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FOR ENGINEERS AND ENGINEERING MANAGERS - WORLDWIDE

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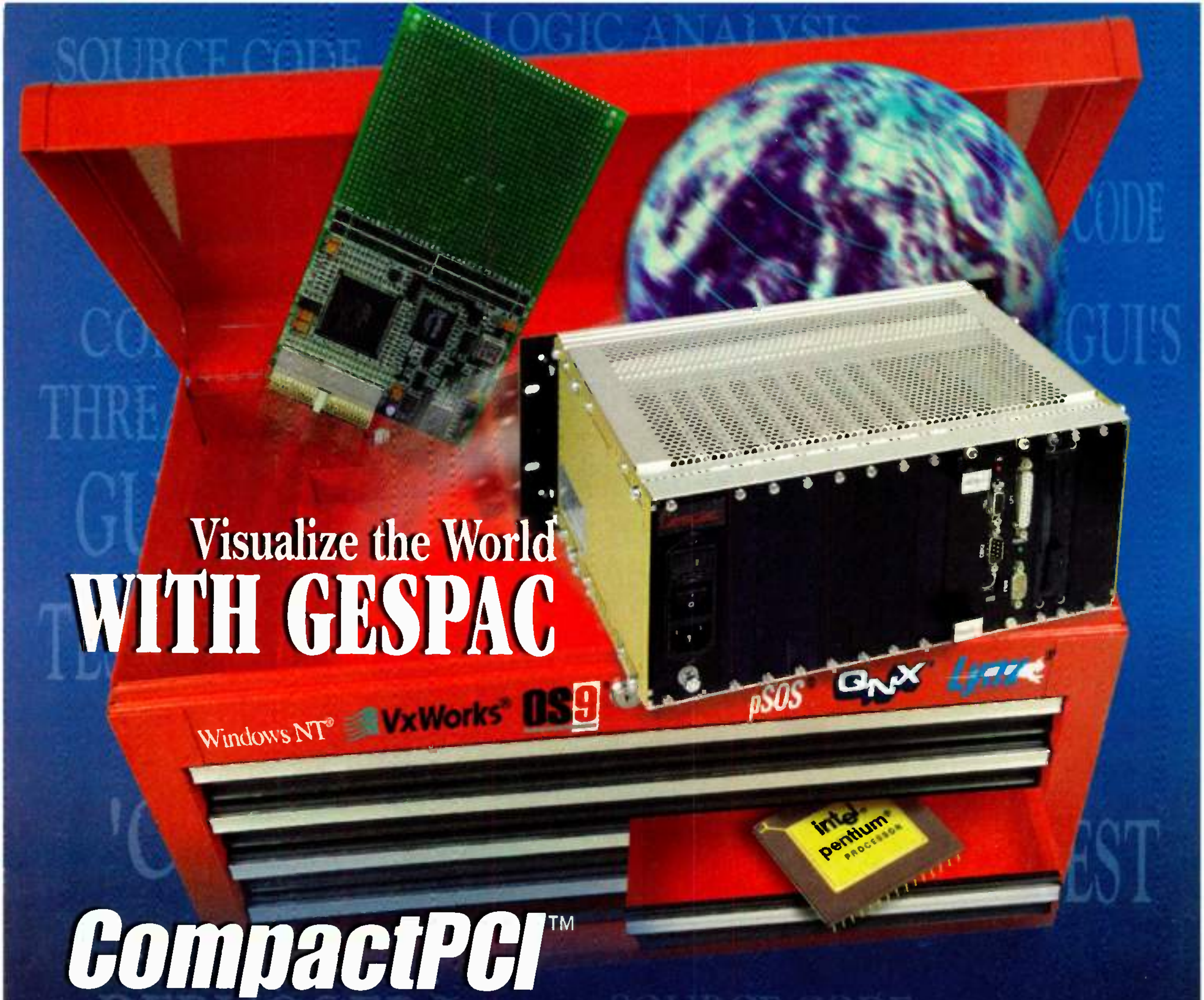

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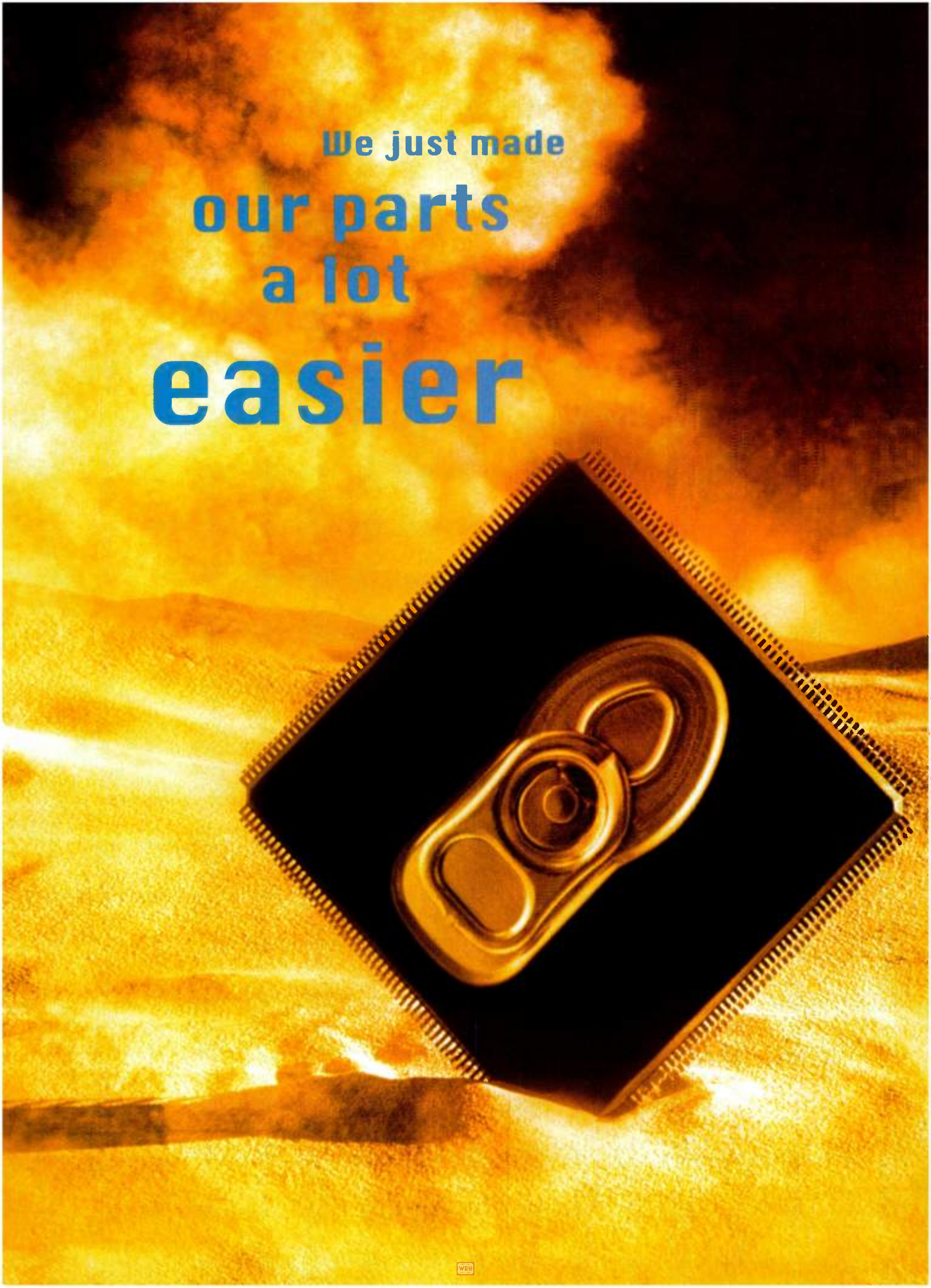
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ERA-3	DC-3000	20.2	12.0	3.8	23	2.10
ERA-3SM	DC-3000	19.4	11.5	3.8	23	2.15
ERA-4	DC-4000	13 5	▲17.0	5.5	▲32	4 15
ERA-4SM	DC-4000	13 5	▲16.8	5.2	▲33	4.20
ERA-5	DC-4000	18 5	▲18.4	4.5	▲33	4.15
ERA-5SM	DC-4000	18.2	▲18.4	4.3	▲32	4 20
ERA-6	DC-4000	11.3	18.5	8.4	36	4.15
ERA-6SM	DC-4000	11.3	18.0	8.4	36	4.20

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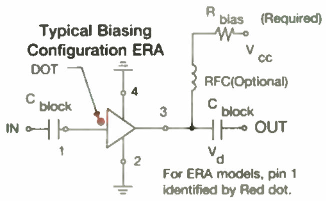
ERA-1 ERA-1SM
ACTUAL SIZE



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ELECTRONIC DESIGN

January 6, 1997 Volume 45, Number 1

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ELECTRONIC DESIGN (USPS 172-080; ISSN 0013-4872) is published twice monthly except for 3 issues in May and 3 issues in October by Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114-2543. Paid rates for a one year subscription are as follows: $105 U.S., $185 Canada, $210, $255 International. Second-class postage paid at Cleveland, OH, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 611 Route #46 West, Hasbrouck Heights, NJ 07604. Telephone (201) 393-6060. Facsimile (201) 393-0204. Printed in U.S.A. Title registered in U.S. Patent Office.

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ELECTRONIC DESIGN

January 6, 1997 Volume 45, Number 1

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PIPS

QUICKLOOK

DEPARTMENTS

COVER ILLUSTRATION BY: BRUCE JABLONSKI

Jesse H. Neal Editorial Achievement

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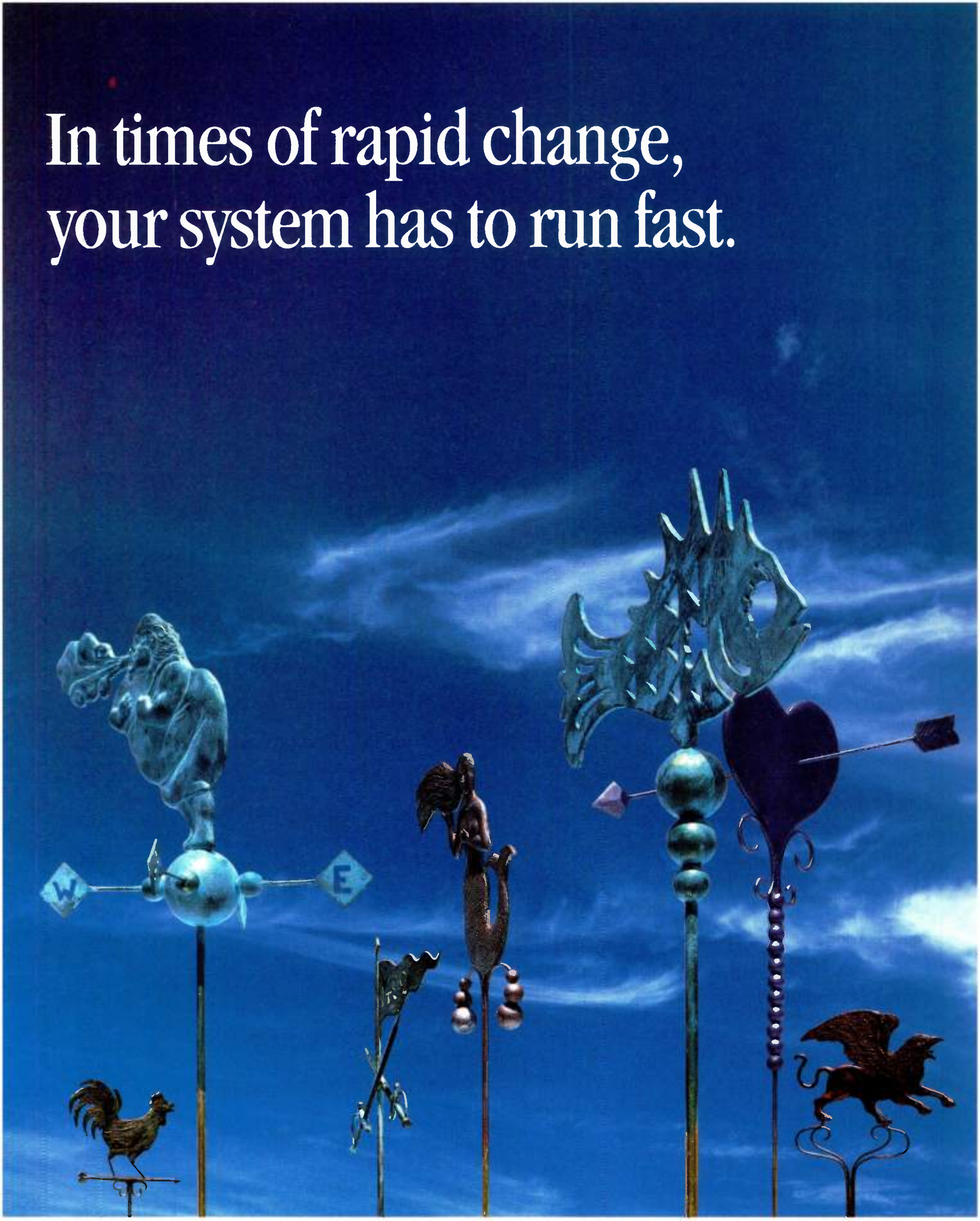
1968 First Place Award	1980 Certificate of Merit
1972 Certificate of Merit	1986 First Place Award
1975 Two Certificates of Merit	1989 Certificate of Merit
1976 Certificate of Merit	1992 Certificate of Merit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Electronic Design Information Group:
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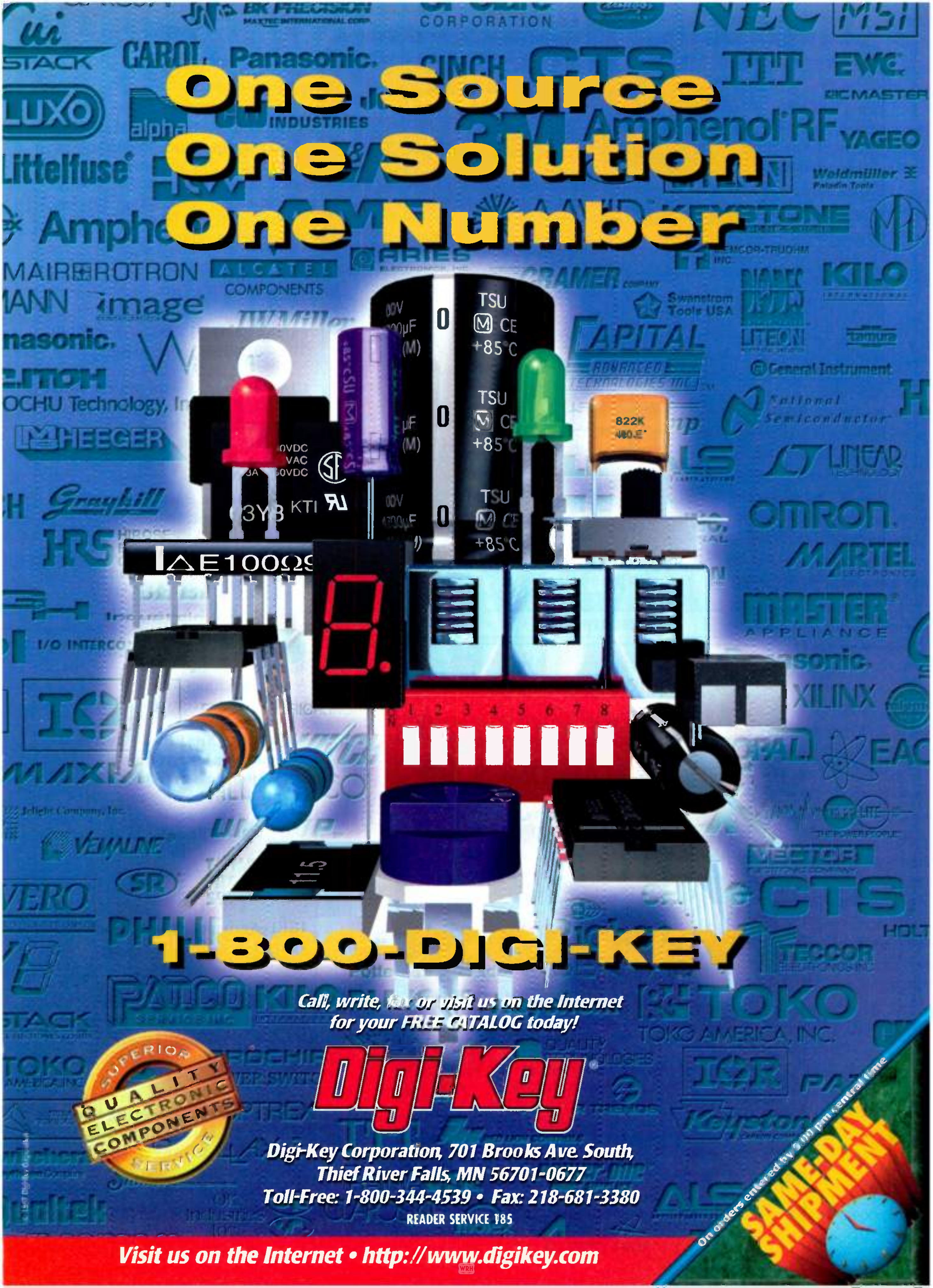
Publisher: **JOHN G. FRENCH** (201) 393-6055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Annual Reliability & Maintainability Symposium (RAMS), January 20-23. Philadelphia Marriott, Philadelphia, Pennsylvania. Contact V.R. Monshaw, Consulting Services, 1768 Lark Lane, Cherry Hill, New Jersey 08003; (609) 428-2342.

CiA Forum: CAN for Newcomers, Jan. 21. Braga, Portugal. Contact CAN in Automation, Am Weichselgarten 26, D-91058 Erlangen, (49) 9131-601091; fax (49) 9131-601092.

CiA Forum: CAN for Newcomers, Jan 23. Barcelona, Spain. Contact CAN in Automation, Am Weichselgarten 26, D-91058 Erlangen, (49) 9131-601091; fax (49) 9131-601092.

Asia & South Pacific Design Automation Conference with EDA Technofair (ASP-DAC '97), Jan. 28-31. Makuhari Messe Convention Center, Chiba, Japan. Contact Yoko Nishikawa, ASP-DAC '97 Secretariat, CONVEX Inc., Ichijoji Bldg. 2-3-22 Azabudai, Minato-ku, Tokyo 106 Japan; (81) 3 3589 3355; fax (81) 3 3589 3974; e-mail: convex@po.iijnet.or.jp; http://www.jesa or jp/ASPDAC/.

Second Annual Pan Pacific Microelectronics Symposium, January 29-31. Sheraton Maui Resort, Maui, Hawaii. Contact JoAnn Stromberg, Pan Pacific Symposium, 5200 Wilson Road, Suite 215, Edina, Minnesota 55424; fax (612) 929-1819.

FEBRUARY 1997

IEEE Aerospace Conference, February 1-8. Snowmass at Aspen, Colorado Contact Stephen Franklin, Deputy Program Chair, 4800 Oak Grove Drive, Pasadena, California 91109; (818) 393-0814; fax (818) 393-0530; e-mail: stephen.f.franklin @jpl.nasa.gov.; Internet: http://chirp.plk.af.mil:1050/ieee/index.html.

IEEE Power Engineering Society Winter Meeting, Feb. 2-6. New York Hilton & Towers, New York. Contact Frank E. Schink, 14 Middlebury Ln., Cranford, New Jersey 07016-1622; (908) 276-8847; fax (908) 276-8847.

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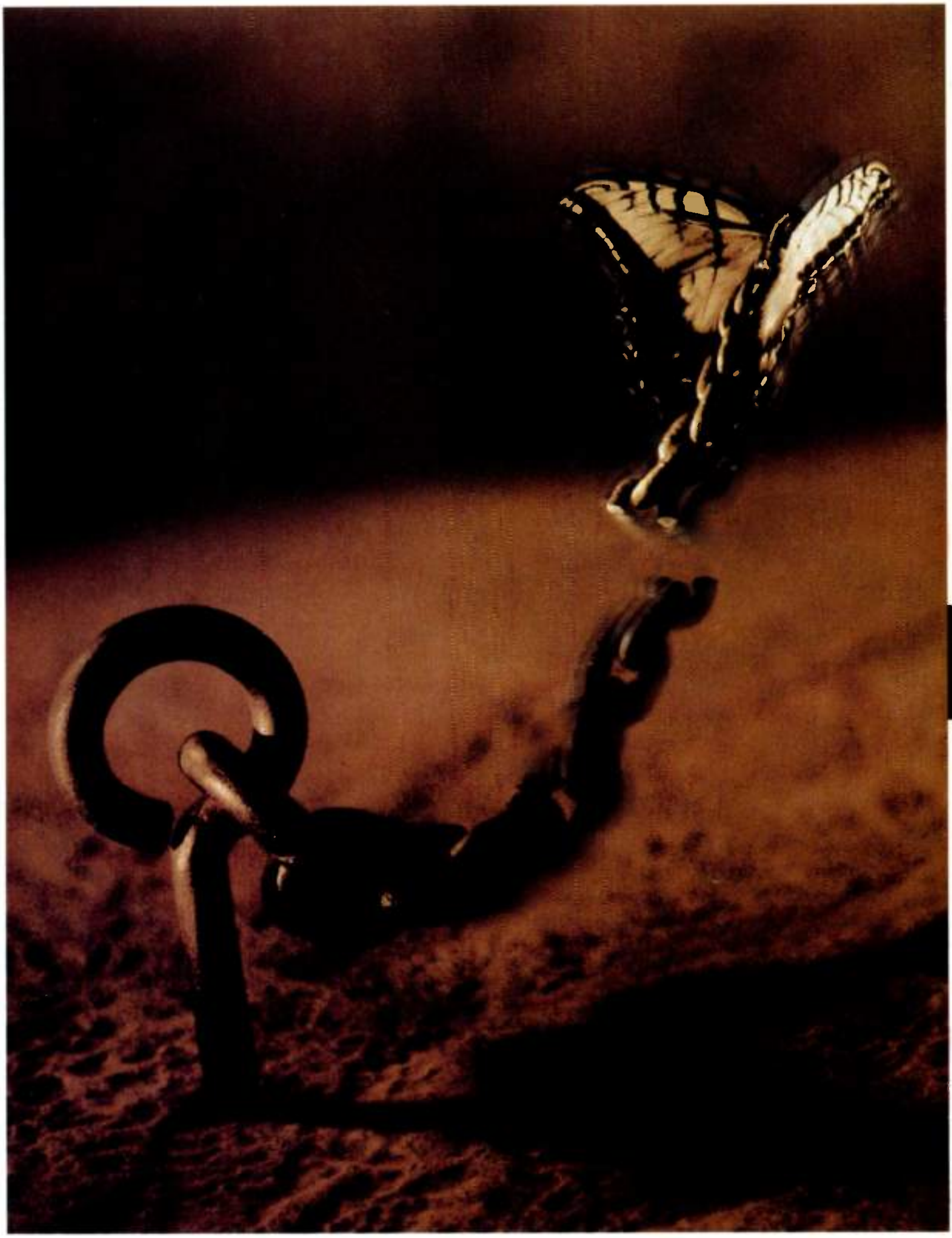

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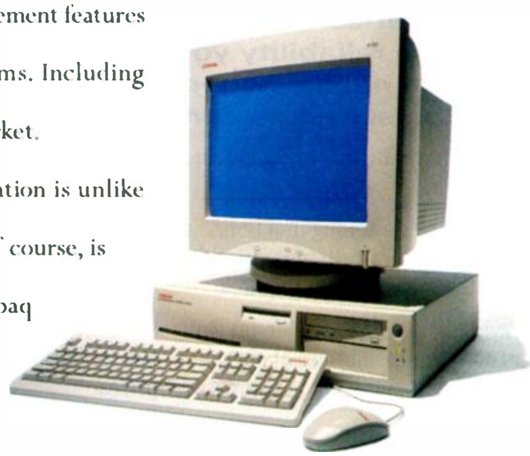

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IEEE International Solid-State Circuits Conference (ISSCC '97), Feb. 6-8. San Francisco Marriott Hotel, San Francisco, CA. Contact Diane Suiters, Courtesy Associates, 655 15th St. N.W., Suite 300, Washington, DC 20005; (202) 639-4255; fax (202) 347-6109; e-mail: isscc@mcimail.com.

Second International Conference on Chip-Scale Packaging, Feb. 20-21. Sunnyvale Hilton Inn, Sunnyvale, CA. Contact Subash Khadpe; (610) 799-0419; fax (610) 799-0519; e-mail: skhadpe@semitech.com.

IEEE Applied Power Electronics Conference and Exposition (APEC 97), Feb. 23-27. Westin Peachtree Plaza Hotel, Atlanta, GA. Contact Pam Wagner, Courtesy Associates, 655 15th St., N.W., Suite 300, Washington, DC 20005; (202) 347-5900; fax (202) 347-6109.

SOUTHCON '97, Feb. 25-27. Greater Ft. Lauderdale/Broward County Convention Center, Fort Lauderdale, FL. Contact Joan Carlisle, Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045; (800) 877-2668 ext. 243; fax (310) 641-5117.

MARCH 1997

IPC Printed Circuits Expo 97 & 40th Annual Meeting, Mar. 9-13. San Jose Convention Center, San Jose, CA. Contact JoAnn Galluzzi (847) 509-9700; Internet: http://www.ipc.org.

European Design & Test Conference (ED&TC '97), Mar. 17-20. CNIT Conference & Exhibition Centre, Paris-La Defense, France. Contact ED&TC Conference Secretariat, CEP Consultants Ltd., 43 Manor Pl., Edinburgh, EH3 7EB, UK; (44) 131-300 3300; fax (44) 131-300 3400; e-mail: edtc@cep.u-net.com.

Communication Design Engineering Conference, Mar. 24-26. Washington, DC. Convention Center, Washington, DC. Contact Denise Chan, Miller-Freeman Inc., (415) 278-5231.

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@ivcconf.com.

APRIL 1997

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, April 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.

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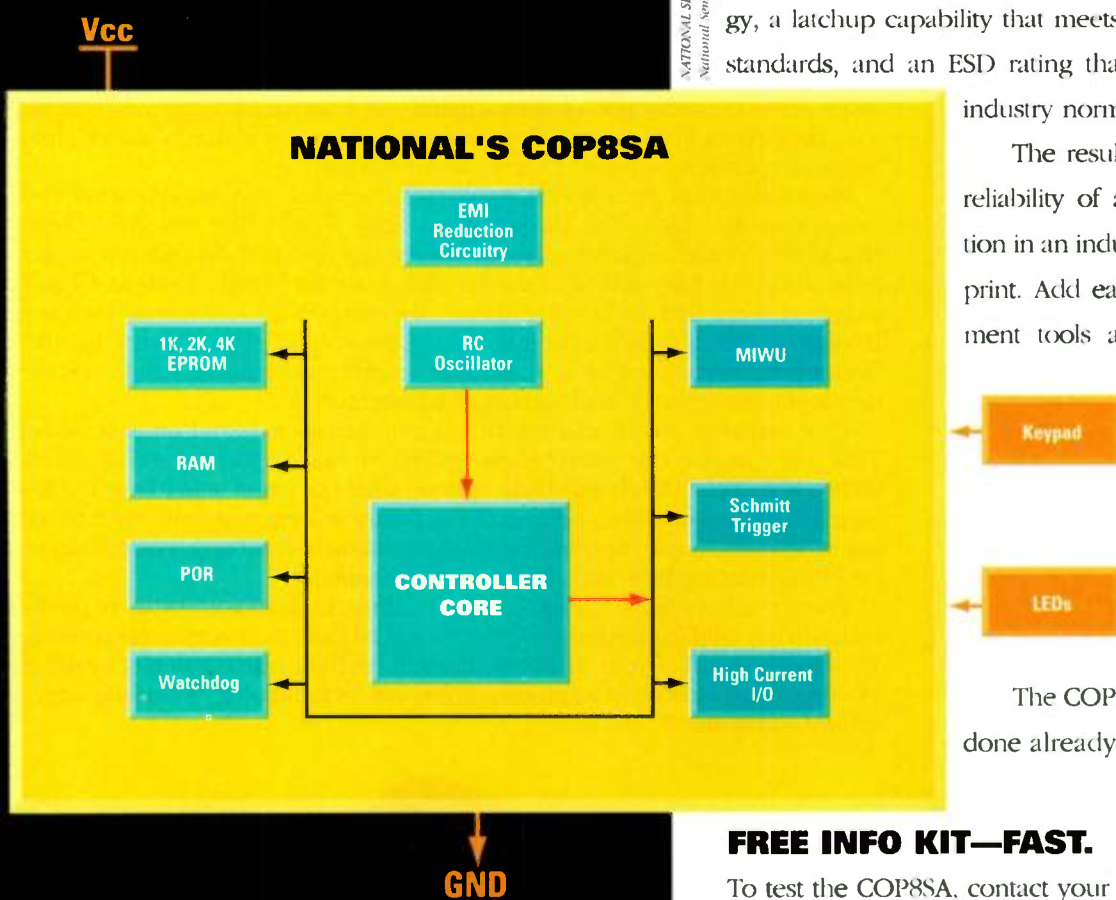

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EDITORIAL

Welcome To A New And Friendlier Look

Electronic Design has a new look with you, the reader, in mind. We've listened to your feedback through letters, telephone calls, faxes, e-mail messages, and focus groups, and as a result, have decided to give the magazine a friendlier and easier-to-read format. No longer will you have to thumb through our magazine while looking for a communications story, a DSP development, or EDA news. We've gone to a more organized format with Application-Specific Sections. This will allow you to quickly zero in on your application area of interest.

There are 12 Application-Specific Sections: Analog Outlook, Boards & Buses, Communications Solutions, Consumer Electronics, Digital Design, Digital Signal Processing, Electronic Design Automation, Embedded Systems, Multimedia, PIPS, Software, and Test & Measurement. Starting next issue, four of these sections will appear in a given issue, on a rotating basis. We've also added two new sections in every issue: Tech Insights and EE Currents & Careers. The former will allow us to bring to you all the up-to-date developments that may not have an Application-Specific Section in a given issue. The latter will address professional, employment, social, educational, job, and other personal issues of interest to our readers.

We've also kept your favorite columns, sections, and departments like Pease Porridge, Ideas For Design, Technology Newsletter, and QuickLook. In addition, noted analog designer Walt Jung, a frequent contributor to our publication, has been added as a columnist. Look for "Jung's Tools and Tips" to appear in the first issue every month. We also added noted digital designer Howard Johnson, who'll have a column in the second issue of every month. Technology Breakthrough is another new addition, bringing you the latest developments from the leading research laboratories.

This redesign is coincident with our annual Technology Forecast issue. This year's topic is the "wired engineer." We've called upon a group of worldwide technologists to give us their view on what the engineer's role in the future will be, and how the engineer of the future will communicate with his or her colleagues, employers, and information databases and archives, thanks to rapidly advancing Internet and intranet technologies.

There you have it. Sit back and enjoy reading the most authoritative publication in the field of electronic engineering. And keep your comments coming. We appreciate all of your feedback and will continue our mission of keeping electrical and electronic engineers informed on technology's leading edge.
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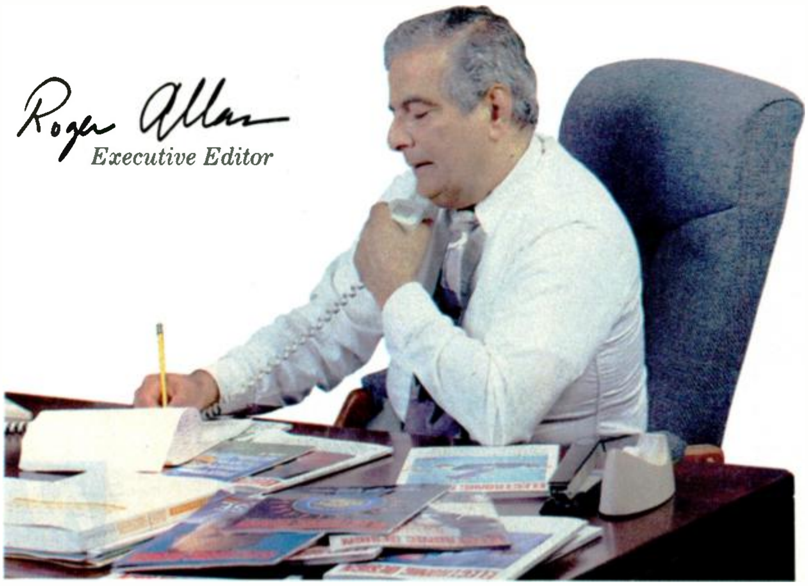

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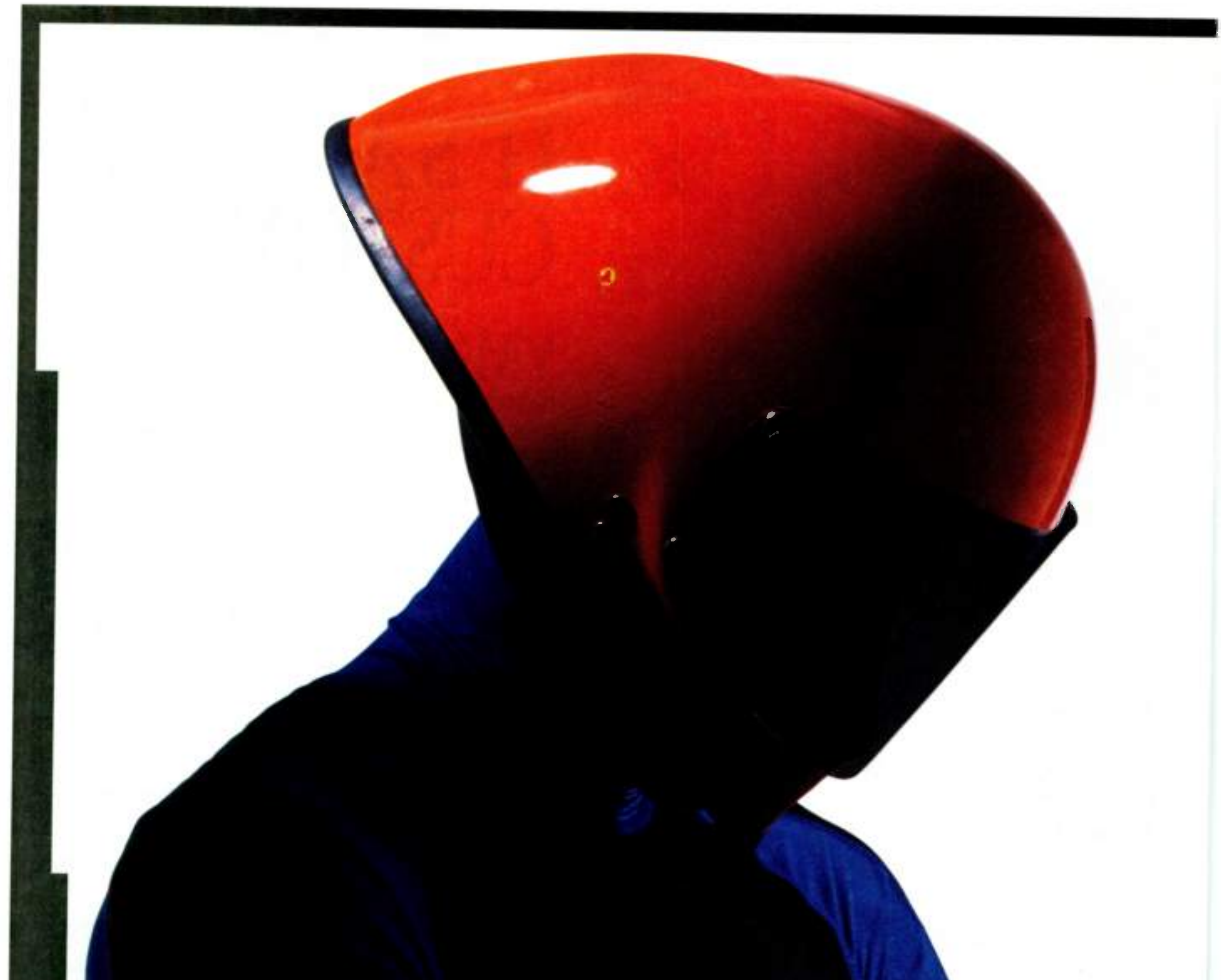

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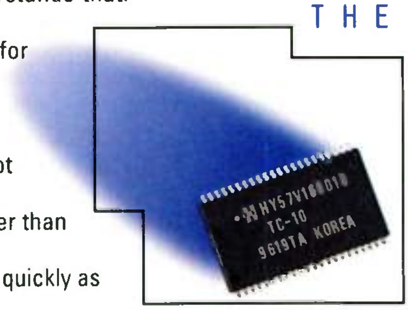

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Music, Wild Horses, And Technology

I recently visited with friends I hadn't seen in a number of years. And in particular with a friend named Tony. Tony is a musician, a balladeer full of songs of love, hate, glory, and the toils of the working class. Picking his guitar with effortless precision, he is as comfortable in the smoky intimacy of the local pub as he is in the focused isolation of the stage.

One day, the conversation wound its way inexorably toward technology. I tried to pinpoint the hotspots in the mercurial world of high technology, but Tony fired words like *cold, isolating, dehumanizing, unsociable, unnatural,* and *dangerous* back at me. I learned that Tony was a "technophobe," one of an increasingly vocal number to whom everything technological is pariah, to be mostly avoided and barely tolerated. I pursued the issue with him, trying to find out his point of view, but my queries were met by an equally abstract line of descriptives. He couldn't quite put his finger on it—he just didn't like it.

Tony's inability to reason with his fear is not unusual. For many outside the "elite" world of the technically savvy, the computer age is truly awe-inspiring (as it is for those inside), but distant, inaccessible, and immensely foreboding. Added is the fact that it affects every aspect of his life, whether he wants it to or not, and you feel you're tied backwards on a wild horse at the edge of a cliff.


PATRICK MANNION
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Why does this fear exist? *Technology* can be defined as the practical application of scientific thought, so to say that technology is "unnatural" is misleading, if not false, as our natural state when born, gives us the capacity to manipulate the environment according to our needs.

The forces behind advances in technology through time consistently reflect upon the basic human condition:A communicative, curious, warring, funloving (when time permitted) creature with a strong urge to stay alive. This led to advances in communication, exploration, weaponry, games and pastimes, and agriculture and medicine. The degree to which a society emphasized a particular pursuit over another depended on the state of that society at that time.

With the end of the Cold War, many countries have turned their attentions inward and focused on communication and transportation infrastructures, medicine, and entertainment, without much worry of being invaded.

With the focus of technology now on the consumer and the workplace, a number of factors are emerging at the domestic level. The first is the rate of change of technology, which is at an exponential rate with no sign of abating. The second is our ability to assimilate technology as it changes. The third is our ability to steer technology in a manner that is mutually beneficial.

There is now a huge disparity between the first two factors, which in Tony's case, results in a mild state of what I call "technoshock," causing anxiety, isolation, and fear. This fear is exacerbated by a distrust in the third factor, our control of technology, which in Tony's mind, is in the hands of a few with their own agenda that don't necessarily coincide with his best interests.

A psycho-social discussion of technology is too broad to attempt here. So too are its practical social ramifications. But some pointers to further discussion on the latter issue might be of interest. As we ride this "wild horse" into the future, much lip service has been paid to us controlling technology and not letting it control us. But not much has been done about it. Many still happily indulge in technology for technology's sake.

For those interested, an area of study called Social Informatics (SI) refers to the social aspects of computerization and information technology. The term is a banner for articles on these studies, and is a reference for theories and ideas. For more information, point your Web browser at *http://www-slis.lib.indiana.edu/SI/*. (Patrick Mannion's e-mail address is: *pcmann@ibm.net.)*

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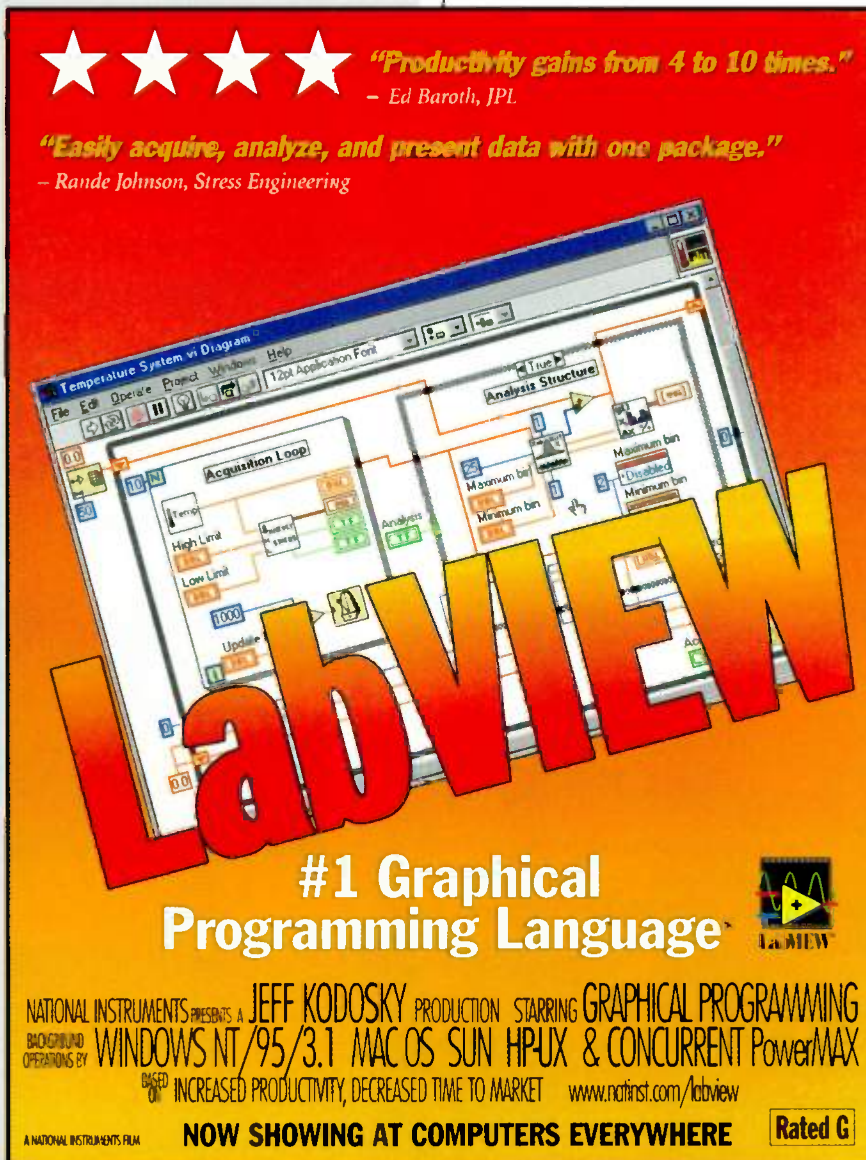

*As shown in T&M World Marketing Insight Study, 1995; Sensors Data Acquisition Survey, 1995; PE&IN Data Acquisition Survey, 1996

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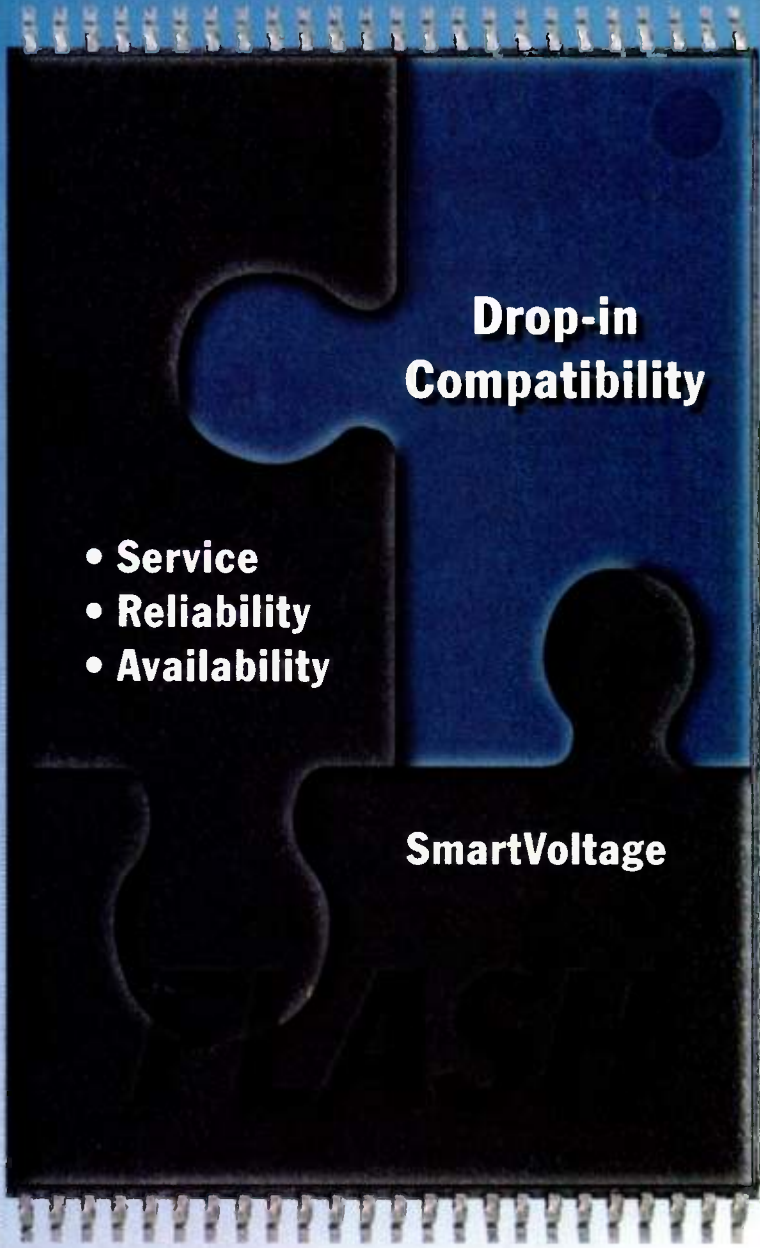

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**256K x 16 / 512K x 8	MT28F400B1	44	48
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READER SERVICE 130

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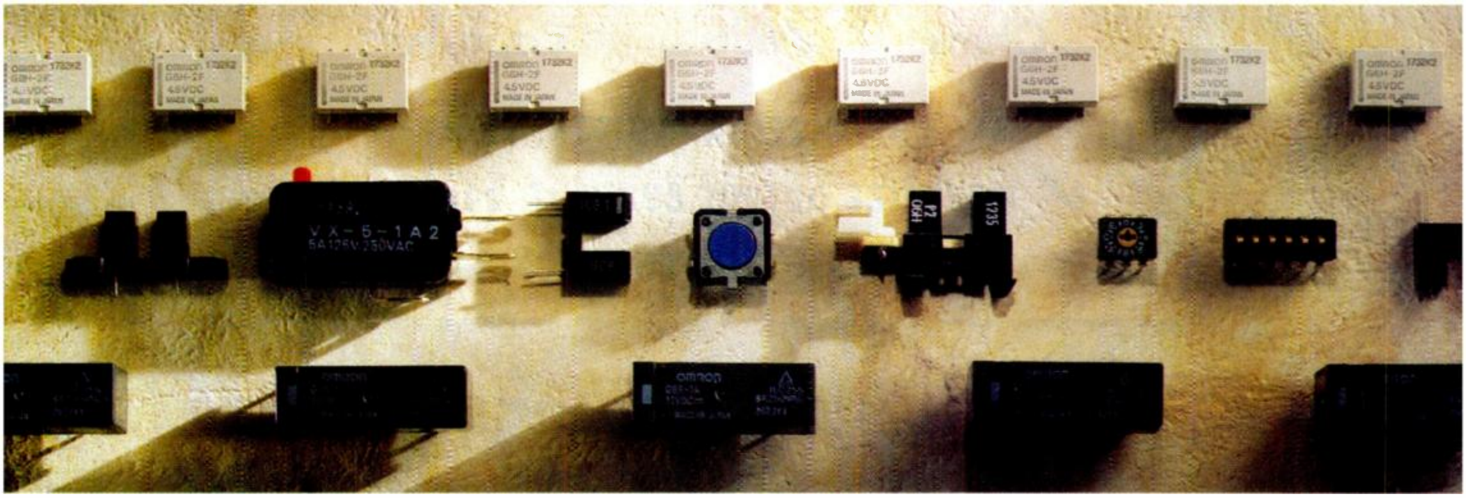

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READER SERVICE 113

Lab Develops First Portable DNA Analysis System

The U.S. Army recently received what's believed to be the first battery-operated portable DNA analysis system. Developed by the Lawrence Livermore National Laboratory, Livermore, Calif., the system could revolutionize testing of food and water in remote locations for contamination, and identification of human remains on the battlefield.

