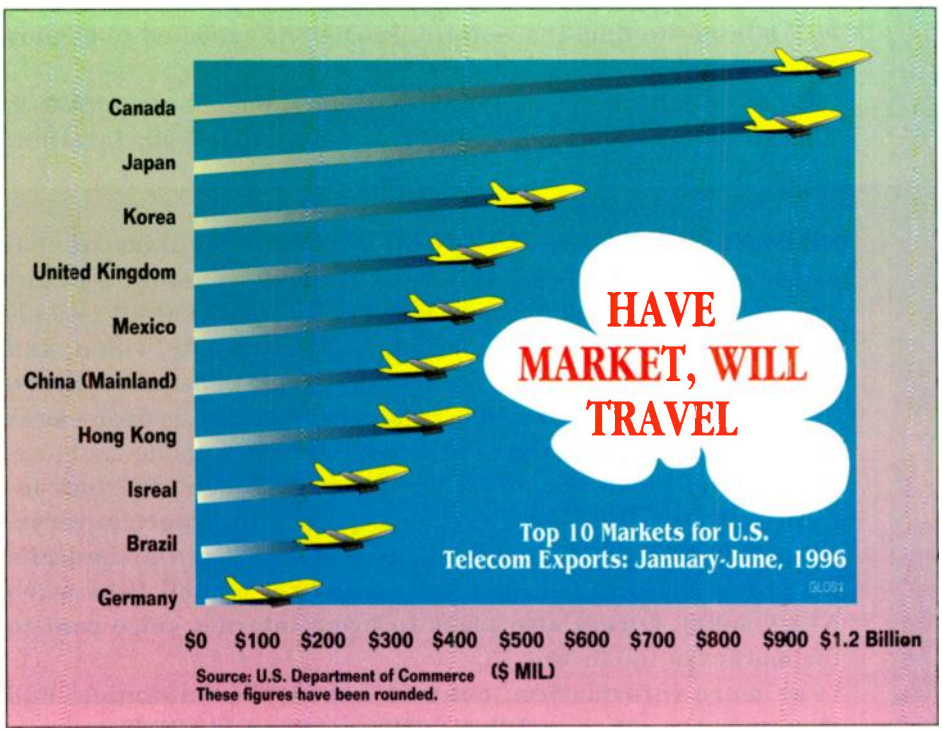
ELECTRONIC DESIGN QUICK LOOK

EDITED BY MIKE SCIANNAMEA AND DEBRA SCHIFF

MARKET Facts

In an election year that's been finding quite a few of the ballot riders with their own web pages, it's no wonder that the telecommunications market continues to soar. According to the latest numbers from the Telecommunications Industry Association (TIA), the United States saw a growth of 5% (over the same period in 1995), during the first half of 1996, hitting $8 billion in exports of telecommunications equipment. The telecommunications industry has been acting like a set of stilts for the U.S. trade surplus house that's built on the shoreline—keeping it above water. Telecommunications trade surplus cashed in at $2 billion during the first six months of this year. In the export market rankings, Canada stayed at the top of the charts, at $1.2 billion, up 46% from 1995. Canada represents 14% of the U.S. export market of telecommunications equipment. The United Kingdom and Mexico each see 6% of the U.S. exports, while Brazil and Israel each accept 4% of the market. Absorbing nearly 30% of the total U.S. telecommunications equipment export market were China, Hong Kong, Japan, and Korea, totalling $2.3 billion. The Asian market is growing exponentially, according to the Hong Kong Trade Development Council. A recent report by the council asserted that 50% of people who live in Hong Kong are projected to own a mobile phone in the near future. At the moment, if you grabbed five people on the street in Hong Kong, and asked each of them if they owned a mobile phone, one person in that five would answer affirmatively. Vietnam, a new trade market to the U.S., is seeing exports from the U.S. 42% higher than last year, to over $5 million. In the telecom equipment breakdown, during the first half of 1996, cellular phones represented $1 billion worth of U.S. exports. Modems filled in $512 million of the exports. Fiber optic cable rose an astronomical 145% to $320 million, with cordless telephones on its heels with a rise of 100% to $171 million. For more information, contact the Telecommunications Industry Association, 2500 Wilson BLVD, Suite 300, Arlington, VA 22201; (703) 907-7221; fax (703) 907-7727; or see their web site at http://www.tiaonline.org.

DS



QUICKLOOK

QUICK NEWS

A WIRELESS PAIRING—Motorola's Cellular Infrastructure Group and Alcatel Telecom have enhanced a prior arrangement to include purchasing of each other's wireless equipment. The deal has Alcatel buying and distributing Motorola's CDMA cellular and fixed access radio systems. Adhering to industry standards, Alcatel will be using the A+ open interface on its switches. This agreement means that the two companies now can offer a turnkey system solution for CDMA applications. In addition, Alcatel will be supplying the mobile switching subsystem and transmission equipment. Both companies will supply Motorola's fixed wireless access system, the CDMA WiLL, with Alcatel using a V5.2 open interface on its switching systems.

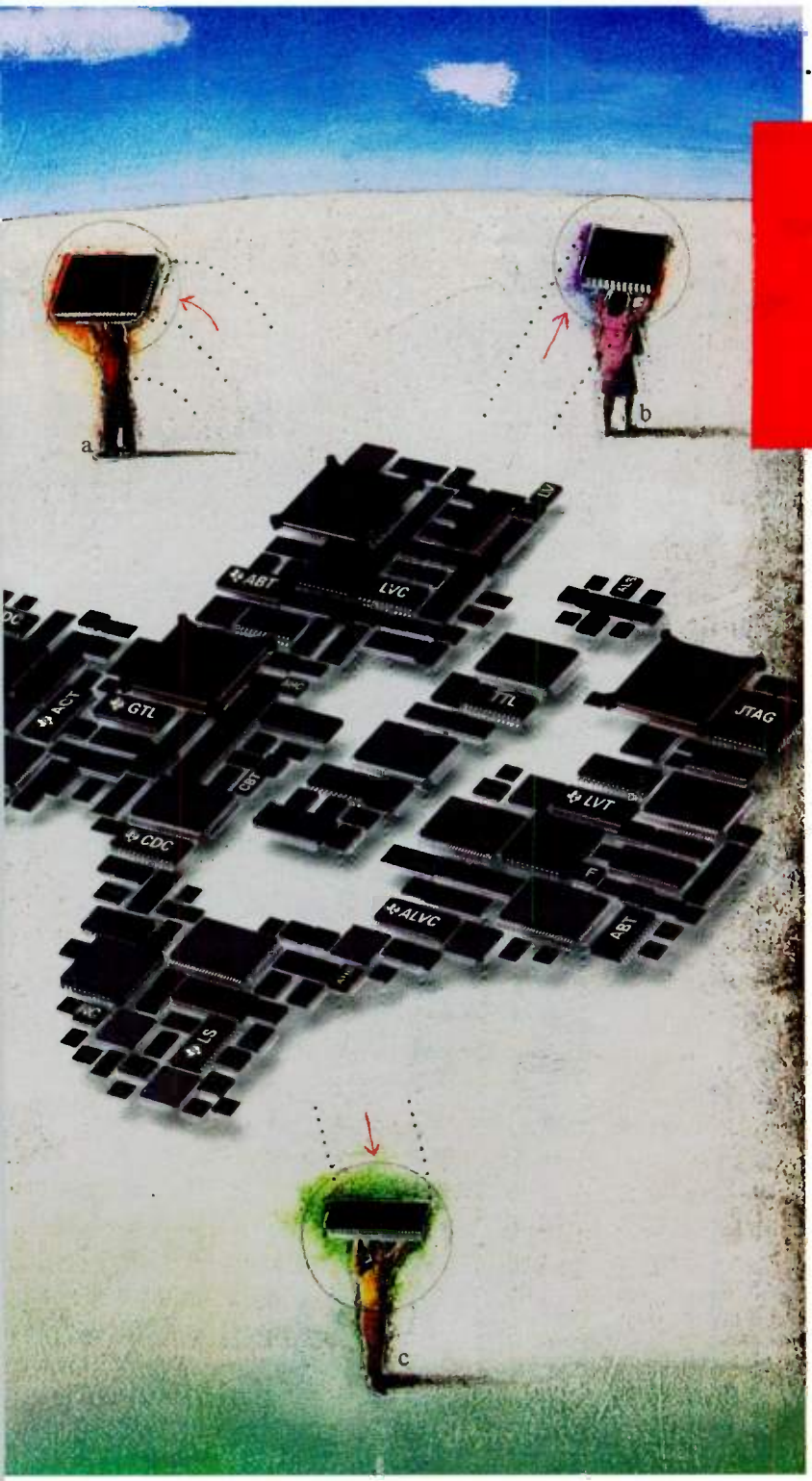
For more information, contact Motorola Cellular Infrastructure Group, 1475 W. Shure Dr., Arlington Heights, IL 60004; (708) 632-2560.

HIGH-DENSITY JOINT VENTURE—A new company to be based in Hsinchu, Taiwan, has been formed by Mosel Vitelic Inc., and Siemens AG. The joint venture, ProMOS Technologies Inc., will produce 64-Mbit DRAMs initially, but Siemens assures that the company will eventually produce 256-Mbit DRAMs. ProMOS will be operating a new semiconductor plant, in addition to fostering a Research and Development program. The production plans call for a 0.35-micron CMOS process, to be joined by a 0.25-micron CMOS process down the line. Management and engineering of the venture will be provided from both Mosel Vitelic and Siemens. It will take two installments—first $1.0 billion, then $0.7 billion—to fund the venture. ProMOS is expected to employ 1500 people.

For more information, contact Siemens Components, 10950 N. Tantau Ave., Cupertino, CA 95014; (408) 777-4500; Internet: http://www.siemens.de.

INTERNET COMMUNICATION MADE EASY—Looking to simplify voice and video Internet communication, Lucent Technologies Inc. has formed Elemedia Internet. Lucent intends for the new business to bring high-quality music, video, and voice communications to more businesses and consumers. By using new software by Elemedia, callers can place calls overseas at local telephone rates. Currently, those Internet phone users experience poor sound quality, but Elemedia's new offerings include software that provides high-quality Internet conversations. Much of the new technology was developed at Lucent's Bell Laboratories (Lucent retained control of Bell Labs when AT&T split). Lucent also plans to bring Internet voice mail to the market in the future.

For more information, contact Lucent Technologies, 600 Mountain Ave., Murray Hill, NJ 07974; (888) 4-LUCENT.



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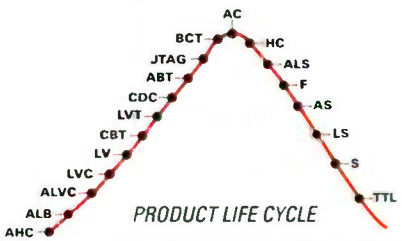

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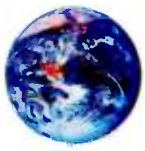

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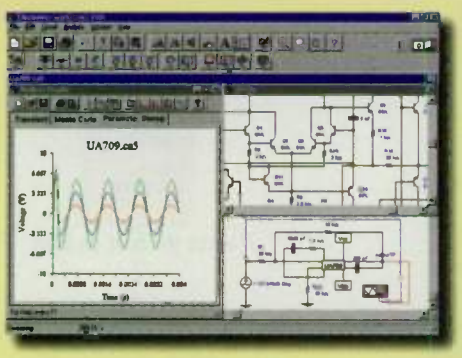

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THE POLYMER SUSTAIN

In the beginning, guitars were made of wood. Then, there were plastic guitars. But, they didn't sound the same. In fact, they often sounded so bad that no one used them except high school garage bands (who dug the effect, man). Again, guitar companies went back and designed composites—combinations of wood and plastic—that didn't do the trick, either. So, now there's this legacy of instruments that cannot compare to their wooden counterparts. It all leads, unfortunately, to a buying public with a negative perception of anything NOT wood.

Despite the mammoth challenge of reeducating generations of guitarists, Roland Giles Jr., of Giles Custom Guitars, Bellingham, Mass., has made it his business to build a polymer guitar. After years of design hit and miss, Giles was pointed in the direction of Polymer Design, Rockland, Mass. Polymer Design uses their trademarked Liquid Resin Casting (LRC) process to produce small quantities of high-quality complex parts for the semiconductor, medical device, electronic, scientific instrumentation, and environmental industries. The LRC technique consists of pouring liquid (at room temperature) resins into molds, vacuum degassing (to prevent porosity), and heating at low temperatures for long periods to cure (solidify) the resins.

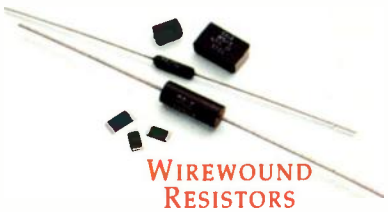
When Giles met with Polymer Design, he asked them to fashion a body for a plastic guitar with the same attributes of a wooden guitar. Not only did they provide Giles with a resin guitar body that had a warm sound, they gave it a longer sustain (the length of time an instrument can hold a note). The new guitar also weighed about half of what an average wooden bodied guitar weighs.

Needless to say, the machinist was very happy.

The blues guitar of the polymer line features three single coil pick-ups with a vintage-style tremolo. All of the pick-up covers are aluminum and anodized to prevent the static shocks that guitarists experience if their pick-up covers aren't grounded. As Giles says, "You can't get zapped from it!" The blues guitar sells for $1650.

Although the necks of Giles' guitars are still wood, polymer necks are in the blueprint stage. Giles doesn't want to frighten off consumers with a totally plastic guitar, so even when the resin neck does come to pass he plans on introducing it into the market slowly. For more information about Giles Custom Guitars or Polymer Design, contact Peter Wilson at Fuessler Group Inc., 324 Shawmut Ave., Boston, MA 02118; (617) 262-3964; e-mail: fuessler@tiac.net.—DS

Passives Partner to the World



Wirewound Resistors

WSL (power metal strip chip), WSC: SMD, low value/high performance. **LVR, RS:** Axial leads, precision power. FlashFax℠ docu. #200.

Chip Resistors

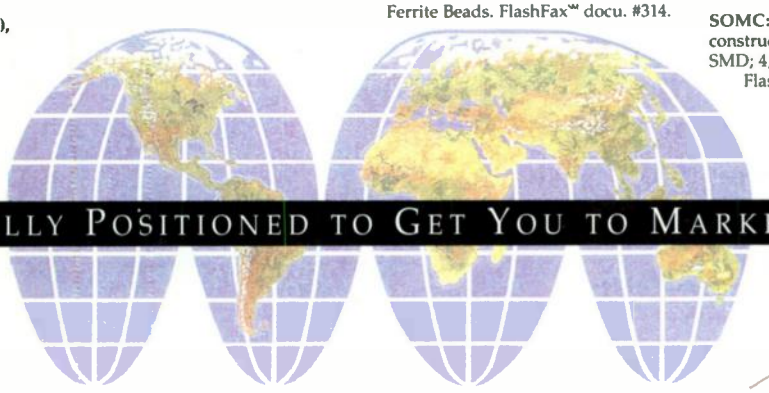
CRCW0402, CRCW0603, CRCW0805, CRCW1206: Thick film, wraparound termination. **SMM0204:** SMD, thin film MELF. FlashFax℠ docu. #16.

Inductors

ISC-1210, ISC-1812: SMD, molded, shielded. **IMC-1210, IMC-1812:** SMD, molded. **IMS-5:** Axial leads, molded, shielded. **IM-2:** Axial leads, molded. FlashFax℠ docu. #310. **ILB-1206:** Ferrite Beads. FlashFax℠ docu. #314.

Thick Film Resistor Networks

SOMC: SMD, rugged molded case construction. **CRA (chip array):** SMD; 4, 8, 10 or 16 terminals. FlashFax℠ docu. #17.



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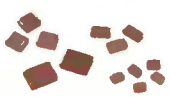

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Capacitance Values: 1.0pF-15µF
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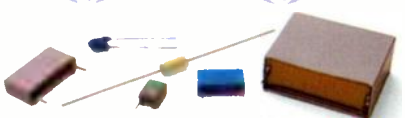
Tantalum Capacitors

293D: SMD, molded case. **199D:** Radial leads. **173D:** Axial leads, molded case. FlashFax℠ docu. #515.



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Film/Foil and Metallized Film Capacitors: Axial, radial and SMD formats; high voltage Disc Ceramic Capacitors; and fully approved RFI Suppression Capacitors, "X" and "Y" function, in both film and ceramic dielectrics. FlashFax℠ docu. #700.

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(Document #'s listed above.)

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But I Gotta' Tell Ya...

***FLASH**—Eveready Bunny arrested; charged with battery.*

Picture this: You're trying to finalize the hardware and software design of your company's latest product by Friday. It's Thursday afternoon, and you're nowhere near completion. Your boss is breathing down your neck. You decide to log on to the Internet to get some last minute technical information from a major university. The sweat is pouring profusely off your brow. Is there no end to this madness?

Of course there is! Take a laugh break! Just like everyone else in the workforce, engineers need to laugh every now and then. While you're on the 'Net, tap into Softaid Inc.'s web site at http://www.softaid.com and follow the links to the Joke Page. You may find such knee-slappers as:

Definition of an Upgrade: Take old bugs out; put new ones in.
Essay: What If Operating Systems Ran Airlines?

In addition, you'll find song parodies. Here's a snippet of one that may get you to break into song at your cubicle, and it may just persuade your colleagues to join in:

UNIX (to the tune of Pink Floyd's "Money")

UNIX, It's a gas
grab that VAX with
both hands and make
it crash

The web site features a button that feeds a random joke from Softaid's Joke Database. All are about techies and technical subjects. According to the company's president, Jack Ganssle, "Life is short. It's important to fill it with smiles."

When not engaging in "Can You Top This?", Softaid designs and manufactures in-circuit emulators for a variety of 8- and 16-bit processors. For more serious inquiries, the company can be contacted through their web site or at 8310 Guilford Rd., Columbia, MD 21046; (410) 290-7760; fax (410) 381-3253.—*MS*

OFFERS YOU CAN'T REFUSE

A new product diskette, free from Unipower, is a complete Product Guide with 11 different product series described. The program runs under Windows 3.1 or Windows 95 and produces 37 screens of product information, plus a table of general features and a table of contents. The product screens are similar to catalog pages, requiring a single click of the mouse to go forward or backward or return to the table of contents. The product series have output power from 20 to 1800 W with from one to 14 outputs. Each series has a list of features and options, including input, output and general specifications, and a selection table of models with all output voltages and currents. Contact Ed Schneider, Executive Director, Unipower Corp., 3900 Coral Ridge Dr., Coral Springs, FL 33065; (954) 346-2442; fax (954) 340-7901.

Analog Magic 2.0 evaluation software is WYSIWYG (what you see is what you get) design methodology for analog and mixed-signal electrically programmable analog circuit (EPAC) devices. It runs on Windows-based PCs and allows users to configure and program working EPAC silicon with a simple "point and click" approach. The software is included as part of IMP Inc.'s new EPAC Design Handbook, which contains product information, application notes, and circuit development tool details. The software can be downloaded free-of-charge from the company's web site at http://www.impweb.com. For more information, contact IMP Inc. at 2830 N. First St., San Jose, CA 95134-2071; (408) 432-9100; fax (408) 434-0335.

Stanford Telecommunications Inc. has announced the availability of a new brochure that presents modulator and demodulator ASICs and board-level assemblies for Hybrid Fiber/Coax (HFC) upstream CATV systems. The brochure includes information on the company's STEL-1108 BPSK/QPSK digital modulator ASIC chip used in subscriber modems and set-top boxes. For a free copy of the brochure, contact the company at P.O. Box 3733, Sunnyvale, CA 94088-3733; (408) 745-2660; fax (408) 541-9030; e-mail tpg.marketing@stelhq.com.

QUICK NEWS

SETTING THE PACE—Product development practices in the high-tech industry are undergoing significant changes, thanks in part to a product development process called PACE—Product And Cycle-time Excellence. Pittiglio Rabin Todd & McGrath (PRTM) developed the process after having worked with hundreds of technology-based companies to improve their product development processes. Companies using PACE have seen their time-to-market cut in half, product development waste reduced by up to 80%, and revenue attributed to new products jump by as much as 100%.

According to Michael McGrath, founding director of PRTM, the high-tech industry has changed dramatically in the past 25 years, adopting new waves of thinking about the product development process.

In the first wave, which occurred approximately in the 1970s through the mid-1980s, companies made functionally-based improvements and used program management techniques to coordinate development activities of multiple functions and improve project scheduling.

The second wave, in the mid-1980s through the mid-1990s, saw a critical shift toward cross-functional integration in the product development process. By empowering project teams, many companies were able to achieve a 50% reduction in time-to-market for new products.

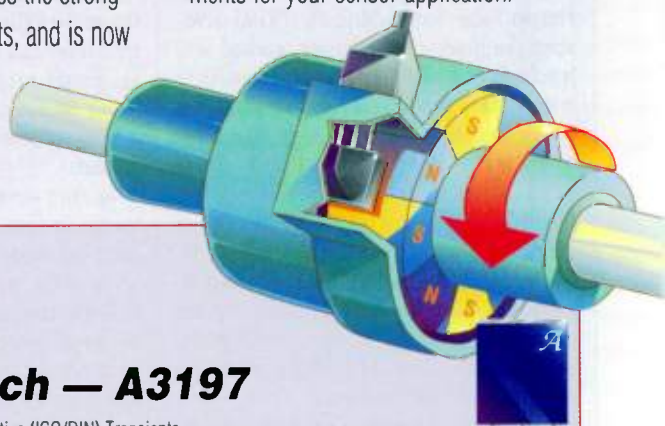
The third wave, which is just now getting attention in some best-in-class companies, focuses on improving cross-project, or enterprise-wide, management. According to McGrath, companies are beginning to look at the larger process issues. McGrath notes that while many companies have completed cross-functional integration at the project level (wave 2), only a few are beginning to accomplish cross-functional integration at the enterprise level.

In the book "Setting the PACE in Product Development," McGrath and several directors at PRTM review successful product development processes used by more than 140 companies, including many Fortune 500 firms. The authors identify the seven elements most common in high-tech product development, and make the point that best practices can be applied across many divisions in a company. PACE provides a common framework, standard terminology, industry-wide process benchmarks, a way of updating best practices and a process for continuous improvement. The book offers a practical model for understanding the product development process and presents specific strategies backed by numerous case examples.

For more information regarding the process contact PRTM, 9 Riverside Rd., Weston, MA 02193; (617) 647-2800; fax (617) 647-2804; Internet: http://www.prtm.com.

ALLEGRO HALL-EFFECT SHOWCASE

Allegro manufactures and designs a full line of Hall-Effect switches, latches and linear devices that are extremely sensitive, with guaranteed operation at temperature ranges of -40°C to +150°C. Our latest edition to the latch family, the A3197, continues the strong tradition of Allegro products, and is now fully protected. We invite you to call Allegro for the latest technical details and other requirements for your sensor application.



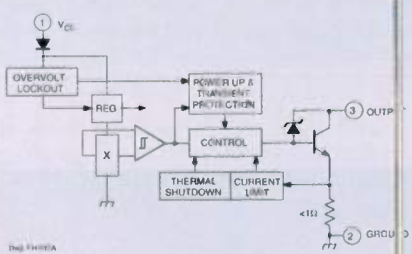
Allegro... the clear choice for Hall-Effect Sensor Design.

New From Allegro

Protected, High- Temperature, Open-Collector Hall-Effect Latch — A3197

These open-collector Hall-Effect latches are capable of sensing magnetic fields while using an unprotected power supply. The A3197LLT and A3197LU can provide position and speed information by providing a digital output for magnetic fields that exceed their predefined switch points. These devices operate down to zero speed and have switch points that are designed to be extremely stable over a wide operating temperature and voltage range.

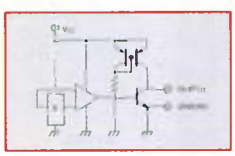
- Internal Protection for Automotive (ISO/DIN) Transients
- Operation from Unregulated Supply
- Reverse Battery Protection
- Undervoltage Lockout
- Supply Noise-Suppression Circuitry
- Output Short-Circuit Protection
- Output Zener Clamp
- Thermal Protection
- Symmetrical Latching Switch Points
- Operate with Multipole Ring Magnets



Ratiometric, Linear Hall-Effect Sensors For High Temperature Operation — A3506 thru A3508

The A3506 linear Hall-Effect sensors provide an output voltage (4.5 V to 5.5 V) that is proportional to the incident magnetic field. On-chip processing circuitry provides the user with an amplified low-impedance output signal that minimizes the need for external circuitry. Internal temperature compensating circuitry lowers the intrinsic sensitivity drift of the Hall element, allowing it to accurately operate continuously over extended temperature ranges -40°C to +150°C.

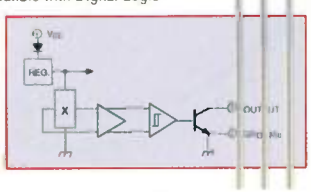
- Increased Sensitivity
- Superior Temperature Stability
- Solid-State Reliability
- Ratiometric Rail-to-Rail Output
- Small Packaging Size



Hall-Effect Switches For High Temperature — A3141 thru A3144

The 3141 thru 3144 Hall-Effect switch is a monolithic integrated circuit with tighter magnetic specifications and switch points, designed to operate continuously over extended temperatures -40°C to +150°C, and is stable with both temperature and supply voltage changes. This small size switch can operate on an unregulated power supply between 4.5 V to 24 V.

- Superior Temperature Stability for Automotive or Industrial Use
- Open-Collector 25 mA Output — Compatible with Digital Logic
- Reverse Battery Protection
- Activate with Small, Commercial Available Permanent Magnets
- Solid State Reliability — No Moving Parts
- Small Size



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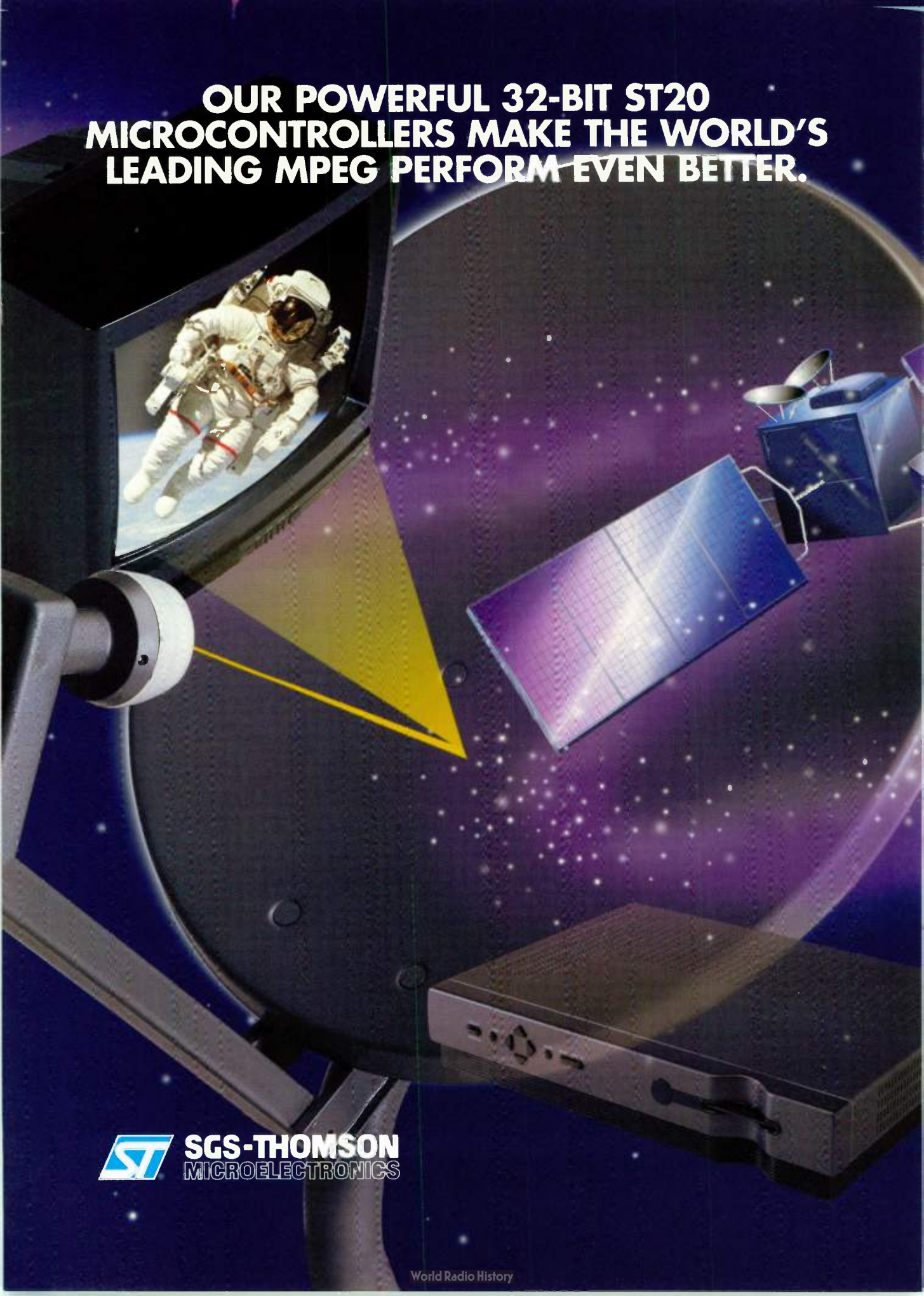
WasteWi$e, and not Pound Foolish–

Launched in 1994 by the U.S. Environmental Protection Agency(EPA) as an incentive to get corporate America to reduce solid waste, WasteWi$e now has 480 member companies. One-third of those companies are Fortune 500 manufacturing or service organizations. WasteWi$e is a voluntary partnership program with the intent of aiding businesses in finding practical ways of reducing, reusing, and recycling their waste, while saving money in the process. In recognizing corporations that have made serious efforts to prevent waste, recycle, and buy or manufacture recycled content products, the WasteWi$e program has developed the Comprehensive Program Recognition Award. This year, Compaq Computer Corporation is one of the award's recipients. Compaq has been a charter member of WasteWi$e since March 1994, enjoying the benefits of reducing waste and overhead simultaneously. Changing its packaging, along with its methods of internal communication have led Compaq to reduce waste and save thousands of dollars. Some of Compaq's WasteWi$e recognized changes include: distributing employee bi-weekly newsletters and bulletins on-line—conserving approximately two million sheets of paper in 1995, reducing and reusing of supplier packaging, reusing foam packaging inserts for some refurbished computer products—saving $62,000 in 1995, installing copiers with a double-sided copying feature—reducing photocopying paper consumption, increasing the use of electronic communications systems, switching from a paper purchasing system to placing orders electronically—saving eight to ten pages per purchase order, and supporting community recycling efforts in the schools and public sectors. In showing businesses that they can increase operating efficiency through reducing purchasing and waste management costs, the EPA helps corporations save energy and reduce pollution. WasteWi$e's efforts in 1994 reduced greenhouse gas emissions by the equivalent of 270,000+ metric tons of carbon.

For more information, contact Compaq, P.O. Box 692000, Houston, TX; (713) 514-0484; fax (713) 514-4583; Internet: http://www.compaq.com.



LET US PUT YOU IN CONTROL

As the leading supplier of MPEG Audio/Video ICs (over 5 million MPEG chips shipped), SGS-THOMSON Microelectronics has played a major role in turning digital satellite television transmission into a home entertainment hit. Now an SGS-THOMSON-developed 32-bit RISC microcontroller core is helping to make the world's leading MPEG ICs perform even better.

The advanced ST20 — the latest in a complete family of 8, 16 and 32-bit SGS-THOMSON microprocessors — is the core technology for a new level of programmable ASICs that will enable consumers to enjoy increased functionality at the lowest possible cost. Moreover, set-top box manufacturers can now respond rapidly and economically to changes in transmission standards. Thanks to the ST20, the first dedicated microcontroller for set-top box operations, suppliers can now take control of their market.

In fact, some of the world's most visible manufacturers of set-top boxes, digital cellular handsets, hard disk drives and laser printers are using ST20 macrocell technology to design optimized 32-bit microcontrollers for their applications.

How about you? Before you develop your application, take a look at a partner with the product portfolio, leading-edge technology, proven in-house processes and global manufacturing infrastructure to put you in control.

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SGS-THOMSON, the No.1 supplier of MPEG Audio/Video Decoder ICs, is leading the digital satellite TV revolution

Service and Technology

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READER SERVICE 142

Kids Of All Ages Can Travel To MARS

A team of artists, animators, computer programmers and music composers at SIMLAB at Carnegie Mellon University (CMU), Pittsburgh, Pa., is fine tuning "Robotix Mars Mission," the world's first interactive, virtual reality cinema production. "Robotix Mars Mission" allows an audience to travel to Mars by spaceship, search for life on the planet, and return to Earth with data and rock samples.

Besides its entertainment value, the effort has scientific merit as well. The details of the mission—from the geography of the planet to the alignment of the planets depending on the time and the position of the mission's spacecraft—have been meticulously recreated from data provided by NASA. The project's merging of graphics and robotics, telepresence and telecontrol in a real-time virtual environment are all elements that can be applied to a future remote robotic exploration of Mars.

This audience exploration of the surface of Mars is unique in several ways. First, it is the world's first fully interactive virtual reality cinema production (an audience of about 30 democratically controls the nine-and-a-half-minute mission with handheld guiders). The artistic details of the mission, such as the shadows cast by craters and canyons and the metallic glimmer of the robot, have been painstakingly designed to be as realistic as possible. It employs a branching system of navigation that works in real time, so that the mission is truly audience-driven. Its custom-made dome-shaped display system allows the audience to be fully immersed in the sights and sounds of the mission.

The production premiered at the Carnegie Science Center last month as part of the center's "Robotics" exhibit, which also features CMU robots Dante and Terragator. The exhibit will then tour children's and science museums around the world.

"Robotix Mars Mission" is funded in part by Learning Curve Toys of Chicago, whose motorized, modular construction toy, Robotix, was used as the project's model. Computer images and a short video featuring highlights of the production are available from SIMLAB.

For more information, contact SIMLAB, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA 15213; (412) 268-2000. Internet: http://ww.cmu.edu.

GaAs MMIC SWITCHES

3 VOLT - INTEGRATED DRIVER - EXTENDED FREQUENCY RANGE

Configuration	Operating Frequency (GHz)	*Insertion Loss (dB)	*Isolation (dB)	Features	Part Number
SPDT	DC- 2.0	.5	23	3 volt positive control; economy priced	SW-373
SPDT	DC- 2.0	.5	33	Extended frequency; industry standard	SW-239
SPDT	.8 -2.0	.9	38	Integral CMOS Driver	SW-335
SPDT	DC-2.5	.5	39	Terminated internally	SW-338

*Typical parameters at 1GHz.

In quantities of 1000: $2.29

In quantities of 1000: $2.50

HIGH POWER HANDLING

Configuration	Operating Frequency (GHz)	*Insertion Loss (dB)	*Isolation (dB)	Features	Part Number
SPDT	DC- 2.5	.5	32	+33dBm, P-1dB	SW-277
SPDT	DC- 2.0	.5	17	2 Watt power handling; single neg/pos control	SW358 /SW359A

*Typical parameters at 1GHz.

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5 Bit Digital	DC- 2.0	1,2,4,8,16	1.6	Highly accurate attenuation; low power consumption	AT-210
4 Bit Digital	DC- 2.0	2,4,8,16	1.6		AT-220
3 Bit Digital	DC- 2.0	4,8,16	1.6		AT-230

*Typical parameters at 1GHz.

VOLTAGE VARIABLE ATTENUATORS

Configuration	Operating Frequency (GHz)	*Attenuation (dB)	*Insertion Loss (dB)	Features	Part Number
VVA	.5 - 2.0	0 - 35	3.2	Best linearity, single positive control	AT-108
VVA	DC- 2.0	0 - 35	7.2	18 dBm IP3	AT-635
VVA	DC- 2.0	0 - 15	3.2	Economical; small size (SOT-14B)	AT-259

*Typical parameters at 1GHz.

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EURO watch

ALFRED VOLLMER

Remember the slogan "Every Day is Earth Day?" On the World Wide Web, that is especially true because Siemens Nixdorf Informationssysteme AG of Munich, Germany, and GWU (Gesellschaft fuer wirtschaftliches Umweltschutzmanagement—Society for Economic Environmental Management), also of Munich, now offer a joint innovation in the field of environmental protection: Using the Internet as a medium for a future on-line waste and residual waste exchange.

The aim in establishing a "World Wide Waste Management Information System" (WWI) is to increase reuse rates and reduce disposal costs for manufacturers and municipalities. The data gathered in the WWI will be made available to waste producers, recyclers, haulers, waste management contractors, and government authorities as an information service. The initial target market consists of companies and municipalities who have large volumes of waste for recycling and/or disposal.

For example, this waste may consist of old printed-circuit boards, solvents, used fluxes, or formerly highly-purified liquids that were slightly "depurified" during chip production at a wafer fab. In fact, some chip manufacturers have already sold some of these used liquids to paint manufacturers. This means that they received money for a product that was formerly considered waste instead of having to pay for the disposal—an aspect underlining that recycling can offer financial, as well as environmental, benefits.

Interested parties have to enter into an agreement with the operator of the exchange before they can actively participate in it. Access to the WWI is available from every computer with Internet capabilities. In addition, the "exchange operators" offer potential users their services by telephone, fax, or e-mail.

As you may or may not know, Germany is one of the world's leading nations in the field of environmental protection. Due to the fact that Germany is so crowded with people, special laws for environmental protection are a must. (Germany is about the size of the state of Montana, but its population is roughly 100 times greater.) A new recycling legislation has gone into effect that will increase the pressure on waste producers from the industrial segment to avoid, reduce or recycle their waste streams. For example, this means that a company must first offer recyclable wastes as secondary raw materials; if no contractor is capable of recycling these wastes, then their waste may be disposed of by special contractors.

Within the new legislative environment, this information system can be employed to tabulate, classify, and analyze all of the waste streams in an economic zone (regionally, nationally, internationally) with existing regional waste, material, and recycling databases also being employed for this purpose. The WWI enabies waste producers, haulers, and recyclers to offer their residual wastes, to obtain quotations for haulage, and for information about the services offered by recycling contractors. For more information on WWI, you may want to take a look at their web site at http://www.ww.de.

Alfred Vollmer is an Electronic Design correspondent based in Munich, Germany. His Compuserve address is 75162,1246.

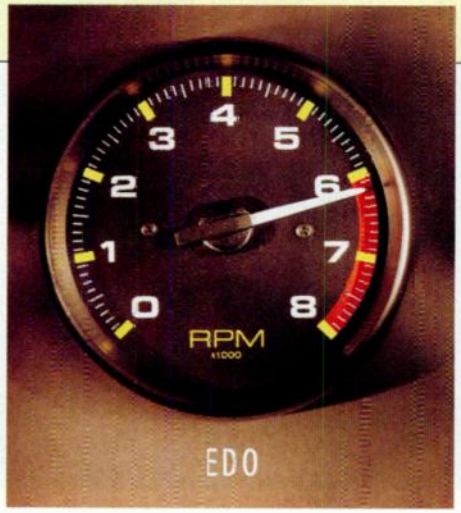
CONFERENCE*CALL*

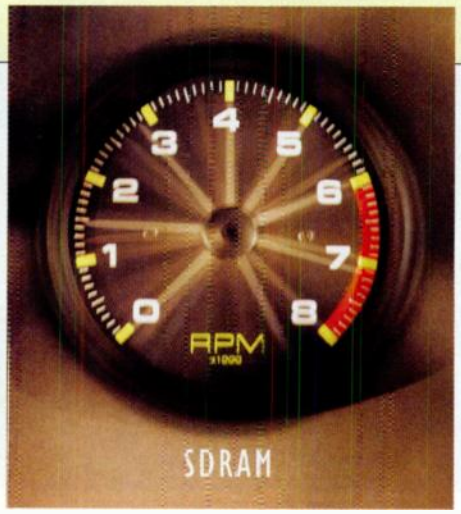
The Telecom and Industrial PCI Conference (TIPCIC) will be held in Framingham, Mass. on Dec. 2-5. The conference will concentrate primarily on "industrial strength" technologies such as Compact PCI, ISA/EISA, PCI/PC104, and others that relate to relatively "hostile" environments. Sessions and tutorials will be held on software and hardware issues involving end products or subsystems such as PMC, Small PCI, CardBus, Universal Serial Bus, IEEE 1394, along with other sessions for hardware designers, software developers, and other interested parties. For more information, contact Bill Weber, TIPCIC General Manager, 16968 Leslie Ct., Morgan Hill, CA 95037; (408) 778-1994; fax (408) 778-7078.

The fourth annual Fall Internet World '96 Conference and Exhibition will be held Dec. 9-13 at the Jacob K. Javits Convention Center, New York, N.Y. Those interested in Internet, Intranet, and World Wide Web applications will find presentations and sessions devoted to such areas as Web development, industry, e-commerce, telephony, communications, and broadcasting. More than 500 companies will be exhibiting their latest products, and special one-day workshops will also be held. For more information, contact Mecklermedia, 20 Ketchum St., Westport, CT 06880; (800) 500-1959; fax (203) 226-6976; Internet: http://events.iworld.com.

Toshiba EDO and Synchronous DRAM

It's not just how much memory, it's how fast.

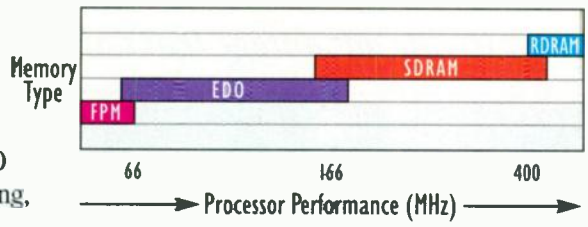




Putting enough memory into today's speedy systems isn't enough. You need to spec the right kind, too.

And that's where Toshiba comes in.

Our wide DRAM product line offers a variety of options, to make sure that you always get the best performance out of any design.



For systems running under 166MHz (or with bus frequencies up to 66MHz), Toshiba EDO DRAM offers a faster, space-saving, more cost-effective solution than conventional DRAM. In fact, with speeds up to 50MHz per I/O, EDO doubles system performance compared to Fast-Page-Mode. It comes in 4Mb and 16Mb densities. And it works with both 3.3V and 5V systems.

When things are really revving, Toshiba synchronous DRAM (SDRAM) offers an easier way to meet system requirements. Ideal for processors running over 166MHz and bus frequencies from 66MHz, our second-generation SDRAM features a smaller die, quicker cycle time and higher performance (up to 125MHz)—making it an economical alternative to EDO with level 2 cache. It's very controllable, since all functions are tied to one clock. And it comes in 16Mb density, with 3.3V operation.

Naturally, EDO and SDRAM are both interchangeable and easily upgradeable, thanks to new controllers and compatible pin-outs within module families.

The Toshiba memory line comprises a range of intelligent options—from Fast-Page-Mode for basic applications, to Rambus™ DRAM for tomorrow's 400-plus MHz systems.

To get your memory up to speed, just call us at 1-800-879-4963. Or URL directly to our memory page at **www.toshiba.com/taec/components/edosdram.html.**

Anything else, well, and you'll just be spinning your wheels.

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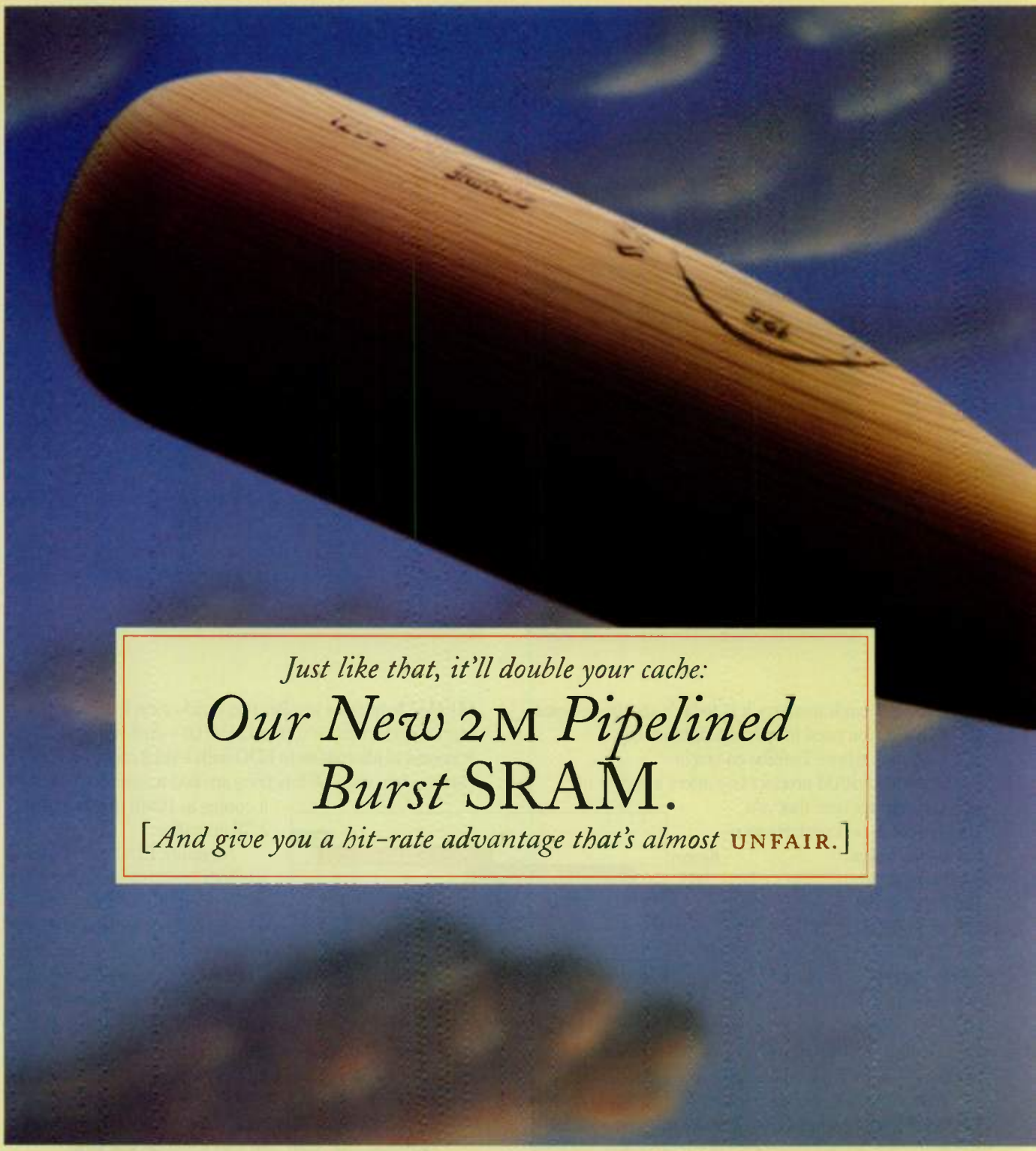


Just like that, it'll double your cache:

Our New 2M *Pipelined Burst* SRAM.

[*And give you a hit-rate advantage that's almost* UNFAIR.]

Juiced ball? Corked bats? Ridiculously oversized strike zones?

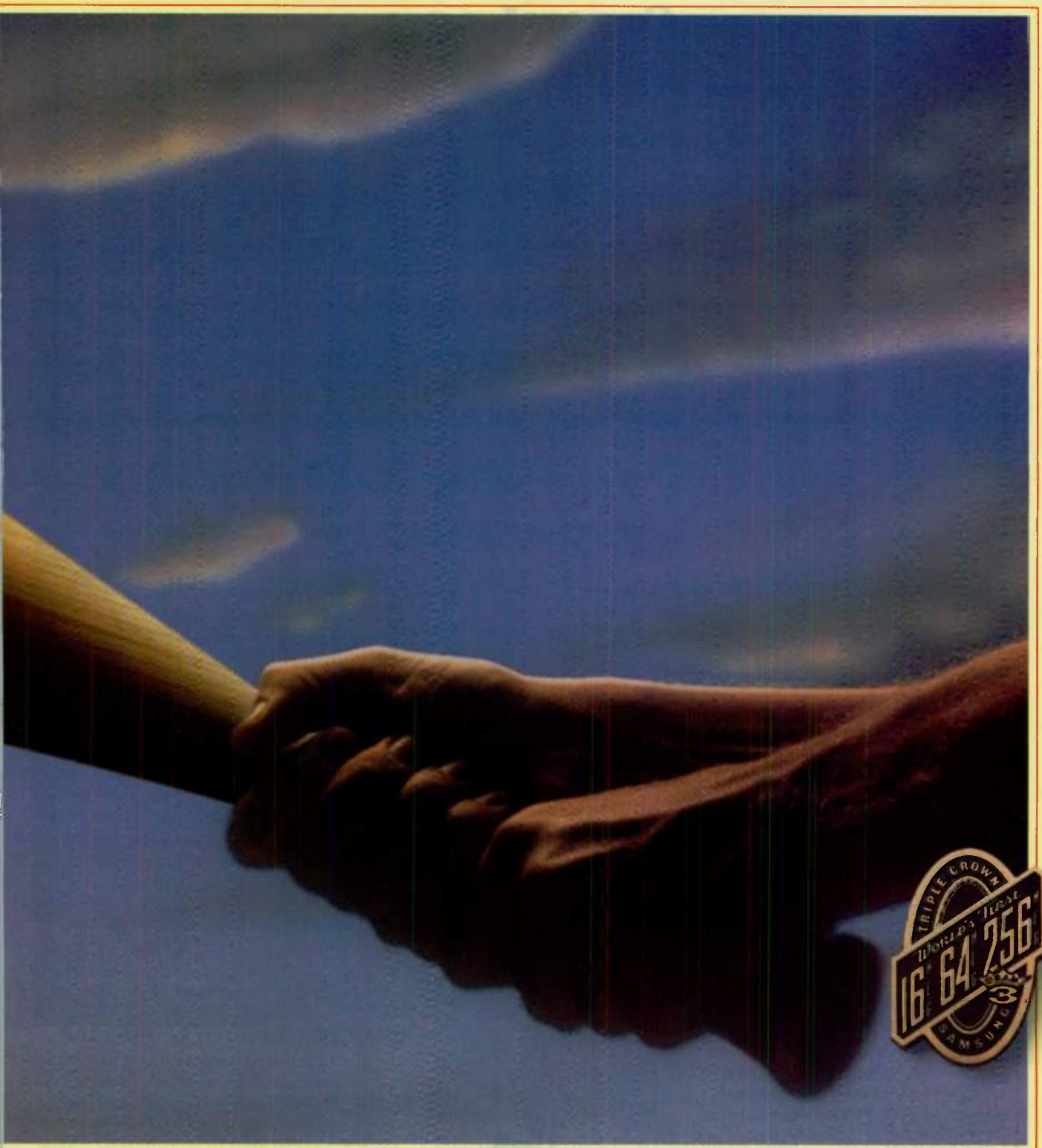
Whatever went on this past baseball season, expect to start seeing comparably astronomical hit rates in PCs.

Because at Samsung, the industry-standard design for PC cache SRAMs—synchronous pipelined burst—is now available in a double-sized density: 2 megs.

This is the design that's cost-effective. The design that gives Pentium-based systems the performance they were meant to have. And the design that we at Samsung pioneered to spark an entire revolution in PC configuration.

Which is one reason that today Samsung is not just the leader in memory and in SRAMs, but also in synchronous SRAMs specifically.

In the new 2M density, you'll



find the pipelined burst part will let you increase not just hit rates, but also overall system performance.

We offer the 2M pipelined burst part for 133-MHZ and 100-MHZ systems, and we also offer a flow-through synchronous version for 100-MHZ systems.

Like we said, we're the leader.

So why not call us for more information now? After all, we've got a part that can take even PCs with rather ordinary performance—and turn them into sultans of swat. For details, call 1-800-446-2760. Or write to SRAM Marketing, Samsung Semiconductor Inc., 3655 North First Street, San Jose, CA 95134.