According to Lt. Col. Victor Weedn, who oversaw the DARPA project, "This system has wide-ranging applications to the military and society in general." He went on to say that "This instrument permits the most rapid, sensitive method of DNA testing available. It permits specific identification of a target molecule as well as quantification of the target molecules."

Using a DNA analysis technique known as polymerase chain reaction (PCR), the machine makes millions to billions of copies of specific DNA from traces of blood or other cells—whether plant, animal, or germ—at a fraction of the cost and time. The PCR technology enabled a handheld unit to be developed that operates on 1.5 W of power from four 9-V batteries (compared to the laboratory-sized version that consumes 1000 W from electrical outlets).

A second unit in the system also performs real-time quantitative DNA detection as it's being synthesized. What once took days (because samples had to be sent back to a lab) now takes minutes. For example, in experiments done by Lawrence Livermore along with Roche Molecular Systems, Alameda, Calif., the DNA analyzer detected HIV and the hepatitis C virus from human blood samples in less than 20 minutes.

The whole system, which fits inside a suitcase, could be five times less expensive than similar commercial DNA analysis instrumentation used today. *RE*

Improving Tiltmeters To Aid In Siting Oil Wells Keeps Lab Busy

Going from DNA to the world of oil, Lawrence Livermore National Laboratory researchers are also developing ways to help lower oil production costs, leading, ultimately, to greater oil output. They're doing this by attempting to create better tiltmeters, which are instruments that measure changes in the tilt of the Earth's surface, and by enhancing computer models that predict tiltmeter signals. With these innovations, oil producers will be able to more accurately determine the best places to site wells.

The "Tiltmeter Hydraulic Fracture Imaging Project" is a collaboration between the Lab and Pinnacle Technologies Inc., San Francisco, Calif., along with the University of Texas, Sandia National Labs, and other oil companies. The key goal of the project is to come up with a tiltmeter that can work for "hydrofractures" as far as 10,000 feet deep. Hydrofracturing is the process of pumping a high-pressure mixture of water, polymers, and sand down a well. As opposed to simply sinking a well and waiting for a "gusher," this process helps oil producers more accurately find a site. Through hydrofracturing, the surrounding rock is moved slightly, enough to allow ultra-sensitive tiltmeters near the surface to detect a slight tilting of the ground. The tilting reveals the primary direction of cracking below, helping drillers decide where to sink other wells.

The problem with today's tiltmeters is that they can be placed no more than 20 feet below the surface of the ground. Consequently, surface "noise," such as vehicles, wind, changing temperature, etc., can affect ground tilt and confuse incoming signals from the deeper hydrofractures. Tiltmeter usefulness, therefore, is limited to hydrofractures 6000 feet deep, which is a problem because 80% of fractures are deeper than that. Not only will the new tiltmeter be effective for hydrofractures 10,000 feet deep, but they can be placed 100 feet below the surface and be controlled remotely.

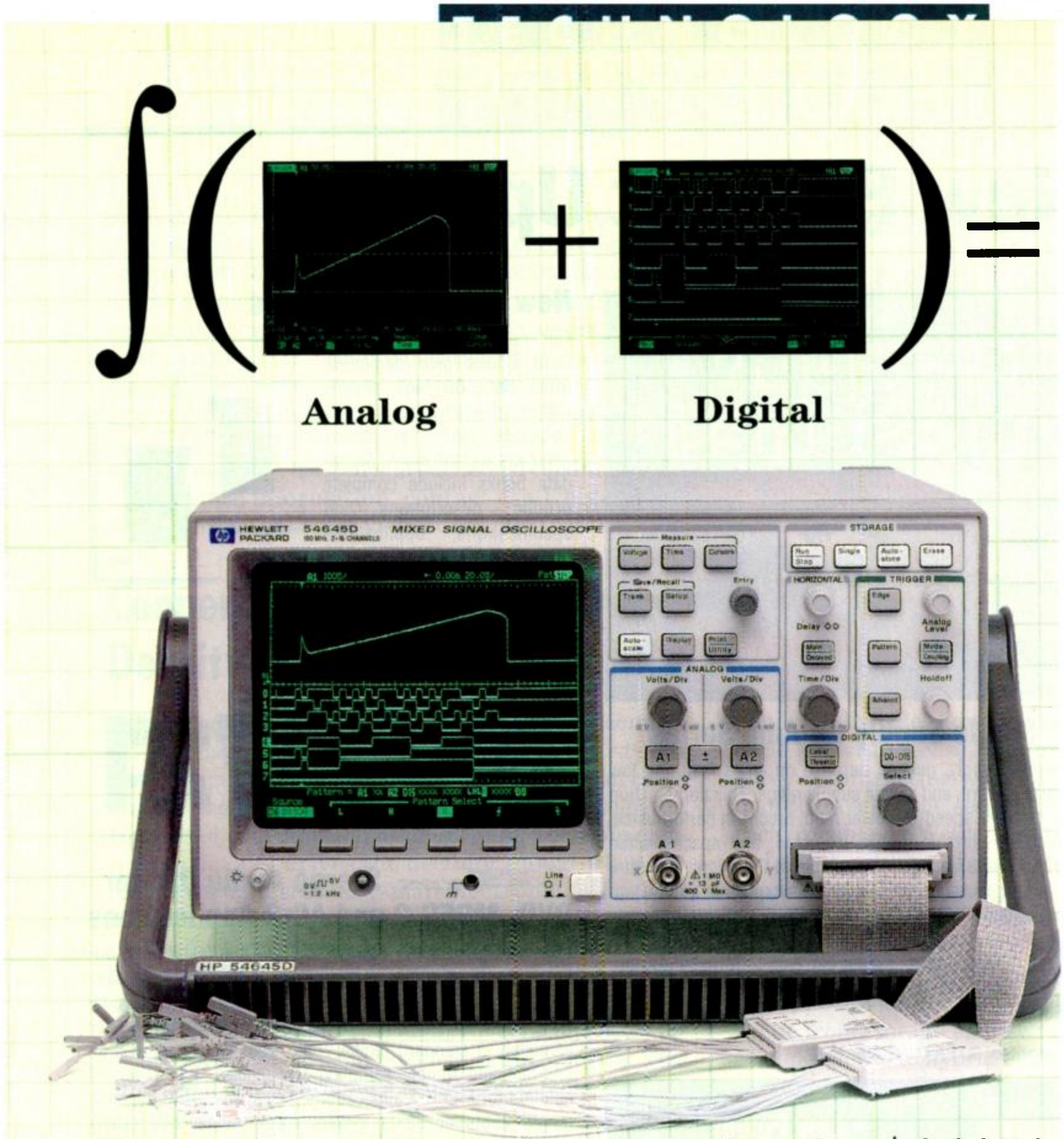
The other part of the project—improved computer modeling—will confirm where main fracturing has occurred, as well as identify secondary fissures, determine horizontal or vertical fracturing, and so on. Testing for the new tiltmeter is underway, and developing computer modeling programs will be the main focus next year. *RE*

Flexible Semiconductors Can Bend Like Rubber

The first single-crystal semiconducting nanomaterials that can actually bend without breaking have been developed by a group of physicists from the University at Buffalo, State University of New York. Some of the new semiconductors, made with ordinary weatherstripping silicone, can be peeled right off their supports, almost like peeling an address label from a sheet of labels.

Molecular beam epitaxy (MBE) is the key factor behind the semiconductors' flexibility, because substrates could be deposited on very thin layers. Using MBE, researchers grew quantum wells (structures so thin that they follow the rules of quantum physics) from zinc selenide and zinc cadmium selenide on gallium arsenide. The MBE-grown sample then was bonded to the silicone and the gallium arsenide was etched away, leaving a 1-μm-thick quantum-well structure on top of the silicone.

Future advances in optical computing, where information will be carried by light instead of by electrons, will be significantly influenced by these semiconductors since they retain their structural integrity and optical properties. More specifically, they will allow optical waveguides (the optical equivalent of wires) and semi-



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Prototype Of A Virtual Display Uses GaAs Array For Credit-Card-Sized Computers

Ultra-low power, light weight and the promise of full-color VGA resolution in three years' time are the main attributes of a novel solid-state miniature display developed over the last six years by Motorola Inc. at its Communications Products Laboratory, Tempe, Ariz. At the heart of the first pre-production prototypes demonstrated in Paris, France, recently is an array of 34,500 gallium-arsenide (GaAs) light-emitting pn junctions with dimensions of just 7 by 4 mm.

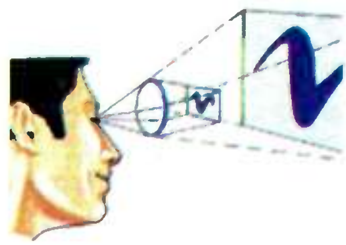

Fig. 1 When held to the eye, this display developed by Motorola and Gemplus presents a virtual image equivalent to viewing a regular 45.7-cm-dia. screen1.5 cm away.

Packaged together with two similar-sized CMOS driver chips as a multichip module, "the display is unique" according to project leader Marlene Begay. She says that with the pixels arranged in a matrix of 240 columns by 144 rows, the display provides a resolution equivalent to one-eighth standard VGA. Moreover, the driver circuits can address each pixel independently, varying their brightness levels to make a monochrome image with 16 shades of gray. Each pixel has a dimension of 10 by 10 µm and each is set at a pitch of 20 µm for a total active area that's approximately 7 by 4 mm.

But it is the packaging that makes the display useful. The GaAs device and its drivers are flip-chip bonded face down onto a transparent glass substrate. Fixed directly to the underside of the substrate is a specially designed plastic diffractive, refractive optical system that turns the light emitted from the face of the array through 90° and magnifies the image 15 times. When held to the eye, this presents a virtual image that Begay says is equivalent to viewing a conventional screen with a diagonal measurement of 45.7 cm at a distance of 1.5 m *(Fig. 1)*.

Begay says that the impetus for developing the display came from the need for light-weight, small, and low-powered display devices for use in handheld portable equipment. She says the specification for such a display was already set by Motorola as far back as 1988.

Dr. Bertrand Cambou, senior vice-president, Motorola Semiconductor in Europe, claims that compared with a conventional liquid-crystal display (LCD) able to present the same resolution and number of gray scales, the Virtuo Vue—as the new device is dubbed—is 40 times less in volume, has a footprint 16 times less, weighs 40 times less, requires an operating voltage 3 times less, dissipates 74 times less power ("that's nearly a two orders of magnitude reduction," he boasts) while response time is just a few microseconds compared with a hundred milliseconds for an LCD *(see the table)*.

Currently, the display is in monochrome, emitting amber light at a wavelength of 605 nm. However, Begay is confident that by the year 2000, she will have a full-color version working.

In the meantime, the Virtuo Vue is scheduled to start volume production during the second quarter of 1997. Initially, work will be concentrated on increasing the number of pixels on the array to provide the equivalent of half-VGA resolution by 1998 and full-VGA resolution of 600 columns by 480 rows in 1999.

The development of the display was carried out in collaboration with French smart-card maker Gemplus SA of Marseilles. Gemplus took an interest in the development since it was seeking a lightweight and pocket-sized gadget that would allow the contents of a smart-card's memory to be viewed.

According to Marc Lassus, chief executive officer, the rapid adoption of smart-card technology for use as an "electronic wallet" has made the need an urgent one. Lassus explains that an electronic wallet is a credit-card-sized smart card with an embedded microcontroller and a relatively large amount of nonvolatile memory that can be pre-loaded with cash units. The card's owner can load the card with cash either at an automatic teller machine (ATM) or over a communications link using a wireline or mobile telephone. And the owner can spend it by wiping it through point-of-sale terminals or automatic vending machines, payphones or parking meters.

There are already several million such cards presently in use in Italy, France and Portugal, Lassus says, and with the widespread use of Groupe Speciale Mobile (GSM) digital mobile telephones, the demand is growing for remote "downloading" of cash over radio.

"But people will not have total confidence in these cards until they have a means of confirming that the electronic cash they have credited to their cards has actually arrived safely" he says. Hence the need for a secure method of viewing the contents of an electronic wallet.

Gemplus has addressed the security problem by designing a small pocket-sized viewer that uses the Motorola display *(Fig. 2)*. Little bigger than the cards it is meant to be used with, it has a number of "cursor" buttons convenient for fingers so that menus shown on the display can be accessed. Lassus says the display drivers are designed to interface directly

A COMPARISON OF PHYSICAL PARAMETERS FOR LCD AND VIRTUO VUE

Technology	LCD	Virtuo Vue
Volume	170 cm^3	12 cm^3
Footprint	131 cm^2	8 cm^2
Weight	140 grams	10 grams
Voltage	9.0 V	3.3 V
Power	2 W	27 µW
Response Time	150 ms	3 µs

Fig. 2 This pocket-sized viewer from French smart-card maker Gemplus uses the Motorola Vituo Vue as an eyepiece display. The viewer is slightly bigger than the smart cards it's meant to be used with.

with the contacts of the smart-card chip and in effect allow a statement of all transactions carried out to be displayed. Here, the need to view through an eyepiece is an advantage since it guarantees privacy, he points out. Marlene Begay and Marc Lassus both assert however that the Gemplus SmartVue card reader, although a useful gadget, is really intended simply as a "proof of concept" for the display and the idea of using cards to contain and generate information displays. They declare that now that they know it works and can be manufactured for a reasonable cost, the display clears the way for other card applications such as for security, where they can be used to store images such as signatures, photographs, or fingerprints. Lassus also says that cards could be used as self-contained games players.

These are likely to be the high-volume applications that will help drive the cost of the miniature high-resolution display down to a few dollars. Many other more professional applications spring to mind, including use of the viewer in telepresence headsets, helmet-mounted displays and surveying instruments.

The MVV 8162A1 Virtuo Vue display is scheduled for production in the second quarter of this year and is expected to sell for around $80 each in volume quantities of 10,000 units or more.

For more information, contact the Motorola Innovation Centre, Level 5, 12 Ang Mo Kio St. 64, Ang Mo Kio Industrial Park 3, Singapore 569088; telephone: +65 481 8188. Marlene Begay can be contacted by e-mail at: *rsxt20@email.sps.mot.com.*

Peter Fletcher

Piezoresistive α(6H) Silicon-Carbide Pressure Sensors Aim For High-Temperature Operation At Up To 600°C

Researchers at Kulite Semiconductor Products, Leonia, N.J., have developed diaphragm-based piezoresistive silicon-carbide (SiC) pressure sensors that could potentially operate at temperatures above 600°C. The high temperature range is well above that of conventional silicon-based sensors available today. The first batch-microfabricated sensors processed at Kulite Semiconductor Products worked from room temperature to 350°C, but the development team assures potential 600°C operation. The higher temperature range would exceed the typical upper temperature limits of pn-junction silicon-isolated piezoresistors of 175°C, as well as silicon-on-insulator (SOI) sensors, which operate up to 500°C.

The sensors use α(6H)-SiC (SiC with a hexagonal crystal lattice structure). The material has a wide bandgap (3.0 eV), a high-breakdown electric field (2.5 by 106 V/cm), and high electron saturation velocity (2 by 10^7 cm/s).

SiC is a ceramic material of considerable interest to researchers. It's lightweight, highly durable, able to operate at very high temperatures, and capable of dissipating high levels of power within small areas. One major advantage of SiC is that it does not readily oxidize or facilitate diffusion at high temperatures. But that advantage also makes SiC more difficult to process.

Kulite's researchers have been able to overcome the processing issue with extensive characterization of the material for electromechanical applications such as stress-strain response, piezoresistance, temperature coefficient of resistance (TCR),

PERFORMANCE CHARACTERISTICS OF n-TYPE α(6H)-SiC PRESSURE SENSORS*

Temperature (°C)	Characteristics	Result
28	Maximum net output (mV)	87.89
	Linearity (% of full-scale output)	0.12
	Hysteresis (% of full-scale output)	-0.39
140	Maximum net output (mV)	62.19
	Temperature coefficient of resistance (TCR) (%/100°C)	1.52
	Temperature coefficient of gage factor (TCGF) (%/100°C)	-26.1
196	Maximum net output (mV)	57.55
	Temperature coefficient of resistance (TCR) (%/100°C)	6.05
	Temperature coefficient of gage factor (TCGF) (%/100°C)	-20.55
252	Maximum net output (mV)	51.99
	Temperature coefficient of resistance (TCR) (%/100°C)	9.72
	Temperature coefficient of gage factor (TCGF) (%/100°C)	-18.23
308	Maximum net output (mV)	48.31
	Temperature coefficient of resistance (TCR) (%/100°C)	18.15
	Temperature coefficient of gage factor (TCGF) (%/100°C)	-16.08
350	Maximum net output (mV)	38.21
	Temperature coefficient of resistance (TCR) (%/100°C)	16.05
	Temperature coefficient of gage factor (TCGF) (%/100°C)	-17.55

**epilayer doping level N_d of 1 by 10^{18} cm^{-3}*

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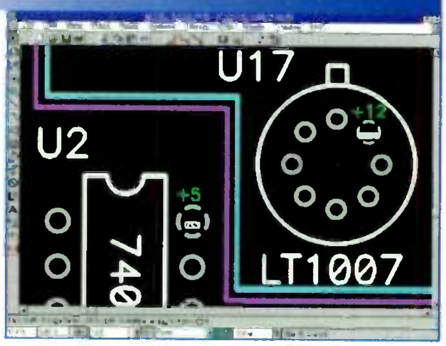

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and temperature cofficient of gage factor (TCGF).

The SiC pressure sensors the researchers studied employ a 1-mil-thick diaphragm. Each sensor occupies a chip area of 48 by 48 $mils^2$.

Essential to fabricating the sensors was the elimination of the inherent SiC problem of micropipes, and the development of an appropriate high-temperature metallization to support sensor operation at temperatures up to 600°C. In developing the sensors, the big problem was patterning inconsistency. This issue was addressed by using different materials and doping levels for the intended applications.

Micropipes—submicron holes through the material—also are a major problem when using SiC in a pressure sensor. The open pipes allow the air to leak through the diaphragm, essentially rendering the pressure-sensing operation useless. High-temperature metallization also is required, and Kulite Semiconductor Products has developed a multilayer structure of titanium, titanium-nitride, and platinum which appears to operate well at the elevated levels of temperature.

In operation, the piezoresistive α(6H)-SiC element is fabricated in a Wheatstone bridge arrangement with a 5-V supply. At room temperature, the output voltage was measured as 87.89 mV at full-scale pressure of 1000 psi. The output voltage dropped to 38.21 mV at a temperature of 350°C—still a usable magnitude *(see the table)*.

Unknowns in the equation are packaging, compensation, and overall performance challenges. Not only are packaging materials for high-temperature operation expensive, but a whole new packaging approach is required for operation at temperature extremes. The Kulite Semiconductor researchers also are looking to make the sensors more compensatible, and would like to have the sensors applicable to different pressure-sensor ranges (about 500-1000 psi, presently).

Kulite Semiconductor Products manufactures silicon piezoresistive sensors, with the SiC effort being a developmental one only. The firm also has investigated the use of diamond films for pressure sensors, discovering that such sensors can operate well in excess of 800°C temperatures. It has been demonstrated that diamond gets even more sensitive with higher temperatures. The diamond project, however, is on the back burner for now.

The new SiC sensors were developed under a NASA contract and were described in a paper delivered at last month's IEEE International Electron Devices Meeting in San Francisco, Calif. The paper was authored by Kulite's Robert S. Okojie, Alex A. Ned, and Anthony D. Kurtz.

For more information, contact Kulite Semiconductor Products at (201) 461-0900.

Roger Allan

Charge-Sharing Technology Enables High LCD Image Quality At Ultra-Low Power Levels

Pixel inversion, or more commonly known as direct drive, has long been touted in the liquid-crystal display (LCD) community as the drive method that provides the best in image quality for displays. Its major obstacles toward universal adoption and widespread use have been that it consumes a great deal of power, and in many cases, is extremely cost prohibitive. Consequently, its use in notebook computers, one of the largest volume applications for LCDs driven primarily by low-cost, low-power components, has remained an implausible option. In recent years, the cost of pixel inversion drivers has dramatically reduced, making them competitive with more conventional column drivers. But without a method to address the power issue, drivers based on pixel inversion technology will continue to be shut out of the growing notebook computer market.

In a recent announcement, Vivid Semiconductor, Chandler, Ariz., claims to have found a way to enable column-inversion equivalent power consumption levels in a pixel-inversion format with no increase in cost. Their solution involves integrating charge-sharing technology into a pixel-inversion driver. This seems to hold the promise of low-power consumption levels, as well as reducing flicker and crosstalk. In addition, it also may increase the aperture ratio on a display that, in turn, will add to the brightness level of a display's backlight.

Typically, pixel-inversion drive techniques rely on the use of column drivers to charge and discharge the columns at a very high frequency to deliver alternating current to an LCD panel. At each row drive time, the voltage level on the column swings from a high to a low voltage around an arbitrary median voltage value as the column gets charged and discharged, respectively.

Because the same amount of energy is expended in charging or discharging the column load, energy within the system can be conserved and used to drive both processes. On the other hand, the process of driving the voltage high and low alternately is exactly what attributes to the technique's high power expenditure disadvantage.

Charge-sharing technology fundamentally mimics this same drive process, but with one hitch. Rather than having the output of each column connected directly to a column within the LCD panel, it is first routed through a 2:1 multiplexer and then on to the individual LCD panel columns. Consequently, the column output is now associated with two inputs into the multiplexer. One simply inputs into the 2:1 multiplexer and is routed on, while the other connects to a common node and then is routed to a capacitor.

The common node and capacitor effectively cause all of the column driver outputs to short for a brief amount of time. This occurs at each row drive time as the column drivers output inputs into the 2:1 multiplexer. When the short occurs, the capacitances of the capacitor and the collective column lines are forced to "capacitive charge share" as the voltage on the column lines transitions to a value near the median voltage value. This transition occurs because the capacitance value of the capacitor is initially much higher than the capacitance value of the collective column lines.

As the company points out, after a brief period of charge sharing, the logic of the 2:1 multiplexer changes such that the column driver output amplifiers are once again connected to the load, which then proceed to drive to the appropriate final values. Since the transitions during the brief charge-sharing period are quite rapid, the overall drive time is reduced, providing a secondary benefit of faster transitions, something that is important on large and complex displays.

The primary benefit of the charge-sharing technology is that because it enables the transition from the voltage on the shared capacitive charge from the capacitor to the median voltage to take place very quickly, the average voltage transition can be reduced by roughly a factor of two. While theoretically this value sounds acceptable, real-world engineering dictates that other factors will come into play to degrade this value.

As would be expected, it turns out that the presence of resistance on the output load causes a reduction in the effective power savings. Therefore, if the column output has both a resistive and capacitive component, then the output timing will be defined by an RC time constant. This means that for large RC values on flat-panel displays, the power savings would be more on the order of 30 to 40%. Estimates suggest that given the use of the capactive charge-sharing technology in conjunction with improvements in the power consumption of the output amplifier and other associated column driver ICs, this value could jump to as high as 70%.

In addition to the benefit of a substantial power savings, an added plus is that implementation of the charge-sharing technology is thought to be rather minor, requiring a small amount of additional circuitry and minimal increases to the die size. And, while the use of a single capacitor plays a big role in the charge-sharing technology, even it is expendable, such as in situations where the average voltage of all of the columns at a given time already is very close to the median voltage prior to charge sharing.

Consequently, the column lines can simply charge share with one another to reach a value near the median voltage value, and effectively do not need the input of the high-voltage capacitor. While the overall power savings will not be as high as if the capacitor had been used, in some instances it may be high enough to be of value.

Vivid Semiconductor currently plans to launch a family of drivers based on the capacitive charge-sharing technology.

For more information, contact the company at (602) 961-3200.

CHERYL AJLUNI

Sophisticated Algorithmic-Based Software Coding Makes Complex Problem Solving Easier

In the past, parallel computing offered a means of solving complex problems that were not previously thought solvable. Today, however, as most problems continue to grow in complexity, this technique is beginning to show its limitations, often requiring a great deal of time, and not always providing the most accurate results.

Addressing the problem of decomposing unstructured grid calculations across the processors of a parallel computer, for example, is not quite as easy as it sounds when using parallel computing techniques. While the problem can be solved in terms of graph partitioning using load-balancing constraints as bounds on partition sizes, the performance of many parallel applications depends critically on the quality of the partition.

Consequently, application performance is directly linked to the progress of the slowest partitioned part of the calculation, and to whether all partitions are the same in terms of size and work load. Identifying and implementing the appropriate partitioning algorithms is crucial to ensuring high processor performance. The other method of complex problem solving, attacking the entire problem with a single powerful processor, also can be quite slow and does not always yield positive results.

A technological development out of the Parallel Computing Sciences Department of Sandia National Laboratory, Albuquerque, N.M., promises to simplify and speed these calculations, while providing results better than was thought previously possible. The development, a sophisticated coding technology, comprised of a variety of multilevel partitioning algorithms, combinatorial optimization techniques, and a host of eigen solvers for spectral methods, has been cumulatively dubbed Chaco. Written in the ANSI standard C language, the code can be invoked on both symmetric multiprocessing (SMP) and massively parallel processing (MPP) platforms.

This code technology for partitioning and ordering graphs works by dividing a complex problem into separate, but equivalently sized, pieces, and assigning each piece to a separate processor. The coding ensures that the work done by each processor is the same and that interprocessor communication, which can be very time consuming, is kept to a minimum. In essence, using graph partitioning, Chaco coding can take on a big problem and by using advanced partitioning algorithms, it can approximate it by a series of smaller problems.

These approximations are then approximated by even smaller problems. This iterative cycle continues until such a point that the smaller problems are more manageable, and more easily solvable. At this crucial juncture, the problems are divided into separate pieces, solved, and then fed back up the hierarchical chain of approximations. This cycle continues until the entire problem has been solved. Sandia's researchers believe the coding technology they developed will be ideal for application to a number of problems. They include auto-crash simulations, the placement of circuit elements on computer chips, database design, as well as archaeological dating.

Bruce Hendrickson, Sandia researcher and one of the code's developers, likens it to a toolkit where you can choose to use the algorithmic tool that is best suited to a particular application. What's unique about the code is that it takes full advantage of advanced mathematical algorithms to accurately partition a complex problem to be solved, and combinatorial techniques to recombine the partitioned solutions into one overall solution that is inherently more accurate then the sum of its parts.

As Hendrickson explains, "In its simplest mode, Chaco can apply any of a number of graph partitioning techniques to an input graph. Each algorithm can handle graphs with edge and/or vertex weights. Each can be applied in a bisection, quadrisection, or octasection mode, with several different cost metrics. Extensive post-processing capabilities are included to improve the partitions in any of several respects or to evaluate the quality of the partition in a variety of metrics."

The coding encompasses many different algorithmic-based tools and is general enough to be applied to many problems very broadly. In fact, because the code technology enables the sequencing of graphs in such a way as to preserve locality, it is anticipated that different classes of applications can now be addressed that previously parallel computing techniques could not touch. Such applications include decomposing parallel preconditioned iterative solvers, the parallelization of direct solvers, particle-in-cell simulations, optimization calculations, and neural networks.

Key to the success of the coding technology is its incorporation of a number of algorithmically-based innovations. For example, a modified multilevel-KL algorithm was developed that uses multigrid techniques to deal with graph partitioning. It can apply a wide variety of minimization metrics and now can be used in conjunction with weighted graphs and an arbitrary number of sets. As an added benefit, it still runs in linear time.

Other algorithms contained in the code are multidimensional spectral algorithms. The main benefit of these algorithms are that they allow for constraints, such as vertex and edge weights, that affect the choice of partitions, to be directly embedded into the code. By comparison, the typical spectral graph algorithm today uses the eigenvectors of a matrix derived from a graph to partition the vertices. These algorithms, with embedded constraint capabilities, are critical to solving the problem of how to place circuit elements on a chip so as to minimize wire length.

According to Hendrickson, another innovation that makes the Chaco coding unique is a technique for using one, two or three eigen vectors to partition a graph into two, four, or eight parts at once. This enabled Sandia to mathematically couple the previously distinct problems of decomposing the graph and mapping the resulting graph pieces onto the parallel machine. As a result, by generalizing to higher dimensions in a particular way, the spectral methods are able to minimize in a graph which metric matches the topology of the most common parallel machines— two-dimensional or three-dimensional meshes and n-dimensional hypercubes.

Among the combinatorial techniques embedded within the Chaco coding is spectral termination propagation, which allows locality to be considered while partitioning. Other combinatorial optimization techniques embedded within Chaco enable post processing of graph partitions for specific numerical applications. The post processing will make possible fine tuning of the performance of the iterative methods

The technology, although not yet commercially available, either as a standalone product or as part of a system solution, is now being offered for licensing.

For additional information, contact the Media Relations Department of Sandia National Laboratory at (505) 844-8066.

Cheryl Ajluni


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1997 Technology Forecast

Exploring the design world of the wired engineer of the future

The Internet and the World Wide Web are two technologies that promise to irrevocably alter (for the better) the way engineers will work and communicate in the future. The future designer will be a "wired" engineer, tied into a vast array of information databases, resources, networks, and services—the theme of this Technology Forecast issue.

Just how will the wired engineer work and communicate as the result of the proliferation of the Internet and the World Wide Web? What will his or her role be in the future? What will all of this mean to future designs? To answer these questions, Electronic Design called upon the thoughts of a group of electronics industry experts who make it their business to forecast the future. They paint a scenario in which engineers will enter a world of enhanced connectivity and have access to "virtual" systems-on-a-chip designs. Future engineers will be challenged to work in groups of design teams with members of many different disciplines including mechanical, industrial, materials, packaging, and test engineers. The future engineer will no longer be dedicated to a single employer. Rather, he or she will be used as a part of a distributed resource base, spread across many design houses. A world of enhanced connectivity will likely mean engineers will not just be able to access information, but to access resources as well.

This Forecast Issue also addresses the human side of engineering, examining a designer's role and responsibility as a "global citizen." As technology permeates our world, the decisions engineers will make will have an increasing impact on society, the economy, and the environment, issues that also are examined in this Technology Forecast issue.

Taking A Look At Internet-Based Design In The Year 2001

It's A Cyberspace Odyssey By Going Back To The Future To See How The Internet Will Affect The Way Designers Work.


DAVID ALLES AND GRANT VERGOTTINI

Mentor Graphics Corporation, 8005 S.W. Boeckman Rd., Wilsonville, OR 97070-7777; (800) 547-3000; Internet: http://www.mentorg.com.

Welcome to the year 2001. A new era of computing has begun. The world now moves on "Internet time," which continually demands new, ever-more capable computing and communicating products. Transistors-per-chip are now measured in the tens of millions. In fact, the first $15 billion manufacturing facility recently went on-line.

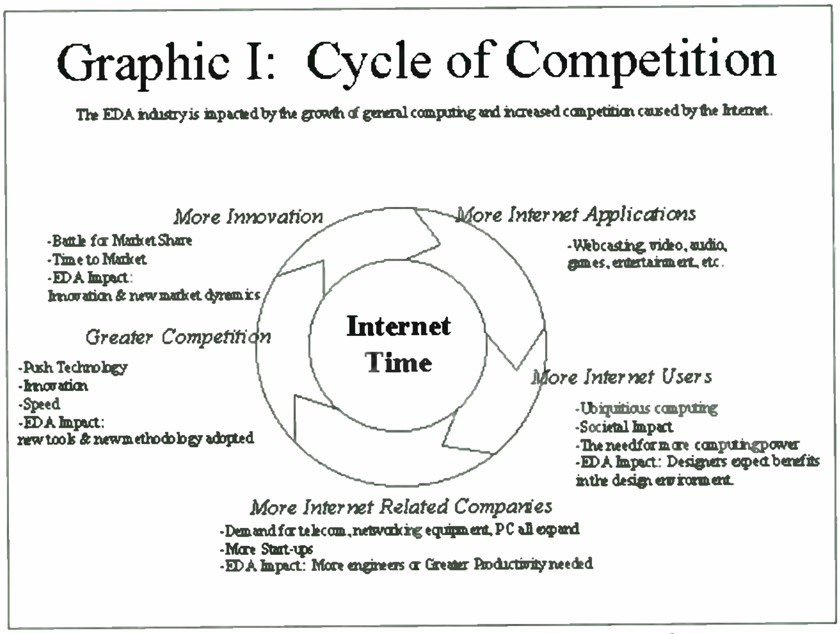
This revolution began in the early 1990's with the development of the World Wide Web (WWW). The Internet's maturation has resulted in a new medium for the communication and delivery of information. A medium that combines many methods of interaction into a single, worldwide conduit. The power of this medium has dramatically impacted society by fostering greater global communication than any other innovation before it. The manner in which people purchase goods, entertain themselves, and receive and transmit information has significantly changed. No other single source provides the ability to combine text, graphics, audio, video, and telephony as seamlessly and instantly as does the Internet. The adoption of this knowledge-centric communication platform in everyday life marked a societal change and greatly altered the world of electronic design.

The design world of 2001 is significantly different from that of the mid-1990s. The Internet has elevated collaborative engineering to a global scale. Design engineers now have instant access to tools, intellectual property, libraries, on-line experts, news, and information from sources around the globe. These information and knowledge services are electronically sourced and fed directly into the engineer's design environment.

Looking Back

There were a number of catalysts in the creation of this Internet-centric electronic design environment. The web browser paradigm received widespread acceptance in the mid-1990s. The resulting battle between Netscape and Microsoft resulted in the rapid development of the Internet computing paradigm. As this battle unfolded, investments in networking technology, supporting software, and infrastructure created the necessary bandwidth to support the widespread adoption of the Internet.

For example, in the mid-1990s, the traditional office automation suites, such as Microsoft Office, were re-



1. New methods were combined with traditional office automation suites that were redesigned for the Internet.

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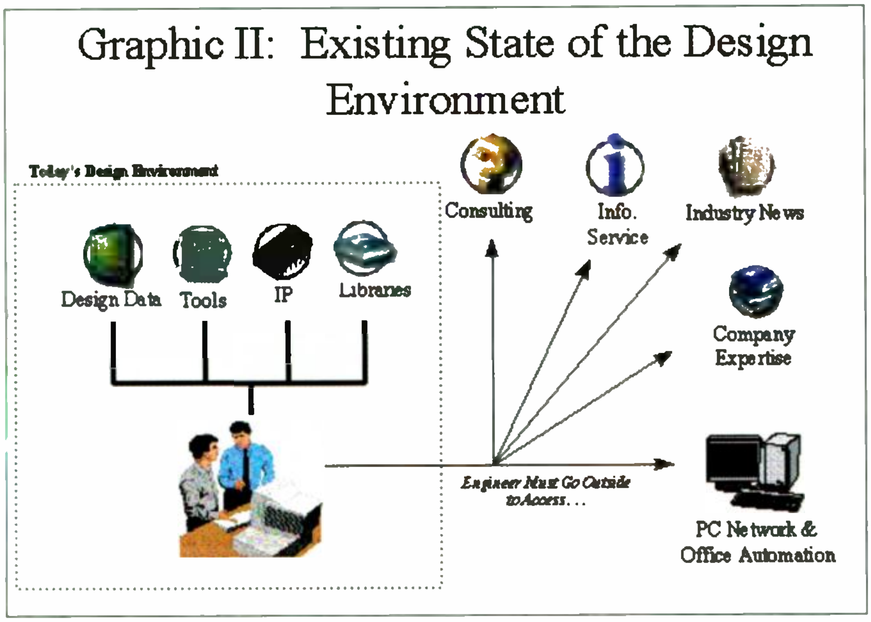


2. In order to boost engineering productivity, as well as realizing the full potential of DSM design, a series of EDA tool and design processes were developed.

designed for the Internet. As these and other products were combined with the "active desktop" introduced by Microsoft's Internet Explorer 4.0, new methods of tool and knowledge integration were pioneered. Technologies like ActiveX allowed information to be seamlessly moved from application to application from the Intranet to beyond the Internet *(Fig. 1)*. The work environment (tool suite) and information environment (Intranet and Internet) became tightly integrated. This trend quickly spread to other market segments, including EDA.

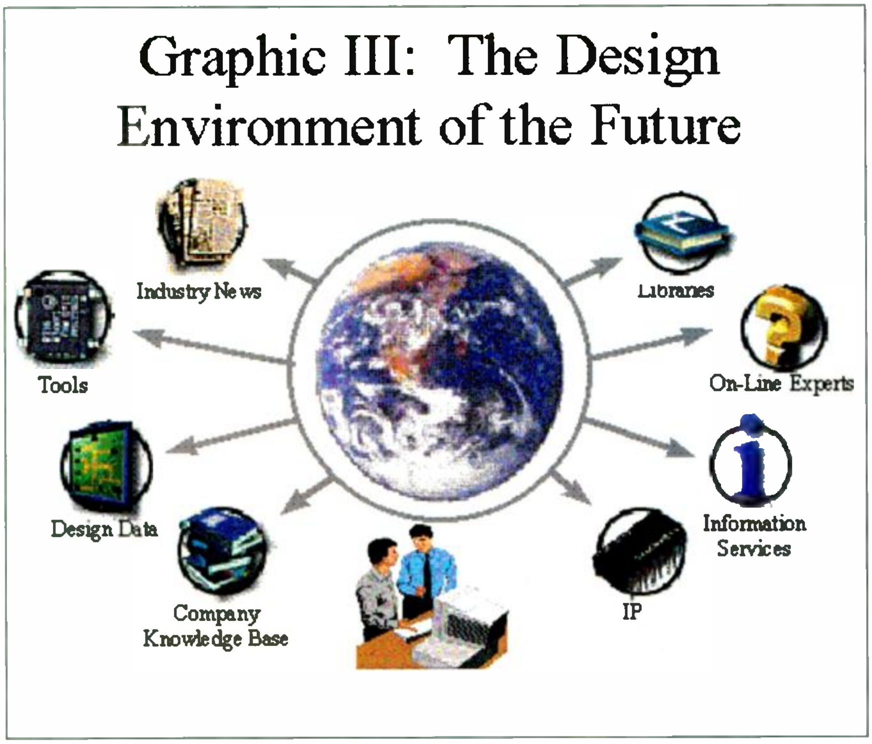
The incursion of Windows NT into the EDA market segment during the late 1990s resulted in an enhanced operating environment with the foundation technologies to support the development of more sophisticated EDA industry standards. The combination of EDA standards, seamless tool integration, and a common computing platform resulted in a rush of new advanced EDA tools designed to work with office automation and business computing applications.

The Transformation Of EDA

The impact of this computing revolution on the world of electronic design was twofold. On one front, as semiconductor companies, system companies, and communication companies scrambled for a position of significance in the Internet-centric world, they were forced to innovate at an ever-increasing pace. Rapid product development cycles became a requirement for survival. This put increasing pressure on engineering productivity. Issues such as hardware-software co-design, design reuse, and the use of externally generated intellectual property came to the forefront as companies struggled to maintain their competitive edge.

These time-to-market pressures were augmented by the advent of deep submicron (DSM) design in the early 1990s. Decreasing feature size resulted in increasingly complex chip designs. As these "systems on silicon" became a reality, a number of things happened. With chips no longer focused on specific functionality, expertise had to be pulled from a number of design disciplines. Increases in complexity and reductions in feature size caused traditional EDA tools to "break" as modeling began to be exponentially more difficult and the relevant "physics" changed.

A new series of EDA tool and design process innovations were required to dramatically boost engineering productivity and realize the full potential of DSM design. Managing the complexities of the design environment and improving engineering productivity became critically important in continuing the pace of innovation throughout the industry. As the amount of information and knowledge required to complete a design increased, the Internet and Intranet emerged as the preferred tool for the communication and delivery of infor-



3. A true plug-and-play environment combines tools, data, information, and knowledge with office automation and communication tools.

Client/Server Computing And EDA

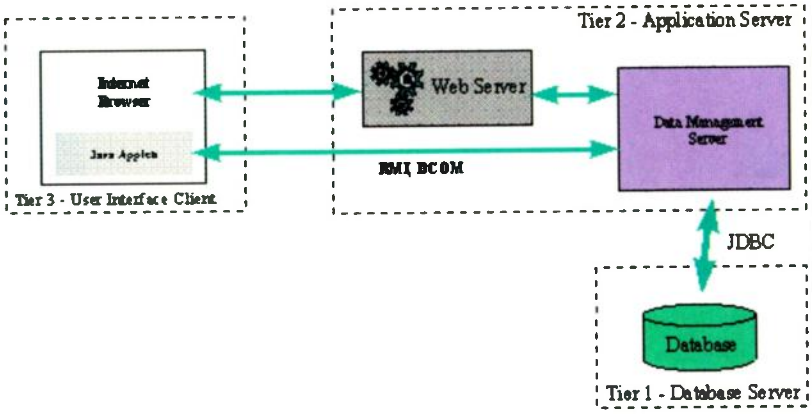
The recent development of the Internet has brought increased focus to the multi-tier client/server computing model. This model divides the application into three or more distinct modules—a database server, an application server, and a lightweight user interface (see the figure). This differs from the traditional two-tier client/server model in that the application and the user interface are separated.

This model is ideal for application in the Internet where the browser becomes the platform for a lightweight hypertext-based user interface. Java-based applets, embedded in the HTML (HyperText Markup Language) pages, are used to communicate with the application servers which function as the heart of the system, executing the core algorithms of the application. The Java applets simply display information to the user and return user feedback to the application server.

Multi-tier client/server computing has several benefits: It allows performance-intensive design tools to run on powerful, remote computing servers, yet it can be accessed from lower-powered desktop computers, and it provides a bridge for UNIX-based design tools to be accessed in a Windows environment. Furthermore, in the future, it may enable remote computing services to be offered over the Internet. In this scenario, a vendor may securely offer the services of a high-performance simulation server to design engineers from around the world. To access these services, the design engineer will simply need to enter a credit card number, upload the design and stimulus, and then from his or her web browser, "kick off" the simulation run and receive the results in Java-based displays.

As distributed multi-tier client/server computing becomes established throughout the corporate enterprise, endless new possibilities for better integrating design tools into the corporate infrastructure will certainly be created. New generations of decision support tools will become possible that access application and database servers throughout the corporate enterprise to assist the designer in making design trade-offs. Communication paths between engineering design teams and their supporting organizations will be streamlined as the separate islands of automation are tied together in a "web" of application servers.

Graphic IV: Multi-Tiered Client Server



mation *(Fig. 2)*. This led to the development of the engineering desktop as the standard computing desktop was enhanced with sophisticated, Internet-centric design management tools.

On the other front, advances in the general computing environment resulted in the advent of "ubiquitous computing." As the computer became more integrated into everyday life, the quality, innovation, and sophistication of general computing software began to affect customer expectations of EDA tools. Their willingness to purchase isolated monolithic design tools quickly diminished. A crop of new entrants to the engineering productivity market emerged to meet the needs of Internet-centric design.

The nature of EDA design tools began to change along with advances in general computing. Tool architectures were rethought as developers first embraced Windows NT, and then the Internet. There were two significant shifts in tool design: Tools adopted componentized architectures and were developed to operate in a three-tier client/server model. These changes enabled the creation of true interoperability standards, "plug and play" EDA design tools, and integration with the Internet.

Eliminating Design Limitations

The level of flexibility and sophistication incorporated into the Internet-based design environment of 2001 has freed the engineer from the limitations of the past, and the result has been greatly enhanced engineering productivity. Engineers no longer move from design tool to design tool inside a custom flow sequence built from endless shell scripts on their workstations, then turning to their Windows PC to perform the rest of their more mundane computing tasks.

Engineers now work in an environment where tools, information, and knowledge are truly plug and play. The designer enters a single, integrated collaborative design environment where design tools, data, information, and knowledge are completely integrated with office automation and communication tools *(Fig. 3)*.

For example, each design project now has a hierarchically-organized

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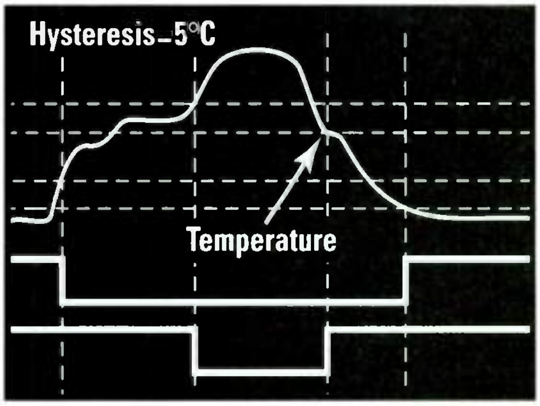

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home page that links directly to pages with the project schedule, team assignments, status reports, and so on. Using hypertext links, team members execute their assignments by navigating through their project design environment. At every step along the way, the design engineer can access the learning tools, workflow descriptions, design tools, and documentation germane to the particular design task at hand, "drilling down" to garner additional, in-depth knowledge on any particular subject.

Internet technologies, which helped everyone sift through the deluge of information now being made available, also made their way to the engineering desktop. Intelligent agents, search engines, and specialized web browsers were developed that helped engineers cull out the required information for a particular design. Now, these technologies are "intelligent" enough to track the engineer's progress in the design flow and serve up the pertinent news, articles, research papers, on-line user groups, and expert services sourced from both within and outside the company's boundaries.

The three-tier client/server architecture also has affected the design environment *(see "Client/Server Computing And EDA," p.46)*. The ability to separate the user interface, the tool, and the design database has given the design engineer greater flexibility in where and how the tools are executed. For example, it is now possible to securely access the high-performance servers of a third-party simulation service provider from a low-powered, 500-MHz desktop machine, or even a mobile computing tablet.

Open Communication

E-mail, bulletin boards, chat rooms, Internet telephony, and desktop videoconferencing have all enhanced the ability to communicate at the beginning of the third millennium. The engineer leverages all of these channels to enhance his or her communication with the rest of the world. The nature of this communication has changed. In the past, the majority of an engineer's communication occurred within the design team, but now, collaboration occurs on a truly global scale.

This widespread collaboration has forever changed the way companies maintain their competitive advantage. The Internet has lowered the barrier to entry in almost every knowledge-intensive business. Everyone now has access to an enormous body of knowledge and global distribution. Being the largest player in a particular segment no longer guarantees success. Those companies that embraced the new communication paradigm experienced such synergy that they soon began to overcome the companies that attempted to remain isolated. As the walls that inhibit communication have crumbled, speed and agility have become more important in staving off all competitive threats. A company's ability to balance the mix of proprietary and shared expertise, to exchange information, and to leverage the Internet also has become a key driver of competitive advantage. As a result, engineers regularly communicate with their suppliers, customers, and competitors.

The span and depth of communication also has changed. Today's design teams have expanded beyond the hardware engineers. Software engineering, purchasing, manufacturing, marketing, and finance are now all closely involved in the design process, requiring the design engineer of 2001 to devote more time to interaction and communication than in the past.

Integrated Information Information is more accessible in the electronic design environment of 2001. The World Wide Web has forever changed the nature of documentation.The design engineer no longer wades through a combination of trade journals, books, academic papers, CDs, and part databases. Instead, he or she uses the multimedia-rich, context-sensitive Internet medium. Furthermore, tool documentation, served online, is now a part of the application, rather than an adjunct. On-line training and instant global access to design know-how has largely relegated training classes and technical conferences to being relics of the past. The Internet allows easy contact and interaction with experts from around the world. On-line EDA consulting and information services have been developed to provide engineers with decision support and design process knowledge.

Moreover, catalogs of intellectual property and tool libraries are integrated into the design environment. At any time, an engineer can browse through these listings in search of a design element to match his or her design specifications, purchase and download it on-line, and then easily integrate it into the design.

The company knowledge base has now become a strategically-important company asset. Instead of isolated islands of design expertise, companies have created vast repositories of their collective design expertise. These knowledge bases are continually expanded by the design engineers. As engineers learn or create, their expertise is captured into the company's knowledge base.

New Designer Responsibilities

Engineers in the year 2001 have more responsibility than ever before. Their choice of which EDA tools to use is now largely a personal decision. With the exception of the extreme "cutting-edge" design tools, all tools plug-and-play into the design environment. In addition, the price of individual tools is such that design engineers now have some degree of freedom to choose their own tools. These changes have dramatically affected how EDA tools are purchased.

The age of the multimillion-dollar EDA tool purchase is gone. Instead, individual engineers control most of the purchase cycle. Since EDA tools and intellectual property are basically bits of information, companies that provided these products began to disseminate them over the Internet in the mid-1990s. Soon after, the first electronic payments for these products occurred. Today, intellectual property and EDA tools are offered as modular, standards-based products, focused on specific design tasks. Designers revel in this new freedom to mix and match EDA tools and intellectual property.

For example, suppose a designer needs a new datapath tool. His or her first step is to browse the available tools on the Internet. The EDA companies providing datapath products all have web sites that include product specifications, supported standards, and performance data. The designer can evaluate these products

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+3.3V under Voltage	$V_{3.3} < 2.5$	
+3.3 > +5V Supply Reversal	$V_{3.3} > V_5 + 300mV$	90nS max
Reset Recovery	All Supplies in Tolerance	100mS typ

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through a series of on-line, interactive demonstrations. Third-party product reviews and existing customers are easily accessed for additional information. When the engineer has narrowed the choice, a trial copy is downloaded and tested out. If the designer likes the tool, it can be immediately purchased and used in the current design environment. Likewise, as a new tool or better version becomes available, the maturation of the EDA market has resulted in such quality that the design engineer now feels comfortable about upgrading in midstream without having to worry about incompatibilities.

A similar approach is used to locate externally sourced intellectual property. Design process-centric browsers are tailored to provide the applicable intellectual property and libraries at each point in the design process. The design environment provides the engineer with decision support tools to review potential design elements in terms of manufacturability, performance and cost. The information required for "make versus buy" decisions resides at the engineer's finger tips and can be applied at any time during the design process. Intellectual property is now purchased on a piece-by-piece basis throughout the design process.

In addition to tools, engineers are now responsible for managing their "knowledge budget." Engineers must efficiently leverage the information services available on the Internet to quickly and cost-effectively achieve their design objectives.

The EDA industry has adapted to the challenge of creating faster, denser, affordable products by adopting Internet-based solutions that allow IC, ASIC, circuit board, and system-level designers to create designs that address these complex needs. The result has been a tremendous boost in design engineering productivity.

The "dead time" associated with the design process has been dramatically cut. The improvement in tool quality and the enhanced ease of use that accompanied the Internet revolution has greatly reduced the need for "face-to-face" vendor demonstrations, technical conferences, and training classes. In addition, the EDA industry has taken advantage of new development methodologies and computing technologies and has introduced a series of innovative, high-performance products.

This boost in productivity has been matched by an equal leap forward in creativity. With the freedom to choose the best possible tools, information services, and intellectual property at every step in the design process, the designer is much better equipped to produce an innovative IC, ASIC, circuit board, or system. Collaboration across the Internet has greatly reduced simultaneous discovery and duplication of effort. Communication between design team members, internal design teams, and companies has increased dramatically, fueling greater synergy toward reaching an optimal design. With Internet access, an engineer can broadcast requests for help world-wide and receive an instantaneous response. The result is that the engineer now has the ability to employ the "design instruments" best suited to unlock his or her own creativity.

EDA has come a long way since its inception in the early 1980s. In the year 2001, small engineering teams will create systems that would have staggered the imagination twenty years before. This progression is directly linked to the impact of the Internet on how engineers work together, source information, acquire intellectual property, and use their tools. The Internet has fostered a much more creative and productive design environment, freeing engineers from the constraints of geography and granting them global access to unlimited sources of knowledge. With the Internet's help, engineers are well prepared to meet the design challenges of the next millennium.

David Alles has been a Business Manager for Internet poducts in the Silicon Systems Division of Mentor Graphics for the past year. He holds a BS in Industrial Management from Carnegie-Mellon University, Pittsburgh, Pa.

Grant Vergottini is a Program Manager for Internet products in the Silicon Systems Division of Mentor Graphics. He holds a BS in Electrical Engineering from Cleveland State University, Ohio.

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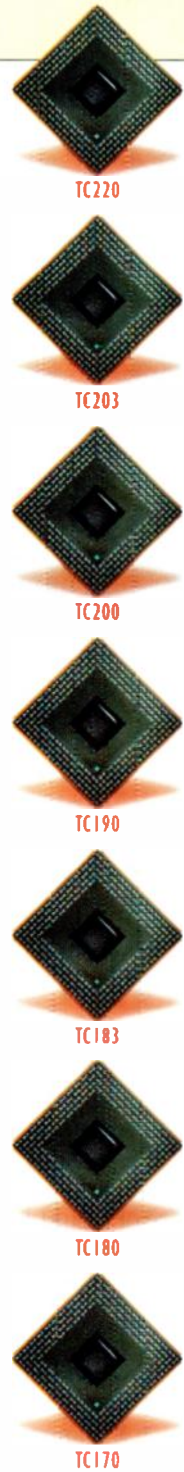

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Virtual Components And The Well-Connected Engineer

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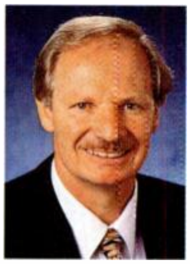


JAKE BUURMA
Toshiba America Electronic Components Inc., 1060 Rincon Circle, San Jose, CA 95131; (408) 526-2810.

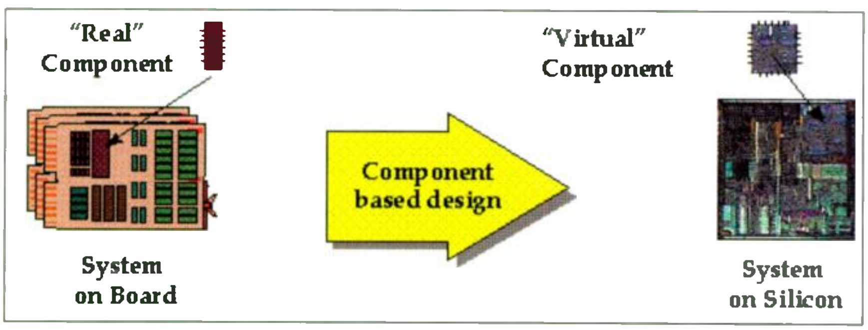
The smiling face on the videophone said, "Sore dewa mata," and a second later the Internet transmission ended. Ashley, a system design engineer at Toshiba Virtual Integration Inc., smiled back. Connected corporations are fine, she thought, but it's still personal relationships and good communication that ultimately determine team success. The daily video conferences with England in the morning and Japan in the afternoon served to keep her well connected. It was less than a second gap to anywhere in the world, but understanding the cultural differences in sharing design information was vitally important. The digital subscriber loop (DSL) line into her home office provided integrated voice data and video transmission at 8 Mbits/s, and her workstation included a media processor that was programmed for a wide variety of functions including high-quality video conferences.

The New Home Office

The new millennia was a fresh beginning in many ways. The fundamental concepts of "job" and "office" had changed, and for Ashley, things had improved. She was a new mother, and working from a home office was better than a long, unproductive commute and using daycare. A billion new consumers, mostly from Asia, had propelled the electronics industry forward, spending over a trillion dollars on products. Almost a third of that trillion went to ICs. The markets for small, customized, consumer electronics had exploded, and skilled engineers with a reputation for leading global development teams were in high demand. Her "old job" had been replaced by an annual employment contract. Her performance was not measured by her title or position, but her ability to accomplish the tasks at hand. If her current project was successful, it would position her for a larger contract with a role in product definition, not just virtual prototyping.

Earlier in the day she had received the DVD-ROM for her project. Her team had contracted to develop a virtual prototype of a portable, digital image processor with real-time audio and video compression. The double-layer, double- sided project disk held 17 Gbytes of design data and training videos. The top-level project folder contained multiple libraries of EDA tools, Virtual Components and the Project Manager application used by her company. Launching the Project Manager gave her access to the design data provided by hundreds of Intellectual Property (IP) and EDA vendors. When she was ready to use one of the highly specialized tools, the Project Manager would send an Internet request to the selected EDA vendor who would immediately send back an encrypted license key to enable the tool and begin charges at the project lease rate. Of course, she would only be charged for the tools she used. As usual, bug fixes and advertisements would piggy back on the download of the license keys, but her Internet watchdog would allow the former to pass and direct the later to the bit bucket.

The Virtual Socket Interface (VSI) for the mix and match of in-



BOARD DESIGN TODAY consists of selecting the best components from several different vendors, integrating the system using standard interfaces, and validating the design functionality, performance, and reliability. Systems on silicon will use the same methods with Virtual Components.

tellectual property provided a consistent and portable interpretation of the design intended to provide interoperability between EDA tools from different vendors. VSI defined the data structures and interchange formats that described the form and content of the virtual component libraries. Virtual socket definitions and consistent terminology for Virtual Component attributes allowed Ashley to compare value from multiple library suppliers. It was easy to search a wide range of components looking for the best fit for her specific application.

Using VSI formats and data models allowed direct downloading of reusable Virtual Components directly into her design database, eliminating the need for reformatting or reentry *(see the figure)*. Until VSI there wasn't even a way to compare the basic claims of power and performance from different vendors, let alone the actual mix and match of IP on a 40 million transistor IC.

Searching For IP By 'Net

When she was done searching the DVD disk for virtual components, she would extend the IP search to the servers on her company's intranet and the Internet. She'd stick with the IP servers that her teammates had recommended. Personal experience still provided the best search lists. Even with cheap, high-capacity DVD disks, most companies put their latest information on the Internet as the most practical way to support rapid distribution to millions of potential customers. Universal encryption standards protected the IP content as well as the transaction processing.

Ashley decided to set up the network search using a Java Application Template to define the search parameters. Her agent would seek and return the specific data described by the search method. First, it would search her own company's intranet servers. Virtual Components were the company's "Crown Jewels," so naturally it was well protected from pirates. She looked at the LCD display on her company IP credit card. Every 30 seconds it gave her a new password that was checked by the IP Server. When her agent was done looking around the links of the intranet, it would search outside of the firewall onto the semiprivate servers of her company's industrial affiliates. The IP on these servers was already cross licensed to her project, but a different password was needed.

Virtual Components Were The Company's "Crown Jewels," So Naturally It Was Well Protected From Pirates.

The semiconductor foundry for her IC had already been selected since other system designers also needed key physical information very early in their design cycle. The foundry was the natural place to find technology dependent IP such as embedded DRAM, EEPROM, high speed I/O and analog components. They also were adept at optimizing interconnect when synthesizing blocks from higher levels. It would be impossible to optimize the 2,000 meters of interconnect on the IC by designing at the cell level.

The next day, the Java search agent would return a list of hard, firm, and soft virtual components and the related firmware for the various embedded processors. The functional blocks would plug into the physical, logical, and bus protocols specified by the VSI on-chip Virtual Bus.

Building a behavioral-level prototype allowed her team to demonstrate the quality of the audio and video under a wide variety of bit-rate errors. VSI behavioral-level models provided a clean separation of design intent from implementation. Formal verification would be used to confirm the consistency between the virtual prototype system specification and the lower-level system models developed later.

The VSI Alliance

The VSI Alliance includes more than 80 companies from all segments of the electronics industry. Participating in the alliance are EDA vendors, intellectual property (IP) providers, semiconductor vendors, and system houses from Europe, Asia, and North America. The goal of the alliance is to quickly create an open, de facto standard for the mix and match of IP. The ability of the semiconductor industry to manufacture multimillion gate ICs has far exceeded it's ability to design all the IC components from scratch, and still meet time-to-market requirements. The Virtual Socket Interface (VSI) allows companies to reuse system-level macros, megacells, and software modules from various internal groups or multiple external sources.

The standard defines the formats, content, and application of reusable virtual components that can be supplied by various sources and integrated on a system IC, much as boards are designed today. The availability of these virtual components will allow more time to be spent on architectural design and validation. It also will provide for faster integration of hardware and software blocks for systems on silicon using deep submicron technology.

Intranets within companies, the Internet, and Java programming language are three logical ways to download information about virtual components. In the near future, even the components themselves can be downloaded, if the IP content is protected via encryption. The vision of VSI is to develop a world-wide IP network that designers can use to find and retrieve the best functional blocks and software modules to be integrated using silicon as a virtual PC board. The VSI standard defines the structure and formats used by the Virtual Socket Interface, allowing developers to compare value and choose the most advantageous IP from a wide range of sources.

For more information, contact the VSI Alliance at: http://www.vsi.org.

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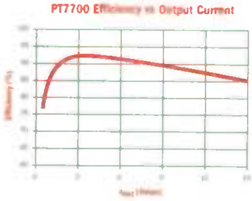

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The highest value IC was produced by designing the system architecture to use an optimal mix of hardware and firmware. Implementation was focused at the chip level integration of virtual components. Then, the interface between hardware and software was validated. The majority of the project development time was devoted to testing the software used to customize the prototype. The virtual prototype would allow Ashley's team to demonstrate functionality long before the silicon was ready. Senior management wanted to see and hear the quality of the video and audio well before tape out.

As the database of VSI components was built, Java engineering agents were used to inspect and summarize the design by generating custom reports directly from the source data used by the virtual components. Whenever a virtual component had its source data updated, the Project Manager would broadcast the change to the various validation agents. After every step of integration a separate validation phase rechecked the design. Validation agents watched the busses to make sure the bus protocols were still followed, and measured the statistics of bus activity looking for bottlenecks. If the top level validation was successful, the Project Manager would give the OK for the validation agents to automatically update the project documentation and post the ECO in the project file.

The productivity of her design team was based on a concurrent design paradigm that minimized rework, maximize reuse, and optimized the architecture for the specific application. Using VSI virtual components allowed the team to reduce the amount of time and bugs introduced by data reentry. The virtual components plugged directly into the functional layer of the design database and were the verified by the test layer of the virtual socket interface that accompanied each component.

The ability to reuse individual or multiple blocks from old designs increased reliability and productivity. The virtual components could be soft blocks that needed to be synthesized and optimized for new process technology. They could be firm blocks that embedded technology and physical information, but were still flexible enough to be molded into different shapes without a dramatic change in performance. Hard blocks provided the highest level of confidence in both performance and physical layout, but were very technology dependent and not very flexible. Using firm and hard blocks reduced synthesis, simulation, and verification runs and dramatically reduced the number of design iterations. Soft blocks were naturally the best vehicle for IP providers which turned out new modules at an amazing rate.

International Teamwork

In the next month, her team would develop several sections in parallel. The European team would focus on verification and design for test, the Japanese team would focus on physical design and signal integrity, and Ashley's team in the U.S. would complete the architecture and integration. Having several groups in different countries required formal program management and data replication. The Project Manager would keep track of the data and tool configurations so designers could trace back the origins of new data and block inheritance.

In two months, she'd have to reserve a conference room for the prototype demonstration. The team could position itself well for the next project if they showed a graceful degradation in video quality as adversarial testing increased. Having a clear priority for the project was key for keeping commitments between team members. Information technology was great for exchanging data and having video conferences, but teamwork still required a group of people who needed each other to achieve a common goal.

Jake Buurma, vice president of SID engineering of the Semiconductor Group for Toshiba America Electronic Components Inc., also has served as senior vice president and corporate officer of the former Vertex Semiconductor. Mr. Buurma received a M.S.E.E. from Santa Clara University, and is a member of the CICC technical program committee. He was a contributing author to the book "Talking Chips."

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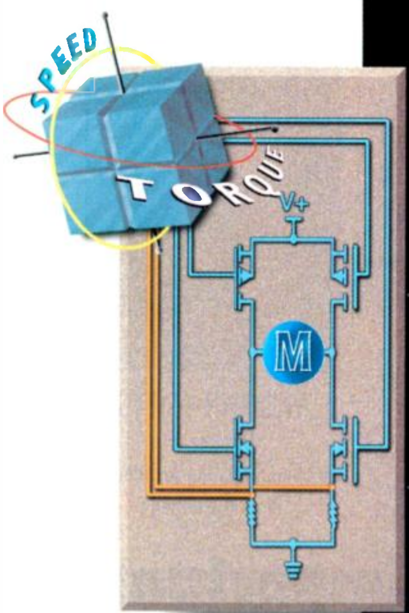

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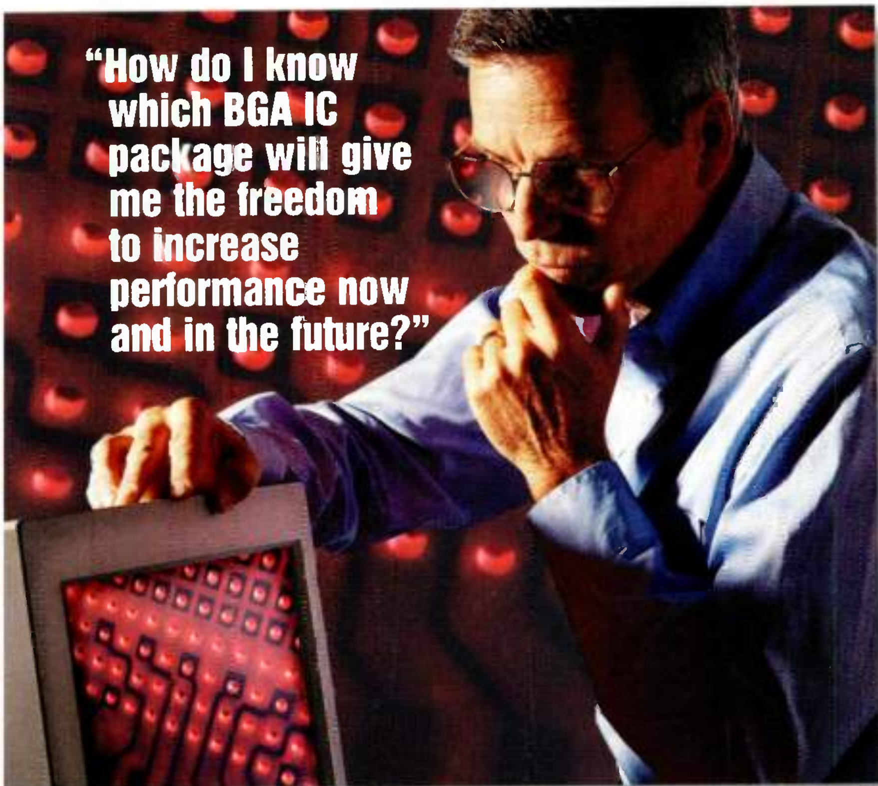

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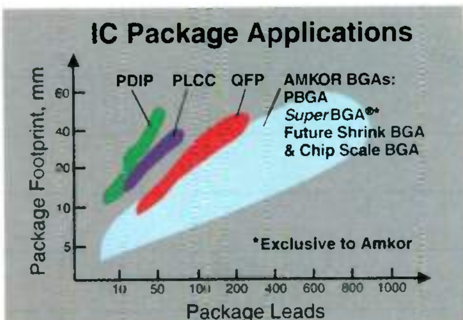

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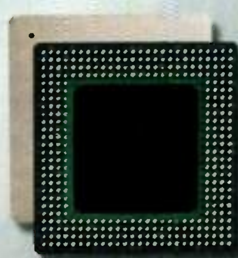

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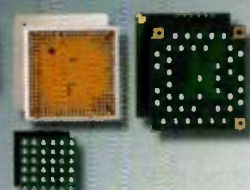

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The Information-Gathering Process For The Wired Engineer

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PATRICK ROMICH

IHS Engineering Products, 15 Inverness Way E., Englewood, CO 80112; (303) 790-0600.

As recently as 18 months ago, an engineer searching the World Wide Web for product information on digital signal processors would have been lucky to find any information at all. Today, using a search engine such as AltaVista, this same engineer will retrieve around 30,000 hits, including anything from press releases and academic articles to advertisements or any home page containing the words. A search on DRAMs will return more than 2000 hits, and digital-to-analog converters about 1000 hits.

Naturally, there are better alternatives than trying to wade through this information overload. For example, many engineers go directly to the home pages of well-known component manufacturers such as Texas Instruments (TI), Intel, National Semiconductor, and Motorola, as they all have web sites that are content rich and easy to search. Most component distributors have home pages that also are well-organized and easy to access.

Accessing these web sites is much faster than using a generic search engine, but can still be time-consuming. For example, there is one manufacturer's web site where it takes nearly 10 minutes just to navigate to the first page of component information. It also can take a minute or two to print out just one HTML (HyperText Markup Language) page. Furthermore, a different search scheme has to be learned for nearly every web site. And products can't be compared side-by-side because there's no way to search and extract parametric data on multiple web sites.

Many engineers also use the proprietary CD-ROMs offered by manufacturers and distributors. These CD-ROMs can be searched through very quickly, but include only those parts manufactured by the sponsoring company, or those on the distributor's line cards. Furthermore, they cannot be used to easily compare parts from competing vendors side-by-side, which restricts the designer's ability to make the best possible component selection.

Some engineers also use third-party databases of information such as the IHS CAPSXpert databases on CD-ROM. This family of databases consists of information on semiconductors, passive components, multipin cylindrical connectors, and commercial connectors, all of which are searchable by characteristics or parameters. For example, the CAPSXpert Semiconductor Database contains information on nearly 1.8 million devices from more than 1100 manufacturers, and is now available via the Web in a version based on CADIS' "Kakatoa" graphical-user interface (GUI) and search engine.

Given the tremendous amount of information now available in electronic format, it is interesting to note that many of today's engineers still prefer databooks. In fact, earlier this year IHS sent questionnaires to 1000 design engineers and engineering managers. Among the questions asked was "Please rate on a scale of 1-5 (with 5 being the highest) your preference in data sources." Databooks scored the highest with an average of 4.1. More than 50% of those who responded said they thought databooks were easiest to use, and 45.3% rated them most trustworthy.

Why do designers continue to prefer printed databooks and datasheets? This likely has to do with time constraints. Product lifetimes are short and getting shorter. Rapid product innovation and development has become paramount in maintaining profit margins and revenues. As a result, engineers today have less time to generate designs and to research parts.

Pinnacles And SGML

Some of the problems associated with manufacturer web sites are being eliminated due to the efforts of the Pinnacles Group. This consortium of National Semiconductor, Texas Instruments, Hitachi, Motorola, Philips Semiconductors, and others is developing a series of standards for electronic publications called the Pinnacles Component Information Standard (PCIS). The format chosen by this group is SGML (Standard Generalized Markup Language) because it easily models the information normally contained in semiconductor datasheets. SGML also handles information in tables the way it is normally displayed in datasheets. This means users will eventually be able to search the tables for information or parse it for import into design tools.

This user-friendly format provides customers with improved access to component information. It also makes it possible (at least in theory) to compare parts from different manufacturers side-by-side.

Today's version of PCIS also includes empty "binders" that can hold information on Spice models and emulators. "We do not include the models themselves," says Jeff Barton, TI's representative to Pinnacles, "but the binders can contain information describing the models with the dates they were created or revised, and pointers to the actual models themselves." On the other hand, testing has shown that this binder scheme requires tighter integration and more structure, and this will be addressed in the next generation of PCIS.

ECIX: The Next Generation

The Pinnacles Group is already looking toward a next generation of standards that will be called the Electronic Component Information Exchange (ECIX). TI's Jeff Barton says that PCIS today is a "one-way street." It allows information to be extracted from electronic datasheets and imported into EDA tools, but not vice-versa. Barton believes the next generation of Pinnacles standards will include tools capable of extracting parameters directly from silicon design systems to populate SGML documents. This will help to further automate the publishing process, and improve document currency.

Design Reuse Of IP

The next significant trend for the wired engineer will be the purchase of reusable designs or intellectual property (IP) via the World Wide Web. These design elements will consist largely of "hard" and "soft" cores and megacells. The hard cores are proprietary design elements supplied by silicon vendors for use in systems on silicon. And the soft cores will be supplied by either silicon vendors or third-party core developers for use in systems in silicon.

Rita Glover, president and principal analyst of "EDA Today," believes that there will be more use of the Internet to distribute information about cores for design selection during the next 12 to 18 months. She feels this will further expand into online sales of the IP that supports such a component, for example, symbols, models, and test benches. This design reuse makes sense for many manufacturers as they see design cycles grow shorter and process geometries smaller. In fact, an association known as the Virtual Socket Interface Alliance (VSIA) has already been formed to develop standards for these systems. Either VSIA or PCIS needs to tackle standards for the documentation that will be required, such as simulation models, schematic diagrams, debuggers, and information on the original designer's intentions. Ms. Glover also believes that PCIS will be an effective means for distributing IP, if EDA-related enhancements can be added quickly enough.

The Next Significant Trend For The Wired Engineer Will Be The Purchase Of Reusable Designs Via The WWW.

Companies such as Xilinx, Altera, Actel, and Lucent are already selling the reuse of cores, and at least one company has been formed to broker IP.

Intranet Vs. Internet

Our crystal ball also tells us that the longer-term answer for many wired engineers will not be the Internet, but a corporate Intranet. This is due to:

Performance. You've probably encountered this issue already (the long wait for a server that never responds, or the time it takes to make a connection because of heavy Internet traffic). This can just kill the productivity of engineers. While bandwidth is bound to improve with the efforts of the major telecomm companies such as AT&T, MCI/BT and TCI, and with the introduction of more Intranet-based technologies, it seems likely that performance will continue to be an issue for at least the next 12 months.

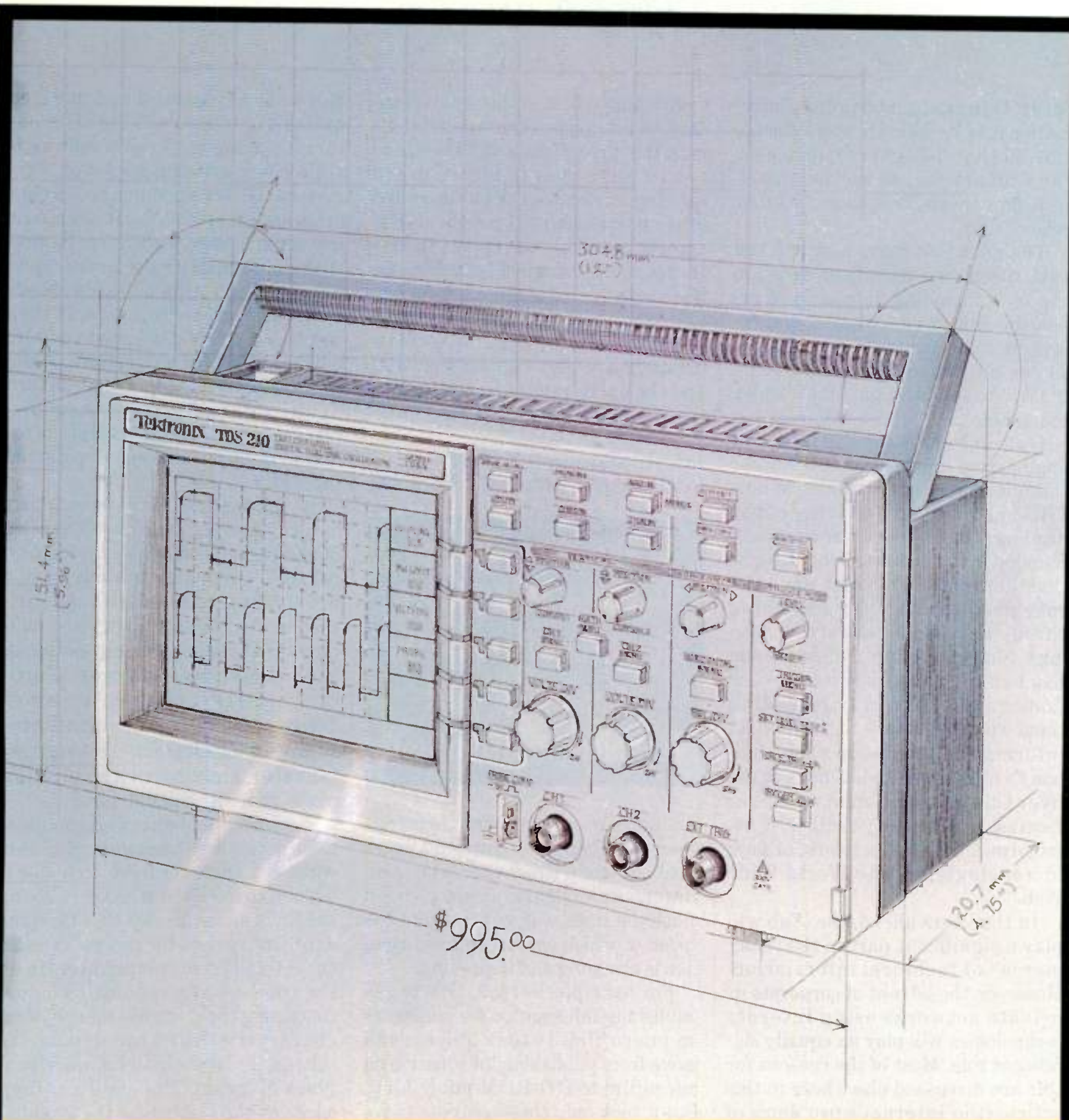
Information integration. Many companies need to integrate external information with their corporate databases. For example, several large manufacturers have integrated their preferred parts and preferred vendor data with the IHS Xpert Semiconductors database using IHS' Congruity Component Information Management Systems. This allows them to link their internal information with IHS' component information, as well as the Xpert databases of information on worldwide commercial standards, mil specs and standards, and vendor catalogs, to provide their designers with access to all the technical information they need.

Replacement parts. The Internet can't easily provide information on replacement parts. Yet, this is critical for companies whose products have long life cycles. For example, IHS works with DoD-oriented manufacturers whose product life cycles are 12 to 15 years. When one of their parts becomes obsolete, they must be able to quickly find pin-for-pin replacements, upgrades, or downgrades (depending on the particular application).

In comparison, a corporate Intranet offers enhanced security, and allows external information from third parties to be integrated with existing databases. A corporate Intranet also offers significant performance advantages, and can include whatever information is important to the company, including data on replacement parts.

More Intelligent Information

Over the next few years, engineering information will become more intelligent as new kinds of data are added to component databases, and existing databases combined to form new, more intelligent versions. IHS has developers today working on integrating the company's component databases with its military and commercial standards databases. This will enable users to find a part, then immediately view any applicable commercial or military stan-



This digital scope is a major breakthrough no matter how you measure it.

It's never been easier to pick up a Tektronix digital scope. Just $995 will get you the 60 MHz TDS 210, while $1695 will get you its 100 MHz big brother, the TDS 220. Both come loaded with dozens of great features like triggering and automatic setup. They'll even store or recall your measurements at the push of a button. Yet despite all that, the actual scopes are as diminutive as their price tags. Making them easy to pick up in more ways than one. For more information, please contact your Tektronix distributor or call 1-800-479-4490, Action Code 318. Or, visit us at www.tek.com.

Tektronix

dards. Ultimately, interpretive information may be added to this information so that designers can access "how to" articles, as well as simulators, flow charts, templates, or other related files.

The next few years also will see new, specialized collections added to the Web, including databases of pc-board connectors, switches and relays, metallic materials, and plastics. These databases are likely to be SGML-based, and parametrically searchable.

How does IHS see the future of engineering information? To answer this question requires looking at how IHS has evolved and where it is heading. The company was originally founded by an engineer who thought that there must be a better way to locate products than by searching through dozens of industrial catalogs. Since then, the company's aim has been to help engineers work faster and smarter by providing them with easy access to the product information they need. The company's objective also has been to deliver this information in whatever form customers need, whether by microform, CD-ROM, network, or now, increasingly via the World Wide Web.

In the years ahead, the Web will play a significant part in the "commerce" of technical information. However, the advent of corporate or private networks using Internet technologies will play an equally significant role. Most of the reasons for this are discussed elsewhere in this article (the Internet's problems of performance, information integration, depth of coverage, and, especially, security).

There also is the possibility of the development of "Extranets," or Intranets extended out of the boundaries of the enterprise to include information and applications from customers and partners such as IHS. It is likely that these Extranets will be based on the Internet Inter-ORB Protocol (IIOP). IIOP will prove especially important because it provides a system by which objects can request services from one another across a wide variety of platforms or database systems.

It is believed that, ultimately, companies will use this open standard to integrate their applications with this type of data and tools, and to also make their information and resources available to customers and other partners. In time, these Extranets are likely to replace the Internet as the "channel" of choice for the exchange of technical information, because they offer all the benefits of the Internet, the platform independence, the standardized GUI and the open standards, but none of the disadvantages expect cost.

Information In 3 Years?

At a recent conference, one of the speakers used the term "Internet years," defining four Internet years as about one normal year. The term "information years" could be used much the same way, to represent the speed at which engineering information is changing and improving.

In The Years Ahead, The Web Will Play A Significant Part In The "Commerce" Of Technical Information.

For example, in 1959, IHS began publishing information for engineers on microfilm. It took 29 years to move from publishing information on microfilm to CD-ROM publishing. But it took only three years to move from standalone CD-ROM systems to CD-ROM networks, and just a year to move this information onto the Internet.

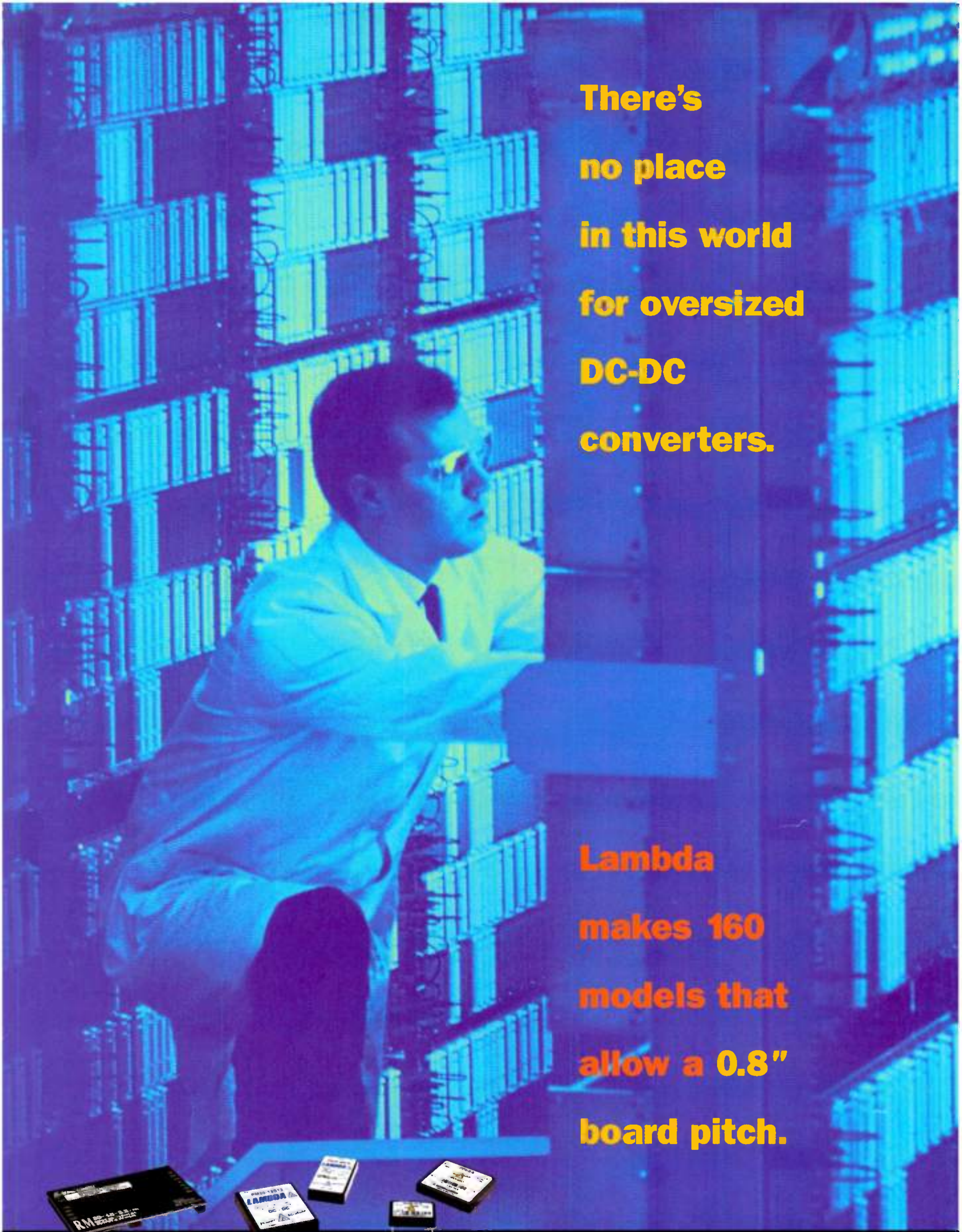
The speed of change makes it extremely risky to try to guess how an engineer might see technical information in as little as three years. However, it seems likely that he or she will receive information via a corporate Intranet or an Extranet, and that all component-related data will include at least some intelligence. For example, an engineer could be developing a new personal communications device. First, the engineer clicks on a database icon and opens a window with a "tree" of components. He or she navigates down this tree until he reaches variable attenuators. Clicking on these words activates a box containing a list of parameters. He scrolls down to current drain and enters 2.7 V and <25 mA. A few seconds later, the system reports that the company's preferred parts database contains no attenuators with these characteristics. It then displays a list of preferred vendors who manufacture attenuators. When a search of these vendors fails to turn up the right part, the system displays a list of attenuators and the required parameters from all potential vendors.

As the engineer clicks on each part in turn, the system displays the price of the part, its availability, history, reliability, manufacturability, and a list of files associated with the part, such as associated industry and military specifications, models, and simulators. It also generates a list of articles published recently on low power design techniques. The engineer reviews this information, chooses an attenuator, and orders a simulation model from the manufacturer.

Because the personal communications device is to be marketed worldwide, the engineer next activates a list of all associated standards. He or she finds an applicable CCITT standard, and revises the design to make sure it will be in compliance. He or she then opens a separate window containing the electrical and physical characteristics of the device, its schematic symbol, and a functional block diagram. The engineer then clicks on the symbol for the attenuator and places it on the schematic layout.

While all this information may seem to reside locally on the company's Intranet, the engineer has actually been accessing information on an Extranet consisting of his company's preferred parts and preferred vendors databases, IHS's Xpert databases of component and worldwide standards information, a third-party database of reliability and manufacturability data, and the attenuator manufacturer's database of cost and availability information.

Meanwhile, the engineer's manager, who has been monitoring the design, sees that a system-on-silic



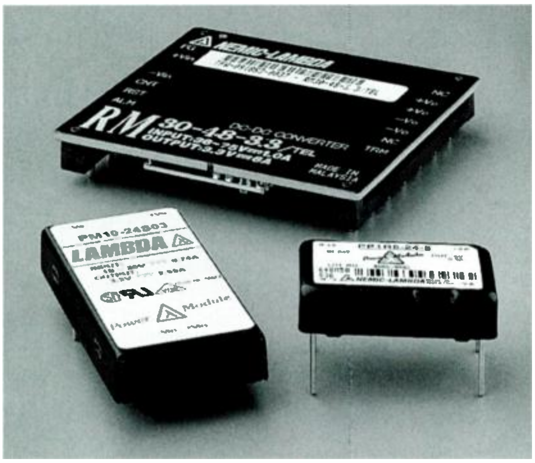
RM Series. 90% efficiency, 30-100W. <0.35" high.

PM Series. 5-30W, standard pin-outs. <0.35" high.

PP Series. Small footprint, 1-6W. <0.35" high.

LAMBDA Electronics Inc.

Lambda's RM, PM and PP Series



Over 200 low profile DC-DC converters with single, dual and triple outputs, up to 100W.

Lambda's low profile DC-DC converters are designed specifically for distributed power architectures in the telecom and computer markets. Their low profiles, down to .33" or less, are ideal for use in tight card pitch applications such as ATM switches, LAN's and cellular base stations. And they comply with worldwide safety agency approvals such as UL, CSA, EN60950, Bellcore and ETSI – as required for the telecommunications market.

Lambda's low profile DC-DC converters are extremely reliable because they're designed with 100% SMT technology. This eliminates point to point wiring, the most frequent cause of failures in a DC-DC converter. They are manufactured on highly automated continuous flow production lines, so Lambda can support production level quantities in a timeframe which adheres to today's aggressive delivery requirements.

Count on Lambda to provide the DC-DC Converters you need, when you need them. Just call 1-800-LAMBDA-4.

Low Profile	Low .33" profile is ideal for telecommunications applications that require narrow card pitch – ATM switches, LAN's and multimedia systems.
No Heatsink Required	Lambda's RM, PM and PP Series operate up to full output power without an external heatsink, making tight card pitch requirements possible and lowering total system costs.
Broad Product Range	Lambda provides over 200 models in single, dual and triple outputs, from 1W to 100W. This allows the use of standard models, thereby minimizing design cycle time, eliminating NRE for spec development, and shortening production leadtime.
5, 12, 24 and 48V Nominal Inputs	Four input voltage ranges from 5V to 48V for diverse applications.
Telecom Approvals	Lambda's RM and PM Series meet the stringent requirements for telecommunications applications as defined by Bellcore and ETSI (European Telecommunications Standards Institute). This minimizes the risk during critical system approval stages.
Worldwide Safety	Safety Agency approvals to UL1950, EN60950 and CSA234M90 ensure compliance throughout the world.
Overvoltage Protection	Overvoltage protection is included on all single output models and on the main outputs of dual and triple output models, protecting logic circuitry from catastrophic failures.
No Electrolytic Capacitors	These converters do not use life-limiting electrolytic capacitors, eliminating planned system maintenance in central office or remote site applications.
High Efficiencies	Lambda's RM Series leads the industry with efficiencies of 90% for 5V @ 100W, with 30% less power dissipation than typical standard converters – without a heatsink.
Built In EMI	Lambda's PM and RM Series contain integral EMI filtering, decreasing the amount of external components required for total system compliance.