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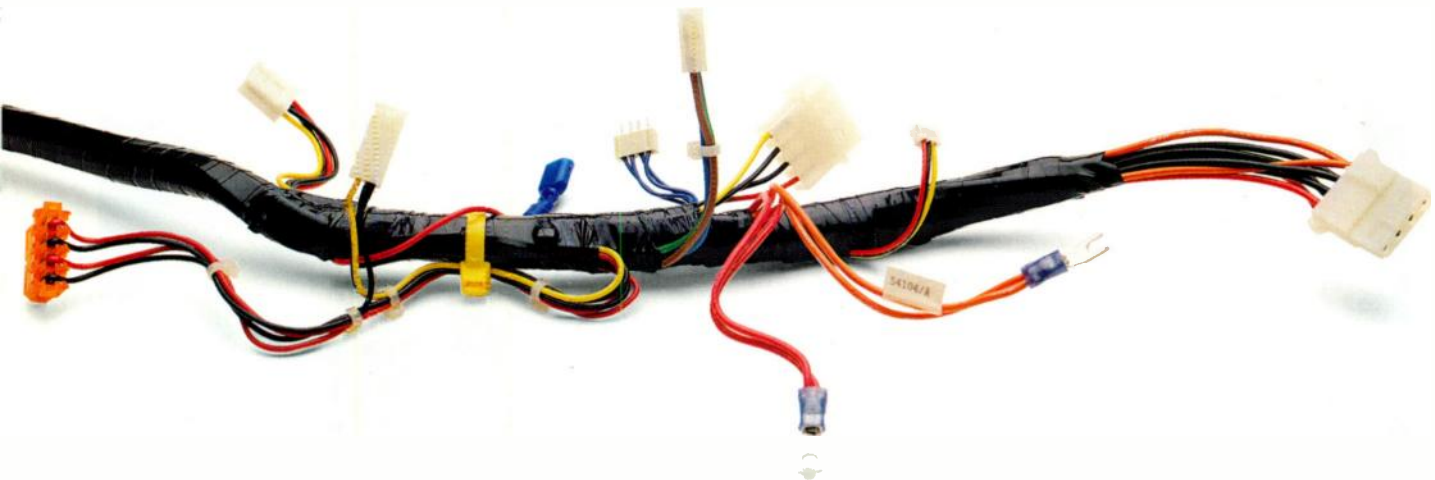

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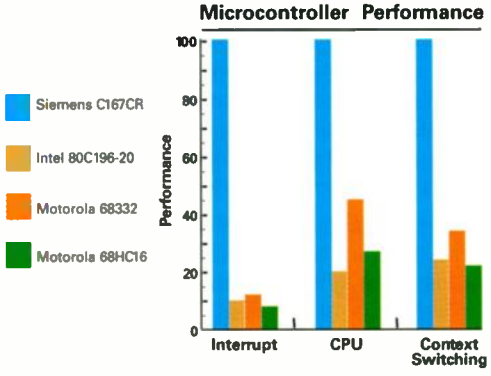
Engineers around the world are discovering the power of Controller Area Network (CAN). And simplified wiring schemes are just the beginning. CAN also offers a host of other benefits, including 1 Mb/s speed over standard twisted pair, rock-solid data integrity in electrically noisy environments, even the ability to send data over AC wiring (great for factory automation). With so many advantages, it's no wonder CAN is rapidly gaining acceptance beyond the automotive market. And no other microcontroller manufacturer offers more CAN 2.0B solutions than Siemens.



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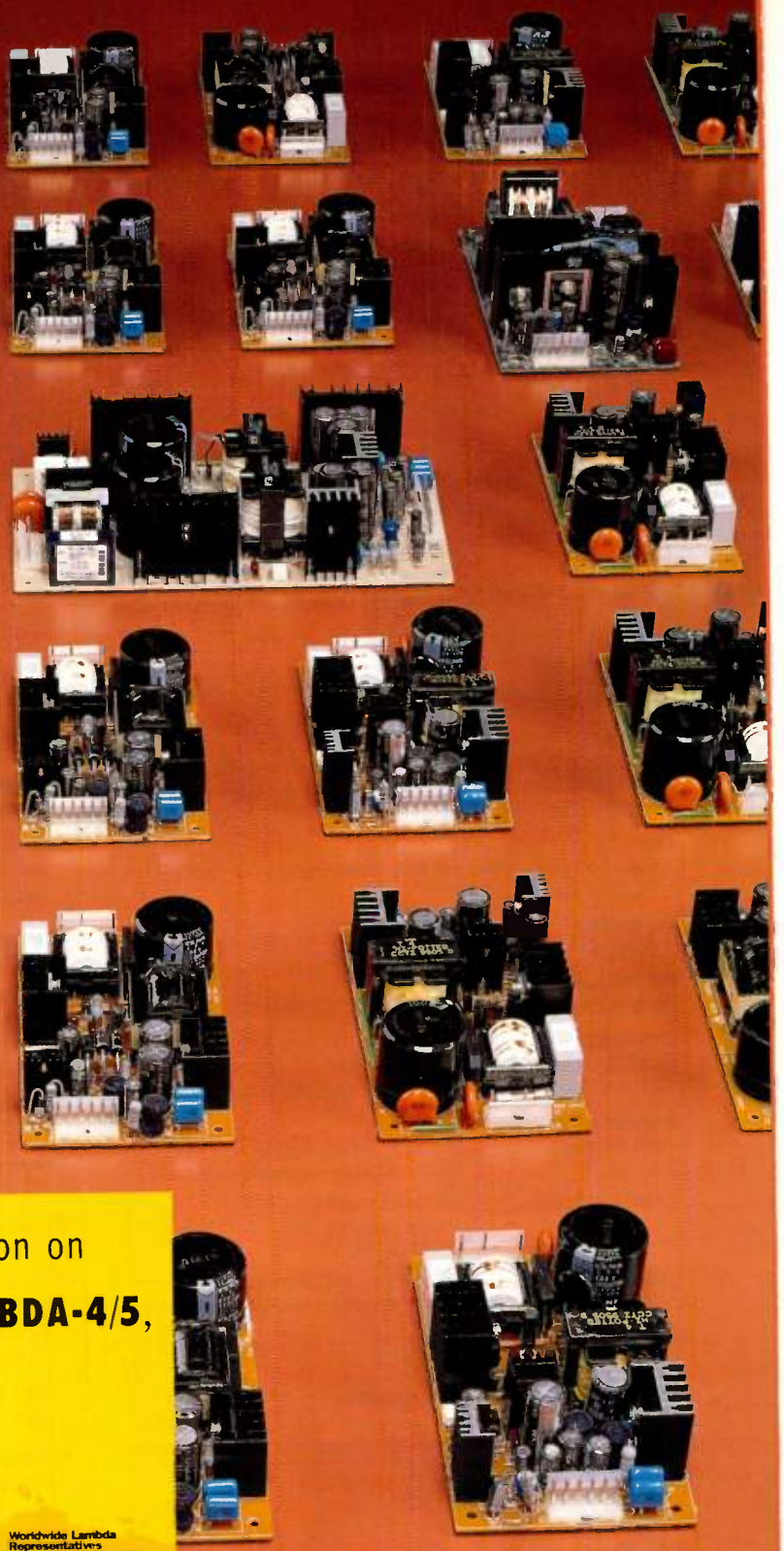

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UPCOMING MEETINGS

MARCH

Sixth International Verilog Conference, Mar. 31-Apr. 2. Santa Clara Convention Center, Santa Clara, CA. Contact MP Associates, 5305 Spine Rd., Suite A, Boulder, CO 80301; (303) 530-4562; fax (303) 530-4334; e-mail: ivcinfo@ivc-conf.com.

APRIL

INTERMAG 97, Apr. 1-4. Hyatt Regency Hotel, New Orleans, LA. Contact John Nyenhuis, School of Electrical Engineering, Purdue University, West Lafayette, IN 47907-1285; (317) 494-3524; fax (317) 494-2706; e-mail: nyenhuis@ecn.purdue.edu.

IEEE International Reliability Physics Symposium, Apr. 7-10. Adams Mark Hotel, Denver, CO. Contact IRPS Publishing Services, P.O. Box 308, Westmoreland, NY 13490; (315) 339-3971; fax (315) 336-9134; e-mail: 103227.2074@compuserve.com.

IEEE Conference on Computer Communications (INFOCOM 97, Apr. 7-11. Kobe, Japan. Contact Tatsuya Suda, Dept. of Information & Computer Science, University of California, Irvine, CA 92717-3425; (714) 856-5474; fax (714) 856-4056; e-mail: suda@ics.uci.edu; Internet: http://www.ics.uci.edu/infocom/ (North America); http://arpeggio.ics.es.osaka-u.ac.jp/infocom.html (Japan).

IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP 97), Apr. 21-24. Gasteig Cultural and Convention Center, Munich, Germany. Contact Bernd Girod, Lehrst.f.Nachrichtentechnik, Univ. of Erlangen Nuremberg, Cauerstr. 7, D-91058 Erlangen, Germany; (49) 91-3185-7101; fax (49) 91-3131-30840; e-mail: b.girod@ieee.org.

IEEE International Conference on Robotics and Automation, April 21-27. Albuquerque Convention Center, Albuquerque, New Mexico Contact Jerry Stauffer, Intelligent Systems and Robotics Center, Program Office, MS0949, Sandia National Laboratories, Albuquerque, New Mexico 87185-0949; (505) 845-8966; fax (505) 844-6161; e-mail: jdstauf@isrc.sandia.gov.

First Convergence Technology & IC Expo, Apr. 22-24. InfoMart, Dallas, TX. Contact Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045; (800) 877-2668, ext. 243; fax (310) 641-5117.

15th IEEE VLSI Test Symposium, Apr. 27-30. Hyatt Regency Monterey, Monterey, CA. Contact Yervant Zorian, General Chair, Lucent Bell Laboratories, P.O. Box 900, Princeton, NJ 08542-0900; (609) 639-3176; fax (609) 639-3197; e-mail: zorian@lucent.com.

MAY

IEEE Vehicular Technology Conference (VTC), May 5-7. Hyatt Regency at Civic Plaza, Phoenix, AZ. Contact Wendy Rochelle, IEEE Conference Services, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331; (908) 562-3870; fax (908) 981-1769; e-mail: w.rochelle@ieee.org.

IEEE Custom Integrated Circuits Conference (CICC 97), May 5-8. Santa Clara, CA. Contact Melissa Widerkehr, Widerkehr & Assoc., Suite 270, 101 Lakeforest Blvd, Gaithersburg, Maryland 20877; (301) 527-0902; fax (301) 527-0994.

ELECTRO 97, May 6-8. World Trade Center, Boston, MA. Contact Kathy Lott-Smith, Hickory International, 595 Gilman St., Bridgeport, CT 06605; (203) 334-1397; fax (203) 334-1397.

Electronics Industries Forum of New England, May 6-8. World Trade & Exhibition Center, Boston, MA. Contact Linda Hanson, (914) 779-0696

IEEE Power Industry Computer Applications Conference (PICA), May 11-16. Contact T.C. Wong, American Electric Power, 1 Riverside Plaza, Columbus, OH 43215; (614) 223-2235; fax (614) 223-2205; e-mail: t.wong@ieee.org.

IEEE/IAS Industrial & Commercial Power Systems Technical Conference (I&CPS), May 12-15. Wynham Hotel, Philadelphia, Pennsylvania. Contact Barry Hornberger, Philadelphia Electric Co., 2301 Market St., Bldg N3-1, Philadelphia, Pennsylvania 19101; (215) 841-4619.

Fifth IFIP/IEEE International Symposium Integrated Network Management (ISINM 97), May 12-16. San Diego, CA. Contact Ann Marie Lambert, BBN Systems & Technologies, 10 Moulton St., Cambridge, MA 02138; (617) 873-3819; fax (617) 873-37776; e-mail: isinm97@bbn.com.

IEEE Particle Accelerator Conference, May 12-16. Vancouver, BC, Canada. Contact M.K. Craddock, TRIUMF, 4004 Wesbrook Mall, Vancouver, BC V6T 2A3 Canada; (604) 222-7341; fax (604) 222-7309; e-mail: craddock@triumf.ca.

IEEE Radar Conference, May 13-15. Sheraton University Hotel & Conference Center, Syracuse, NY. Contact Michael Wicks, Rome Laboratory, 26 Electronics Pkwy., Rome, NY 13441; (315) 330-4437; fax (315) 330-2528; e-mail: wicksm@rl.af.mil.

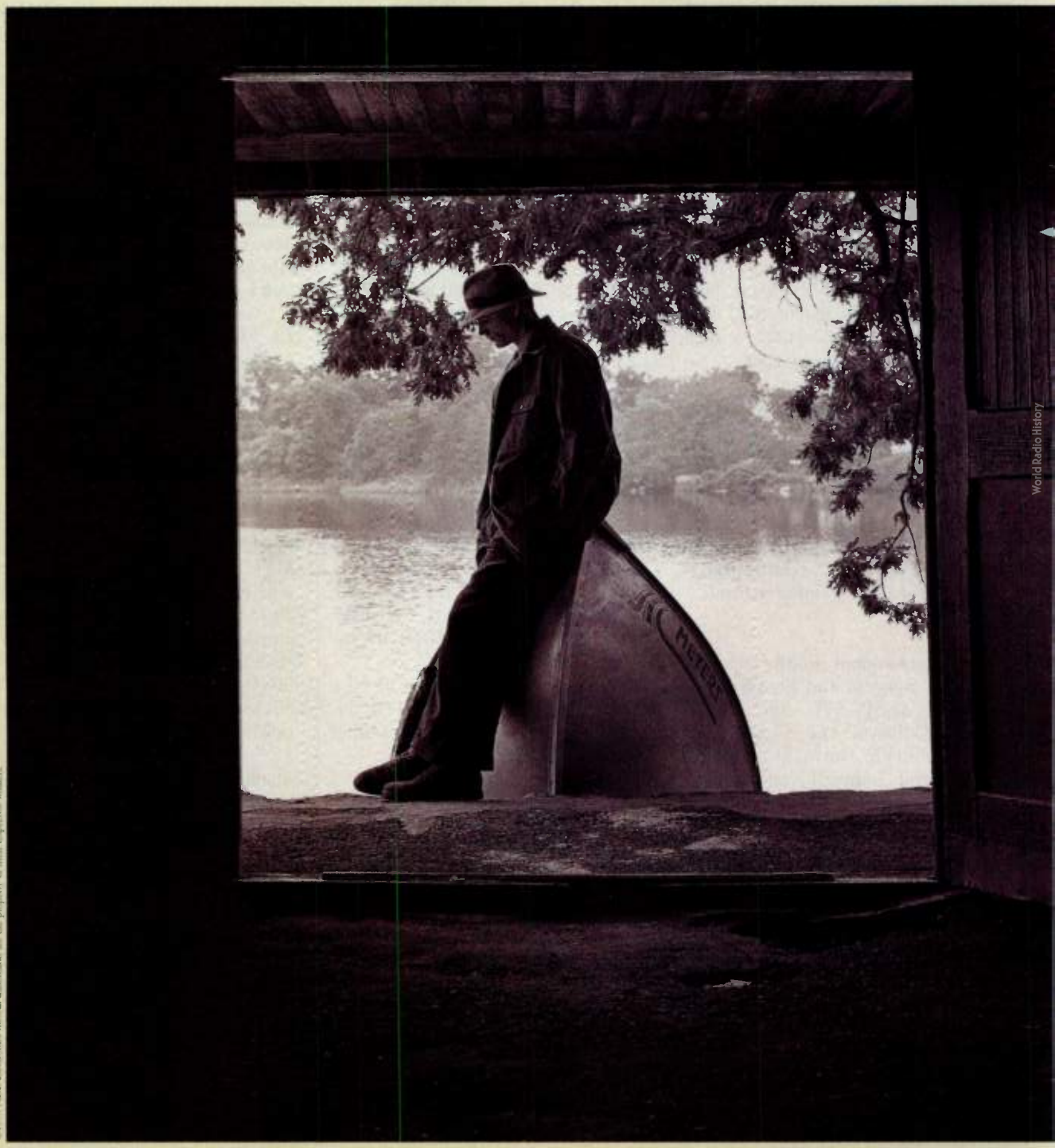
47th Electronic Components & Technology Conference, May 18-21. The Fairmont Hotel, San Jose, CA. Contact Jim Bruorton, Electronic Industries Association, 2500 Wilson Blvd., Arlington, VA 22201-3834; (864) 963-6621.

IEEE Instrumentation & Measurement Technology Conference (MTC 97), May 20-22. Chateau Laurier, Ottawa, Ontario, Canada. Contact Robert Myers, Conference Coordinator, 3685 Motor Ave., Suite 240, Los Angeles, California 90034; (310) 287-1463; fax (310) 287-1851; e-mail: bob.myers@ieee.org.

Canadian Conference on Electrical & Computer Engineering, May 25-28. Delta Hotel, Newfoundland, Canada. Contact David Collett, Newfoundland & Labrador Hydro, Post Office Box 12400, St. Johns, NF, A1A 4K7, Canada; (709) 737-1372; fax (709) 737-1782; e-mail: t.d.collett@ieee.org.

Fifth IEEE International Conference on Properties & Applications of Dielectric Materials (ICPADM), May 25-30. Sheraton Walker Hill, Convention Center, Seoul, Korea. Contact Joon-Ung Lee, Dept. of Electrical Engineering, Kwangwoon University, 447-1 Wolgye-Dong, Nowon-Ku, Seoul, 139-701, Korea; (82)-2-910-5144; fax (82)-2-942-0107.

THERE'S A LITTLE BIT INTO EVERY



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	V_R4300	PPC603	V_R5000	PPC604
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Bus Interface	32-bit	32/64-bit	64-bit	64-bit
I-Cache Size D-Cache Size	16KB 8KB	8KB 8KB	32KB 32KB	16KB 16KB
Pin Count/Package	120 PQFP	240 CQFP 256 BGA	272 BGA 223 CPGA	304 CQFP 256 BGA
SPECint92/SPECfp92	80/60	75/85	---	---
SPECint95/SPECfp95	---	---	5.5/5.5	3.29/n/a
Price in 1,000 Qty *	$45	$195	$300	$549

* PowerPC prices from PowerPC FAQ, 12/1*/95. Prices subject to change.

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READER SERVICE 170

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- Commercial and industrial temperature grades
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Digital Potentiometer Products

Device	Pots/ Pack.	Wiper Memory	# of Positions	Resistance	Power Supply	Control Interface
DS1267	2	Volatile	256-Lin	10K, 50K, 100K	5V, ±5V	3-Wire Serial
DS1666	1	Volatile	128-Lin	10K, 50K, 100K	5V, ±5V	Increment/Decrement
DS1667	2	Volatile	256-Lin	10K, 50K, 100K	5V, ±5V	3-Wire Serial
DS1669	1	Nonvolatile	64-Lin	10K, 50K, 100K	4.5V to 8.0V	Pushbutton
DS1800	2	Volatile	128-Log	50K	2.7V to 5.5V	3-Wire Serial/PB
DS1801	2	Volatile	64-Log	45K	2.7V to 5.5V	3-Wire Serial
DS1802	2	Volatile	64-Log	45K	2.7V to 5.5V	3-Wire Serial/PB
DS1803	2	Volatile	256-Lin	10K, 50K, 100K	2.7V to 5.5V	2-Wire Addressable
DS1804	1	Nonvolatile	100-Lin	10K, 50K, 100K	2.7V to 5.5V	Increment/Decrement
DS1806	6	Volatile	64-Lin	10K, 50K, 100K	2.7V to 5.5V	3-Wire Addressable
DS1807	2	Volatile	64-Log	45K	2.7V to 5.5V	2-Wire Addressable
DS1866	1	Volatile	8-Log	10K	2.7V to 5.5V	3-Input Parallel
DS1867	2	Nonvolatile	256-Lin	10K, 50K, 100K	5V, ±5V	3-Wire Serial
DS1868	2	Volatile	256-Lin	10K, 50K, 100K	5V, ±3V	3-Wire Serial
DS1869	1	Nonvolatile	64-Lin	10K, 50K, 100K	3.0V to 8.0V	Pushbutton

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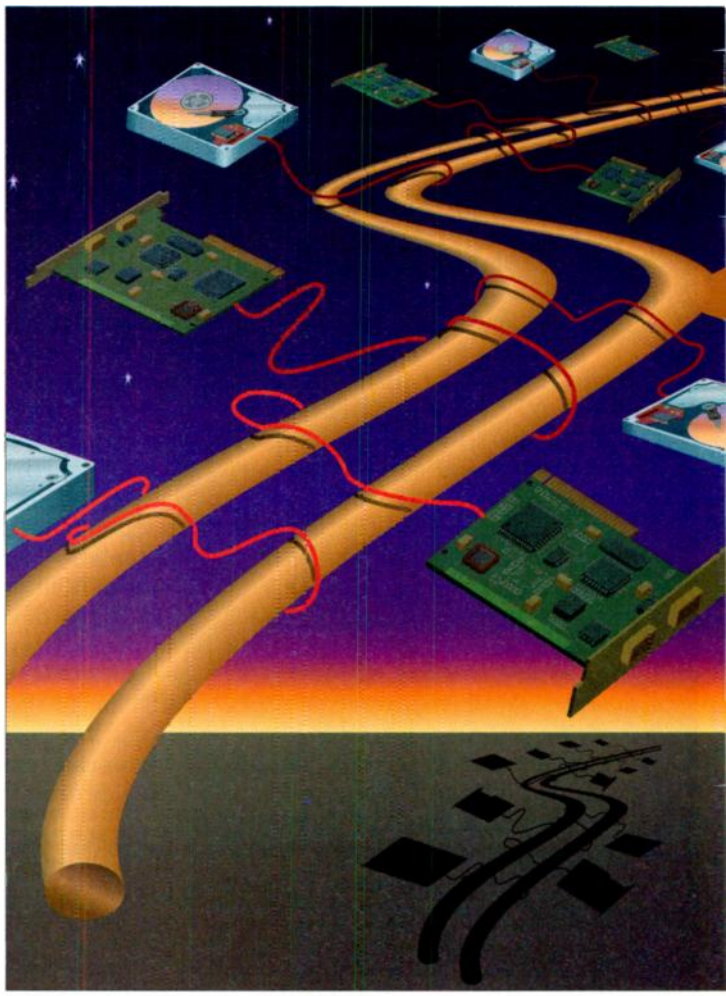
READER SERVICE 131

USB Chip Set Of Hub, Transceiver, And Codec Promises To Make Neater And Smaller Sealed PCs With Ports For New Peripherals And CD-Quality Audio.

Chip Set Targets The Universal Serial Bus

PETER FLETCHER



Next year, personal computers are likely to take on an entirely new look as architectural changes are introduced to allow them to cope with demands for greater flexibility and easier expansion. In particular, the PC's new-found status as both a host for a variety of sophisticated telecommunications devices in business, and as an entertainment center in the home demand that it be able to support a number of diverse peripherals that will overwhelm the traditional connection points such as serial and parallel ports and internal expansion slots.

At the same time, stringent electromagnetic-compatibility rules now in force in many parts of the world, discourage users from opening and disassembling their computers to fit "upgrades," with the risk of disturbing RF shielding, the consequent voiding of compliance certification, and potential unwelcome attention from "the authorities." For the last reason alone, the idea of a "sealed PC" has generated a lot of interest among manufacturers. A sealed PC potentially offers users an easier time—provided, of course, that it does not detract from their ability to add to and configure their systems.

The movement to seal the box has generated at least three new industry standards that are as yet "ad hoc." The AC-97 standard sets out to ensure that multimedia audio, modem, and telephony features are built-in under the permanently closed "hood," while two serial bus standards, the Universal Serial Bus (USB) and the IEEE 1394 "Firewire" standards, look attractive as ways of providing easy points of attachment for peripherals. Now, semiconductor manufacturers are vying to be the first to introduce specifically-designed parts for these new architectural features.

Claiming to be first with volume production of chips for implementation of the USB, is Philips Semiconductor, with a family of devices that include a $0.40 USB transceiver chip, a single-chip "hub" able to support five USB ports, and specialized USB audio digital-to-analog converters (DACs) with built-in microcontrollers and facilities for working alongside digital signal processors.

Compared with the IEEE-1394 bus, the USB is aimed at the less-sophisticated end of the market, and is designed to provide a very low-cost expansion capability. The USB uses

to medium-speed applications while 1394 is reserved for high-speed applications." He asserts that Philips Semiconductors will have IEEE 1394 products sampling before the end of 1996.

In the meantime, Philips Semiconductor has just started volume production of a number of USB parts. First is the PDIUSBH11 USB hub with embedded control functions and external microcontroller interface. It provides one upstream (hub to host PC) USB port and four downstream (hub to peripheral or other hub) USB ports.

It also contains embedded USB functions with associated integrated memory which can be accessed by an external microcontroller using the industry standard I^2C bus, enabling the monitor or keyboard to communicate with the host PC. According to Van Ginderdeuren, this function is ideal for use in monitors or keyboards where there already is a microcontroller. It gives the designer the choice of using a microcontroller of their own choosing rather than an integrated solution of the USB hub.

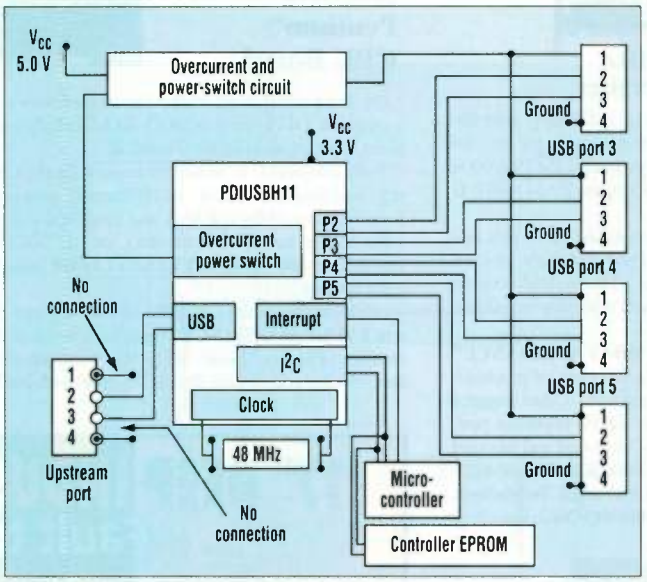
Each port contains the functionality of a USB transceiver. Between the upstream and downstream ports is a "repeater" block which is responsible for routing the USB packets from the upstream port to the peripheral device connected to the relevant downstream port. It also routes messages from the downstream ports to the PC via the upstream port *(Fig. 3)*.

Since the PDIUSBH11 also has an embedded USB function, a serial interface engine (SIE) is also included inside the IC, saving the time and effort of designing custom internal USB I/O cells. The SIE is a hardware design available from the USB Implementers Forum in the form of VHDL code, as a royalty-free, open-design specification for integration into ASIC designs. It converts serial USB data into parallel format that can then be processed by a peripheral device. A memory management unit (MMU) within the PDIUSBH11 then stores data into the internal RAM.

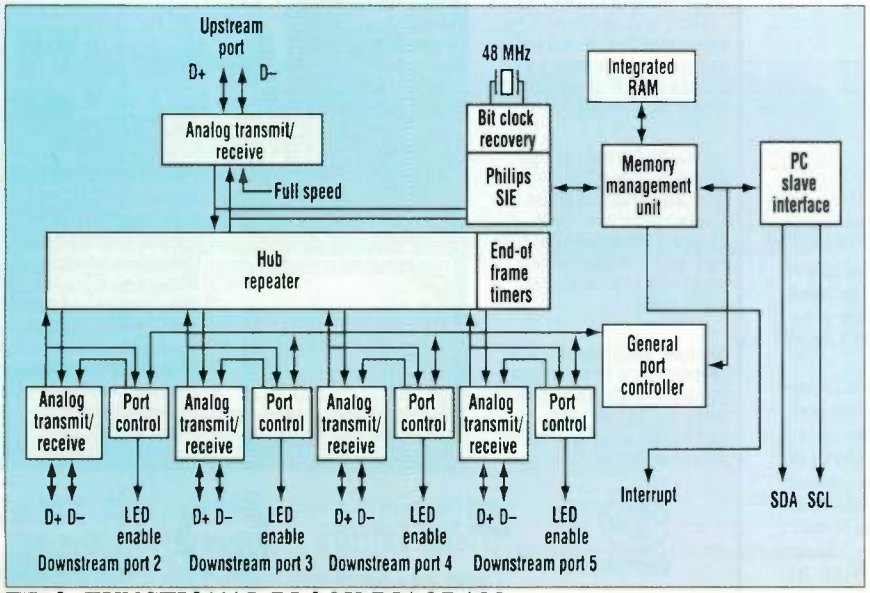
When the PC sends data via the USB to the monitor or keyboard, it ends up in the internal memory of the PDIUSBH11. The PDIUSBH11 then generates an interrupt on one of its pins to indicate to the system microcontroller that the data has arrived. The monitor or keyboard system microcontroller can then read this data from the memory via the I^2C bus. Similarly, when the peripheral device wants to send data to the PC, it writes the data into the memory of the PDIUSBH11 using the I^2C bus. The PDIUSBH11 then converts this data into USB protocol and transmits it to the PC via the upstream port. The I^2C bus interface on the PDIUSBH11 is a slave receiver device which means that no special I^2C bus hardware is required to be implemented in the system microcontroller of the peripheral device.

In the case of using the PDIUSBH11 in a monitor application, the IC provides USB expandability within the PC system, functioning as a hub, as well as providing plug and play control of the monitor. The PC can automatically detect the presence of a monitor, read its display capabilities, and automatically set the correct video mode suitable for the monitor. It also allows the user to adjust the various geometric parameters (e.g. H and V size, east-west correction, pin cushion, etc.) together with the normal user controls such as brightness and contrast. These adjustments are done from software running on the PC, not necessarily using the controls on the front panel of the monitor. The bidirectional nature of USB enables consistency to be maintained with manual controls *(Fig. 4)*.

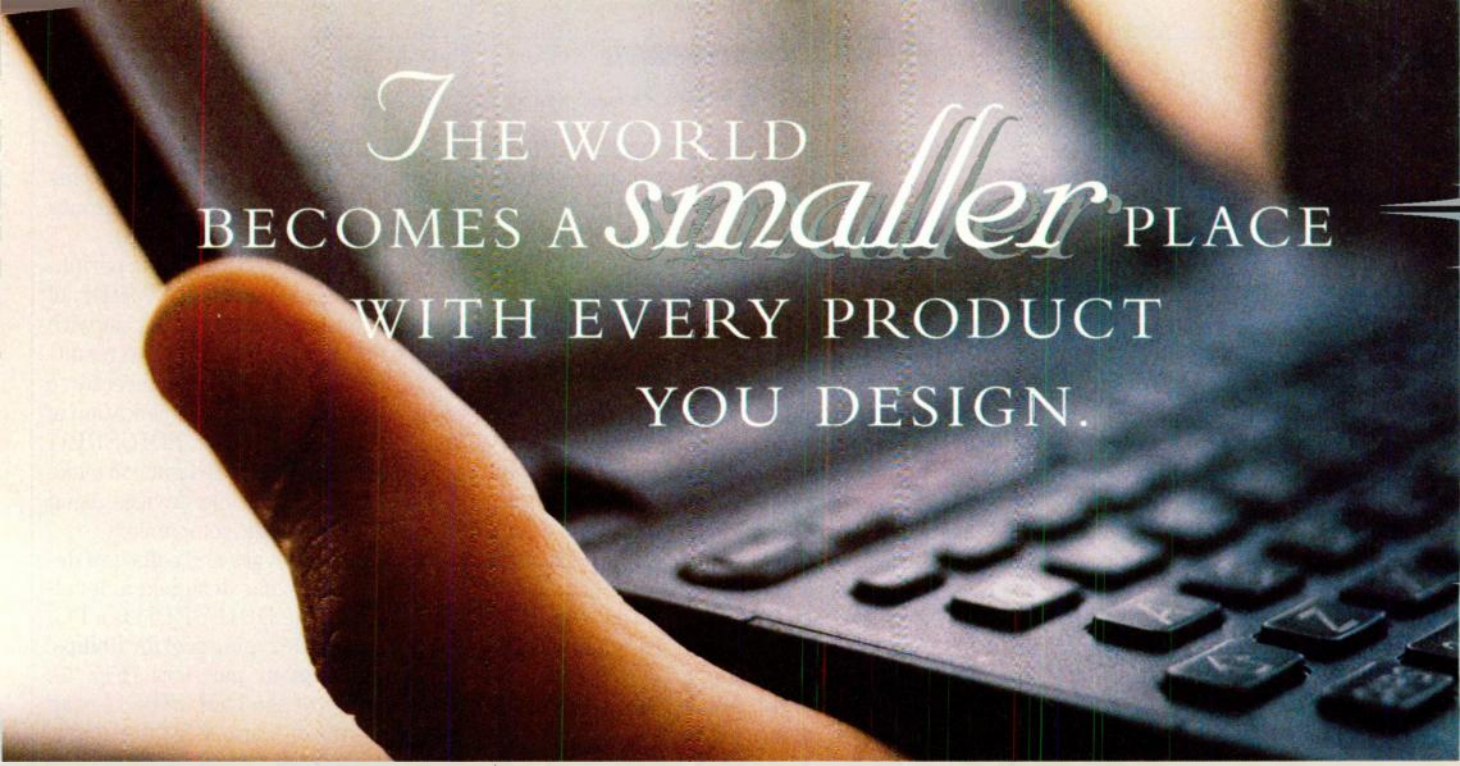
A small amount of control software is required to drive the PDIUSBH11 device. The software may reside in the existing monitor system microcontroller or can be implemented in a small, low-cost, dedicated microcontroller. Van Ginderdeuren says the



4. IMPLEMENTING A HUB with one upstream and four downstream ports requires a microcontroller and power control components.



3. FUNCTIONAL BLOCK DIAGRAM of the Philips PDIUSBH11 hub chip.







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READER SERVICE 171

PDIUSBH11 conforms to the USB specification version 1.0 and operates from a 3.3-V supply.

Two other devices intended for applications in USB monitor/hubs are the P83C190 and P87C190. These devices are similar to the PDIUSBH11, except they both integrate an 80C51 microcontroller and use the 80C51 instruction set for easy programming. Both are specifically designed for use in monitors and provide USB and DDC bus interfaces. The internal hardware can separate composite sync signals and detect the plural display modes. It also can provide a variety of digital/analog voltage outputs that can be used to control monitor-specific control functions, such as video, deflection, and convergence.

Each IC provides four downstream ports, an embedded function with two endpoints, integral FIFO memory for hub and function, asynchronous transmit/receive FIFOs, and full USB power-management support. The P83C190 and P87C190 have 16 kbytes of ROM and 18 kbytes of ROM, respectively. Both have 512 bytes of RAM.

The UDA1321T USB audio DAC for monitors, speakers, and telephone answering machines is a USB DAC, and has an embedded 80C51 microprocessor core. It provides stereo audio playback over a USB link with an audio sample redistribution module to spread the incoming audio packets over a 1-ms frame period. It also provides self-synchronization with the clock for sample frequencies from 5kHz to 55kHz—from low-quality voice to above CD (44.1 kHz) sampling quality.

A separate digital volume control and soft mute are provided for left and right channels via the USB. Bass and treble tone are digital and also are effected via the USB. There also is a bypass function that enables the signal to be taken out of the IC for external DSP via a standard or the I^2S bus serial input format—for example, for graphics equalizers, speaker correction, and other processing—and then returned into the chip for the final stages prior to output. The UDA1321T is fully compatible with the Serial Interface Engine (SIE).

The PDIUSBP11 is a one-chip generic USB transceiver IC which can be used to implement a USB function in any PC peripheral device. It conforms to the USB specification version 1.0 and operates at a supply voltage of 3.3 V. It is designed to allow 5.0- or 3.3-V programmable or standard logic to interface with the physical layer of the USB and is capable of transmitting and receiving serial data at both full-speed (12-Mbit/s) and low-speed (1.5-Mbit/s) data rates. It utilizes digital inputs and outputs to transmit and receive USB data to and from the USB cable. These pins (D+ and D-) conform to the electrical specification of the USB cable. This CMOS IC designed to interface with the digital SIE hardware.

When sending data from the peripheral to the PC, the outputs of the SIE are connected to the PDIUSBP11, which then drives the USB cable pins D+ and D- with this data. When the peripheral device receives data from the PC, the PDIUSBP11 first receives data from the USB cable on the D+ and D- pins and then transfers this data to the SIE using the gated inputs (i.e. the RCV, VP and VM pins).

Van Ginderdeuren says a PC peripheral maker can integrate the VHDL of the serial interface engine together with their existing system logic. The resulting IC can then be connected directly to the PDIUSBP11 IC. Implementation of the SIE along with the PDIUSBP11 transceiver allows the designer to make flexible USB-compatible devices using widely available logic components.

For USB hardware and software developers, Philips has designed a development tool. The DDIUSBP11 is a PC-based USB prototyping tool for Philips' USB development partners *(Fig. 5)*. The key part of the DDIUSBP11 is an ISA card that fits into a PC, turning it into a development platform where the software to control a new USB device can be developed and debugged, prior to being embedded into an ASIC. It also contains a library of software routines that cover all the USB interface requirements, leaving the developers free to concentrate on the device driver and application parts of the software. The DDIUSBP11 incorporates the PDIUSBP11 generic USB transceiver IC that can be used to implement a USB function in any PC peripheral device. □

PRICE AND AVAILABIITY

Price for the UDA1321T audio DAC is $6.75 each in volume quantities. It is sampling now with full volume production scheduled for mid 1997, and is packaged in a 28-pin SO28.

The PDIUSBH11 is priced at around $6.00 each in 10,000-unit volumes. Samples are available now and volume production is scheduled for the fourth quarter. It is available in a 32-pin SDIP.

The PDIUSBP11 is priced at around $0.40 each in 10,000-unit quantities. Production volumes are available now. It is available in a 14-pin SO, SSOP or TSSOP packages.

Prices for the P83C190 and P87C190 have yet to be set. Samples will be available late this year with full production early 1997. They are available in a 56-pin SDIPs.

The DDIUSBP11 development tool is available in limited quantities to selected partners.

For further information, contact Philips Semiconductors, Eindhoven, The Netherlands, telephone +31 40 2 722091, or fax +31 40 2 724825. Ir. Johan Van Ginderdeuren's e-mail address is: belvjvg@beccmail.snads.philips.nl. CIRCLE 503

5. FOR USB HARDWARE AND SOFTWARE DEVELOPERS, Philips has designed a pc-board-based USB prototyping tool, the DDIUSBP11. This ISA card

HOW VALUABLE?	CIRCLE
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MODERATELY	538
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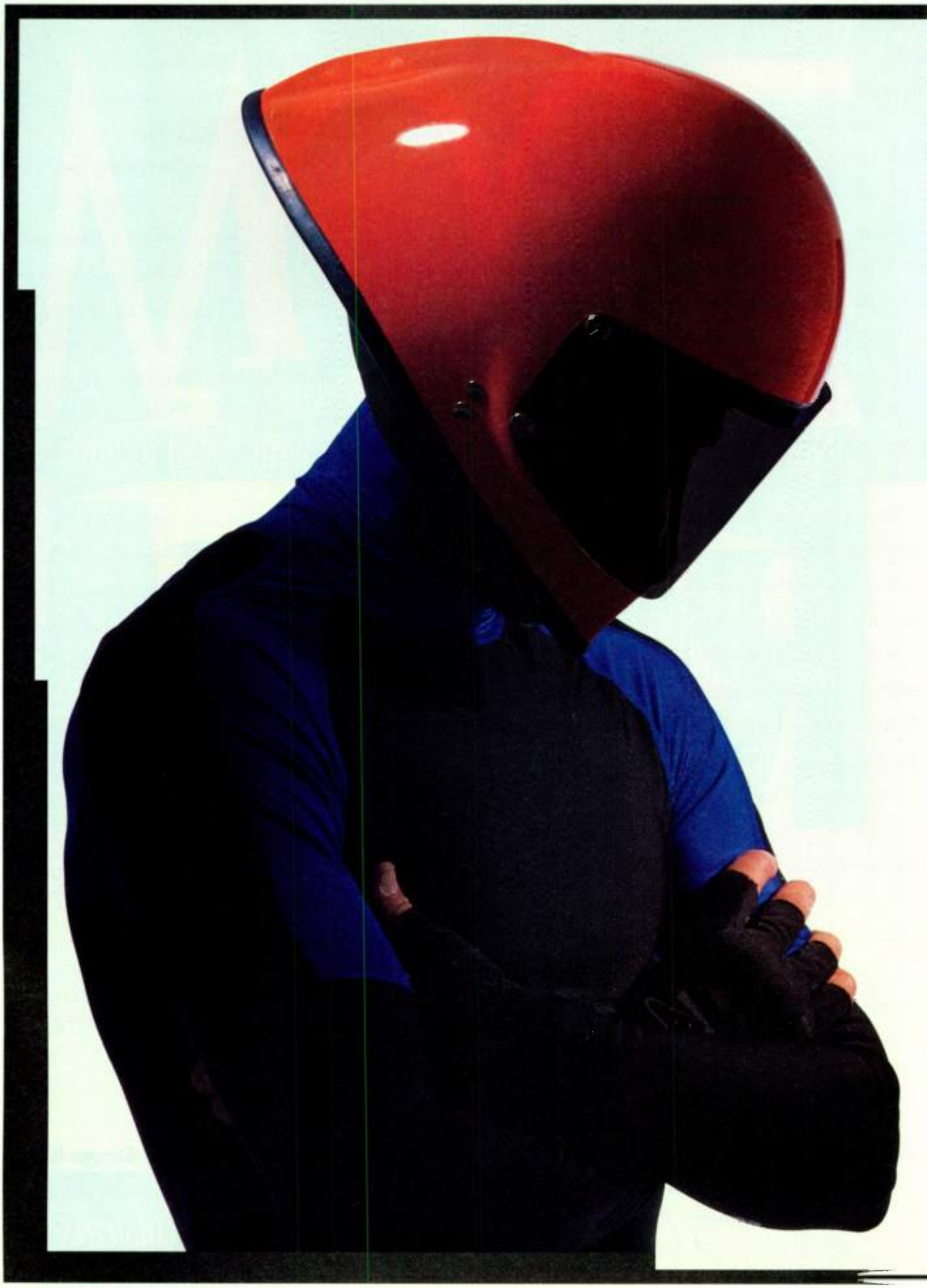

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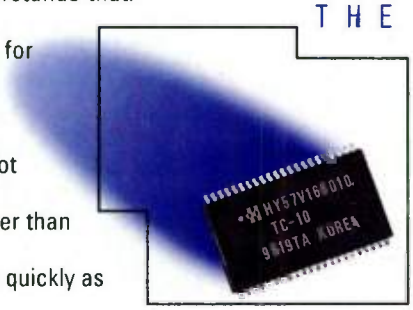

Config.	Volt.	Speed	Refresh
4M x 4	3.3V	66/83/100MHz	4K
2M x 8	3.3V	66/83/100MHz	4K
1M x 16	3.3V	66/83/100MHz	4K

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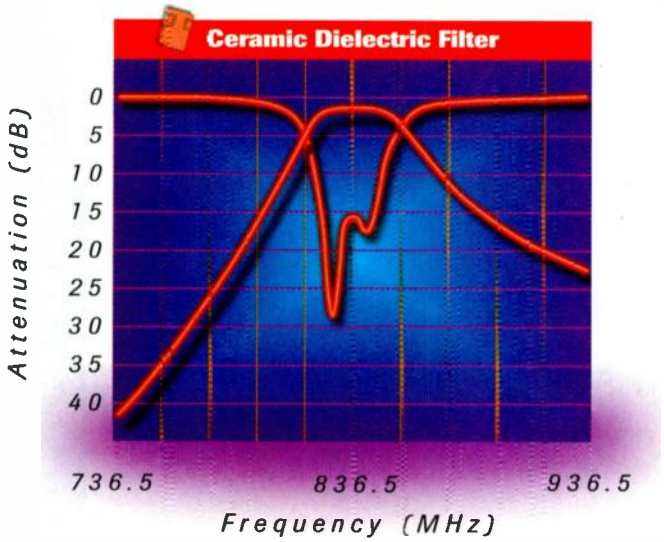
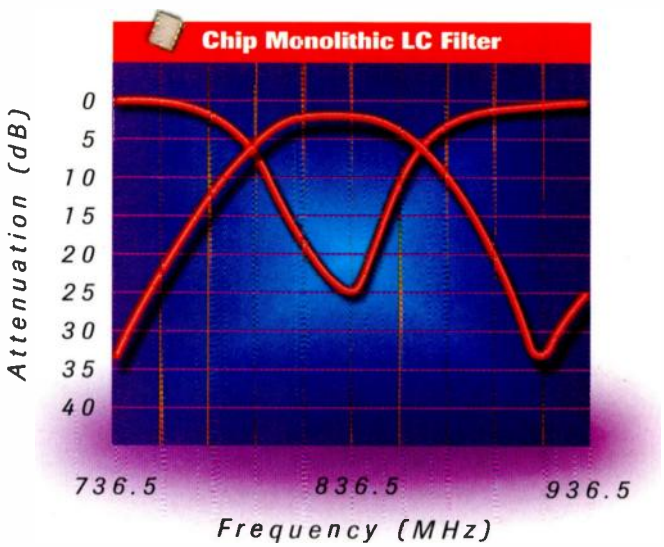
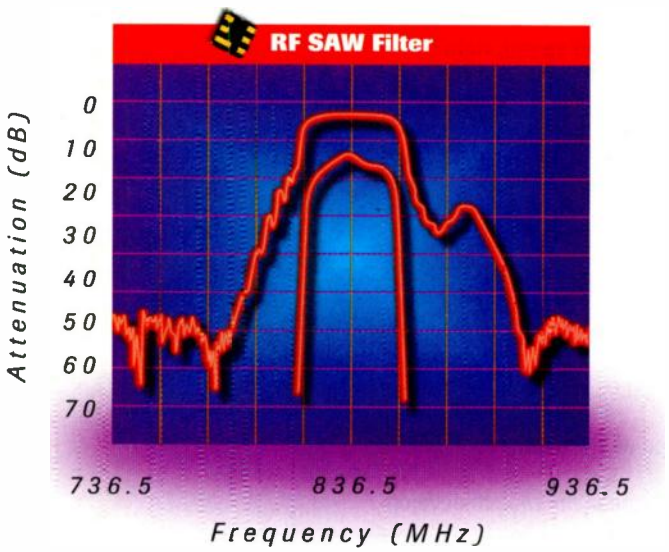
READER SERVICE 152

Downsizing a microwave filter is one thing, upsizing its performance is something else.







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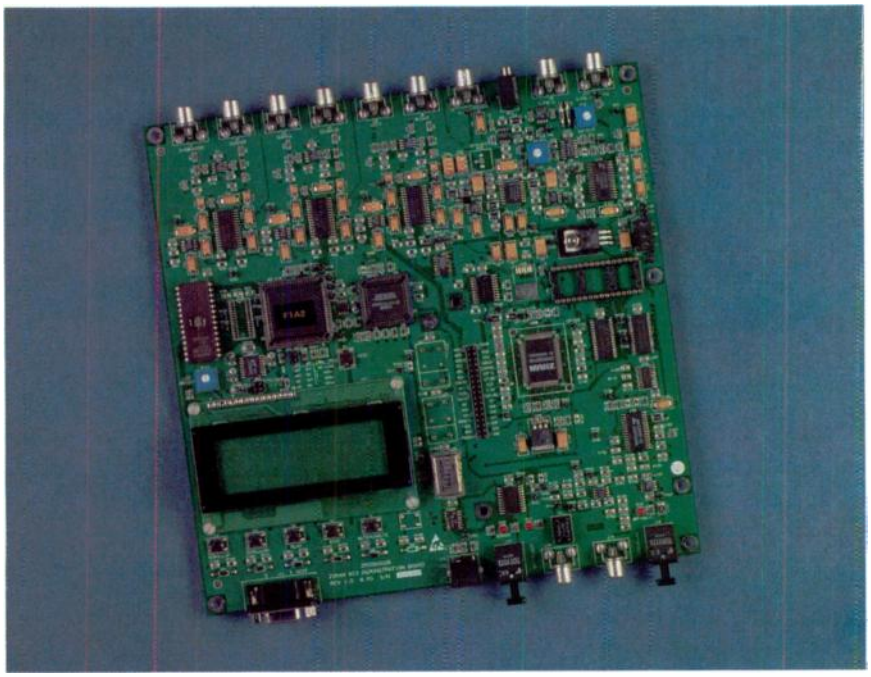


COURTESY: ZORAN CORP.

3D Audio Technologies Provide Realistic Sound

DAVE BURSKY

Surroundsound Effects Span Theater Quality To Home PC Budgets, Thanks To DSP.

As computer and home-entertainment systems provide higher-quality images due to advances in JPEG and MPEG playback schemes, audio subsystems also must improve. No longer will basic monaural or stereo audio be an acceptable output from a TV, stereo system, or a computer. The high end of the consumer industry has begun transitioning from the Dolby ProLogic four-channel sound to the five-channel Dolby AC-3 sound systems. This has taken a massive effort to develop high-performance DSP chips that can process the AC-3 digital data streams and recreate the multiple analog channels. Companies such as Zoran and Motorola have already developed advanced signal processors to tackle the decoding problem.

On the playback side, these new systems require five preamplifiers, five power amplifiers, and of course, five speakers. That adds up to a significant investment beyond the basic decoding logic. But alternatives to the true multichannel sound also are starting to appear—various stereo enhancements achieved through signal-processing algorithms that allow two speakers to give the appearance of three, four, or five sound sources *(see the table)*.

Some of the more established companies in the sound-extension arena include SRS Laboratories and Spatializer, which provide products, chips, and algorithms that enhance sound to provide a 1-dimensional space that can fill an area around the listener in an arc that reaches up to 270°. Other stereo extensions from companies such as QSound and Yamaha provide full left/right (LR) dimensionality and panning so that sounds are positioned on an arc extending through the speakers.

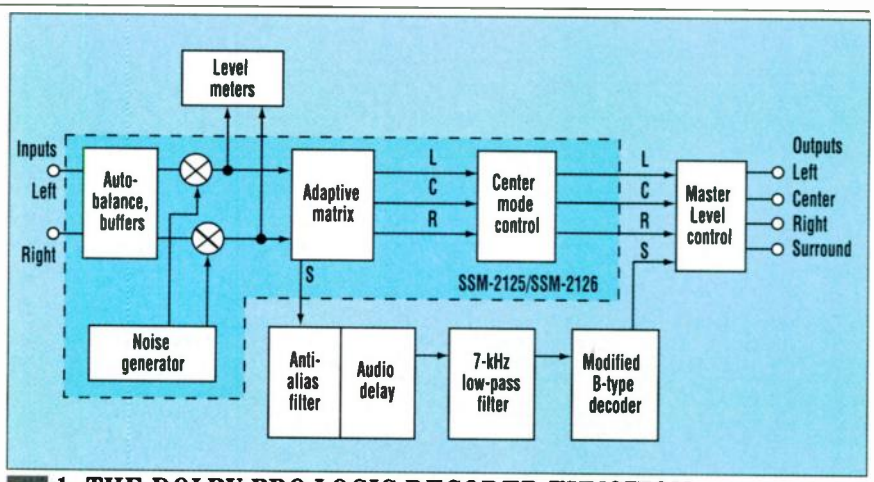
All of these enhancement approaches do not require the use of precoded audio material. They can be used to enhance the playback of any stereo-audio material. Most of these schemes also can be applied to any uncoded audio source to enhance the basic audio signals. Then, the enhanced audio can be stored for future playback on an ordinary stereo.

The previously mentioned surroundsound multispeaker arrays required by the Dolby ProLogic and AC-3 standards, as well as the Digital Theater Systems (DTS) audio coding system, require the use of preencoded material. But the playback systems provide sound from all directions since the four or five speakers plus a subwoofer form a circle around the listener. For the present, though, the sound is on one plane and the systems do not provide vertical positioning of the sound to give

theappearanceof, for example, a helicopter circling overhead.

A relatively new approach offered by Aureal Semiconductor has been dubbed as "interactive 3D." In this approach, sounds not only appear to come from the left or right, or front and back, but also from above and below, providing a full 3D sound zone. The company claims that their approach is one of the few enhancement schemes that can be used with headphones as well as standard speakers. In addition, the company feels that their approach is the only one that is currently Microsoft Direct 3D Sound capable, although other suppliers may argue that point.

And, yes, even Microsoft is getting into 3D audio, with a system interface API called Direct3DSound. Unveiled earlier this year at the Windows Hardware Developer's Conference (WinHEC 96), the API allows designers to add 3D audio to Windows-based platforms in the form of a software-only approach for low-cost systems, or hardware-assisted for higher-performance systems. The goal is to have the sound API and hardware included in every computer so that anyone playing games, immersing themselves in virtual worlds on the Internet, or even listening to video soundtrack playbacks, can enjoy the better sound without paying for 5+ channels of hardware.



1. THE DOLBY PRO-LOGIC DECODER FUNCTION can be implemented with one circuit such as the SSM-2125/2126 developed by Analog Devices. The decoder, however, does require an off-chip antialiasing filter and a low-pass filter, as well as an audio delay and a modified b-type decoder to recreate the surround channel. From two input channels, the Pro-Logic circuitry creates both left and right as well as center and surround outputs to deliver four-channel sound.

AUDIO TECHNOLOGY COMPARISON

Type of processing	Dimesionality	Interactive controls	Perceptual performance	Headphone compatible	Stereo-speaker compatible	Direct 3D Sound compatible
Mono	0D	None (on/off)	Single-point source from speaker location	Yes	Yes	No
Stereo	1D (left/right)	Left/right panning	Sounds placed on line between speakers	Yes	Yes	No
Simple stereo extender (SRS, Spatializer)	1D (spaciousness only)	None (on/off)	Sounds fill area around speakers	No	Yes	No
Advanced stereo extender (QSound)	1D (left/right)	Left-right panning	Sounds placed on arc extending through speakers	No	Yes	No
Multispeaker array (Surround sound formats)	2D (left/right, front/back)	Usually none (soundtracks are pre-encoded)	Sounds placed on circle formed by speakers	Yes	Yes	No
Interactive 3D audio (Aureal 3D)	3D (left/right, front/back, up/down)	Full 3D placement using XYZ coordinates	Sounds placed at any distance and position from listener	Yes	Yes	Yes

Aureal 3D can be used to create "virtual speakers" and playback surroundsound on a single pair of speakers or headphones.

Although originally slated for release this past summer, a little more work was needed on the software and interface to ensure compatibility with all the other software and hardware. With the API, full 3D sound effects can be recreated—volume would increase as you get closer to a sound source, Doppler effects are recreated for moving objects, and the effects of the head and outer ear also are taken into account when processing the sound data to virtualize the speakers. The scheme works best on headphones, but also on speakers using crosstalk cancellation (however with speakers, it does introduce a "sweet spot", an ideal listening position).