RM, PM and PP Series Single Outputs

MAXIMUM OUTPUT RATINGS VOLTAGE (V)	POWER (W)	CURRENT (A)	MODEL 5V INPUT	12V INPUT	24V INPUT	48V INPUT	UNIT PRICE PER DELIVERED QUANTITY 1	10	100
2.0	12.00	6.00	—	—	—	RM30-48-2/TEL	$135	$116	$105
2.0	20.00	10.00	—	—	—	RM50-48-2/TEL	175	145	130
2.0	40.00	20.00	—	—	—	RM100-48-2/TEL	200	185	166
3.3	4.20	1.27	—	PM05-12S03	PM05-24S03	PM05-48S03	—	—	46
3.3	8.40	2.55	—	PM10-12S03	PM10-24S03	PM10-48S03	51	47	46
3.3	15.00	5.00	—	PM15-12S03	PM15-24S03	PM15-48S03	—	—	78
3.3	19.80	6.00	—	—	—	RM30-48-3.3/TEL	135	116	105
3.3	24.75	7.50	—	PM30-12S03	PM30-24S03	PM30-48S03	99	97	83
3.3	33.00	10.00	—	—	—	RM50-48-3.3/TEL	175	145	130
3.3	66.00	20.00	—	—	—	RM100-48-3.3/TEL	200	185	166
5.0	1.50	0.30	PP1R5-5-5	PP1R5-24-5	PP1R5-24-5	PP1R5-48-5	24	22	19
5.0	3.00	0.60	PP3-5-5	PP3-12-5	PP3-24-5	PP3-48-5	29.50	27	23
5.0	5.00	1.00	—	PM05-12S05	PM05-24S05	PM05-48S05	—	—	46
5.0	10.00	2.00	PP10-5-5	PM10-12S05	PM10-24S05	PM10-48S05	51	47	46
5.0	15.00	3.00	—	PM15-12S05	PM15-24S05	PM15-48S05	—	—	78
5.0	20.00	4.00	—	PM20-12S05	PM20-24S05	PM20-48S05	84	83	81.50
5.0	30.00	6.00	—	PM30-12S05	PM30-24S05	PM30-48S05	99	97	88
5.0	30.00	6.00	—	—	—	RM30-48-5/TEL	135	116	105
5.0	50.00	10.00	—	—	—	RM50-48-5/TEL	175	145	130
5.0	100.00	20.00	—	—	—	RM100-48-3.3/TEL	200	185	166
12.0	1.44	0.12	PP1R5-5-12	PP1R5-12-12	PP1R5-24-12	PP1R5-48-12	24	22	19
12.0	3.00	0.50	PP3-5-12	PP3-12-12	PP3-24-12	PP3-48-12	29.50	27	23
12.0	5.00	0.42	—	PM05-12S12	PM05-24S12	PM05-48S12	—	—	46
12.0	10.00	0.83	—	PM10-12S12	PM10-24S12	PM10-48S12	51	47	46
12.0	15.00	1.25	—	PM15-12S12	PM15-24S12	PM15-48S12	—	—	78
12.0	20.00	1.67	—	PM20-12S12	PM20-24S12	PM20-48S12	84	83	82
12.0	30.00	2.50	—	PM30-12S12	PM30-24S12	PM30-48S12	99	97	88
15.0	1.50	0.10	PP1R5-5-15	PP1R5-12-15	PP1R5-24-15	PP1R5-48-15	24	22	19
15.0	3.00	0.20	PP3-5-15	PP3-12-15	PP3-24-15	PP3-48-15	29.50	27	23
15.0	5.00	0.33	—	PM05-12S15	PM05-24S15	PM05-48S15	—	—	46
15.0	10.00	0.67	—	PM10-12S15	PM10-24S15	PM10-48S15	51	47	46
15.0	15.00	1.00	—	PM15-12S15	PM15-24S15	PM15-48S15	—	—	78
15.0	20.00	1.33	—	PM20-12S15	PM20-24S15	PM20-48S15	84	83	82
15.0	30.00	2.00	—	PM30-12S15	PM30-24S15	PM30-48S15	99	97	88

Features

	90% EFFICIENCY	EMI FILTERING	BUILT IN INRUSH LIMITING	AGENCY APPROVALS
PM Series		✔		✔
RM Series	✔	✔	✔	✔

RM, PM and PP Series Dual Outputs

MAXIMUM OUTPUT RATINGS VOLTAGE (V)	POWER (W)	CURRENT (A)	MODEL 5V INPUT	12V INPUT	24V INPUT	48V INPUT	UNIT PRICE PER DELIVERED QUANTITY 1	10	100
±12V	1.44	0.06	PPD1R5-5-1212	PPD1R5-12-1212	PPD1R5-24-1212	PPD1R5-48-1212	$25.50	$23.50	$20.50
±12V	2.88	0.12	PPD3-5-1212	PPD3-12-1212	PPD3-24-1212	PPD3-48-1212	33	30	24
±12V	5.00	0.21	—	PM05-12D12	PM05-24D12	PM05-48D12	—	—	47
±12V	10.00	0.42	PPD10-5-1212	PM10-12D12	PM10-24D12	PM10-48D12	52	48	47
±12V	15.00	0.63	—	PM15-12D12	PM15-24D12	PM15-48D12	—	—	80
±12V	20.00	0.83	—	PM20-12D12	PM20-24D12	PM20-48D12	87	86	85
±12V	30.00	1.25	—	PM30-12D12	PM30-24D12	PM30-48D12	100	98	95
±15V	1.50	0.05	PPD1R5-5-1515	PPD1R5-12-1515	PPD1R5-24-1515	PPD1R5-48-1515	25.50	23.50	20.50
±15V	3.00	0.10	PPD3-5-1515	PPD3-12-1515	PPD3-24-1515	PPD3-48-1515	33	30	24
±15V	5.00	0.17	—	PM05-12D15	PM05-24D15	PM05-48D15	—	—	47
±15V	6.00	0.20	PPD6-5-1212	PPD6-12-1515	PPD6-24-1515	PPD6-48-1515	46	42.50	36
±15V	10.00	0.33	PPD10-5-1515	PM10-12D15	PM10-24D15	PM10-48D15	52	48	47
±15V	15.00	0.50	—	PM15-12D15	PM15-24D15	PM15-48D15	—	—	80
±15V	20.00	0.67	—	PM20-12D15	PM20-24D15	PM20-48D15	87	86	85
±15V	30.00	1.00	—	PM30-12D15	PM30-24D15	PM30-48D15	100	98	95

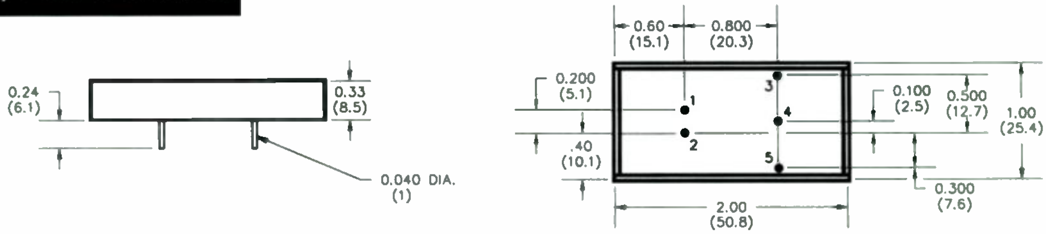
RM, PM and PP Series Triple Outputs

MAXIMUM OUTPUT RATINGS VOLTAGE (V)	POWER (W)	CURRENT (A)	MODEL 5V INPUT	12V INPUT	24V INPUT	48V INPUT	UNIT PRICE PER DELIVERED QUANTITY 1	10	100
3.3	30	7.00	—	PM30-12T03-12	PM30-24T03-12	PM30-48T03-12	$105	$104	$101
±12		1.00							
5.0	30	5.00	—	PM30-12T05-12	PM30-24T05-12	PM30-48T05-12	105	104	101
±12		1.00							

Features

	EMI FILTERING	ETSI & BELLCORE APPROVALS	5VOLT INPUTS
PM Series	✔	✔	
PP Series			✔

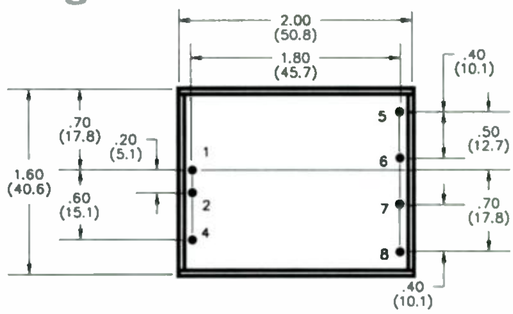
PM05, PM10 Series Outline Drawings



Note: Dimensions are in inches except dimensions in ( ) are in mm. Net weight is 1.0 oz.

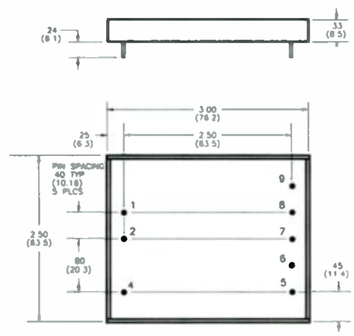
PM15, PM20 Series Outline Drawings

Note: Dimensions are in inches except dimensions in ( ) are in mm. Net weight is 1.5 oz.



PM30 Series Outline Drawings

Note: Dimensions are in inches except dimensions in ( ) are in mm. Net weight is 1.5 oz.

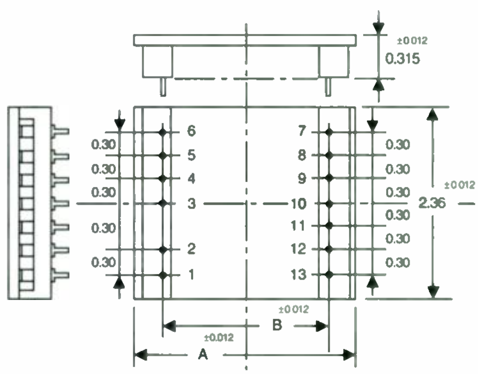


RM Series Outline Drawing

Dimensions

	RM30,/TEL	RM50,/TEL	RM100,TEL
A	2.56	3.86	4.57
B	1.80	3.50	4.20

Note: Dimensions are in inches.

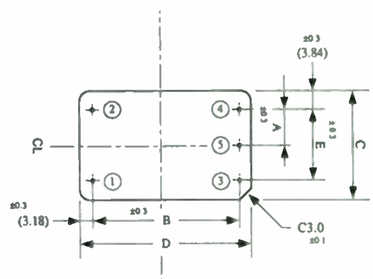


PP Series Outline Drawing

Dimensions

	Singles			Duals		
Dim.	PPIR5*	PP3*	PP6/PP10*	PPD1P5	PPD3	PPD6/10
A	N/A	N/A	N/A	0.3"	.4"	.4"
B	1.1"	1.6"	1.6"	1.1"	1.6"	1.6"
C	.827"	1.10"	1.65"	.827"	1.10"	1.65"
D	1.30"	1.85"	1.85"	1.30"	1.85"	1.85"

*Note: Pin 5 is not used on single output models



RM, PM and PP Series DC-DC Converter Specifications

DC Input

PP Series	5V Input 4.5-7.2VDC
PP and PM Series	12V Input 9-18VDC
PP and PM Series	24V Input 18-36VDC
PP Series	48V Input 32-63VDC
PM Series	48V Input 36-75VDC
RM Series	48V Input 36-60VDC
RM "TEL" Series	48V Input 36-75VDC

Efficiency

	Output Voltage			
	2V	3.3V	5V	12V, 15V
RM Series	80%	86%	90%	–
PM Series	–	73%	78%	79%
PP Series	–	–	65%	70%

Regulated Voltage

line regulation. . . . 20mV on the RM Series. 0.2% for main and dual outputs of the PM Series, 3% for auxiliary outputs of triple output PM Series modules over full input line range with constant load. 0.4% on the PP Series.

load regulation . . . 40mV on the RM Series. 1% for main outputs of the PM Series from 10% load to 100% load with constant input line .8% on auxiliary outputs of triple output PM Series models from 25% to 100% load, and with greater than 5W main output load. 0.6% on the PP Series.

ripple and noise. . . 100mV pk-pk on the RM Series. 75mV pk-pk on the 5V and 3V outputs of the PM Series. 120mV pk-pk for 5V outputs of the PP Series and 12V outputs of the PM Series.150mV pk-pk on 12 and 15V outputs of the PP Series.

Temperature Coefficient . . . . . . 0.03% °C.

Setpoint Accuracy

±1% on the main outputs of PM Series modules. 1.5% for auxiliary outputs of PM Series. ±5% on PP Series.

Output Adjustment

The RM Series, PM15, PM20 and PM30 outputs can be adjusted ±10% using resistive or voltage programming.

Overload Protection

The RM Series has constant current limiting with shutdown after 0.5-1.5 seconds.
PM Series models have current limiting to protect the load and converter from overload.
Avoid overloading auxiliary outputs on the PP Series for greater than 30 seconds.

Overvoltage Protection

RM modules provide latching overvoltage shutdown.
All PM Series models are provided with overvoltage clamps:

Vo	Clamp Level
3.3V	3.7-4.7V
5V	6.0-6.6V
12V	13.1-14.0V
±12V	26-30V
15V	16.37-17.5V
±15V	32.5-37.5V

Remote On/Off

The RM Series, PM15, PM20 and PM30 models include remote on/off via a TTL pin.

Alarm and Reset

RM modules are designed to give a TTL alarm status when the module output is below a specified value. This signal and the error status can be reset by applying a TTL reset signal.

Operating Temperature Range

-25°C to +85°C (+100°C Base plate) on the RM Series. Consult the factory for -40°C start-up.
-25°C to 105°C on the PM Series with derating (consult derating charts. Full load up to +70°C with forced air on all models. Consult the factory for -40°C start-up.
-20°C to +71°C on the PP Series. Derate linearly above +50°C from full load to 20% at +71°C.

Storage Temperature Range

-40°C to +105°C on the RM Series and the PM Series.
-40°C to +85°C on the PP Series.

Isolation Rating

RM Series: 1500VDC input to output; 50 VAC input to case; 500VDC output to case. (2500VDC input to output for the "TEL" versions.)

PM Series: 900VAC, 1500VDC, input to output on 48V input models; 500VAC, 700VDC input to output on 12/24 input models; 10MΩ output to chassis at 25°C, 75% RH.

PP Series: 500VAC (<5mA) input to chassis and input to output; >100MΩ output to chassis at 500VDC, 25°C and 70% Humidity.

Physical Data

Package Model	Weight (grams)	Dimensions (inches)
RM100,/TEL	170	2.36 x 0.31 x 4.57
RM50,/TEL	100	2.36 x 0.31 x 3.86
RM30,/TEL	62	2.35 x 0.31 x 2.56
PM05/10	28	1.00 x 0.33 x 2.00
PM15/20	43	1.60 x 0.33 x 2.00
PM30	71	2.50 x 0.33 x 3.00
PP1R5	15	1.29 x 0.31 x 0.81
PPD1R5	15	1.29 x 0.31 x 0.81
PP3	25	1.84 x 0.31 x 1.09
PPD3	25	1.84 x 0.31 x 1.09
PP6	30	1.84 x 0.31 x 1.65
PPD6	30	1.84 x 0.31 x 1.65

Agency Approvals

The PM Series Meets:

EMI: EN55022 Level B, FCC Part 15 Level B, Bellcore TA-NWT-001089 (an external capacitor and chip inductor may be required for some models. Consult the factory for application notes).

Input Transients: IEEE-C62.41-1980 (0-.5ms 100kHz ring-wave), ETSI Standard ETS300-132 (100V 10Joule pulse).

Inrush: ETSI Standard ETS300-132 (<50A peak), Bellcore.

Safety: UL1950, CSA234, EN60950. Consult the factory for BABT. CE Mark (Low Voltage Directive).

The RM "TEL" Series meets UL1950, CSA234 and EN60950.

Contact the factory for information on the RM Series and PP Series.

Guarantee

The RM Series is guaranteed for 3 years for operation within published specifications. The PM and PP Series are guaranteed for 2 years for operation within published specifications.

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L-127 12/96

consisting of the microprocessor, the memory, a digital signal processor and some kind of custom logic could be used in place of separate components, and that this would help reduce both the cost and the design time. He e-mails his thoughts to the engineer who then orders the system and associated files, including a simulation model, schematic diagrams and a debugger.

As our engineer's design progresses towards completion, a manufacturing engineer in Malaysia monitors it for manufacturability, and a buyer monitors it for cost. At several points during the design process, the Malaysian engineer e-mails the engineer suggestions for components that would simplify manufacturing, and deliver approximately the same performance. And the buyer suggests several component substitutions that would cut product costs without effecting performance.

In other words, the engineer of the future will be able to access many times the information he can today, and in just minutes. He or she will generate better designs because they can be tested for manufacturability and reliability before the design is finalized. Cycle times will shrink even further as engineers learn to buy and use logic blocks or systems-on-silicon. Designs will improve because it will be easier for engineers to compare more parts side-by-side and, thus, make better selections. Products will be more competitive worldwide because they can be designed to the appropriate standards right from the beginning. Design reuse can help reduce costs. Less rework will be required because everyone involved in the design process can have their input considered before the design is finalized. And designs can be tested faster and easier using models, simulators, debuggers, and real-time operating systems.

Patrick Romich, president of IHS Engineering Products, has been with IHS for 13 years. He has been a sales representative and general manager of the company's Federal Region. Prior to becoming president of IHS Engineering Products, he was the company's vice-president of sales.

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READER SERVICE 162

Coping With Convergence: The Future Of Wireless System Design

Designing The Wireless Products For The Next Century Requires Vision, Technology, And The Right Design Tools.

HOMAYOON SAAM
Alta Group, 555 Mathilda Ave., Sunnyvale, CA 94086; (408) 523-4600; e-mail: hs@cadence.com

If we extrapolate the current rate of growth in wireless communications and examine the demands of the late nineties global lifestyles, we can begin to get a glimpse of what may be lying ahead of us at the turn of the century. This view is dominated by the demand for communication at any time or place, facilitated by affordable, high-quality, mobile communication products. The associated system design complexity required to handle multiple forms of communication (voice, data, and multimedia) on a global scale necessitates the application of new technologies and system design methodologies which are just beginning to surface.

Today's emerging multimode, multiband handsets are precursors to the Universal Mobile Telecom Services (UMTS). The next generation of handsets will require integration of many diverse technologies such as multiple variable-rate speech coders, multiband and wideband RF components, different forms of modulation, and multiple access as well as diverse receiver architectures conforming to various cordless, PCS/PCN, paging, messaging, cellular, and satellite communication technologies. Efforts are currently underway at various system design and design-automation houses to address these complex design issues.

The path towards UMTS will require integrating these diverse technologies based on such future building blocks as several-hundred-MIPs processors, programmable-architecture processors and ICs, wideband data converters running at more than 100 Msamples/s, digital IF processing, and multiband RF conversion blocks. This all leads to the concept of software-defined radio, and the significance of the role of software in future system architecture that embody new levels of programmability.

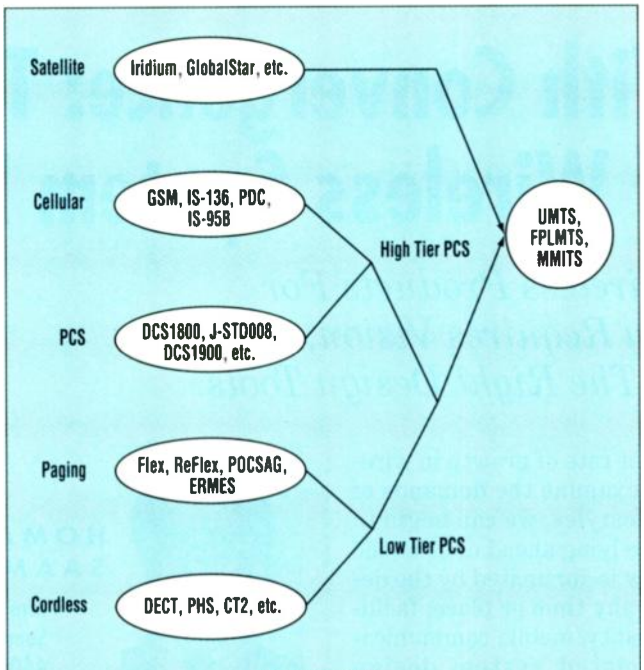
The UMTS Superset

Multiband, multimode handsets address the needs of the end user in keeping in touch at home, on the road, and in the office via the same handset and mobile telephone number. This arrangement requires the integration of various existing and upcoming cordless, cellular, PCS, paging, and satellite forms of mobile communication (*see the figure*). These include existing TDMA and CDMA digital cellular/PCS standards such as GSM, DCS1800, IS-136, and IS-95, in addition to cordless standards such as DECT, CT2, and PHS. Various paging standards such as Flex, ReFlex, ERMES, and POCSAG also will be possible candidates for the multimode handset, depending on its feature set.

These multimode handsets will require a melange of speech coding, channel coding, modulation, and multiple-access techniques as found in the above standards. For example, such speech coders as the Enhanced Full Rate vocoder (EFR) of GSM, Enhanced Variable Rate Coder of IS-95, and the PSI-CELP of the Pacific Digital Cellular (PDC) will need to be implemented within the same handset. Various modulation techniques such as GMSK, DQPSK, and DS-Spread Spectrum along with their corresponding receiver structures such as MLSE equalizer, and DFE equalizer with channel tracking and rake-receiver structure will need to be implemented with their diverse requirements for sampling rate, analog-to-digital resolution, and MIPs of processor loading among others.

But the vision of UMTS includes the multimode functions as only one component of the universal handset, and goes beyond existing voice and messaging technologies. It also includes the promise of wireline quality and capacity of information access as exemplified in such high-bit-rate standards as ADSL and HDSL (used for carrying multimedia forms of information such as compressed audio and video). For example, the European RACE Mobile Project has specified a 2-Mbit/s target data rate conforming to the HDSL standard which may be allocated based on demand to the mobile terminal. This specification is based upon the idea that mobility should not impact the type and quality of communication needed by the user.

These future technologies will require the implementation of additional wideband receiver architectures. They will conform to such modulation techniques as discrete multitone (DMT) or orthogonal frequency division multiplexing (OFDM). These techniques are known for their inherently superior properties in combating mobile-channel impairments, such as frequency selective fading and inter-symbol interference. These qualities are especially important because channel impairment tends to intensify as the transmission symbol rates are increased. Adaptive adjustment of the bit rate on the narrow-band channels making up the DMT channel based on channel characteristics are additional challenges to the system design of such handsets.



Evolution of UMTS

Undoubtedly, the UMTS system goals are quite ambitious and the design tasks at hand, from the RF front-end to the baseband signal processing and multiprotocol software running on the microcontroller, are quite daunting. However, a three-pronged advance in the underlying semiconductor technologies comprising the wireless system is pointing the way to some relief in the system engineering and design tasks.

Digital IF Processing

The apparently endless miniaturization of semiconductor technology is giving rise to the availability of wideband data converters approaching 100 Mbit/s. This same phenomenon has been responsible for the digitization of large sections of the receiver subsystems which, up to now, have been the exclusive realm of analog RF technology. Digitization has multiple benefits to the receiver design. First, it replaces the imperfections of the analog components with the precise and consistent performance of their digital counterparts. By replacing analog mixers, oscillators, and filters with their corresponding high-speed digital multipliers, numerically controlled oscillators, and digital filters, undesirable effects and considerations such as mixer/oscillator nonlinearities, calibration, temperature drift, and alignment can be put to rest. Furthermore, a digital IF receiver can be easily integrated with a baseband processor. This technique enables the receiver to be easily reprogrammed via its own software, accommodating changing parameters such as receiver bandwidth, sampling rate, and resolution.

High-Speed DSP Processors

By one estimate, the performance figures of programmable DSPs have tripled in the past seven years to 120 MIPS, and will reach 500 MIPS early in the next decade. While the processor speed in itself will enable the integration of such functions as voice recognition, acoustic echo cancellation, and spread-spectrum functions within the same processor, unprecedented processing power also will become available from the integration of several processors (DSP or micro) within the same device. Such a multiprocessor architecture for baseband and voiceband has multiple advantages. These include distribution of the processing load, a better peak-to-average MIPS ratio, simplification of the baseband process scheduler and RTOS design, and finer granularity of the system-level power control. This approach to the baseband design has already been recognized and implemented in the form of processor plus coprocessor architectures. They integrate such units as Viterbi coprocessors or vocoder accelerators with the main DSP engine. Software programmability of the entire baseband/IF will naturally benefit the system design by shortening the design cycle and providing high flexibility in the design.

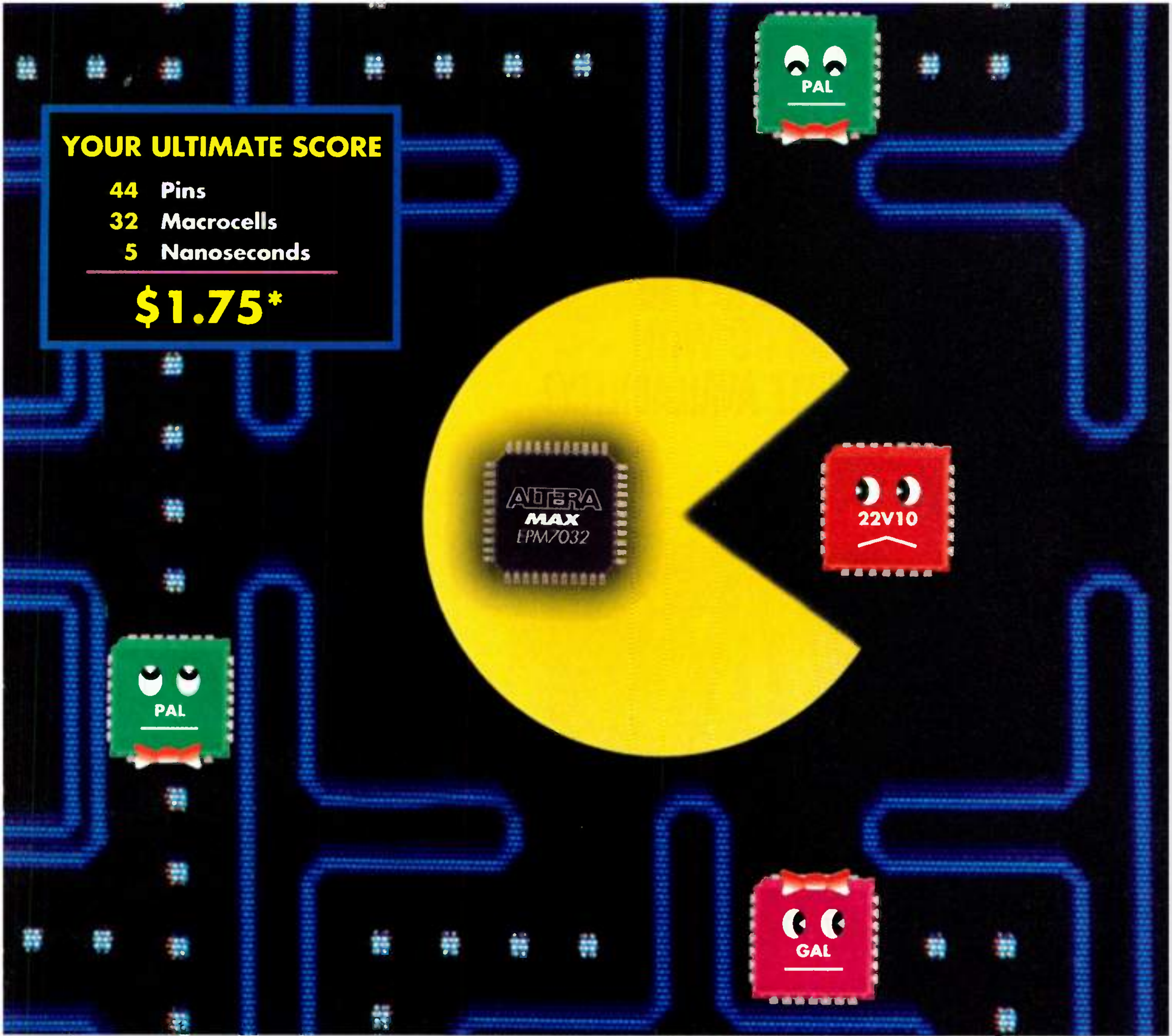
Reconfigurable Architectures

One of the quiet undercurrents of electronic design has been the advance of field-programmable ICs in such forms as FPGAs, flash memories, and interconnect devices (FPICs). While this technology has been mostly limited to the prototyping and design-exploration domains, new innovations put it squarely at the center of the future device architectures. This advance could result in plastic hardware architectures that could be configured in milliseconds to suit the need at hand.

This level of programmability will form the foundation of a new and powerful technology that will allow the future system designer to create smart systems capable of transforming their interconnections, architectures, and instruction sets in real time to work with the task at hand. Such systems could be programmed to support a variety of different vocoders, modulation systems, and channel-adaptation algorithms. The demands of designing these complex systems will extend the concept of software design to include this new programming paradigm, opening the way for new software design tools and concepts to emerge.

New Tools To The Rescue

It is unimaginable that the above system design complexities and technologies can be managed without appropriate tools becoming available to the future system designers. The di-



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READER SERVICE 101

verse range of advanced technologies calls for an equally sophisticated design environment which integrates algorithmic, architectural, software, and hardware design from RF to IF, to baseband and voiceband processing. New levels of design and performance visualization will become necessary to facilitate complete software prototyping of the system before committing to implementation. Block-based design will become standard practice, requiring processor and ASIC vendors to supply software and hardware libraries.

These collections of high-level functional blocks also will be made easily accessible to the system designer within the same integrated design environment used for system modeling and simulation. Instruction-set and cycle-accurate processor CORE models will have to complement DSP offerings, as will fixed-point extensions to compilers written in C and C++. These tools will relieve future DSP programmers from the arduous task of low-level assembly programming, and allow them to concentrate on bigger problems.

It has been estimated that by the year 2000, 50% of all forms of communication will be wireless. It is incumbent upon the semiconductor and EDA industry to understand the implications of future wireless designs, and to make corresponding investments in technology to address those needs. Only then will we be able to free ourselves from the tethers of both wired communication and antiquated design practices.

Hamayoon Saam has been involved with DSP and telecommunication design for over twelve years, working for the telecom division of National Semiconductor and the microelectronics and global wireless products divisions of Lucent Technologies. He is currently a wireless system architect at the Alta Group of Cadence Design Systems. His current duties include development of wireless products for various cellular standards. He holds a BS degree in EECS from the University of California at Berkeley, and an MS degree in EECS from the University of Michigan at Ann Arbor.

The Continuing Evolution Of The Modern Engineer

Electronics designers are used to changing other peoples's lives. Now they're changing the way they themselves work.

BILL SCHULZE

Hewlett-Packard, Colorado Springs Div., 1900 Garden of the Gods Rd., Colorado Springs, CO 80907; (719) 590-3678; e-mail: bill_schulze@hp.com.

Electronics engineers are working at the cutting edge of technology in industries that are changing the way modern society works and lives. The impact of computing technology is widespread, reaching into many corners of our lives in the form of PCs and special purpose computers, like the microcontroller in our microwave ovens.

Communications technology, whether it be wireless communication systems like the cellular telephone network, or more traditional systems like cable television and the Internet, is exploding around the world as people take advantage of the convenience and productivity it enables.

Perhaps at no time in history, however, has there been greater potential for the technology being developed by electronics engineers to change the very nature of their own work. The combination of computer and networking technology simplifies and enhances engineers' working environments by making increasingly powerful development tools more available and improving the communication between various members of the project team.

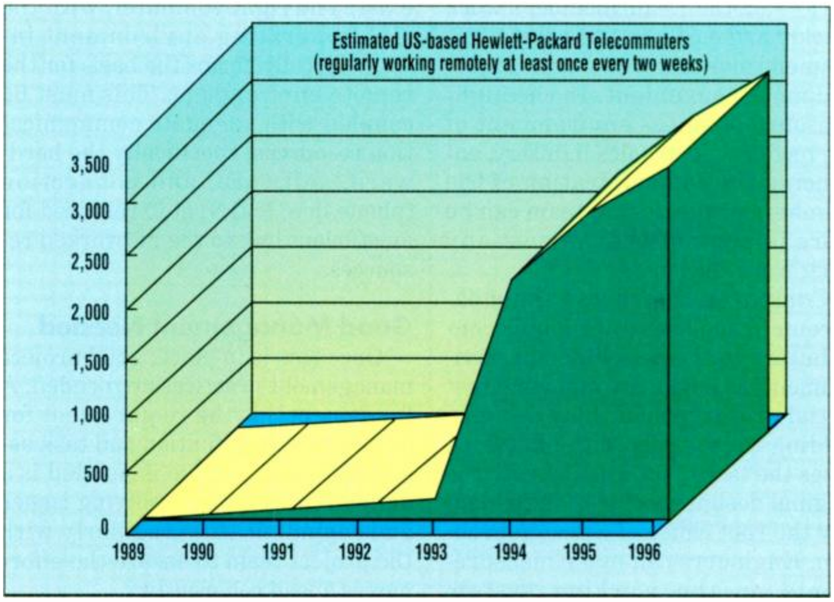
This same technology even offers the potential for new alternatives in choosing the environment itself. With ever-increasing pressure in the electronics industry on faster time to market and increased design functionality, the individual engineer often faces significant personal pressures. The demands of the job often require long hours, interfering with personal plans and forcing difficult trade-offs. The need to work in a traditional office environment, as most engineers have done over the years, may mean living in a less desirable place, at odds with personal objectives.

New Options Available

Improvements in networked computing are yielding new options in these important work/life decisions for engineers and their managers: The engineer's work is not just easier to do in the office, but it is possible to do it outside the office. As a result, better situations can be crafted to ease some of the difficult tensions that exist.

For example, at Hewlett-Packard Co., these options allow the company to retain valued employees with unique skills who would otherwise leave the company for personal reasons, often associated with the relocation of a spouse or a change in family situation *(see the figure)*.

While these options sometimes require open-



Shown is the dramatic rise in the number of Hewlett-Packard employees who telecommute from their homes on a rotating basis.

minded and nontraditional management approaches, they can prove very successful for both the employee and the employer. In fact, they often result in increased productivity.

How It's Done

Many of the activities of today's electronics engineers center around computers. Powerful workstations run electronic design automation (EDA) software for hardware developers and software development systems for those developing low-level and application software. These software systems are the modern-day design tools of engineers, increasing their design productivity and offering the ability to manage design complexity beyond what could be done in the past with less-automated methods. Having these software tools and the powerful computer hardware to run them efficiently is an important element of the engineer's working environment.

In addition, networking among these computers enhances the communication of engineers in the context of their development work and supports the project management practices used. Important design software can be shared, reducing the project's development cost. More importantly, the ability to discuss the specifics of a design issue with other team members via electronic mail or to view another team member's work quickly and easily in one's own environment makes development easier and more convenient. In the high-pressure business environment of the modern electronics industry, enhancing the communication of the members of the design team can be more important than almost any other contribution.

Computer-based test and measurement tools also are major contributors to the development environment, as engineers build and test initial prototypes of their designs. Adding these tools to the network eases the task of interacting with the original design specification to identify the root cause of a design problem. Engineers can make measurements on the working system remotely, then display and process the results on the network anywhere in the world. This is an especially significant advantage when debugging a complex design, where a great deal of time can be spent identifying the cause of a subtle problem.

Taken together, the technologies of computing, design software, networking, and test and measurement systems provide project teams an electronic product development environment that offers tremendous flexibility and productivity. By taking advantage of a networked environment, teams can significantly improve the management of the interactions between development tasks and individuals.

All it takes is a dose of management flexibility, and some good planning. First of all, adequate computer and communication resources must exist. The right computer, with the right operating environment installed locally, forms the basis for the remote environment. This must be coupled with adequate communication resources, specifically the hardware, software, and connection (phone line, ISDN, etc.) required for an efficient link to the networked resources.

In today's environment, enhancing the communication of the design team members can be more important than almost any other contribution.

Good Management Needed

Once this is in place, good project management practices are needed. A fundamental is the requirement for clear problem definition and task assignment. What also is needed is a defined process for resolving issues and communicating regularly with the project team to ensure the effort moves ahead coherently.

The promise of ever-improving connectivity leaves only one's imagination to describe the possibilities for electronic product design engineering. The relentless pace of technology ensures that more powerful computer and operating system resources will become available to provide a basis for more powerful remote development environments.

Higher Bandwidths Coming

Communications technology promises to deliver links with bandwidths high enough to make connections to remote networked resources appear transparent. Videoconferencing applications may become commonplace and will further enhance communications with other members of the project team. The capabilities of development software and test and measurement tools will continue to grow to enhance the ability to analyze and characterize the operation of the system.

Perhaps most importantly, management practices must evolve to recognize the power of the connected team and to exploit that power, whether members of the team be local or remote. Better detailed planning and project management practices to help the team delineate the responsibilities of each individual will contribute to this success, and enable the increased use of remote, connected teams.

One thing is certain: Improvements in connectivity will continue to enhance the working environment of the electronics engineer. While working remotely will not be practical for everyone, it will become increasingly possible for more members of the design team. Perhaps one day it will be typical for the only "official" gatherings of the development team to be the project kickoff meeting and the celebration of the product's release to manufacturing.

Bill Schulze is product marketing manager at Hewlett-Packard's Colorado Springs Division. Prior to his current position he was marketing manager at MINC Inc. He has also served in various roles in HP's EDA software and microprocessor development systems busienesses. Schulze received his BSEE from the University of Missouri-Rolla.

READER SERVICE 120

Redefining Test And Measurement By Enhancing Connectivity

Soon To Be Coming To A Manufacturer Near You: 24-Hour Design Teams And "Shared Views."

RICK WILLS
Tektronix Inc., P.O. Box 500, 13975 S.W. Karl Braun Dr., Beaverton, OR 97077; (503) 627-2894

Significant changes are coming in the way engineers test their designs. Enhancements in connectivity will lead not only to improved "hook-ups" between test equipment and the device under test, but also to application-specific instrumentation and networked instrumentation. The result will be 24-hour design teams and a "shared-view" environment between manufacturers and their customers. And just as connectivity will be the enabler of application-specific instrumentation and networking, compatible, configurable platform architectures will be the building blocks for connectivity.

But it is impossible to discuss the future of instrumentation without first acknowledging the economic realities of today's marketplace and the technological revolution shaping it. As always, electronic designers must reconcile the conflicting demands of time to market and new, emerging technologies. On the one hand, manufacturers must efficiently deliver products within ever-narrowing windows of opportunity. Yet to be competitive, those products must incorporate innovative technologies, and the adoption of new technology takes time.

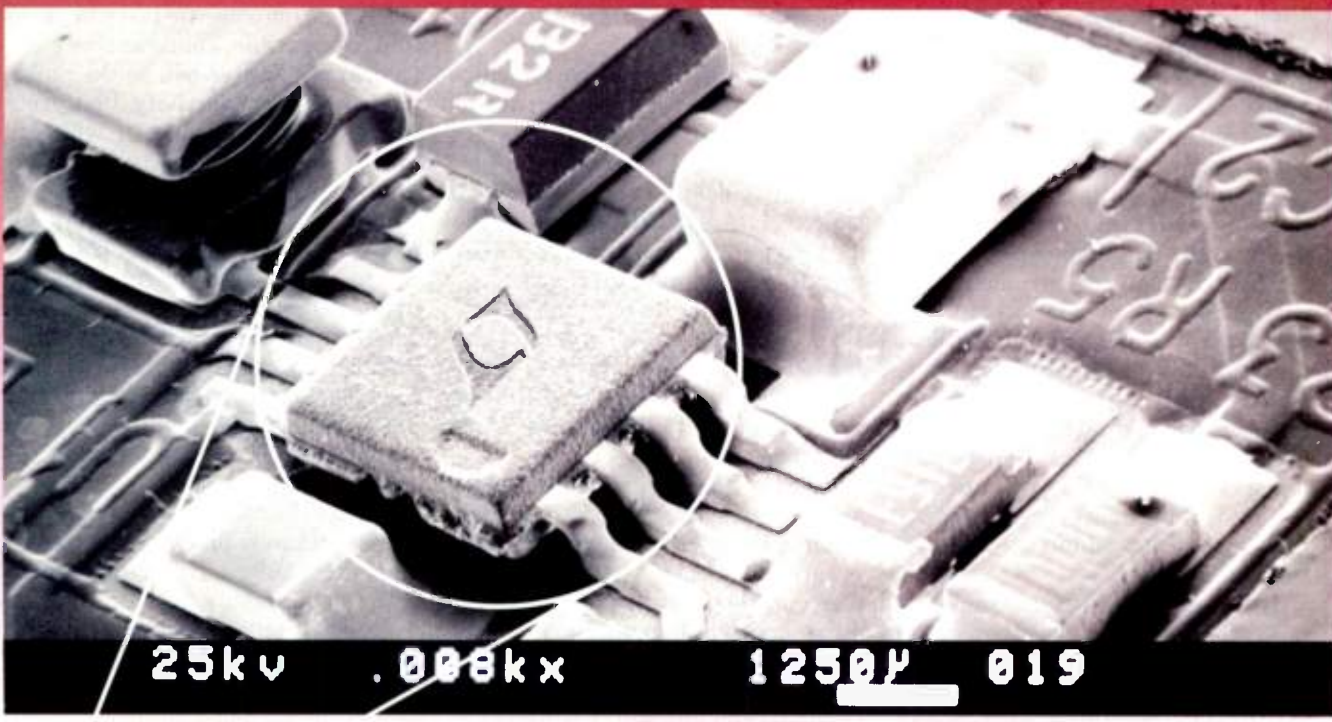
The Rise Of Digital Design

Serving these two masters is not a new dilemma for designers and manufacturers of electronic products. What is new is the proliferation of digital design, which has long been anticipated, and, more importantly, the convergence of communications, computer, and digital video formats. Designers must now cope knowledgeably with new, hybrid technologies, transforming a familiar problem into one more formidable than ever.

Clearly, this contemporary marketplace will place greater demands on test and measurement devices. Yes, they must continue to get "faster, wider, and deeper." The performance of digital circuits steadily increases, and telecommunications signals, particularly video, exhibit much broader bandwidths. Without question, digital signal speed and bandwidth will in turn require new, more powerful digital design products.

That prediction is easily seen through a crystal ball made clear by events already well underway. But as

Smallest Single Cell DC/DC Converter



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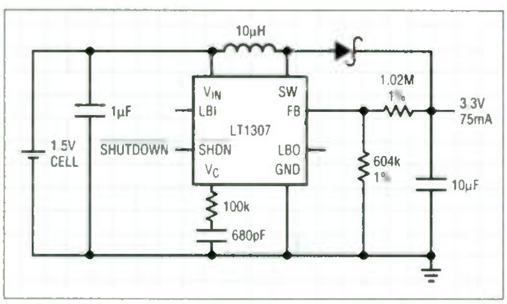
The LT1307 has performance no other 1V DC/DC converter IC can offer— like fixed frequency 600kHz operation. This high frequency switching not only reduces the physical size of the associated components but keeps spectral energy out of the sensitive 455kHz IF band at all load levels. The input voltage range extends down to 1V while using only 60µA quiescent current so you can squeeze your battery dry.



And the LT1307 delivers load currents of up to 75mA at 3.3V or up to 40mA at 5V, from a depleted 1V battery. The device also includes a handy low-battery detector with a 200mV reference. Need higher voltage? The LT1307 is great for generating 12V for flash memory or LCD bias up to 28V. So you can save space in a variety of DC/DC conversion applications.

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important as more robust performance is, it is only a partial and short-term view of the future of instrumentation. The view further ahead is murkier, but it points to a revolutionary definition, and role, for instrumentation.

Getting Down To Specifics

Part of that view is "application-specific" instrumentation. The days of general-purpose design are rapidly becoming a memory. Test and measurement devices must now and in the future actively help design teams cope with the convergence of technology if time-to-market demands are to be satisfied.

That will require instrumentation that is not only more powerful but also more intelligent, and able to deal transparently with standards such as MPEG, SDH, Sonet, and ATM. It means instrumentation that will be far removed from its traditional, passive, bench-top role, becoming instead an active, contributing, and value-added member of the design team.

If application-specific instrumentation is the destination, then connectivity is the road that will lead to it. If designs are to be quickly verified and put rapidly into production, instruments must aid in getting the signal off the design and into the analysis tool. Given the complexity and dense packaging of digital designs, that is no small task. Today's connectors and probes, often thought of as the most mundane aspect of instrumentation, will give way to new devices that don't interfere with the circuit or signal under test and will become key pieces of future measurement solutions.

There is more to connectivity, however, than the hook-up. Connectivity will become the enabler of application-specific instrumentation, allowing test data to be presented in user-friendly and user-familiar formats. Most profoundly, connectivity will be the gateway to networked instrumentation, including familiar Windows interfaces to the PC world and to enterprise-wide measurement capabilities. Such "tailored" tools, already configured to the way designers are accustomed to working, will soon appear and accelerate the trend toward 24-hour design teams.

Ours is already a "wired" world (even if that often, and paradoxically, means "wireless"). Connectivity already occupies a place on the desk—and often the lap—of the design engineer, in the form of a personal computer that can access global networks. The challenge now is to overcome the bottlenecks that constrain connectivity. The goal is to create the wired engineer.

The means to this goal—networked, enterprise-wide instrumentation—is an idea whose time is rapidly coming. For example, a customer may need to replace all of its logic analyzers to keep pace with the measurement of microprocessor speeds. As part of that program, the customer wants its multiple design sites to be able to all work on the same project at the same time. (Currently, each site works on different projects or parts of one project simultaneously.)

Twenty-four hour design teams have for some time been identified as a competitive advantage, and some progress has been made in their implementation. But 24-hour effort requires more than multiple sites and multiple time zones. Those sites must be networked in ways that are dependable and efficient. Connectivity will make such "perpetual design" not only possible but likely, and its impact on productivity and competitiveness is self-evident.

Networked instrumentation also helps realize the goal of a "shared view" between a manufacturer's support centers and its customers. In one case, a major semiconductor company had 140 application engineers calling on customers in person to help them design-in the company's microprocessors. On-line networking of design data greatly reduced travel requirements and increased productivity. Furthermore, both manufacturer and customer were more satisfied with the results.

In addition, networked instrumentation can be a valuable response to constraints less technical in nature. Sheer physical work space, for example, is often an issue. Through networked instrumentation, multiple printers are eliminated and much more bench space is made available. At the same time, instrument setups are saved to the network rather than on floppies, which are often misplaced. Data can be taken off-line for analysis, for work on home-based PCs, or sent to colleagues for analysis, opinions, and discussion.

Using The Building Blocks

Just as connectivity is the enabler of application-specific instrumentation, compatible, configurable platform architectures will be the building blocks of connectivity. Platforms that allow for design reuse will permit measurement companies to deliver customized tools to their customers, while maintaining manufacturing efficiencies. They also will be the enablers for "multiple-domain" instrumentation that can, for the first time, effectively combine different measurement functions. Such architectures are essential if price-performance points are to be maintained across a broad range of customer requirements.

Forecast articles such as these often prematurely proclaim "new eras" and new solutions. It's risky business to predict the role of instrumentation five years from now. Indeed, it was not long ago that test and measurement was viewed as little more than an essential, but declining, technology, soon to be displaced entirely by computer-aided software approaches. At the time, that view gained much endorsement, but it has ultimately been proven wrong. The convergence of digital technologies, like the military/aerospace and mainframe computer eras that preceded it, shows promise as a driver, and beneficiary, of a rejuvenated approach and application of instrumentation. While the timetable is subject to speculation and adjustment, the trend is clear. Instrumentation will remain the traditional mainstay and ally of the designer, even as both assume new roles.

Rick Wills is vice president and general manager of Textronix' Measurement Business Division in the company's Instruments Business Unit. He has been with Tektronix for 17 years. Wills received a BA in computer science from Linfield College, McMinnville, Oreg. and an MBA from the University of Oregon in Eugene.

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PAUL McGOLDRICK

Experts Forecast Major Changes In Analog Design In Five Years

Analog Editor

And There Is In This Business More Than Nature Was Ever Conduct Of. Some Oracle Must Rectify Our Knowledge.—The Tempest (V.i.243-245).

If we knew what was going to happen in the future, we obviously would be acting in a different manner today. For instance, you might be out buying the next winning lottery ticket, or you might be investing in an obscure stock that you know is going to be the size of AT&T. There are any number of senior managers in the industry who must believe they can see into the future and then commit to their vision. Those that falter or delay will lose the competitive war in the marketplace. Most people assume that the critical decisions are made in "marketing," but it is clear that this is simply not the case.

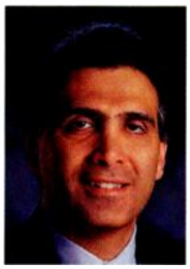
TUNÇ DOLUCA,

Vice-president, Portable Power Management, Maxim Integrated Circuits.

Technology itself does not sell. But the right technology, at the right place, at the right time, and at the right cost, can be sold in the parts that can be produced. The decisions about what the market will buy are made by "marketing," but if they cannot be built, they are immaterial decisions. Ask any of the major players in the analog semiconductor market and they will tell you that they would spend a fortune on finding the secrets of how to predict which of the few parts out of thousands will really take off each year.

The fact that a formula has not been found directly results in engineering-design groups using resources to complete parts, or variants, that are clearly not really needed. This has become a fact of life and one that perhaps can be read in some of the forecasts in this story, where *Electronic Design* talked with some significant people in the business about needing to know the future in the analog design industry.

Stretching resources, new environments, new technologies, new processes, new thinking, new education? They all formed part of the questions that were asked of: Tunç Doluca, vice-president of Portable Power Management at Maxim Integrated Circuits; Roubik Gregorian, vice-president and chief technical officer, Communications & Computer Division, Exar Corp.; Behrooz Abdi, IC design manager, Communications Segment IC Div., Motorola Inc.; Graham Baskerville, vice-president, Analog Product Development Technology, National Semiconductor Corp.; Robert L. Dobkin,vice president of engineering, Linear Technology Corp.; Keith Jones, product line manager for catalog products, Triquint Semiconductors; and David Robertson, senior design engineer, High-Speed Converter Group, Analog Devices.



ROUBIK GREGORIAN,

Vice-president and chief technical officer, Communications & Computer Division, Exar Corp.

If the group doesn't seem eclectic enough, it also is incumbent on this editor to add his own voice in what is known in the publishing business as "soft" editorial—in other words. writing from feeling rather than fact. The order of the interviewees, incidentally, is not alphabetical, not in ascending, or descending sales volumes, not this editor's company preferences, but is simply the order in which the interviews happened to fall. And, of course, the opinions are those of the individuals and do not necessarily represent corporate policies or directions.

Tunç Doluca

Doluca believes that engineers will still be working out of their company premises because of the importance of interaction between designers. He says, "Telecommuting is not feasible." Remote design locations or centers will increase in number with a central depository for sharing information, but with local simulation. Doluca does not find the quality of teleconferencing to be high enough to be of use today. He feels it will improve somewhat in five years but probably not be useful enough for

BEHROOZ ABDI,

IC design manager, Communications Segment IC Division, Motorola Inc.

more than the basics. The local design centers will have local supervision and will be project-based. A major concern is that the sharing of information, particularly to avoid collisions, must improve between managers.

Simulation tools are now much better for analog and although developments in analog are much slower, advanced versions will probably catch up with digital in five years; synthesis tools are not yet "earth shattering" but there seems to be movement. In the simulation area, the problems seem to be in not asking the right questions. The goal has to be to design so that it works the first time, not just to complete a design. Doluća notices a desire to over-simulate from those just out of school and the intuitive and mentor needs must be improved. Others don't ask questions and the market is still seen as digital, with analog tool developments being a mixed-signal affair.

In the future there will be an increased use of library models, but this will not be an "unemployment quickener." Analog is the "last bastion of true design work; thinking at the transistor level."

In five years, processes will only change slightly. The older processes will be needed for the higher voltages, and if Maxim needs new processes, it will acquire them. There will be large increases on integration in biCMOS and it is likely that 8-in. wafers will be the maximum for diminishing returns on smaller die sizes. The push for higher numbers of bits and lower voltages will increase and there is a squeeze with acceptable noise being the middle of the sandwiched compromise. In the power-supply arena, the push for lower and lower voltages for PCs will be determined by the biggest player of today, Intel, while the highest growth will be RF— where you have to stay at the "forefront of the curve."

If you are just getting into electronic design, go for RF; and find "the college with professors with the right background." Intuitive analog engineers will still be needed with a training balanced between electronic engineering and device physics. Doluca believes the design core can be taught in one week and the engineer can be really productive in about five years and the mark point seems to be when the trivial and important can be separated.

Growth in five years is not going to be limited by ideas, but by resources. Analog will continue to be a business and one person will still be doing some small projects. The burden of documentation has to be reduced while communications have to be improved so that others can document formally. To get ahead you will have to be a good teacher, and professional involvement — what is passed on to others — will have to increase. A good question for a design engineer's proposal is, "How many customers have you talked to?"

Roubik Gregorian

Gregorian sees analog design as a "specialty" with more analog interfaces needed in the form of pads, amplifiers, converters, PLLs, and sensors, with the remainder of designs being completed in digital. As processing speeds increase, he also sees the need for dedicated hardware blocks instead of programmed DSPs. Gregorian feels strongly that the analog engineer needs to learn DSP or digital design using high-level design tools. The analog engineer needs to know, "How would you take the algorithms and apply them to the design?"

While purely analog manufacturers may have design groups of one or two engineers, Gregorian says he feels his design teams will be multiples of analog, digital, software, and applications engineers with layout and CAD support. Close interaction will be needed between the team members, but very select telecommuting will be possible. The fact that the various ICs will need to talk to one another will be a critical definition of team discipline. Gregorian sees no difference in five years between the behavior tools for either analog or digital; the present gap will be closed because of speed. Simulation will be back-end with no VHDL for analog.

Even in five years, Gregorian thinks that most technical information for design engineers will come from conferences, meetings, workshops, and technical publications. The most acceptable job candidates will continue to be those with graduate degrees from institutions like the University of California at Berkeley, UCLA, and Stanford University, or undergraduates from San Jose State University. All should have a practical work history and a business familiarity to help identify in a team environment products that might sell.

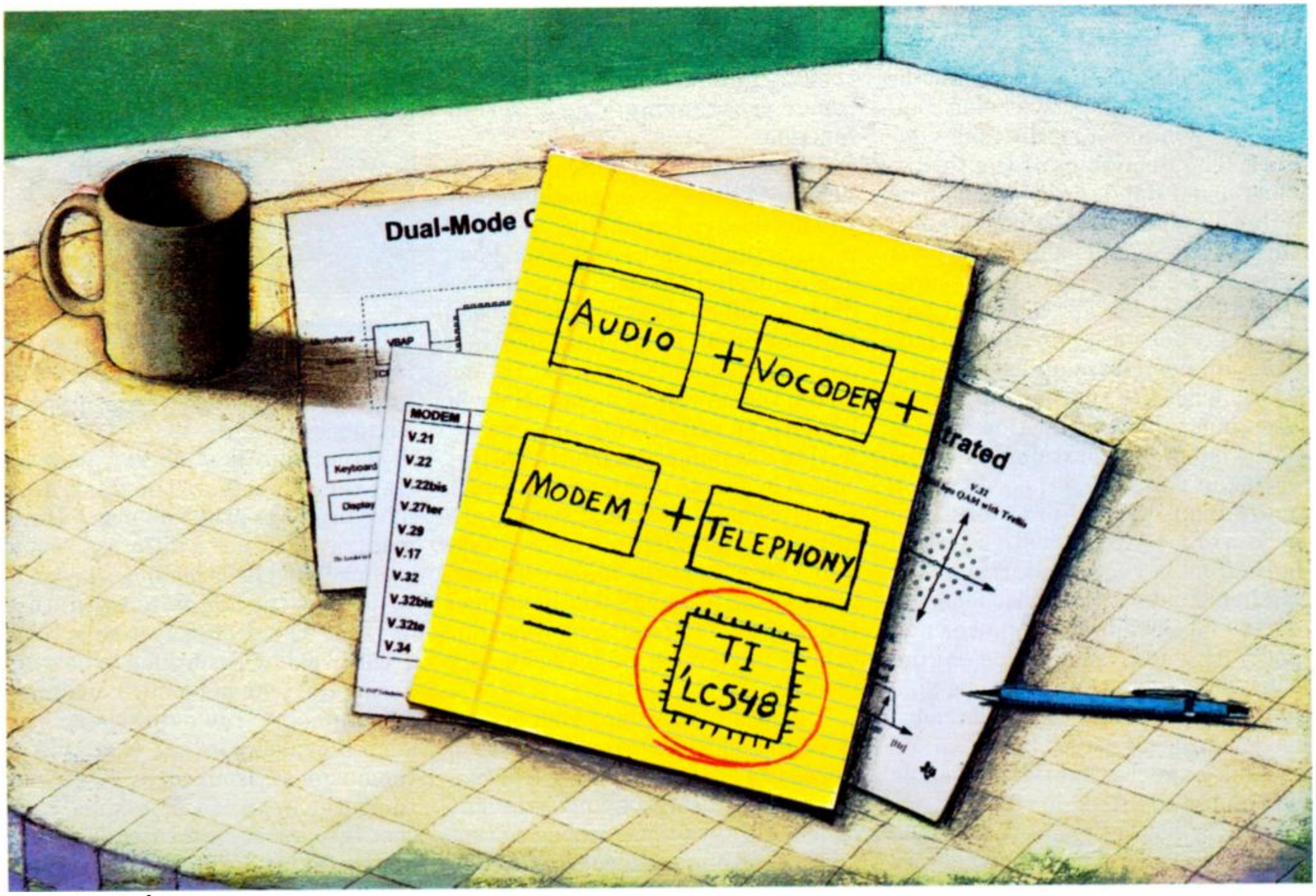
Gregorian believes that the most critical aspect of the business in five years is going to be time to market, with lead times reduced to three or four months.

Behrooz Abdi

Cutting down cycle time and increasing productivity with digital design goals being the targets for analog and mixed signal are the future, as Adbi sees it. The working environment to him will be mostly telecommuting, complementing the office; it won't happen tomorrow, and it won't happen with just ISDN service: An improvement in subscriber local-end service to at least 1 Mbit/s will be needed. Abdi feels there will be more global design teams, domestically and in Europe and Asia, with communications open between sites 24 hrs/day: design will be around the clock with improved videoconferencing, virtual design reviews and moving complete schematics around the

GRAHAM BASKERVILLE,

Vice-president, Analog Product Development Technology, National Semiconductor Corp.



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sites electronically.

Abdi feels that the semiconductor industry is evolving from being component vendors to solutions vendors. The designers of the future must understand the system and be able to focus on their customers' success; their skills will range from function deigns to systems designs (the application, not the function.) Too many designs today are still bottoms-up designs modeled after an ASIC with the customer giving a non-sinusoidal specification as seen in the lab. Behavioral simulation for analog/mixed signal is needed with a speed improvement of at least two orders of magnitude, with a virtual lab in front of you and the results being immediately available. This will need a lot of computing power and possibly a dedicated Spice engine chip. The ideal should be to be able to hand or communicate behavioral models to customers.

Abdi expects that design teams will be ten to fifteen in strength, including layout designers. A lot of the size has to do with having the design expertise close to the customer. For local markets it is better to have the design talent on the scene using their local knowledge of the market peculiarities but being able to call on the global design team. It also is expected that while individual components might be designed at one center on a workstation, they will, at some time, be fed back to a central library. In five years, the new systems engineer designer will have to work with both analog and digital; a lot more RF, wireless, and data communications theory will be needed all around. Digital communications will be extremely important.

At the same time, at the baseband end, DSP talent will be critical where all must be able to understand and write some of the embedded software; the key to "mass customization" will be with the customer programming the different functions.

ROBERT L. DOBKIN,

Vice President Engineering, Linear Technology Corp.

To be trained for the jobs in five years, Abdi believes the engineer will need a good grounding in device physics, digital processing, and good analog design basics. The best candidates will be those who have been through co-op programs and other, meaningful hands-on work. In five years, the new design engineer will have to be effectively integrated within six months with their first silicon in nine to eighteen months. It is increasingly clear that schools are not teaching systems knowledge and the curricula must change. "Platform" products will have lead times of nine to twelve months, but others have must be less than six months.

The future of design, Abdi insists, is where the design information comes from the customers in a design cooperative, using a lot of co-designs from both, always remembering that vendors are most successful when they offer the whole solution.

Graham Baskerville

Baskerville has no doubt that a "lot of things are going to change" in the next five years with a lot more integration with different strata of engineers. At the high end will be those who can take library designs and blocks and work them into a system: "Call them the systems engineer." Beneath that, people will be doing the latest "block" with a very detailed understanding. And below that will be the silicon "junkies" squeezing the last drop out of the process and material. The people worrying about the device physics will be a small proportion of the total team.

The differences between digital and analog CAD tools will disappear, in Baskerville's opinion, in the next five years. There also should be place-and-route tools for analog that will be equivalent but not as sophisticated as digital for 10^7 devices and up. The size of the design teams will remain similar with few people working at the system level; tools are keeping up with the complexities needed while turnaround is getting faster with computer-aided flow. The target is six months, even on massive circuits.

KEITH JONES,

Product line manager, Catalog Products, Triquint Semiconductors.

"Over the last thirty years," Baskerville says, "the designers have been the prima donnas." However, he now sees a different "show stopper" and he is leading a crusade to develop the ability to test future devices. The design system is hierarchical and will continue to be even as the devices become "consumer appliances." However, there's no such hierarchy on the test side of the business, from cores, to blocks, to systems. "Academia must turn test into a very specific area with heavy talent." The industry average test cost is about 30% and it is "purely there to compensate for poor manufacturing. It does not add value. We test things to death. We need to change things." Baskerville feels that the design and test engineers must work hand-in-hand—even on pilots that have been run, "test engineers have found problems in design."

The high level description used for testing must allow for customer intervention; paper specifications should become a thing of the past, particularly as paper loses many "subtleties."

In five years it is hoped that work in the lab will become mostly "redundant" with working at home being perfectly practical. There is no need to be "stuck in the office." Baskerville feels that there are more managers afraid of such a situation rather than it being impractical, although the team manager, or leader, may have to be in the office to pull things together, put issues on the Web, schedule deliveries, and call "virtual meetings" using project automation systems. Real, physical meetings should become obsolete. For designers to be working

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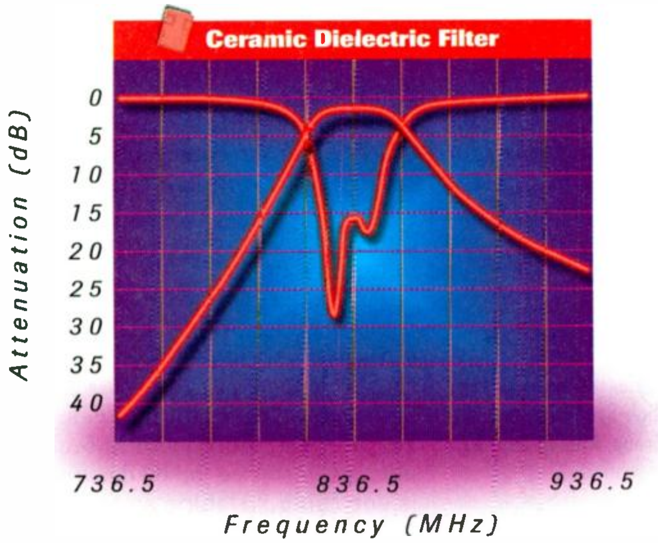

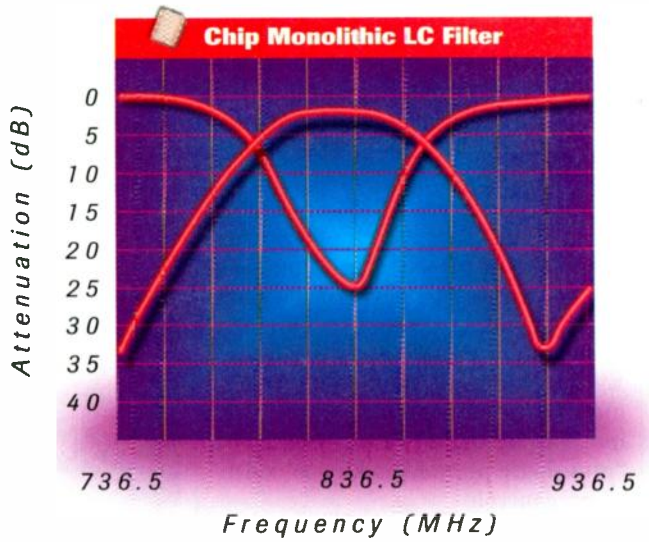

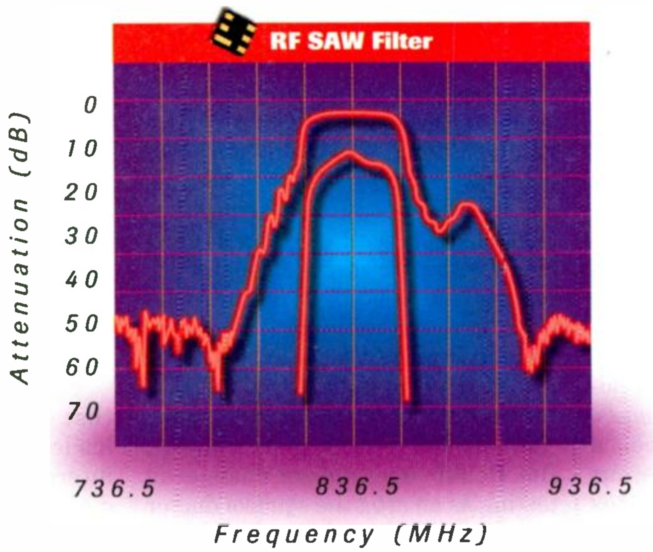

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alone they really do have to be independent types and there has to be a stress on the communications provided; with some engineers, the idea of working alone without social interaction is bad — it can get lonely — and one way or another, engineers must be able to bounce ideas off one another.

Design centers need to be opened wherever there is talent. It is preferable that those engineers be employees in order to get the commitment, but ultimately it may be IRS rules that make the decision. Multiple sites can be working on parts of the same project and care must be taken to avoid duplication. The key to success, Baskerville feels, is in having a common design methodology which is more structured than it was, and a "glue-logic person" is key to cell-library control.

Analog is not a fringe area anymore and the new design and process engineer in five years will need a mix of electrical engineering and computer systems know how in their background. Degrees from Berkeley, Davis, and Stanford may look good, but the employer will be looking for someone who has taken the effort to get practical experience and is prepared to live it: College training will not be enough and the candidate must be able to analyze simple circuits and to take a problem and work it through. The engineer has to realize that they are entering a business. "We are willing to sell a service... a 'collective' that cannot dole out money that we don't have," notes Baskerville. He adds that if there is a cooperative program available, "take it if you can."

Baskerville feels that the section leader in a design group is the "best job on earth." "Design rules are now well in place; technological ability has increased, but productivity has not."

Robert Dobkin

Dobkin is a believer that "real engineering requires interaction." Portions of a project may be done at home and engineers are allowed to do that. He doesn't foresee any increase there in five years. The high interaction within teams will continue with one to five members per team. Currently, Linear Technology has two design centers and they grow "where we can grow," because it is hard to move people to the Bay Area. Communication with design centers is through videoconferencing, speakerphone conferences, and travel, and there will probably be more videoconferencing and some standalone design centers.

Tools will be faster and more sophisticated with greater mixed-signal capability in five years, Dobkin thinks, but there will be little basic change or revamping. It is likely the tools will be easier to use and more robust and the silicon is going to match the simulation better, with accuracy and speed progressing. Bottlenecks may well be caused, however, by the increasing difficulties in testing.

DAVID ROBERTSON,

Senior design engineer, High-Speed Converter Group, Analog Devices.

"A major rethinking is needed," Dobkin says, "At least at the wafer level." The long leads associated with testing cause problems. There is, "Not enough data, no good answer." But Dobkin does not see changes in testing as an area the semiconductor manufacturer should explore. Outside vendors need to be able to provide testing and QA to the data sheet completely. Non-data sheet parameters may need to be tested as well if they cause a problem.

The trend, that Dobkin sees, is that customers will want more and more custom ICs. Better tools will help and a good IC house will be needed to make each project work. No real changes in geometries will probably be needed in analog designs but analog circuits at the leading-edge will be needed and they will not be custom.

His advice for the future design engineer is "to study analog." "It doesn't matter as long as it's analog," Dobkin says, "Then figure you don't know anything for the next five years." Using mentor situations, the incoming designer needs much more specific design experience for a component library, and to solve a reasonable number of problems. Systems-level experience is needed to ensure that the hook-up really works. Some digital knowledge doesn't hurt, but is not needed—the candidate needs to be able to read state diagrams and understand logic gates, and, of course, must have PC skills.

In the first five years on the job, the design engineer is kept up-to-date by the job itself. After that there is a need for magazines, advertisements, and conferences. The World Wide Web, Dobkin feels, is not a good source for IC designs. "It is one thing," Dobkin says, "to put an IC together and make it work — it's another thing to make 50,000 devices per month and for them to work when customers buy them." He also feels that design engineers need to know more about the processes.

In five years, the turnaround time for a new IC will be 30 to 50% of what it is today. Target will be one year while product life will be about five years for standard products and about two years for custom products.

On a personal side, Dobkin feels that overly optimistic projections made by marketing benefits no one; interaction is needed for a clear understanding of the problems: particularly since any design is a compromise, a trade off, between cost, die size, even the design team. "This is a business and we're here to make money. Being an IC company is only one thing. It has to be a complete team with everything working together, including manufacturing, packaging and applications."

ICs are becoming so complicated that more help needs to go to the customer. The design has to be good but many customers need the "whole ball of wax" because they are non-experts in analog ICs. "Data sheets only tell part of the story," Dobkin says, "30% of users need applications work. Design and applications do their part."

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Keith Jones

Jones thinks that more can be accomplished by the design engineer off-site, particularly with the move from workstations to PC-based tools. With all-hours communications access, Jones doesn't see telecommuting as displacing the team environment but allowing more focused work with enhanced creativity. The size of design teams will be quite small to make them more productive and quicker in response. Time to market, Jones believes, is critical and in five years it must be six to nine months with the ability to ramp up quickly. Outside design centers are feasible with technology and communications making them more likely using videoconferencing, fax, e-mail, and even snail mail.

At least a couple of customers are needed to define a product, while some may design it and hand it off to the foundry to produce standard products. But there will be an ongoing dichotomy between standard and custom. Jones believes the paper specification is going to remain because of contract needs; this slows things down but not prohibitively. The bottleneck is first-pass success. As tools improve, it will become more viable to quote yields up-front. As it is, ASIC customers seem to want answers within days.

More products will be moved into the auto-test arena with testing of 100% of products. The company is looking for faster tests, trying to get all the answers by simpler tests with one-third of the costs being in each of the die, testing and packaging.

The future design engineer for Triquint Semiconductor will have studied communications and RF and will probably come from one of the West Coast schools such as the University of California at Berkeley, Stanford University or the University of California at Santa Barbara, and will have a proactive, positive, can-do attitude. "There are a million people that can bring me problems," says Jones. It is important the engineer knows how to make money and must be fully exposed to the customer and the market with a mentor in tow for the first six months to a year. "Sponsor customers," says Jones, "a good engineer is one who knows what perfection is; a great engineer is one who knows what enough is."

Analog tools are improving, getting very comparable performance to digital, with Spice becoming more and more useful. Layout is now on the PC environment. Still needed are parasitic extraction tools to be done accurately, but vendors are working on it. Lumped equivalences are working well up to 20 GHz; distributed issues raise their head higher than the frequencies being used now. In processes cost is everything; "That's why we're sticking with MESFETs," says Jones, "SiGe and SiC are science fair stuff."

David Robertson

"So much of what we are moving towards," says Robertson, "is at the systems level, needing coordination across. Brainstorming is still needed on a white board." Design engineers are still therefore going to be in cubicles, in groups. While product complexities are growing exponentially, turn times are shrinking linearly. A design team will probably increase from the current average of about three to six or seven built up from a pool of generalists and specialists. Some work will be possible at home and the breakthrough may well come in California because of the traffic.

As the power of the PC catches up with the workstation, more will be practical, so the engineer can put in a couple of hours in a personal crafting of workload. Design centers will be structured around major customer bases all over the world and there will be a mixture of independent-working and central-control in five years. There will probably not be a single specialization at the design centers. The videoconference network can be "maddening" but will be much better in five years.

A lot of travel time is still being spent by people and by the shipping of complete data bases and the trickiest interfaces in designs are proving to be geographic. Redundancies between centers, Robertson says, are "inevitable. Some things are so important that sometimes twice is better." The tools being used are about a 50/50 mix between in-house and purchased, with the vendor items almost inevitably being optimized for digital. The analog designer has to be fluid on tools changes every two years or so and there always has to be someone on the team who is good at getting into and out of tools.

While the lead times for major innovations will continue to be about one year, iterations are expected within a few months and fabrication turnaround time is down to less than a month. ASIC prototypes are expected in six to nine months and this will shorten. There also are a lot of situations in chip sets that are developing into supplies to a customer while also being that customer's competitor.

Future blockages could be associated with voltage. There are some interesting discontinuities with shrinking supply voltages, reduced signal-to-noise ratios, and higher currents. Packaging also is going to go through some major jumps and testing at probe level leaves lots of questions. Standard testing is costing up to 50% with some products. How can it change? While testability is well ahead in digital but the boundary from analog doesn't quite work and re-configuring doesn't work.

The future design engineer should be studying communications. It is harder and harder to find explanations of devices at the transistor level and it is critical; the engineer should understand the third terminal of a resistor and the nature and structure of parasitics in sidewalls and routing. Robertson says that he likes to ask an applicant, "Tell me about your favorite circuit." Once he has done so, you then throw him into a new space with old surroundings. Those who get excited by the new space are the candidates to go for.

Robertson also believes it takes five years to build an analog intuition. Analog's mentoring program is casual with an open-door policy and people will put down what they are doing to advise. A co-op program is operated with MIT. As Robertson says, "I don't see us running out of fascinating problems to solve in the analog space."

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READER SERVICE 202

Beam Me Up! I Really Want To Be Mobile

What Was Once Futuristic To Star Trek Viewers Is Rapidly Becoming A Reality.

PETER COCHRANE
BT Laboratories, Martlesham Heath, Ipswich, U.K.; +44 1473 64 47 12; fax +44 1473 64 74 31; e-mail pcochrane@bt-sys.bt.co.uk.

If ever I had a dream of mobile communication, it was fueled by my Tuesday night experiences as a student in the 1960s. Those nights were special—the dorm would be packed with anticipation as people waited to see James T. Kirk beam down to some unknown planet. His first act was always to confirm safe arrival through his flip-top communicator. This remarkable device worked convincingly with the occasional twist of a rotary knob to fine tune and avoids static. At that time, mobile radios used by military, police, emergency services, and cabs still employed thermionic tubes and were about the same size as a briefcase. Therefore, what Captain Kirk had was barely believable.

Thirty years later, Jean-Luc Picard just wears a badge—and a stroke of his hand is all it takes to contact anyone or anything of choice. Communication is always clear and concise; no numbers to remember, no directories or buttons to push, no knobs to adjust—all very easy and natural to use. But this dream is now much closer to reality. Today, we have mobile phones the size of chocolate bars that cost almost nothing, and networks that cover over 90% of all major countries *(Fig. 1)*. But remember, only a decade ago, the first cellular phones were the size and weight of a small briefcase, and the so-called pocket phones were about the size of a brick. So, perhaps we are catching up with the future!

Overcoming The Limitations

Among the smallest devices available are Dick Tracy-style wrist phones (at $1500); some to be announced will be jewelry-like devices worn like clothing. In all cases, the primary physical limitations to size are power (batteries), keyboard, and display—in that order. Also, key user problems are poor (over-complex) interfaces, background acoustic noise, cell coverage, and channel availability due to increasingly chaotic demand for access.

Multifunction displays and buttons, and an assumed microphone-to-ear distance half that of a human head, often seems to demand unnatural acts in terms of just switching on, making contact, and talking. Buttons with four or five functions are not uncommon in this race to reduce size, production costs, price, improve reliability, while increasing the number of seldom-used facilities.

More critically still is full functionality, irrespective of country, location, or service provider. In Europe, the Group System Mobile (GSM) system—the European Time Division Multiple Access (TDMA) digital standard for mobile telephones—means that a 100% roaming

1. The evolution of the telephone has gone from a clunky, old rotary phone to a wristwatch-sized unit.

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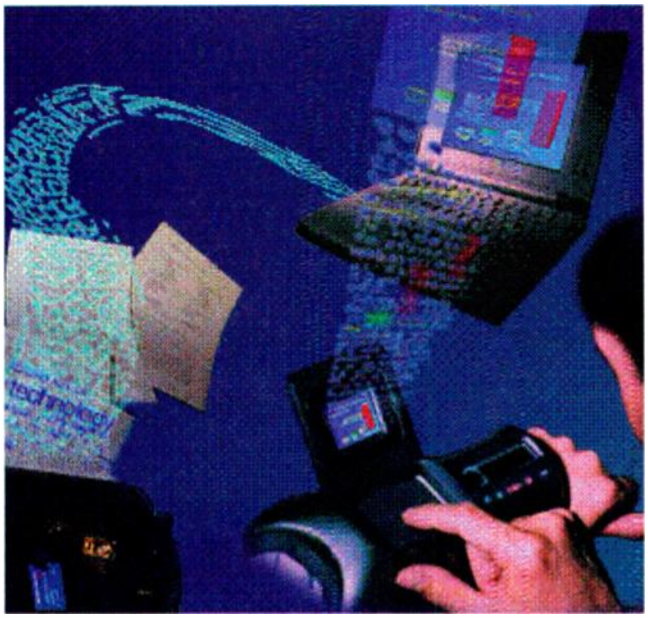
ability with speech and data connections at 9.6 kbit/s is the norm. Connecting your laptop, organizer, camera, or other device to the Internet or an Intranet is no longer a problem. In fact, this article comes to you direct from the Ipswich to London Inter-City train at over 90 mph via an Intranet connected to the Internet. But it also could have been transmitted from a car or coffee shop. The only inconvenience is separate devices, connecting cable, limited power capacity, and weight.

In the fixed terminal market, there is a migration toward a wide ranging integration of functionality that is also now evident for mobile terminals. Laptops already have built-in modems, and soon the entire digital phone will be integrated into one device. So it is size and weight that plays a key limiting role. Soon, we may have a species of human with longer arms and shorter sight as a result. However, the market has already seen compact devices, such as the Nokia 9000, combining a pocket organizer and a GSM telephone, and more will follow *(Fig. 2)*. So, what happens next?



2. The office of the future will contine to see the integration of mobile devices into a single device with multiple functions.

Moore's law will see chip density doubling at less than 18-month intervals for at least another decade, and probably more. Computers will become over 1000 times more powerful, and complete mobile phones and modems will be on a single chip. But more fundamental changes are afoot. First, there's voice-command and control that may do away with both the keyboard and mouse. It also may get rid of the screen for many applications. Second, there are new display technologies that could change the entire nature of the interface and the box. Third, there is the very nature of networking and interaction between people and machines.

Finding The Intelligence

Where are we going to locate the intelligence in the future? It will have to be everywhere—we will carry some, and networks will provide us with the rest. In the forefront of this revolution today is the new programming language Java, with Applets on demand. This relies on networks that are ubiquitous, reliable, and low cost. In the time frame of development, this has to be the telephone network—it is all we have. So what will be able to do—what kind of terminals could be engineered in the short and long term?

It's already possible to talk to a machine to gain directory advice, and to buy and sell goods. But when we're on the move, background acoustic noise from cars, trains, and people is a major limiter. The addition of a lightweight headset with noise canceling is an obvious and long-awaited addition for those who want to drive, ride, walk, and talk *(Fig. 3)*. But there are other possibilities, such as adaptive noise cancellation using one or more microphones, with single- and multiple-phased speakers adapting to create acoustic bubbles. Active feedback acoustic (howl around) suppression, and constant sound level relative to background noise also is possible to negate the variation due to head position and location. Therefore, the Star Trek 23rd-century badge communicator now looks feasible.

Mobile computing also will see a revolution in distributed network intelligence to realize a minimal portable hardware requirement. But again, spoken command and control will improve the usability while reducing overall cost. The primary attraction of such a future is the ubiquitous and general access to everything, anywhere, anytime, in any form, at low cost. When coupled with an interface simpler than a VHS, such a box will see a market of people previously frozen out of the information world by the horrors of the PC. Some estimates put this underprivileged majority as high as 80% of the population—it is a huge market. Users also will see the advantage of continual software updates at low cost over the network, instead of being sold a stream of upgrades to a product that never fully worked when first purchased.

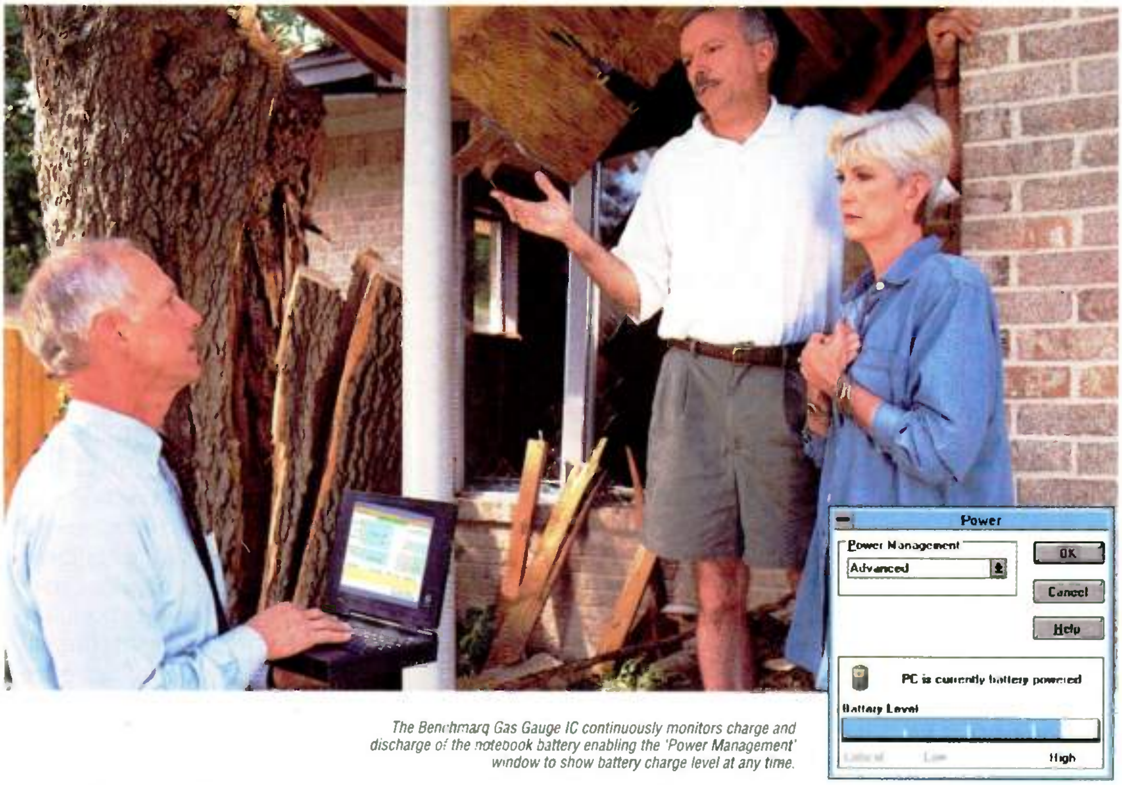
Newer Applications

For the more powerful mobile terminals, there are new applications for sectors such as the medical, engineering, and insurance arenas. For example, in recent experiments, Nurse Practitioners have been able to bring the expertise of General Practitioners to bear at remote sites--with a standard GSM phone, laptops, and miniature-TV cameras. Dermatological examination, fetal scanning, remote diagnosis, minor operations, and emergency ambulance paramedic support from hospitals to the point of need also have proved possible.

Probably the most revolutionary move will be toward the wearing of technology. Just like the carriage clock of 300 years ago that became a pocketwatch and then a wristwatch, cameras, computers, and communicators can all be worn as items of clothing, jewelry and body furniture. In fact, everything from roving news and sports reporting, to precise surgery and insurance loss adjusting, can be done with a minimal amount of technology. Throughout all of these possibilities there is one underlying limitation—power! Although power requirements will fundamentally reduce as the integrated circuits and functions are optimized, the radio transmitter will still demand approximately 0.5 W. A reasonable estimate for the total power demand for a combined computer-communicator is around 2.5 W. If we add a screen, this can be at least doubled. However, for head-mounted displays, we may only

Benchmarq supplies the chip that monitors the battery that runs the notebook

that calculates the damage...



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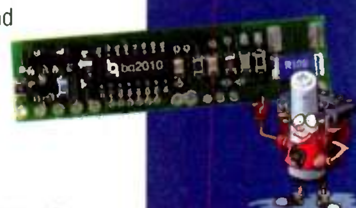
bq2014	Gas Gauge IC with Ext. Charge Control	NiMH, NiCd and Li-Ion	16/0.150" SOIC
bq2050	Power Gauge™ IC	Li-Ion	16/0.150" SOIC
bq2091	SMBus v.95 Gas Gauge IC	NiMH, NiCd and Li-Ion	16/0.150" SOIC



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What other functions might we desire in our new mobile world? We could have broadcast radio, TV, information services, and of course, e-mail and Internet access. But there is more. Satellite mobile services are coming, and the ability to flip between terrestrial and satellite would be an advantage, as would a guidance-positioning system (GPS) receiver to give us precise navigational data. Everything in the information world direct to our head—just by asking.

Meeting The Challenges

All of the technology described exists in the research phase somewhere. The single most neglected item is power--batteries and charging. Nothing much is being done in industry, and we are coming to the end of the road. Assuming we could get away wsith 5 W as an average, then the best results for a thermal vest-torso heat to electricity conversion is less than 1 W. As for kinetic energy—walking and swinging your arms and legs—is approximately 2 W. In both cases, these solutions currently mean being wired into your clothes, and do not justify the discomfort. It is still better to carry a bag full of batteries. Therefore, a program on new materials and energy storage, and or generation, may be required to realize a really mobile future.

Most of the mobile services and connectivity can be achieved using the Plain Old Telephone Service (POTS) and cellular radio. But where is the next great challenge? More people going mobile means more chaos in the mathematical sense. We will see more people in cells than networks can cope with due to computer-aided meetings, traffic jams on freeways, social and public events. There also will be a growing demand for more bandwidth. At this point, the laws of physics are in our favor. Moving radio communication up from the 1- to 2-GHz region to 24, 60, 120, and 180 GHz would realize sufficient bandwidth in atmospheric absorption peaks that naturally preclude communication over more than 100 to 1000 meters. The perfect microcell! But there is a new option; optical wireless has been made possible by the revolution in fibre systems. Devices working in the 1300- and 1500-nm windows can provide cells of room, desk, and chair size with razor-sharp definition. The higher frequency (approximately 300 THz) means much greater precision and bandwidth. In experiments with these technologies, bit rates of 100 to 1000 Mbit/s to the pocket and wrist have already been demonstrated.

If I were a young engineer just starting out, I would find this an irresistible future. From the need for new chip technologies, robust speech interaction systems, to the engineering of head mounted displays, body worn units, power generation, network intelligence ,and switching algorithms, to the creation of new wireless systems using optics to generate carriers above 60 GHz, or spread spectrum on optical carriers, I could have a ball. Right now, I think I would choose to work on solving the power problem, I really would like an air conditioned vest. Torso heat to power, with my computing and communication technology distributed over its surface. I really do want to stop carrying technology and start wearing it. Or will it be wearing me?

Peter Cochrane joined BT Labs in 1973 and has worked on a wide range of technologies and systems. In 1993, he was appointed Head of Research. A graduate of Trent Polytechnic and Essex University, he's a visiting professor to UCL, Essex, and Kent Universities in the U.K. He has published and lectured on technology and its implications for society. He led a team that received the Queen's Award in 1990; and was awarded the Martlesham Medal for contributions to fiber-optic technology in 1994; IEE Electronics Division Premium in 1986; Computing and Control Premium in 1994, and the IERE Benefactors Prize in 1994.

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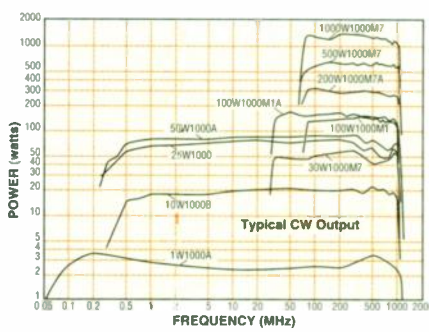

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Mobility And Information A La Card

Applications And Opportunities For SmartCard Technology.

FRIEDRICH V. DIEST

ACG AG, Am Kuemmerling 21-25, 55294 Bodenheim, Mainz, Germany; 49-6135-9230-0; fax 49-6135-9230-99.

Imagine a perfectly organized person who has all of his or her important documents and belongings at hand at all times—passport, driver's license, birth certificate, insurance policies, vehicle documents, checks, credit cards, small change, different currencies, business cards, telephone cards, house keys, car keys, id cards, club and customer cards, travel tickets, parking permits, health insurance papers, medical records, training data, awards and certificates, references, service manuals, and so on.

The list could go on forever. It shows that in an age when information is being produced at a host of decentralized sources, is required at decentralized locations, and often needs to be kept strictly separate from other information, a perfectly organized person would be essential. In these modern times, however, with the means of transporting information that we have at our disposal, that person would be totally overwhelmed physically, if nothing else, by the vast weight of the papers, forms and objects that would have to be carried. This doesn't even mention the tremendous organizational strain, and the process of actually procuring and updating all of it. The average person—assuming he or she has some conception of tidiness and order—will have all certificates, cards, and documents stacked away at home.

Nevertheless, there would be considerable advantages if all that information was able to be carried around, since it would allow the individual to access and confirm important information at any time. It would entirely do away with the need to search out individual objects or documents, and to keep these readily available—not to mention the savings in space this would allow. Keeping an electronic backup copy of all information would be straight-forward. Anyone who has lost even a few of the documents and objects listed above knows just how difficult and time-consuming it can be today to have these replaced.

This fact of life is particularly true for the individual in high security areas where the "pass/ID" and "access" functions in many sectors are currently resolved via complex hardware solutions. If keys or other hardware are lost and/or need to be replaced, the cost can be high. Here, too, a suitable instrument is required which can offer the multifunctionality needed to meet the high requirements applied in the security sector.

What's more, this person, together with a contingent of other comrades-in-arms, uses a whole raft of technical tools and devices that have to be readjusted each time to his or her own particular requirements. How wonderful it would be if these devices could be equipped with simple, customized, and user-independent off-line memory functions that could be matched quickly and effortlessly to the user in question. Seats, sofas, beds, chairs, car seats, steering wheels, car mirrors, radios, HiFi equipment, TV sets, computers, and training equipment are just some of the applications that could benefit.

Falling into a similar category are all the procedures for which authorizations and account balances need to be verified. Today the verification is accomplished using expensive and complicated on-line checks. A procedure allowing a simple off-line solution would be ideal, temporarily removing expensive network structures at remote sites.

The organized person outlined above is still very much a dream for the most part. Nevertheless, our technical capabilities already exceed many of the requirements set out above. All that's missing is the vision to implement and integrate them.

The Smart Card

Over the last decade, a technology has crept almost unnoticed into our life, and is slowly, but surely changing our daily routine in one area after another. This major innovation looks like a small piece of plastic with a gold plate. Its name—the SmartCard. Its possibilities—virtually unlimited. As a result, it could be possible for a person in the year 2005 to actually use one of these SmartCards to manage every aspect of daily af-fairs. Some of the possibilities include everything from unlocking and locking doors to presenting passport or driver's license identification. Vehicle ergonomic preferences could be set via Smart Card. The volume of a radio or the temperature of a room are also possibilities. Paying highway tolls, parking charges, recording times (of virtually anything), performing access checks, operating automatic vending machines, booting up computers, and activating mobile phones could all be done by Smart Card. In fact, the possibilities are almost endless

The SmartCard In Action

Imagine the following scene: You enter a rented car, plug in your chipcard which contains your preferred car adjustment data, such as seat and mirror position, air conditioning level and favorite kind of radio station. The car immediately customizes itself to your preferred presettings--independent of the make and manufacturer. Once you have returned the car at the airport, the same chipcard, this time its contactless part, serves as your airline ticket without any need for a printed one.