To recreate realistic 3D sound, algorithms must accurately model the way people hear the sounds and the way their heads modify or interact with the sound. To that end, three key aspects must be dealt with. The first is the interaural time difference (ITD). This models how the sound hits one ear first and then the second ear a moment afterwards, thus providing left-right clues for positioning. Second is the interaural intensity difference (IID), which models the effect of the head in the path of the sound—sounds are quieter at the far ear after passing through the head. This also is useful in providing more left-right positioning clues.

Finally, there's the head-related transfer function (HRTF), which com-

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putes the difference between the source sound and the sound that reaches the inner ear. It also takes into account reflections from the head, torso, and shoulders. This model is needed for up-down and front-back control and contributes significantly to the realism of the sound, but is computationally expensive to apply. In contrast, the ITD and IID schemes are inexpensive and include simple per-channel delays and a pan setting, respectively.

Depending on system resources, different levels of sound quality can be activated, with the lowest quality not implementing the HRTF and employing mostly left-right control and visual clues from the screen. This level could run on existing PCs since no DSP is required. At the high-end, the HRTF would be active and either the P55C or P6 CPU can execute the algorithms with the MMX instruction set extensions, or a DSP chip can be added to support the 3D sound.

Only The Best

Designers have many options for embedding sound in stereo systems, games, and PCs. For the last few years, the Dolby ProLogic system has offered top-of-the-line performance. It took in left and right audio streams and reprocessed the streams to create a left and right channel plus a rear right and rear left channel to provide surroundsound capability *(Fig. 1)*. A single-chip decoding solution developed by Analog Devices includes the adaptive matrix and center-mode control as well as an automatic balance control and noise generator, which is used to null out some of the channel noise.

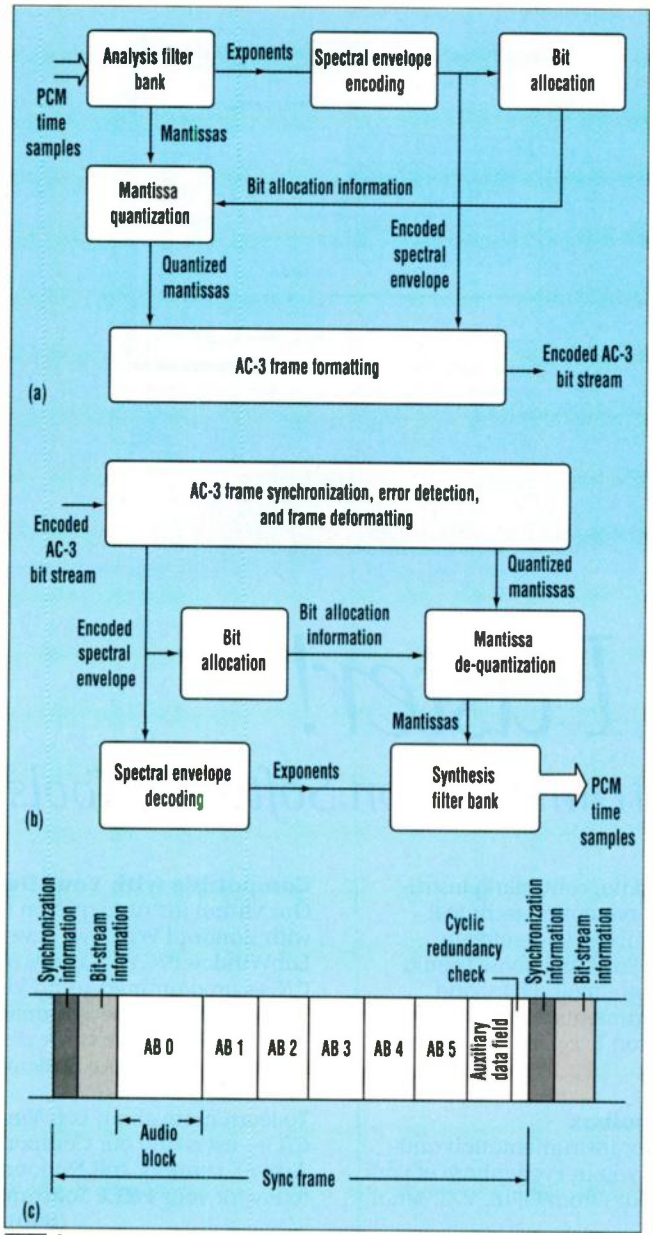
The SSM-2125 and 2126 are basically the same chip, but the 2125 has a better channel separation specification—a minimum of 35 dB for the center to right or left channels and 25 dB for the remaining channels. The other chip has a minimum separation of 25 dB between any channels.

Another player that has entered the ProLogic decoder market, Medianix, has licensed the Dolby technology and has partnered with New Japan Radio Inc. to supply the MED25005, a Pro Logic surroundsound decoder based on a 24-bit fixed-point digital signal processor and internal ROM and RAM. The chip has a maximum delay of 30 ms and implements the Dolby 3 stereo mode without requiring any external memory. The DSP algorithms executed by the internal processor allow the chip to implement various types of surroundsound effects. Various custom algorithms can be downloaded to the chip or can be executed from extended off-chip memory.

Special effects such as concert-hall simulation are included. A digital delay of up to 1.5 seconds can be created when external SRAM or DRAM is used to supplement the on-chip memory. The chip delivers three stereo output channels, one channel for the left/right speakers, another channel for the surround left/right speakers, and the third channel for the center and subwoofer outputs.

For the up and coming MPEG-1 and MPEG-2 digital standards, the analog Pro Logic circuits required too many support circuits to digitize, convert, compress, and synchronize the data streams. In addition, for large spaces such as a movie theater, the separation of the speakers dissipated the quality. The need for an all-digital approach that would merge well into the MPEG-2 multimedia standard and other interfaces and provide more audio channels has resulted in the creation of a new standard—AC-3.

The AC--3 standard is a digital encoding scheme that uses a serial bit stream to provide five audio channels and a subwoofer channel for a total of 5.1 channels. The subwoofer is referred to as a 0.1 channel since its low-frequency response allows for a much lower data content. Al-



2. TO ENCODE THE AUDIO PCM time samples, the AC-3 encoder executes algorithms developed at Dolby Labs (a). It not only organizes the six audio channels into a serial bit stream, but compresses the data so that the required data rate drops from 5.1 Mbits/s to just 384 kbits/s. The decoder does just the opposite, expanding the data stream back to 5.1 Mbits/s and then separating out six audio data streams (b). The digitized audio-data streams are composed of six audio blocks, a synchronization block, a bit-stream information block, and a CRC block that helps the system keep watch for errors that could cause distortion (c).

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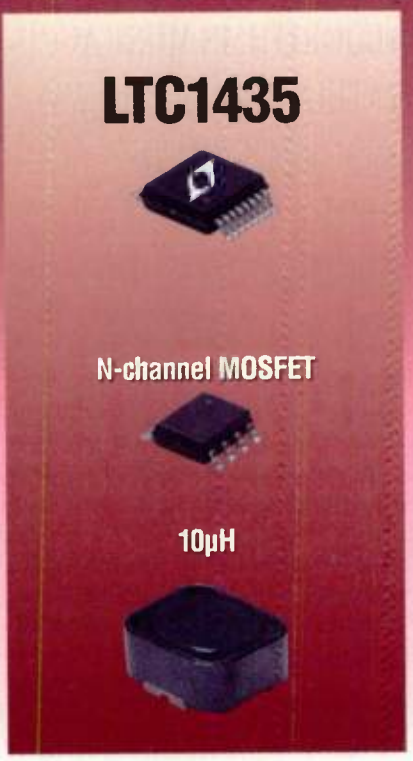

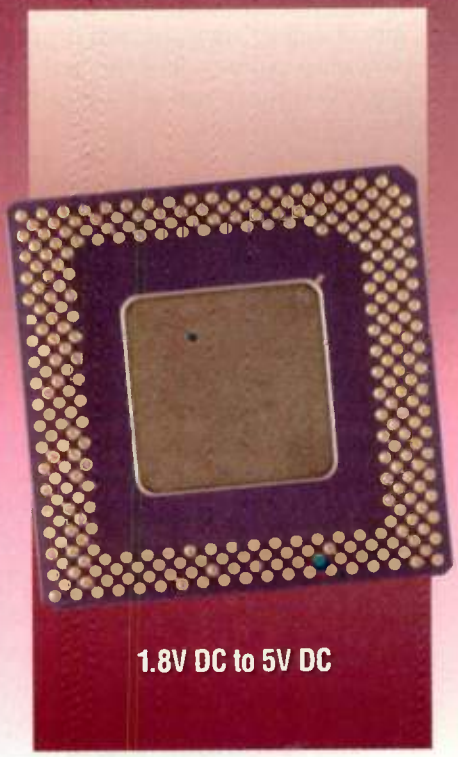

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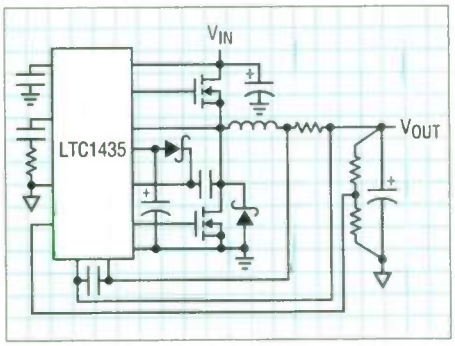

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though optimized for surroundsound, the channels can be used to handle other audio information as well. For example, each channel could be used to hold a different language, permitting the disk to be used in multiple countries. The AC-3 standard also has been adopted for use in the high-density DVD (digital versatile disk) standard, which many companies expect will be the next CD player to be integrated into the desktop computer platform.

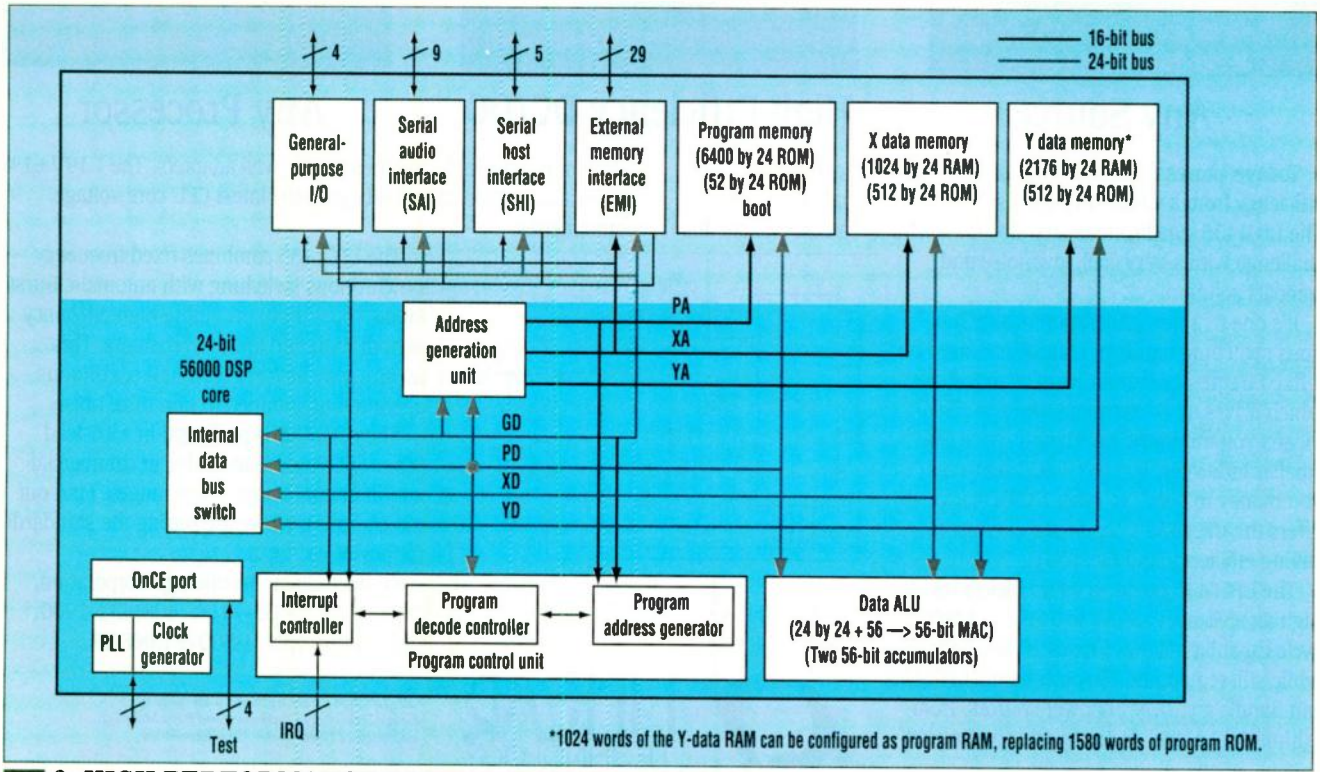
In the AC-3 standard, analog audio streams are first converted into pulse-code-modulated digital data streams, that are then compressed and processed by the encoding subsystem to produce the AC-3 encoded bit stream *(Fig. 2a)*. This encoded bit stream (6 channels by 48 kHz by 18 bits/word = 5.184 Mbits/s that is compressed to 384 kbits/s) is then stored on the medium (CD ROM, or other bulk-storage format) and synchronized to the other image information it interacts with, such as a game, a video, or a movie.

The decoding circuits decompress the bit stream and regenerate the multiple audio channels, delivering the PCM time samples to the multiple audio digital-to-analog converters *(Fig. 2b)*. The actual bit stream consists of a synchronization frame that contains multiple sub-blocks—a synchronization information block, a bit-stream information block, six audio blocks, an auxiliary data field, and a cyclic-redundancy-check block to help the system keep track of incomplete or noisy block transfers *(Fig. 2c)*.

TO RECREATE REALISTIC 3D SOUND, ALGORITHMS MUST ACCURATELY MODEL THE WAY PEOPLE HEAR THE SOUNDS AND THE WAY THEIR HEADS MODIFY OR INTERACT WITH THE SOUND.

Although the encoding side is critical for the content developer, most of the volume is generated by end users who only require decoding capability. To that end, over 44 chip manufacturers and algorithm developers are crafting AC-3 support products and tools. For example, Motorola and Zoran have developed application-specific DSP ICs targeted specifically at decoding the AC-3 bit stream. The ZR385xx family from Zoran was the first such offering.

Today, the company offers a variety of decoders to meet various playback and cost points. For example, the ZR38500 provides a full six-channel digital data stream with a number of options. It can, for example, merge the six channels down to two and provide a stereo output. Or, it can recode the data into ProLogic outputs. It also can perform ProLogic decoding. Finally, it can just mix one- or two-channel PCM data streams for mono or stereo playback. For lower-cost systems, the ZR38521 delivers only two channels



3. HIGH-PERFORMANCE DIGITAL-SIGNAL PROCESSORS such as the DSP56007 and 56009 developed by Motorola can perform the AC-3 decoding thanks to abundant chip resources. Not only do the DSP chips include a 24-bit-wide data path, over 6 kwords of ROM and over 3000 words of RAM, but a 24-bit multiplier-accumulator that can perform a 24-by-24-bit multiplication and feed the result into a 56-bit accumulator, all in two clock cycles.

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voice without affecting the 3D enhanceeffects,andcanalsosharpenthe standard stereo signals when used on unenhanced stereo signals. The chip restores some of "crispness" to the speech and music signals, making it easier to hear dialog and lyrics, for example. The chip does that by reconstructing the sound. Input signals are divided into three frequency bands—the bass (20 to 150 Hz), middle (150 to 2400 Hz), and treble (2.4 to 20 kHz)—and then combined by first adjusting the time-delay characteristic in every frequency by modifying the base differences. That minimizes the distortion of the rising edge of the sound.

All processing is done in the analog domain through the use of high-speed detection and voltage-controlled amplifiers that control the amplitude of the treble constituent. That helps recover the harmonics of the signal and that, in turn, improves the definition level of the music or voice.

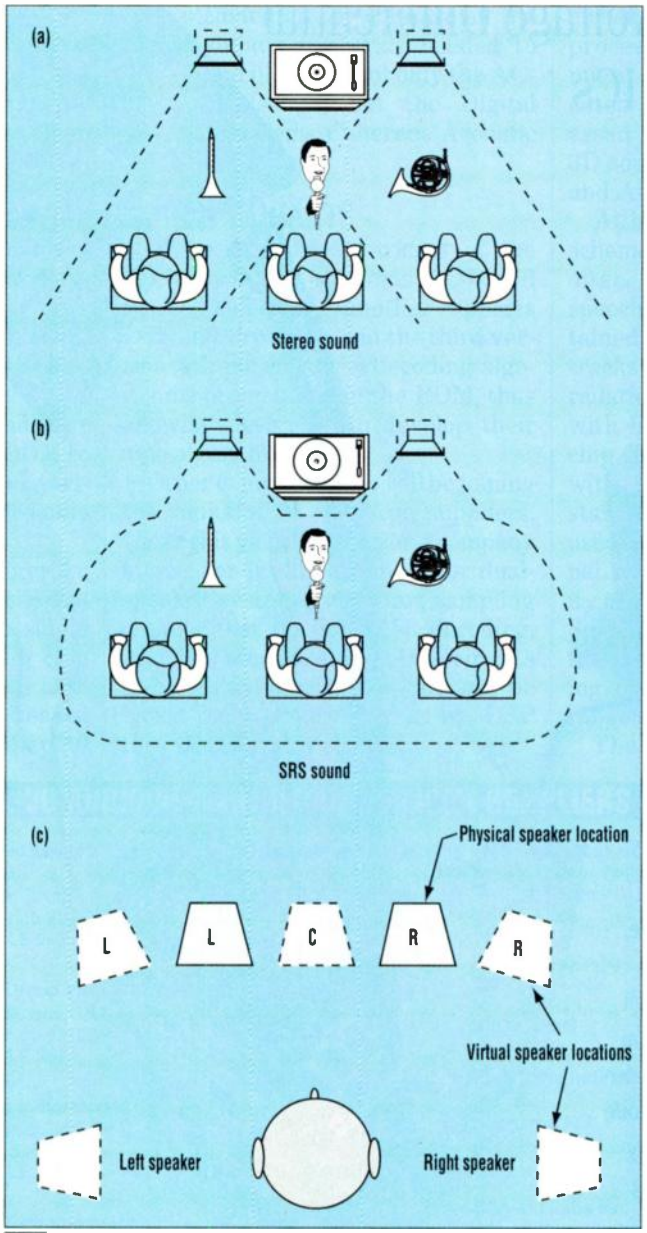
Another problem that the variety of enhancing schemes could cause is enhancing the same signal more than once by inadvertently applying a second enhancement algorithm on top of a previously enhanced signal. Such a doubling up would do more harm than good, and rather than be enhanced, the signals would be trashed. The BA3884 would help to restore trashed audio to its original enhanced state.

To prevent doubling up from taking place, designers at Spatializer developed a scheme called double detect and protect (DDP). It is included as part of the enhancement circuitry in their chips and prevents the audio signal from becoming overprocessed. It instantaneously examines the incoming signal for certain spatial and frequency components to determine whether the signal was already enhanced and is susceptible to overprocessing. If it so determines, the DDP block reduces the level of Spatialization performed on the signal stream.

As mentioned earlier, there are at least a half-dozen enhancement approaches and no common shared standard among them. Several vendors such as QSound, SRS, and Spatializer have been actively licensing their algorithms and circuits to various system and silicon suppliers and currently have the bulk of the enhancement market. Suppliers such as Aureal, Binaura, Euphonics, InternationalJensen, Virtual Listening Systems, and Yamaha have each developed their own algorithms, that in most cases, are available for license and as off-the-shelf silicon.

Spatializer, for example, has licensed its 3D technology to companies such as ESS, Panasonic (Matsushita Electronics Corp.), and On-Chip Systems, all of which offer chips to the computer and consumer industries. Furthermore, the algorithms have been licensed to suppliers of DSP chips and computer/game systems for incorporation into additional products. The company also has developed a tool set plug-in for the Pro Tools 3 software from Digidesign. The PT3D software provides a Windows user interface for controlling all the sound-processing features in real time using a single DSP56001 chip model from the Pro Tools DSP farm.

The scheme used by Spatializer derives phantom left and right rear channels from the standard L/R stereo channels, one that represents the sum (L+R) and can be thought of as containing all the significant monophonic information in the L and R signals. The other is a difference channel consisting of L-R data and represents the all-important spatial information that characterizes the program material. The algorithms and circuitry manipulate the difference signal such that it causes the listener to



4. THE DEVELOPMENT OF BOTH analog signal processing and DSP circuits that can enhance the basic stereo signals allows designers to let budget-conscious users obtain much more realistic sounds. The basic stereo scheme (a), can be enhanced to provide a broader field that delivers more of a "live" result. In the layout suggested by SRS Labs, the critical "sweet" spot of the basic stereo system can be considerably expanded by using the company's algorithms to enhance the two-channel sound (b). Providing AC-3-like 5.1 channel sound, designers at Aureal have a scheme that creates "virtual"speakers1—imaginary sound sources—that are algorithmically positioned to mimic the AC-3 speakers (c).

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perceive a stereo image beyond the boundaries of the speakers.

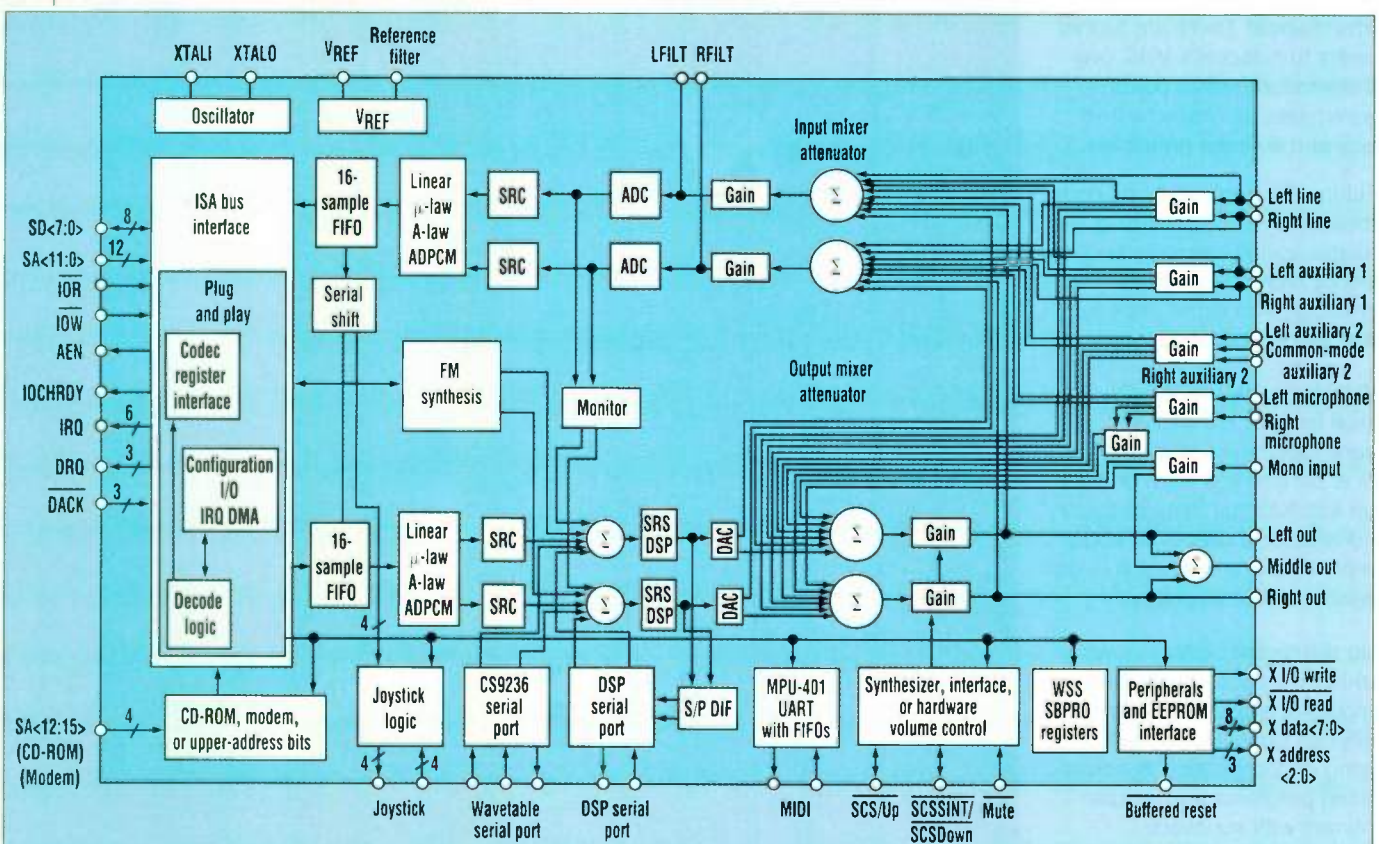
The building blocks to perform the manipulation include a difference circuit, which then passes the difference information through a psychoacoustically-correct filter that performs three key functions. It boosts the portion of the audio spectrum that provides many of the spatial cues, adds just enough phase delay to enhance the listener's sense of "space," and lastly, the filter block helps prevent acoustic cancellation at low frequencies, thus avoiding any sense of weak bass response *(Fig. 5)*.

Matsushita has been both a supplier to Spatializer and an OEM source of the chip to system manufacturers, while ESS has been delivering the ES938 as an OEM product. The most recent partner, OnChip Systems, offers two versions, the PSZ739 and 740, with the PSZ739 providing a third channel output called the "surround output." That extra output can be used to drive two rear-positioned speakers to further enhance the spatial effect. But the chips are otherwise functionally compatible with the circuits available from ESS and Panasonic.

The technology behind the 3D enhancement software provides spatial expansion, sound localization, and directional positioning by using all the psychoacoustic cues processed by ITD, IID, and HRTF models and transaural processing. DSP-based solutions are available for chips from Analog Devices and Motorola, cores from companies such as the DSP Group, also can run on Intel x86 CPUs under the native signal processing (NSP) approach. And the most recent upgrade to the company's software is Worf-3D audio positioning, a software package that maps sound into three planes (X, Y, and Z). The software is compatible with Microsoft's Windows 95 API and drivers are available to licensed OEMs.

In comparison to SRS, Spatializer has its unique DDP circuitry to prevent overprocessing, does not modify the centered material, and provides the directional positioning of sounds. In contrast to QSound, designers at Spatializer claim their solution provides a greater range of effect levels, does not affect the centered material, offers the directional positioning of sounds, and is a lower-cost solution since it uses a simple analog-processing circuit.

Of course, both SRS and QSound contest most of these claims. The SRS approach recreates the 3D effect by processing the ambient or reflected sounds so that they take on the characteristics of sounds naturally entering the ear from the side. That is done



ADPCM = adaptive differential pulse-code modulation; AEN = address enable; DACK = data acknowledge; DRQ = data request; SD = system data; SA = system address; IOR = I/O read; IOW = I/O write; IOCHRDY = I/O channel ready; IRQ = interrupt request; XTALI = crystal input; XTALO = crystal output; SRC = sampling-rate converter; SRS = SRS Labs; S/P DIF = Sony/Philips interface format; SCS/UP = synthesizer chip select/up; SINT/DOWN = synthesizer interrupt input/down; WSS SBPRO = Windows sound system Sound Blaster Pro.

5. THE MAJOR CIRCUIT FUNCTIONS needed to implement the Spatializer 3D audio processor includes a frequency-dependent filter and adjustable phase delay, a double-detect and protect-block (to prevent double 3D audio processing by checking to see if the audio data is already enhanced), and a signal matrix to route the proper enhanced signal to the desired channel.

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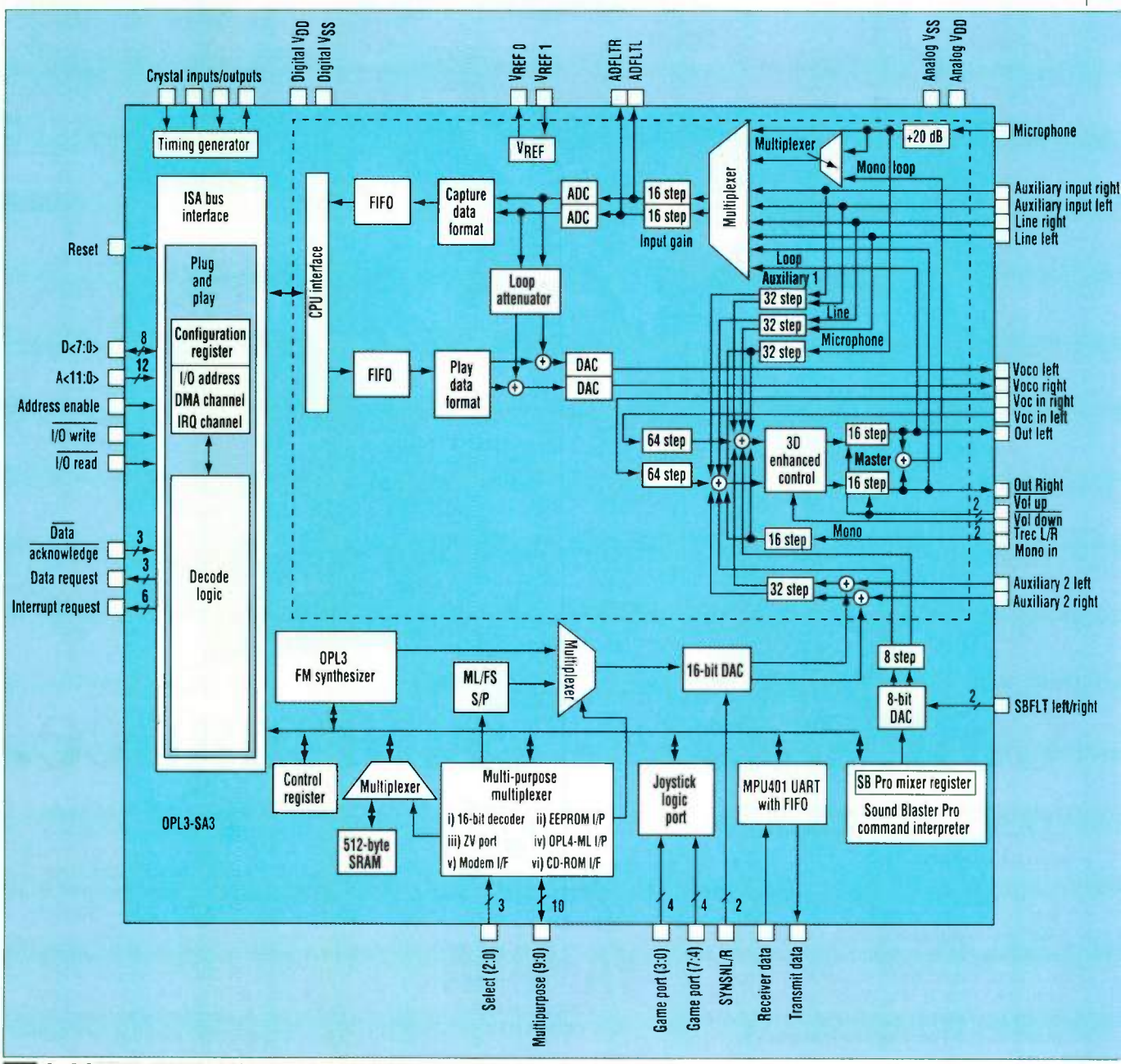
by first identifying the sound location and distance by sensing slight variations in the frequency response, relative phase, midrange intensity, and relative arrival times. The results are then divided into sum and difference values of L+R, L-R and R-L (one extra result not used by Spatializer). These signals are processed and mixed in with the original standard L/R signals.

Various implementations of the SRS system give the user different levels of control. At the low end, center and space adjustments are common, with more complex systems offering more sound-sculpting control. The SRS scheme has been implemented in silicon by Crystal Semiconductor, which has embedded the capability in a full sound-system chip, the CS4237B *(Fig. 6)*. And most recently, SRS inked a deal with Chromatic Research to incorporate the algorithms on the Mpact media processor, which forms a complete single-chip multimedia system for the PC.

The Crystal chip also is close to a complete system. The single-chip audio subsystem includes a 6-channel input mixer, full plug-and-play ISA-compatible interface, on-chip delta-sigma converters, internal FM-synthesis capa-



6. SOUND-ENHANCEMENT ALGORITHMS, such as those developed by SRS Labs, can run on a DSP-based FM sound chip such as the CS4237 from Crystal Semiconductor. This chip was designed to be flexible and can be internally configured to execute almost any company's sound algorithms on top of providing a full multimedia FM sound subsystem (including codecs) for a PC. Another version of the same chip, the CS4238, is coded to implement the QSound sound-expansion algorithms. The CS423X family of sound chips include a complete audio subsystem and are SoundBlaster-compatible as well.

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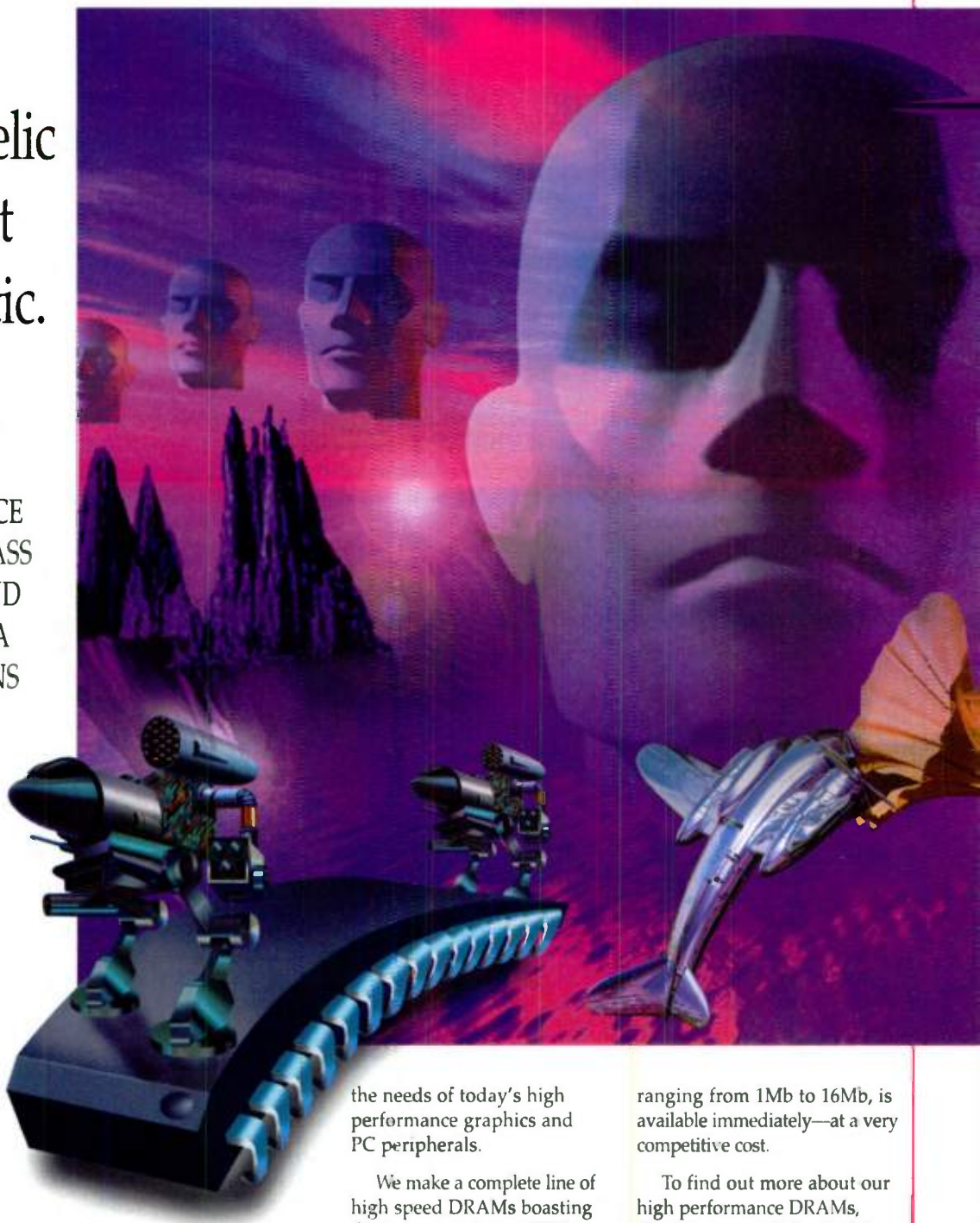

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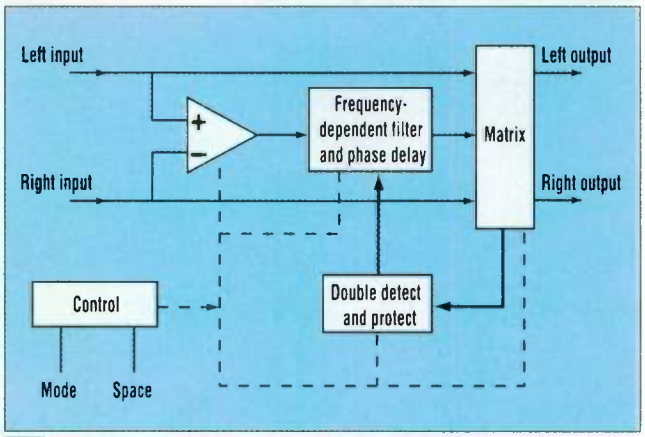
bility, dual DMA channel support with FIFO buffers, an MPU-401 MIDI interface, a joystick port with digital assist, and full SoundBlaster and Windows sound-system compatibility. Additional features support power management, a CD-ROM interface, and wavetable audio.

Hedging its market development with SRS, Crystal Semiconductor also offers a version (the CS4238B) of the same audio sound-system chip with the QSound algorithms embedded in the silicon. In addition, QSound has ported its algorithms to the audio chip set developed by Spectrum Signal Processing based on the NEC SPX digital signal processor. The QSound chip, referred to as the QXpander, is targeted mostly at PC motherboards and other PC-based products. QSound has also indicated that the multimedia instruction extensions (MMX) for the P55C, and Pentium Pro CPUs from Intel will be able to support a software implementation of the algorithm on PC platforms. In addition to the QXpander solution, QSound also has some older algorithms available for speakers (Q1) or for headphones (Q2 and now Q2X).

Both SRS and QSound employ a method referred to as subtracted signal. A new scheme developed by Yamaha, dubbed NoroSound, employs an approach referred to as the crosstalk method. In this scheme, the opposite channel is inverted in phase and mixed with the original channel. The amount of inverted channel is adjustable as well as is the overall gain. Additional bass boost is used to compensate for the low-frequency "suck-out" that often occurs in phase-inverted systems. As a result, the output of the NoroSound scheme is similar to that of the SRS approach.

NoroSound will be incorporated as Ymersion, a 3D stereo enhancement that will be part of the company's AC97 PCI audio codec activity, and is currently incorporated in the OPL3-SA3 sound processor *(Fig. 7)*. Like the Crystal audio subsystem on a chip, the OPL3-SA3 is also a full subsystem with SoundBlaster compatibility, and on-chip FM synthesizer (OPL3), MIDI I/O port, zoomed video port, joystick interface, and both ISA plug and play and Windows Sound System compatible.



7. OFFERING FULL soundblaster support, the OPL3-SA3 from Yamaha includes a proprietary collection of sound-enhancement algorithms for 3D sound creation. The chip is the first of a family of 3D-audio-enabled processors, and is intended as a high-integration solution for use on computer motherboards.

Complementing the codec will be a digital chip that is a follow-on to the OPL-4 sound synthesizer. In early 1997, another superset chip that includes AC-3 decode capability will be ready for release. Consequently, a system architecture will be possible that consists of an AC97 codec and a support chip that packs everything else—PCM audio Wave, DirectSound, ZoomVideo Port, FM and wavetable synthesis, and Dolby AC-3 decode. An option upgrade digital signal processor also will be available in 1997 so that 3D positional audio (somewhat like the Worf capability from Spatializer) can be added to the subsystem to provide even more realistic sound effects.

New players are constantly entering the 3D sound arena, each offering a slight improvement or cost benefit to the system designer. For example, Euphonics, a developer of music synthesis and audio effects software, has released an algorithm package that runs on the Pine and Oak DSP cores developed by the DSP Group. The EuSpace algorithms provide 3D localization and spatial enhancement of audio signals. For sound effects, it provides true 3D localization while for musical accompaniment, it provides spatial enhancement to broaden the stereo sound stage. The DSP Group also is working on a new core, dubbed "Palm" that will have abundant resources on board to handle 3D audio, simultaneous digital voice and data, AC-3 playback, and other applications.

Another company, Binaura, offers a 3D audio enhancement technology that restores the spatial content of recorded material and increases the breadth and depth of the sound image (it broadens the "sweet spot" for optimal listening). The company offers its enhancement technology in the form of a discrete analog circuit and a DSP algorithm, and currently has a custom IC that implements the algorithm. The enhancement scheme is compatible with any two-speaker stereo playback system and with multispeaker 3D sound systems and requires no precoding of the audio material.

Referring to its technology as "virtual spatial hearing," Virtual Listening Systems has targeted its enhancement technology for use with stereo headphones. The Toltec enhancement system includes an advanced method for customizing the HRTF processing for individual listeners. By using HRTFs developed from the general population, Virtual Learning Systems has created a unique subset that it uses as an advanced model of the human auditory system. A fast and effective psychoacoustic selection test then allows the listener to customize the HRTF processing to best suit their virtual listening needs. Employing the Toltec algorithms, Auri is an end product that combines the principals of binaural hearing, HRTFs and advanced DSP to reproduce the virtual 3D sounds over standard headphones.

Providing the sound positioning in one plane is the way most of the 3D enhancement schemes deliver their results. The Worf system from Spatializer is the tip of the next iceberg, providing Z-plane positioning as well to move the sounds above and below the listener as well. Competing with Worf is a 3D positioning approach called interactive 3D audio that was developed by Aureal through its recently acquired Crystal River Engineering design team, whose three-plane positioning algorithm forms the heart of the interactive 3D product.

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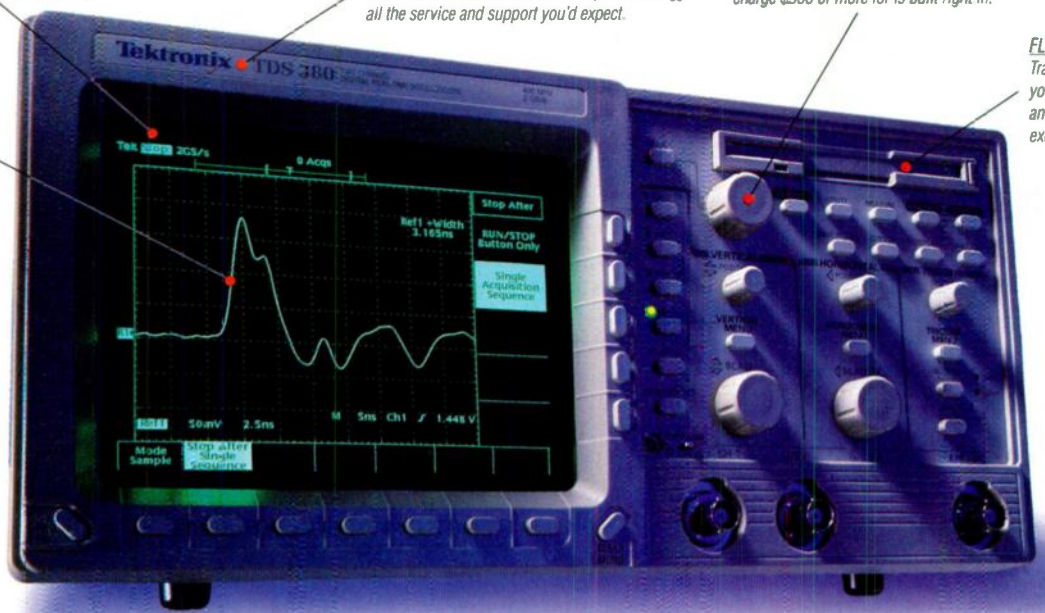

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ELECTRONIC DESIGN REPORT

3D AUDIO TECHNOLOGY

The technology, in the form of algorithms, has already been licensed to Diamond Multimedia and to Oak Technology. Diamond will embed the technology in end-user products, while Oak will incorporate the algorithms into silicon that can be sold to system designers.

Aureal also has a custom IC available, the ASP301, that incorporates dual DSPs and parallel "slot" processing and delivers very realistic sound. The chip also is a music-synthesis processor and incorporates support for FM, wavetable, and waveguide synthesis, and can be used for effects processing. Internally, the ASP301 has two processor blocks running concurrently—the foreground processor and a background processor that provides hardwired implementations of unit-generator functions such as oscillators, delay lines, and envelope generators. There are 128 discrete processing units that are organized into 32 programmable blocks or "slots." Each slot can be individually programmed to implement a synthesis algorithm such as a waveguide, FM, or wavetable instrument voice. The foreground processor uses a customized instruction set optimized for music synthesis to execute, in real time, musical instrument models that are composed of a network of the unit generators and other operators. Separate contexts can be maintained for up to 32 voices.

What the Aureal scheme does is take surroundsound audio formats such as the Dolby ProLogic and AC-3, and play them back using a single pair of speakers or headphones, creating an environment with five virtual speakers that surround the listener. To do that, the algorithms recreate cues that people perceive in everyday life—everything from absorption of sound waves in the atmosphere to HRTF cues. The algorithms then sum up the effects of all cues and incorporate the results in the sound-processing algorithm. □

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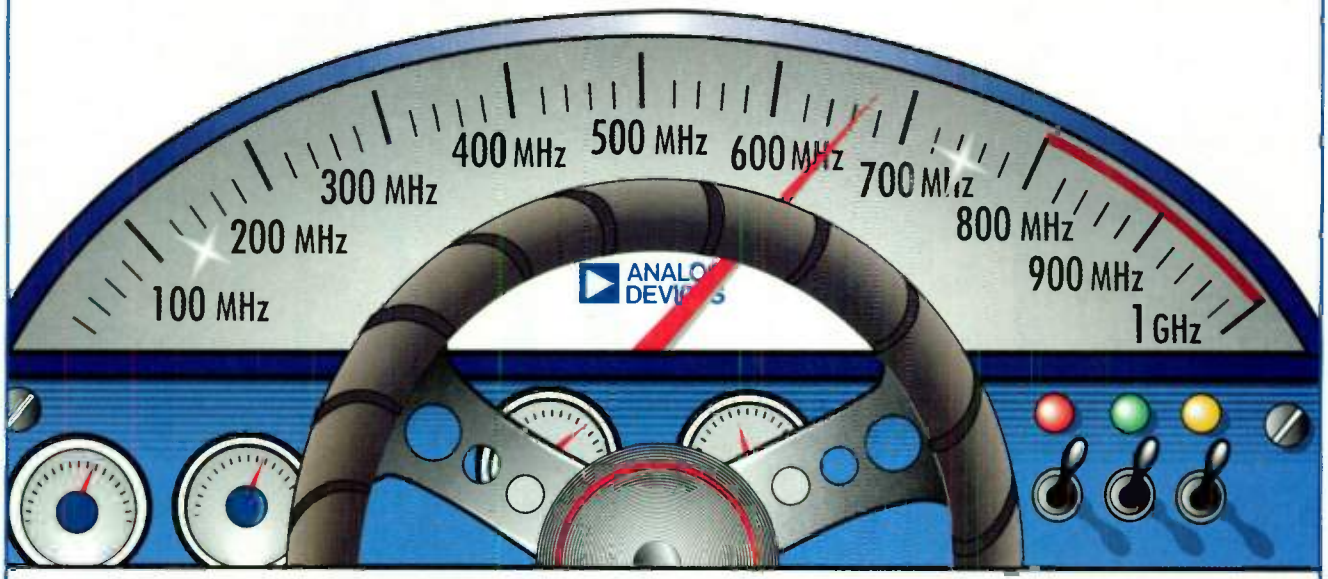

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LDO Regulators Require Proper Compensation

They Maintain Output Regulation With A Low Voltage Drop, But Stable Operation Means Selecting The Right Output Capacitor.

The proliferation of battery-powered equipment in the last decade has accelerated the development and usage of low dropout (LDO) voltage regulators. Compared to a standard npn regulator, the LDO regulator can maintain its output in regulation with a much lower voltage across it. While the npn requires about 2 V of headroom to regulate, the LDO will typically work with less than 500 mV of input-to-output voltage differential. This reduced input voltage requirement is advantageous in battery-powered systems, since it translates directly into fewer battery cells (and lower cost). The trade-off for this higher level of performance is that the LDO requires external compensation capacitors, something an npn regulator does not. The capacitor also must be carefully selected to assure stability.

THE NPN REGULATOR

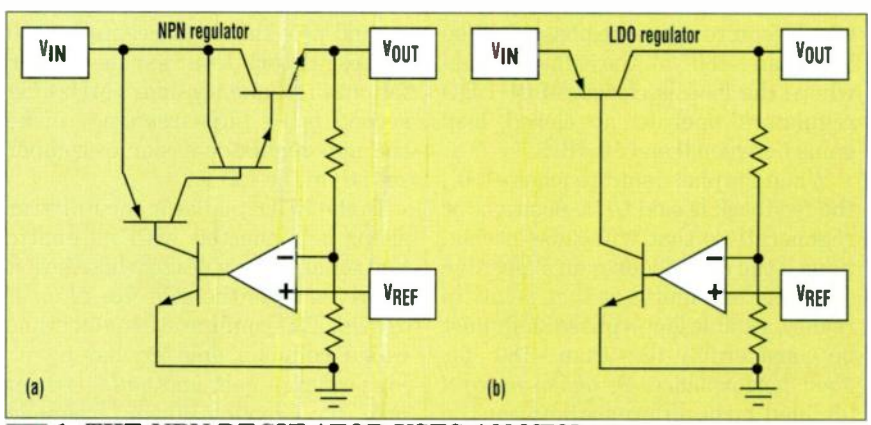
The first IC regulators, like the LM340 or LM317, were npn devices *(Fig. 1a)*. The devices' pass transistor was comprised of an npn Darlington. The npn regulator maintains a constant output voltage by sampling the output through a resistive divider, and uses this feedback signal to control the error amplifier. Here, the regulator output is locked at a constant voltage that is a multiple of the reference voltage as determined by the resistor values.

The dropout voltage for the npn regulator (defined as the minimum input-to-output voltage differential required to maintain regulation) is the voltage needed to keep its pass transistor operating in the linear region. In this case, the dropout voltage is:

$$V_{DROP} = 2V_{BE} + V_{SAT}$$

For the industrial temperature range (–40 to +125 °C), the dropout voltage for a typical npn regulator will be about 2.0 to 2.5 V.

The LDO regulator operates exactly the same as the npn with the exception that the npn Darlington pass tran-



1. THE NPN REGULATOR USES AN NPN Darlington pass transistor which requires about 2 V across it to operate (a). The LDO uses a PnP, which can maintain output regulation with only a few hundred millivolts across it (b).

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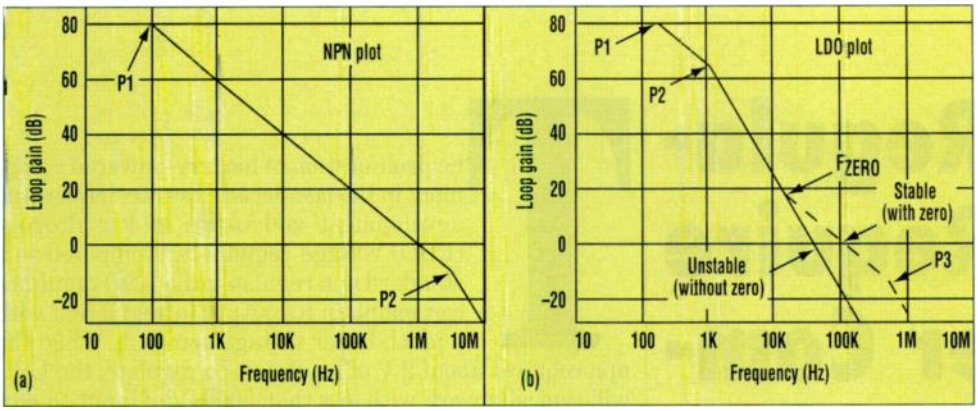
COMPENSATING LDO REGULATORS



2. THE NPN REGULATOR GAIN PLOT IS STABLE because it has only one low-frequency pole (a). The presence of a second low-frequency pole in the LDO loop response means that a zero must be added to reduce some of the excess phase shift that would cause oscillation (b).

sistor has been replaced by one PnP transistor *(Fig. 1b)*. The LDO's advantage is that the PnP pass transistor can maintain output regulation with very little voltage drop across it:

$$V_{DROP} = V_{SAT}$$

For LDO regulators, full-load dropout voltages of 400 to 800 mV are typical.

Nearly all npn regulators have internal compensation that makes them unconditionally stable without any external capacitance. However, LDO regulators must be compensated externally. Why this is true requires an explanation of stability and compensation.

All voltage regulators use a feedback loop to hold the output voltage constant. The feedback signal experiences a shift in phase as it goes through the loop, and the amount of phase shift determines whether or not the loop is stable.

To maintain stability, the applied signal must be negative feedback, which requires that the phase shift be less than –180° at the value of gain where the loop is closed. Most LDO regulators operate at closed loop gains between 0 and 10 dB.

When the phase shift reaches –180°, the feedback is said to be positive (or regenerative) that will cause oscillations if the closed loop gain is positive (greater than unity) at that point. In reality, a stable loop's phase shift must be considerably less than –180° for good performance. A *phase margin* (defined as the difference between the signal phase and –180° at the closed-loop gain point) of at least 20° to 30° is preferred.

It should be noted that a single pole in a gain plot will contribute a total of only –90° phase shift to the loop. This means that getting a regulator to oscillate requires the effect of a second pole, which allows the total phase shift to reach –180°. All regulators have secondary poles, but the critical factor for determining stability is the frequency where they occur.

NPN Vs. LDO Regulator

The pass transistor of an npn regulator is connected in a configuration known as a common collector or emitter follower *(Fig. 1a, again)*. In the emitter follower, the collector of the npn Darlington pass transistor is connected to the input voltage source and the load is driven from the emitter. As a result, the voltage gain of the signal going from the base of the pass transistor to the emitter is very close to unity.

An important characteristic of the emitter follower is wide bandwidth, which is another way of saying the second pole that it places in the voltage regulator's loop response is very far out in frequency (like 3 MHz). The second pole's high frequency makes the npn regulator easier to compensate than the LDO.

In the LDO regulator, the PnP transistor is connected with its emitter tied to the input voltage while the load is driven from the collector *(Fig. 1b, again)*. This configuration, sometimes called common emitter, has a very high voltage gain and adds a second pole at a much lower frequency (around 500 kHz). It's also important to note that the reality of IC fabrication dictates that PnP power transistors have lower bandwidths than their npn counterparts, which also contributes to increased phase shift at lower frequencies in the LDO design.

Typical npn regulators employ a method called dominant pole compensation, which means that a capacitor is placed in the circuit which causes the loop gain to begin rolling off at a very low frequency *(Fig. 2a)*. The dominant pole is set at about 100 Hz using a 30-pF capacitor, which is built into the IC. The 100-Hz pole causes the gain to roll off at a rate of 20 dB/decade until reaching the second pole, located at 3 MHz, where the slope of the gain plot changes to 40 dB/decade. The reason the npn regulator is unconditionally stable at any closed loop gain is that the second pole (which brings the phase shift to 180°) doesn't take place until well below 0 dB (unity gain).

Dominant-pole compensation works well in npn regulators because the second pole occurs at a very high frequency. In LDO regulators, the presence of poles at much lower frequencies requires a different approach.

In compensating an LDO regulator, a dominant pole is used, as well as a technique called pole-zero cancellation. Adding a zero to the loop-gain response effectively cancels a pole: while a pole changes the slope of the gain curve by –20 dB/decade and adds a total of –90° phase shift, a zero does just the opposite. The added zero is necessary because the gain plot of an LDO has a second low-frequency pole resulting from R_{LOAD} and C_{OUT} *(Fig. 2b)*.

To illustrate how an LDO is compensated, the loop gain plot of a typical LDO regulator will be developed through a simplified analysis using the following four assumptions:

1. A pole (P1) occurs at the frequency:

$$P1 = 1/(2\pi \times R_{LOAD} \times C_{OUT})$$

For this example, assume that $R_{LOAD} = 100\Omega$ and $C_{OUT} = 10\mu F$ (which places P1 at 160 Hz).

2. The internal compensation (domi-

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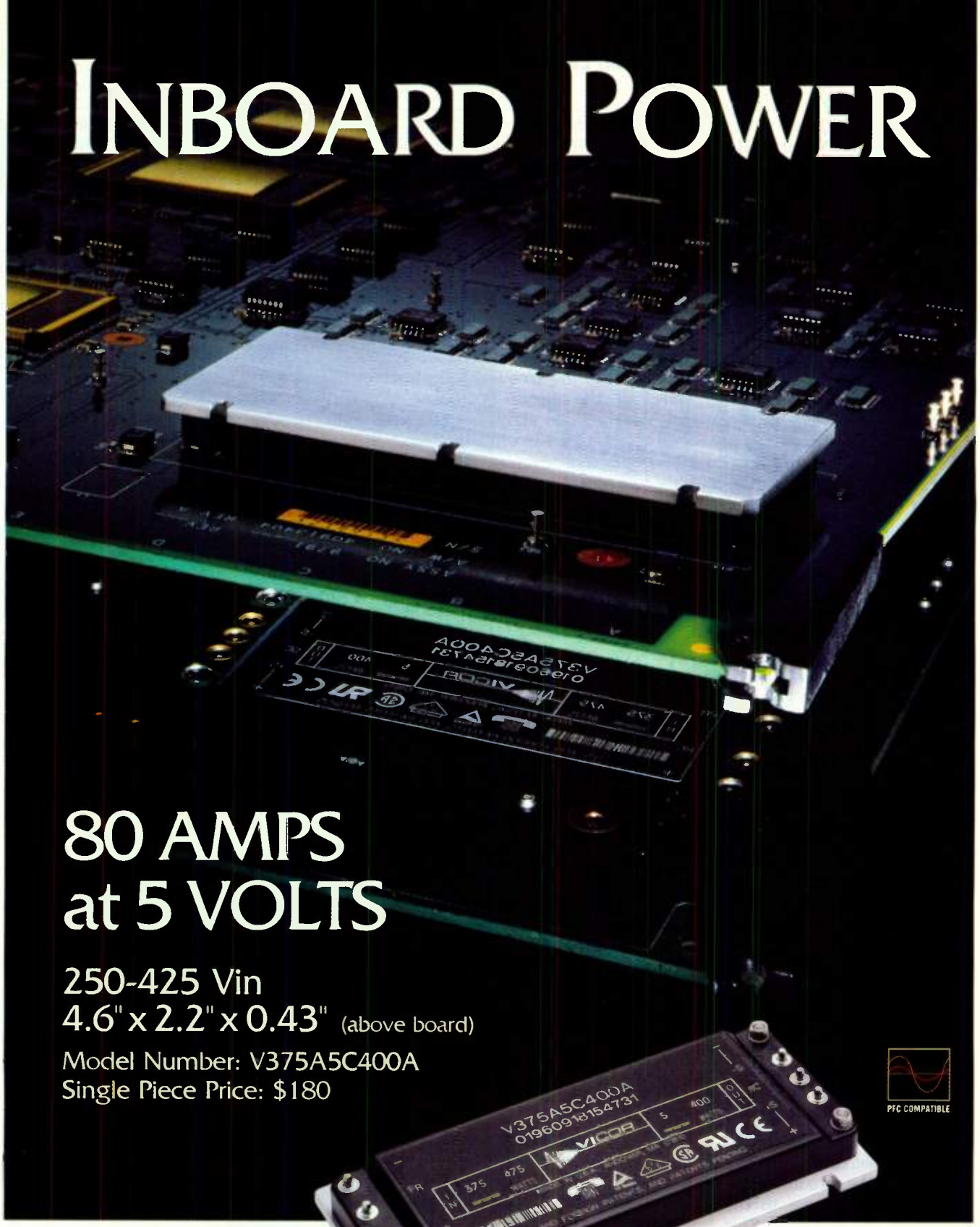

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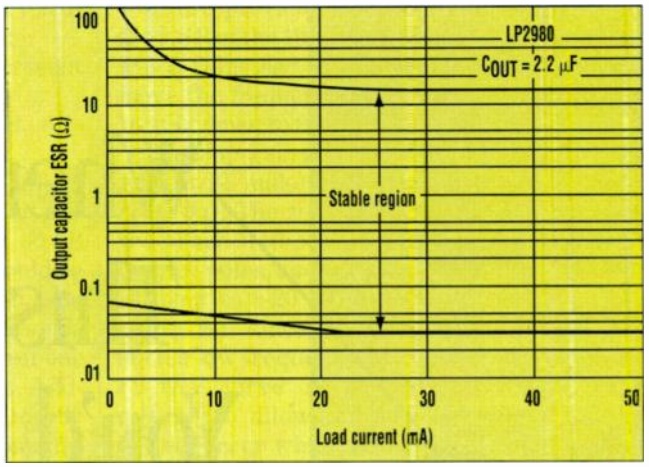
3. ESR is sometimes specified indirectly as dissipation factor (DF). To find the ESR using DF, the formula is:

$$ESR = DF/(2\pi \times f \times C).$$

4. The maximum ESR limit is only guaranteed at room temperature, and no data is given on what it will do at other temperatures. Most capacitors show an increase in ESR at cold temperature, and this causes more LDO regulators to oscillate than any other reason.

5. Beware of capacitors that only specify ESR (or DF) at 120 Hz, as the zero that the ESR creates needs to be working in the 10- to 200-kHz range to do any good. The rule of thimb is if you can't get a 50- or 100-kHz specification for ESR, you should shop for another capacitor.



4. THE ESR CURVE for the LP2980 (which is a 50-mA LDO regulator) shows the range of stability when a 2.2 µF output capacitor is used. The ESR range allows more than a 100:1 variation between minimum and maximum ESR while still maintaining stability.

These statements might seem to imply that getting an LDO to work is difficult, but the fact is that most of the time, there are no problems. The (reputable) makers of LDOs design them so that they work with the typical capacitors which are commercially available. Of course, it's advised that the LDO user follow good design practices (following the data-sheet limits) and also be careful about capacitor sources.

Most capacitor-makers provide a good product that gives consistent performance. This means that once you get your design working well, there shouldn't be any surprises later.

CAPACITOR CHARACTERISTICS

The three most common capacitor types are aluminum electrolytic, tantalum electrolytic, and ceramic. Aluminum electrolytic capacitors are popular because they provide the highest capacitance-per-cost ratio and give very good overall performance in most electronic applications. However, the significant ESR change with temperature of aluminum electrolytics makes them unsuitable for use in most LDO applications.

Compared to the value that is measured at 25 °C, the ESR of a typical aluminum electrolytic increases by a factor of 50X as the temperature is reduced to –40 °C. If used as the output capacitor for an LDO regulator, the rising ESR would likely cause the regulator to oscillate at cold temperatures. For this reason, using aluminum electrolytics as LDO output capacitors should be restricted to applications where the operating temperature is always above 0 °C. At lower temperatures, it's advisable to parallel the aluminum electrolytic with a solid tantalum to reduce the effective ESR at the LDO regulator output.

TANTALUM CAPACITORS

Solid tantalum capacitors are the best choice for use as LDO output capacitors for several reasons: they provide good capacitance/size and capacitance/cost values; surface-mount package devices are readily available from many sources; and the ESR characteristics of tantalums are almost perfectly suited for use with LDO regulators.

The reason tantalums are so compatible with LDOs is that their ESR is much more stable with temperature, and the value of ESR is very nearly the center of the "stable" range for a typical LDO. As an example, an AVX 4.7-µF tantalum was tested for ESR at 25 °C and found to be 1.3 Ω. The maximum ESR (at –40 °C) was seen to be 1.7 Ω, while the minimum ESR value (+125 °C) was 1.0 Ω. This shows that the ESR varied less than 2:1 over the entire temperature range. Such a device is suited for an LDO such as the LP2980 *(Fig. 4, again)*.

A ceramic capacitor typically doesn't supply as good a value as a tantalum, as they are usually larger and more costly for a given amount of capacitance. The ESR of a ceramic device is quite stable with temperature, but is possibly low enough to cause an LDO to oscillate.

It's common to find ESR values as low as 10 mΩ on 2.2-µF ceramic capacitors, well below the lower limit on the stable region of an average LDO regulator. A simple solution is to place a small resistance (like 1 Ω) in series with the ceramic capacitor to simulate the ESR.

1. Keep it close. Place the output capacitor less than 0.25 in. from the regulator's output pin and return it to a clean analog ground.

2. Bypass the input. Although not always specified as a requirement, an input bypass capacitor (such as a 1 µF tantalum) is an inexpensive insurance policy. The increasingly wide frequency response of linear regulators makes them more prone to oscillate against a reactive source impedance.

3. Don't forget the tolerances. The initial tolerance of a capacitor is likely to be ± 20% or more, and its value will also change with temperature. A Z5U ceramic will typically change by –50% in going from +25 °C to +80 °C. Whatever capacitor is chosen, make sure that its capacitance won't drop below the minimum C_{OUT} required for stability in the temperature range of your application.

4. Pass up the bargains. Avoid off-brand capacitors if you don't know their pedigree. The output capacitor is not the place to save money. □

Chester Simpson is a member of National Semiconductor's Technical Staff, working in the Applications group for Power Management. He holds an AA degree in Education and a BSEE.

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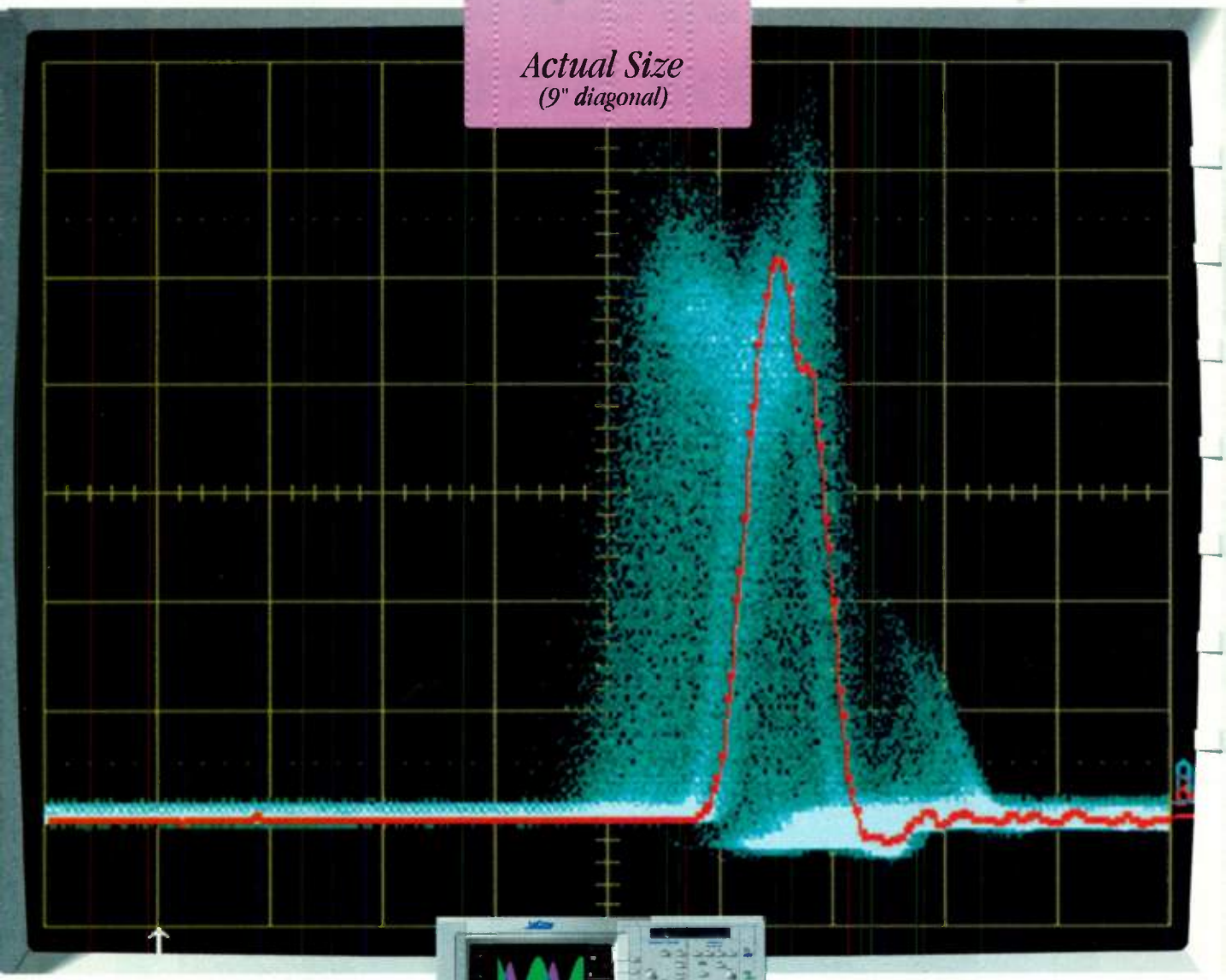

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PEASE PORRIDGE

BOB'S MAILBOX

Dear Mr. Pease:

My husband, Ed Gill, (a.k.a. "Ed the Good" and "Saint Ed") gave me a copy of your June 10 article, "What's All This Hollering Stuff, Anyhow?" Mr. Gill informed me that it reminded him of me. I want to make it perfectly clear that I rarely, if ever, have cause to holler at Mr. Gill. This could be because I have seen him yell at other people—sort of like the effect your Mr. Swanson had on his co-workers.

However, I must admit I have raised my voice on occasion to others who do give me just cause. I don't see anything wrong with this, because I feel that if a person can't understand something the first (or second, or possibly THIRD) time they were told, then you need to turn up the volume and turn up the heat on the words chosen.

Just recently, I was loudly explaining something to a co-worker, which won me a trip to my supervisor's office to listen to her for a while. All my sound-bitten brain could come up with was, "I yell because I care," which, by the way, I saw on a T-shirt. I will give a copy of your article to my supervisor.

One other comment before I close—your Mr. Swanson may have been acting more from self-preservation than chivalry in opting not to holler at the "fairer" sex. Believe me, at times, there are not less fairer people on this planet when the hollering starts.

MAGGIE BOLEYN, R.N.
Blue Care Network
Southfield, Mich.

Maggie, I'm glad you care enough to holler the very best!—RAP

Dear Bob:

I enjoyed the letter from G. Roland Bradbury regarding a power circuit in a very old house that needed to "warm up" before it delivered full power. He traced it to a corroded junction between some copper bus-bars, and guessed that copper oxide or copper sulfide was acting as a semiconductor, conducting when hot, but not when cold.

While his explanation seems plausible, it struck me that there may be another one. As the bus-bars are heated by the voltage drop across the corrosion, the copper expands. Perhaps this expansion, and the resulting tightening or shifting of the joint, was what caused the improved connection.

Talk of corrosion reminded of a time, shortly after I had received my BSEE from MIT, when I fixed a malfunctioning turn signal on my father's car. I spent about an hour on it, grumbling all along about the trouble I was having diagnosing a circuit that was not much more complex than a flashlight. After all, I was now officially an Electrical Engineer! I found it amazingly difficult and time-consuming to make continuity measurements from one side of the firewall to the other. But what mainly caused my diagnosis to take so long was my assumption that the car's bumper, a heavy steel chrome-plated assembly, was surely electrically connected to the car's frame, seeing as it was held in place by four one-inch diameter bolts. I forgot what a good insulator iron oxide is! Eventually, I figured out that the problem was in the ground return, and solved it by attaching a wire from the bumper to the frame. The next day, my father mentioned to his mechanic that he was not dropping the car off to have the turn signal fixed because "my son fixed it." To this, the mechanic replied, "Lost the ground, huh?"

LAWRENCE J. KRAKAUER
Kronos Inc.
Waltham, Mass.

Yeah, troubleshooting simple things that could not possibly go WRONX is a challenge for young engineers. Fortunately, silicon dioxide is a much better insulator than iron oxide.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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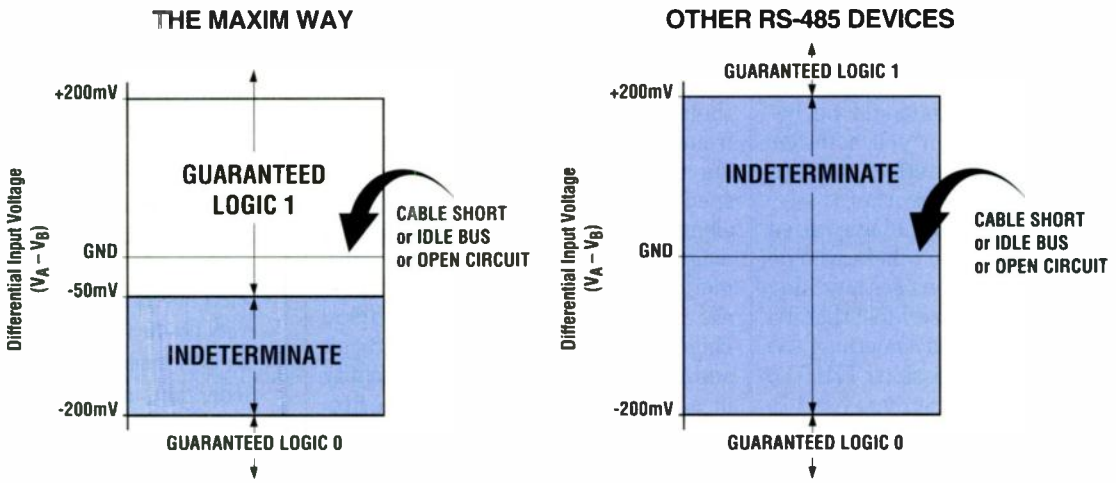
FAIL-SAFE OUTPUT GUARANTEES LOGIC 1 DURING SHORT OR OPEN CIRCUIT



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PART	HALF/FULL DUPLEX	DATA RATE (Mbps)	SLEW-RATE LIMITED	LOW-POWER SHUTDOWN	RECEIVER/ DRIVER ENABLE	QUIESCENT CURRENT (µA)	TRANSCEIVERS ON BUS	PIN COUNT	INDUSTRY-STANDARD PINOUT
MAX3080	Full	0.115	Yes	Yes	Yes	375	256	14	75180
MAX3081	Full	0.115	Yes	No	No	375	256	8	75179
MAX3082	Half	0.115	Yes	Yes	Yes	375	256	8	75176
MAX3083	Full	0.5	Yes	Yes	Yes	375	256	14	75180
MAX3084	Full	0.5	Yes	No	No	375	256	8	75179
MAX3085	Half	0.5	Yes	Yes	Yes	375	256	8	75176
MAX3086	Full	10	No	Yes	Yes	375	256	14	75180
MAX3087	Full	10	No	No	No	375	256	8	75179
MAX3088	Half	10	No	Yes	Yes	375	256	8	75176
MAX3089	Selectable	Selectable	Selectable	Yes	Yes	375	256	14	75180*

* Pin compatible with 75180 with additional features implemented using pins 1, 6, 8, and 13

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CIRCLE 520

PVI Gate Drive With Fast Reset

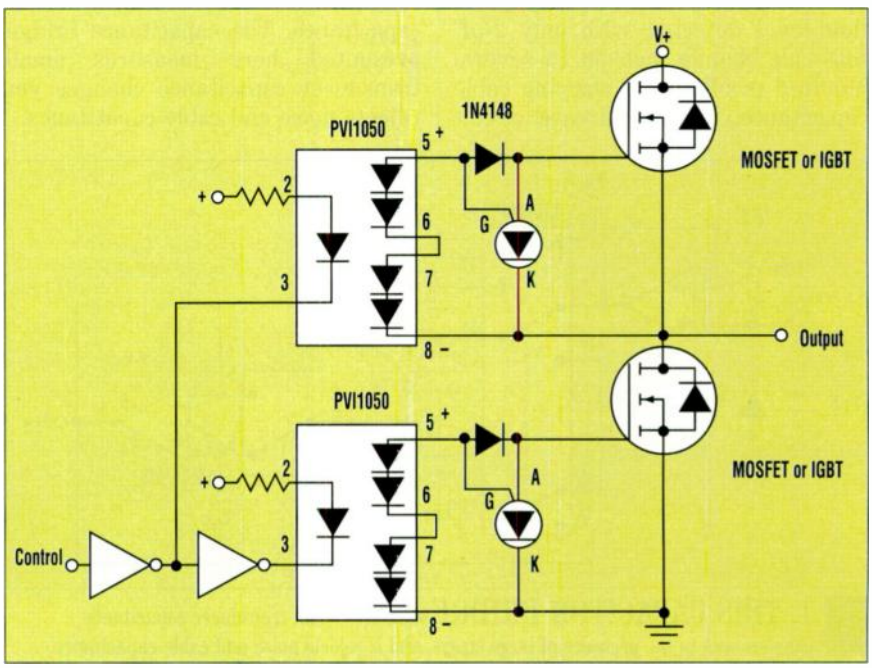
HENRY E. SANTANA, 21317 Palo Verde Pl., Canyon Country, CA 91351-5167.

Photovoltaic isolators (PVIs) provide an isolated gate drive for MOSFETs and IGBTs. At turn-off, however, they don't pull the gate down to drain the gate charge. Using a programmable junction transistor (PUT) provides a very fast gate pull down, pulling as much as 5 A to discharge the gate in less than 0.2 µs.

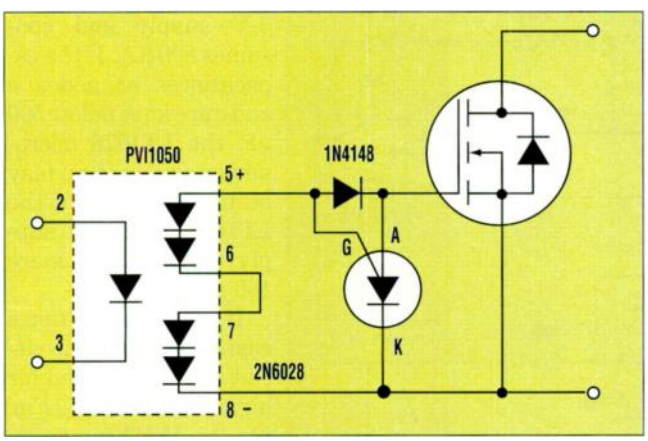
The PUT is a four-layer structure much like a silicon-controlled rectifier but with a much more sensitive anode gate. In this application, the PUT gate is driven by the PVI to a voltage equal to or greater than the anode that holds the PUT in the blocking state so that no current flows through the anode-cathode channel *(Fig. 1)*. When the PVI is turned "off," the PUT gate voltage drops below the anode voltage, triggering the PUT and causing the anode-cathode channel to conduct. Conduction continues until the MOSFET gate voltage drops to about 0.5 V, at which time the PUT stops conducting and recovers for another cycle.

The advantage of the PUT over a P-MOSFET used as a gate pull-down *(Fig. 2)* is that the PUT will pull the gate well below the MOSFET threshold voltage much faster at lower cost. The PUT can discharge a gate capacitance of 5 nF at 12 V in 100 ns.

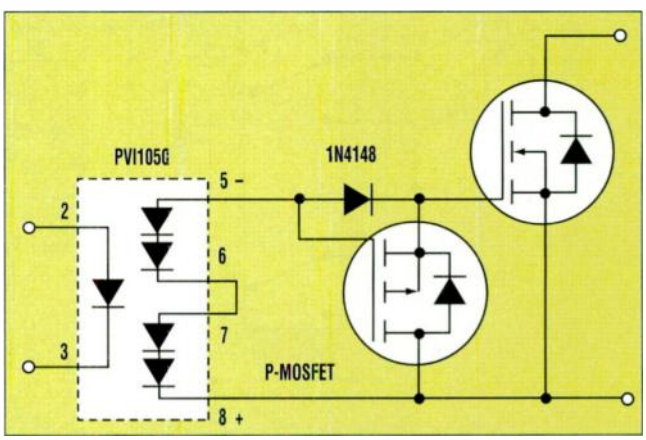
The combination of a weak PVI pull-up and a strong PUT pull-down leads to a very simple half-bridge FET or IGBT driver, which virtually guarantees that the devices won't crowbar the power supply. The device turning "off" will do so rapidly, while the device turning "on" will do so very slowly *(Fig. 3)*. A dead time is inherent in the circuit dynamics, requiring no additional circuitry to prevent a crowbar or "shoot-through" effect. □



3. COMBINING A WEAK PUT PULL-UP and PVI pull-down forms a simple half-bridge FET or IGBT driver. These circuit dynamics will create an inherent dead time, preventing a crowbar or shoot-through effect



1. THE PROGRAMMABLE JUNCTION transistor (PUT), a four-layer structure, can provide a very fast gate pull-down (as much as 5 A) to discharge the gate in less than 0.2 µs.



2. BY USING A PUT INSTEAD of a P-MOSFET as a gate pull-down, the gate is pulled well below the MOSFET threshold voltage much faster. The cost of this implementation is also less than the circuit shown in Fig 1.

CIRCLE 521

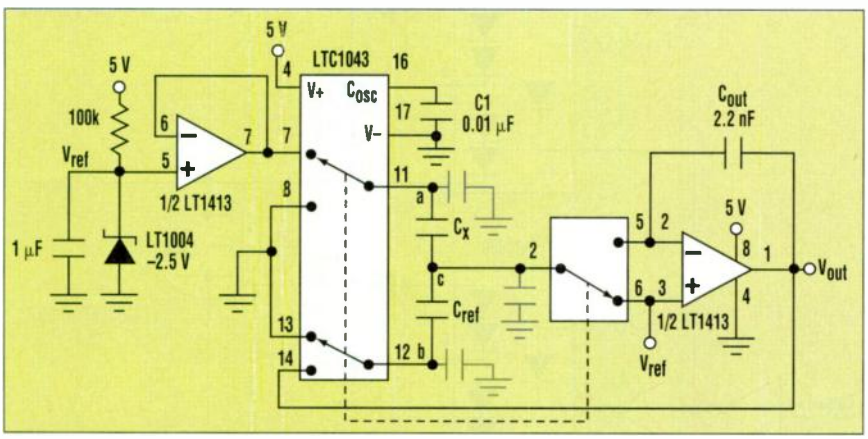
Bridge Measures Small Capacitance

JEFF WITT, Linear Technology Corp., 1630 McCarthy Blvd., Milpitas, CA 95035-7487; (408) 432-1900, ext. 3710.

Capacitance sensors measure a wide variety of physical quantities, such as position, acceleration, pressure, and fluid level. The capacitance changes involved often are much smaller than the stray capacitances, particularly if the sensor is remotely placed.

The circuit described was developed to measure a 50-pF cryogenic fluid-level detector, with only 2-pF full-scale change, hooked to several hundred picofarads of varying cable capacitance. This requires a circuit with high stability, sensitivity, and noise rejection, but insensitivity to strays caused by cables and shielding. Battery operation and analog output also were desired for easy interfacing to other instruments.

Two traditional circuit types have drawbacks: Integrators are sensitive to noise at the comparator, and voltage-to-frequency converters typically measure stray as well as sensor capacitance. The capacitance bridge presented here measures small transducer capacitance changes yet rejects noise and cable capacitance.



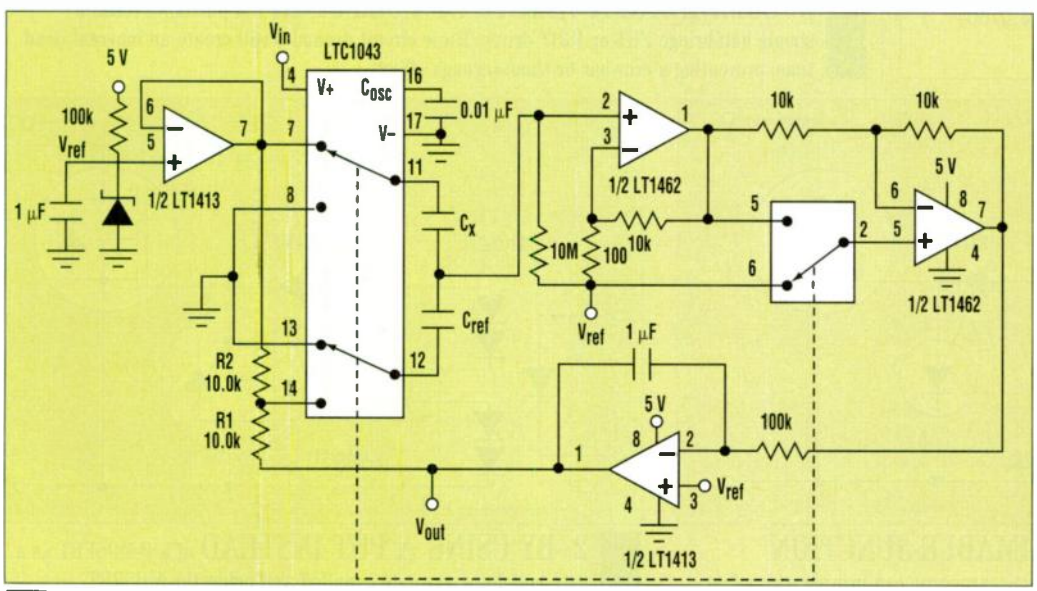
1. THIS CAPACITOR BRIDGE measures small transducer capacitance changes even in the presence of large strays, and it rejects noise and cable capacitance.

The bridge shown is designed around the LTC1043 switched-capacitor building block *(Fig. 1)*. The circuit compares a capacitor (C_X) of unknown value with a reference capacitor (C_{ref}). The LTC1043, programmed with C1 to switch at 500 Hz, applies a square wave of amplitude V_{ref} to node a, and a square wave of amplitude V_{out} and opposite phase to node b. When the bridge is balanced, the ac voltage at node c is zero, and:

$$V_{out} = V_{ref}(C_X/C_{ref})$$

Balance is achieved by integrating the current from node c using an op amp (LT1413) and a third switch on the LTC1043 for synchronous detection. With Cref = 500 pF and Vref= 2.5 V, this circuit has a gain of 5 mV/pF. When measured with a DMM, it achieves a resolution of 10 fF for a dynamic range of 100 dB. It also rejects stray capacitance (shown as ghosts in Figure 1) by 100 dB. If this rejection isn't important, the switching frequency f can be increased to extend the circuit's bandwidth, which is given by:

$$BW = f(C_{ref}/C_{out})$$



2. HIGHER RESOLUTION was obtained by modifying the circuit in Figure 1, for cases when capacitance change is small.

C_{out} should be larger than C_{ref}. The circuit operates from a single 5-V supply and consumes 800 µA. If the capacitances at nodes a and c are kept below 500 pF, the LT1078 micropower dual op amp may be used in place of the LT1413, reducing supply current to a mere 160 µA.

If the capacitance change is small, the circuit can be modified for higher resolution *(Fig. 2)*. A JFET-input op amp (LT1462) amplifies the signal before demodulation for good noise performance, and

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POS-100	50-100	-107	-23	20	11.95
POS-150	75-150	-103	-23	20	11.95
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POS-400	200-380	-98	-28	20	13.95
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*Max. Current (mA) @ 8V DC.

Notes: Tuning voltage 1 to 16V required to cover freq. range. 1 to 20V for POS-1060 to -2000. Models POS-50 to -1025 have 3dB modulation bandwidth, 100kHz typ. Models POS-1060 to -2000 have 3dB modulation bandwidth, 1MHz typ. Operating temperature range: - 55°C to +85°C.

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the integrator's output is attenuated by R1 and R2 to increase the sensitivity of the circuit.

If $\Delta C_X << C_X$, and $C_{ref} \approx C_X$, then:

$$V_{out} - V_{ref} \approx V_{ref}(\Delta C_X / C_{ref})[(R1 + R2)/R2]$$

With C_{ref} = 50 pF, the circuit has a gain of 5 V/pF and can resolve 2 fF. Supply current is 1 mA. The synchronous detection makes this circuit insensitive to external noise sources and, in this respect, shielding isn't terribly important. However, to achieve high resolution and stability, care should be taken to shield the capacitors being measured. This circuit was used for the fluid-level detector mentioned previously by putting a small trim capacitor in parallel with C_{ref} to adjust offset and by trimming R2 for proper gain.

Bridge circuits are particularly suited for differential measurements. When C_X and C_{ref} are replaced with two sensing capacitors, these circuits measure differential capacitance changes, but reject common-mode changes. CMRR for the circuit in Figure 2 exceeds 70 dB. In this case, however, the output is linear only for small relative capacitance changes. □

CIRCLE 522

Generate Auxiliary Bias For LCD

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

This single-cell boost converter can generate two supply voltages commonly needed in pagers and other portable instruments with small, graphic LCDs. The first is a regulated 3.3 V at 100 mA, and the other is a regulated negative output suitable for use as an LCD bias voltage. Overall efficiency is about 80%.

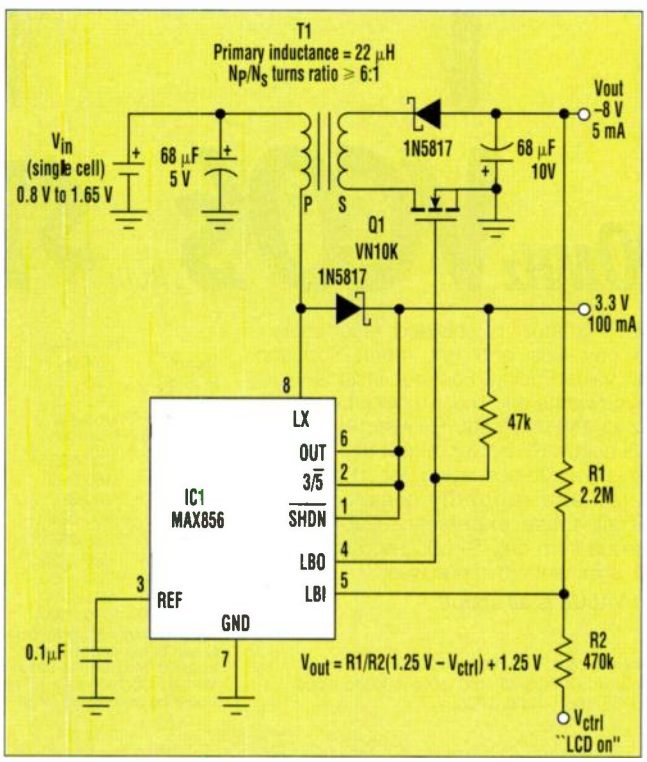
The main 3.3-V supply is provided by a boost converter (IC1) operating in its standard configuration *(see the figure)*. The auxiliary bias voltage is provided by an extra flyback winding (the T1 secondary), and is regulated via Q1 and the low-battery detector internal to IC1.

As the battery discharges, its declining terminal voltage causes a decline in the voltage induced in the flyback winding. At minimum battery voltage (0.8 V), the T1 primary sees 3.3 V – 0.8 V = 2.5 V, so the 6:1 turns ratio produces 6(2.5) = 15 V in the secondary. At maximum battery voltage (1.65 V), the primary sees only 1.65 V, producing 9.9 V in the secondary. MOSFET Q1 stabilizes this output by interrupting the secondary current, introducing the regulation necessary to generate a constant negative output.

The regulator employs IC1's low-battery detector (a comparator/reference combination) as an on/off controller for Q1. Usually, the input (LBI) monitors a positive battery voltage and drives the output (LBO) low when LBI drops below 1.25 V. In this circuit, the R1/R2 divider holds LBI between V_{CTRL} (normally 3.3 V) and the LCD bias output (normally –8 V). The R1 and R2 values are chosen such that LBO turns off when the LCD bias becomes too negative (and pulls the LBI voltage below 1.25 V). Load current then causes the LCD bias to drift upward (toward 0 V) until LBI exceeds 1.25 V, which causes Q1 to turn on again.

The bias output makes excursions above and below its nominal value, producing a ripple voltage whose frequency depends on the size of the output filter capacitor, the output load, and the hysteresis in IC1's low-battery comparator. This frequency is about 150 Hz for the circuit shown, and the hysteresis (about 25 mV) dominates ripple magnitude. Multiplied by the R1/R2 ratio, the hysteresis results (for –8 V/1 mA out) in a ripple amplitude of about 100 mV. Ripple is essential to operation in this hysteretic converter, so it can't be reduced directly. Most LCDs are very forgiving of bias ripple. However, it can be minimized by adding an RC network or linear regulator at the negative output.

A logic signal at the "LCD ON" terminal provides a means to enable and disable the negative output. This signal voltage also sets the feedback level, so it should have a full CMOS swing. In addition, a variable voltage at "LCD ON" can be applied to make the output variable. Voltages below 1.25 V turn the output off, and voltages greater than 1.25 V change the output with a slope of –R1/R2 times (V_{in} – 1.25 V), with an offset of 1.25 V. This variable input, generated by



THIS SINGLE-CELL CONVERTER establishes a regulated V_{CC} (3.3 V or 5 V) and a regulated, negative, LCD-bias voltage (–8 V).

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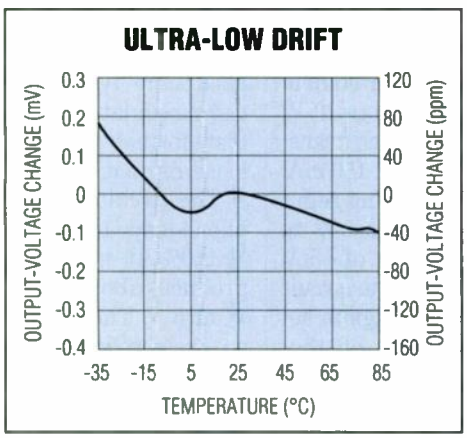

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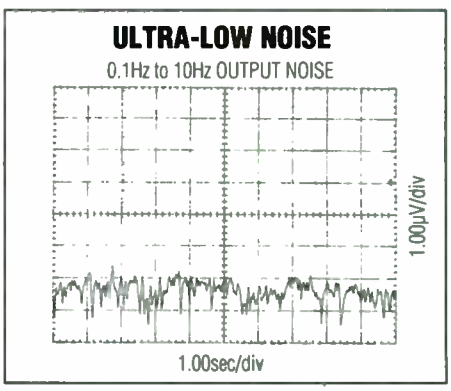

* 10Hz ≤ *f* ≤ 1kHz

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a low-power digital-to-analog converter or the filtered PWM output from a microcontroller, can vary the LCD contrast in response to a change in temperature or viewing conditions (see the V_O equation in the figure).

The main voltage can be changed from 3.3 V to 5 V by grounding the 3/5 terminal on IC1. In that case, the turns ratio should be reduced to 3:1 because the highest battery voltage will induce 3.35 V in the T1 primary. And, of course, R1 and R2 should be adjusted to obtain the desired level of negative output. □

CIRCLE 523

SLIC Supply Uses Stock Transformer

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

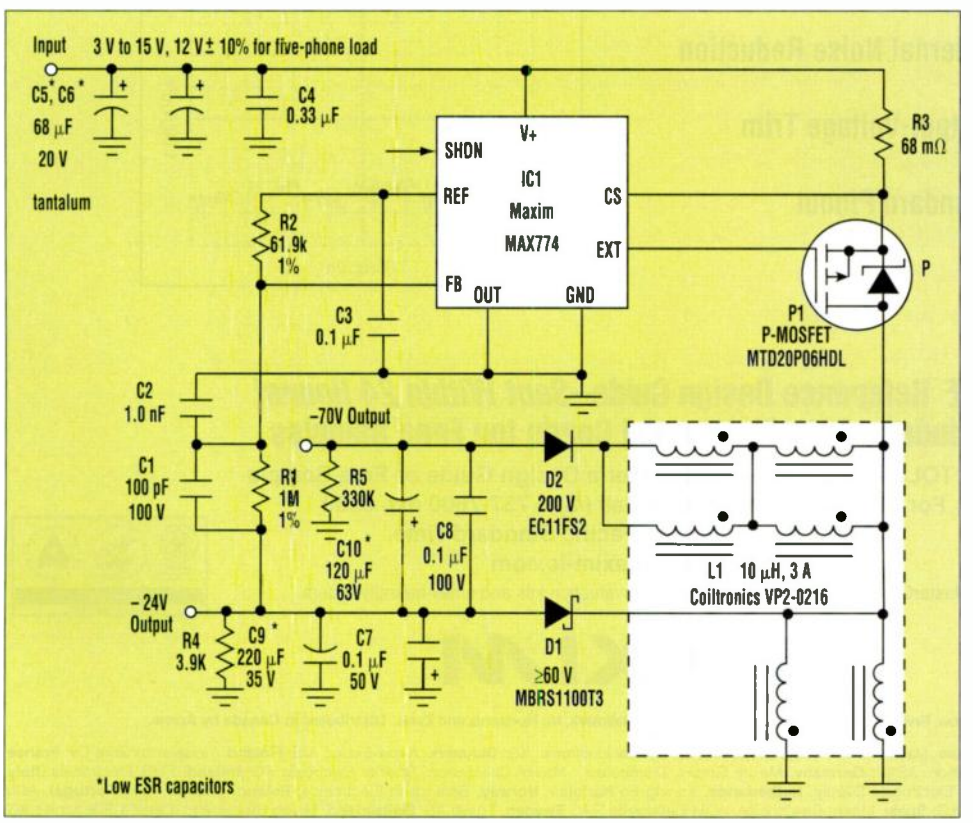
A new multi-winding transformer (configurable by the user for a variety of applications) enables an inverting controller to produce the high negative voltages required by an ISDN board or other telephone line card *(see the figure)*.

Such line cards employ a subscriber-line interface circuit (SLIC) such as the 79R79 ringing SLIC from AMD. This IC generates the off-hook and on-hook signal transmission, ring-tone generation, and ring-tip detection that constitute an analog telephone interface. For off-hook signal transmission, it requires a tightly regulated –24 V or –48 V, and to generate ring tones it requires a loosely regulated –70 V. The "5-ringer-equivalent" requirement demands 9 to 10 W from the –70-V output, which translates to a full-load I_{out} of about 150 mA.

IC1 is an inverting switching regulator that usually converts a 3-V to 16-V input to a fixed output of –5 V or an adjustable output. In the circuit shown, three pairs of windings in series (provided by a single, off-the-shelf, multiwinding transformer) enable IC1 to generate the high voltages needed by a SLIC IC (D1).

Connecting a diode and output capacitor (C7,C9) at the first or second pair of windings produces –24 V (as shown) or –48 V, respectively. Feedback to the IC via R1 and R2 achieves tight regulation at this output. The transformer turns ratios establish a loose regulation at the –70-V output.

The circuit can service a five-telephone load (10 W) from an input of 12 V, ±10%. It operates down to 3 V and produces about 2.4 W at 3.3 V and 3.9 W at 5 V. The –70-V output depends on cross-regulation with respect to the –24-V output, and is therefore affected by relative loading on the two outputs—i.e., whether one is heavily loaded and the other is lightly loaded, or vice versa.

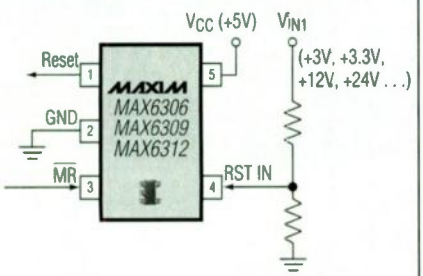
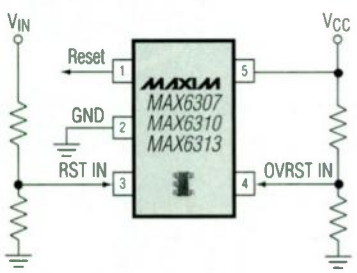
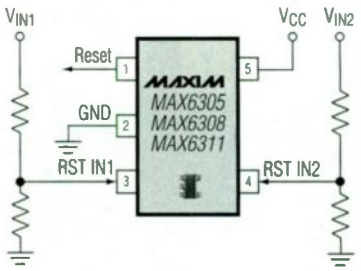


DUAL POWER-SUPPLY OUTPUTS for a ringing SLIC IC (not shown) can be derived from a single inverting controller (IC1) by connecting several windings in an auto-transformer configuration.

Multifilar transformer windings improve cross-regulation by increasing the voltage coupling between outputs and by reducing the voltage spiking caused by leakage inductance. Cross-regulation also is improved by connecting the –70-V output's filter capacitor (C8 and C10) to the –24-V output instead of ground. This connection also simplifies the board layout and enhances stability.

The circuit is optimized for compact applications, and produces a worst-case ripple voltage at the -24-V output of approximately 200 mV p-p. To reduce this ripple, increase the capacitor values and use low-ESR, through-hole filter capacitors (e.g., the Sanyo MV-GX series). To prevent interference, place the dc-dc converter on a corner of the board opposite the sensitive audio circuitry. Cross-regulation graphs and a tested pc-board layout are available on request from Maxim's applications department. □

SINGLE SOT RESET IC MONITORS 3V/5V, 5V/12V, 5V/24V, . . . SYSTEMS

V_{CC} Undervoltage + Adjustable Undervoltage	V_{CC} Undervoltage + Adjustable Undervoltage + Adjustable Overvoltage	Dual Adjustable Undervoltage
		

- 8µA I_{SUPPLY}
- 4 Timeout Delays: 1/20/140/1120ms
- Factory-Trimmed V_{CC} Reset Thresholds; 2.5V to 5.0V in 100mV Increments
- Guaranteed Reset Valid to V_{CC} = 1V
- Guaranteed Over Temperature
- Immune to Short V_{CC} Transients
- 5-Pin SOT Package

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MAX6306	✔	✔		✔	
MAX6307	✔	✔	✔		
MAX6308		✔			CMOS $\overline{\text{RESET}}$
MAX6309	✔	✔		✔	
MAX6310	✔	✔	✔		
MAX6311		✔			CMOS RESET
MAX6312	✔	✔		✔	
MAX6313	✔	✔	✔		

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READER SERVICE 147

MEETING THE STANDARD

Embedded PC Cards

VAUGHAN WESSON and CAMERON BRICKER, SEISMOLOGY RESEARCH CENTER, RMIT

The PC Card Standard defines the software and hardware aspects of an implementation. In the defined multilevel software architecture, the lowest level is called Socket Services. Above this is Card Services (CS), then the application software. Socket Services and CS are each described in the standard. Other pieces of the PC Card software include the Metaformat Specification, which describes the implementation of the Card Information Structure (CIS) on PC Cards; the Media Storage Formats specification, which describes how data is formatted on the cards; the PC Card ATA specification, which details the requirements when implementing ATA-protocol mass-storage devices; and the XIP specification, which describes a method of directly executing code from a PC Card.

Because the software described here was written in C++, each of the Socket and Card Services was implemented as a class. The CS implementation also employed other classes to represent things such as sockets, cards, and clients. Each service is implemented as a method of the class and contains a variable number of arguments rather than a fixed structure.

The code is run under a real-time multitasking operating system. Generally, each client is a separate task that calls methods of the CS. These methods run as part of the client task. Card Services also has its own task that executes the event-handling code in response to status changes.

Socket Services provide a hardware-independent set of services to the higher software layers. All hardware dependencies should be contained in the Socket Services layer.

Card Services is more complex than Socket Services. It manages access to a number of resources, and also performs callbacks to client code. Client handling covers the methods to add, remove, and search for clients. Each client is represented as an instance of the client class and a number of linked lists help keep track of the existing clients. Configuration methods include registering and deregistering clients, requesting and releasing exclusive use of resources, and generally modifying configurations.

The event handling code is what copes with status-change events. The three events that can trigger the CS task are a time expiration, a card-status change, and a client request to perform an operation. A group of routines return information about the CS itself, as well as about clients, configuration information, or general status. Another group of methods relate to requesting and releasing access to I/O, interrupt, and window resources. Again, a linked list of window objects helps manage these requests.

A group of routines is supplied to access the PC Cards' memory. These provide open, close, read, write, and copy routines that are typically used by higher level device-driver code. These routines must be aware of the memory type installed in the card and use the appropriate Memory Technology Driver (MTD) to perform the memory access.

Finally, there's a series of methods related to tuple handling. The basic routines traverse the tuple chain, searching for particular tuples. Higher level routines find the partition and region information and verify a tuple chain's validity.

Clients can register to be notified by Card Services when certain events occur. The notification is performed by a callback to the client's code. Most of the events correspond to status changes on the cards. Other events are reported on card insertion and removal.

The callback is performed as a normal function call to the address obtained upon client registration. In a multitasking environment, it is executed as part of the CS task, not the task that the client belongs to.

MTDs are used by Card Services to access memory devices on the PC Cards, assuming that an MTD will be provided for each type of memory to be encountered. All implementations must provide an MTD for SRAM devices. Other MTDs are provided for bulk-flash devices and ATA interface cards. For flash cards, the device-read portion uses the standard SRAM read routines, but the write and erase portions are specific to the types of supported flash memory. For ATA-based cards, read and write are performed a block at a time.

An enabler is a piece of code that understands how to configure a specific family of PC Cards, and is implemented as a CS client that is notified when a new card is inserted. The enabler determines whether the card is controllable. If it is, the enabler configures the card, and in a system-specific manner, notifies the system that the new device is available.

The Metaformat specification outlines the various tuples (and their formats) used within a CIS. A number of them relate to memory cards that describe items like the geometry of the memory devices (its width and the block size of flash devices), the data-recording format, and the file system employed (if any).

A DOS-compatible file system is provided on most memory-based cards. For SRAM- and ATA-based cards, this is reasonably simple to implement. Flash cards have two options: Use a flash transition layer (FTL) to map block-read and -write requests to operations on the underlying flash devices; or use an alternative file system suited to flash devices.

fined signal, PIPE#, is used for AGP read and write requests, similar to how FRAME# is used during the PCI address phase. The AD and C/BE# buses carry address and command information in the AGP request phase, and data- and byte-enable in the AGP data phase. The maximum AGP pipeline depth is determined at configuration time by the AGP master and target.

AGP bus accesses are handled as 32-bit memory reads and writes. AGP memory addresses are always aligned on Q-word boundaries. The length of an AGP access is defined by the AD bus' three LSBs during the AGP request phase. The remaining 29 bits point to the memory address in the Q-word. The C/BE# bus in the request phase contains the bus commands, including Read and Write, high-priority Read and Write, long Read, long high-priority Read, Flush, and Fence. The high-priority accesses (Read and Write) are the same as the low-priority accesses except that high-priority transfers must be done within the maximum latency window. The long Read is the same as Read except that its length is four times longer than a normal read.