Originally equipped with very small memory and computing power, the Smart Card underwent a long period of experimental testing. It was an expensive alternative to the magnetic strip card, though its robustness and versatility made it technically superior. It began the climb to fame in 1984 when it gained a foothold in the telecommunications market in the form of the telephone card (initially introduced in France to be followed by around 50 other countries). In this application it has become an accepted part of everyday life.

Having conquered this sector of the market, it continued its victory march into the fields of mobile communication, health insurance, and admission. In Germany, it is now in its first generation as an administrative health card, featuring memory card technology and 265 byte memory. Around 80 million of these cards are in use. It also is making tremendous inroads in the field of customer cards and electronic payment transactions. Known as "Quick" in Austria and the "Geldkarte" (money card) in Germany, around 50 million cards fitted with a processor chip have been in circulation since the middle of 1996. They are being used as electronic purses in a wide range of similar projects worldwide. Systems from Visa/MasterCard, Banksys (Proton), Mondex, KZA (German money card), and many others are now in fierce competition. In this battle for market share, technical suitability is less a factor than the market influence of the issuing company.

The solutions are all similar from a technical aspect. A meter is used to write monetary sums onto a processor chip which can be reduced, i.e. spent, at special terminals. Mutual authentication and communication is ensured by means of a secret encryption algorithm and a Message Authentication Code (MAC). A transaction record is created for every procedure. Central record registers which maintain anonymous shadow accounts for every card are employed to perform subsequent clearing. This feature also permits off-line transactions to be performed without difficulty. Should electronic purse systems establish a firm foothold by the year 2000, cash will probably disappear completely over the long term and will be replaced by credit cards and electronic purses.

The SmartCard is now also being used on local public transport employing either contact or contactless technology. Further applications in other fields, such as pay TV, are only a matter of time away. Intensive studies are currently underway into using the SmartCard as a vehicle for customized codes for encrypting documents, transactions, and electronic money on the Internet and other open networks.

Currently, the further rapid development of the SmartCard seems to be limited by the user's power of imagination, the general fear of technology, cost aspects, and standardization problems. It is, therefore, worthwhile taking a closer look at the SmartCard in order to gain a clearer understanding of its technology, further development, and possible areas of application.

How It Works

A SmartCard is nothing more than a chip (memory, controller, or cryptocontroller with additional coprocessor) which is embedded in an interface (module) and a surrounding

1. The organized traveller will no longer need to carry tickets, passports, cash, or other weighty documentation as the SmartCards begin to replace long check-in lines in airports and train stations.

piece of plastic, which uses the standardized interface to establish contact with an appropriate reader. A special form of SmartCard is the contactless card which exchanges energy and data with an appropriate reader (using contactless technology) via a miniantenna (coil) which works on the induction principle. The power supply is generally 5 V, although 3 V technology is slowly beginning to gain in popularity. The serial interfaces which cards usually have today currently have a very slow mean data transfer rate of 9600 bits/s. from the card to the terminal. This bottleneck can be expected to be eliminated quickly as the interface is enhanced and the market begins demanding faster transfer rates.

2. A balance has been written onto a processor chip within this card to be spent at special terminals. Over 50 million money cards have been in circulation since the summer of 1996.

SmartCard History

In the early days, the SmartCard was only available as a storage medium pure and simple. It was only equipped with an EPROM since this was the sole possibility at that time of receiving data without a continuous power supply. Improvements to the storage capability and processor power were quick to follow, however. Within a short time, the capacity and performance of the processor on the cards had been multiplied quite dramatically. The EPROM was replaced by the EEPROM, which employed a very similar capacitor principle (as employed by PC hard disks) for storing data. The required write and erase voltage of approximately 20 V is generated using the principle of cascaded voltage doubling.

At the current time, users can get inexpensive solutions providing memory sizes of up to 16 kbytes EEPROM, 512 bytes of RAM, 16 kbytes of ROM, and coprocessor power for processing encryption procedures like DES/MAC, RSA etc. with lengths of up to 768 bits in approximately 4 seconds for a card s (processor) clock frequency of 3.5 or 4.9 MHz. These performance levels and storage capacities can be expected to quadruple by the year 2000. This will result in many more potential applications.

Up to 10,000 write and plug-in cycles are guaranteed, though, in reality, up to 200,000 cycles can already be assumed as the average service life. The teething troubles (plastic and modules insufficiently rigid, fracturing of the chips, detaching of the modules from the card, and so on), that would hardly be apparent to an unknowing user at first glance, have now been largely resolved by reducing the surface area of the chip. The surface area of the chip has been reduced to as little as 25 mm^2; further reductions can be expected through the increasing use of 3 V technology. Additional improvements have been made in plastics and adhesives.

In concrete terms, an employee of a firm would have one or two biometric features entered onto the personal chip card using image-generating techniques, along with an additional alphanumeric ID.

The market has already seen the introduction of hybrid cards. When combined with optical storage foils similar to CD-ROM technology they can achieve WORM storage levels of up to 20 Mbytes. In this process, a laser burns information into the tracks of the optical foils. This information can be read by laser scanning.

As a result, SmartCards are an increasingly interesting prospect for fields which, in addition to requiring a high level of security, also need substantial data and a sizeable memory. Examples of such applications include image generating processes in the health sector (X-ray or ultrasound), the long-term recording of large quantities of data (clinical research), or the optical storage of customized data on cards (a "CarCard" containing the complete documentation of the service record or a "MaintenanceCard" for aircraft turbines).

007-Style Features

Also undergoing testing are combinations of SmartCards with James Bond-type procedures in the field of biometry. Initial studies into storing fingerprints, hand outlines, scannings of the iris and retina, photographs, handwriting samples, voice samples, and physiognomic face recognition methods on SmartCards have already been concluded and are very promising.

If these biometric methods are combined with PIN numbers or codes unauthorized access would be extremely difficult, since the relevant user-specific data are only stored decentrally on this card. They are known, in part, only to the card bearer. They also are customized with biometric information, i.e. they can only be duplicated or altered with immense effort.

In concrete terms, an employee of a firm, would have one or two biometric features entered onto the personal chip card using image-generating techniques along with an ad-

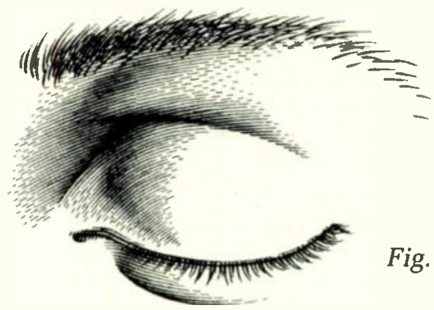
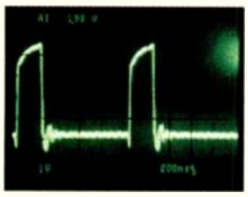


Fig. 1

Ordinary digital scopes are asleep 99.9935% of the time.

Fig. 2

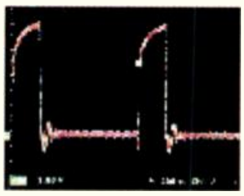
Introducing the Tektronix InstaVu™ family.



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.



Conventional DSO

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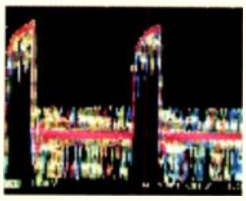
Call 1-800-426-2200 (code 500) for more information on the InstaVu acquisition family, or visit our Web site at www.tek.com. And open your eyes to a new standard in digital oscilloscopes.



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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

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ditional alphanumeric ID. If the cardholder wants to gain access to a building, the chip card is inserted into a reader which checks the biometric features (e.g. hand print, iris) while the user submits to a hand print testing device or camera's lens. The cardholder then enters the personal alphanumeric access code.

applications of 1 kbyte each on a single card. Generally, the number of applications can be expected to quadruple, as a result of the quoted increase in processor power and storage space. This development sets new and powerful standards for the vision of a multifunctional/multi-application card, and will certainly

The Impact Of The Internet On Electronic Engineering

The Evolution Of The Internet Allows The Change From Access To Information To Access to Resources.

LIAM GOUDGE

ARM Ltd., 90 Fulbourn Rd., Cherry Hinton, Cambridge, CB1 4JN, U.K.; 44 1223-400440; fax 44 1223-400410; Internet: http://www.arm.com

For many in the technical and academic communities, the Internet has always been available. Command line runes were never a problem for those engineers who wanted to telnet into File Transfer Protocol (FTP) sites on the network, access discussion groups, or send e-mail. It wasn't pretty, and it was limited to the few who generally had access either from large company or academic connections to the Net.

It comes as no surprise to hear that all of this has changed over the last five years. A new wealth of online information, more readily available to a wider range of people, has certainly impacted engineering professionals. With their skills, resources, and interest, engineers have been the first to embrace Internet technology. The Internet has already brought significant change to engineering.

The Internet is nothing more than a very large collection of computers that can share data and communicate. Its roots go back more than 30 years to the early U.S. Department of Defense ARPANET work to develop robust data communications. In recent years, however, what has been truly significant hasn't been the further development of this networking technology, but the development of services like e-mail and the World Wide Web. For engineers, the impact of the Internet has evolved across three key areas: Communications, Access to Information, and Access to Resources.

Communications

The first widely-used Internet services were communications oriented: E-mail, FTP, and discussion groups. E-mail allowed people to send text messages to one another, both inside and outside a company, while FTP allowed the early Internet users to transfer files over long distances. The discussion groups enabled people to hold group e-mail conversations on a variety of topics.

In the workplace, the e-mail service had the most significant impact. It provided a replacement for paper memos and, once the network connections were in place, wasn't limited by time zones or national boundaries. Combined with the ability to transfer files via FTP, this enabled the first "real" telecommuting—much more than just bringing home a briefcase and redirecting phone calls. Designers with a computer at home could stay in touch with colleagues, and have useful file access, as long as the required software tools were all available locally.

Access To Design Information

Even five years ago, dealing with requests for product information such as datasheets and applications notes was a full-time job for several people at a typical semiconductor company. What did engineers need to design-in commodity devices? The answers were obvious—they needed easy access to product information, applications information to make the design easier, fast access to samples for breadboard experiments, and applications expertise for well-advanced designs.

Providing this information was easier said than done. With many thousands of devices available, databooks became weighty and expensive. Linear devices tended to require detailed applications notes, making these tomes heavier and more costly. Providing large volumes of these books required expensive, slow bulk shipments all over the world. It was extremely difficult to track the return on this investment in terms of design wins, so the argument for printing more books often wasn't obvious.

When it came to supporting large OEM accounts worth millions of dollars, no one questioned a million-unit design. The problem was more acute for medium and small-sized accounts, often serviced by distributors. Though many small (less than 10,000 units/yr) designs combined made up large volumes, the cost of servicing them was too high for the return on investment. The outcome was that distribution accounts received little service. Early dial-up bulletin boards provided a

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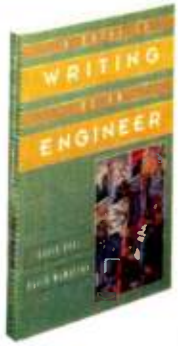
A Guide to Writing as an Engineer

David Beer and David McMurrey



This essential guide focuses on what is important for engineering writing in particular, rather that just technical writing in general. Clearly explains all key writing concepts and covers content, organization, and format. Also provides complete coverage of computer communication, e-mail, and finding information on the Internet. Practical, relevant examples of solid engineering writing throughout help you apply the material covered right away.

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Web Page Design: A Different Multimedia

Mary E.S. Morris

Written for Web page authors, this hands on guide covers the key aspects of designing a successful web site including cognitive design, content design, audience consideration, interactive, organization, navigational pathways, and graphical elements. Includes designing for VRML and Java sites as well as designing with templates, style sheets and Netscape Frames.

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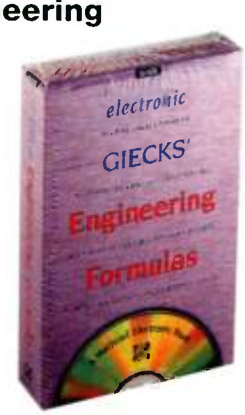

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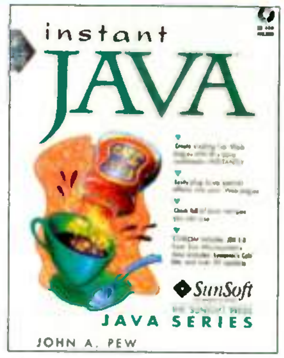

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partial solution to the problem.

The industry began moving to direct marketing as a solution. In the analog world, Maxim led the way with regular magazines, advertising, and easy access to samples and good documentation via mail, fax, and an 800 number.

These methods provided engineers with the information they needed. They also gave the supplier more information about their customers, for example, who they were, where they were, and what they wanted in terms of new products. However, direct marketing in this style still required heavy investment.

Everything changed with the advent of the World Wide Web protocols on the Internet. Suddenly, it became easy to widely distribute product information at very low cost. The information providers did not need to provide the paper. Customers would take only the information they really wanted, since they would be the ones paying to print it. As the information became available, it was usually up-to-date and free. For the product supplier, this method still requires a full-time staff to run a professional presence on the Web, but it 's a far lower-cost solution than printing books that rapidly go out of date. For marketers, registration information and customer data request profiles improves their customer knowledge, so that better future products can be designed.

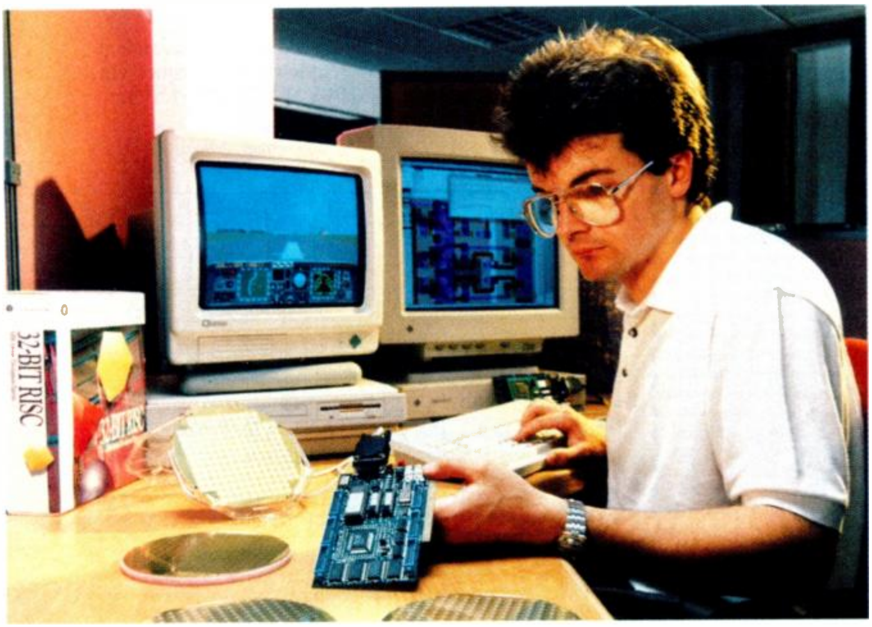
Advanced RISC Machines (ARM) has found that publishing information on the Web gives customers the information they want when they want it. The company now treats the Web as one of its main communications channels. Approximately half of the ARM user manuals are shipped "electronically." However, the company must update its electronically distributed information diligently, as this is what customers have come to expect.

In terms of product design, the impact of the Web on distributing device information has been huge. It has given designers much of the information they need on demand. Engineers at small firms get service they would never have received and the big OEM's get more up-to-date information faster. From the suppliers' point of view, it also has greatly addressed the issue of supporting the smaller-sized customer and tapping into their volume. The Web's platform independence also simplifies the dissemination of information both inside (intranet) and outside the company.

Web search engines, such as Alta Vista, are effective for directing users to the information they need. However, as those who regularly search out product information know, this is a new communications medium which suppliers have yet to learn how to use effectively. Some firms have made more effort in graphics—which can be annoyingly slow—than in useful content. Some Web information can be very dated or of limited use, making it difficult to find quality information.

Databases of embedded design sites such as Cera (www.cera.com) and Chip Directory (http://cal003109.student.utwente.nl/~stefan/chipdir/) provide a simple way to locate manufacturers making a particular device type, as well as tool suppliers, applications support, and other useful services. Although most web sites are currently free to users, the future may well see such sites go to subscription charges as companies begin to realize their value to engineers searching for device data.

New tools are enhancing the Web information provision abilities. Many engineers no longer look though several trade magazines on the off-chance they will see something relevant. Instead, they are using search engines to take them directly to suppliers' sites or even to webzines, such as PointCast, to send information which is of interest to them. URL watchers notify users by e-mail if any of the Web pages they care about are updated, and "intelligent agents" which gather information of interest, also have begun to appear.



An ARM engineer is shown developing an ARM-based application.

Access To Resources And Telecommuting

Will the availability of networking allow people to work from home more often? One example is ARM's CEO Robin Saxby, who spends half his time on the road, a quarter of his time at home, and only a quarter of it in the office. Yet, he effectively stays in touch and interworks through e-mail, dial-in central file servers, and the company's intranet. Although most users don't go to this extreme, many other professionals do telecommute on a regular basis.

Although people at many companies today are free to telecommute, few engineers do. The attractions seem numerous, so why don't more designers do it? The short term issue is mainly one of bandwidth. Chip design data files are very large, typically over 40 Mbytes—much too large to load over a modem. Data files are often needed by several designers simultaneously, so they can't be taken home by a single person. Also, it is difficult to handle revisions between multiple remote workers.

Additionally, most software design tools reside on central servers. They usually have floating licenses which allow a set number of copies of a given

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tool to be in use simultaneously. These programs are much too large to use with current modem technology, but putting high-speed bandwidth in place opens up some very interesting possibilities. Large design companies with several sites can let their design tool floating licenses wander globally, so offices in different time zones can reuse the same set of tools. Eventually, we may start to see "per use" tools pricing—the tools would record their own usage with the supplier via the Internet through a secure protocol. With sufficient Internet bandwidth, software could be rented for a set time—which is the basis for much of the Network Computer concept, extended to design tools.

Telecommuting also may be rare among design engineers because of the nature of the work done. Much of the technical work at ARM, for example, is microprocessor system design, processor modeling, VLSI layout, and software toolkit development. These are all intricate tasks requiring careful project management and coordination. Design of the various blocks of the processor becomes considerably harder if members of a team are in different locations. This is especially true of the model validation stage of design, where corner cases and obscure bugs need to be painstakingly hunted out.

However, many companies do have development teams scattered across the globe. For example, software teams in the US, Europe, and India enable 24-hour project development. This arrangement may make work exceptionally difficult, and what is saved on coding time may be lost in debug time. Ford's Modeo project is an often-quoted example of this kind of development. Some code development at ARM is done remotely, however this is not the norm. Telecommuters still come into work frequently, to ensure they are in-synch with the rest of the team.

Experience would say telecommuting is possible with sufficient bandwidth and infrastructure (depending on the nature of work). However, it is difficult to see how it could be the most effective solution for complex projects involving heavy team interaction.

Help Yourself To IP

The Virtual Socket Alliance (VSI) would seem to be an extension of what the software industry has been doing for years: Using the Internet to lower distribution costs and making products available to a wider audience.

The objective of the Alliance is to make the virtual components required to build a system-on-chip as easily available as physical ICs from a catalogue. These components would include macrocell designs, layout, software algorithms, and system modeling technology.

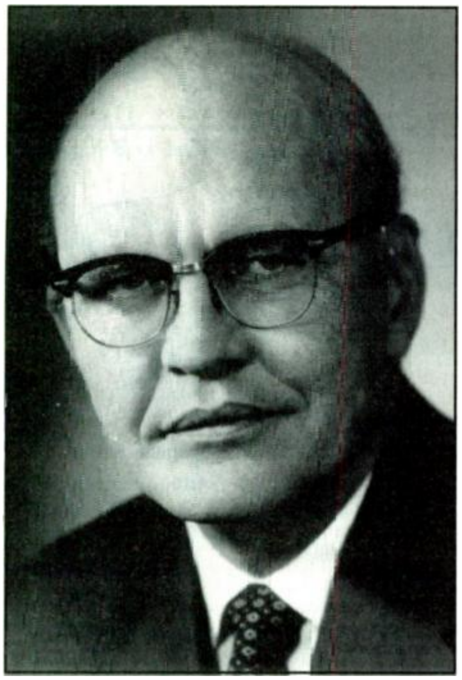
The Web has made information on commodity device building blocks more available. It now promises to make information on the blocks much more accessible. An ASIC designer will now be able to search on-line databases for products that best meet the needs of a design. Various offerings can be traded off against each other for price, performance, and quality, and a selection made on-line. VSI standards would ensure that the blocks all work together in the final design.

To an extent, this already exists. IP companies such as ARM already deliver device layout or models to customers via the Internet. VSI promises to make more of the components more readily available. This move marks a transition from Access to Information to Access to Resource.

Several companies have development boards wired to their Web servers, and remote customers can submit jobs to run on these boards. This arrangement allows not only remote benchmarking and evaluation, but development as well.

Always a powerful communication tool for design engineers, the Internet has become an important resource for all types of information. As bandwidth improves and services mature, all types of interesting and useful resources should come on-line. And more "ready-rolled" technology will become available which, if handled properly, will allow engineers to design better products faster.

Liam Goudge is a product manager with Advanced RISC Machines. Before joining ARM, Goudge worked at Texas Instruments in France and England. He holds a bachelors degree in electronics from Nottingham University, U.K.



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Revered by engineers worldwide as the inventor of the IC and a pioneer of solid state technology, Jack Kilby will once again make an appearance at the Portable By Design Conference & Exhibition. Two years ago, Mr. Kilby was the keynote speaker—this year, he will present the first annual "Electronic Design Award For Technical Innovation." The award will be presented the author of 1997's most innovative conference technical paper. The award represents the first of its kind given annually. The ceremony will take place at the Industry Reception, held on the show floor at the Santa Clara Convention Center in Santa Clara, Calif., on Tuesday, March 25, 1997 at 5:00 p.m.

Also at this year's gathering. . .

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Worldwide Marketing
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RICHARD PIERCE
Director of Marketing
Mobile and Handheld Products Group
Intel Corporation

ROBIN SAXBY
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LEE GOLDBERG

Green Engineering: Designing For A Brighter Future

Communications Editor

An Exclusive Electronic Design Interview With Amory Lovins, Co-founder Of The Rocky Mountain Institute.

Amory Lovins is not your typical technologist. Then again, he's not your typical environmentalist, either. Unlike many technologists, Lovins is acutely aware and concerned about the impact that civilization and its technology is having on the environment, as well as its inhabitants. Unlike many environmentalists, he feels that technology is not only the problem, but also can be part of the solution. A profoundly unconventional thinker, he challenges both traditional thought and its critics with his notion that market forces and capitalism will play a pivotal role in creating a cleaner, safer, and more hopeful world.

Together with his wife, Hunter, he established the Rocky Mountain Institute a dozen years ago. From their solar-powered aerie high in the mountains of Colorado, the 40-odd member RMI team works with architects, engineers, citizens groups, legislators, and surprisingly, a wide cross-section of high and low-tech industries, to envision and realize a world where both the environment and people's wallets are green (Fig. 1). Their enthusiasm and hope are infectious. After speaking with them for even a short time, it's hard not to imagine a nearby future that's cheerfully filled with self-sufficient homes, an improving environment, 300 mile-per-gallon hypercars, and well-fed, well-educated children in both first- and third-world countries. The following interview was extracted from a conversation with Mr. Lovins that took place this past October.

If this article caught your interest and your want to see a complete transcript of the interview, you can find it at Electronic Design's new website; www.penton/ed.com

Electronic Design: Okay, the tape is running, let's get started. First question: What is all this whole-system engineering, green engineering, and sustainable engineering stuff, anyhow? Why should the average engineer care about it?

Lovins: The essence of good or even great engineering is to do more with much, much less. Engineers ought to be rewarded for practicing elegant frugality. Besides, it's more fun that way. The profession's contribution to efficient utilization of resources is probably the most important single need in our technical system today. It will have the most far-reaching benefits for society.

Using our resources more productively will bring us a number of benefits. For example:

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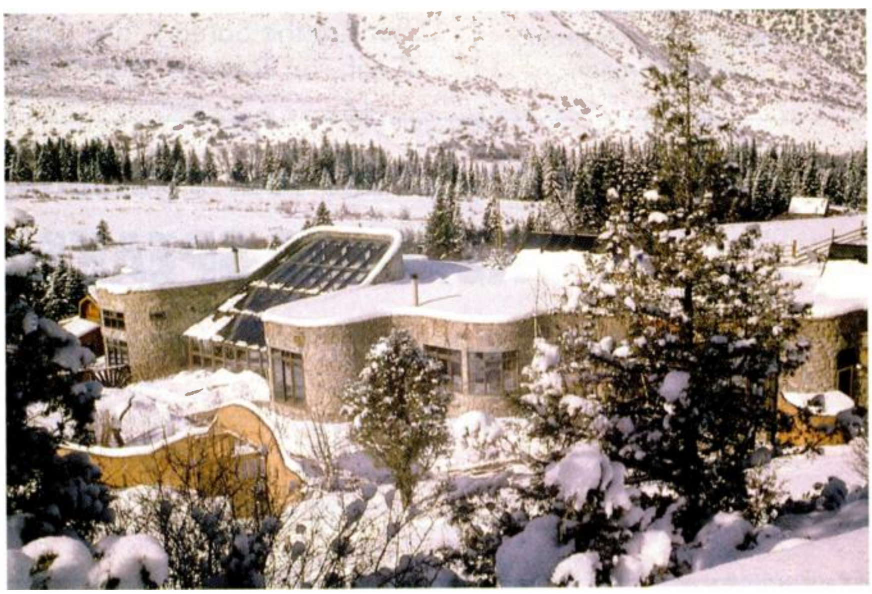

1. The Rocky Mountain Institute occupies this building, located at 7100 ft. in the Rocky Mountains. Although it is nearly completely energy self-sufficient for both heat and electricity, it actually cost less to build than a conventional structure.

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2. The heart of the RMI heating system is this solar greenhouse which also serves as a warm, green haven during the harsh Colorado winters, where temperatures drop to as low as 46° below zero. A small wood stove serves as a backup heater for the entire building.

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8) This approach also reduces the waste of people. Instead of laying off the people, we can lay off the unproductive tons, gallons, and kilowatthours, leaving the people with more and better work to do in more competitive businesses.
9) This leads to a safer and cleaner world if people are substituted for scarcer and more expensive natural resources.
10) Resource efficiency bypasses ideology. Even the most hard-nosed business person is in favor of efficiency. The concept of stewardship is at the root of our most cherished political and religious philosophies.
11) Resource efficiency accommodates diversity. In order to welcome efficiency, you don't need agreement about social values. Since its a means, not an end, we can all get together and agree on this, and worry about the ultimate goals later.

Now, efficiency is not a new concept. Engineers have been doing it for thousands of years. What's new is that we now have incredibly powerful tools for both designing and implementing the things we want. To understand how vast the scope is, take a look at the fact that even the most developed countries have an energy utilization efficiency of only a few percent.

Our materials efficiency is even worse than that. A study conducted in 1992 revealed that about 93% of the mass flow of materials used to produce American goods are discarded before the final product is finished, and about 80% of finished products are discarded after just one use. From this, you can figure that somewhere near 99% of all the original materials used to manufacture goods in the United States ends up as waste within six weeks of sale.

Electronic Design: Wow. I guess that sounds about right, unfortunately.
Lovins: Yeah. And when you realize that after decades of effort by countless scores of superb engineers, our cars still waste 99% of the gasoline that they consume. Think about the fact that only 3% of the fuel burned in a power plant actually produces light in an incandescent bulb. The rest is just wasted as heat along the way! We shouldn't think of these gross inefficiencies as problems, but as opportunities. Just think of how much better we can get with even a modest effort!

Electronic Design: And engineers who are involved in resource optimizing are sitting at the cutting edge of an economic and technical revolution?
Lovins: The total waste of water, energy, mobility and materials services in the world may well approach $10 trillion a year.

Electronic Design: So even recovering a small fraction of that represents a tremendous opportunity for engineers. It would seem that even if you aren't worrying about the future of your grandchildren's children, there's still lots of incentive to get involved.
Lovins: You bet. Economically, morally, professionally, and every other way, engineers have an extraordinary opportunity to finally start to play the full role that they could and should in creating a sustainable world. What's more, they can make lots of money at it, and have a ton of fun in the process.

Electronic Design: I'm glad you mentioned fun.
Lovins: Of course. Engineering ought to be one of life's great pleasures.

Electronic Design: Can you explain a bit more about the concept of whole systems engineering, and do you have an example about how it applies to electrical engineering?
Lovins: Well, I haven't been involved directly with electronics for nearly thirty years--I may be the last guy to

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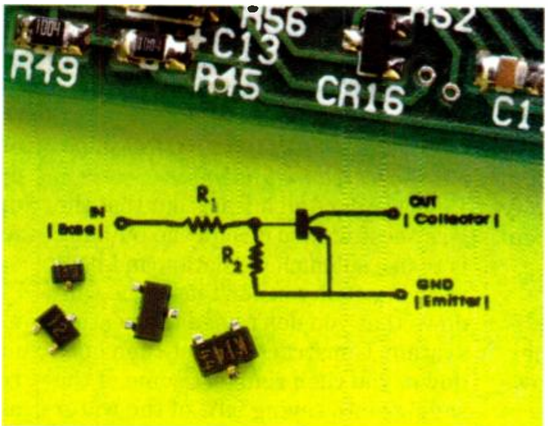

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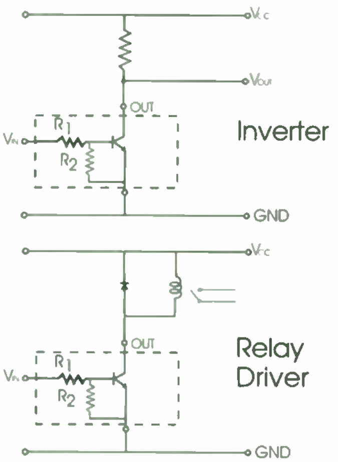

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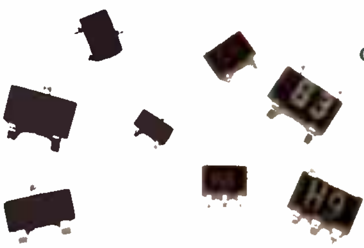

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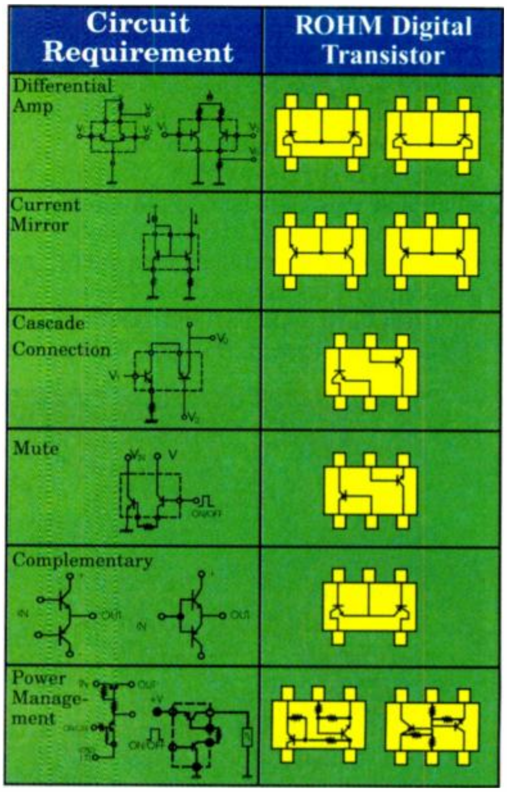

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get a patent on a vacuum tube circuit (in 1965)--but here goes. Let's start with a simple example: I live in a house at 7100 ft. in the Rocky Mountains, where it gets as cold as -46°F, and yet we have had 24 successive banana crops in our solar greenhouse with no central heat source *(Figs. 2 and 3)*. Surprisingly, its actually cheaper to build our home that way. That's because the extra cost of super insulation, super windows, and ventilation heat recovery is actually less than the cost of installing a central heating system.

Electronic Design: Super windows?
Lovins: There are several commercially-available brands of windows that insulate as well as 10 sheets of glass, look like two-pane windows, and cost less than triple-glazed windows. In fact, they gain heat even on northern exposures.

Electronic Design: So how do you heat the house on the rare times that the sun doesn't come out for a week?
Lovins: Well, the house is about 99% energy self-sufficient from passive solar, and 1% of our heat is obtained from a single wood stove. To save wood, we occasionally use it to burn government energy studies. If you do a standard calculation to figure the heat loss through the roof, walls, foundation, etc., and used that to optimize the insulation thickness, we would say "How much more does it cost to make the insulation thicker, what's the present value of the heating fuel that we save, and is it worth it?" Well, that leaves out the not so little matter of the furnace and ductwork, which can be significantly downsized, or in our case, eliminated.

Electronic Design: At 7100 feet in the snow-covered mountains.
Lovins: Yes. And it turns out that the least-cost way to design the building is to use so much insulation and heat recovery that you don't need the windows that you don't need the heating system. Construction cost then goes down, you then reinvest some of the savings into saving 99% of the water heating energy, half the water, and 90% of the household electricity. What happens is that out monthly electric bill is around $5, and that's before we sell back excess energy from our own solar panels. Actually, the utility pays us a little. The payback on these investments is around 10 months: And that's with 1983-vintage technology! Now you can do much better.

You get there by designing the house as a system, not simply optimizing components in a way that "pessimizes" the whole thing. In another example, we recently eliminated both heating and cooling equipment in buildings located in parts of California that reach 110° or even 115°F. We actually reduced the real cost of the house and made it more comfortable by saving the cost of the heating and cooling system.

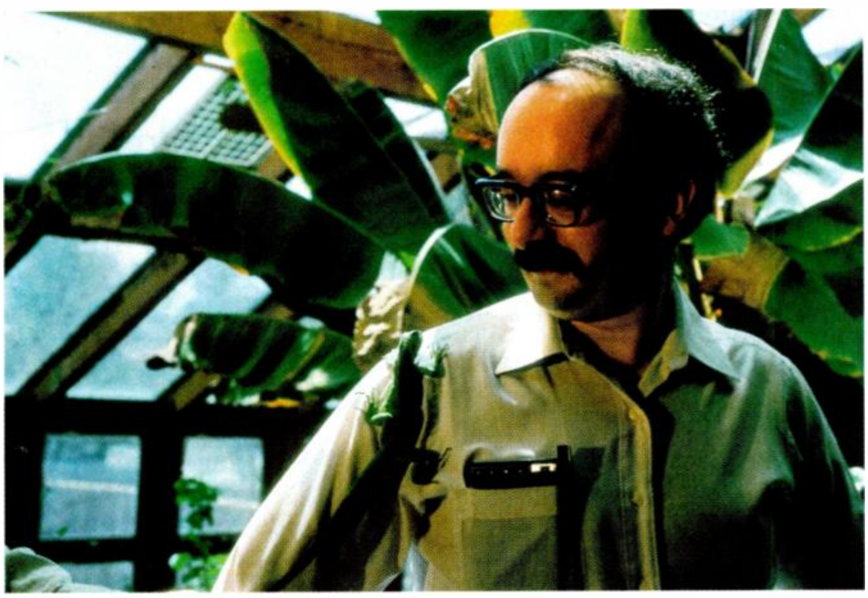
This is a good example of reaping multiple benefits for a single expenditure. It's a good design heuristic that if any element of a design does only one thing, it's probably a missed opportunity. So, the arch that holds up the middle of the building performs 12 discrete functions, but only pay for it once.

Now, I'll give you an example in electronics. It's pretty simple, but it might ring some bells with your readers. I was involved several years ago with the redesign of an energy efficient desktop computer. Of course we all know that CMOS chips are as cheap NMOS ones, in fact, they're cheaper on a systems level because they need less cooling. But it turned out that when we went to a very efficient power supply that maintained its efficiency even at low loads, the entire computer shrunk to a much smaller size and no longer required a fan. The more efficient power supply costs a dollar more, but the bean-counters didn't like it until they realized that they saved more than that getting rid of the fan.

We also started to realize that eliminating the fan did more than cut cost and noise. Without a fan, you no longer needed to pull air through the case, which brought dust along that collected on the chips and other internals. Without any dust, the chips tended to run much cooler and much longer; in fact, you could lock the whole damned thing in a drawer (for security).

Whether you were counting EMI shielding, acoustics, or reliability, we found that there were lots of important byproducts of improving the computer's efficiency to the point where you didn't need a fan. It ended up not only cheaper to make, but also functionally superior.

Electronic Design: At first glance, the move towards a sustainable culture looks like a massive, perhaps impossible, challenge. What tools and resources do we already have going for us today? Have there already



3. Dr. Lovins inspects the banana crop which is harvested twice yearly form the institute's solar greenhouse. Besides setting an unofficial altitude record for banana production, the food, heat, and shelter produced by the greenhouse is intended to demonstrate how innovative engineering practices can help people live better while actually consuming far fewer natural resources.

been any significant achievements in this direction?

Lovins: Well, our most powerful tool is the field of resource efficiency. For example, we can now save about twice as much electricity as we could five years ago, and at only a third of the real cost. This trend has been holding true for at least the past 15 years. The importance of this becomes apparent when you realize that we're spending over close to $200 billion on electricity, and every unit of it that we save saves three or four units of the fuel used to produce it at the power plant. It's actually cheaper for the utilities to save the fuel than to burn it. This helps cut by a third one of the main threats to the climate, not at a cost, but at a profit!

We've already cut $180 billion of the nation's energy bill by simple things, such as using caulking guns, plugging steam leaks, installing more efficient windows, and building slightly better cars. Unfortunately, we're still wasting more than $300 billion in energy, not to mention twice that in water and materials--a grand total of a trillion dollars in resources lost every year.

There have been major savings in every area, materials, power, mobility, services, etc.. but we have only scratched the surface. I'm looking at a paper that I did back in 1976 in which I was heavily criticized for suggesting that U.S. energy use might stabilize, and even decline, as we wring out the losses in the system. Well, the energy intensity of the economy has already decreased by a third more than I said it might do, yet the potential savings are now enormously larger and cheaper than 20 years ago. This is because we're learning faster than we're exhausting the ripest opportunities. I used to argue 20 years ago about whether the potential for energy conservation in the US was 10 or 30%. Ten years ago, we were arguing about whether it was 40 or 80%. Now we're arguing about whether it's 80, 90, or even 99% in the long run.

Those are not fantasy numbers. We all know that a good laptop computer is somewhere around 95 to 98% more power efficient than a standard desktop unit (5 W versus 150). You save about 98% with an inkjet printer or fax over a comparable later model. We recently did an air-conditioning retrofit in an office building and cut the power consumption by 97%, and the engineer who did that said he could do better on the next one! When we built the institute 13 years ago, we saved 99% of the space and water heating energy, and 90% of the electricity (a 10-month payback). Today, we can do better than this. Although our recent book, "Factor Four" (published in Germany) talks about living twice as well on half the resources by increasing utilization efficiency by a factor of four, I think that's pretty tame. Now, we're looking at factors of 10, and in some cases, 100.

We're Spending Over Close To $200 Billion On Electricity, And Every Unit Of It That We Save Saves Three Or Four Units Of The Fuel Used To Produce It At The Power Plant

In almost every case, the service you get by very efficient provision is qualitatively superior. Although I think energy and other resources will keep getting cheaper for a long time, I think efficiency will be getting cheaper even faster. Most efficiency will be bought not because it saves resource costs, but because it provides better service.

Electronic Design: Are there any examples of this out in the consumer market yet?

Lovins: Sure. There are loads of them. Besides electronics which are always getting better, smaller, faster, cheaper, there's my refrigerator. The Sun Frost-brand refrigerator that I own is made in quantities of a thousand odd units per year and uses something like 8% of the electricity that a normal appliance would. Today's super windows typically have four to five times the performance of double glazed units but cost only an extra 10 to 30%. Most household appliances are available in energy saving versions that use one-half to one-third the power that their competitors do, at close to, or the same cost. It's becoming common for my friend M. E. Lee to save at least 80% of the fan and pump energy in the buildings he designs while saving capital costs as well. He also can usually cut two-thirds of the energy out of a typical HVAC system in his buildings.

You can save about half of industrial motor energy, just from the input shaft to the driven machine. This has a payback of about 16 months if your electricity costs five cents per kilowatt hour. Getting there takes doing seven things that you pay for and an additional 28 benefits you get for free, as byproducts. This alone is enough to save a quarter of all the electricity in the country. Lighting retrofits are saving between 70 and 90% of the original power consumption with a payback period of a couple of years. The list goes on...

Electronic Design: What are some of the most significant challenges that society will face in the next few years, and what role will engineers play in meeting them?

Lovins: Climates, energy, soil fertility—for farming and forestry, fisheries and marine health, public health, adequate and clean water supplies, biodiversity, preservation of traditional knowledge and culture, and learning tolerance of social diversity. Now, not all of these are amenable to technical fixes, but many are, and many more can be strongly helped by technical assistance.

Certainly any issues that have to do with conflicts over resources have enormous scope for technical improvements. For example, you might think that protecting the rain forests or old growth timber regions is not a very promising area for a technical solution. Yet we've recently been looking at a matrix of improvements that can be made in resource productivity to reduce what we refer to as "extractive pressure" on natural resources such as forests. Each of these factors has a multiplier effect when properly implemented that results in a decrease in the demand for raw stock by at least one, and maybe two, orders of magnitude. It typically takes a savings of somewhat less than an order of magnitude to attain a sustainable resource cycle. Most of these technical fixes are well-established and are very profitable.

Electronic Design: What projects is RMI working on right now? What ideas are you most excited about?
Lovins: RMI's mission is to foster the efficient and sustainable use of resources as a path to global security. The interlinked areas we work on are energy, transportation, water, farming and forestry, sustainable corporate practices, green real estate development, local economic development, and global security. We're especially interested in how they are all connected. We tend to pursue them by combining advanced technology with the creative use of market forces and community organizing. That means that our most important audiences are the private sector and communities, two of the most badly neglected and vital focal points for action.

I'm spending most of my time working on transforming the automobile and real estate, and electric utility industries towards advanced resource productivity. I suppose since the "Negawatt" work is now being carried on as a for-profit enterprise by our E-source subsidiary, I'm spending less time in that. I'm still keeping in active hand in the concept of distributed power generation. That's where the power plant moves from a remote central facility to your roof, basement, back yard, and driveway. This may happen faster than any of us are ready for.

We're also doing a lot of work with "green buildings" that work better and cost less than "brown buildings," and are much more healthful, pleasant, and pleasurable to work or live in.

If I had to pick one thing that I'm most excited about, it would be the unexpected link we've discovered this past year between hypercars (ultra-slippery, ultra-light fuel efficient vehicles) and polymer proton-exchange membranes, a new kind of fuel cell. Basically, it turns out that hypercars require one-quarter to one-tenth the tractive power of conventional cars. This means that they could easily adopt polymer fuel cells as their on-board electrical power source, using either hydrogen or natural gas as fuel.

Even in their initial stages of commercialization, the low energy requirements of the hypercar would make it economically feasible to use early fuel cells by the late 1990's. As soon as you start to make enough fuel cells for even a small hypercar industry the price of a fuel cell will plummet to a few hundred dollars per kilowatt. You could also put the fuel cells

Basically, It Turns Out That Hypercars Require One-Quarter To One-Tenth The Tractive Power Of Conventional Cars

in buildings, which use two thirds of our electrical energy. In buildings, the waste heat that fuel cells produce (at around 70°C) will provide enough building services to justify the cost of the natural gas. Once you do that, the net cost of the electricity becomes one to two cents per kilowatthour. This could put most central power plants out of business.

Electronic Design: Will the utilities stand for this? Won't they try to stop it?
Lovins: How can they? The cars could even be leased by the gas companies. Alternatively, you could lease your hypercar back to the power company as a 20 kW power station on wheels. The fuel cell in it is clean, quiet, durable, and parked 96% of the time. Imagine if some entrepreneur came along and provided a natural gas or hydrogen hookup and an electrical feed at your normal parking place. You drive to work, hook up your car, swipe your credit card, and while sitting at your desk, the car is sending 20 kW back to the power grid at a real-time price. This should earn you about $2500 per year, which is probably at least half the cost of financing and depreciating the car. This means that your second largest idle household asset is now a substantial income earner. It doesn't take long for the rest of the centralized generating facilities to be displaced because the hypercar fleet could eventually have five times the generating capacity of the national power grid.

Electronic Design: That's too hilarious for words...
Lovins: Yeah. That, in turn, would not only speed up the arrival of a distributed utility system, but also accelerate the conversion to a solar-hydrogen economy. You see, most renewable energy sources (sun, wind, water) can make hydrogen a whole lot more cheaply and easily than they can make utility-grade electricity. In fact, owners of big, old hydroelectric dams may find they make a lot more money making hydrogen at the foot of the dam (at the equivalent of seven to nine cents per kilowatthour) for the vehicular fuel market than they can selling electricity into a very crowded, low-priced wholesale electricity market. What you have in effect is hypercars acting as a nega-OPEC, saving about as much fuel as OPEC now extracts.

Electronic Design: The big question here is where do you bootstrap an enterprise like this from? How do you raise the capital to produce and create an initial market for the first wave of products?
Lovins: That's a good question, something we'll discuss at length some other time. For now, let me tell you that we've already raised over a billion dollars in capital commitments for the hyper car by simply maximizing competition and exploiting things we've put in the public domain. By the way, some of the bigger players are electronics companies.

Electronic Design: Really? That's interesting. Can you mention names?
Lovins: Mmmmm... no. But I can tell you that a third of the first billion we raised is committed by "wannabe" car companies, mostly from aerospace, electronics, car parts, polymers, plus some new start-ups. Two thirds of the funding commitments

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USA phone (+1) 510 623 1231 USA fax (+1) 510 623 1434 Europe (+44) 1908 234030 Asia (+61) 9 361 9705 E-mail *info@smartm.com* came from another dozen companies that are already established auto makers, mostly big ones. It's moving very fast. We expect the first hypercar to hit the market somewhere around 1999, give or take a year.

Electronic Design: So I guess I'll put off buying that new Saturn I was looking at.... OK, the last question I have is: Most engineers make decisions about a small part of a project. Even if he or she agrees with you, what kind of influence can they have if they're just a cog in the machine?