Flush, which is used for synchronization, ensures that the AGP master's transactions are visible to the system. When the Flush command is executed, the master issues a synchronization event, such as requesting an interrupt or setting a flag. Flush occupies one slot in the AGP pipeline. Fence creates a boundary in an AGP access stream to prevent a write-pass-read from occurring.

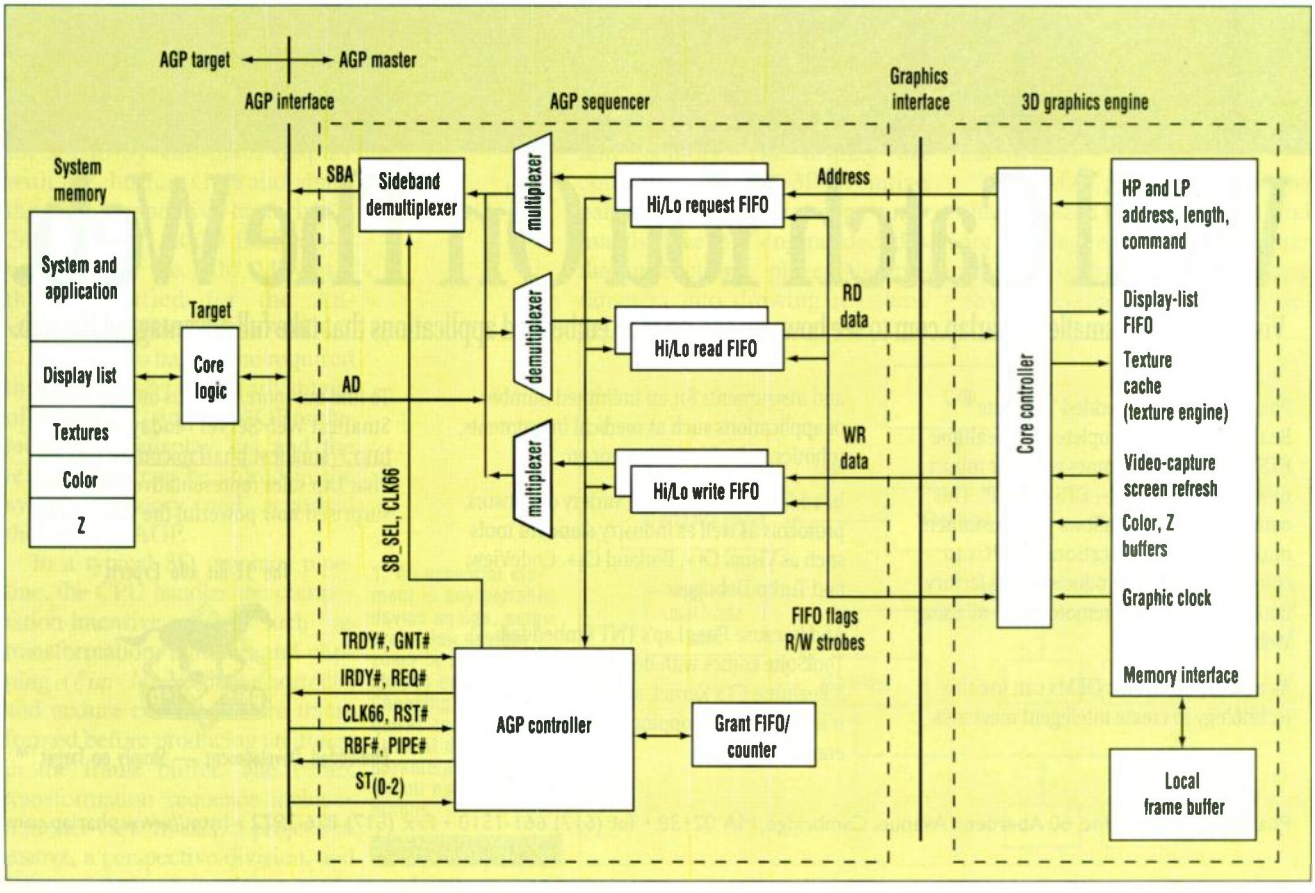
The AGP request and the associated data may be disconnected by other AGP operations. For example, the AGP master can send the second request before it receives the first requested data. Ordering rule should be followed by AGP accesses to ensure that the requesters get the correct data.

The four ordering rules apply only to AGP transactions within the same priority (low or high). Rule One: Read data returned from the target is in the same order as read requests initiated by the master. Rule Two: The target processes the write operations in the same order as write requests initiated by the master. Rule Three: An AGP write access may bypass previously generated AGP read accesses. Rule Four: Data returned for an AGP read request is coherent with previous write requests by the master.

For example, in the master request queue sequence of "Write A, Write B, Read C, Write D, Read E," where they all access the same address, the final data in that location is written by Write D (Rule Two). The data returned from Read E is what is written by Write D (Rule Four). The data returned for Read C may be what was written by Write B or Write D, if Write D bypasses Read C (Rule 3).

The data returned for Read C is ahead of the data from Read E (Rule 1). If avoiding write-pass-read is required, it may be disabled by using the Fence command via the master, or prevented by delaying the next write request until all previous read data is returned. Write-pass-read is useful in taking full advantage of the AGP's deep pipeline because the write data isn't delayed to queue into the

2. For a charger/adapter in the typical mobile device, TVS diodes connected between the signal line and ground serve as parallel protection elements. In this case, as the transient voltage rises above the operating voltage of the device, the TVS becomes a low-impedance path to divert the transient to ground.



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READER SERVICE 188

PCI LOCAL BUS

pipeline by read transactions which may have long latency.

Unlike PCI, the AGP flow control is based on "blocks of data" instead of individual data. There are two kinds of blocks: initial and subsequent. Transactions with 32-byte or less data have only initial blocks, while those with more than 32 bytes contain both initial and subsequent blocks.

Both the master and the target can throttle the read transaction by inserting wait states after each transferred 32-byte block. A throttle point (TP) is defined as two clocks prior to the start of next subsequent block's transfer. There's one throttle point for every 32 bytes. If the TRDY# and IRDY# signals are asserted by the target and master, respectively, at the throttle point, the subsequent block is transferred without delay. Otherwise, wait states are inserted between the previous block and the subsequent block. TRDY# and IRDY# are meaningless if they occur between throttle points. For write transactions, the master can't throttle the transaction because the master knows the size of the data transfer. Only a target can throttle the write transaction by controlling the TRDY# signal at the throttle point.

The AGP specification states that there are two exclusive methods to enqueue AGP requests. The master must use either the AD and C/BE# buses or sideband (SBA) signals. The specific method used by both the AGP master and target is determined during system initialization. For the AD bus transaction, the AGP master sends an AGP request to the target through the AD and C/BE# buses.

In order to fully utilize the AD bus, the AGP protocol defines optional sideband signals SBA_{0-7} to de-multiplex address pins from data pins. The AD pins can't be used to send requests to the target in sideband transfer mode. However, data can be transferred on the AD bus. AGP requests are transferred on the SBA bus only.

The sideband address port only has 8 pins. Consequently, an AGP request must divided into three portions: low-order address bits and transfer lengths, mid-order address bits and commands, and high-order address bits. The last two portions are loaded into two registers and updated only when changed from the previously request. When data is highly localized, only low address bits change and need to be transferred, minimizing the traffic on the SBA. The master doesn't transfer the high-order address and command each time, instead, each portion is transferred through a separate SBA operation.

The SBA operations transfer 16-bit data in two 8-bit phases. Two clocks are required to transfer one SBA operation in standard clock mode, and one clock in 2X mode. System-memory accesses are enqueued only when the master issues a low-order address portion. There's no restriction on the relative ordering of three SBA operations.

The 3D engine uses system memory for all three-dimensional data storage *(Fig. 2)*. Several 3D graphic operations run through the AGP interface. The engine reads the display list through the AGP bus, processes the data, then generates texture_read, Z_read (if Z is enabled), and color_read (if blending is enabled) requests to read texture, Z, and color data from system memory. After processing, the data is returned to system memory.

The target device can read status and read-write configuration registers inside the engine with PCI-only bus transactions. Traffic on the AGP can be a mix of interleaved AGP and PCI transactions.

T. Chan, Director of Engineering, holds a PhD from the University of Arizona, Tucson, Ariz. Jim Soong, a Design Manager, holds an MSEE degree from Arizona State University, Tempe, Ariz. Hong Jun Shu, a Design Engineer, holds an MSEE degree from Rensselaer Polytechnic Institute, Troy, N.Y.

▼ TOUCHSCREEN WORKS THROUGH 1 IN. OF GLASS

Touchscreens can be used in completely new applications thanks to a new product from MicroTouch Systems. The ThruGlass is a touchscreen capable of sensing a touch through 1 in. of glass, such as a store window. It also works through plastic or any other non-conductive material. The ThruGlass touchscreen mounts to the inside of the window in front of a display, and operates like a traditional touchscreen. Users simply touch the window glass to interact with the system. The device is based on a projected-capacitive technology that projects a low-voltage field through the window glass. When the user touches the window, minute changes in the field are detected. ThruGlass supplies a resolution of 1024 by 1024 touch points and is sensitive enough to operate when the user is wearing gloves. The current model fits a 17-in. display. Other sizes will be available shortly. It ships with all the necessary software drivers. A single unit sells for $995. Large-quantity discounts are available.

MicroTouch Systems Inc.
300 Griffin Brook Park Dr.
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(508) 659-9000
▶ **CIRCLE 592**

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Embedded applications requiring the power of a 486 microprocessor can take advantage of the Biscuit PC Series. The boards are built with integrated PCI and an enhanced IDE hard-disk-drive interface, as well as a Super VGA-flat-panel controller or Ethernet. Suitable applications include medical computing devices, point-of-sales terminals, or industrial machinery. Measuring 4 by 5.7 in., the Biscuits OCs include dual serial ports, a multimode parallel port, four-channel digital I/O, and connectors for a keyboard and mouse. Expansion is handled using a PC/104 interface. Based on the PC/AT architecture, the boards are compatible with off-the-shelf software. Power-saving modes are supported for peripheral devices. Prices start at $166.

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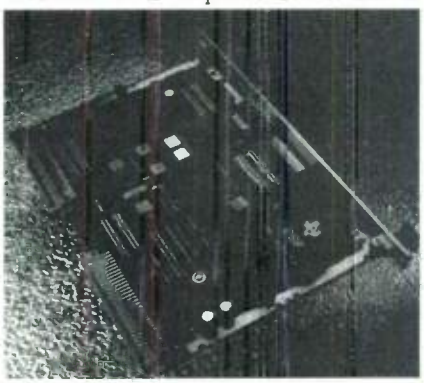
Zilog Inc.
210 E. Hacienda Ave.
Campbell, CA 95008
(408) 370-8056
▶ **CIRCLE 594**

▼ VME BOARD HANDLES IMAGE AND GRAPHICS ROCESSING

Three or four current boards can be replaced by the Eclipse, a VMEbus-based graphics- and image-processing board. The board combines a TI TMS320C80 DSP processor with four



32-bit parallel Advance Digital Signal Processors (ADSPs), all connected through a 4.2-Gbyte/s multiport crossbar switch. The end result is a performance level of 2 BOPS. The Eclipse board gains flexibility by employing a multimaster VXbus, for high-speed video expansion. The 64-bit bus connects to the on-board graphics output channel and two mezzanine daughtercards. The on-board video display channel has 4 Mbytes of VRAM, controlled by a TI TVP3026 video interface palette. Display length can be programmed for 8-bit indexed, 15-, 16-, or 24-bit true-color operation. Video outputs conform to RS343A, RS170, or STANAG 3350, with either synchronous on green, separate synchronizations, or a composite synchronization. The board operates with industry standard software tools and operating environments. Available now, prices for the Eclipse graphics- and image-processing board start at $12,480.

Radstone Technology Corp.
50 Craig Rd.
Montvale, NJ 07645
(800) 368-2738 or
(201) 391-2700
▶ CIRCLE 595

▼ EMBEDDED MOUSE SUITS INDUSTRIAL APPLICATIONS

OEMs can easily evaluate the HulaPont, touted as "a joystick for your finger." A kit is available for designers that includes all the required electronics, cables, documentation, and a software driver. A set of removable switches and buttons is included for testing purposes. The electronics consists of a sensor, the MouseCoder ASIC, and a compact pc board. The sensor offers 10 degrees of movement for positive motion control. According to the company, the sensor never wears out, making it suitable for industrial applications. The software driver was developed such that the harder the sensor is pressed, the faster the cursor will move. This permits users to make small, precise movements. PC-based two- and three-button protocols are supported. A Sun-compatible version also is available. The HulaPoint evaluation kit sells for $150.

USAR Systems Inc.
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New York, NY 10012
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▶ CIRCLE 596

SYSTEM DESIGN PRODUCTS

▼ DEVELOP IMAGE-PROCESSING ALGORITHMS

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American Eltec Inc.
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Princeton, NJ 08540
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▶ **CIRCLE 597**

▼ SBC CLAIMS LONG-TERM AVAILABILITY

One of the key advantages of the EPC-30 single-board computer is its long-term availability. Users typically employ such boards for many years, and in most cases, when they want to add boards to a system or replace defective units later, they find that the board is no longer in production, has been replaced by a higher cost alternative, or hasn't been replaced at all. That won't happen with the EPC-30, according to its developers. The board is based on a 25-MHz Intel 386EX microprocessor that has interfaces to the ISA bus and PC/104. The board also is built with the R380EX embedded system controller, a single-chip ISA bus controller that supplies a glueless I/O interface, as well as a DRAM controller, a keyboard-mouse controller, a real-time clock, an enhanced IDE interface, and power-management features. Other features include up to 20 Mbytes of DRAM and 4 Mbytes of flash memory. Available now, the EPC-30 sells for $531 each in lots of 100.

RadiSys Corp.
15025 S.W. Koll Pkwy.
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(503) 646-1800
▶ **CIRCLE 598**

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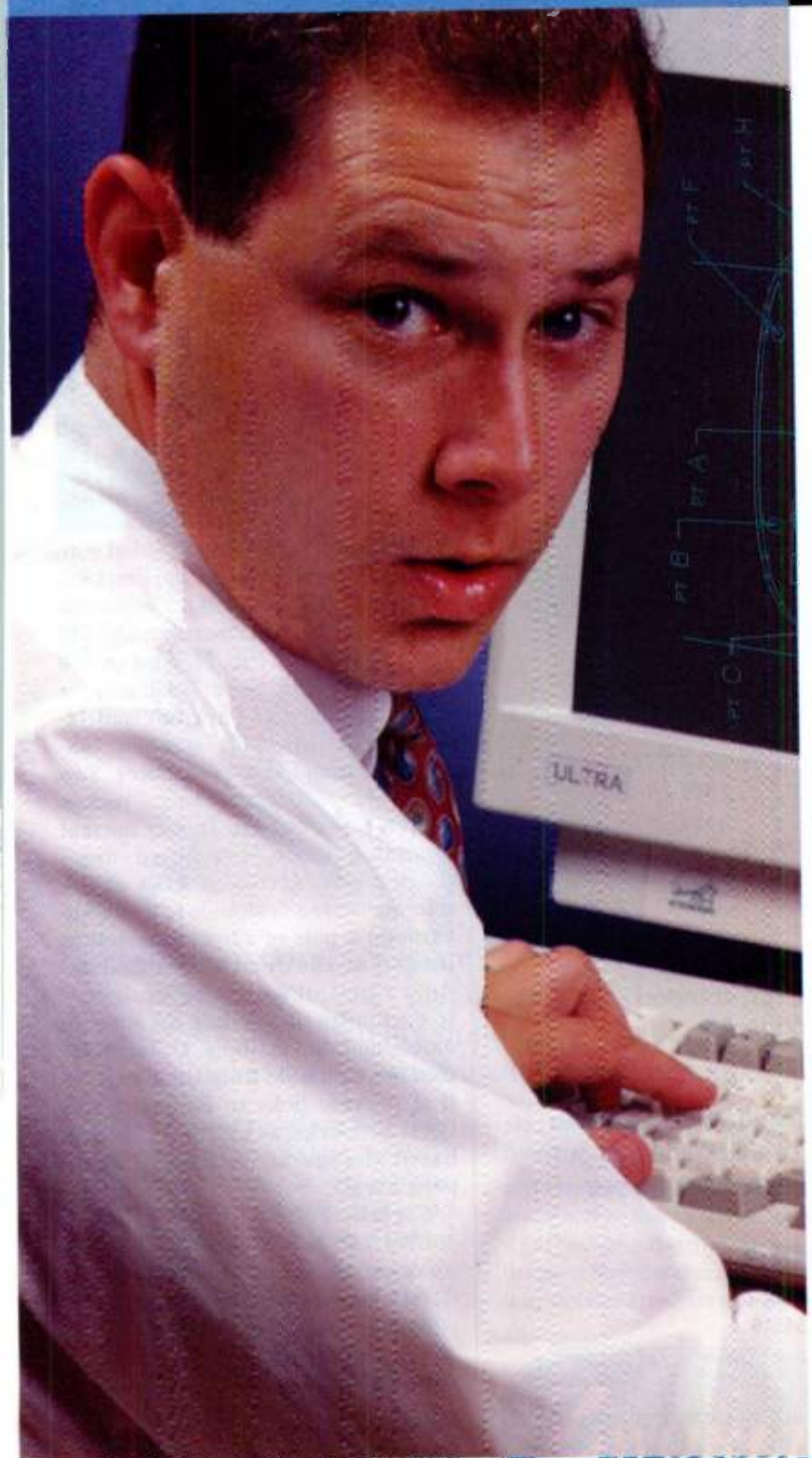
We've had our second field failure this week."



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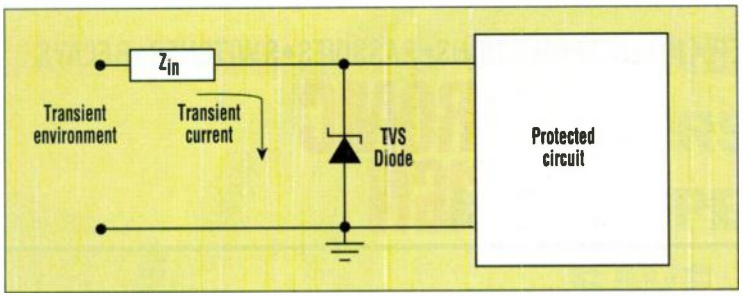
SURGE PROTECTION



1. An essential element in any portable device design, surge protection devices come in many shapes and forms. Choosing one requires careful evaluation of device parameters against circuit operating conditions.

uncommon for a person to develop voltages as high as 15 kV. If the discharge path includes semiconductor-based equipment, catastrophic or latent damage may occur.

Inductive switching: If the current flow through an inductive load is interrupted, a voltage is induced by the collapse of the magnetic field. This voltage is defined by Faraday's law of induction:

$$V = -N d\phi/dt$$

where V = Voltage (in volts), N = the number of turns in the winding, and $d\phi/dt$ = the change in the magnetic flux per unit time.

An inductive switching transient occurs when a reactive load, such as a motor or relay, is turned off. This may be due to the normal opening and closing of a switch or to a total power failure. The result is usually a high-power impulse for a very short period of time, which can produce a catastrophic or latent failure within an IC.

Lightning, ESD, and inductive-load switching all can produce electrical transient pulses characterized by high dv/dt that may cause electronic component and system failures. For example, in the case of an ESD pulse, although it contains little energy, the extremely fast rise time and high overvoltage can cause catastrophic destruction of semiconductor components resulting from arcing or heating. Arcing occurs as a result of the high static potential of ESD. Consequently, in MOS circuits, an electrostatic potential can punch a hole through the oxide layer and destroy the high-speed input-gate structure.

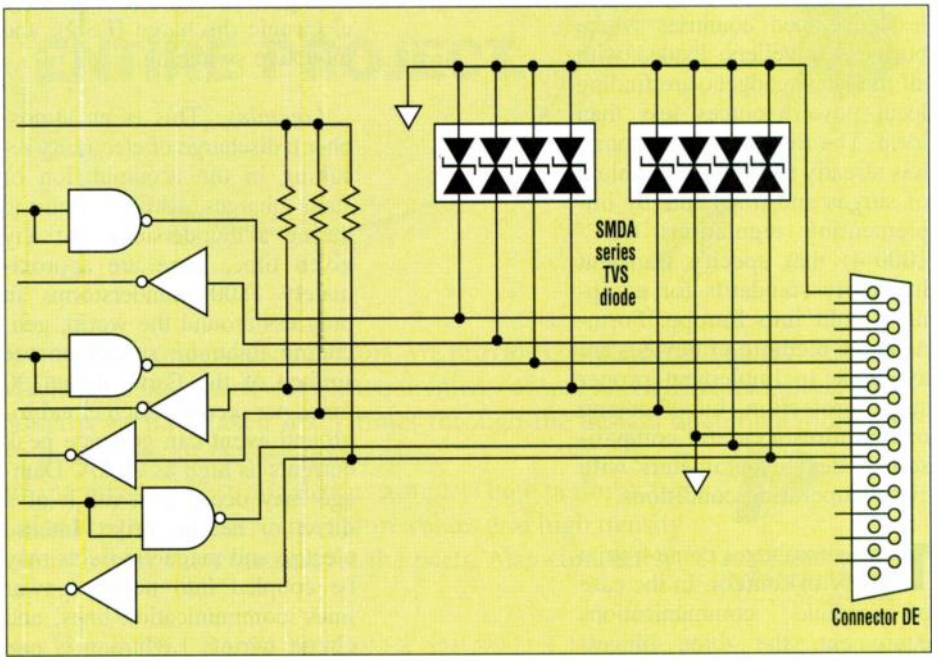
Once the dielectric field strength has been reached, overheating and destruction occur when even small amounts of energy are dissipated through the oxide layer. The failure level of bipolar and CMOS ICs is generally less than 2000 V. In these instances, ESD damage can lead to immediate or subsequent failures that are not always catastrophic. These may show up as hard-to-find intermittent software bugs, signal timing errors, or random memory errors.

Clearly, the exact magnitude of a transient voltage depends upon several factors. As a result, designers will have to consider the different types of protection levels required to ensure the correct protection device for the appropriate conditions and applications.

In the case of mobile communications, the main protection requirements will be at the board level. Here, transient voltages generally range from tens to thousands of volts with currents usually in the tens to hundreds of amperes. With the industry's transition from ICs operating at 5 V to sub 3 V, the possibility of damage to these new ICs is significantly increased. This is partially due to this new generation of ICs having smaller geometries such as metal lines, gate widths, and oxides, that are less able to absorb energy. In addition, lower operating voltages mean greater susceptibility to even the smallest of spikes. In the mobile world, the proliferation of sub 3-V systems is well under way, driven primarily by the need to have longer field operation from a single set of batteries.

2. For a charger/adapter in the typical mobile device, TVS diodes connected between the signal line and ground serve as parallel protection elements. In this case, as the transient voltage rises above the operating voltage of the device, the TVS becomes a low-impedance path to divert the transient to ground.

Standards for surge protection, apart from Europe's IEC-1000-4 (formerly IEC-801), are in existence to ensure transient immunity. These include Bellcore 1089, FCC Part 68, and ITU K.17-K.20. Unlike the other standards, IEC-1000-4 applies to any electronic/electrical product. In effect since the beginning of this year, the standard is enforced and policed by the manufacturers and users within the European Community. Noncompliance is not tolerated. Penalties for violation include large fines and possible prison terms for senior



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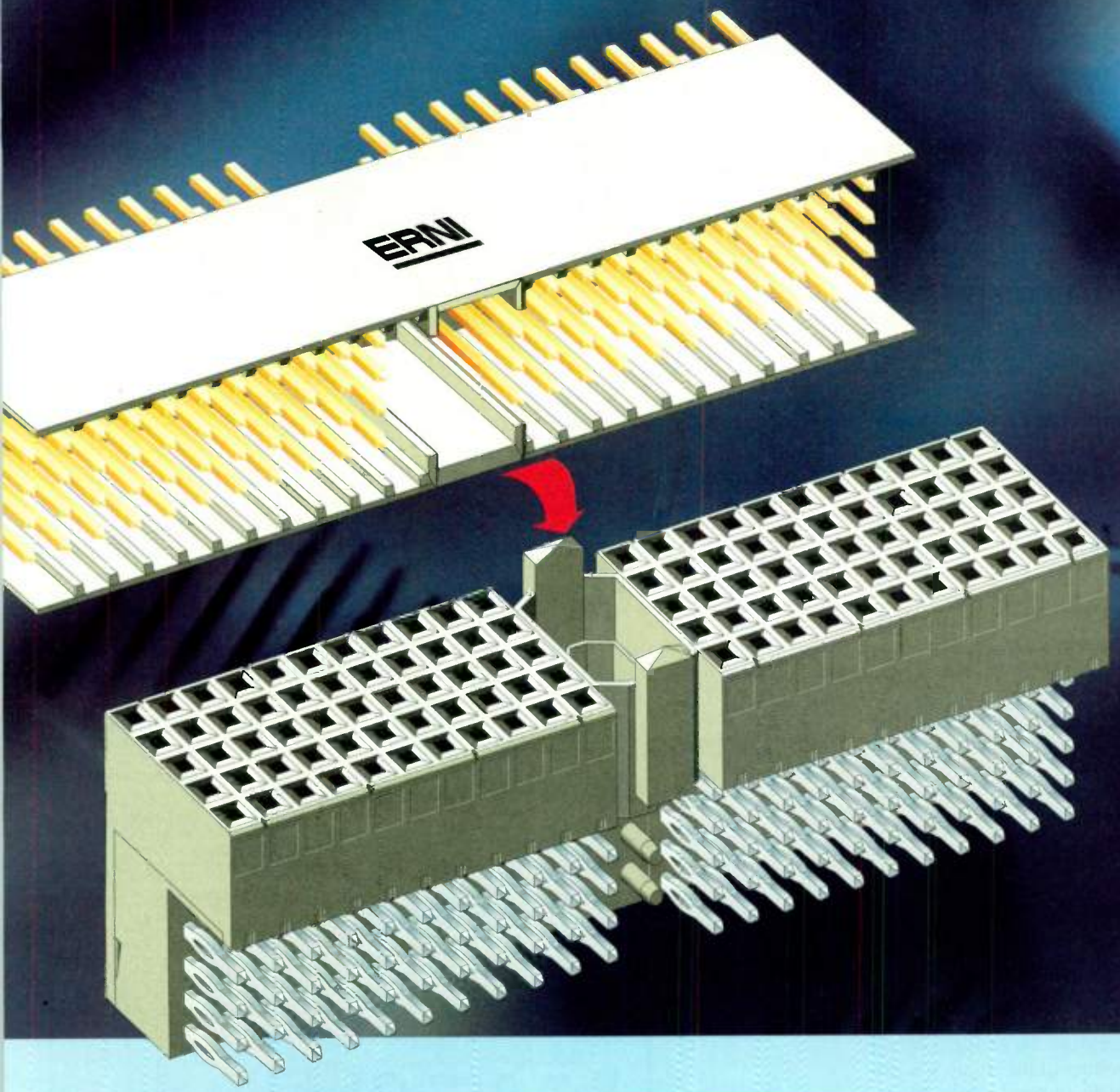

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company executives in companies that fraudulently claim compliance.

IEC-1000-4 is divided into six parts. Part one is a general introduction, while three of the remaining five parts deal with overvoltages caused by transients and are titled:

- IEC-1000-4-2: Electrostatic Discharge (ESD).
- IEC-1000-4-4: Electrical Fast Transient/Burst (EFT).
- IEC-1000-4-5: Surge Immunity.

In the case of portable equipment, the two most applicable standards are IEC-1000-4-2 and 1000-4-4. IEC-1000-4-2 defines immunity requirements for ESD that can be coupled into the equipment directly or through radiation. Direct coupling includes any user-accessible entry points such as I/O ports, switches, computer keyboards, panel displays, and equipment housings. Radiated coupling results from the discharge between two bodies that are external to the system.

IEC-1000-4-4 specifies the EFT threat in both power and data lines. EFTs occur as a result of arcing contacts in switches and relays, and are common in environments where electromechanical switches are used to connect and disconnect inductive loads. Further reading on this standard is recommended.

Designing a system with appropriate protection involves a comparison of device parameters with circuit operating conditions. Choose a device family whose stand-off voltage is equal to, or greater than, the nominal operating voltage of the circuit it is supposed to protect. Next, select a device capable of dissipating the expected transient peak pulse current. The device clamping voltage should be less than the maximum clamping voltage handling capability of the IC for the same pulse waveform. Also, anything connected to a high-speed data line, such as fiber distributed data interface (FDDI) and asynchronous transfer-mode (ATM), must have very low capacitance to ground. High loading capacitance can cause rounded edges on the data signals and cloud the transition between logical 1 and 0. Further, propagation delays due to any parasitic capacitance can run 25 ps/pF, dictating the need for a device with a very low capacitance value.

COMPARISON OF SUPPRESSION DEVICES

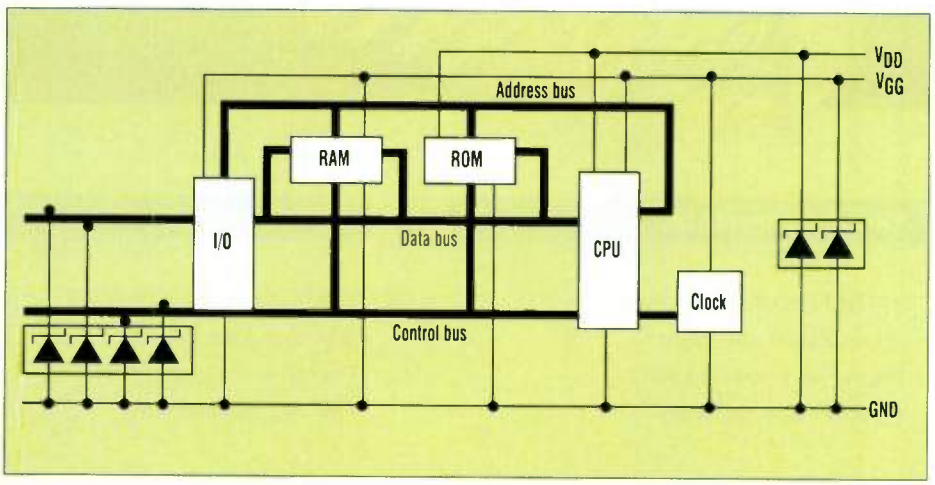
Suppression Element	Advantages	Disadvantages	Expected Life
Gas Tube	• Very high current-handling capability • Low capacitance • High insulation resistance	• Very high firing voltage • Finite life cycle • Slow response times • Non restoring under dc	Limited
MOV	• High current-handling capability • Broad current spectrum • Broad voltage spectrum	• Gradual degradation • High clamping voltage • High capacitance	Degrades
TVS Diode	• Low clamping voltage • Does not degrade • Broad voltage spectrum • Extremely fast response time	• Limited surge current rating • High capacitance for low voltage types	Long
TVS Thyristor	• Does not degrade • Fast response time • High current-handling capability	• Non restoring under dc • Narrow voltage range • Turn-off delay time	Long

In a typical application of mobile communications equipment, all I/O ports, including SCSI, modem, serial, and parallel ports, must take voltage transients without a failure. Several types of devices are available for transient protection and care must be taken when deciding which device to use. An ill-chosen device will not only be ineffective, but can interfere with the normal operation of the circuit.

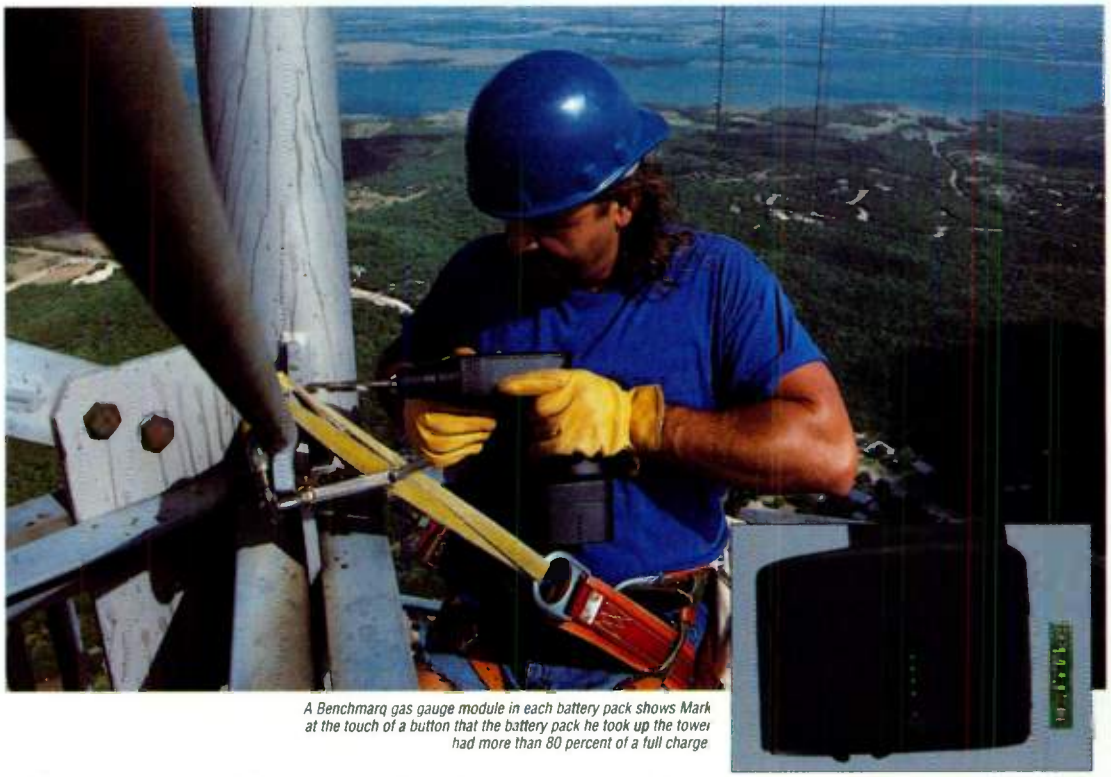
3. In situations where noise, as well as transient voltages, can be coupled (i.e., an EIA(RS)-232 interface), protection could comprise of two TVS diode arrays, each with multiple discrete chips that are electrically independent of each other.

In addition, the move into sub-3-V portable systems has resulted in the power supply being pulled down for lower power dissipation and higher efficiency. Unfortunately, most of today's protection devices are quite inefficient due to high reverse leakage current at below 5 V. In general, for the suppression of transients in mobile equipment, the protection device must provide the following:

- Extremely fast response time
- Low clamping and operating voltages commensurate with system voltages
- Capacity to handle high peak transient currents
- Ability to remain undamaged by repetitive transient strikes



Benchmarq makes the module that displays the charge that's in the battery that runs the drill...



A Benchmarq gas gauge module in each battery pack shows Mark at the touch of a button that the battery pack he took up the tower had more than 80 percent of a full charge.

that Mark carried 1,500 feet up the tower.

Thanks to the Benchmarq battery gas gauge designed into Mark's drill, Mark can finish his job with confidence, knowing his drill won t run out of power before the work is complete. Smart battery technology helps sell products. And Benchmarq makes it easy for you to make your battery packs intelligent.

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Gas Gauge IC/Module Selection Guide

16-Pin IC Part No.	Description	Battery Technology	Module Part No.
bq2010	Gas Gauge IC	NiMH and NiCd	bq2110, bq2110L
bq2011/J	Gas Gauge IC for Power Tools	NiMH and NiCd	bq2111L
bq2012	Gas Gauge IC	NiMH and NiCd	bq2112, bq2112L
bq2014	Gas Gauge IC with Ext. Charge Control	NiMH and NiCd	bq2114, bq2114L, bq2164
bq2050	Power Gauge™ IC	Li-Ion	bq2150, bq2150L, bq2165
bq2090	SMBus v.95 Gas Gauge IC	NiMH, NiCd, Li-Ion	bq2190L

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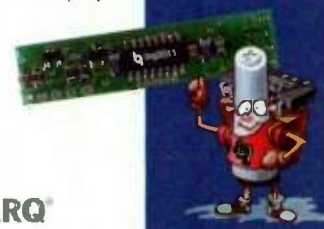

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**Study conducted by Usability Sciences Corp. May 9-July 9, 1996. For complete study results see www.visio.com/usability.

- Minimal size
- Minimal reverse leakage current

A number of technologies are available to satisfy these requirements. These include gas tube, MOV, TVS diode, and TVS thyristor devices. Each has their own advantages and disadvantages. A summary of the types of devices is described, along with each device's advantages and disadvantages *(Table 1)*.

From the table, it is clear that the most appropriate type of device for the protection of portable or handheld equipment from ESD is the TVS (transient-voltage suppressor) diode. It has low operating and clamping voltages, no wear-out factor, and has an extremely fast response time to adequately cope with the rise-time speed of the ESD waveform (defined by IEC-1000-4-2 as 0.7 to 1.0 ns).

Theoretically, there are three failure modes for a typical sub-5-V mobile system: The charge/adapter malfunctions due to an ac-line transient; data corruption occurs due to an electrostatic discharge on the signal; or a software error occurs, freezing the operating system (the cause for this failure could be the absence of TVS protection across the microprocessor, I/O chips, and cache memory).

In each of these circumstances, the inclusion of a TVS diode into the system design, could have prevented these failure mechanisms from occurring. In the case of the charger/adapter, a circuit is shown that illustrates how to protect such a system from a transient entering the unit from an ac line *(Fig. 1)*.

In the case of data lines, TVS diodes connected between the signal line and ground serve as parallel protection elements. As the transient voltage rises above the operating voltage of the device, the TVS becomes a low-impedance path to divert the transient to ground.

For example, the EIA(RS)-232 interface assembly consists of two TVS diode arrays, each with multiple discrete chips that are electrically independent of each other, an important feature on data lines, where noise, as well as transient voltages, can be coupled *(Fig. 2)*.

This same technique can be used for a high-speed data line, such as an RS-485. However, devices with low capacitance must be used in order to maintain signal integrity at high speeds.

Finally, an approach is illustrated to protect the CPU and I/O chips from potential harmful transients coming into the system from the power, or data lines *(Fig. 3)*. The best strategy for dealing with these, or any transient event, is to divert the transient current away from the sensitive semiconductor components. In this illustration, there is separate protection for the signal interfaces and the power bus. □

For further reading:

Boxleitner, Warren, *Electrostatic Discharge and Electronic Equipment*, IEEE Press, 1989.

IEC Publication 801-2, "Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 2: Electrostatic Discharge Requirements." International Electrotechnical Commission, April 1991.

Russell, William, "Defuse the Threat of ESD Damage," *Electronic Design*, March 6, 1995; p.115.

Squires, Carl, "Protecting Microprocessor-Based Equipment from EMI and ESD," *I&CS*, September 1995.

Goodenough, Frank, "Novel Diode Protects Low-Voltage Lines from ESD," *Electronic Design*, Oct. 13, 1995; p.69.

Russell, William, "Transient Protection for Data and I/O Interfaces," Applications Note from Semtech's TVS data book, October 1996.

HOW VALUABLE?

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MANUFACTURERS OF BATTERY-CHARGING ICs

Manufacturer	Part number	Chemistry	Charge-termination method	Safety-termination method	Maintenance-charge mode	Charge-status indication	On-chip current or voltage regulation	Fast-charge while operating	Package types and sizes
BTI Graz, Austria http://www.wpobmt.tv-graz.ac.at CIRCLE 643	CCS 9310	NiCd, NiMH, NiFe, lead acid, Li-Ion	Impedance	Over voltage	Intelligent recharge	LED, audible alarm	No	Yes	18-pin DIP and SOIC, 20-pin SSOP
	CCS 9410	NiCd, NiMH, NiFe, lead acid, Li-Ion	Impedance	Over voltage	Intelligent recharge	LED, audible alarm, serial data out	No	Yes	18-pin DIP and SOIC, 20-pin SSOP
	CCS 9505	NiCd, NiMH, NiFe, lead acid, Li-Ion	Impedance	Over voltage	Intelligent recharge	LED, audible alarm, serial data out	No	Yes	18-pin DIP and SOIC, 20-pin SSOP
	CCS 9620	NiCd, NiMH, NiFe, lead acid, Li-Ion	Impedance	Over voltage	Intelligent recharge	LED, audible alarm, serial data out	No	Yes	18-pin DIP and SOIC, 20-pin SSOP
	CCS 9630	NiCd, NiMH, NiFe, lead acid, Li-Ion	Impedance	Over voltage	Intelligent recharge	LED, audible alarm	No	Yes	18-pin DIP and SOIC, 20-pin SSOP
	CCS 9633	NiCd, NiMH, NiFe, lead acid, Li-Ion	Impedance	Over voltage	Intelligent recharge	LED, audible alarm	No	Yes	18-pin DIP and SOIC, 20-pin SSOP
Benchmarq Microelectronics Inc. Dallas, Texas 214-437-9195 http://www.benchmarq.com CIRCLE 644	bq 2002	NiCd, NiMH	-ΔV, PVD	Max temp, max time	Selectable pulse trickle charge rates	1 LED	No	No	8-pin DIP, SOIC
	bq 2002T	NiCd, NiMH	ΔT/Δt	Max temp, max time	Selectable pulse trickle charge rates	1 LED	No	Yes	8-pin DIP, SOIC
	bq 2003	NiCd, NiMH	ΔT/Δt, -ΔV	Max temp, max time, max voltage	Pulsed top-off charge, trickle with external resistor	1 or 2 LEDs	Yes	Yes	16-pin DIP, SOIC
	bq 2004	NiCd, NiMH	PVD, ΔT/Δt, -ΔV	Max temp, max time, max voltage	Pulsed top-off charge, configurable pulsed trickle charge	1 or 2 LEDs	Yes	Yes	16-pin DIP, SOIC
	bq 2004E	NiCd, NiMH, Li-Ion	PVD, ΔT/Δt, -ΔV	Max temp, max time, max voltage	Pulsed top-off charge, configurable pulsed trickle charge	1 or 2 LEDs	Yes	Yes	16-pin DIP, SOIC
	bq 2005	NiCd, NiMH	ΔT/Δt, -ΔV	Max temp, max time, max voltage	Pulsed top-off charge, configurable pulsed trickle charge	2 to 4 LEDs	Yes	Yes	20-pin DIP, SOIC
	bq2007	NiCd, NiMH	PVD, -ΔV	Max temp, max time, max voltage	Configurable pulsed trickle charge, pulsed top-off charge	1 to 8 LEDs, single BCD digit, audible alarm, 7-segment bargraph	Yes	No	24-pin DIP, SOIC
	bq 2031	Lead acid	Δ^2V	Max and min temp, max time	Float charge, pulsed trickle charge	1 to 3 LEDs	Yes	Yes	16-pin DIP, SOIC
	bq 2054	Li-Ion	Minimum current	Max time, max and min temp, max voltage	No	1 to 3 LEDs	Yes	Yes	16-pin DIP, SOIC
	bq 2902	Rechargeable alkaline	PVD	None	No	1 LED	No	No	8-pin DIP, SOIC
	bq 2903	Rechargeable alkaline	PVD	None	No	2 LEDs	No	No	14-pin DIP, SOIC

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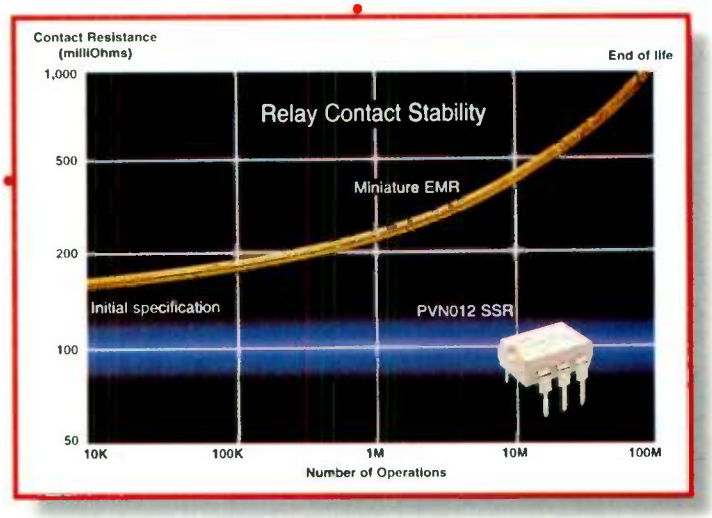

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MANUFACTURERS OF BATTERY-CHARGING ICs

Manufacturer	Part number	Chemistry	Charge-termination method	Safety-termination method	Maintenance-charge mode	Charge-status indication	On-chip current or voltage regulation	Fast-charge while operating	Package types and sizes
Dallas Semiconductor **Dallas, TX** **972-371-4448** **http://www.dalsemi.com** **CIRCLE 645**	DS1633	NiCd, NiMH, lead acid	Peak voltage and/or timer	Timer	Trickle charge after peak voltage and/or max time	None	No	Yes	3-pin TO-220
Integrated Circuit Systems Inc. **Valley Forge, PA** **610-630-5300** **http://www.icsinc.com** **CIRCLE 646**	ICS1712	NiCd, NiMH	After inflection, before peak voltage: $\Delta V/\Delta t(max)$-Δ^2V/Δ^2t, $\Delta T/\Delta t$	Peak voltage, -ΔV, temp, timer, max voltage	Top off and trickle	LED	No	Yes	16-pin DIP, 20-pin SOIC
	ICS1702	NiCd, NiMH	After inflection, before peakvoltage: $\Delta V/\Delta t(max)$-Δ^2V/Δ^2t, $\Delta T/\Delta t$	Peak voltage, -ΔV, temp, timer, max voltage	Top off and trickle	LED	No	Yes	20-pin DIP, 20-pin SOIC
	ICS1700A	NiCd, NiMH	After inflection, before peakvoltage: $\Delta V/\Delta t(max)$-Δ^2V/Δ^2t	Peak voltage, -ΔV, temp, timer, max voltage	Top off and trickle	LED	No	Yes	16-pin DIP, 20-pin SOIC
	ICS1722	NiCd, NiMH	After inflection, before peakvoltage: $\Delta V/\Delta t(max)$-Δ^2V/Δ^2t	Peak voltage, -ΔV, temp, timer, max voltage	Top off and trickle	LED	No	Yes	16-pin DIP, 16-pin SOIC
Linear Technology Corp. **Milpitas, CA** **408-432-1900** **http://www.linear-tech.com** **CIRCLE 647**	LTC1325	NiCd, NiMH, sealed lead acid, Li-Ion	Software programmable for all	Max temp, max cell voltage, min cell voltage	Software-programmable charge current	Microprocessor output	Yes	Yes	16-pin PDIP and SOIC
	LT1513	NiCd, NiMH, sealed lead acid, Li-Ion	Constant voltage with shutdown for external termination	None	Constant voltage	None	Yes	Yes	7-pin DD package
	LT1512	NiCd, NiMH, sealed lead acid, Li-Ion	Constant voltage only	None	Constant voltage	None	Yes	Yes	8-pin SOICand PDIP
	LT1511	NiCd, NiMH, sealed lead acid, Li-Ion	Constant voltage	None	Constant voltage	None	Yes	Yes	24-pin SOIC
	LT1510	NiCd, NiMH, sealed lead acid, Li-Ion	Constant voltage	None	Constant voltage	None	Yes	Yes	8- and 16-pin SOIC
Maxim Integrated Products **Sunnyvale, CA** **408-737-7600** **http://www.maxim-ic.com** **CIRCLE 648**	MAX846	Li-Ion, NiCd, NiMH	1% voltage detection and external controller	None	Fast, top-off, trickle	Controller output	Yes	Yes	16-pin QSOP
	MAX1647	Universal	External controller or smart battery	Thermistor	Selectable by controller or smart battery	SMBus serial interface	Yes	Yes	20-pin SSOP
	MAX1640/1641	NiCd, NiMH, lead acid, Li-Ion	Determined by external controller	Determined by external controller	Fast, top-off, trickle	Controller output	Yes	Yes	16-pin narrow SOIC
	MAX2003A	Universal	$\Delta T/\Delta t$, -ΔV, max voltage	Max temp, max voltage, timeout	Fast, top off, pulsed trickle	LED	Yes	No	16-pin narrow SOIC, wide SOIC, and PDIP
	MAX712/713	NiCd, NiMH	Peak voltage detect, zero $\Delta V/\Delta t$, -$\Delta V/\Delta t$	Max temp, max voltage, timeout	Fast and trickle	LED	Yes	Yes	16-pin narrow SOIC
Microchip Technology Inc. **Chandler, AZ** **602-786-7200** **http://www.microchip.com** **CIRCLE 649**	PIC14000	All	Software programmable for all	Software programmable for all	Software programmable for all	Software programmable for all	Yes	Software-programmable for all	28-pin PDIP, SOIC, SSOP, CERDIP

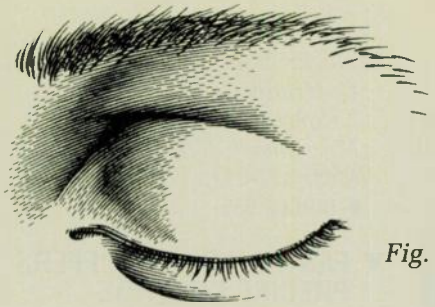


Fig. 1

Ordinary digital scopes are asleep 99.9935% of the time.

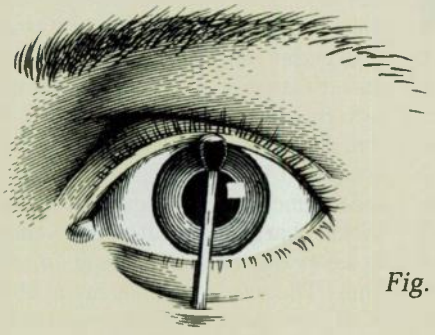
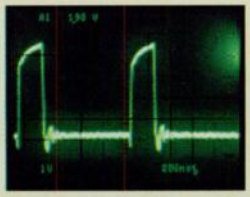


Fig. 2

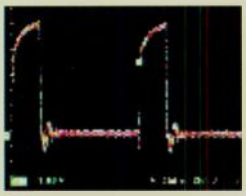
Introducing the Tektronix InstaVu™ family.



Analog

If you think your digital scope is giving you a live, real-time picture of your waveform, it's time to wake up.

Most digital scopes acquire a few hundred waveforms or so a second, missing all the rest. So you could miss an infrequent glitch simply because your scope is "blind" when it happens.



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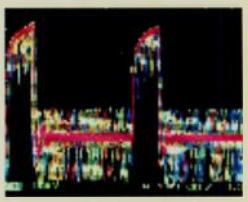
Call 1-800-426-2200 (code 500) for more information on the InstaVu acquisition family, or visit our Web site at www.tek.com. And open your eyes to a new standard in digital oscilloscopes.



InstaVu™

	TDS520B	TDS540B	TDS724A	TDS744A	TDS784A
Bandwidth	500 MHz	500 MHz	500 MHz	500 MHz	1 GHz
Channels	2 + 2	4	2 + 2	4	4
Max. Sample Rate	1 GS/s	2 GS/s	1 GS/s	2 GS/s	4 GS/s
Max. Record Length	250K	500K	250K	500K	500K
Max. Wfm. Acquisition Rate	100,000 Wfm/s	100,000 Wfm/s	180,000 Wfm/s	400,000 Wfm/s	400,000 Wfm/s
Display	Monochrome	Monochrome	Color	Color	Color

Tektronix

READER SERVICE 198

▼ OFF-LINE CHARGER HAS WIDE INPUT RANGE

The UCC3890 off-line battery charging unit has an input range of 100 to 400 Vdc and low-output operation at 1 or 2 W with either constant voltage (down

to 0.8 V) or current. Suitable for trickle-charging single-cell batteries, the device can also drive small electric motors in constant-current mode.

The charger uses a single switch whose on time is varied inversely proportional to input line voltage. The off time is varied inversely porportional to the output voltage. This action is automatically controlled by an internal feedback loop and reference, providing inherent voltage feedforward compensation and output short-circuit protection. A cascaded flyback topology is used, allowing large voltage conversion ratios directly from the rectified ac line. This design requires no transformer and few external components. Pricing is $1.22 ea/1000 with delivery in 10 to 12 weeks. Samples are available now.

Unitrode Corp.
7 Continental Blvd.
Merrimack, NH 03054-4334
(603) 424-2410
▶ **CIRCLE 655**

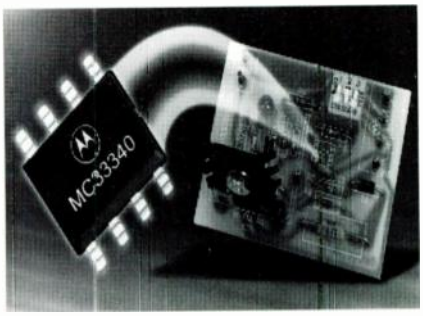
▼ FAST-CHARGE IC OFFERS PRECISE CONTROL

Designed for fast-charge control of NiCd, NiMH, and Li-Ion batteries, the U2407B is offered as the first such device in a small-outline package to combine fast charging with precise overcharge protection using $+d^2V/dt^2$ and -dV gradient detection algorithms. The charger is designed for systems with cycles ranging from 10 to 180 minutes. Features include the ability to detect drained or virgin batteries and charge accordingly, measurement every 20.48 seconds, a plausibility check function for irregularities, and a trickle-charge mode after 100% charge to keep the battery topped up over time. The device comes in a 16-pin SOIC and can run off automotive battery voltages from 8.5 to 24 V. A 16-pin DIP version is also available. Pricing is $1.50 ea/100,000, with delivery in 8 to 12 weeks. Samples are available now.

Temic Semiconductors
2201 Laurelwood Rd.
Santa Clara, CA 95056-0951
(408) 567-8220
▶ **CIRCLE 656**

▼ CHARGER IC PROVIDES HIGH ACCURACY

The MC33340 is a monolithic control IC for fast charging NiMH and NiCd batteries. The device features negative-slope voltage detection as the primary means for fast-charge termination and ensures accuracy with an output that momentarily interrupts the charge cur-

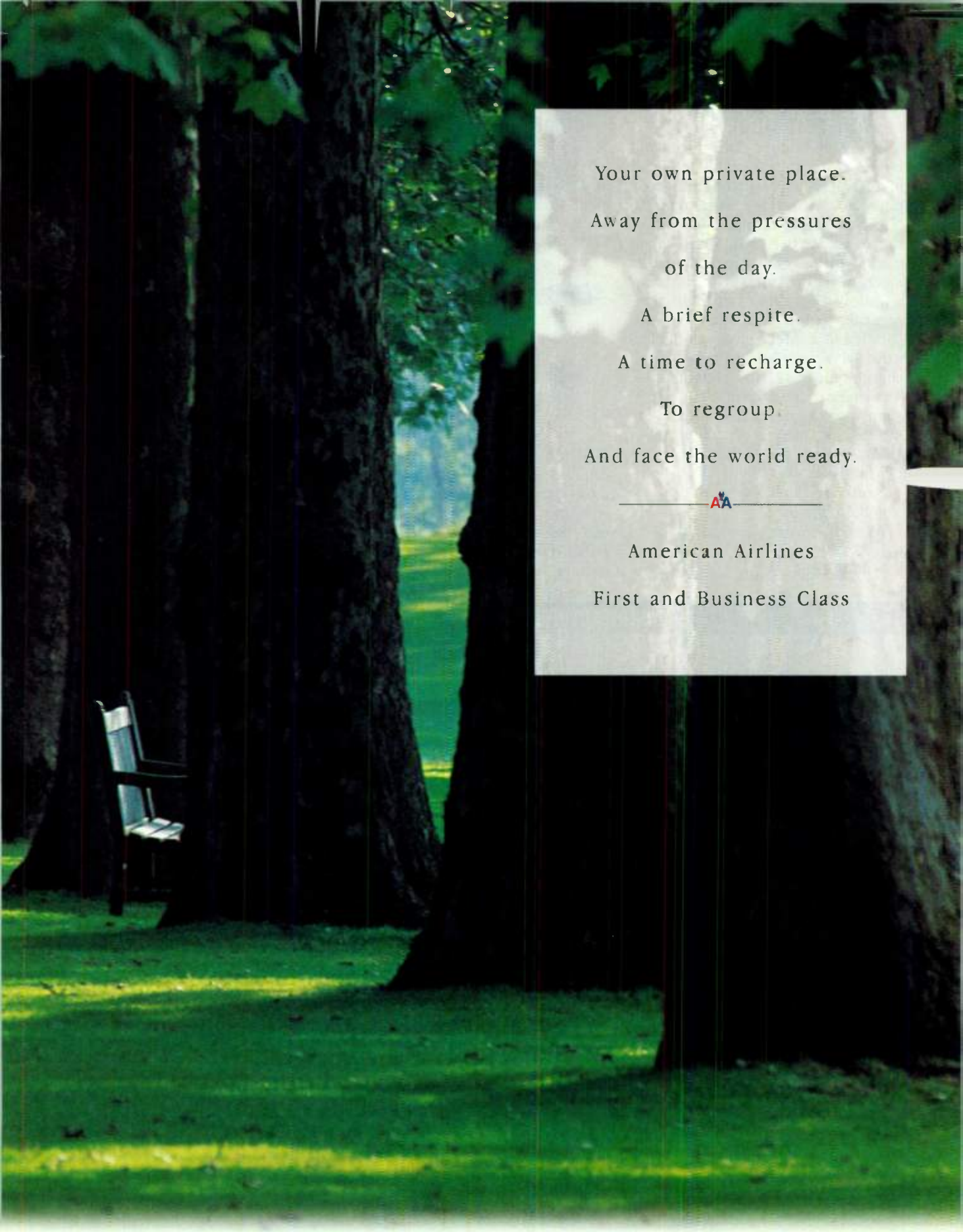


rent for precise voltage sampling. Secondary backup termination includes programmable time or temperature limit. Protection features include battery over and undervoltage detection, latched over-temperature detection, and power-supply input undervoltage lockout with hysteresis. The device comes in an 8-lead surface-mount package and includes a rapid system test mode.

Motorola, Analog IC Division
2100 E. Elliott Rd., (EL 340)
Tempe, AZ 85284
(602) 413-6007
▶ **CIRCLE 657**

MANUFACTURERS OF BATTERY-CHARGING ICs

Manufacturer	Part number	Chemistry	Charge-termination method	Safety-termination method	Maintenance-charge mode	Charge-status indication	On-chip current or voltage regulation	Fast-charge while operating	Package types and sizes
Microchip Technology Inc. (continued)	MTA-11200B	NiCd, NiMH Lead Acid	-ΔV, peak voltage, timeout, ΔT/Δt	Timeout, peak voltage	Yes	LED, digital output	No	Yes	28-pin PDIP, SOIC, SSOP
Motorola Analog IC Div. Tempe, AZ 602-413-6007 http://Design-Net.com CIRCLE 650	MC33340	NiCd, NiMH	Peak voltage detect	Maximum temperature or timeout	Trickle charge	LED	No	No	8-pin plastic DIP, 8-pin SOIC
National Semiconductor Analog Div. Sunnyvale, CA 408-721-4319 http://www.natsemi.com CIRCLE 651	LMC6984 and 6980	NiCd, NiMH, Li-Ion, sealed lead acid	-ΔV, ΔT/Δt, ΔV/Δt, maximum state of charge	Max voltage, max temp, max time	Trickle and maintenance	Digital output via SMBus	Yes	Yes	44-pin dual flatpack, 24-pin SOIC
	LMC6988 and 6980	NiCd, NiMH, Li-Ion, sealed lead acid	-ΔV, ΔT/Δt, ΔV/Δt, maximum state of charge	Max V, max temp, max time	Trickle and maintenance	LED and digital output via SMBus	Yes	Yes	44-pin quad flatpack, 24-pin SOIC
	LM3420M 5	Li-Ion	Peak voltage detect	Discrete control circuit	No	None	No	Circuit dependant	SOT-23-5



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READER SERVICE 106

▼ CHARGER IC INCLUDES FAST-TEST MODE

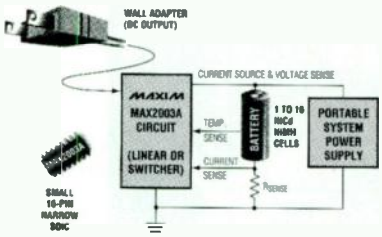
The SCI766 battery-charger controller IC allows the circuit to be tested in a few seconds by pulling the mode pin high. The device charges up to 10 NiCd or NiMH cells using -dV detection (accurate to 0.25% of peak value) as the primary charge termination mechanism. Backup is provided using a peak voltage timer, maximum temperature cutoff, maximum voltage cutoff, and a safety timer cutoff. The safety timer can be set for an overall charge time of 40, 80, or 160 minutes. The charger operates off a 9- to 18-V supply, comes in an 8 or 14-pin surface-mount package, and provides LED drivers for status detection. Pricing is $2.39 ea/1000.

Semtech Corp.
652 Mitchell Rd.
Newbury Park, CA 91320-2289
(805) 498-2111
▶ CIRCLE 658

▼ COMPACT FAST CHARGER COMES COMPLETE

Available in a 16-pin narrow SOIC, DIP, or wide SOIC package, the MAX2003A is offered as a compact but complete, stand-alone fast charger for NiCd or

UNIVERSAL FAST-CHARGER FOR NICd/NiMH BATTERIES



NiMH batteries. The device can be configured as an efficient switch-mode current regulator or as a cost-effective gating controller for an external current source. The charger pulses during trickle charge to extend battery life by preventing dendride formation in NiMH batteries. The devices also varies slope sensing as a function of charge rate to improve termination accuracy.

Fast-charge termination is achieved through temperature slope, -dV, maximum temperature, maximum time, and maximum voltage. For safety, fast charge is inhibited until battery voltage and temperature are within acceptable limits. Other features include a switch-activated discharge-before-charge option that allows for battery conditioning and more accurate measurement. In addition, a top-off option is provided, along with direct drivers for LED status indication. The device comes in a DIP or wide-SO package. Pricing starts at $3.80 ea/1000.

Maxim Integrated Products
120 San Gabriel Drive
Sunnyvale, CA 94086
(408) 737-7600
▶ CIRCLE 659

MANUFACTURERS OF BATTERY-CHARGING ICs

Manufacturer	Part number	Chemistry	Charge-termination method	Safety-termination method	Maintenance-charge mode	Charge-status indication	On-chip current or voltage regulation	Fast-charge while operating	Package types and sizes
Semtech Corp. Newbury Park, CA 805-498-2111 http://www.semtech.com CIRCLE 652	SC1766	NiCd, NiMH	-ΔV	0ΔV timer and safety timer	Trickle	LED driver	No	No	SO-8, SO-14
Temic Semiconductor Santa Clara, CA 408-567-8220 http://www.temic.com CIRCLE 653	U2402B-B	NiCd, NiMH	$\Delta^2V/\Delta t^2$, $-dV(d^2V/dt^2)$	Temperature	Trickle charge	LED	Yes	Yes	18-pin DIP, 20-pin SOIC
	U2402B-C	NiCd, NiMH	$\Delta^2V/\Delta t^2$, $-dV(d^2V/dt^2)$	Temperature	Trickle charge	LED	Yes	Yes	18-pin DIP, 20-pin SOIC
	U2405B	NiCd, NiMH, Li-Ion	$\Delta^2V/\Delta t^2$, $-dV(d^2V/dt^2)$	Temperature	Trickle charge	LED	Yes	Yes	18-pin DIP, 20-pin SOIC
	U2407B	NiMH, NiCd, Li-Ion	$\Delta^2V/\Delta t^2$, $-dV(d^2V/dt^2)$	Temperature	Trickle charge	LED	No	Yes	16-pin DIP, 16-pin SOIC
Unitrode Corp. Merrimack, NH 603-424-2410 http://www.unitrode.com CIRCLE 654	UC3906	Lead acid	Minimum current	N/A	Float charge	LED	No	Yes	16-pin DIL, SOIC, 20-pin LCC
	UC3909	Lead acid	Minimum current	N/A	Float charge	LED	No	Yes	20-pin DIL, 20-pin SOIC, 28-pin LCC
	UCC3890	NiCd, NiMH	Peak voltage (trickle current)	N/A	Trickle charge	N/A	N/A	No	8-pin DIL, 8-pin SOIC

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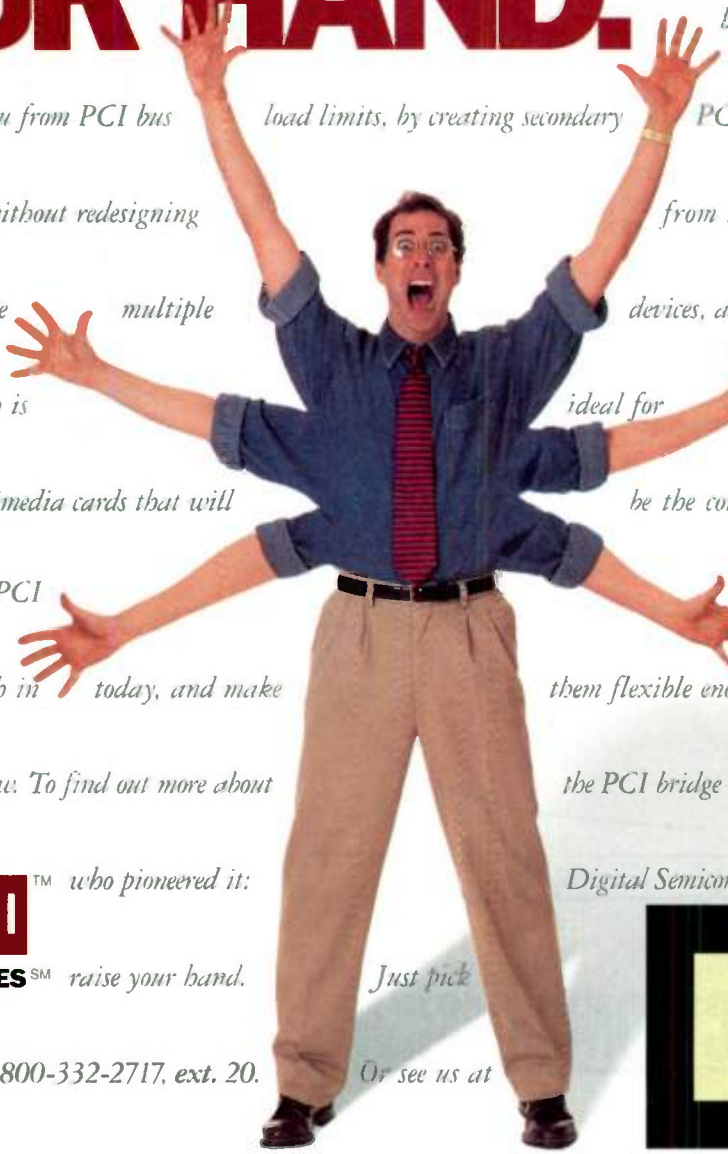

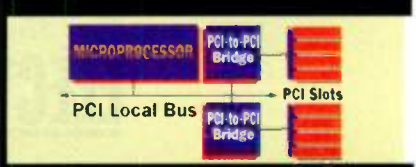

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▼ CHARGER IC SELECTS BUCK OR BOOST AUTOMATICALLY

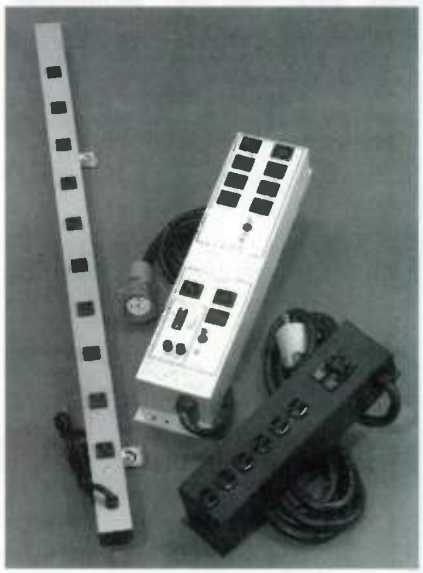
The LT512 is a 500-kHz current-mode switching regulator IC configured as a constant-current, constant-voltage battery charger that continues to charge normally after the input voltage varies above or below the battery voltage. The device charges single or multiple Li-Ion, NiMH, NiCd, or sealed lead-acid cells at voltages up to 20 V. The charging current sense circuit is completely separate from the battery itself and allows the battery minus terminal to be directly grounded.

A single-ended, primary inductance configuration provides step-up and step-down capability for applications where the input voltage can vary greatly, or when the battery voltage rises from below the input supply or above it during charge. The maximum switch current is 1.5 A. The IC is available in 8-lead PDIP and SO-8 packages. Pricing starts at $3.60 ea/1000 and delivery is from stock.

Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035-7417
(408) 432-1900
Fax (408) 434-0507
▶ **CIRCLE 670**

▼ UNITS DISTRIBUTE A 30-A INPUT

The PDU Series power-distribution units convert a 30-A input into two NEMA 5-15 branch circuits. Approved by UL as heavy-duty, high-power distribution boxes, the units are rated at up to 250 V ac. They have 16-gauge chassis and are offered in several lengths and widths with circuit-breaker protection. Surge suppression and EMI/RFI filtering are also available optionally.



The Clip-Strip Series is another line designed to distribute power within enclosures and racks. Constructed of shallow, extruded aluminum housings in lengths up to 8 feet, they feature universal spring-steel mounting clips. They're rated up to 20 A, 125/250 V ac and offer circuit-breaker protection. Call for pricing and delivery information.

SL Waber Inc.
520 Fellowship Rd.
Mt. Laurel, NJ 08054
(800) 634-1485
▶ **CIRCLE 671**

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READER SERVICE 227

▼ DC SUPPLY MAKES LOW-CURRENT MEASUREMENTS

The HP 6612B general-purpose power supply delivers up to 40 W (20 V at 2 A) and provides a ranging-current measurement function down to microamp level. High-speed programming and 2-ms output response time help improve production-test throughput. The supply features current sinking for a fast-down programming response that enables the power supply to go quickly from a high to low output level.

Other features include a low output noise, a vacuum fluorescent display, and a fan-speed control to lower acoustic noise. Programming can be done in either SCPI or HP compatibility language and communication is via an RS-232 or an IEEE 488.2 interface.

Hewlett-Packard Company
PO Box 58059, MS51L-SJ
Santa Clara, CA
(800) 452-4844
▶ **CIRCLE 672**

▼ RUGGED BATTERIES PROVIDE STABLE BACKUP

The HT and Phoenix series of batteries are designed for back-up power in applications where wide-temperature tolerance and high power, respectively, are required. The HT series provides 28 and 40 Ah of capacity and will operate in temperatures ranging from -40° to 176°F, while the Phoenix series ranges in capacity from 90 to 150 Ah. Physical dimensions for the Phoenix series ranges from 12 (W) by 6.71 (L) by 9.6 (H) in. to 14.1 (W) by 7.0 (L) by 11.9 (H) in.

Yuasa-Exide, Inc.
PO Box 14145
Reading, PA 19612-4145
(800) 538-3627
▶ **CIRCLE 673**

▼ BATTERIES HAVE HIGH OPERATING TEMPERATURE

The TL-6526 and TL-6537 are C- and DD-size, respectively, 3.9-V cylindrical lithium cells capable of operating in temperatures as high as 150°C over extended periods. The capacity, maximum continuous current, and maximum pulse current for the TL-6526 is 5.0 Ah, 0.5 A, and 0.5 A, and for the TL-6537 is 23.0 Ah, 1.0 A, and 1.5 A, respectively.

Tadiran Electronic Industries, Inc.
2 Seaview Blvd., Suite 102
Port Washington, NY 11050-4676
(516) 621-4980
▶ **CIRCLE 674**

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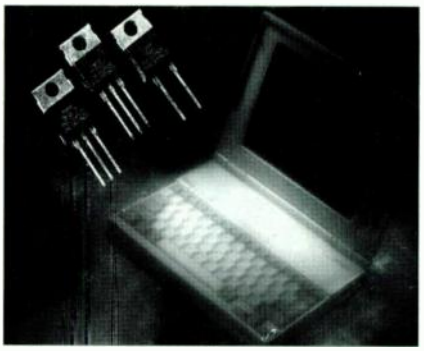
READER SERVICE 126

▼ SCHOTTKY DIODES TARGET LOW VOLTAGES

Targeted specifically at 3- and 3.3-V switch-mode power supplies, the PBYR series of schottky rectifier diodes feature a typical forward drop of 0.33 V (maximum 0.41 V) at their full rated forward current. The devices are available as a single diode with an average forward current rating of 10 A, or in two dual common-cathode versions with average forward currents rated at 15 or 20 A. The diodes have a maximum operating junction temperature of 150°C and a reverse leakage at high junction temperatures of 22 mA at 100°C (typical). All versions are packaged in TO-220 plastic power or SOT-404 surface-mount packages. Pricing

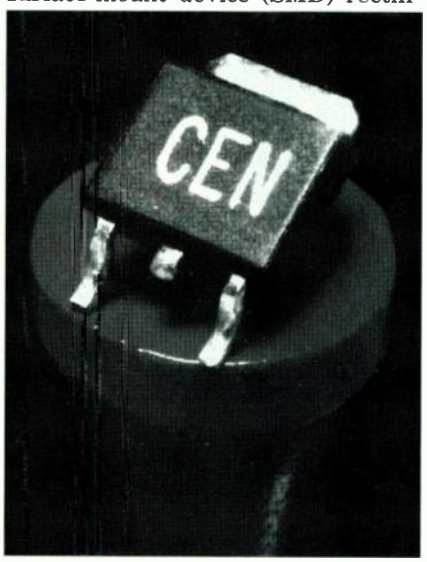


ranges from $0.42 to $0.67 ea/100 with delivery in four weeks.

Philips Semiconductors
811 E. Arques Ave., PO Box 3409
Sunnyvale, CA
(800) 447-1500 ext.1320
▶ CIRCLE 675

▼ SMD RECTIFIERS COME IN DPAK CASE

Direct replacements for Motorola's MBRD and MURD series, this line of surface-mount device (SMD) rectifi-



ers comes in a DPAK case. Available devices include the CSHD3-40 and 40C series of schottky rectifiers rated at 3.0 A, 40-60 V and 6.0 A, 40-60 V, respectively, and the CUD3-02 and 6-02C series of ultra-fast rectifiers rated at 3.0 A, 200 V and 6.0 A, 200 V, respectively. The devices are available bulk packed or on the preferred 16-mm, 13-in.-diameter reel. Pricing starts at $0.62 each on a 2,500-piece reel.

Central Semiconductor Corp.
145 Adams Ave.
Hauppauge, NY 11788
(516) 435-1110
Fax (516) 435-1110
▶ CIRCLE 676

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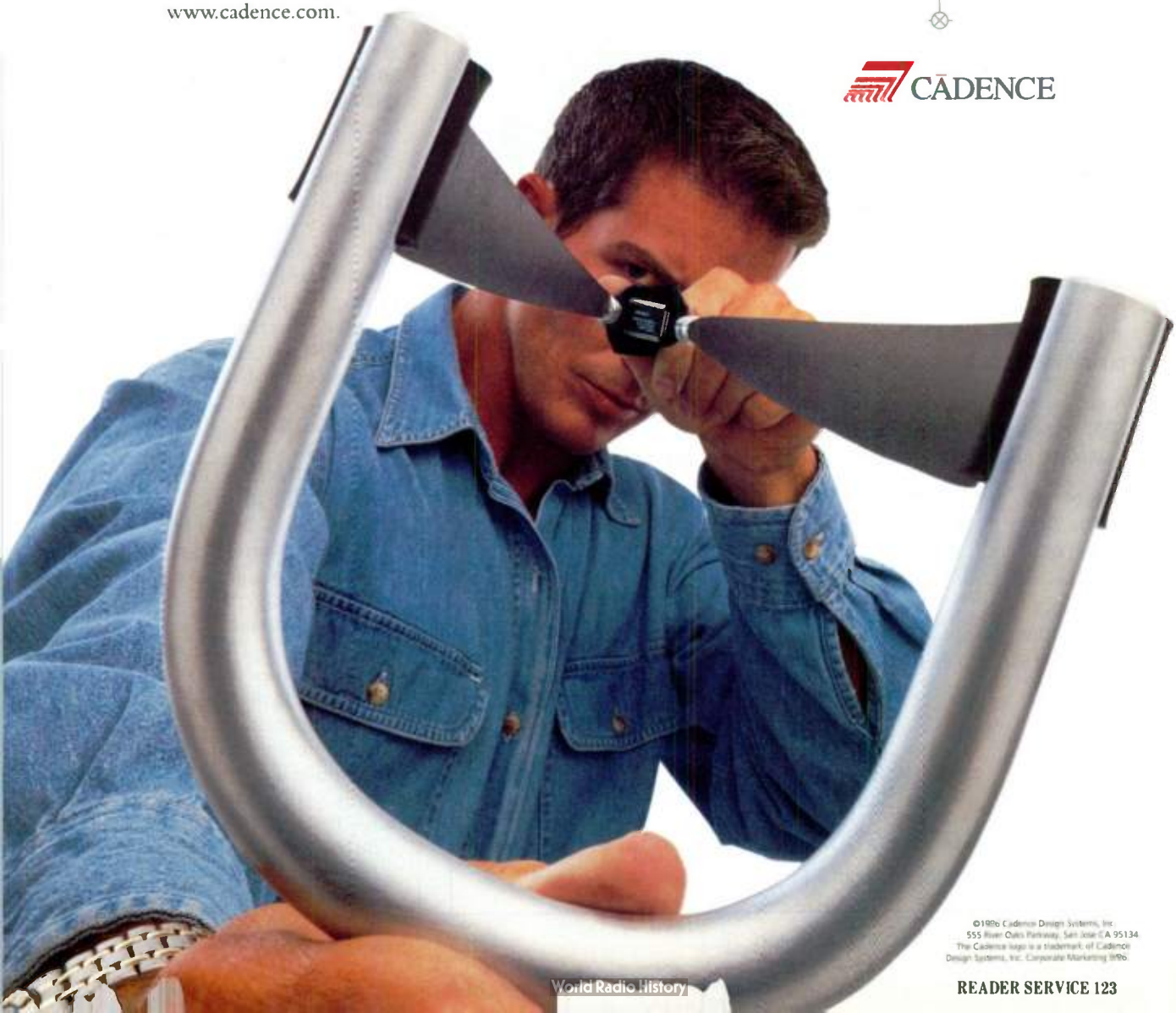

READER SERVICE 123

▼ POWER-ENTRY MODULE SAVES ON SPACE

The 83511410 Interpower 4-function power entry module combines an IEC 320 inlet, a double-pole on-off switch, a fuse carrier for either a North American 3AG or international 5 x 20-mm fuse, and a two-position voltage selector rated at 110 to 120 Vac or 220 to 240 Vac. The fuse drawer also doubles as a voltage selector and the contacts are combination solder tabs and 4.8-mm quick disconnects. The module is CSA certified at 6 A and VDE approved and UL listed at 10 A. Contacts are combination solder tabs and 4.8-mm quick disconnects. Mounting is vertically oriented with screws. Pricing is $13.61 and delivery is from stock.

Panel Components Corp.
100 Interpower Ave., PO Box 115
Oskaloosa, IA 52577-0115
(515) 673-5000
▶ CIRCLE 677

▼ DC/DC MICROREGULATORS HAVE 10-W OUTPUT

The AA10U Series of dc/dc microregulators provide a 10-W maximum output, a 4:1 input range of 9 to 36 Vdc or 18 to 75 Vdc, input-to-output isolation of 1,500 Vdc, and regulated outputs. The unencapsulated devices come in a 1.0 x 2.0 x 0.38-in., anodized aluminum and plastic case. Other features include a switching frequency of 400 kHz, an input efficiency of 85%, and and an industrial temperature range of -40° to 75°C. Pricing is $40 ea/100.

Astec America, Inc.
6339 Paseo del Lago
Carlsbad, CA
(619) 757-1880
▶ CIRCLE 678

▼ LITHIUM BATTERIES CAN BE CUSTOM MADE

The company's line of lithium-thionyl chloride batteries can be custom made with voltages from 3.6 V up in multiples of 3.6 V, with 0.14 Ah or better capacities. Featuring hermetic, all-welded 304L stainless steel cans and covers with reinforced construction, the devices can be built to withstand shocks up to 20,000 G. Sizes range from individual AA to #6 cells with optional connectors and terminations. Operating temperatures range from -55° to 200°C.

Battery Engineering, Inc.
1636 Hyde Park Ave.
Hyde Park, MA
(617) 361-7555
▶ CIRCLE 679

If you're looking for high-speed, cost-effective solutions for your tough design challenges—the wait is over. Introducing the SPARClite™ embedded processor from Fujitsu. Delivering workstation-speed for optimizing high-end imaging designs such as digital cameras—for around $15 per chip.

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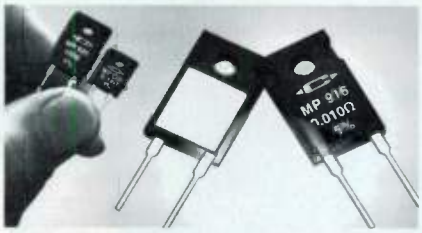
READER SERVICE 143

▼ LOW-OHM RESISTORS SENSE CURRENT



The MP916 is an addition to the company's line of TO-220-packaged heat-sink-mountable power resistors. The device extends the company's resistance range down to 0.010 Ω (+/- 5%) and is rated at 16 W (40 A continuous current) at a case temperature of 25°C. The ceramic, heat-dissipating mounting surface provides cool operation. With a low inductance value of less than 10 nH (typical), the MP916 resistor is suited to critical current-sensing applications for IGBTs and other motor-control feedback, power supply, and battery charger applications.

Caddock Electronics Inc.
1717 Chicago Ave.
Riverside, CA 92507-2364
(909) 788-1700
▶ CIRCLE 680

▼ MINI TRIMMER CAPS OFFER LOW PROFILE

With a mounted above-board height of just 1.0 mm, the CTZ2 Series SMT chip trimmer capacitors meet the needs of wireless systems that require values of more than 20 pF. The ultraminiature devices have minimum footprints for the tight confines of portable communication devices. Capacitance values range from 3 pF up to 30 pF and the entire family allows for adjustable tuning. The capacitors measure 3 by 2.5 mm with two height options of 1.3 and 1.0 mm. TCR values are up to 500 ppm/°C, and there's also a high-stability version with a 1% setting drift. All versions are offered in a washable configuration. Typical pricing ranges from $0.45 to $0.60 in lots of 2000 with lead times for production quantities of eight to 10 weeks. Samples are available immediately.

AVX Corp.
P.O. Box 867
Myrtle Beach, SC 29578
(803) 946-0414
▶ CIRCLE 681

▼ CHIP-RESISTOR ARRAYS SAVE ASSEMBLY COSTS

The BMC1604 Series chip-resistor arrays comprise four isolated resistor elements in one high-density package The arrays are suited to high-volume OEM SMT applications. Resistance values range from 10 Ω to 1 MΩ (5%), power ratings are 1/16 W per resistor, and the maximum operating voltage is 50 V dc. The arrays operate in a temperature range of –55° to 125°C. Parts are available with solder terminations on both sides of the element and in tape-and-reel or bulk packaging. Pricing is $65/5000 pieces. Call for delivery information.

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9 BEAVER BROOK ROAD
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LITTLETON, MA 01460, U.S.A.

READER SERVICE 105

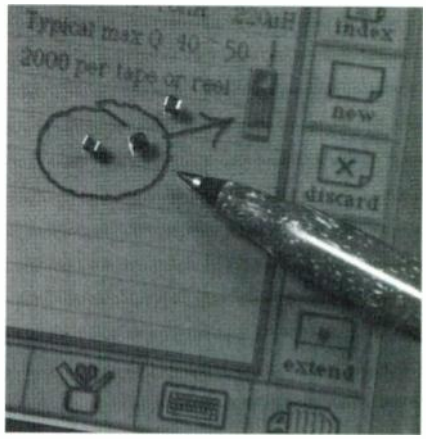
▼ LOW-POWER LED LAMPS OFFER HIGH OUTPUT

By achieving 10 times the brightness of commodity-type LEDs, the U-Series of InGaAlP-material LED lamps attains the same luminance levels they do at 1/10 the power consumption. The TLSU (soft-red), TLOU (orange), and TLYU (yellow) LEDs offer 260-mcd output at 4 mW (2 mA). They enable designers to reduce component counts and power consumption while maintaining the brightness their designs require. The LEDs range in luminance levels from 1800 to 2600 mcd typical at wavelengths of 590 to 636 nm. The devices contribute to cutting total system power consumption in portable equipment. Other applications include large-scale displays, backlighting, instrumentation, cellular and cordless phones, indoor message displays, and status indicators. Pricing ranges from $0.20 to $0.30 in lots of 5000. Call for delivery information.

Toshiba America Electronic Components Inc.
9775 Toledo Way
Irvine, CA 92718-1811
(800) 879-4963
http://www.toshiba.com/taec
▶ **CIRCLE 683**

▼ TINY CHIP INDUCTORS CONDITION SIGNALS

An EIA-standard 1008 footprint and low profile of just 1.8 mm are featured in the FSLU2520 Series of wire-



wound SMT chip inductors. The devices are designed for signal-conditioning applications in a wide range of electronic equipment. Their proprietary wire-wound structure, with welded terminations, offers high reliability. Inductors are precisely wound on a ferrite core for excellent temperature stability and sensitivity. Inductance values range from 10 nH to 220 µH in tolerances of 5, 10, or 20%. Operation is in a temperature range of –40° to 85°C. Typical maximum Qs are from 40 to 50. Products are supplied on tape and reel to facilitate automated assembly. The parts offer superior solderability and high heat resistance for flow and reflow soldering. Packaging is tape and reel with 2000 per reel. Call for pricing, delivery information, and samples.

Toko America Inc.
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Mt. Prospect, IL
(800) PIK-TOKO
Fax (708) 699-1194
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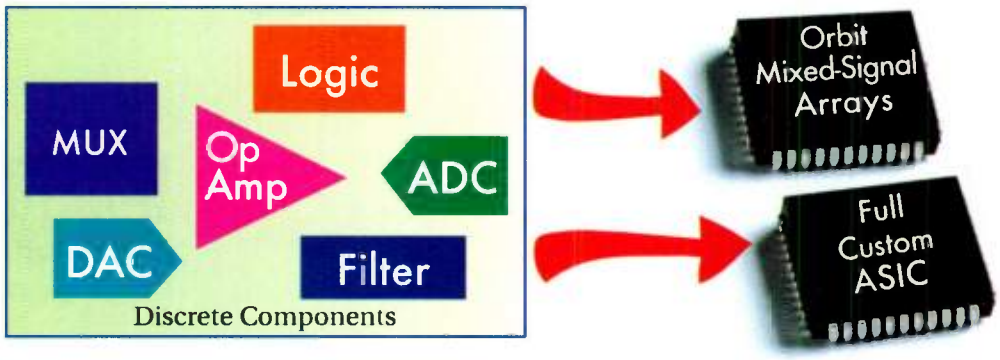

COMPARE & SAVE

Key Decision Factors	Orbit Mixed-Signal Array	Full Custom ASIC	Discrete Components
NRE costs (typ)	Low ($15K-$75K)	High ($100K-$300K)	N.A.
Prototypes*(typ)	Fast (6-18 wks)	Slow (24 to >52 wks)	N.A.
Time-To-Market	Fast	Slow	Moderate (8-24 wks)
Design Risk	Minimal	High	Low
Price (10K-100K/yr)	Low	Medium	High
(100K-1M/yr)	Low	Low	High

*Design completion to silicon

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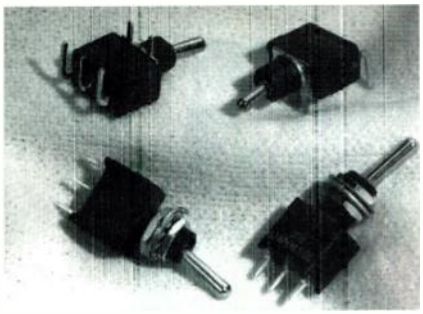
READER SERVICE 176

▼ TOGGLE SWITCHES WITHSTAND WASHING

Rather than a two-piece case with epoxy terminal seals, the S and SF Series miniature toggle switches uses a one-piece case design with an epoxy base and terminal seal. The result is

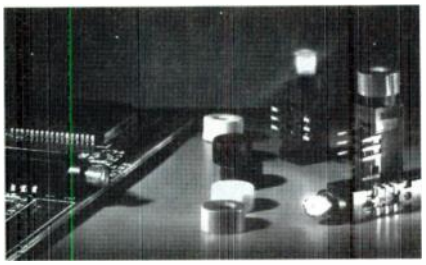


a switch with superior sealing that withstands many different soldering and cleaning processes including foam fluxing or flux bath; pre-heat temperatures of up to 380°C; turbulent and laminar wave soldering at temperatures up to 266°C; washing and rinsing with water, detergents, and freon; and blow drying at up to 180°C. Both SPDT and DPDT models are offered in two or three positions with various momentary and maintained configurations. Mechanical outlines include vertical, horizontal right-angle and vertical right-angle pc-board-mounting types as well as panel-mounting models with either solder-lug or pc terminals. Pricing for a two-position toggle switch is $2.14 in lots of 1000.

APEM Components Inc.
P.O. Box 544
Wakefield, MA 01880-4444
(617) 246-1007
▶ **CIRCLE 685**

▼ LIGHTED SWITCH IS SMT COMPATIBLE

The HDS/HDT combines an LED and a switch in a surface-mount package that mounts horizontal to the pc board and measures less than 0.75-in. thick. The device comes with momentary- or latch-type switch action in six different electrical variations, including normally open or normally closed one- and two-pole and externally tied for SPDT operation. The LED has a luminous intensity of up to 50 mcd for green and 32 mcd for red or yellow. A cap can be used to focus the light. Both switch and LED contacts self clean as they wipe during actuation. Mounting styles include through hole



and surface mount with j-bend or gull-wing tin-coated leads. Pricing starts at $3.83 ea/100 with delivery from stock to six weeks.

Schurter Inc.
1016 Clegg Court
Petaluma, CA 94975-0158
(800) 848-2600; Fax (707) 778-6401
73024.2314@compuserve.com
http://www.schurterinc.com
▶ **CIRCLE 686**

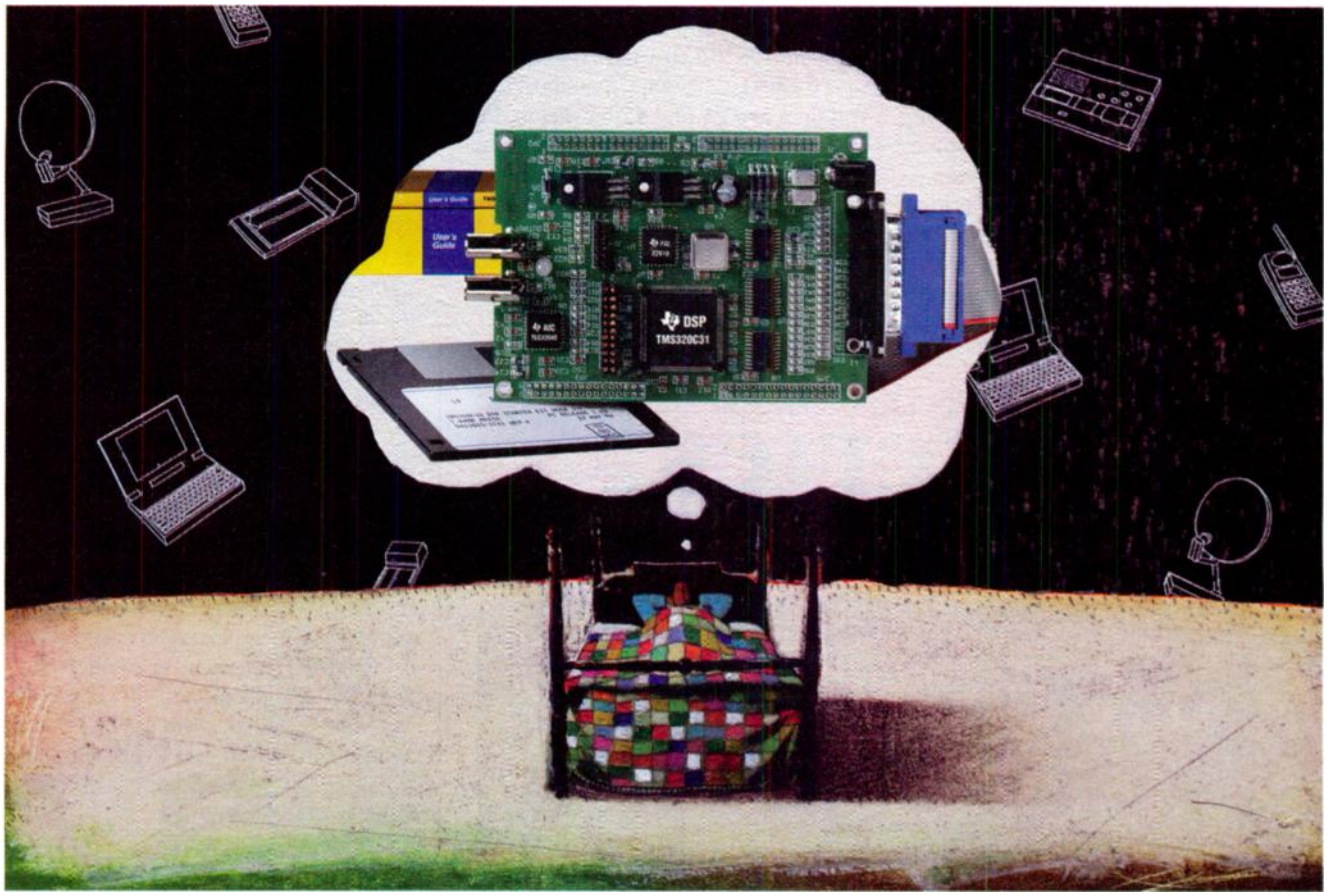
▼ REED RELAY IS INSTRUMENT GRADE

The SIL4 is a single-in-line reed relay with out-going quality levels rated up to less than 50 parts per million. Capable of over 50 billion switching operations, the relay has a maximum switching voltage of 200 V, a power rating of 10 W, and a typical insulation resistance between all isolated pins of

$10^{13}\Omega$. The dielectric strength between coil and contact is 2500 Vdc. The relay has a switching current of 0.5 A, a carry current of 1.5 A, and a dynamic contact resistance of 150 mΩ. Available coil voltages are 3, 5, 12, and 24 V. The 5-V version requires 50 mW to operate and has an operate time of 0.5 ms (typical). Options include normally open contacts, normally closed contacts, or diode suppression. The operating temperature range is -40° to 85°C. Pricing is less than $1 ea/25,000, with sample and production quantities available now.

CP Clare Corp., Reed Relay Products
15 John L. Dietrich Blvd.
N. Attleboro, MA 02763
(508) 643-9990; Fax (508) 643-9991
▶ **CIRCLE 687**

T I D S P S O L U T I O N S



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Ever dreamed of using digital signal processing in your design? Wake up to the new 'C3x DSK from TI. The first floating-point, 32-bit DSP starter kit. It's fast and easy and costs only $99. It will get you designing with floating-point DSPs quickly, while allowing you to develop software code right on your own PC.

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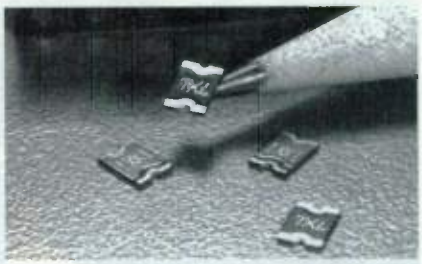
EXTENDING YOUR REACH

TEXAS INSTRUMENTS

08-1924

▼ RELAY PROVIDES DELAY-ON-DROPOUT FUNCTION

The DOD Series time-delay relay provides a delay-on-dropout function for alarm, copier, vending, and food-processing applications. The device comes with fixed or adjustable timing options. Fixed values may be preset in seconds or minutes ranging from 0.1 to 300 s, while the unit's knob-adjustable potentiometer accommodates standard timing ranges of 0.1 to 10 s, 0.6 to 60 s, 1.2 to 120 s, and 0.3 to 300 s. Standard input voltages are 24 and 120 V ac, and 24, 48, and 110 V dc. Custom voltages and timing are available. The device's contact arrangement is DPDT with eight-pin octal-style plugs. Eleven-pin spade terminals are also available. UL and CSA approvals apply and the lifespan



is 100 million operations at 25°C. Pricing is $42.44 ea/500 and delivery is stock to two weeks.

Amperite Co. Inc.
600 Palisade Ave.
Union City, NJ 07087
(800) 752-2329; Fax (201) 864-3955
▶ CIRCLE 688

▼ MINIATURE SWITCHES ARE SURFACE MOUNTABLE

The TL36WS84000 two-position toggle switch is representative of three series of miniature switches targeted at surface-mount applications. The three series are called the TP Series pushbutton switch, the TG Series slide

switch, and the TL Series toggle switch, and all come in tape-and-reel packaging and are reflow solderable and washable. Dimensions for the pushbuttons are 0.400 (L) by 0.318 (W) by 0.218 (H) in., the slide switches measure 0.378 (L) by 0.397 (W) by 0.218 (H) in., and the toggles measure 0.400 (L) by 0.318 (W) by 0.218 (H) in. All models are SPDT, carry dry-circuit ratings of 0.4 VA at 20-V max. (ac or dc), and are offered with optional positioning pins. Electrical configurations include momentary for the pushbuttons, maintained for the slides, and both momentary and maintained for the toggles. Pricing is $3.01 ea/1000.

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▶ CIRCLE 689

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Your phone line interface designs just got easier. CP Clare's Semiconductor Group brings you the CYBERGATE™ 2000 Series Data Access Arrangement (DAA) Module - the fastest, smallest, and most cost-effective gateway to the cyberworld of telecommunications. You name the application, and CYBERGATE™ 2000 will get your design to market - on time, worldwide and complying with FCC part 68, UL and BSI (pending) requirements.

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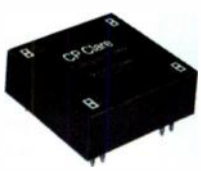

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▼ SMT ADHESIVES SPEED PROCESSING

Two Chipbonder surface-mount adhesives are available to aid in maximizing processing speed. During application, the adhesives demonstrate identical performance characteristics. But the Chipbonder 3612 is formulated with a yellow color while Chipbonder 3614 appears red. The availability of the two colors allows the adhesives to be compatible with vision systems and be visible regardless of the pc-board color. The on-stencil life of these materials is five days. During the screen-printing process, the adhesives flow readily through the screen apertures and recover their viscosity quickly to form extremely consistent dot profiles. Call for pricing and delivery information.

Loctite Corp.
1001 Trout Brook Crossing
Rocky Hill, CT 06067
(800) 562-8483
Fax (203) 571-5465
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▼ METAL STANDOFFS GROUND PC BOARDS

Applications requiring electrical grounding and/or high-strength mounting of printed-circuit boards are candidates for a line of grounding pc-board supports. The metal standoffs enter the chassis from the bottom, or reverse side, providing minimal protrusion below the panel. No special insertion or fixturing equipment is required. The easy-to-use supports snap into a 0.270-in.^{2} (0.002 in.) chassis hole by hand for quick installation. They accommodate panel thicknesses from 0.040 to 0.060 in. Electrical contact and secure mounting are achieved by driving a #6-32 screw through the pc board into the support. The screw threads engage metal tabs and drive the sides of the part laterally to lock it into place. Three available standoff heights are 0.190, 0.250, and 0.375 in. Zinc plating provides corrosion resistance. Call for pricing and delivery information.

ITW Fastex
195 Algonquin Rd.
Des Plaines, IL 60016
(847) 299-2222
Fax (847) 390-8727
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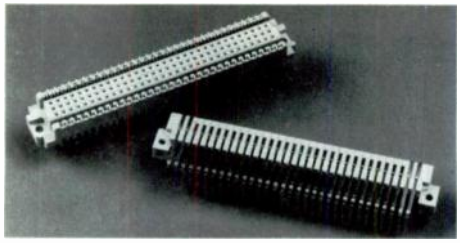
▼ THERMAL COMPOUND IS EASY TO USE

A convenient applicator is provided with the Thermstrate-TC thermal compound that allows users to gradually dispense the solid compound as a film-like deposit on either a heat sink or component surface. The material is dry to the touch, will cold-form with pressure, and liquefies at 51°C to fill any interface voids. The compound is said to have a lower thermal resistance than thermal grease. It's silicone-free and offers unlimited shelf life as well as long-term applied stability. A one-ounce applicator goes for $12.50 in quantities from 10 to 24.

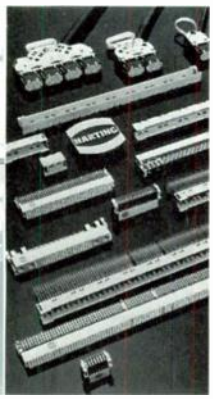
Power Devices Inc.
26941 Cabot Rd., Bldg. 124
Laguna Hills, CA 92653
(714) 582-6712
▶ CIRCLE 692

har-bus 64 New 160 Pin Connector For VME64



New connector series satisfies the new 64-bit computer architecture's requirement for higher speeds, more I/O and additional functionality. Offering a five row connector solution that is 100% backward compatible with the popular 96-pin Eurocard connectors, the new ***har-bus 64*** has 160 pins with preleading contacts for live insertion. New contact rows can be used to improve signal speed of VME bus and as ground contacts. Current 96-pin Eurocard connectors mate to the 160 pin connectors, allowing all PCB's to be used in new or existing backplanes.

Reader Service 241



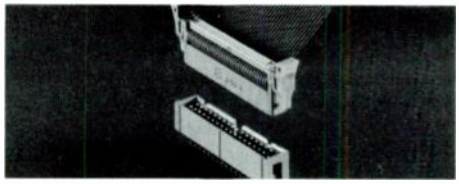
har-pak®2.5MM High Density Connector system

Developed for backplane and daughterboard applications in modern rack systems. The 5 row 2.5 mm connector design offers solderless PCB terminations, optimum utilization, of space three dimensional modularity, high contact density, EMI protection, and the ability to double-side surface mount components on daughter cards without loss of a 15mm card pitch. The *har-pak* connector system permits using a three dimensional 2.5mm grid. With the exceptional capabilities of the connector, only one connector style is required to solve your power, signal, ground, and high data rates, simplifying the design and manufacturing of future systems. The compliant pin technology utilizes the same 1mm plated through hole standard for many DIN 41612 compliant pin technologies.The consistency in design uses the many years of manufacturing and design experience already available. These attributes combined can lead to new advancements in board-level designs:15mm card pitch with double sided surface mounted daughter cards, butterfly or mid-plane techniques, modular design both horizontally and vertically, low number of system components combination with other standardized packaging systems, and lower applied costs.

Reader No. 242

New SEK "Press'n Snap" Press In Header

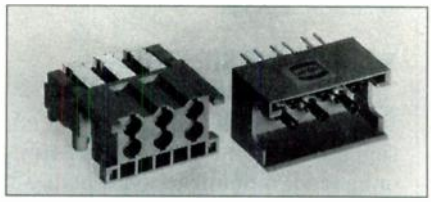
The new "press'n Snap" low profile press-in headers can be added to single or double-sided surface mount printed circuit boards any time after reflow. Press-in terminations of the two row .100" pitch headers permit easy installation into plated through holes without soldering. Removable temporary inserts allow any flat die to press the connectors. The straight header is shrouded by four plastic walls and available in versions from 6 to 64 contacts. The mating connectors are flat ribbon terminated socket connectors from HARTING's SEK range. These can be latched to the headers by using the locking levers installed onto the strain relief. The levers secure the socket connector to the end walls of the header. Placing the



locking levers on the socket instead of the PCB header saves valuable board real estate.

Reader Service 243

NEW HIGH DENSITY MICRO-COAXIAL CONTACTS



Designed for high speed data transfer rates. Can be used in the iec 1076-4-2 2.5mm High Density connector system, *har-pak*®. Provides more space efficiency, high frequency capabilitiy, easy handling, low applied cost and application with current equipment and emerging metric equipment practices. Designed for PCB termination on both daughter card to backplane connection; allowing users to bring signal directly into the backplane without a cable transition.

Reader No. 244

▼ HEAT DISSIPATORS ARE OMNIDIRECTIONAL

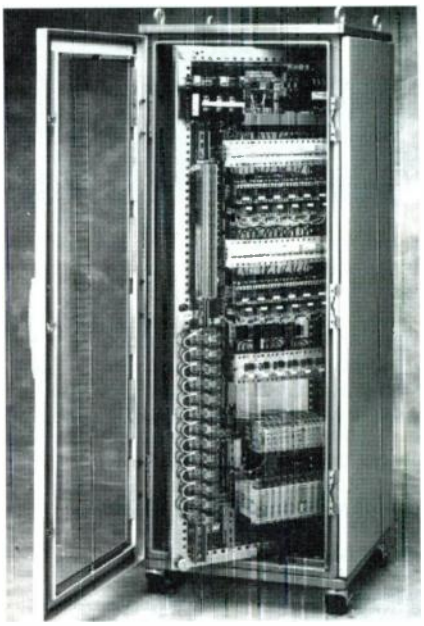
Uniform heat distribution with additional surface area is featured in an enhanced, omnidirectional heat sink.

The family conforms to the socket profile, requiring no additional board space. They're available in 1.25- and 1.50-in. heights for Pentium processors running from 150 to 200 MHz. They're also designed to accept the company's family of chips. A full line of cooling products is offered for the entire family of Intel Pentium and Pentium Pro microprocessors. Custom-engineered heat sinks with various clip configurations are available to meet critical customer requirements. Call for pricing and delivery information.

IERC
135 W. Magnolia Blvd.
Burbank, CA 91502
(818) 842-7277
▶ CIRCLE 693

▼ UNIVERSAL MOUNTING CUTS ENCLOSURE COSTS

A universal component-mounting system for large enclosures is designed to reduce installed costs while improving space utilization and heat dissipation. The system uses DIN rails and struts combined with a DIN swing frame to create an open architecture that's easily assembled and modified. According to the manufacturer, space savings of 25% or more are possible compared with traditional subpanel mounting methods. This can result in using smaller or fewer enclosures for the same equipment, and/or more efficient use of floor space in end-users' facilities. The open architecture also allows air to circulate more freely for more efficient cooling. Cable management is also made easier, it's claimed. Call for more information.