Lovins: Well, that's a tough one, but let me try. Whatever piece of a project you have, you can make it efficient. But it will be most efficient and effective if you change the organization so that it's not a bunch of little bits, but an integrated whole. I see a lot of areas of engineering—automobiles come to mind—that are encrusted with many layers of baroque complexity from many years of slice-and-dice, component-by-component design methodology. If instead we begin with a clean sheet of paper and act more like Kelly Johnson's "Skunkworks," we get a great design that—as Einstein said—"is as simple as possible but not simpler."

Unfortunately, it takes muddling through complexity to get to simplicity. Fortunately, the automotive industry and many others have been in the complex phase for decades now, and I think many of us are ready for something else that offers leapfrogs in cost and performance beyond anything we've dreamed of. For example, a car that costs as much or less than today's models that's more safe, durable, and goes coast-to-coast on a single tank of gas.

It seems to me that the challenge before every engineer is not how to do better on the little piece in front of you, but how to re-think the entire design process to go the necessary detail of good engineering to the radical simplicity of great engineering.

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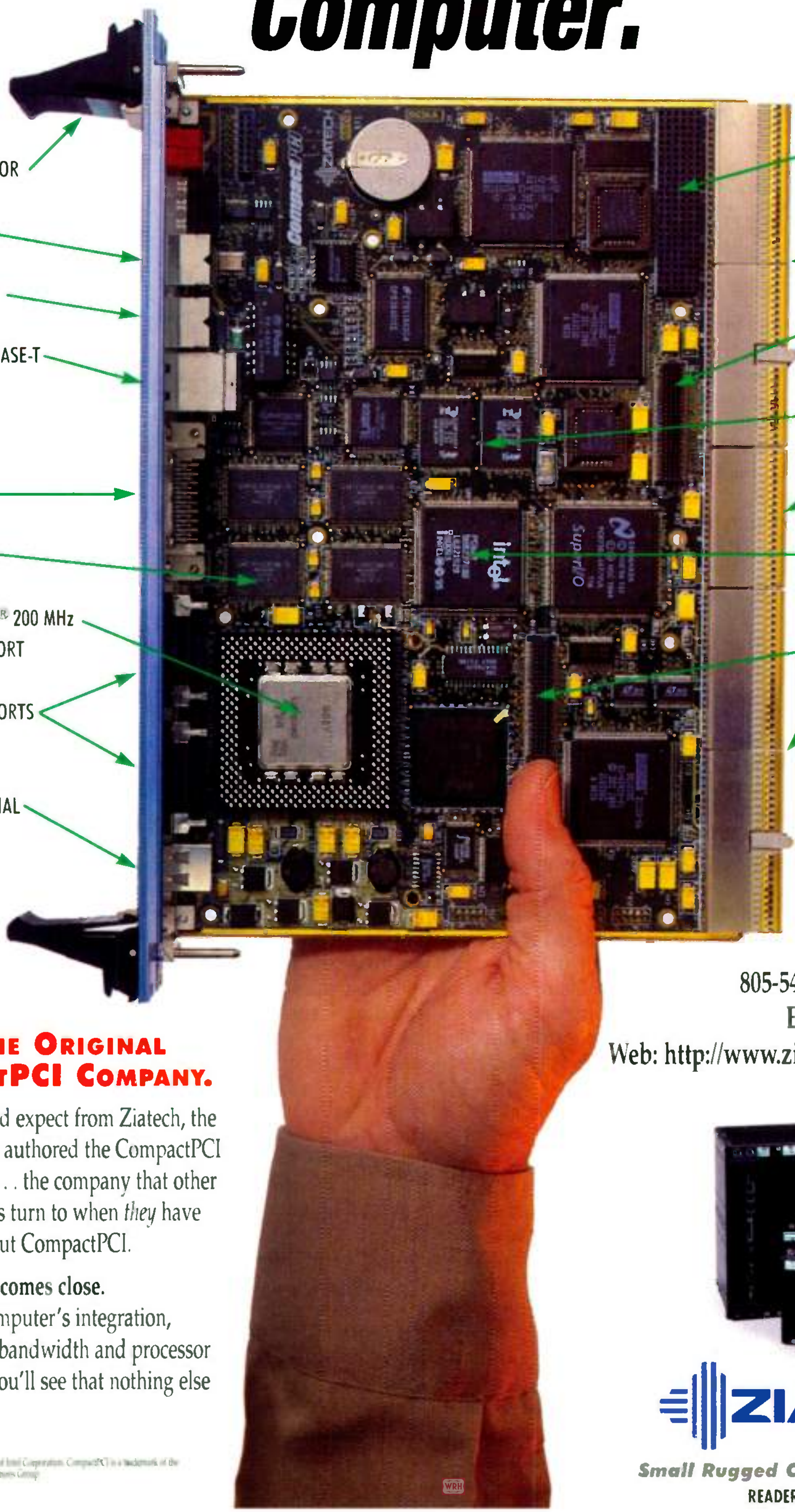

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System-On-Chip Technologies Call For A New Breed Of Engineers

Design Teams Seek Talent From Many Different Disciplines To Answer Integration Challenges.

BRUNO MURARI
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It hasn't been a long time since an engineer could design an integrated circuit single-handedly. Today, however, there are few areas where there is still room for a lone genius. Even in smart power ICs, teamwork and cooperation are essential for all but the simplest of circuits.

Behind this change lies the development of integrated-circuit technologies that allow for the integration of an increasingly large part of a system on one chip. Advances in the processes of lithography make it possible to integrate several, more complex functions on the same chip. There are several companies that already have 0.35-µm semiconductor technology in production and plan to have 0.18-µm IC technology before the end of the decade. The benefit is greater than it appears at first glance. While a typical 0.35-µm process gives a density of around 20,000 gates/mm^2, the 0.18-µm generation raises the density to 50,000 gates/mm^2.

Integrated Systems

At the same time, the increasing versatility of technology gives the possibility of integrating different kinds of technology on the same silicon chip. It is possible, for example, to integrate signal and power circuits in a smart power chip. Memory and logic functions can be integrated into a disk-drive controller, and analog and digital capabilities can be combined in a one-chip modem. Adding micromachining know-how also combines electronic functions with micromechanical parts such as sensors and actuators.

Today, there are two basic types of integrated systems that can be distinguished. One is the complex chip, generally CMOS, where a microprocessor, memory, and other functions are integrated. A good example is the decoder engine for a digital set-top box, which combines a microprocessor, a PAL/NTSC encoder, a demultiplexer, and MPEG audio/video decoders. Just by itself, the MPEG decoder is a complex circuit; in the integrated engine, this is only one of the blocks.

Another approach is the one-chip system that integrates all of the functions of a less complex system. Circuits of this type include input signals for sensors, processing functions, and output stages for actuators. They are generally produced using power technology. In some cases, they integrate all of the functions except the microprocessor, forming an umbrella of interface functions that isolate the increasingly delicate microprocessor core from "high" voltages and other types of danger.

An example of a completely integrated solution of this type is an automotive doorlock circuit, where a serial interface, microprocessor, memory, and motor driver circuits are integrated. An example of the umbrella approach is a chip for an engine control unit (ECU) that integrates all of the power drivers and signal circuits.

Teamwork In Circuit Design

What these different types of circuits have in common is the complexity of design and the reliance on more than one design engineer to develop the chips. Many circuits are just too complex to be designed by one person; they require detailed knowledge from several fields. Complicating matters further, many design cycle times continue to shrink. Participants in the disk-drive business are lucky if they have three months to develop a new circuit at the leading edge of technology.

System-on-chip circuits have to be designed by a multidisciplinary team that includes experts from many different disciplines. As a result, each team member must be skilled in interpersonal communications and teamwork. Moreover, to direct these teams, a new breed of engineers with a broader outlook and the ability to integrate information from diverse fields are needed.

The design team for a single-chip photographic camera must bring together practical knowledge of power circuits for motor driving, precision analog circuits for light sensor processing, and embedded software design. An understanding of the application also is essential because the silicon designer who understands the overall system design is more likely to propose novel solutions that exploit the technology to the limit.

The Virtual Design Team

Moving to circuits that include micromachined functions widens the breadth of proficiency dramatically. To design an accelerometer sensor for an automobile airbag, for example, demands expertise in acoustics to deal with resonance problems. The design team for an inkjet printer head needs players skilled in the fluid dynamics of droplet formation.

Bringing together such a diversity of talents in a single laboratory is rarely practical. The industry is seeing a trend towards a virtual design team which spans national and corporate boundaries, much like the Internet. A team developing a superintegrated solution for a disk drive might include system engineers in California, circuit designers in several European countries, and production engineers in Asia. This team has to work effectively despite its distribution. This, too, presents a new challenge for the team leader—how to motivate the members.

Where once the stimulus was rivalry between design teams with each team bound by national or parochial loyalties, today the inspiration must come from the experience of participating in a global dream team breaking new ground. It also must come from the excitement of working with people of many different nations and different cultures.

Our new engineers will not just lead their multidisciplinary virtual design departments, they also will push the design to higher levels, promoting a system approach. A powerful demonstration of the effectiveness of this approach comes from the disk-drive industry.

Extraordinary progress has been made in a short time because the interface between the drive and the computer is standardized so the designers can focus on improving performance. Compare this with the automotive industry, where every automobile model is different and only now is the system approach being embraced.

Bringing In Technologists

Clearly there will be many design teams that develop macrocells. In the majority of cases, these cell design teams will work independently of the technology developers. But there also will be times where the design is so close to the limit of the capabilities of the technology that technologists must be brought into the design team. It happens when circuits are developed that operate at extremely high frequencies, high voltage levels, or at high power levels. These are all cases where each cell must be optimized. Typical examples of these cases include the RF front end for a 1.9-GHz cellular telephone, a high-voltage lamp ballast chip, or a disk-drive read/write channel.

After all this about teamwork, though, a final word about the lone genius. Though lone geniuses do not fit well with the well-tempered team concept, they are far from obsolete. Many of the breakthroughs in history have been the work of mavericks and this may never change. It then becomes the challenge for the design managers: how to best merge the contributions of the lone wolves with those of the team players.

Bruno Murari is the Director of the Castelletto Research and Development laboratories of SGS-THOMSON Microelectronics at Cornaredo, near Milan, Italy. He graduated with a degree in Electrical Technology at the Pacinotti Technical Institute, Venezia-Mestre, followed by a two-year postgraduate course in electronics at the Beltrami Institute, Milan. Mr. Murari holds 50 patents concerning IC design and technology and has contributed to the book "Power Integrated Circuits."

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PC GRAPHICS WATCH

A Look At Graphics And Related Standards

P.J. Stegen, Managing Director, VESA

The Video Electronics Standards Association (VESA) continues to create new standards for emerging technologies to enhance the display, interactive multimedia, and graphics fields. Under the organization's charter to set and support interface standards, six technical committees are actively producing and promoting technology standards worldwide.

A new workgroup has been added to the Software Systems Committee (SSC) known as the Video Firmware Interface (VFI). Chartered to develop a standard for the next-generation graphics interface, the workgroup's goal is to develop an interface standard for "bolt-on" VGA- or non-VGA-compatible video hardware to the system BIOS, and to develop an initialization, configuration, and power-management interface standard from the display hardware to the system BIOS or protected-mode operating system. This standard is in response to the growing concern expressed by manufacturers of graphics controllers and operating systems.

This latest development comes on the heels of the release of the VESA BIOS Extensions/Accelerator Functions (VBE/AF) standard that defines accelerator functions to allow a standard interface to the 2D accelerator functions found in most graphics controllers. These functions include BitBLT, color-space conversions, and hardware cursors. Other standards under development include the VBE Core 3.0 revision that provides stereo LCD shutterglass support, and VBE/Flat-Panel (FP), which standardizes the common interface to flat-panel controllers. The VBE/FP enables the development of applications using flat-panel controller ICs.

Progress continues at a rapid pace in the Flat Panel Display Interface (FPDI) Committee. The group's initial standard, FPDI-1, provides a standard connector type, standard signal names and timing, and power sequencing requirements. It also addresses 640-by-480-pixel (VGA) color STN-LCDs (single and dual scan), 800-by-600-pixel (SVGA) color STN-LCDs (dual scan only), and 640-by-480-pixel and 800-by-600-pixel TFT-LCDs with 9-, 12-, and 18-bit color.

The recently released FPDI-1B enhances FPDI-1 in describing the standard connector and pin positions for each panel type, and details the electrical, logical, and connector interface between flat-panel displays and display controllers in an integrated environment. It also covers VGA and SVGA addressability on color passive-matrix LCDs and dual-scan displays with 16 data lines.

The Flat Panel Display Measurements (FPDM) workgroup is set up to develop voluntary standards for the measurement of flat-panel displays and to give a clear focus to the development of accurate and practical display measurement procedures.

The VESA Plug and Display (P&D) committee should release its interface standard for direct-view and projection monitors early this year. The initial standard will define an efficient digital interface for a standalone fixed-pixel digital-video display. The committee's long-term goal is to define a standard for an efficient multipurpose digital interface for video displays and to have all P&D standards developed within an architectural framework that addresses near- and long-term compatibility.

The Monitor Committee's activities for the last year include passage of many key standards and establishment of a new workgroup to explore magnetic susceptibility issues with the utilities industry. The committee's list of industry-effective initiatives includes the Display Data Channel (DDC), version 2.0, which defines a communication channel between a computer display and the host. This channel can carry configuration information to allow optimum use of the display and also can carry display-control information. In addition, the channel can act as a data channel for Access.bus peripherals connected to the host through the display.

The Extended Display Identification Data (EDID) specification, which falls under the DDC, version 2.0, was approved last year and defines data formats to carry the display's configuration information. Discrete Monitor Timings (DDT), version 1.0, rounds out the display-centric trio and offers a set of timing standards for display monitors and covers resolutions from 640 by 350 to 1280 by 1024, and from 60 to 85 Hz.

Other proposals that have been produced include the VESA Unified Memory Architecture (VUMA) Standard released in March 1996. VUMA enables core logic chip set and VUMA device designers to design VUMA devices supporting the Unified Memory Architecture.

For more information about VESA, any of the associated standards, or any related issues, call the group at (408) 435-0333 or access their web site at http://www.vesa.org.

The Whys And Why Nots Of Designing A CDPD Modem

CDPD, A Wireless WAN Standard, Uses Existing Technology For Vertical Applications.

Carl Temme VLSI Technology Inc., 1109 McKay Dr., San Jose, CA 95131; (408) 922-5185.

In 1992, a group of U.S.-based companies demonstrated that the existing Advanced Mobile Phone Service (AMPS) cellular telephone infrastructure could support a reliable, high-speed packet-data-network overlay. Cellular carriers have now initiated deployment of this packet-data service, called Cellular Digital Packet Data (CDPD), and are currently offering commercial CDPD service in several markets.

CDPD is based on the internet protocol (IP) suite, and therefore provides a straightforward approach for wireless access to the internet. CDPD provides a method for notebook and Personal Digital Assistant (PDA) users to access e-mail and on-line services without the benefit of a wired telephone jack. Some vendors offer CDPD modems which can easily be used with notebook computers and PDAs.

The potential market for notebook- and PDA-oriented CDPD modems is large, but for the immediate future, the targeted application for CDPD may be in the vertical markets. These manufacturers integrate CDPD modems into products and utilize CDPD as part of a complete service strategy. Examples of vertical applications include point-of-sale (POS) data collection; fleet-management and dispatch; and telemetry for vending machines, utilities, and alarm systems. Designers of these types of devices currently are seeking efficient ways to integrate CDPD modem capability.

CDPD is a WAN standard that's designed to work with existing data networks. CDPD utilizes a high-speed, IP-based, wireless packet-data system that use idle channels on AMPS cellular systems to send packets of data. The basic elements of a CDPD system include the Mobile-End System (M-ES), the Mobile Data Base Station (MDBS), the Mobile Data Intermediate System (MD-IS), the Intermediate System (IS), and the Fixed-End System (F-ES) *(Fig. 1)*.

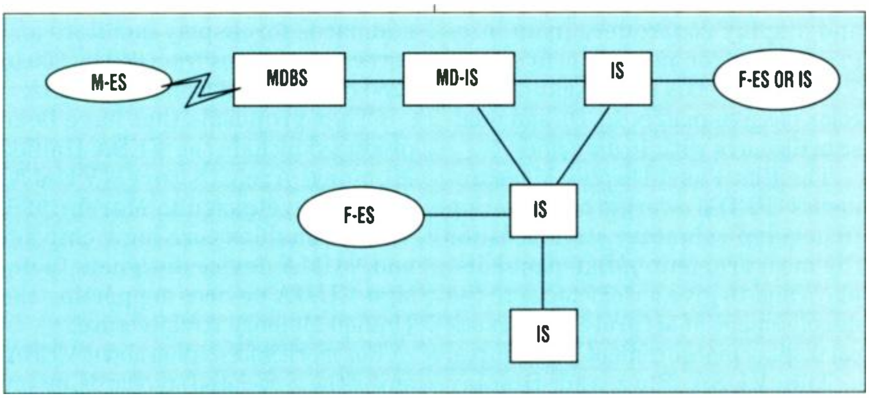
The M-ES is simply the term given to the CDPD wireless modem device. The MDBS is added to an AMPS cellular base station. The M-ES communicates wirelessly with the MDBS over the air interface using the CDPD airlink protocol. The MDBS serves as the interface between the RF data and land-line data networks.

The IS is a common router using standard network protocols (typically IP). The MD-IS is a specialized type of router that provides an interface between standard network protocols and the specialized protocols used in CDPD. The MD-IS enables a straightforward extension of an existing wired network into the wireless CDPD domain. The F-ES, in most cases, resides on a home-computer network, and is a host for wireless M-ES communication.

Physically, a CDPD modem typically comprises a baseband chip set and circuit, radio, and packaging. A power source and system interface may also be needed for implementation *(Fig. 2)*. A CDPD modem usually performs a number of processing tasks including airlink protocol, network and transport layer protocol, radio-resource management, application and system interface, and security processing.

The CDPD airlink protocol software comprises the following layers: physical, medium Access control (MAC), mobile data-link protocol (MDLP), and sub-network-dependent convergence protocol (SNDCP). The physical layer is concerned with defining RF characteristics such as center frequency, bandwidth, modulation, and power level, as well as interface primitives for controlling these parameters.

The MAC layer defines the procedures for synchronization, forward error correction (FEC), and access to the transmission medium. The MAC layer channel-access arbitration pro-



1. CDPD, a wireless WAN standard, typically consists of the Mobile-End System (M-ES), the Mobile Data Base Station (MDBS), the Mobile Data Intermediate System (MD-IS), the Intermediate System (IS), and the Fixed-End System (F-ES).

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cedure bears similarity to Ethernet. CDPD uses a technique called Digital Sense Multiple Access with Collision Detection (DSMA/CD) for arbitrating access to the channel.

MDLP defines the link-layer control procedures between the CDPD mobile modem (or M-ES) and the MD-IS, which is a specialized router for CDPD systems. MDLP performs functions such as sequencing control, flow, and error-rate in transfers of data units between the M-ES and the MD-IS. MDLP also handles special routing issues that arise in CDPD. These come as a result of the mobility of M-ESs.

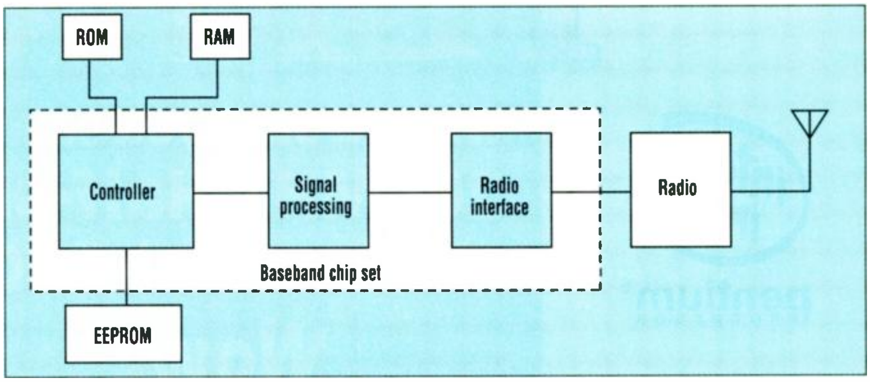
SNDCP defines the manner in which the CDPD airlink will interface with the network layer protocols (IP and CLNP). SNDCP also defines the operation of such procedures as segmenting and reassembling network-level packets, compressing network-level headers and data, allowing multiple network layer entities to share a single data link, and controlling subnetwork management functions such as security.

The functions of the radio resource manager are described in the CDPD System Specification, and have changed somewhat in the latest version (Release 1.1). The radio resource manager deals with functions such as acquiring a channel on power up, tuning the radio to particular RF channels in the event of a channel hop, and setting transmission power levels.

The nature and complexity of application software or system-interface software varies greatly depending on the application. Application software may execute on the CDPD modem's processor or on a host system's processor.

CDPD specifies security devices and procedures that are to be used across the airlink. These procedures include encryption, key-exchange, and authentication. The primary encryption algorithm used in CDPD is RSA's RC-4, but the specification also allows for the possibility of future algorithms.

To reduce cost and size, CDPD modems typically achieve integration using a two- to four-part chip set that performs protocol processing. Because physical-layer processing is required, the chip set includes either digital or analog signal processing. A microprocessor is typically used for control and data-manipulation. Chip sets may be based on general-purpose processors for which CDPD-specific software is written, standard fax/data modem chip sets modified for CDPD processing, or also chip sets specifically designed for CDPD products.



2. A block diagram for a conventional CDPD modem shows its components: a baseband chip set and circuit, a radio, packaging, a power source, and a system interface.

CDPD radios share several characteristics with AMPS cellular radios found in common cellular handsets. However, there are some significant differences between common AMPS and CDPD radios.

The data-transmission requirements of CDPD impose tighter specifications on differential group-delay distortion. CDPD radios use GMSK for digital keying of transmissions. CDPD radios must possess sufficient frequency agility to accommodate the frequency-hopping function that CDPD specifies. The CDPD specification allows for both half- and full-duplex radios.

Packaging requirements depend heavily on the application. CDPD modems have been packaged as PC peripherals, PC cards, and OEM card sets. In the future, as CDPD modems are increasingly integrated into alarm systems, hand-held terminals, point-of-sale terminals, traffic control devices, vehicles, and vending machines, a broader variety of packaging is expected. Typical packages may include specialized housings, batteries, solar cells, sensors, and transducers.

All of the significant elements of a CDPD modem must be realized as part of a "make or buy" decision. If the aforementioned elements are designed or purchased individually, a considerable integration effort is required. Certifications and tests are required for these individual elements as well as the complete CDPD modem.

For each of these elements and for the CDPD modem as a whole, the developer must consider the time, expense, and risk incurred by undertaking an in-house development. On the other hand, the developer also must consider the benefits of an in-house design effort, such as the freedom to tailor the design to the physical and electrical requirements of the project at hand, ability to control the future of the product, and opportunity to reduce recurring cost using in-house manufacturing.

Assuming a reasonable level of proficiency in the necessary disciplines, an effort to design all of the elements of a CDPD modem might involve ten or fifteen labor-years of effort. Fortunately, developers no longer need to design all of the elements. After a thorough market survey, developers will find that CDPD modem elements can be purchased in a variety of configurations.

The POS segment places higher importance on price and form-factor for a CDPD modem than on multimode communications and low power-consumption features. POS manufacturers need a CDPD modem design that's small and flexible enough to fit into their standard terminal housing. Most importantly, the modem cost must be low enough to prevent a significant rise in the cost of the terminal.

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Sipex Corporation, 22 Linnell Circle, Billerica, MA 01821 Tel. 508-667-8700 Fax 508-670-9001 straints may impel the POS manufacturer to keep the design in-house. Designing the modems in-house allows for a layout that will best fit into the space and have the specifications and interface characteristics required for the application. In addition, an in-house design provides for in-house manufacturing expertise and its resultant cost savings. On the other hand, design-resource, expense, risk, and time-to-market considerations could drive the POS manufacturer to consider outsourcing the design.

One possible solution for this example is VLSI Technology's Geode CDPD reference solution. The design is fully documented and tested for a CDPD modem with a feature set appropriate to the market (small form-factor, CDPD-only communication, low material cost).

Because the Geode reference design is fully certified, risk, time-to-market, and demand for design resources can all be reduced relative to those for an in-house design. And because the Geode design can be licensed, the POS manufacturer can use its manufacturing capability to further reduce the cost of the modem. The Geode reference solution can be modified, if necessary, to fit the constraints of the particular POS terminal.

If additional software running on the Geode microcontroller needs to be developed, a software development environment is available. Designers can employ the Geode microcontroller as the embedded controller for the POS terminal. In that case, the application software would run on top of the CDPD protocol task that executes on the Geode processor. Because the Geode software operates under a multithreaded, real-time operating-system kernal, adding more software tasks is typically a straightforward project.

Carl Temme is the CDPD Product Manager in VLSI Technology's Wireless Products Division. He holds a BS in Electrical and Computer Engineering from the University of California Davis and an MS in Engineering Management from Stanford University.

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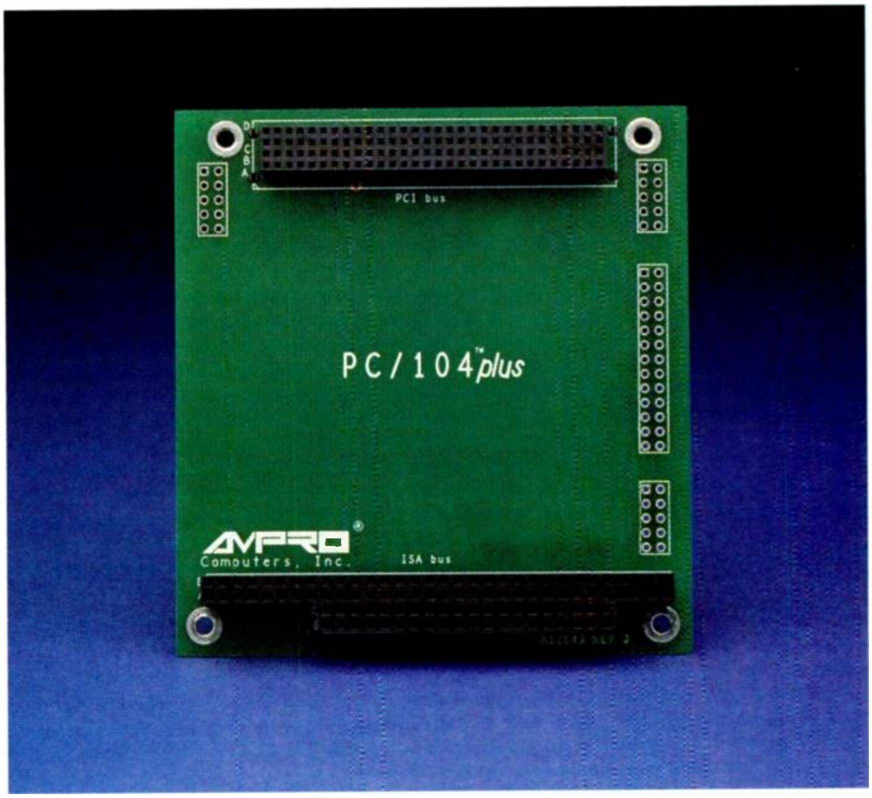
UPDATE ON BUSES

The PC/104 Spec Hops On The PCI Bus To Drive Higher Performance



Everybody wants to get connected to the PCI bus. First desktop manufacturers moved all their systems from the ISA bus to the PCI bus. Then high-end boards, like VMEbus, Futurebus+, and Multibus boards moved to PCI, using a variation called the PCI Mezzanine Card (PMC). The PMCs were electrically identically to desktop PCI cards, but altered in the physical connection. That was followed by Compact PCI, an industrial specification that's also identical electrically, but not mechanically. Now, we've got another PCI variant, called PC/104-Plus. This time the bus is part of the existing PC/104 specification, which is a self-stacking. 3.575- by 3.775-in. daughterboard module that connects directly onto a PC/104-equipped baseboard.

The original PC/104 modules typically handled low-bandwidth customized I/O, for things like graphics, networking, SCSI, and analog and digital I/O. For most of these applications, the 5-MHz speed specified for PC/104 was adequate. However, with more embedded designs taking advantage of the faster available processors, designers needed access to higher-bandwidth I/O devices. That's why PC/104-Plus was developed, as an extension to PC/104. PC/104-Plus currently runs at 33 MHz, with an upgrade path to 66 MHz.

The biggest differences between PC/104 and PC/104-Plus are the third connector that's needed to support the PCI bus; the changes to the component height requirements to increase the module's design flexibility; and the control logic that was added to handle the requirements of the high-speed bus.

The mechanical dimensions for PC/104-Plus are identical to what's specified for PC/104 with the exception of the added pin-and-socket connector (J3). The self-stacking 120-pin high-density (2-mm) PCI bus connector fits between the standard PC/104 mounting holes along the edge opposite the standard PC/104 bus *(see the figure)*. Each PC/104-Plus daughterboard module must maintain the J1 and J2 connectors to enable backward compatibility with the PC/104 (ISA) bus.

The component height on the top side was reduced from 0.435 to 0.345 in., but increased on the bottom side form 0.100 to 0.190 in. The spacing remains at 0.6 in. between stacked modules.

One challenge that had to be overcome in the design of PC/104-Plus dealt with PCI's slot-specific implementation (PC/104 and PC/104-Plus have no slots). The PCI specification contains four slot-specific IDs. On the PC/104-Plus bus, the IDs are assigned radially to the stacked modules. This is a flexible architecture because any module can have any slot ID. For example, the first module in the stack doesn't have to be "slot 0" as is the case in desktop implementations.

The PC/104-Plus standard allows for five stacked modules, four of which can be direct masters. This can be increased using bus-bridge chips, similar to what's done in desktop-based PCI.

Like the original standard, PC/104-Plus is an open, public standard. To handle the new standard, the existing PC/104 Consortium has formed a PCI Extensions Working Group. The new specification is available from Ampro Computers Inc., Sunnyvale, Calif., who authored it. The company can be reached at (408) 522-2100 or by e-mail at info@ampro.com. In addition, the PC/104 Consortium can be contacted at (415) 903-8304 or by e-mail at pc104@ix.netcom.com.

Ampro also offers a baseboard that's configured for PC/104-Plus. The Little Board/P5i holds a Pentium microprocessor and is suited for embedded applications that demand small size, low power consumption, and high functionality. In addition, a host of other companies have released products based on PC/104-Plus, including a frame grabber, a PC/104-Plus-to-PCI connector, and a full-motion color digital video-capture and display board.

RICHARD NASS

WHAT'S ON BOARD

Providing connectivity to the universal serial bus (USB), designers at CMD Technology Inc., Irvine, Calif., have released two ICs. The first chip, the USB0670, provides an interface between the USB and the host PCI bus used in most computers. The 100-lead package has two USB ports. It's a simple solution for designers wanting to add USB ports to a host system (desktop or portable PC, PDA or other computer-based hardware). Based on the OpenHCI specification, the chip allows two USB peripherals to connect to the host at data rates from a few kbits/s to 12 Mbits/s using asynchronous or isochronous transfers over the same set of wires. The chip operates from a 5- or a 3.3-V supply and can withstand "hot" insertion or removal of devices from the USB without system reboot. Flow-control for buffer handling is built into the chip's protocol architecture, and error-handling and fault-recovery are also embedded in the USB chips. CMD also offers driver software for DOS, Windows 3.1, Windows 95, Windows NT, OS/2, Novell, and SCO Unix. In small lots, the chip sells for $6.75; a board-level version using the USB0670 also is available for $59 (unit quantity). The second chip is the industry's first USB controller for keyboards—the USB0678KMp. It can directly replace the traditional PS/2 style interface. Also able to implement virtual-hub capability, the controller allows PS/2-type pointing devices to be plugged into the keyboard, eliminating the need for a serial or PS/2 port to connect non-USB products—mouse, trackball, or touchpad, for example. Selling for just $4.95 in sample quantities, the controller achieves low cost thanks to its use of the low-speed back-channel USB mode to reduce system complexity. Samples are available now. Contact Fred Theil, (714) 470-3172.

A dual-boot PowerPC-based reference platform motherboard, dubbed Yellowknife, can boot the Macintosh OS, Windows NT, and other operating systems. Developed by Motorola Inc., Austin, Texas, the platform will actually be built and sold to developers in complete system form by Alaris Inc., Fremont, Calif. A simple four-layer pc board in the ATX motherboard form-factor, Yellowknife can support PowerPC microprocessors with clock speeds to 240 MHz (internal) and on-board bus speeds of 66 MHz. The reference design includes a PCI-bus bridge/memory controller, a PCI-ISA bridge circuit, a Super I/O chip for ports and storage control (serial, parallel, IDE, and floppy-disk), and the Apple Hydra I/O controller to provide the Macintosh hardware support for ADB, SCSI, and other interfaces. In addition to the IDE port supplied by the Super I/O chip, the motherboard supports the SCSI channel used by most PowerMacs, allowing developers to employ either or both drive interfaces. The reference board also includes a secondary cache of 256 or 512 kbytes, andmain-memory addressing of up to 128 Mbytes. Two ISA slots and three PCI expansion connectors also are on the motherboard so that features such as video and Ethernet controllers, and a modem, can be added to configure and test the system. Contact Motorola at (512) 434-1502 or on the web at www.mot.com/PowerPC/, and Alaris at (510) 770-5700 or on the web at www.alaris.com.

Pushing CD-ROM systems to new performance levels, designers at Mitsumi Electronics Corp., Irving, Texas, have developed the first 16X CD-ROM drive with an enhanced IDE interface. The drive has a data-transfer rate of 2400 kbytes/s and employs a combination of CLV and CAV operating modes to vary the spin rate for maximum performance and reliability. Also offering an average access time of just 120 ms, the drive's performance is comparable to some early hard-disk drives. A 256-kbyte buffer is included and firmware provides full plug-and-play compatibility with operating systems such as Windows 95 and OS/2 Warp. The drive also supports new CD standards such as CD-extra, CD-plus, and CD-I, and is MPC-3 compliant. It will initially retail for $249 and will be available to both retail and OEM customers in the first quarter. Contact John Antonchick, (408) 970-0700.

VME Board Holds 200-MHz Pentium Pro

The power of a Pentium Pro microprocessor now resides on the VMEbus, thanks to the VMIVME-7686 CPU board. The board's processor ranges in speed from 180 to 200 MHz. The VME interface is based on a PCI-to-VME controller from Tundra Semiconductor. The fast and wide UltraSCSI 2 controller supports devices up to 40 Mbytes/s. The DEC 21142 Ethernet controller can operate as 10Base-T, 10Base-2, or 100Based-TX. A front-panel USB connection works with peripherals up to 12 Mbits/s. Up to 64 Mbytes of DRAM can be accessed. Support is available for Windows NT, VxWorks, and LynxOS. Available immediately, the VMIVME-7686 sells for $5842 to $9995, depending on configuration.

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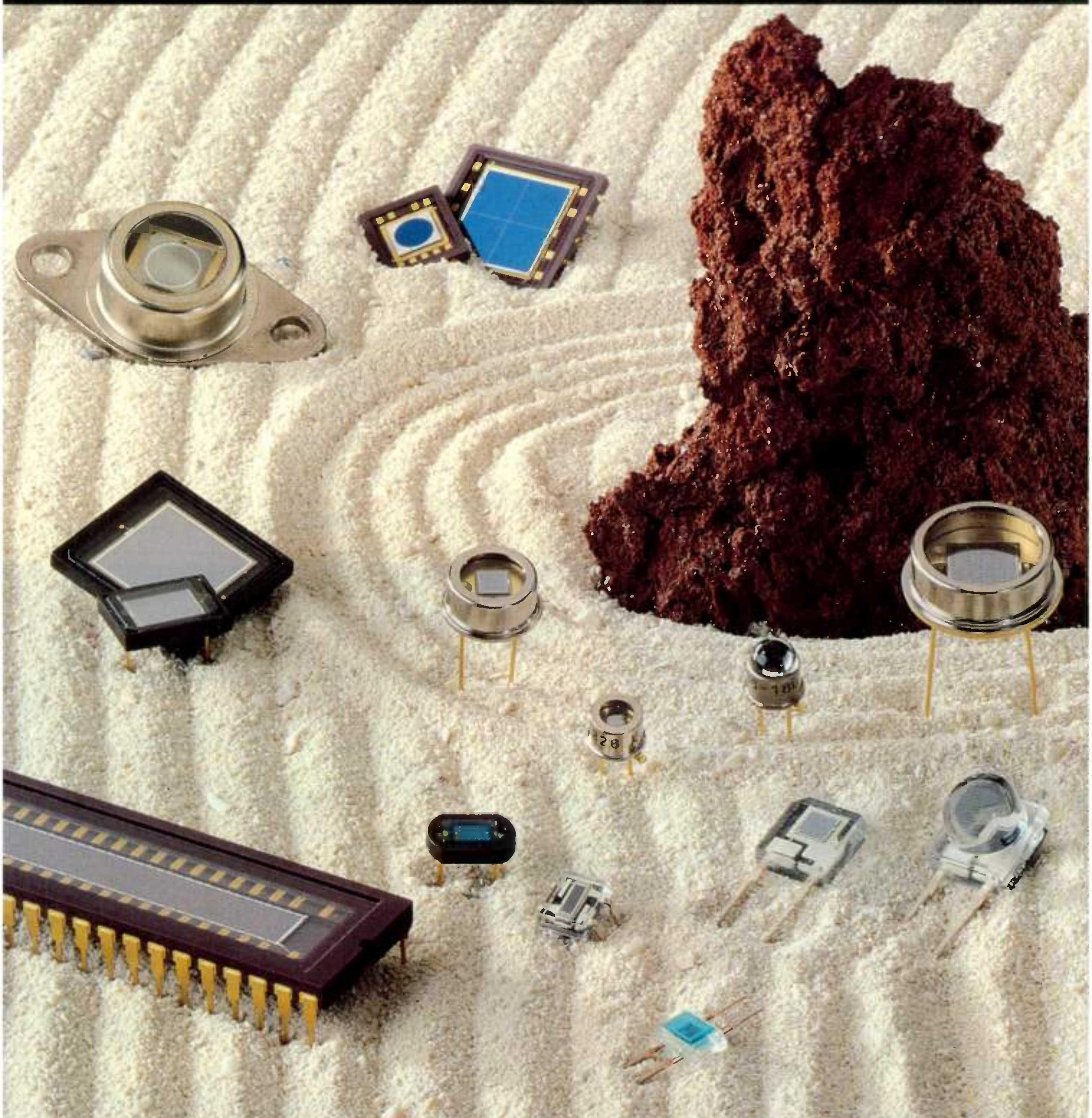

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READER SERVICE 187

Graphics Accelerator Works With 3D Titles

True arcade-quality graphics are possible using the Righteous 3D graphics accelerator board. It offers full-motion full-screen 3D graphics on a PC. It also has a pass-through mode that's transparent with 2D adapters. Righteous 3D has dual 64-bit memory using up to 4 Mbytes of EDO RAM on the PCI bus. Designed for Windows 95, it has plug-and-play operation and supports Microsoft's Direct3D API. It includes perspective correction and texture mapping, bilinear and advanced filtered textures, double, triple, and Z buffering, alpha blending, and texture animation and modulation. Bundled with a slew of 3D-enhanced games, it costs $299 and is available now.

Orchid Technology
221 Warren Ave.
Fremont, CA 94539
(800) 577-0977 or
(510) 651-2300
Internet: http://www.orchid.com
CIRCLE 630

Software Eases USB Integration

As the Universal Serial Bus (USB) comes closer to being a "real" shipping product, vendors continue to release USB-related components. USB is a 12-Mbit/s serial channel that connects such devices as keyboards, mice, scanners, and modems to the PC. One enabling product is the USB Software Suite, which is a family of standard and customized system-level firmware, device drivers, and user control applications. The suite is designed to enable PC peripheral manufacturers to support USB. Specifically, the suite consists of USB-interface and device-specific firmware, host device drivers, and a series of utilities. The software is now available and is already being bundled into systems.

SystemSoft Corp.
2 Vision Dr.
Natick, MA 01760
(508) 651-0088
Internet: http://www.systemsoft.com
CIRCLE 631

Link-Layer IC Simplifies 1394 Designs

Designers of consumer electronics and computer peripherals will find it easier to integrate a 1394 interface using the TSB12LV31 link-layer chip. The general-purpose part offers an 8- or 16-bit interface, and operates at 3.3 V. The part supports both asynchronous and isochronous data transmissions and offers an 8- or 16-bit microcontroller interface, making it compatible with a broad selection of standard microcontrollers and digital-signal processors. An internal 200-byte FIFO memory helps facilitate operations. Depending on the application, the FIFO can be logically partitioned into two memory spaces. Housed in a 100-pin PQFP, the chip sells for $9.72 each, in lots of 1000.

Texas Instruments Inc.
Semiconductor Group.
P.O. Box 172228
Denver, CO 80217
(800) 477-8924, ext. 4500
Internet: http://www.ti.com
CIRCLE 632

Drive Controller Conforms To Ultra DMA Standard

The design goal of the AIC-8381 disk-drive controller was to help drive designers stay ahead of their customers' demands, with minimal firmware changes. The AIC-8381 can transfer data across the IDE bus using the Ultra DMA standard. The part offers the functionality needed for video applications where it is acceptable to release an uncorrectable sector to the host. When this bit is set, the hardware will attempt correction. Another feature is that it won't release sectors until all bytes are written to the disk. It generates a release signal to the buffer memory only after the disk sequencer has executed the Reset Write Gate instruction. This helps ensure that the write has written all of the data and error-correction codes (ECC).

Adaptec Inc.
691 South Milpitas Blvd.
Milpitas, CA 95035
(408) 945-8600.
CIRCLE 633

6U VME CPU Board Handles PC Functions

Only one VMEbus slot is required for the DPC1 Pentium-based processor board. The 6U board is built with a Triton II chip set that offers PCI bridging, plus cache and DRAM control. Besides standard PC I/O and mass-storage connections, the DPC1 has a flat-panel interface, 100Base-TX Ethernet, and fast and wide SCSI-2. One PMC-module slot offers extra expansion. Flash memory is accessed by a secondary IDE interface. Flash drives mount on-board for densities up to 60 Mbytes. The BIOS can select the flash drive as a bootable device, suitable for embedded systems. For development systems, a single-slot transition module supports IDE hard-disk and floppy drives, and connectors for parallel, serial, and SCSI ports. Large-volume prices start at $3150.

Dynatem
23263 Madero, Suite C
Mission Viejo, CA 92691
(714) 770-3481
CIRCLE 634

Pentium SBCs Combine ISA With PCI

Pentium processor speeds from 75 to 200 MHz can be accommodated by the P5000HX and PV5000HX industrialized single-board computers. ISA and PCI performance is enhanced through the use of the Intel 430HX chip set. The boards improve reliability and data integrity by supplying high-level integrated ECC memory. The P5000HX features on-board interfaces for 16-bit PCI-based fast and wide SCSI and enhanced IDE devices. The PV5000HX features an on-board PCI interface for 8-bit SCSI-2 devices. The boards' BIOS offers a setup utility that automatically updates configuration information. The P5000HX costs from $1655 to $2695; the PV5000HX runs from $1295 to $2795.

Texas Microsystems Inc.
5959 Corporate Dr.
Houston, TX 77242
(800) 627-8700 or
(713) 541-8200
CIRCLE 635

Microcontrollers Ease USB Integration

The Universal Serial Bus (USB) offers a way to connect relatively low-speed peripherals in a convenient manner. Such devices could include keyboards, mice, and joysticks. A family of controllers simplify the design and development of USB peripherals and hub products. The microcontroller family includes the FT8U24AM, aimed at conventional input products; the FT8U64AM, which is suited for applications that combine the USB peripheral interface with USB hub functionality; and the FT8H64 U7, targeted at stand-alone hubs.

The FT8U24AM incorporates a USB interface, a dual-system timer, 15 I/O pins, and a 4-kbyte mask ROM in a 24-pin SOL package. The FT8U64AM holds the USB interface, a dual-system timer, 29 I/O pins, three down-stream USB hub ports, and a 4-kbyte mask ROM, all in a 64-pin PQFP package.

Finally, the FT8H64A7 includes seven down-stream USB hub ports with power control, over-current detectors, and status-activity indicators. It's also housed in a 64-pin PQFP.

In quantities of 10,000 pieces, the FT8U24AM IC costs $2.95 each, the FT8U64AM chip costs $3.65 each, and the FT8H64A7 device costs $3.95 each.

Future Technology Devices International Ltd.
St. George's Studios
93/97 St. George's Rd.
Glasgow, G3 6JA
Scotland, UK
(44) 141-353-2565
CIRCLE 636

UltraSCSI Drives Double Capacity

Up to 9.1 Gbytes of information can be stored on the Tomahawk 3.5-in. disk drive. What further differentiates the disk drive from other products is its UltraSCSI interface, which offers a 40-Mbyte/s data-transfer rate. The interface is backward compatible with previous generations of SCSI. The disk-drive's 7200-rpm rotation speed combines with a 512-kbyte multi-segmented cache buffer to provide an impressive access time of just 7.9 ms.

Other features include magneto-resistive read/write heads and PRML read channels with digital filtering. An ID-less header format increases storage capacity by about 10%. On-the-fly error correction ensures data integrity and maximum performance. The drive's mean time between failure is rated at one million hours.

Available immediately, the Tomahawk 9.1-Gbyte drive sells for $2900. A 4.55-Gbyte model costs $1630.

Micropolis Inc.
21211 Nordhoff St.
Chatsworth, CA 91311
(818) 709-3300
CIRCLE 637

3.0-in. Disk Drive Stores Up To 1.6 Gbytes

It's bigger than a 2.5, yet not as big as a 3.5. It's the 3.0-in. disk drive, which is starting to become fashionable. That's because it can be produced as thin as a 2.5-in. model, but can hold lots more data. For example, the N1080-2AR Nordic drive is just 10.5 mm high, yet stores 1.08 Gbytes. Two other models in the family, the N1620-3AR and N1440-3AR, measure 12.5 mm high, and store 1.6 and 1.4 Gbytes, respectively. Notebook computer designers are currently more concerned with Z height, rather than the X and Y dimensions, the niche that's filled by the 3.0-in drive. The Nordic family doesn't sacrifice performance. It features a seek time of less than 14 ms, a 128-kbyte cache buffer, and a transfer rate of 16.6 Mbytes/s. the drives can withstand 350-g shocks.