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FAX: 800-848-3825/402-467-4528

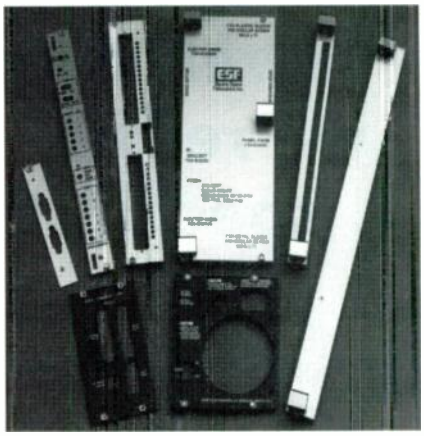
Lucent Digital Cellular Telephone 6720

Centurion International has developed antennas for many Lucent Technologies Inc. wireless terminals which meet Bell Labs specifications.

READER SERVICE 94

▼ CUSTOM FRONT PANELS MEET USERS' SPECS

Euro-style front panels are available for easy customization to meet specific user requirements. Thanks to ESF's broad in-house capabilities, custom panels are available at relatively low cost without sacrificing turnaround time or delivery. Custom cutouts, holes, and extra hardware can be specified as well as special finishing and silk-screening. The company also offers a stainless steel M2.5 collar screw and plastic or metal sleeves for fastening panels to subracks. To speed the design-to-manufacture process, ESF can work from CAD-file data with or without support drawings. System software includes Graftek GMS, Pro/Engineer, AutoCAD, IGES, and DXF. Call for



pricing and delivery information.

Electro-Space Fabricators Inc.
300 W. High St., P.O. Box 67
Topton, PA 19562-0067
(610) 682-7181
▶ **CIRCLE 695**

▼ WATER-SOLUBLE FLUX CONTAINS NO HALIDES

With no halide content to contribute to board degradation, Heraeus Cermalloy's SURF50 liquid flux is a water-soluble material that can be used with standard wave-soldering equipment for through-hole, mixed-technology,

and SMT assembly processes. The flux is highly activated, allowing use on difficult-to-solder areas on boards. In addition, its VOC-free formulation eliminates environmentally dangerous organic emissions. The absence of VOCs can also simplify users' efforts to comply with government regulations. The flux is available in one-, five-, and 55-gallon quantities.

Heraeus Inc., Cermalloy Div.
24 W. Union Hill Rd.
W. Conshohocken, PA 19428
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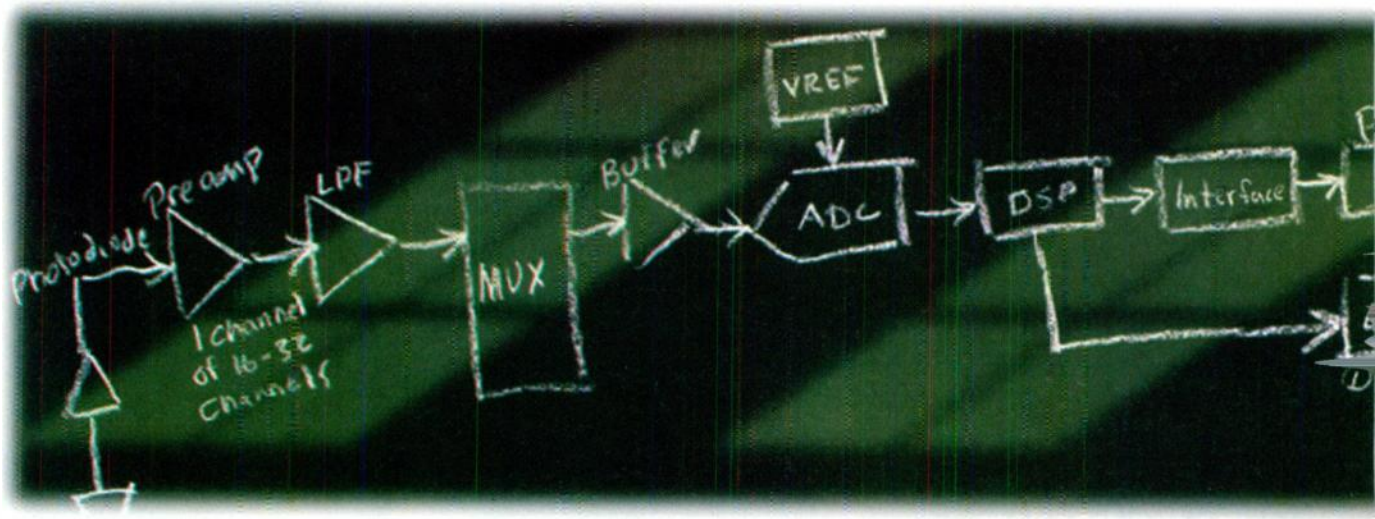

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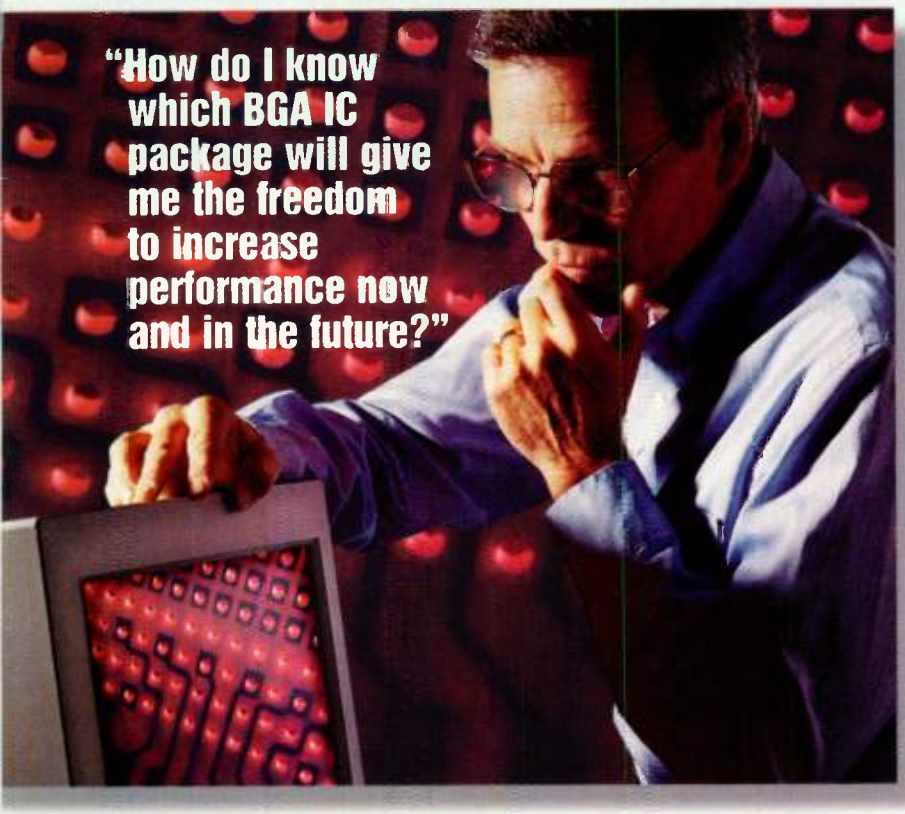

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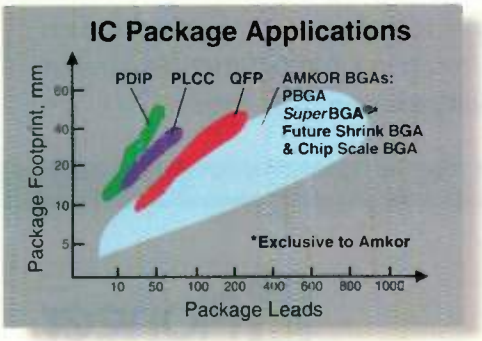

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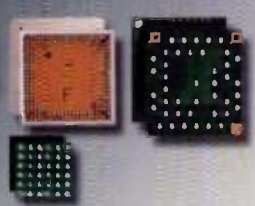

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Dual-Frequency PLL Synthesizers Target PCSs

Ultra-Low-Current Consumption Parts Offer Two RF PLLs With Low Phase Noise And High-Performance Charge Pump.

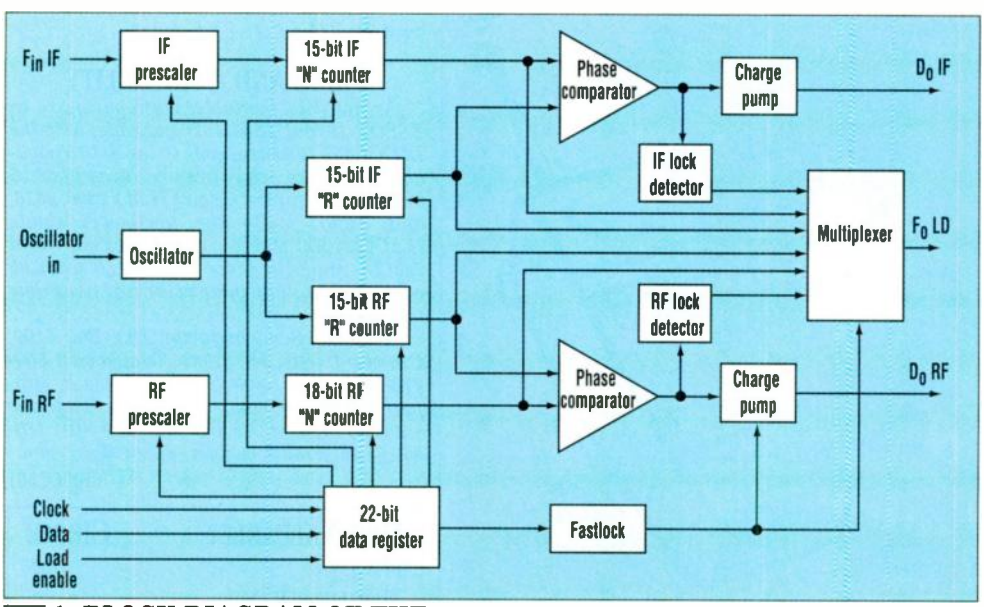
PAUL MCGOLDRICK

The need for phase-locked loop (PLL) frequency synthesizers has grown as dramatically as the personal communications market. The plethora of international standards also has demanded that any product offering has to cover a range. Meanwhile, the need to conserve active-circuit area has required that synthesizers offer outputs for the often two-frequency source needs of a circuit.

National Semiconductor's wireless communications group now has added a new range of low-power-consumption synthesizers to their *PLLatinum* family with five dual-frequency synthesizers and three single-frequency devices built around the same basic format *(see the table)*. The duals provide both RF/IF and RF/RF outputs. The highest power consumption in the series is 5.0 mA (at a supply of 3 V), compared to 13 mA in the previous series—for which these are pin-to-pin replacements. The frequencies are the maximums, while the minimum operating IF is 45 MHz and minimums for the RFs depend on whether they are primary or secondary outputs. For a 1.1-GHz primary output, the minimum is 100 MHz, and for a 1.1-GHz secondary output it's 50 MHz. For 2- and 2.5-GHz primary outputs, the minimum is 200 MHz.

The parts are made using the latest version of National's ABiC silicon biCMOS process, 0.5-µm ABiC V process, with frequencies up to 3 GHz (ELECTRONIC DESIGN, October 14, p.37). The most challenging parts—those with RF and IF outputs—are described here, while the other duals (RF/RF) use the same circuit arrangements and the singles use a simplified arrangement.

The 22-bit data register accepts serial data on the three-wire clock (clocking is on the rising edge), data (binary serial data, MSB first), and load enable (CMOS, high-impedance) pins *(Fig. 1)*. The first five MSBs are used for program modes, the next fifteen MSBs are used for the divide ratio of the reference divider, and the last two MSBs are the control bits. The data locations from the control bits are 00 for the IF "R" counter, 01 for the RF "R" counter, 10 for the IF "N" counter, and 11 for the RF "N" counter. The reference "R" counters set a divide ratio from 3 to 32767, acting on the high-precision oscillator. The divide ratios for the "N" counters are set in two parts: an 11-bit programmable counter divides from 3 to 2047 and a 7-bit swallow counter divides from 0 to 127. In the latter case, the last three bits are "don't care" bits for the IF where the swallow division is 0 to 15. Prescaler ratios are 8/9 or 16/17 for the IF, 32/33 or 64/65



1. BLOCK DIAGRAM OF THE National Semiconductor LMX2330L frequency synthesizer. It produces a digital PLL control up to 2.5 GHz on the RF channel and 510 MHz on the IF channel.

NATIONAL SEMICONDUCTOR'S SINGLE- AND DUAL-FREQUENCY SYNTHESIZER ICs

Part number	Type	RF input(s)	Prescalers	I_{cc} (typical) (@V_{cc} = 3 V)	Power-down I_{cc}	V_{cc} range	Package type
LMX2306	Single	550 MHz	8/9	1.2 mA	1 nA	2.3-5.5 V	TSSOP-16
LMX2316	Single	1.2 GHz	32/33	2.0 mA	1 nA	2.3-5.5 V	TSSOP-16
LMX2326	Single	3.0 GHz	32/33	3.5 mA	1 nA	2.3-5.5 V	TSSOP-16
LMX2330L	RF/IF dual	2.5 GHz 510 MHz	32/33, 64/65 8/9, 16/17	5.0 mA	1 nA	2.7-5.5 V	TSSOP-20
LMX2331L	RF/IF dual	2.0 GHz 510 MHz	64/65, 128/129 8/9, 16/17	4.0 mA	1 nA	2.7-5.5 V	TSSOP-20
LMX2332L	RF/IF dual	1.2 GHz 510 MHz	64/65, 128/129 8/9, 16/17	3.0 mA	1 nA	2.7-5.5 V	TSSOP-20
LMX2335L	RF/RF dual	1.1 GHz 1.1 GHz	64/65, 128/129 64/65, 128/129	4.0 mA	1 nA	2.7-5.5 V	SO-16/TSSOP-16
LMX2336L	RF/RF dual	2.0 GHz 1.1 GHz	64/65, 128/129 64/65, 128/129	5.0 mA	1 nA	2.7-5.5 V	TSSOP-20

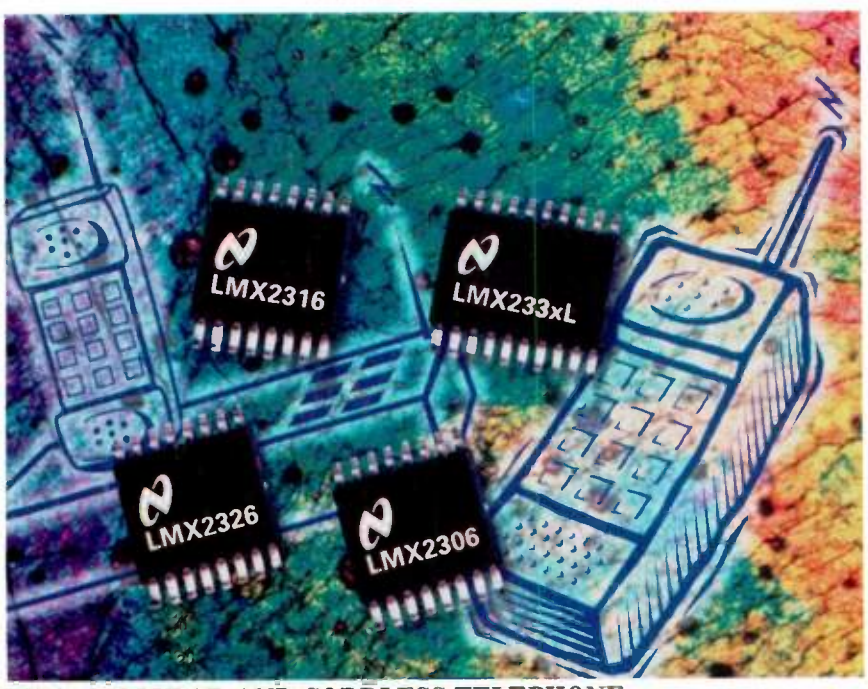
for the 2330L, and 64/65 or 128/129 for the 2331L and 2332L.

The divided signals (low-level voltage-control-oscillator inputs and the oscillator input) feed two phase comparators (one each for the RF and IF paths), and drive charge pumps which have selectable current levels. The charge-pump outputs, D_0RF and D_0IF, are connected to loop filters to drive the inputs of the external VCOs. A multiplexer also takes the RF and IF programmable or reference dividers, the RF and IF lock-detect signals, and the fastlock mode, and outputs them at CMOS levels at F_0LD. The selectable fastlock mode, on the RF side, uses the raw input and performs a coarse-frequency correction, thereby speeding up the lock process. During the fastlock mode, the open loop is widened just long enough for the fastlock mode to take place without compromising the stability of the original circuit design. Although any part of the loop could be opened for this purpose, the decision was made to go for the programmable charge pump; during the fastlock mode, the charge-pump output current is increased from the standard 1 mA to 4 mA.

The current change is enacted by switching in a second damping resistor to ground. Once locked on the correct frequency, the PLL can return to the standard low-noise operation. The transition does not affect the charge on the loop-filter capacitors and is enacted synchronously with the charge-pump output. As such, it creates a nearly seamless change between fastlock and standard modes.

Power-down facilities are provided such that either the RF or IF may be disabled. The oscillator circuit function only shuts down if both the RF and IF are disabled. The three-wire Microwire control register remains functional at all times.

With the frequency ranges and combinations offered, these parts will be used in international cellular telephones, international cordless telephones, personal communications systems (DCS-1800 and PCN-1900), dual-mode PCS telephones, cable T.V. tuners, and numerous other wireless systems *(Fig. 2)*. □



2. CELLULAR AND CORDLESS TELEPHONE applications will be the target of the LMX2300 family of frequency synthesizers from National Semiconductor.

PRICE AND AVAILABILITY

As noted in the table, these parts are in TSSOP-16 and TSSOP-20 packages with the LMX2335L also available in the SO-16 package. 1000-piece prices are in a range of $3.45 to $4.95 each for the singles (LMX2306, 2316, and 2326), while the low-power duals (LMX2330L, 2331L, 2332L, 2335L, and 2336L) range in price from $4.50 to $6.95 each. Production quantities are available this quarter.

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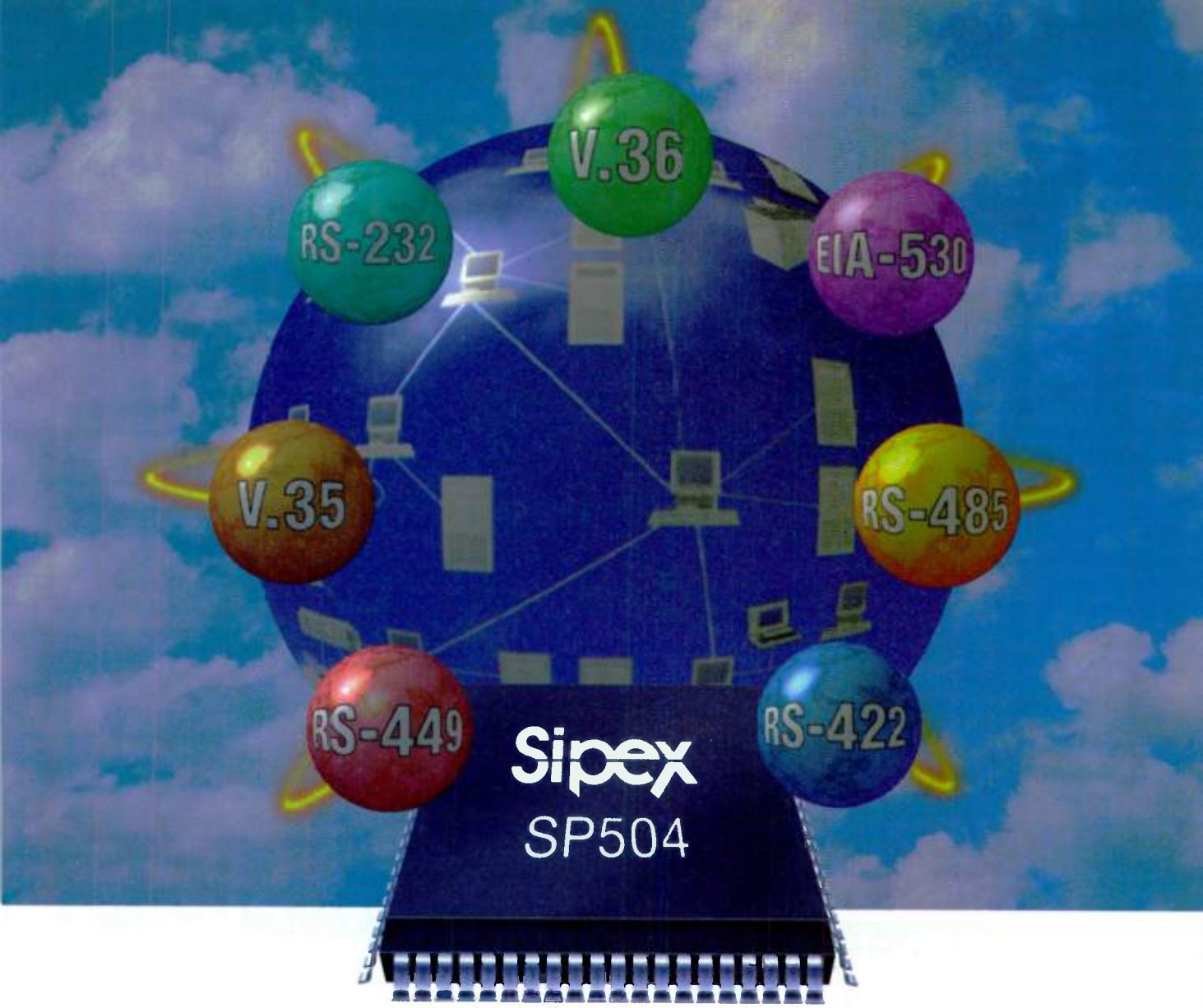

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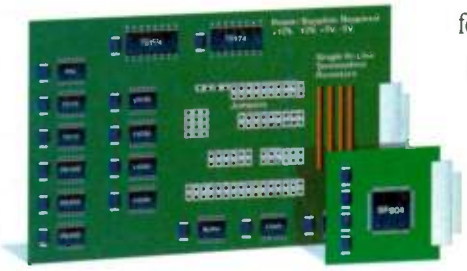

The SP504 offers an efficient single chip solution for serial ports that require supporting multiple physical interface standards. Serial port designs for Frame Relay, X.25, and networking routers can be simplified by the SP504. The SP504 can be used in either DTE or DCE systems.

The SP504 supports the popular interface standards for Wide Area Network serial ports: RS-232 (V.28), RS-422 (V.11), V.35, V.36, EIA-530, or EIA-530A.

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Switch Completes Digital Interface Products

With 1.2-Gbit/s Performance, Part Also Is Silicon Answer To SONET/Telecom Switching.

PAUL MCGOLDRICK

Now, the full interfacing and routing needs for the serial digital interface (SDI) digital video standard can be met at one location—Comlinear's CLC018. This 8-×-8 digital-cross-point switch is optimized for the SMPTE 259M SDI digital video standard. It is the third part in a series, comprised of the CLC014 adaptive equalizer, CLC016 timing recovery/retimer chips, as well as the CLC018. They work together with cable drivers such as the CLC006/7. The basic 8-×-8 switch can be expanded to any rectangular or square array in multiples of eight. The IC exhibits low jitter and is operable at data rates greater than 1.2 Gbit/s, with low power consumption.

The serial equivalent of a 10-bit D-1 (4:2:2) digital video transmission requires a 270-Mbit/s (plus overhead) throughput. Available parts for serial video routing switchers are based on GaAs technology, or are "in-house" solutions, some of which are less than elegant.

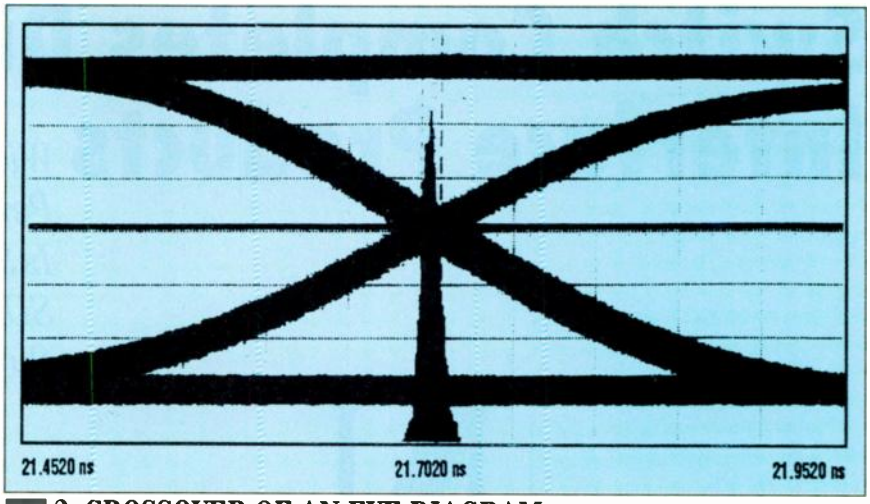
Key to the CLC018's performance is the process on which it is made. National Semiconductor's (Comlinear's parent company) biCMOS ABic IV process, ensures that silicon ICs are made with high produceability, as well as lower power consumption at a lower cost than available GaAs parts. According to Comlinear, the CLC018's low cost makes it competitive for even 16-×-16 crosspoint switch applications.

For expansion of up to, say, 16-×-16, the four CLC018 ICs required still will offer a cost margin per crosspoint as well as substantial savings in power. The CLC018 requires about 100 mW per output, so a 16-×-16 switch would dissipate about 1.6 W; that's roughly a 1:2 ratio compared to existing GaAs parts, with no heat sinking required for reasonable junction temperatures. An added advantage of using multiple chips to make a larger router is that space in such designs is generally not a problem. The constriction on design is usually associated with the number of BNC connectors that need to be mounted on the backplane of the unit. Being able to spread the chips out on a circuit board will allow for better heat dissipation, and the smaller chip size makes the routing of signals on the board much easier to handle. Layout is, of course, paramount at these frequencies.

The architecture used in the CLC018 digital cross-point switch is a current-mode process, and signals are run around at a low impedance with eight, non-blocking, independent 8:1 multiplexers allowing each input to connect to any or all outputs. Each output can be independently connected to any input. The inputs, outputs, and internal circuitry are totally differential, giving high immunity to noise. The specification for input-return loss for SMPTE 259M is 15 dB up to 270 MHz, a specification many manufacturers have had trouble meeting. This specification translates to an input capacitance of about 2 pF. The Comlinear part specifies an input capacitance at 1.5 pF, which is well within the return-loss requirements.

The basic arrangement of the IC shows the 8-x-8 matrix with its control systems *(Fig. 1)*. Each differential input to the matrix drives eight differential pairs in parallel. The output, in current form as noted, travels across the chip to a unique output. The output-side current is received by a cascode device with summing taking place in the cascode collectors. Apart from a quiescent current of about 7 mA in the device, the majority of the power consumption is in the output circuit, where each active output takes about 18 mA. Unused inputs are turned off. Additionally, each output can be individually disabled and set to a high-impedance state that Comlinear is calling "Tri-State." This feature is essential to the expansion capabilities. Broadcast reset results in all outputs being connected to DI0, while a Tri-State reset disables all the outputs.

The configuration register consists of eight 4-bit registers, one for each output. Three of the 4 bits are input address information, while the fourth is dedicated to Tri-State. The total 32 bits come from the load registers which can be programmed in the background. A single pulse on the Configure pin strobes the loading to the configure register. Unchanged outputs maintain their jitter performance and data integrity during reconfiguration. The Load pin acts in a similar manner to the Configure pin, strobing input instructions from a remote location.

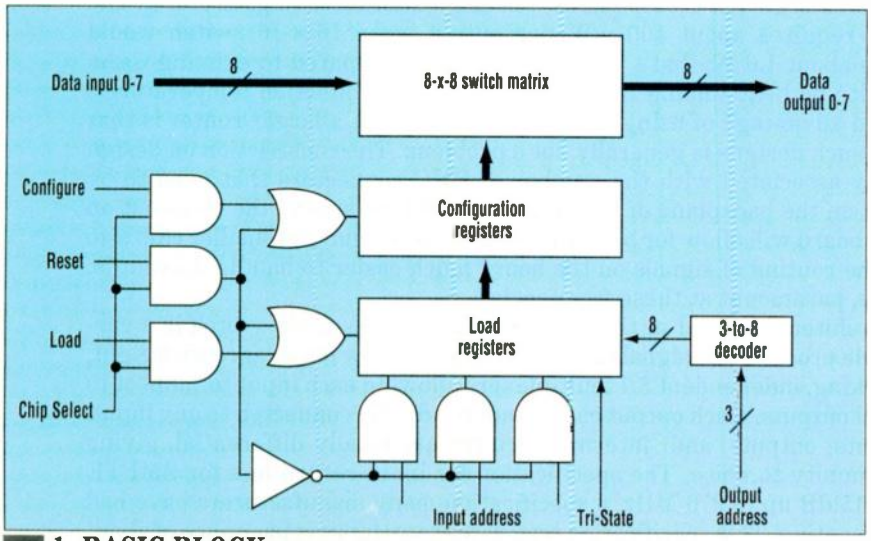


2. CROSSOVER OF AN EYE DIAGRAM of the CLC018 at a 270-Mbit/s data rate showing a jitter of 6.0 ps rms.

Comlinear feels that their customer base will be educated enough to have been already involved in building suitable user interfaces. The Chip Select pin is used for array expansion.

Switching time is nearly instantaneous, while signal propagation is typically 0.75 ns, and delay matching is specified as ±200 ps. Switching is a standard make-before-break action. The slowest reset time, 70 ns, occurs when a Tri-State is broadcast to all outputs. The bit-error rate (BER) is specified at less than 10^{-9} over 50% of the bit-cell interval, i.e. for an up-to-25%, each-way slide from the center of the eye.

Jitter is specified as typically 50 ps p-p up to 500 Mbit/s and 100 ps p-p up to 1.4 Gbit/s *(Fig. 2)*. Jitter measurements are made using a pseudo-random binary sequence, with all the other channels activated with non-correlated signals. Jitter caused by signal-induced crosstalk from other channels has been measured at about 45 ps p-p for the worst case with 1.4 Gbit/s in the interfering channels.



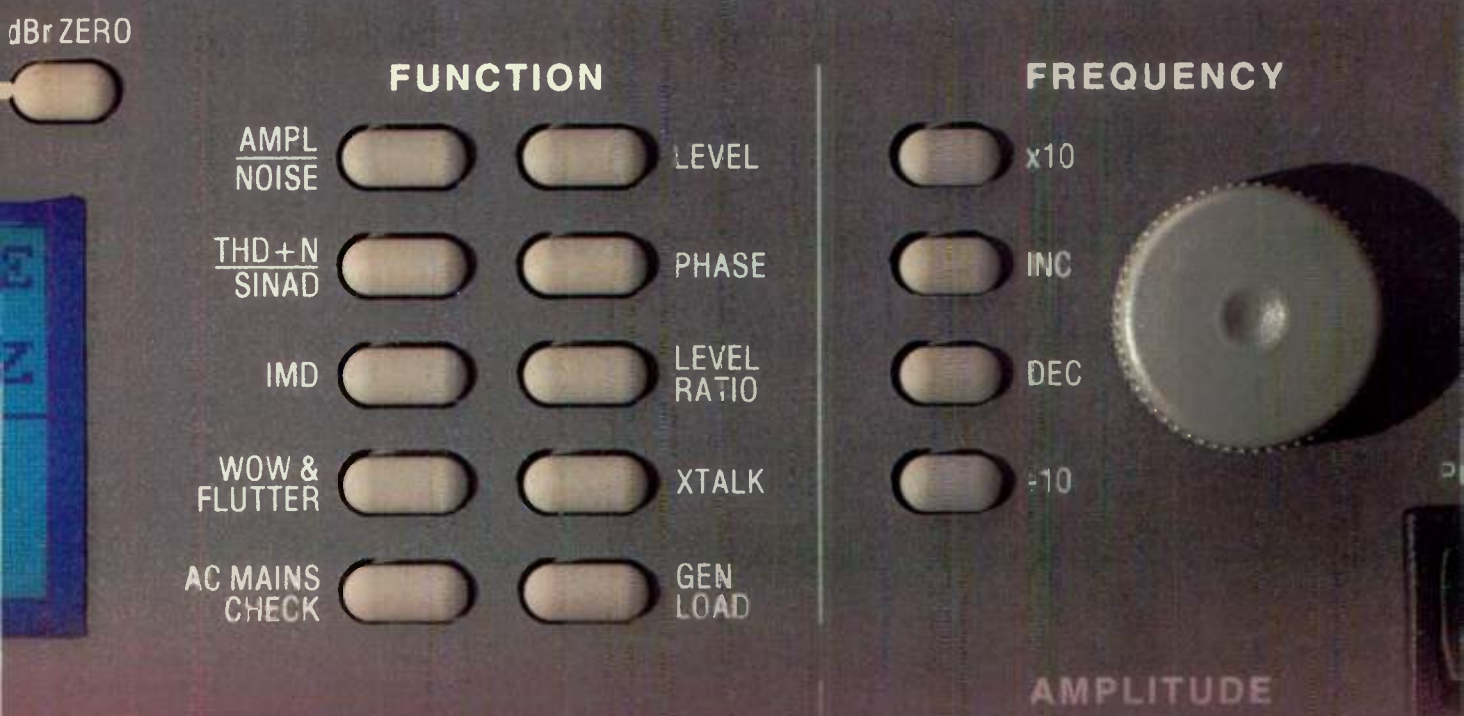
1. BASIC BLOCK of the Comlinear CLC018 serial digital video crosspoint switch exhibiting low jitter above 1 GHz.

EXPANDING THE ARRAY

Multiple CLC018 parts can be combined to build a switching matrix array that has any N-x-8 inputs by any M-x-8 outputs. The keys to this provision are the high-impedance inputs and the facility to Tri-State the outputs to a disabled, high-impedance state. Expanding the number of outputs, for example, is a matter of daisy-chaining the input signals to multiple parts with a single controlled-impedance termination network on the end of each of the eight inputs. Accessing the outputs in the multiple devices is enabled by the Chip Select signal, which is decoded from the most-significant bits (MSBs) of the output address bus.

Expanding the inputs is a similar situation. The outputs of multiple devices are wired together with, again, a single controlled-impedance termination. As a result of the high impedance on the Tri-Stated outputs, the connection is, effectively, an OR statement. The control, in this case, is on the Tri-State pins driven by the decoded MSBs of the input address bus, ensuring that only one output is activated.

Expanding both inputs and outputs can be done simultaneously. Imple-



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minicomputers. In fact, recent studies show that support costs on a PC can be quite enormous, with businesses spending an average of $8170 annually on each PC they own. More than $3800 of that expense is attributed to management costs.

The LM78 diagnostics chip alleviates much of this cost by providing a proactive means of troubleshooting rather than a reactive one. By alerting a systems administrator when specified parameters reach pre-defined thresholds, problems can be fixed quickly with little on-site support and a minimal loss in the computer user's productivity.

Because the device enables up to three different fan-speed measurements, it is possible to detect when a computer's microprocessor is starting to heat up and is thus susceptible to heat-related damage. Through early notification of this occurrence, quick action can then be taken to eliminate the threat to the microprocessor.

The LM78 is fully equipped with a board temperature interrupt active low input for chaining of system management interrupt outputs of multiple external sensors. Consequently, thermostat output temperature sensors can be strategically placed throughout the computer system a board temperature interrupt active low input for additional health-monitoring purposes.

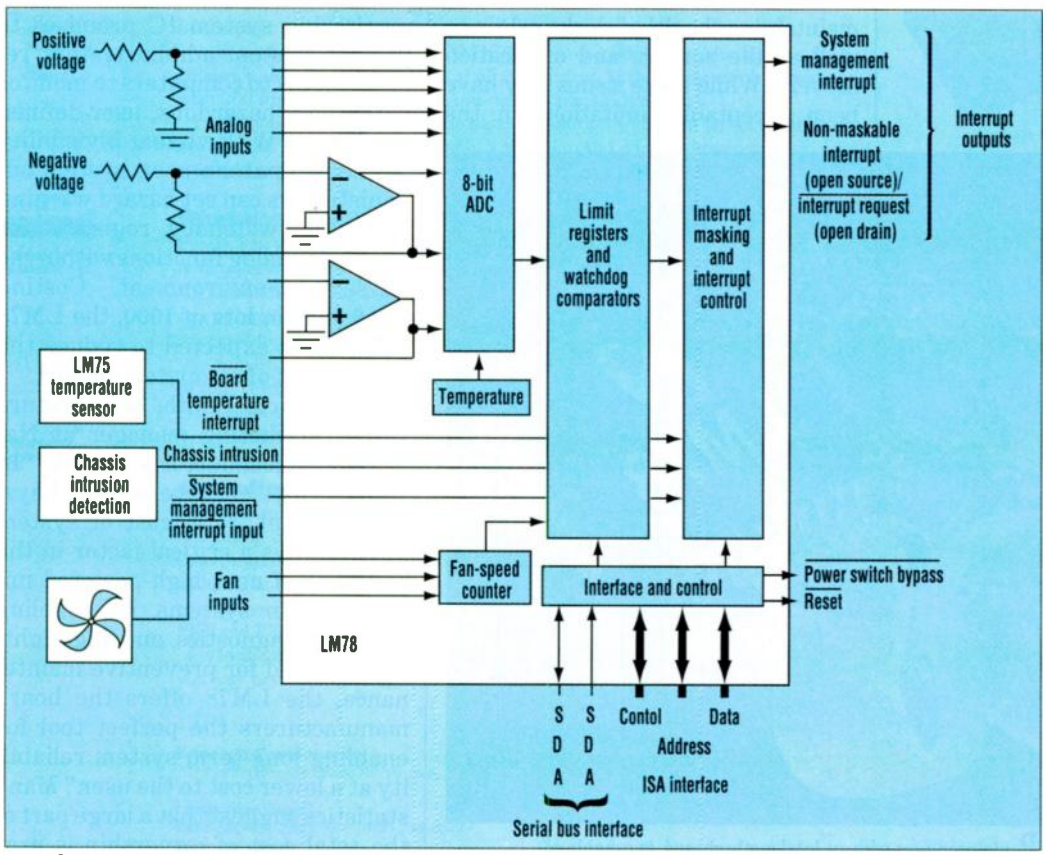
The LM78 also includes a chassis intrusion interrupt which has the potential to be used as a security system. The interrupt is designed to accept an active signal from an external circuit that latches when the case is removed from the computer. A system administrator is remotely notified of the event, and then able to check the computer's health to determine why the computer had been opened, as well as what damage, if any, had been done.

The LM78 hardware monitoring chip was originally developed at the request of Intel, San Jose, Calif., for use on motherboards with high-performance processors. It offers a bandgap-type temperature sensor, 5 positive analog voltage inputs, two operational amplifiers for negative-voltage monitoring, 3 fan-speed monitoring inputs, one input for additional temperature sensors linked to the interrupt system, a board-temperature input interrupt, a chassis-intrusion detector input, and an 8-bit analog-to-digital converter (ADC) *(Fig. 2)*. A 32-byte auto-increment RAM also is provided for POST (Power On Self Test) code storage, and allows the motherboard to waken and record the performance of other system parts during system bootup. Both ISA and serial bus interfaces are available.

The diagnostics chip can be accessed easily from specialized software. Additionally, it can communicate via either of its interfaces, error conditions, and generate interrupts based on user-defined and programmed limits for key parameters.

While the digital part of the chip is derived from an old process, the key to the device's success is the use a standard 1-µm CMOS process in conjunction with E^2 capability for the analog functions. The use of E^2 memory modules enables high precision by effectively trimming many of the analog functions.

The diagnostics chip works by continuously converting analog inputs to 8-bit digital words with 16-mV least-significant bit (LSB) weighting, yielding input ranges of from 0 to 4.096 V. The chip cycles through each measurement, in sequence, and continuously loops through the sequence approximately once every second. These measurements include, for example, the negative analog inputs which provide measurements of negative voltages, such as those from –5- and –12-V power sup-



2. BLOCK DIAGRAM of National Semiconductor's LM78 chip indicates its broad range of analog and digital capabilities. In a typical PC application, it can be used to monitor power-supply voltages, temperatures, and fan speeds.

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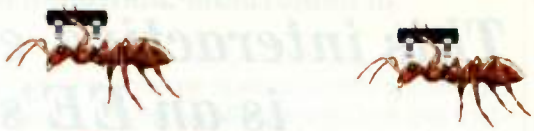

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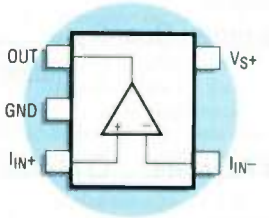

Contact factory to find out about other amplifiers that will be available in the SOT-23 package

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READER SERVICE 137

PRODUCTS NEWSLETTER

EMC, Safety Testing Services Available

Companies that need to perform electromagnetic-compatibility (EMC) and safety testing on their products have a new option available to them. Siemens Rolm Communications Inc., Santa Clara, Calif., now offers testing services at its ISO 9001-certified Compliance Engineering laboratories. The EMC lab can test devices ranging from handheld calculators to large medical equipment. It includes a 10-m semi-anechoic chamber that complies with the site attenuation requirements of ANSI C63.4-1992. The chamber's turntable handles weights to 5000 lbs. The lab can test products to numerous domestic and international emission and immunity standards. Automated test equipment is used to accelerate the process. Other services include consultation to help isolate failures and complex technical construction file applications required for the European CE Mark. Safety-testing services help companies secure approvals from Underwriters Laboratories, the Canadian Standards Association, and the European Community. For more information, contact Al Slutman, Siemens Rolm Compliance Engineering manager, at (408) 492-3923 or al.slutman@siemensrolm.com. Or check the company's web site at www.siemensrolm.com/products/bus_sols/compeng/comp. *JN* **CIRCLE 630**

New DSP Chip For Wireless Messaging

The POMP-15 processor is a new low-power DSP chip for the wireless messaging market. A successor to the Lucent DSP 1615, the renumbering sequence indicates the start of a new family of processors for the wireless market. A new level of integration is set by including the codec and microcontroller functions, therefore it's software-programmable for different protocols. As a result, this should reduce product manufacturers' time to market. Targeted at the voice and data-paging markets, the POMP-15 has a power consumption of 0.7 mA/MIPS and a minimum operating voltage of 2.4 V. The first commercial application will be in Motorola's new family of two-way, narrow-band personal communication services (NPCS) products, with pagers marketed as Tenor, TangoLite, and PageWriter. For more information, contact Lucent Technologies, Microelectronics Group at (800) 372-2447, Dept. R06; or fax (610) 712-4106. *PMcG* **CIRCLE 631**

Floating-Gate EEPROM Family Costs Less

The PCF85xxC-2 family of floating-gate EEPROMs, developed by Philips Semiconductors, Sunnyvale, Calif., now is available in a new pricing range. The EEPROMs, which come in 2-, 4-, and 8-kbit (256, 512, and 1024 by 8 bit) configurations, cost from $0.38 to $0.77 in 50,000-unit quantities. Featured in the EEPROM family is an internal redundant storage code that's fault-tolerant to single-bit errors. This increases the family's reliability compared to conventional EEPROMs. Other attributes of the PCF85xxC-2s include high endurance (1,000,000 erase/write cycles at $T_{amb} = 22^{\circ}C$), built-in error correction, and an I^2C bus interface. Low-power CMOS technology, nonvolatile storage, single supply with full operation down to 2.5 V, an on-chip multiplier, single byte/word and 8-byte page write modes, and sequential and random read operations also are incorporated into the devices. For further information, contact the local Philips distributor, or call (800) 234-7381. *RE* **CIRCLE 632**

Diagnostic IC Monitors Key System Functions

The LM78 is an integrated diagnostic IC that's capable of monitoring potentially hazardous, user-defined condition within microprocessor-based systems. Developed by National Semiconductor Corp., Santa Clara, Calif., the part combines key analog and digital monitoring functions, including temperature, voltage, and fan speed. It communicates the error conditions over the I^2C or ISA bus and can generate interrupts based on user-defined and programmed limits for key parameters. Among the key features of the LM78 include $\pm 3^{\circ}C$ temperature accuracy; a user-programmable watchdog-limits register for over-temperature; and seven voltage-monitoring analog inputs over a range of 0 to 4.096 V The BTI is used with thermostat output temperature sensors that can be located in strategic positions throughout the target system. The LM78 also includes an 8-bit, delta-sigma, analog-to-digital converter with a seven-input multiplexer for high noise immunity. Thanks to an on-board, 32-bit power-on, self-test (POST) RAM, the LM78 is among the first devices on the board to wake up and record the performance of other components. Available now, the LM78 diagnostic IC sells for $5.50 each in lots of 1000. For more information, contact National Semiconductor at (800) 272-9959 or on the Internet at http://www.national.com. *RN* **CIRCLE 633**

EUROPEAN PRODUCT NEWSLETTER

The products listed are available in Europe but may not be available in other market areas of the world.

3-V CPLD claimed as world's fastest

A 3-V complex programmable logic device (CPLD), the first in a new 3-V CoolRunner family of products, is the world's fastest of its kind, according to Philips Semiconductors. Dubbed the PZ3032, the CPLD features an 8-ns delay from any input to any output. The 32-macrocell device incorporates the company's recently announced XPLA (eXtended Programmable Logic Array) architecture, which provides product-term allocation and sharing capability for maximum density with minimum speed degradation. Consequently, up to 32 product terms (gates) can be added with a maximum speed penalty of 2.5 ns, giving designers the fastest product-term allocation solution available.

The CPLD also implements the FZP (Fast Zero Power) technique designed by Philips. A chain of CMOS gates are employed to implement logic rather than sense amplifiers, eliminating the need for constant current. Dynamic current requirements, which are minimal, are determined by the gate switching times. Ultimately, FZP translates into propagation delays of 8 ns.

Stand-by power is less than 100 μA. Measuring dynamic power by implementing 16-bit counters into a device, the dynamic worst-case current at 50 MHz is 20 mA. The chip is presently supported by Synario Design Automation and Philips' XPLA Designer (a PC/Windows-based development tool). In the United States, the PZ3032 CPLD (which comes in 44 PLCC packages) goes for $10.18 in quantities of 10,000 units. For pricing outside of the U.S., contact the company. RE

Philips Semiconductors, *P.O. Box 218, 5600 MD, Eindhoven, The Netherlands, telephone: +31 40 2722091; fax: +31 40 2724825.* **CIRCLE 635**

Fully insulated NiMH accumulator

The prismatic nickel-metal-hydride (NiMH) accumulator PH600 is housed in a special composite plastic package that eliminates the need for further insulation. The accumulator, with a nominal voltage of 1.2 V and a nominal capacity of 550 mAh, is ultrasonic-welded and can be used in any mounting position. It delivers a maximum discharge current of 2 A, and that can be increased to 6 A for up to 2 seconds. A resealing value that's integrated in the lid safely releases any overpressure resulting from excessive charging currents or high temperature. The device uses a positive nickel hydroxide electrode together with a negative hydrogenized plated electrode in an alkaline electrolyte. The accumulator is resistant to deep discharging and doesn't contain any lead, cadmium, or mercury. It weighs 12.5 grams and is 17 mm long, 7.7 mm wide, and 48 mm high. AV

Christoph Emmerich GmbH & Co. KG, Homburger Landstrasse 148, 604335 Frankfurt/Main; telephone: +49 69/548 03-0; fax: +49 69/548 03-210. **Circle 636**

Fluid coolers effective in small areas

Fluid coolers offer an alternative method for efficient heat dissipation from electronic components with a high power loss. They can dissipate large quantities of heat even in very constricted areas. A series of fluid coolers constituting a system for cooling power modules, etc., now has been developed. Due to the internal fin structure, the is effectively dissipated to the fluid. The user has the choice of many different kinds of fluids, such as very pure water, water with corrosion protection additives, oils, alcohols, and so on. All conventional connections or mounting flanges can be fitted to the coolers. I, U, or multiple flow versions can be supplied according to design and dimension requirements of the customer. AV

Fischer Elektronik, *Nottebohmstrasse 28, 58511 Luedenscheid, Germany; telephone: +49 2351/435-0; fax: +49 2351/457 54.* **Circle 637**

Fuse-holder module meets needs

Available in one- or two-pole versions, the CombiFit inlet/fuse-holder module satisfies customer requirements regarding protection against electrical shock protection (class 1), and cost-saving pc-board mounting. The fuse-drawer also meets tool-only accessibility of medical standards (IEC 601-1, BS 5724 part 1, DIN/VDE 0750 part 1), and it accommodates one or two spare fuses. Thanks to a special mounting concept, simultaneous assembling and soldering of all components on the pc board is possible. Furthermore, there are versions available with inlet/outlet and inlet/switch (one or two poles) configurations. Pluggable mains filters can be attached at the back of the base modules. Medical-type filters are currently being developed. An additional surge protector backpack contains two varistors and one gas arrester for protection against overvoltage peaks. All modules are approved according to UL, CSA, VDE, and SEV. AV

Schurter AG, *Werkhofstrasse 8-12, 6002 Luzern, Switzerland; telephone: +41 369/31 11; fax: +41 369/33 33.* **CIRCLE 638**

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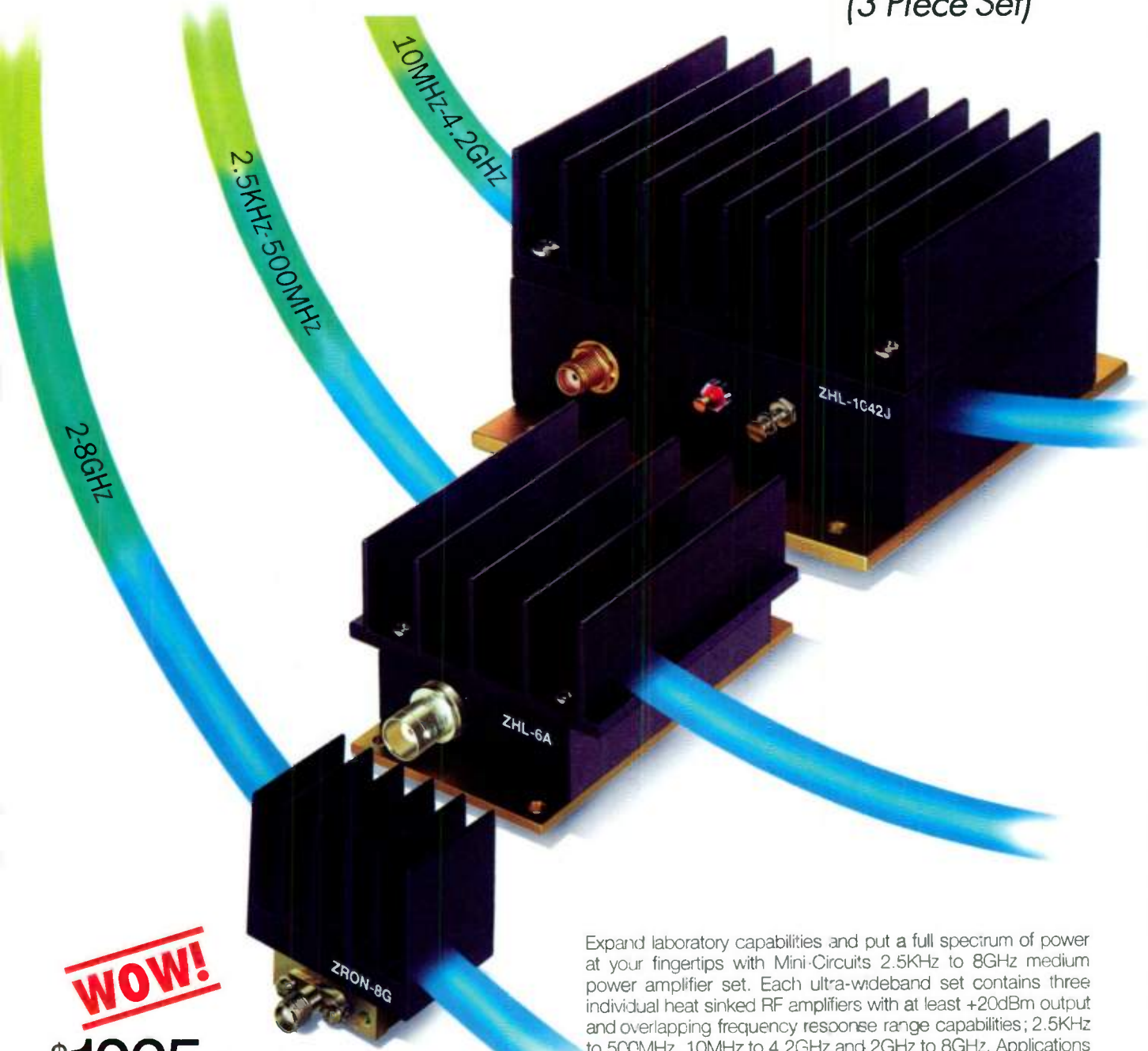

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READER SERVICE 173

COMMUNICATIONS

TWO-STAGE 1.4-W AMPLIFIER ICS TARGET TDMA AND AMPS CELLULAR PHONES

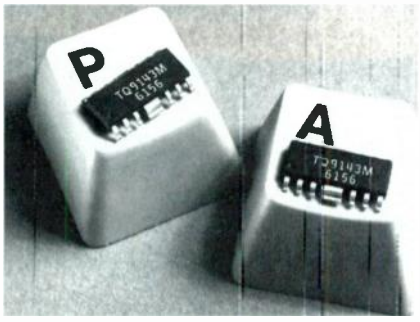
The TQ9143/9147 monolithic GaAs power amplifiers devised by TriQuint Semiconductor provide a cost-effective integrated alternative to discrete solutions and power modules for cellular telephone and modem applications. Both amplifiers provide high output power and efficiency for longer battery life, and a high level of integration for reduced pc-board space.

The TQ9143 is a two-stage IS-54 power-amplifier IC for TDMA and AMPS telephones, and the TQ9147 is a two-stage power amplifier IC for AMPS applications only. Both also can be used for cellular digital packet data (CDPD) modems. The TQ9143 is a linear (Class AB) power amplifier. It's designed for portable terminals operating in the frequency range of 824 to 849 MHz. It has two amplifier stages and provides dual-mode (IS-54) operation (AMPS and TDMA) and meets the requirements of IS-136 operation.

According to Chris O'Connor, marketing and applications manager of TriQuint Semiconductor's Wireless Communications Div., "The TQ9143 addresses the market demand for cellular telephones that operate in both digital (TDMA) and analog (AMPS) modes. A simple change in the bias point shifts the device between the TDMA mode and the AMPS mode." Most of the device's RF matching circuitry is on-chip. The input is matched to 50 Ω and the output is matched with a simple network minimizing the need for external components.

The TQ9143 features a +31.5-dBm power output (1.4 W) and typical power efficiency of 65% at V_{DD} of 4.6 V and a battery voltage of 4.2 V in the AMPS mode. In the TDMA mode, the TQ9143 has output power of 30 dBm (1 W) with typical power efficiency of 40%. Adjacent-channel power is –30 dBc and alternate-channel power of –49 dBc provide for less interference from signals transmitted in adjacent frequency channels.

The TQ9147 is optimized for use in the RF transmitter section of AMPS mobile telephones and is designed for portable terminals operating over the 824-to-849-MHz frequency range. It also



has two amplifier stages. The device features a +31.5 dbm output (1.4 W) at a typical power efficiency of 65% at V_{DD} of 4.6 V and a battery voltage of 4.2 V. Like the TQ9143, its input is matched to 50 Ω and the output is matched with a simple network minimizing the need for external components.

Commenting on the TQ9147, O'Connor adds "The development of new high-power fabrication processes has allowed TriQuint to offer low-voltage and the highest-efficiency high-power integrated power amplifier available. This allows cellular-telephone manufacturers to design lightweight cellular telephones that provide the longer talk times users demand."

A power-control range of more than 25 dB is available with the TQ9147 by using either the device's V_{D1} or V_{G2} pins as control voltages. Other features of both the TQ9143 and TQ9147 include 2nd, 3rd, and 4th harmonic outputs of –30, –35, and –35 dBc, respectively (at +30 dBm output power), spurious levels of –80 dBc (at an input power of –30 to +7 dBm), and –90 dBm noise in the receive band (at an input power of –30 to +7 dBm). Small-signal gain is 32 dB (at –10 dBm input power), input return loss is 10 dB (at –30 to +7 dBm input power), and RF off isolation (TQ9143 only) is 30 dB. Both the TQ9143 and TQ9147 operate from a 2.7-to-6-V power supply provided by three to five NiCd and NiMH battery cells. The TQ9143 features a quiescent current of 450 mA. Both devices are available in SO-16 packages. They both operate over the temperature range of –55 to +100 °C and are rated for a storage-temperature range of –55 to +150 °C.

The TQ9143 is priced at $4.50 each and the TQ9147 goes for $3.25 each, both in quantities of 100,000 units per year. Each is available from stock.

TriQuint Semiconductor Inc., *3625A SW Murray Blvd., Beaverton, OR 97005; (503) 644-3535; fax (503) 644-3198.*

CIRCLE 700

■ LEE GOLDBERG

DIGITAL QUAD TRANSMITTER TARGETS WIRELESS SYSTEMS

Designed to be used as a building block in digital transmitter applications, the GC4114 quad transmitter offers four identical channels on an all-digital chip. The DSP-based IC upconverts external signals to user-programmable center frequencies at sample rates as high as 50 Msamples/s. Chips can be cascaded to obtain additional channels for more complex applications. A 20-channel basestation transmitter, for example, can be designed from five GC4114s, a high-performance digital-to-analog converter, and a single RF upconverter digital oscillator. They offer over 80 dB of spurious-free dynamic range and 70-dB noise-to-power ratio. Tuning resolution is less than 12 μHz when the chip is running at 50 MHz and passband ripple is less than 0.05 dB p-p for each channel. The GC4114 operates at either 5 or 3.3 V. Running at 33 MHz on a 3.3-V supply, the chip dissipates 800 mW. It's housed in a 100-pin plastic thin quad flat pack (TQFP). Pricing is $60.63 in 10,000-unit quantities. JS

Graychip Inc., *2185 Park Blvd., Palo Alto, CA 94306; (415) 323-2955.*

CIRCLE 701

DSP-BASED IC KILLS ECHO TAILS

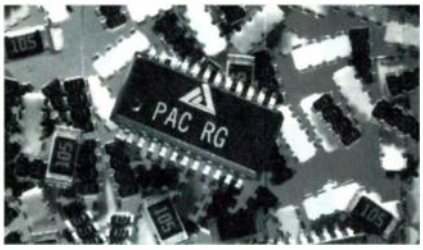
The single-IC MT9122 eliminates voice echoes and distortion, incorporating all of the functions needed to ensure high voice quality in applications that until now have relied on general-purpose digital signal processors. The dual-channel MT9122 eliminates long echo tails of 64 ms for each channel, configurable to 128 ms for single-channel operation. It accepts 16-bit linear or G.711-companded PCM formats and is compatible with the ST-BUS and SSI. Applications are in wireless base stations, video-conferencing systems, and central-office switches. The chip is available in limited quantities. VB

Mitel, *350 Legget Dr., Kanata, Ontario, Canada K2K 1X3; (613) 592-2122.* CIRCLE 702

COMPONENTS

RESISTOR NETWORK TERMINATES PENTIUM BUSES

The PAC RG resistor network provides bus termination and pull-up/pull-down for Intel's Pentium Pro desktop and server designs. It contains 22 integrated thin-film resistors in a single, miniature QSOP (a typical



Pentium Pro motherboard otherwise requires 300 discrete terminating resistors). It's available in three different values for different pc-board impedances. A 50- and 56-Ω network is available for server designs. A 68-Ω network serves desktop PCs. VB

***California Micro Devices**, 215 Topaz St., Milpitas, CA 95035; (800) 325-4966.* CIRCLE 709

DRIVE ELECTRONICS BUILT INTO PLASMA PANEL DISPLAY

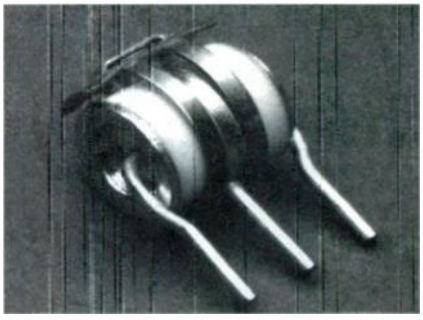
The APD-320G064 plasma panel display includes drive electronics, a TTL-level data interface, and a dc-dc

converter. Measuring 20.45 in. wide and 4.19 in. high, the dot-matrix display consists of a total of 320 columns and 64 rows. It features a viewing angle of 150°. The built-in dc-dc converter generates the necessary panel voltage. Priced at $225.00 in quantity, the APD-320G064 plasma panel display is available from stock to eight weeks. ML

***Dale Electronics Inc.**, 2064 12th Ave., P.O. Box 609, Columbus, NE 68602-0609; (402) 563-6417.* CIRCLE 710

GAS TUBES SUPPRESS VOLTAGE SPIKES

A line of ceramic surge-arrester gas tubes are available with breakdown voltage ratings from 75 to 5000 V. Energy dissipation characteristics range from 5 to 100 kA. All tubes have an internal or external fail-safe option.



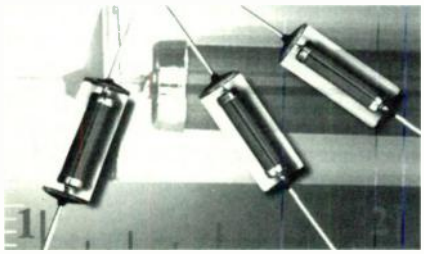
They're hermetically sealed, not radioactive, and retain their characteristics in the dark. In both two-electrode and three-electrode designs, the gas tubes go for $0.30 to $0.90 each. ML

***Citel America Inc.**, 1111 Parkcentre Blvd., Suite 474, Miami, FL 33169; (305) 621-0022.* CIRCLE 711

COMPONENTS

METAL-FILM RESISTORS HAVE S-LEVEL RELIABILITY

RNR (solderable) and RNN (weldable) metal-film resistors have an S-level reliability (better than 0.001%/1000-hr. failure rate) and feature high stability, low noise, and uniformity of construction. The moisture-proof resistors feature a glass-to-metal hermetic enclosure. The enclosure seals the resistor element in an inert-gas atmosphere for protection against all adverse environments while withstanding an external force of over 3000 psi without leakage. RNR/RNN resistors exceed the requirements of MIL-R-55182, Characteristics E and C, for use in military, aerospace, and oceanography programs. Key specifications include 10.0-Ω to 4.99-MΩ resistance range, ±0.1%, ±0.5%, and ±1.0% tolerances, and power ratings from 1/10 W to 1/2 W at 125°C, and 1/8 to 3/4 W at 70°C. Pricing for 200-Ω to 100-kΩ, 1% tolerance units is $2.16 each in quantities of 100. Availability is stock to 10 weeks. ML



Angstrohm Precision Inc., 18400 Precision Pl., P.O. Box 1827, Hagerstown, MD 21742; (301) 739-8722. CIRCLE 712

PRESSURE SENSORS SUIT OEM DESIGNS

Featuring micromachined, silicon strain-gauge technology, the MSP-300 and MSP-310 pressure sensors are fabricated from a single piece of stainless steel. They don't contain any O-rings, welds, or oil-filled cavities. The MSP-300 (pressure) and MSP-310 (pressure and temperature) are offered in several pressure ranges from 0-100 psi (7 bar) to 0-10,000 psi (700 bar), with output signal levels of 1-100 mV, 1-5 V, and 4-20 mA. Combined linearity, hysteresis, and repeatability is 1.0% of full-scale output (FSO) maximum. Long-term stability is

0.25% FSO. The MSP-310 includes an IC temperature sensor and operates over a temperature range of –20 to +85°C. Both units are 2.2 in. long, weigh 3 oz., and use a 1/4-in. NPT pressure-port input. Other pressure ports are available Unit pricing is $40.00 in OEM quantities. ML

Measurement Specialties, 80 Little Falls Rd., Fairfield, NJ 07004; (201) 808-1819. CIRCLE 713

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b. Paid and/or Requested Circulation 1) Sales Through Dealers and Carriers, Street Vendors, and Counter Sales *(Not Mailed)*	24,936	25,127
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NEW PRODUCTS

SOFTWARE

SOFTWARE ENHANCES PRODUCTION PROCESSES

ControlPRO, originally intended for embedded control of semiconductor production equipment, now is available in a PC-on-the-side configuration for enhancing existing production equipment or supplementing proprietary embedded systems on new machines. ControlPro/OTS allows users to physically attach a PC to a piece of equipment and add applications that aren't part of the original equipment system, such as communication with factory control software and data analysis. Benefits include reduced human error, improved process and equipment performance, early warning of process problems, reduced downtime, and fewer test wafers in a production run. With ControlPro/OTS providing distributed data processing at the individual-equipment level, using an EDS (Equipment Data System) allows multiple pieces of equipment to form a networked data-management system. Each site contains control and processing ability, plus data-analysis and management functions. ML

Realtime Performance Inc., *158 Commercial St., Sunnyvale, CA 94086; (408) 245-6537.* CIRCLE 714

MATH-MODELING SOFTWARE UPGRADES TO WINDOWS

Release 3 of TK Solver developed by Universal Technical Systems is an enhanced mathematical modeling software product for moving databases onto PC networks. With OLE Automation capability, Release 3 of TK Solver becomes an application development platform that handles equations, units, data tables, and graphs. TK results, such as inputs/outputs, tables, and plots, can be included in a word processor, spreadsheet and database documents, and CAD drawings using OLE 2.0. Once linked or embedded, TK objects can be upgraded dynamically. With support for external function calls, TK can port legacy Fortran, C, Pascal, or other code into Windows. A rule-based declarative programming language reduces the time and cost of an applications development. The company offers attractively priced unlimited-use site licensing and run-time licensing plans. ML

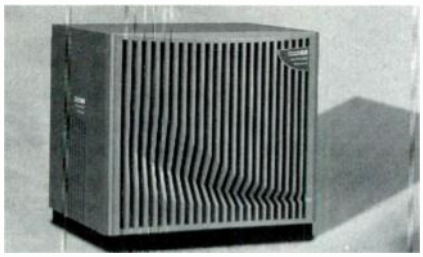
Universal Technical Systems Inc., *1220 Rock St., Rockford, IL 61101; (815) 963-2220.* CIRCLE 715

COMPUTER BOARDS

WORKSTATIONS, SERVERS SUIT HIGH AND LOW ENDS OF COMPUTE SPECTRUM

A new series of workstations and servers from Hewlett-Packard Co. take advantage of the PA-7300LC and PA-8000 microprocessors. The Visualize B-Class workstations are being touted as the mid-range family. The platforms hold the 7300LC CPUs, but are designed to house future processors as they become available. Other features include 128 kbytes of on-chip cache memory and 1 Mbyte of secondary cache. Up to 768 Mbytes of DRAM fit on the motherboard. The systems contain expansion slots for PCI, EISA, or GSC boards. Fast and wide SCSI is available as an option. The model B132L, which holds a 132-MHz processor, processes 5.9 SPECint95 and 6.2 SPECfp95. Prices for this model start at $10,840. The B160L with a 160-MHz CPU, which is capable of 7.8SPECint95 and 7.6 SPECfp95, starts at $16,840.

Four technical servers are based on the PA-8000 microprocessor. The D Class is the entry-level model and it's built with a 160-MHz processor. It offers support for two-way multiprocessing. Various networking options are available, including Ethernet, FDDI, ATM, and Fibre Channel. The K Class can hold four processors, 3.75 Gbytes of main memory, and 8.3 terabytes of disk space (20 Gbytes internal). It offers an I/O bandwidth of 288 Mbytes/s. This



model is suited as a compute or file server. The K Class server costs $60,400 with 128 Mbytes of DRAM, 2 Gbytes of hard-disk space, a CD-ROM drive, and a two-user license.

The S Class system holds up to 16 microprocessors to perform 11.52 GFLOPS. Up to 16 Gbytes of DRAM can be accommodated, while the crossbar interconnect system offers a bandwidth of 16 Gbytes/s. Expansion is handled through the PCI bus, with slots for 24 boards. A four-processor box with 256 Mbytes of DRAM, and a 4-Gbyte hard-disk drive costs $180,000. The highest performer is the X Class, which holds up to 64 CPUs. With a peak performance of 46 GFLOPS, this version can handle high-end mechanical and electrical design automation. It sells for $718,000 with 16 CPUs, 1 Gbyte of DRAM, and a 4-Gbyte hard-disk drive.

***Hewlett-Packard Co.**, 300 Apollo Dr., Chelmsford, MA 01824; (508) 256-6600.*

CIRCLE 716

■ RICHARD NASS

3D GRAPHICS AND VIDEO ACCELERATOR CARD

The Fahrenheit Video 3D provides PC users with integrated 2D and 3D acceleration for multimedia and entertainment applications as well as Internet VRML browsing. Based on the S3 ViRGE 64-bit graphics and video accelerator chip, Fahrenheit Video 3D supports Microsoft's Direct 3D technology. It supports both Windows 95 DirectDraw and Direct3D, and provides driver support for Windows 3.1x, Windows 95, Windows NT, OS/2 Warp, and AutoCAD. The card is available now, with prices starting at $239. CM

***Micronics Computers**, 221 Warren Ave., Fremont, CA 94539; (510) 651-2300.* CIRCLE 717

WORKSTATION MOTHERBOARD OPERATES WITH PENTIUM PRO

Building a high-performance workstation is easy using the W6-LI Pentium Pro-based motherboard. The board is designed to fit the ATX form factor and holds one or two CPUs running from 150 to 200 MHz. Built with Intel's 440FX chip set, it offers support for enhanced-data-output (EDO) and fast-page-mode (FPM) memory technologies with error checking and correction. It has a wide UltraSCSI connection, full-duplex, 16-bit SoundBlaster-compatible audio, integrated Enhanced IDE, and PCI and ISA slots. Large-volume quantities are available. RN

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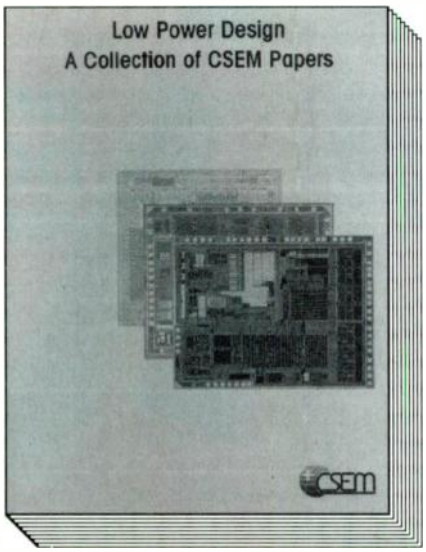

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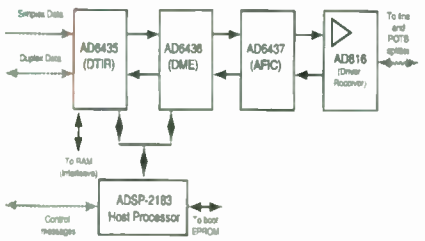
EASY-TO-USE ADSL MODEM CHIP SET MEETS ANSI/ETSI SPECS, SLASHES COST

Modems that can deliver up to eight Mbits/s over standard twisted-pair phone lines now are a practical reality when using the AD20msp910 asymmetric digital subscriber line (ADSL) modem chip set. Priced at under $80, the five-chip modem/controller/line



interface is among the first products to meet the stringent ANSI T1.413/ETSI standards for ADSL transmission. By using a completely integrated approach, it will be possible to implement a complete ADSL modem with a retail price of around $200. This will help telephone companies that hope to provide ADSL service meet their projected target cost of $500 per line.

By employing discrete multitone (DMT) modulation, the transceiver can deliver data rates of 6 Mbits/s downstream and 244 kbits/s upstream over lines up to 12,000 feet in length. Rates of 8 Mbits or greater can be achieved over shorter loops. The chip set's rate-adaptive capability allows it to be configured to provide an alternative downstream rate of 4.5 Mbits/s, with a 450-kbit/s upstream channel.

The AD20msp910 includes all required hardware and software components for an ADSL transceiver and host processor. It includes a microcontroller, line driver, and interface circuits. The chip set consists of the AD6435 modem interface, the AD6436 DMT coprocessor, the AD6437 analog front end, the AD816 line driver/receiver, and the ADSP-2183 digital signal processor, plus a full set of configuration and management software. In addition, a full range of support is available for modem manufacturers. This includes complete reference designs that use pre-developed application software and off-the-shelf components. A complete design kit also is available, providing pc-board layouts and schematics.

The AD6435 modem interface serves as an interface between the ADSL chip set and external systems, and includes a V.35 interface that permits it to connect easily to any standard router. The AD6436 DMT coprocessor performs the core DSP operations required to generate and decode DMT signals. The AD6437 analog front end is a mixed-signal chip that executes all of the analog and mixed-signal operations required in ADSL systems, including analog-to-digital and digital-to-analog conversions, filtering, and amplification.

The AD816 line driver/receiver provides the amplification and line-interface functions for ADSL transmission and meets all ANSI/ETSI noise and distortion specifications. The ADSP-2183 is a general-purpose fixed-point DSP that analyzes line conditions, calculates equalization parameters, and performs control operations. It's powerful enough to also function as a general-purpose embedded controller for other application-specific tasks. The AD20msp910 will be sampling in December, with full production slated for the first quarter of 1997. Production pricing will be under $50 for the transceiver chip set, plus $30 for a line interface and host controller.

***Analog Devices Inc.**, Ray Stata Technology Center, 804 Woburn St., Wilmington, MA 01887; (617) 937-1428; fax (617) 821-4273; Internet: http://www.analog.com.*
CIRCLE 719

■ LEE GOLDBERG

QAM IN ADSL/VDSL TRANSCEIVER SPEEDS DATA

The BCM6010 is the world's first complete single-chip QAM (quadrature-amplitude modulation) ADSL/VDSL transceiver. Intended for use in both central office and customer premise equipment in broadband local loops, it can support data rates of up to 52 Mbits/s. It incorporates a frequency-agile, rate-adaptable 4-to-256 QAM transmitter and receiver, a digital line equalizer, forward-error-correction (FEC) circuitry, as well as ADCs and DACs. A standard UTOPIA data interface allows byte- or cell-based data transfers between the transceiver and its host system. Its low power consumption (< 1 W) makes it ideal for use in compact, unventilated cases. Although the BCM6010's data rate, center frequency, and other parameters are fully programmable via configuration registers, no microcode is required to operate the device. A sophisticated digital decision-feedback equalizer has programmable tap lengths to permit line equalization for ADSL loop lengths of up to 18,000 feet, and higher rate VDSL data rates on shorter loops. The equalizer's feed-forward filter also provides a powerful tool for combating static and dynamic loop impairments, such as AM radio RFI and funneled noise from appliances. Error protection is handled using Reed-Solomon error correction and convolutional, programmable depth interleaving techniques.

Housed in a 100-pin PQFP, the BCM6010 will be sampling in February of 1997, with full production scheduled for early in the second quarter. Pricing is below $25 each in volume production quantities. LG

***Broadcom Corp.**, 16251 Laguna Canyon Rd., Irvine, CA 92618; (714) 450-8700; fax (714) 450-8710; e-mail: info@broadcom.com.* CIRCLE 720

SLIC/RING GENERATOR COMBO CUTS COST OF LOOPS

The ATTL7554 ringing SLIC (subscriber line interface circuit) provides a single-chip solution for line interface and ring generation in short loop applications. Designers can realize cost and space savings by eliminating the separate ring generation circuitry required for previous SLICs. It offers distortion-free, on-hook transmission in both the send and receive directions. As a result, the caller ID feature can be used for many applications, including fiber-in-the loop, ISDN, POTS, hybrid fiber coax, and wireless local loop. Evaluation boards, support, and local application engineering assistance also are available. Available now, the ATTL7554 is priced at $5.70 each in quantities of 100,000 units. LG

***Lucent Technologies.**, Room 30Q050BA, 555 Union Blvd., Allentown, PA 18103; (800) 372-2447; Dept. P92, (610) 712-4106.* CIRCLE 721

INTEGRATED LINE DRIVERS FOR DMT-BASED ADSL APPS

The MC03AX1456xx family of integrated line drivers is designed to give engineers a single-chip line interface for DMT (discrete multitone)-based ADSL applications. Designed to work in concert with the MC145650 ADSL transceiver, both chips perform three basic functions. They provide digital input and output interfaces to the ADSL transceiver's transmit and receive ports, and provide a bidirectional analog line interface to the local loop's twisted pair. Together, they support transmission of ANSI-standard T1.413 Category-2 ADSL modem operation, with downstream payload data rates of up to 6.4 Mbits/s, and an upstream capacity of 640 kbits/s. In non-ANSI modes, the pair can deliver up to 8 Mbits/s downstream, and 1 Mbit/s bidirectionally.

Offered in -RT and -CO versions, the two driver chips are optimized for the power and data rate requirements of applications in central offices and remote terminals (customer premises equipment). The transmit port incorporates a programmable high-pass filter with three gain settings. The receive port has an on-chip programmable HF-boost and gain stage, each with three settings. Transmit band for the -CO part is 26-1104 kHz, and 26-138 kHz for the -RT driver.

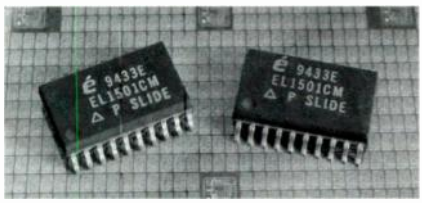
Scheduled for production in the first quarter of 1997, the MC03AX1456CO and MC03AX1456RT will come in 30-pin HSOPs. Pricing will be under $10 each for high-volume orders. LG

***Motorola Communications Group**, 3501 Ed Bluestein Blvd., Austin, TX 78721; attn: Al Hoelck at (512) 934-6874; fax (512) 934-7991; e-mail: rdjj90@email.mot.com.*

CIRCLE 722

LINE DRIVER/RECEIVER PUMPS ADSL OVER UTP

The EL501C is an integrated line driver/receiver that can move virtually any analog data across conventional twisted-pair copper phone lines. Known as the SLIDE (subscriber line interface device), the EL501C has been designed to serve as an interface between an analog phone system's copper phone lines and a digital communication system's ADCs and DACs. It can be used as a complete full-duplex, physical-layer ADSL transceiver, thanks to its two wideband high-voltage drivers and two receiver amplifiers. The transceiver's latch-proof output stage can drive 45-V p-p signals at 2 MHz into a 200-Ω load with a typical output distortion figure of –60 dB, and typical input distortion of –73 dB. It also can be used to transmit standard analog



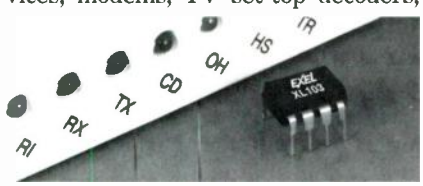
video signals across twisted-pair phone lines. Its low power dissipation is a real advantage in unventilated applications and enables it to be housed in a compact SO package.

The EL501C supports all standards for ADSL and HDSL transmission by the T1/E1 committees. Housed in a 20-lead SIP, the EL501C operates in a ±5-V to ±15-V power-supply range. Available now, the transceiver costs $7.57 in quantities of 1000 units. LG

***Elantec Inc.**, 1996 Tarob Court, Milpitas, CA 95085; attn: Ken Fields (408) 945-1323, ext. 361; fax (408) 945-9305.* CIRCLE 723

REAL-TIME ENCRYPTTION FOR MODEMS, CELLPHONES

The XL103 CryptChip is a single-chip encrypt/decrypt device that provides real-time protection of data streams in products such as Internet access devices, modems, TV set-top decoders,



and cellular telephones. It can be used with a modem to protect sensitive data such as authorization codes, or in cellular telephones to prevent interception and duplication of the phones' sensitive 11-digit electronic serial number (ESN), which is transmitted to establish a call and determine billing charges.

The XL103 encrypts (or decrypts) data at a rate of 6.4 bits/ms. The process of encrypting consists of three steps. First, a 32-bit data word is loaded into the XL103 via its serial link. Next, the data is encrypted using a 64-bit key, which is stored on an on-chip EEPROM. Finally, the data is read from the chip. Commands and data are both loaded in and out of the XL103 via its simple two-wire serial interface. Power consumption is low, drawing 1 µA in standby and 1 mA during operation. Available now, pricing is $0.97 each in 1000-piece lots. LG

***EXEL Microelectronics Inc.**, 2150 Commerce Dr., San Jose, CA 95131; (408) 432-0500; fax-back service (800) 853-5886 or (908) 935-2774; Internet: http://www.exel.com.* CIRCLE 724

DSL MODEM RUNS AT UP TO 8 MBITS/S OVER POTS LINES

The FastInternet DSL (digital subscriber line) modem system lets telecommunications companies and institutional networks use their installed base of copper lines to carry data at speeds between 384 kbits/s to 8 Mbits/s, depending on distance and other factors.

FastInternet supports all types of DSL transmissions, including high-bit-rate digital subscriber line (HDSL), asymmetric digital subscriber line (ADSL), symmetric digital subscriber line (SDSL), and very-high-speed digital subscriber line (VHDSL) services. Because it requires no special line testing or conditioning, telephone companies wishing to offer their subscribers fast access services need only install a FastEthernet line card at the central office and a standalone modem, similar in size of current POTS modems, at the subscriber's home or business.

The FastInternet system features a fully integrated passive POTS splitter that allows subscribers to talk on the phone at the same time they're connected to the Internet or other high-speed data connections. Depending on distance from the central office, symmetric data services can be supported at speeds up to 2 Mbits/s. Asymmetric services can provide 4 or 8 Mbits/s of downstream bandwidth, with a 640 kbit/s upstream channel.

Available now, the FastInternet system costs $2500 per link in trial volumes. Volume pricing is anticipated to be less then $1500 per link by early 1997. LG

***Orckit Communications**, 2 Enterprise Dr., Suite 303, Shelton, CT 06484; (888) 9-ORCKIT or (203) 926-0776; e-mail: info@orckit.com.*

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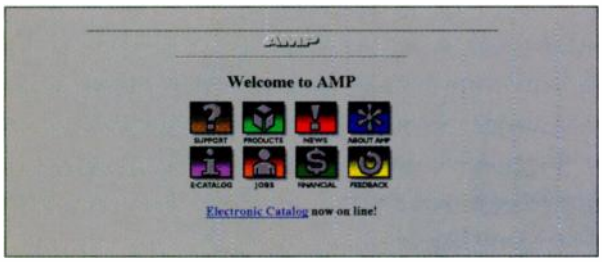

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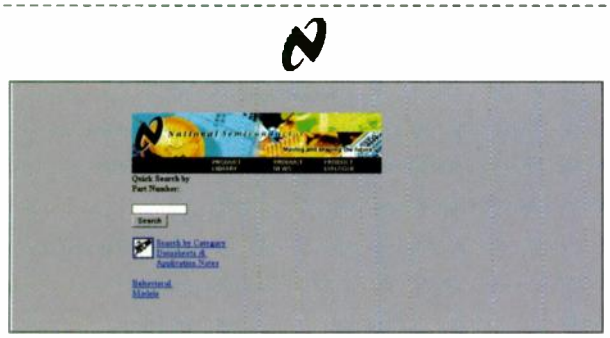

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The SR620 Time Interval Counter makes single shot time measurements with 25 ps resolution as well as one second frequency measurements with 11 digit resolution. It also measures period, counts, pulse width, rise time and fall time, and reports statistics on up to one million samples. Interfaces include RS-232, GPIB (IEEE-488) and a printer port, which provides a hardcopy output of histograms or plots of mean and jitter vs time. (408) 744-9040

CIRCLE 254

STANFORD RESEARCH SYSTEMS

M/S ASIC CAPABILITIES

The Mixed-Signal Division of American Microsystems, Inc., is continually improving its analog, digital, and mixed-signal design and simulation tools. Adding cells to its cell library, reducing cost and time required to develop mixed-signal ASICs. For more information on MPD, call **(208) 233-4690** or visit our home page http://www. amis.com

CIRCLE 255

AMERICAN MICROSYSTEMS

AIN INSIGHTS INTO FUTURE TRENDS

This 14-page discussion of the competitive landscape created by the Telecom Act of 1996 examines trends and technologies affecting the telephony market. Heurikon Corp., a division of Computer Products, Inc., used its communication system product development experience, customer and prospect interviews to develop this overview.

CIRCLE 256

HEURIKON CORPORATION

HIGH EFFICIENCY RECHARGEABLE

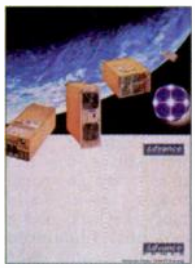
Eagle-Picher introduces a new 12 volt 5.1 ampere hour VRLA battery to its HE, The HE12V5.1 delivers 30-50% more performance than batteries of comparable size. The HE12V5.1 is optimized for high rate discharge applications providing 250 watts for 5 minutes and 125 watts for 15 minutes. The high energy density gives the OEM the advantage of designing smaller systems with the same or more power output as large ones. Call 417-776-2256

CIRCLE 257

EAGLE-PICHER

POWER SUPPLY CATALOG

Advance Power's 1996/97 Power Supply Catalog contains specs on units ranging from 15W to several kilowatts—including the new Kestrel VWF350 multi output switch-mode power supplies. Catalog also features a complete line of rectifiers for telecom applications.

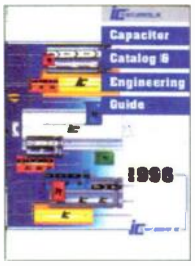


CIRCLE 258

ADVANCE POWER, INC.

ILLINOIS CAPACITOR'S CATALOG

Illinois Capacitor's and Engineering Guide contains complete information on company's aluminum electrolytic, film, ceramic and power capacitors. It's all you need to make a knowledgeable capacitor selection. Available capacitance range, voltage ranges, operating temperature, case styles, IC authorized distributor listings, 208 pages.

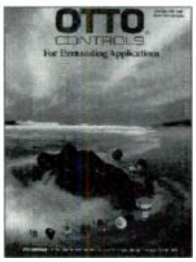


CIRCLE 259

ILLINOIS CAPACITOR, INC.

SNAP-ACTION SWITCHES

All new Catalog 105 has 72 pages featuring the new sealed rocker K Series and detailing an in-depth line of precision snap-action push-button, toggle, rocker, limit and basic switches. All feaure OTTO's unique design assuring low contact resistance, high contact pressure and long cycle life. Quality made in the U.S.A.

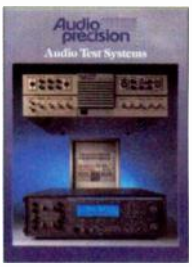


CIRCLE 260

OTTO CONTROLS

AUDIO FREQUENCY TEST SETS

AUDIO PRECISION offers technical catalogs covering the system One & the ATS-1 audio test systems. The system One is available in GPIB & PC-based versions. The new ATS-1 provides GPIB & manual front panel control. Both instruments offer extremely low residual noise & distortion for high performance measurements on audio & low frequency systems.

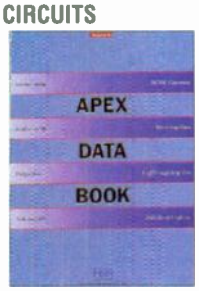


CIRCLE 261

AUDIO PRECISION

POWER INTEGRATED CIRCUITS

The 7th edition Apex Power Integrated Circuits data book contains complete product data sheets and applications notes for Apex Microtechnology's Power Amplifier, PWM Amplifier and DC/DC Converter product lines. Call: 1-800-862-1021; FAX: 1-520-888-3329; E-MAIL: Prolit@TeamApex.com.

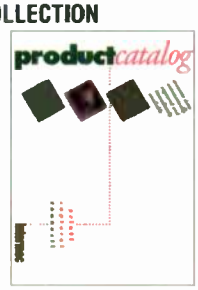


CIRCLE 262

APEX

AUTOMATIC DATA COLLECTION

A 60 page, four color catalog from Intermec Corp. Everett, WA, the world leader in Automatic Data Collection technology. This new catalog includes thermal transfer bar code printers, scanners, handheld computers, network controllers, radio frequency data collection systems and much more.

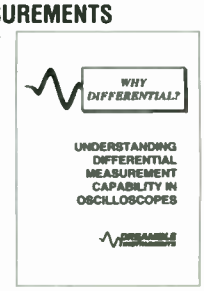


CIRCLE 263

INTEMEC CORPORATION

DIFFERENTIAL MEASUREMENTS

A discussion of single-ended and differential scope measurements on ground referenced and floating signals. Differential amplifier characteristics such as common mode rejection ratio and common mode range are covered.
1-800-376-7007



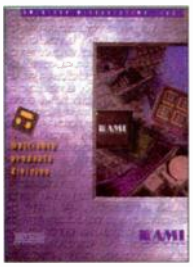
CIRCLE 264

PREAMBLE INSTRUMENTS

ELECTRONIC DESIGN CATALOG/LITERATURE REVIEW

THE MULTICHIP PRODUCTS DIVISION

The Multichip Products Division of American Microsystems, Inc. provides design, manufacture and test services to customers needing a multichip solution. AMI offers a full range of substrate, die attach and packaging for multichip products. For more information on MPD, call (208)233-4690 or visit our home page http://www.amis.com

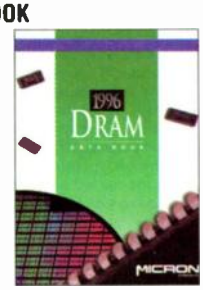


CIRCLE 265

AMERICAN MICROSYSTEMS INC.

1996 DRAM DATA BOOK

Micron Technology, Inc. brings quality, productivity and innovation together to provide advantages for you. This book contains product and technical information for Micron's DRAMs, including FPM, EDO an Burst EDO DRAMs; modules; and SGRAM.



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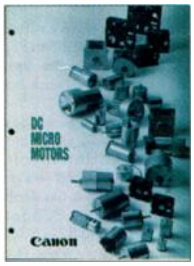

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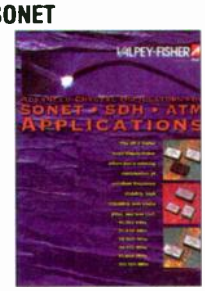

CIRCLE 268

VALPEY-FISHER

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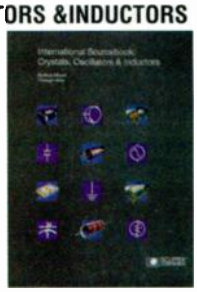
Sagebrush Systems introduces a new generation of powerful, affordable desktop EDA tools. Starting with Analog Circuit Master (ACM) for Windows and Windows95, Sagebrush puts fast, powerful, simulation and analysis, and features until now only found on high-end programs, right on your desktop.

CIRCLE 269

SAGEBRUSH SYSTEMS

CRYSTALS, OSCILLATORS &INDUCTORS

The International Source Book offers detailed specifications on Ecliptek's through-hole and surface-mount crystals, oscillators, and inductors. Visit our newly revised internet site at http://www.ecliptek.com. Phone: (714)433-1234 or E-mail: ecsales@ecliptek.com

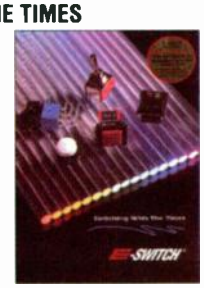


CIRCLE 270

ECLIPTEK CORPORATION

SWITCHING WITH THE TIMES

Within the familiar cover of the new E-Switch catalog lies an all new interior-now in full color! The redesigned catalog contains product descriptions, specifications, and dimensions for push-button, toggle, rocker, power, lever, slide, rotary, keylock, and tact switches. Illuminated, sealed, and SMT versions are available.



CIRCLE 271

E-SWITCH

NEW TRIMMER CATALOG

C&K's new Trimmer Catalog has single & multi-turn models, top and side actuated, thr-hole or 3mm & 4mm surface mount models. All have cermet resistive elements & tin-lead terminals with epoxy seal. C&K Components, Inc. 57 Stanley Ave. Watertown, MA 02172-4802. Phone: (800) 635-5936

CIRCLE 272

C&K COMPONENTS, INC.

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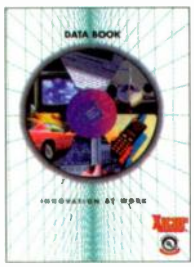
Xicor's broad line of in-the-system programmable semiconductor integrated circuits retain information even when system power is lost or turned off. In-the-system programmability enables telecommunications, consumer, computer industrial, automotive and military products to adapt to changing software and operation environments . Call (408) 432-8888 Ext. 3336.



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XICOR

WHO MAKES DESIGN EASY?

Protel eases complex electronic design easy by providing the only fully-integrated environment that supports the entire process from schematic capture and circuit simulation, through PCB layout and artwork generation. To learn more about this revolutionary system, contact Protel at 1-800-544-4186 or visit our website at www.protel.com.

CIRCLE 274

PROTEL TECHNOLOGY

RF/IF DESIGNER'S GUIDE

180 page RF/IF Designer's Guide is loaded with informative features such as practical articles, definitions of terms, environmental and reliability test procedures, answers to frequently asked surface mount technology questions, and more! It also contains the most complete and up-to-date specifications and price information about all Mini-Circuits signal processing components. To receive a free Designer's guide, simply call (718) 934-4500

CIRCLE 275

MINI-CIRCUITS

OMRON RELAYS, SWITCHES, MORE

Standard Product Catalog shows Omron's most popular relays, switches, and sensors. The 176-page catalog also includes card readers, time delay relays, totalizers, limit switches and temperature controllers. Literature sent only to addresses in the U.S.A. Omron Electronics, Inc. Call toll-free 1-800-55-OMRON or e-mail EDLit@oei.omron.com

CIRCLE 276

OMRON ELECTRONICS, INC.

PRINTED CIRCUIT BOARD DESIGN

The PADS-PowerPCB design tool catalog from PADS Software, Inc. highlights the PowerPCB product line, including the Dynamic Route Editor and Database Viewer features. PADS-PowerPCB is a function-rich PCB design tool suite for Windows.

CIRCLE 277

PADS SOFTWARE, INC.

SINGLE BOARD COMPUTERS

ICP Acquire Inc. is a manufacture of single Board computers, passive Backplane, rack-mount chassis, and Industrial Power supplies. Including: 3-20Slot BP, 386/486/Pentium SBC, 3-20Slot chassis, DC-12V/24V/-48V PS and 85-265V AC PS. Contact Allen, phone: 415-967-7168

CIRCLE 278

ICP ACQUIRE, INC.

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CIRCLE 279

ROLYN OPTICS CO.

ELECTRONIC DESIGN CATALOG/LITERATURE REVIEW

INTRODUCING CodeTEST TM

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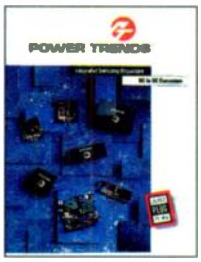
CIRCLE 280

APPLIED MICROSYSTEMS CORPORATION.

NEW SWITCHING REGULATORS

Power Trends Inc., has released a new 72 page full line catalog for its Integrated Switching Regulators (ISRs) and DC to DC Converters. The catalog introduces significant new products along with extensions to existing product lines. Complete specifications, photos and standard applications are provided for each product, along with mechanical configuration options and ordering information.

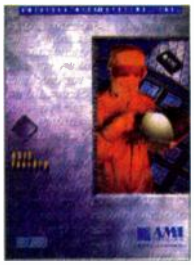


CIRCLE 281

POWER TRENDS INC.

FOUNDRY

American Microsystems, Inc. has offered custom and semicustom foundry expertise for over 30 years. AMI supports 0.35m through >1m design and will increase its production capacity by 3x with the completion for FAB 10. For more information on AMI's foundry, call (208) 233-4690 or visit our home page http://www. amis.com



CIRCLE 282

AMERICAN MICROSYSTEMS INC.

P&B®RELAYS & BREAKERS

Catalog lists stock relays and circuit breakers from Potter&Brumfield® products Division. Describes electromechanical, solid state and time delays, as well as thermal and magnetic circuit breakers. Numerous options. Fax: (812) 386-072,e-mail:info@ae.sec. siemens.com

CIRCLE 283

SIEMENS ELECTROMECHANICAL

MECHANICAL ENCODER SOLUTIONS

New Product Bulletin #698 lists the Series 25, single and multi-deck encoders. The Series 25 offers Binary, Binary Compliment and Gray code outputs in 1 deck through 4 decks. Choose from 4 to 36 switch positions for the selected code output. For an economical alternative, The Series 25L, single deck design, provides similar coding and position choices. The Series 25L is priced at $1.25 in production quantities.

CIRCLE 284

GRAYHILL

HARTING har-mik

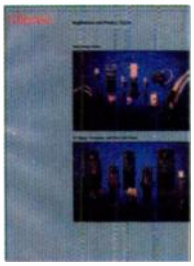
Harting har-mik 4 color brochure shows and describes comprehensive range of 0.050" pitch miniature connectors designed to meet the requirements of Internal and External connections of the future. Reduced size: contact density. 847/519-7700 or Fax: 847/519-9771.

CIRCLE 285

HARTING ELEKTRONIK, INC.

APPLICATION AND PRODUCT GUIDE

Free 84-page catalog features detailed specifications on Kilovac's full line of high voltage relays, contractors and power controllers. Whether your applications call for 28V or 70,000V; isolation or power switching, Kilovac can meet your needs. Phone:(805) 684-4560, Fax: (805) 684-9679

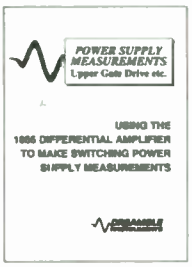


CIRCLE 286

KILOVAC

APPLICATION NOTE

Covers how to make safe and reliable measurements on switching power supplies operating on line, Includes such difficult measurements as upper gate drive and transistor saturation characteristics. Tells how to quantify measurement corruption caused by high dv/dt common mode. 1-800-376-7007



CIRCLE 287

PREAMBLE INSTRUMENTS

ON-LINE CATALOG

Visit http://www. keyelco.com and quickly locate up-to-date Electronic Hardware and Interconnect Components. Website includes photos, drawings and specifications. Listings include PCB Components & Hardware, Interconnect Components, Battery Connectors & Holders, Mechanical Hardware, Panel Hardware plus a monthly product spotlight. General information such as capabilities and ISO 9002 are clearly defined.

CIRCLE 288

KEYSTONE ELECTRONICS CORP.

COMPARE MODEL SPECS ON TECHRON

ELKHART, INDIANA..For easier model comparison and ordering, Techron has compiled specifications for its full line of industrial power amplifiers into one brochure..available free. Among the specifications listed for these low-noise linear single-and bi-level amplifiers are output load, voltage, current, power, bandwidth and price. For more information, contact: Techron (219)294-8300.

CIRCLE 289

TECHRON

FREE AND EASY DESIGN

Centurion International offers a PC-format Antenna and Battery Pack Design Specifications Kit. This diskette will help designers obtain faster, more accurate project proposals from Centurion, and will make communication between specifier and vendor more efficient. Antenna and battery design worksheets make specifying easy, and users return the diskette to Centurion engineers for quick-turnaround proposals.

CIRCLE 290

CENTURION INTERNATIONAL, INC.

FREE Instrumentation Reference

The National Instruments 1997 catalogue features the latest versions of the company's LabVIEW® , LabWindows® /CVI, and HiQ® application software products. New products include Bridge VIEW™ and Lookout™ software packages for industrial automation. In addition, our new line of IMAQ™ products features a complete hardware, software, and driver software solution for imaging.

CIRCLE 291

NATIONAL INSTRUMENTS

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CIRCLE 294

Z-WORLD ENGINEERING

ELECTRONIC DESIGN CATALOG/LITERATURE REVIEW

CATALOG OF EMBEDDED CONTROLLERS

Micromint, Inc. is a leading supplier of single-board computers, controllers and peripheral controllers to the world-wide OEM market, as well as providing custom-engineered computer solutions to consultants.
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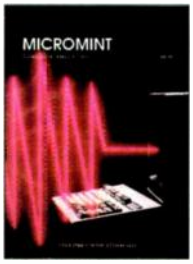
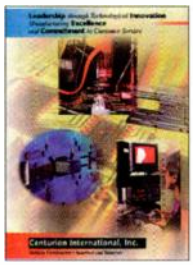


CIRCLE 295

MICROMINT, INC.

NEW BROCHURE OF CENTURION

LINCOLN, NEBRASKA- A new brochure describes the innovative capabilities of Centurion as one of the world's largest and most experienced companies in the design and manufacture of antennas and batteries for the wireless communications industry. Centurion International, Inc. P.O. Box 82846, Lincoln, Nebraska 68501-2846 USA. Phone: (800)228-4563, FAX: (800) 848-3825.



CIRCLE 296

CENTURION INTERNATIONAL

RELIABILITY PREDICTION

Catalog describes the RelCalc2 software package, which automates Mil-HDBK-217 or Bellcore on your PC, and allows quick and easy reliability analysis of your electronic products.
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CIRCLE 297

T-CUBED SYSTEMS

INNOVATIVE INTEGRATION

Innovative Integration sells Blazingly Fast Data Acquisition Products. FREE DSP & Data Acquisition Products Catalog
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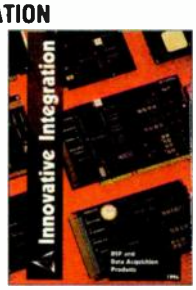


CIRCLE 298

INNOVATIVE INTEGRATION

FREE SPICE NEWSLETTER

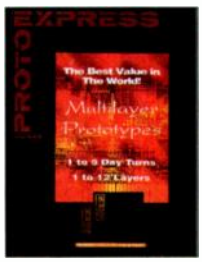
The Intusoft newsletter is a free publication dedicated to discussing topics related to the spice circuit simulators. Each issue contains application notes, technical articles, and modeling techniques that help engineers simulate.

CIRCLE 299

INTUSOFT

MULTILAYER PROTOTYPE

Award winning quick turn multilayer prototype manufacture specializing in 24 hour to 5 day turns, for commercial and milspec boards (Mil-P-55110E) on FR4 and polyimide materials. Our capabilities also include "blind and buried" vias, full body gold, carbon baste, metal core boards, small hole drilling, and net list testing.



CIRCLE 301

PROTO EXPRESS

RELIABILITY SOFTWARE

The Relex Reliability Software for Microsoft Windows and the Mac provides Reliability Predictions per the MIL-HDBK-217, Bellcore, Mechanical, and CNET standards, as well as FMEA/FMECA analysis and Maintainability Predictions. The new four color 20-page catalog describes the flexible CAD Interface, extensive parts libraries, and stunning graphics.

CIRCLE 302

INNOVATIVE SOFTWARE

MADE TO ORDER

The Data I/O catalog is the direct-order source of affordable tools for users of programmable devices. From design software to device programming and automated handling systems, the Data I/O catalog offers unbeatable values on the the high quality tools you need. Call 1-800-332-8246, ext. 806.

CIRCLE 303

DATA I/O

ADHESIVES AND SEALANTS

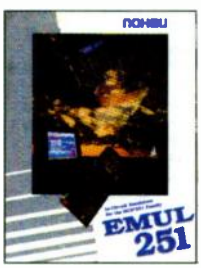
Master Bond Inc., Hackensack, NJ manufactures over 3000 grades of adhesives, sealants and coatings. Line cosists of epoxies, anaecobics, cyanoacrylates, silicones and acrylics. One and two part systems are available.
Tel. 201-343-8983.

CIRCLE 304

MASTER BOND INC.

IN CIRCUIT EMULATORS

Nohau Corporation is a manufacturer of In-Circuit Emulators for the following families: 8051, MCS251, P51XATM, 80C196, 68HC16, and 683XX families. Web Site Address:
http://www.nohau.com



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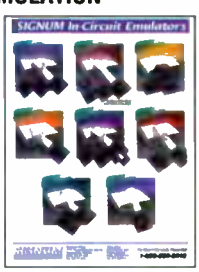

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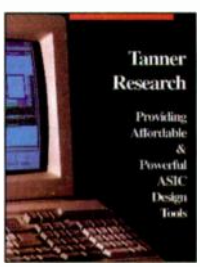

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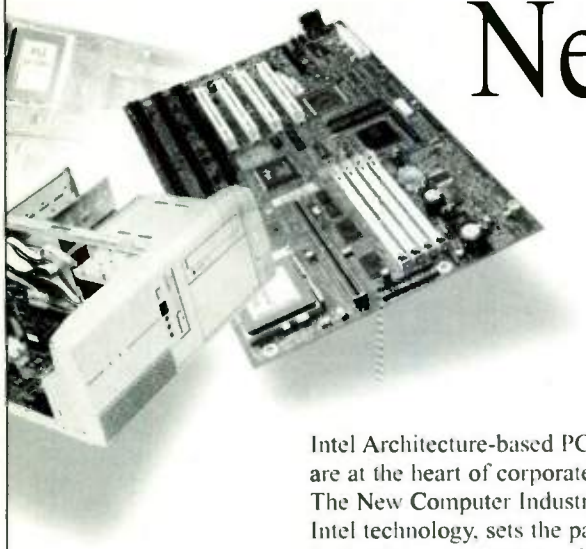

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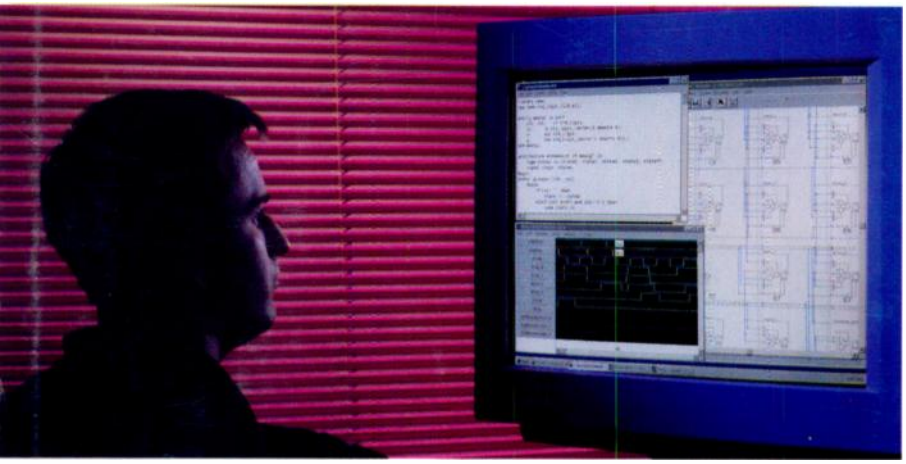

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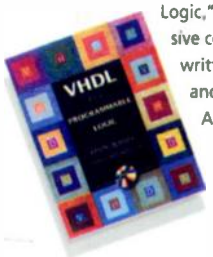

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