JTS Corp.
166 Baypointe Pkwy.
San Jose, CA 95134
(408) 468-1800
CIRCLE 638

CD-ROM Drives Spin At 12X The Standard Speed

The XM-5701B and XM-5702B drives have upped the ante in disk-drive speeds from 8X to 12X the standard speed. The difference between the two comes in the interface—the 5701B ships with a SCSI-2 interface, while the 5702S connects to Enhanced IDE (AT-API). The drives feature a 115-ms average random seek time and a 125-ms average random access time. Sustained data-transfer rate is 1.8 Mbytes/s, a performance improvement resulting from the use of a 256-kbyte cache buffer. Both drives are compatible with most industry standards. Available now, the XM-5701B is priced at $195, while the XM-5702B sells for $165.

Toshiba America Information Systems Inc.
Disk Products Div.
9740 Irvine Blvd.
Irvine, CA 92618
(714) 457-0777
Internet: http://www.toshiba.com
CIRCLE 639

VME Board Holds 200-MHz Pentium Pro

The power of a Pentium Pro processor now resides on the VMEbus, thanks to the VMIVME-7686 CPU board. The board's processor ranges in speed from 180 to 200 MHz. The VME interface is based on a PCI-to-VME controller from Tundra Semiconductor. The fast and wide UltraSCSI 2 controller supports devices up to 40 Mbytes/s. The DEC 21142 Ethernet controller can operate as 10Base-T, 10Base-2, or 100Based-TX. A front-panel USB connection works with peripherals up to 12 Mbits/s. Up to 64 Mbytes of DRAM can be accessed. Support is available for Windows NT, VxWorks, and LynxOS. Available now,, the VMIVME-7686 costs $5842 to $9995, depending on configuration.

VME Microsystems International Corp.
12090 S. Memorial Pkwy.
Huntsville, AL 35803
(800) 322-3616 or
(205) 880-0444
CIRCLE 640

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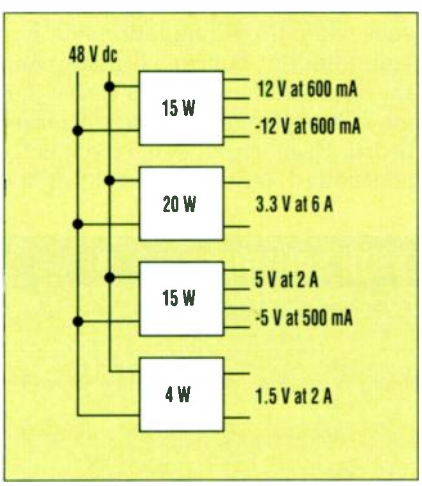
POWER CONVERTIBLES™

How Many Isolated Dc-Dc Converters Do You Really Need?

By replacing them with ISRs, designers can make significant gains in space, cost, reliability, and performance.

BRIAN NARVESON
Power Trends Inc., 27715 Diehl Rd., Warrenville, IL 60555; (630) 393-6901; fax (630) 393-6902.

The days of a 5-V logic standard are waning. A printed-circuit board assembly that contains the latest-generation processors or ASICs requires multiple voltages just to power the logic. It is common for an assembly to require 5 V for standard logic and interfacing, 3.3 V or 2.9 V for the processor or ASICs, and 1.2 to 2.5 V for bus termination. This arrangement is usually accompanied by the need for ±12 or –5 V for communications circuits. In computers or telecommunications systems where dc power-bus isolation is a necessity for each circuit board, this means using multiple, large, and costly isolated dc-dc modules. In those instances where space is at a premium, a custom multiple-output module often is developed. With the introduction of 5-V input, nonisolated integrated switching regulators (ISRs), only one 5-V isolated dc-dc module will be needed. Some of the advantages of ISRs are greater flexibility, lower cost, reduced time-to-market, increased reliability, improved product performance, and more board space.

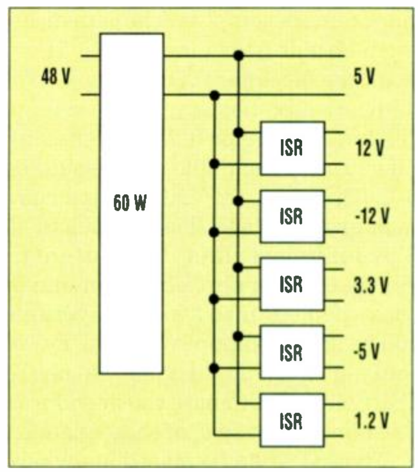


1. A typical solution for deriving the myriad voltages needed for a system board requires the use of many large and costly isolated dc-dc converters.

A typical power design challenge for a communications or computer board is to derive from a 48- or 24-V bus the following voltages: 5 V at 1 to 3 A for interface logic; 3.3 V at 4 to 10 A for processor(s) or ASICs; 1.5 V at 1.5 A for bus termination; ±12 V at 600 mA each for analog interfacing; and –5 V at 500 mA for communications. As a result, a system capable of delivering upwards of 50 W is required. A typical solution uses off the shelf isolated dc-dc modules *(Fig. 1)*.

An innovative design alternative utilizes the new 5-V input ISRs powered by a single isolated dc-dc module *(Fig. 2)*. The single isolated module is sized at 60 W to provide the additional power required to compensate for the loss in overall efficiency due to the double conversion. Both solutions should be used with power-sequencing logic to ensure orderly startup of the applications circuits, and reduce in-rush currents.

Due to the low power required in each ISR, the turn-on circuit for this design alternative can be a single FET per ISR, driven by a logic circuit. The higher-power ISR (3.3 V at 6 A) has an on/off control input that eliminates the need for a FET. This design alternative provides many benefits, including lower cost, higher performance, increased reliability, and faster time-to-market.



2. An innovative design alternative to multiple dc-dc converters uses the new 5-V input ISRs powered by a single isolated dc-dc module to save on cost and space while improving performance and reliability.

Cost

While features and performance are essential to every power-system design, the primary concern of every designer is lowering overall cost. The relative cost difference of each power module design alternative, using distributor pricing and assuming an annual quantity of 5000, is shown *(Table 1)*. High-volume pricing would be considerably lower for both solutions. In addition, consideration must be given to the cost of the pc board and necessary support circuitry.

At the operating voltages of 3.3 V and below, the resistive voltage drop and parasitic conductor inductance in the power path become major concerns. These situations usually necessitate using separate power planes in the pc board, unless the modules can be placed as close as possible to the load. The most common design practice when using isolated dc-dc modules is to place them as close to the input connector as possible to avoid routing the 48-V dc supply around the board.

This design helps maintain isolation from the supply without dedicating a circuit board layer to it. However, the designer is then required to dedicate a pc-board plane to each of the low-voltage or high-current supplies. In this example, that would be 5 V, 3.3 V, and 1.2 V all using a common ground plane. The ±12 V and –5 V would most likely be routed directly to the point of use on one of these planes, or to a signal layer due to the small amount of circuitry requiring these potentials. The use of ISRs should eliminate the need for at least one, if not two, of these planes.

The ISRs can be placed anywhere on the pc board without concern about maintaining isolation between the input traces and the rest of the circuit, allowing a single circuit layer to be utilized for multiple voltages. In this example, the 3.3- and 1.2-V ISRs can be placed at their point of use, and a local voltage plane established on a single layer. This strategy eliminates the cost of a pc-board layer with an estimated cost of $0.20/in^2$. The cost savings for a large 15 by 12-in. board would total up to $36. This type of cost savings can be achieved if the ISRs are carefully placed.

In addition, there is the potential to save cost on support circuitry. If in-rush current protection is needed for hot-plug operation, the ISR solution requires a single circuit for the one isolated dc-dc module instead of the four required for the multiple isolated dc-dc solution. An estimated cost of $3 for each in-rush protection circuit would result in a $9 cost saving. If overvoltage protection, fusing, or other safety circuitry on the input supply of each isolated module is required, an additional saving of up to $2 per isolated module, or $6, is possible *(Table 2)*.

Placing an ISR as close to the load as possible will reduce the designer's need to worry about issues such as regulation, noise generation and pickup, and dynamic response.

Performance

Point-of-use power, where the power module is within inches of the load, has increased with each generation of low-voltage (less than 3.3 V) processors. The latest-generation processors require delivering a tightly regulated, low voltage at high currents. Some processors and bus transceivers require that the supply voltage be maintained within ±100 mV of nominal under all conditions, including transient response. With current slew rates of 1 A/ns and load changes of 5 A or more, even 10 mΩ of resistance and a few nH of inductance can cause the supply voltage delivered to the processor to be out of specification. It is virtually impossible to develop the processor's voltage at any distance from it and still meet requirements. Small amounts of resistance can cause voltage drops that are significant in this new low-voltage world. That 10 mΩ of resistance in both the supply and return paths of a 3.3-V processor can significantly erode the tolerance margin.

This small amount of resistance can come from connectors, wiring, pc-board traces, and sockets. With the processor drawing 5 A at 3.3 V, 50 mV is lost in each leg of the supply wiring. The voltage delivered to the processor is only 3.2 V. This voltage may be right on the edge of proper operation, allowing nothing for transient response and noise. Placing an ISR as close to the load as possible will reduce the designer's need to worry about issues such as regulation, noise generation and pickup, and dynamic response.

Using an ISR for each output voltage eliminates cross-regulation issues while providing fault isolation. Independent current limiting and thermal shutdown prevent most single failures from disabling the entire board. Each output is independently controlled, leaving the rest of the

TABLE 1: COMPARISON OF COST AND BOARD AREA FOR BOTH SOLUTIONS

Multiple Isolated Modules (see Fig. 1)			Single Isolated with ISRs (See Fig. 2)		
Module	Cost	Area (in.^{2})	Module	Cost	Area (in.^{2})
15 W +/- 5 V	$40	7.5	60 W single, 5 V @ 12 A	$50	11.25
15 W +/- 12	$40	7.5	5 to 3.3 V	$23	0.62
20 W, 3.3 V	$38	6.8	5 to 12 V	$8.90	0.54
4 W, 1.5 V	$21	1.7	5 to -12 V	$8.90	0.54
			5 to 1.2 V	$12	0.76
			5 to -5 V	$8.90	0.54
Total	$139	23.5	Total	$111.70	14.25

TABLE 2: POTENTIAL SAVINGS ON A 15- BY 12-IN. BOARD

Power modules	$27.30
PC-board layer	$36.00
Inrush protection	$9.00
Safety protection	$6.00
Total savings	**$78.30**

system operational in the event of a single fault. The one exception is a failure on the 5-V rail.

The fundamental design of an ISR uses fewer and smaller magnetic elements, which provides the better transient performance required by high-performance digital circuits and processors. Most ISRs operate at switching frequencies greater than 500 kHz which gives them superior transient response and small size.

Electromagnetic interference (EMI), both conducted and radiated, also is a major concern. Since EMI is directly proportional to the input voltage, multiple ISRs with a 5-V input will generate less radiation than multiple dc-dc modules with a 48-V input. The high frequencies at which ISRs operate make it easy to reduce conducted interference with small ceramic capacitors. Additional attenuation can be obtained with small inductors or ferrite beads. The high switching frequency allows these parts to be small, surface-mounted components.

Another performance issue of concern in some multivoltage systems is that processors and mixed-signal logic devices have a requirement that the difference between the 5-V supply rail and the 3.3-V (V_{DD}) supply rail cannot exceed 4.0 V at any time during power startup. The use of independent isolated modules makes the tracking of these two voltages very difficult. Each will come up independently, allowing the supply rails to possibly exceed the 4.0-V difference.

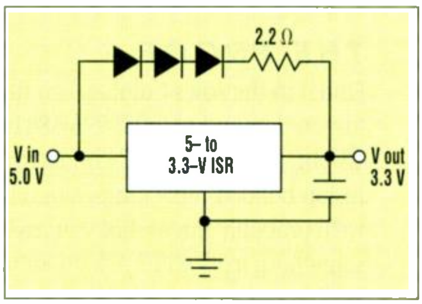
In addition, the designer can guarantee the difference specification will not be exceeded by using a 5- to 3.3-V ISR powered from the 5-V rail (*Fig. 3*). On power-up, the diodes become forward biased, forcing V_{DD} to track the 5-V rail up to 2.1 V. Once the ISR reaches its rated output voltage, the diodes become reverse biased, preventing any power dissipation in the series diode string. If the supply voltage is a value other than 5.0 V, and the output voltage is a value other than 3.3 V, then the diode chain also must be recalculated to maintain the difference at less than 4 V. This implementation is not possible with the all-isolated architecture because the isolation barrier would not be maintained.

Size

Space is an extremely important consideration in power system designs. Even in this age of custom very large scale integration, the circuitry required for the functionality of a board assembly usually demands all available space, leaving the power designer scrambling for every square inch. Because ISRs require fewer components to implement, allowing greater flexibility in packaging, they have a significantly smaller footprint. Table 1 compares the board space required for the two system design alternatives. From the table, it can be seen that the ISR solution requires only 60% of the space required by the all isolated module solution. Dimensions are taken from catalog data sheets for products from leading industry suppliers.

Flexibility

Flexibility, especially with respect to voltage and current output, but also in their packaging design, is a key feature of ISRs. Individual ISRs can be replaced with units of different voltage or current ratings, without necessitating a pc-board layout change. If current demand increases, a simple module swap may be all that is necessary. For designs where the required current is undetermined due to the rough estimates provided by the custom silicon providers, many ISRs can provide space-efficient modular solutions. Board space can be allocated so ISRs can be paralleled, then added or removed as necessary. Due to the small footprint, minimum extra board space is necessary in order to realize significant cost savings as current requirements decrease with future spins of silicon. Only the 5-V isolated module must be sized for anticipated demand.



3. Circuitry can be added to multivoltage systems to ensure compliance with requirements that the potential difference between the 5-V supply rail and the 3.3-V supply rail does not exceed 4.0 V at any time during power-up.

This flexibility in operating voltage is becoming more important as silicon suppliers develop devices with operating voltages that do not necessarily conform to prior iterations. Some processors need a different voltage for each performance grade. Many ISRs address this problem with an adjustability over an output range greater than the ±10% available with standard isolated modules.

When laying out a board, a designer can place ISRs close to the load for improved performance and more flexibility. Because the ISRs require little board area they can be placed in small open areas on the board near the functional load without having to clear a major area.

Packaged as a single in-line package module, ISRs can be configured for vertical through-hole (minimum board area), horizontal through-hole (minimum vertical height), or surface mounting. Some manufactures also provide optional heat tabs for thermal management and mechanical mounting.

Reliability

Reliability in a power system using a single isolated supply with multiple ISRs will be inherently greater than that of multiple isolated dc-dc modules, due to the lower number of components required to execute ISR designs. The typical ISR design is a buck or buck-boost topology which contains about 15 components versus 40 for an isolated dc-dc module of sim-

ilar power rating. In the example given, the all-isolated design would have a total parts count of 160 components. The single isolated design with five ISRs would have a total parts count of 115 components.

Because the ISRs are single-output devices, the power dissipated in each package is lower, resulting in lower component temperatures—provided that sufficient air flow is maintained. The total power dissipated is slightly higher for the ISR design solution due to the decrease in efficiency resulting from the double conversion. The increased dissipation is offset by improved thermal management because each ISR dissipates less power and can be located at the point of use. Spreading the heat sources around the board reduces the temperature of each regulator below what it would be if they were clustered together. The combination of fewer components running at lower temperatures could result in a reliability improvement of 25 to 50%.

Time-to-market also can be decreased thanks to the flexibility and performance advantages of the ISR solution. ISRs are stocked at leading distributors, providing quick availability for design qualification or last minute changes. They are fully qualified standard products with application data for everything from EMI performance to transient response. The design risk, qualification time, and overall time-to-market is greatly reduced.

Brian Narveson is vice-president of Engineering at Power Trends.. Prior to joining Power Trends, he was director of Engineering at Teradyne's Telecom Test Division and R&D manager for the Electronics group at Navistar. Mr. Narveson holds a BSEE from Iowa State University and is a member of the IEEE.

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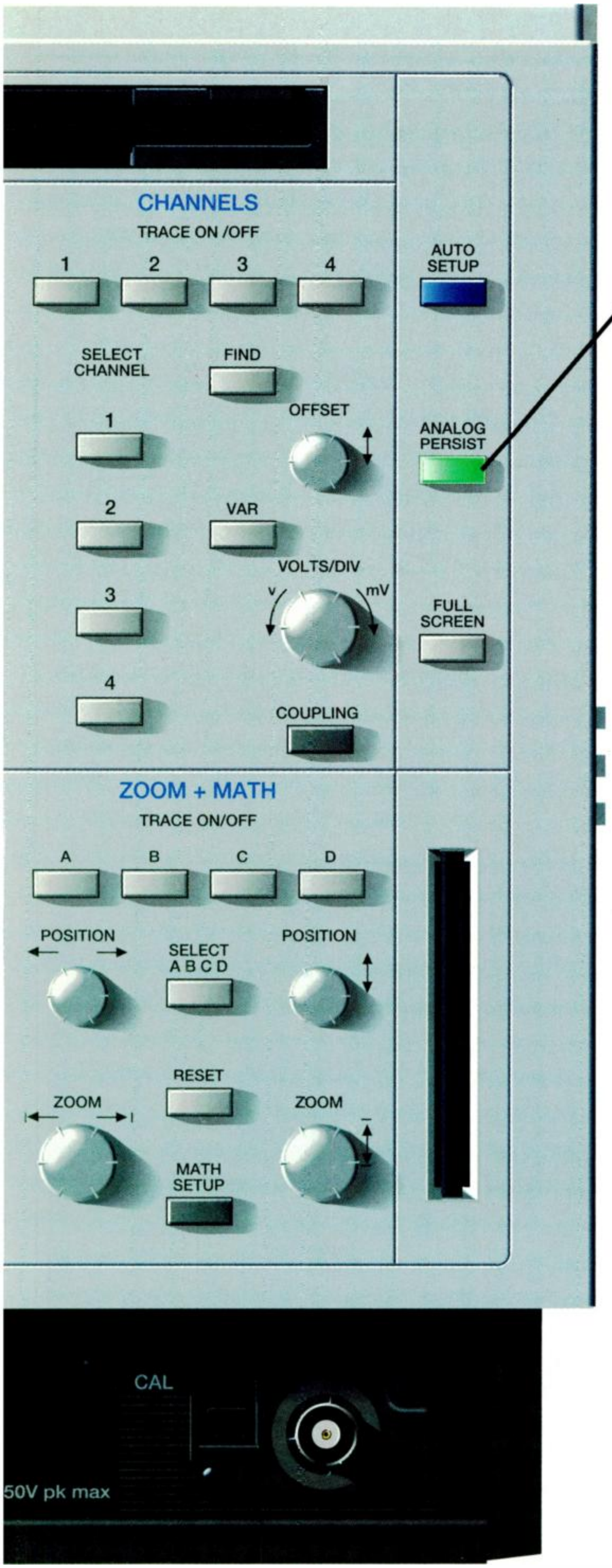
3. Lindman, P., Thorsell, L., "Applying Distributed Power Modules in Telecom Systems," Applied Power and Electronics Conference, 1994.

MANUFACTURERS OF DC TO DC CONVERTERS

Manufacturer	Output power range (W)	Number of outputs	Input voltage range (V dc)	Output voltage range (V dc)	Output current range (A)	Output ripple and noise	Line and load regulation	Power density (W/in^3)	Isolation voltage	EMI/RFI shielding
Absopulse Electronics Ltd. Carp, Ontario, Canada Nanno Habets (613) 836-3511 absinfo@absopulse.com http://www.absopulse.com CIRCLE 660	50 to 10,000	1 to 5	12 to 260	12 to 260	0 to 100	Less than 1 % of V out	+/- 0.5 % over input range	–	500 V (min)	Yes
Behlman Electronics Hauppauge, NY Helenanne LaBau (516) 435-0410, ext. 197 sales@behlman.com CIRCLE 661	100 to 30,000	Custom (as many as required)	5 to 300 V, dc or ac	3 to 25,000	Up to 125	0.1 %	0.5 %	N/A	1 kV	Yes
Brandt Electronics Inc. Mountain View, CA Joe Churchill (415) 967-4944, ext.15 Fax (415) 967-9105 CIRCLE 662	8000	15	9 to 270	2.5 to 250	400	10 to 250 mV	+/- 1 % (typ)	15	500 to 1000 V	Yes
Computer Products South Boston, MA Janell Kasmer (617) 350-5100 http://www.computerpro-ducts.com CIRCLE 663	0.5 to 300	One, two, or three	9 to 75	3.3 to 48 (typ)	0.033 to 48	75 mVp-p (typ)	0.01 to 2.5 % and 0.05 to 2.5 %, respectively	Up to 54	To 1500 V	Yes
Conversion Devices Inc. Brockton, MA Hanlan Vatchelder (508) 559-0880 CIRCLE 664	1 to 500	1 to 3	5 to 300	2 to 385	0.033 to 60	Less than 1 % (typ)	0.2 to 1 % (typ)	Up to 90	500 to 1500 V	Yes
Conversion Equipment Corp. Orange, CA Roy Allman (714) 637-2970, ext. 121 Fax (714) 637-8654 CIRCLE 665	250 to 1500	Typically 5	18 to 72	2 to 48 with +/- 5% adj.	1 to 120	50 mVp-p or 1 % (whichever is greater)	+/- 0.5 % for both	4	All high-potted at 3000 V ac	Optional
Converter Concepts Inc. Pardeeville, WI Lisa Siegle (608) 429-300 http://www.convertercon-cepts.com CIRCLE 666	10 to 350	One to four	10 to 60 V dc and 85 to 264 V ac	5 to 48	0 to 16	2 % (max)	1 % (max)	3	0 to 4000 V ac	Yes
Digital Power Fremont, CA Forrest Sass (510) 462-5280 Fax (510) 484-1981 CIRCLE 667	50 to 750	One to four	12 to 300 (nominal)	3.3 to 48	1.6 to 150	1 % p-p	0.2 %, +/- 3 %	2.8 to 4.6	1500 V ac, 2100 V dc	Yes
EG&G Electro-Optics Covina, CA Stephen Schwarzmann (818) 967-9521 sschwarzmann@egginc.com http://www.egginc.com/electro-optics CIRCLE 668	Up to 125	One, two, or three. Custom outputs available	10 to 440	5 to 40 with one output	3.1to 25 with one output	2 %	0.5 %	Up to 30	Input to output and to chassis, 1 µA @ 750 V dc	–
Gamma High Voltage Research Inc. Ormond Beach, FL Don Galluzzo (904) 677-7070 Fax (904) 677-3039 CIRCLE 669	mWto 1000k	Two to three	6 to 48	100 to 125,000	0.0001 to 1.0	0.001 to 10 %	0.001 to 10 %	1	500 V dc	Yes
HC Power Inc. Irvine, CA Jack Graham (714) 261-2200 Fax (714) 261-6584 CIRCLE 670	1000 to 1500	One to four	42 to 58	2 to 48	0 to 300	1 % or 50 mV, whichever is greater	0.2 % over full input range and +/- 0.2 no load to full load	3.3	Meets IEEE 472	Yes



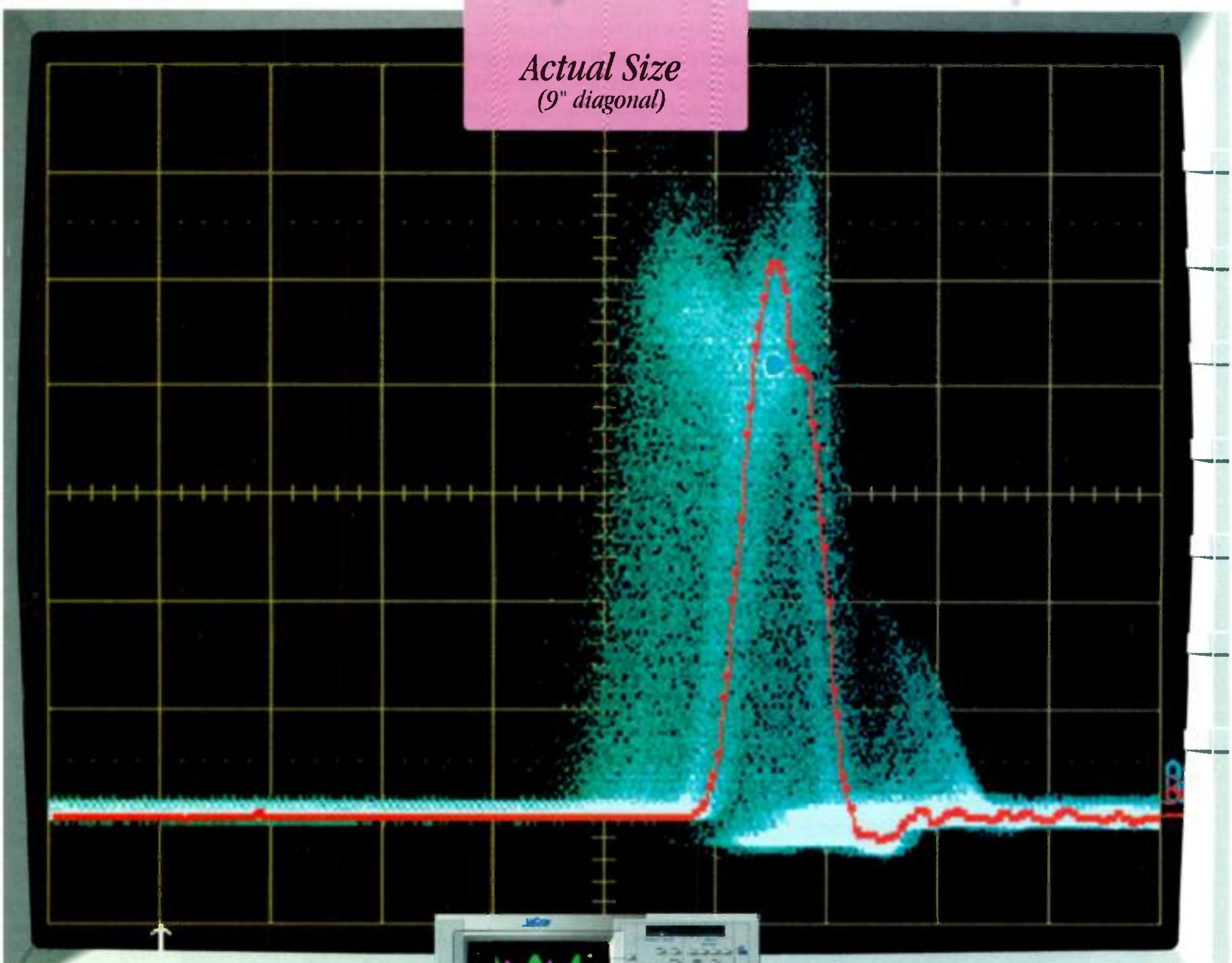
When You Hit This Button, You'd Better Be Standing Back

POWER

MANUFACTURERS OF DC TO DC CONVERTERS

Manufacturer	Output power range(W)	Number of outputs	Input voltage range (V dc)	Output voltage range (V dc)	Output current range (A)	Output ripple and noise	Line and load regulation	Power density (W/in[3])	Isolation voltage	EMI/RFI shieldng
International Power Sources, Inc. Ashland, CA Jack Swartz (508) 881-7434 http://www.intlpower.com CIRCLE 671	1 to 240	1 to 4	4.5 to 400	3.3 to 48	0.030 to 40	50 mV to 150 mV	From 0.3/0.5 % to 1.0/1.0 %	Up to 30	500 to 3000 V dc	Yes
KGS Electronics Arcadia, CA Linda Beltran (818) 574-1175 kgselec@aol.com http://www.kgselectronics.com CIRCLE 672	10 to 600	One to four	12 to 48	5 to 28	1 to 30	25 mVp-p	2 % for both	8	–	Yes
Lambda Electronics Inc. Melville, NY Michael Wagner (516) 694-4200 lambda.mk@ix.netcom.com http://www.lambdapower.com CIRCLE 673	0.5 to 600	One, two, or three	4.5 to 75	2 to 48 and +/- 12 and +/- 15	0.5 to 120	50 mVp-p	+/- 0.4 % and +/- 0.8 % (typ)	From 62	1500 V dc	Yes
Melcher Inc. Chelmsford, MA Larry Goldberg (888) Melcher info@melcher-power.com http://www.melcher-power.com CIRCLE 674	1 to 720	One to three	???	0 to 50	<1 to 25	1 % (typ)	1 % (typ)	N/A	Up to 7000 V dc	Yes
Modular Devices Inc. Shirley, NY Sales (516) 345-3100 Fax (516) 345-3106 CIRCLE 675	4 to 80	One to six	8 to 335	2 to 100	0.010 to 15	50 mVp-p (typ)	10 mV and 20 mV (typ)	Up to 50	500 V dc	Yes, plus MIL-STD 461C and EMI filtering
Pioneer Magnetics Inc. Santa Monica, CA Param Panesar (310) 998-5628 Fax (310) 453-3929 CIRCLE 676	500 to 6000	Up to 11	38 to 150 /264 V ac	2 to 48	7.5 to 600	Less than 1 %	+/- 0.25 %	5 to 10	–	Yes
Powercube Chatsworth, CA Shree Ramadas (818) 734-6500 shrram@aol.com CIRCLE 677	75 to 500	One	24 to 300	3.3 to 28	4.5 to 50	1 % typical, 3 % max	0.5 % typical, 0.2 % max	Up to 90	3000 Vrms input to output	Yes
Power General Canton, MA C. Welsch (617) 830-1104 cwelsch@nidecpg.com CIRCLE 678	1 to 500	One to four	5 to 72	2.0 to 48	0.4 to 90	50 to 100 mVp-p, max	0.3 to 5.0 %	1.5 to 18	500 to 1500 V dc	Yes
Power Solutions Inc. Pompano Beach, FL Ron Koslow (516) 484-6689 ronk@powersolutions.com http://www.powersolutions.com CIRCLE 679	1 to 300	One to four	9 to 72	2.2 to 48	Up to 50	1 % p-p or 20 mVp-p to 1 %p-p max	+/- 0.2 to 0.5 % typical, and +/-0.5 to 3 % typical	Up to 15	500 dc	Yes
R.O. Associates Inc. Sunnyvale, CA Wayne Niederjohn (408) 794-1450 wniederjohn@roassoc.com http://www.roassoc.com CIRCLE 680	50 to 250	One to three	18 to 400	2.1 to 28	3 to 60	1 to 3 %p-p, 60 dB	0.02 to 0.2 %for both	Up to 58	1000 to 4500 V dc, input to output	Yes
SGS Thomson Microelectronics Lincoln, MA Sales (617) 259-0300 http://www.st.com CIRCLE 681	1 to 300	1 to 3	4 to 72	3 to 48	0.1 to 60	5 mVrms/30 mVp-p	5 mV/5 mV	1.5 to 29.5	Up to 10,000 Vrms	Yes
STC Keltec Operation Ft. Walton Beach, FL Didier Juges (904) 244-0043 jugesd@keltec.sigtech.com http://www.sigtech.com CIRCLE 682	25 to 1000	One to eight	28 to 270	3 to 48	1 to 100	25 mV	0.5 %	Up to 40	500	Yes

Introducing The New Color DSO Family From LeCroy



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- **Transparent Display Mode** allows you to clearly differentiate overlaid signals. Overlap area is shown in a unique color and managed dynamically as waveforms are updated.

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http://www.lecroy.com

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READER SERVICE 208

3-A Monolithic Synchronous Battery Switcher Achieves 96% Efficiency

Designed for portable systems, the LM2650 is a monolithic, synchronous step-down switching regulator with a 3-A output and a peak efficiency of over 96.5%. The device comes in a SO-24 package and uses the company's LMDMOS 300 B process to allow the integration of a controller and a MOSFET on a single die. The chip's design eliminates the need for a current-sense resistor, a Schottky diode, and several ESR capacitors, thus saving on both cost and board space.

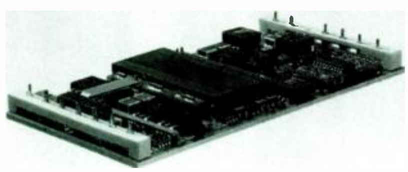
The LM2560 accepts 4- to 18-V inputs, offers adjustable 1.23- to 16-V outputs, and provides more than 90 % typical efficiency over the 15-mA to 3-A load range. An automatic sleep mode maintains efficiency even under light load conditions. On-chip protection includes thermal shutdown, current limiting, and programmable Soft Start to limit current surges at startup and to simplify sequencing of multiple power supplies. Pricing is $4.38 each in quantities of 1000.

National Semiconductor Corp.
2900 Semiconductor Drive
Santa Clara, CA 95052-8090
(800) 272-9959
Internet: http://www.national.com
CIRCLE 693

PATRICK MANNION

100-W Dc-Dc Converters Are 90% Efficient

The RM Series of dc-dc converters provide efficiencies of 90% at 5 V and 100 W. The converters require no



heatsink, measure 8-mm high, come in 30- and 50-W versions, and feature hot-plug capability, EMI filtering, and built-in in-rush limiting. No life-limiting electrolytic or tantalum capacitors are used. The operating temperature range is -40° to 85°C. Pricing is from $105 each in 100-unit quantities and delivery is from stock.

Lambda Electronics Inc.
515 Broad Hollow Rd.
Melville, NY 11747
(516) 694-4200
fax (516) 694-4200
CIRCLE 694

60-W Dc-Dc Converters Are Stable And Quiet

The HD1-60 and HD3-60 series of dc-dc converters can handle thermal cycling of -60° to 130°C with simultaneous 60 G rms vibration. EMI filters are built in. The 3 by 3 by 0.86-in. units are available as single- and triple -output supplies with input voltage ranges of 20 to 60 V or 36 to 75 V. The single-output model provides 5 V at 12 A while the triple-output model provides 5 V at 9.6 A and a choice of ± 12 or ± 15-V auxiliary outputs. Latching overvoltage protection, undervoltage lockout, and over-current and short-circuit protection are provided. Pricing is: Single output, $78; triple output, $85.50 each in 1000-lot quantities. Delivery is eight weeks ARO.

Power General
152 Will Dr.
Canton, MA 02021
(617) 828-6216
power@nidecpg.com
CIRCLE 695

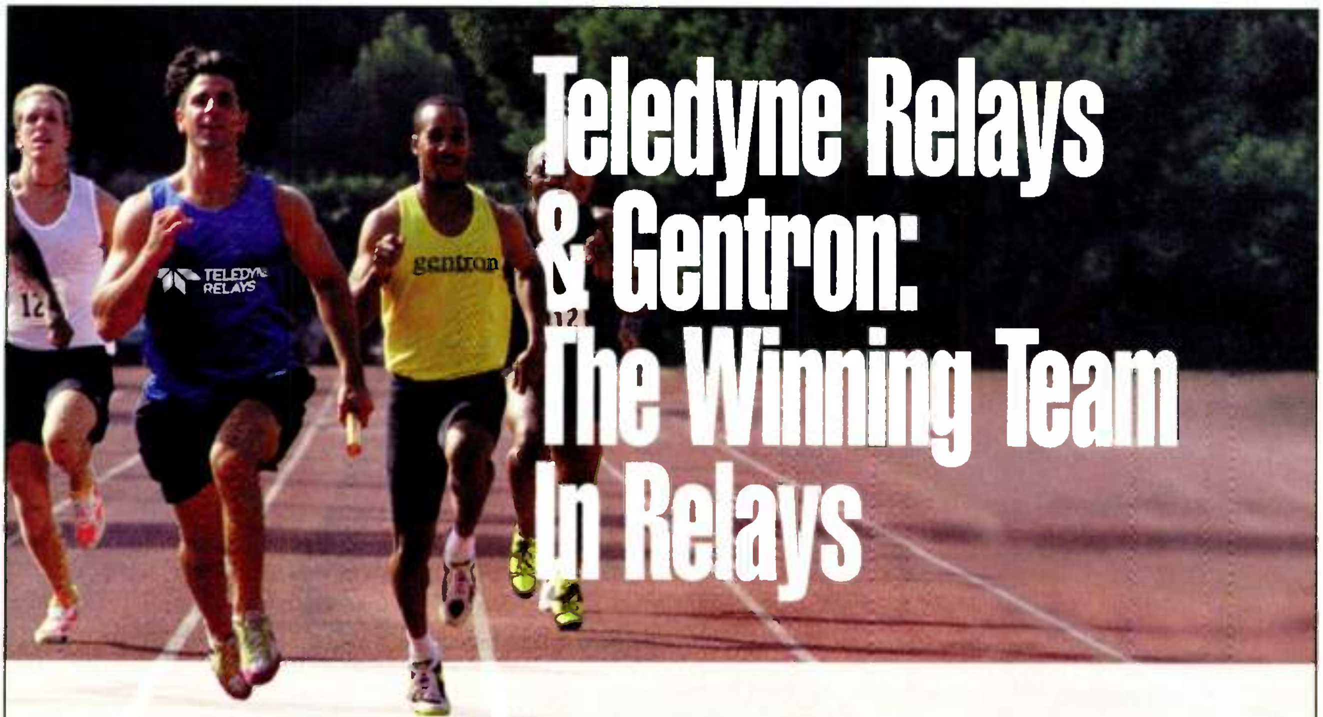
Ac Power Source Is Low Cost

The 1001P and 1251P ac power supplies deliver 1000 VA and 1250 VA, respectively, with any combination of utility voltage and frequency. Features include continuously variable voltage (0 to 135 V or 0 to 270 V) and frequency (16 to 500 Hz), current measurement (0.1-A resolution), current limit, and an RS-232C interface for SCPI control. Pricing is: 1001P, $2950; 1251P, $3450; RS-232C interface, $250. Delivery is from stock.

California Instruments
9025 Balboa Ave.
San Diego, CA 92123
(619) 279-8620
http://www.calinst.com
CIRCLE 696

MANUFACTURERS OF DC TO DC CONVERTERS

Manufacturer	Output power range (W)	Number of outputs	Input voltage range (V dc)	Output voltage range (V dc)	Output current range (A)	Output ripple and noise	Line and load regulation	Power density (W/in^3)	Isolation voltage	EMI/RFI shielding
Schaefer Inc. Ashland, MA Sue Gillogly (508) 881-7330 Fax (508) 879-8669 CIRCLE 683	50 to 2500	Up to four	10 to 900	4.5 to 400	0.25 to 220	Less than or equal to 1 %, 30 mVp-p	0.1 %, 2.0 % (typ)	N/A	Up to 3.5 kV dc	Yes
Sierra West Power Systems Inc. Las Cruces, NM John Camilliere (505) 522-8828 Fax (505) 522-8766 CIRCLE 684	1 to 10,000	One to 10	5 to 400	2 to 1000	0.001 to 500	10 mV to 1 V dc	0.01 %, 1 %	1 to 30	500 to 1500	Yes
Switching Power Inc. Ronkonkoma, NY John Bellone (516) 981-7231 sales@switchpwr.com http://switchpwr.com CIRCLE 685	100 to 4000	One to five	24 to 128	2 to 48	0 to 350	1 %	1 %	5	4242	Yes



Teledyne Relays & Gentron: The Winning Team In Relays

With razor sharp technology and the most innovative product line in the industry, Teledyne Relays has always been a winner. Now, with the acquisition of Gentron Corporation, Teledyne Relays wins more relay events.

The Gentron solid state relay product line immediately expands Teledyne Relays' offering from milliamps up to a whopping 1000 amps and 1600 volts. Gentron-developed proprietary designs are used in these products. The Fused CopperTM process reduces thermal resistance, making for improved performance and thermal management, when switching high currents. Some models are available with the Trans Ax TM transient "killer" that withstands transient voltages up to 6000 volts.

For SSR applications in process & industrial controls, motor controls, theatrical lighting, commercial heating & air conditioning and more — just call Teledyne Relays. Now! With the addition of Gentron you can get the right relay from the winning team.

TELEDYNE RELAYS
GENTRON PRODUCTS

TELEDYNE RELAYS
12525 DAPHNE AVENUE • HAWTHORNE, CALIFORNIA 90250 • Ph 800.2.Teledyne • Fax 213.779.9161 • http://www.teledynerelays.com

GENTRON
7345 ACOMA DRIVE UNIT 101 • SCOTTSDALE, AZ. 85260 • PH 800.Gentron • FAX: 602.443.1408 • http://www.gentron.com

READER SERVICE 199

High-Power Converters Provide Flexibility

The BXB100 series of dc-dc converters are offered as high-power devices that allow designers flexibility when specifying for a new or replacement design. The converters measure 2.40 by 2.28 by 0.50 in., have an MTBF of greater than three million hours, and meet UL, CSA, and VDE EN 60950 agency standards. Pricing is $109 each in 1000-unit lots.

Computer Products
Power Conversion
7 Elkins St.
South Boston, MA 02127
(800) 733-9288
fax (617) 464-6679
CIRCLE 699

Dc-Dc Converters Pack Up To 84 W/in.^{3}

The MOR Series of 120-W dc-dc converters measure 1.5 by 3 by 0.4 in. to provide a power density of up to 84 W/in.^{3}. Other models are available down to 100 W. Designed for military

and aerospace applications, the converters come in single and dual models with output configurations of 3.3, 5, 9.5, 12, 15, ± 5, ± 9.5, ± 12, and ± 15 V. The output trim range is from 60% to 105% of output power.

Package options include tab case and end flange case styles with straight, upleaded, or downleaded options. Efficiency is rated at 87%, the input ripple current is less than 30 mV p-p, and the output ripple voltage is 30 mV p-p. Protection includes transient, indefinite short circuit, and low-voltage lockout. Pricing is from $840.

Interpoint
10301 Willows Rd.
P.O. Box 97005
Redmond, WA 98073-9705
(800) 822-8782
fax (206) 869-7402
CIRCLE 700

Single-Chip Dc-Dc Converter Offers High Efficiency

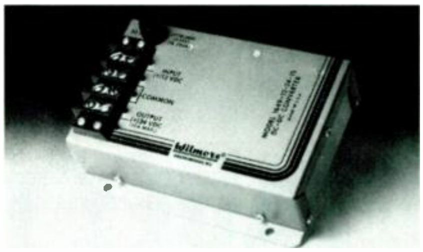
Targeted for use in cordless and cellular phones, the TEA1204t is a single-chip dc-dc converter with a peak output power of 8 W and a conver-

sion efficiency of greater than 95%. The device uses closed-loop output regulation and provides all necessary power-switching FETs on chip. Only two low-value reservoir capacitors, a small inductor, and a medium-power Schottky diode are required. The device comes in an 8-lead SO package and incorporates on-chip overcurrent and overtemperature protection.

Philips Semiconductors
PO Box 218
5600 MD Eindhoven
The Netherlands
Tinus Ramaekers 31 40 272 20 91
fax 31 40 272 48 25
CIRCLE 701

Dc-Dc Converter Targets Mobile 12-V Dc Applications

The Model 1649-12-24-15 dc-dc converter is designed to power 24-V dc equipment from standard 12-V dc vehicular electrical systems. The converter provides up to 15 A on an intermittent-duty basis, and up to 10 A continuously. The device is housed in



a corrosion-resistant aluminum enclosure and measures 1.9 by 4.5 by 6.9 in. Efficiency is better than 90% and the operating temperature range is -30° to 60°C. Protection is provided against load short circuits and input-polarity reversal. The converter is priced at $150 and delivery is from stock.

Wilmore Electronics Co. Inc.
PO Box 1329
5600 MD Eindhoven
Hillsborough, NC 27278
J.L. Harris (919) 732-9351
fax (919) 732-9359
CIRCLE 702

Low-Profile Inductors Save Space On Dc-Dc Converters

The P0144 and P0153 are low-profile self-leaded surface-mount inductors for dc-dc power conversion where real estate is at a premium. The devices have a maximum height of 0.215 in. and come

with nominal inductance ranges of 10.4 to 470 mH at dc current ratings of between 3.8 and 0.58 A. The devices meet UL94 VO ratings, have an operating temperature range of 30° to 130°C, and are surface mount, pick and placeable. Pricing is $1 each in 10,000-unit lots and delivery is from stock.

Pulse
1220 World Trade Drive
San Diego, CA 92128
Richard Hull, (619) 674-8173
richardhull@pulseeng.com
http://www.pulseeng.com
CIRCLE 703

"We Need A Device That Can Find A Needle In A Haystack, Fits In Your Back Pocket, And Retails Under $9.95. Could We See A Prototype Next Week?"

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ED9701

READER SERVICE 97

Resettable Fuse Combines Both Overtemperature And Overcurrent Protection

The result of advances in conductive polymer composites, the PolySwitch VTP210 resettable fuse combines overtemperature and overcurrent protection for NiCd, NiMH, lithium, and other battery technologies. The device also has a low impedance to help extend battery run-time in computers, telephones, and other equipment.

Although existing PolySwitch devices provide overcurrent protection, overtemperature protection has been limited at low currents as they do not trip until the ambient temperature exceeds 100°C. This is well above the 90°C design threshold achieved by thermal fuses. Therefore, thermal fuses have been combined with PolySwitch devices to achieve both modes of protection. The VTP device trips with low currents at ambient temperatures between 60° and 70°C, thus providing improved thermal and current protection, while eliminating the need for a thermal fuse in many batteries.

The VTP210 has a minimum hold current of 2.1 A, a maximum trip current of 5.1 A, and maximum initial resistance of 0.030Ω. With an overcurrent of 10 A at an ambient temperature of 20°C, a typical time to trip is 3 seconds and maximum time is 5 seconds. Available form factors include axial leaded, long lead, and one-slit lead. Pricing is from $0.40, depending on quantity, and lead time is four weeks.

Raychem Corp.
300 Constitution Dr., M/S 110/7568
Menlo Park, CA 94025-1164
(800) 227-7040
CIRCLE 710
PATRICK MANNION

Potentiometer Uses Proprietary Technology For Position Sensing In Rugged Applications

Based on Spectrol's Silver-in-Glass technology, the Finite Position Potentiometer (FPP) is claimed to have an operating life that exceeds 25 million cycles in dirtyor harsh environments, at temperatures up to 200°C. In addition, the device's high firing temperature during manufacture makes the cermet resistance element inherently stable over a wide temperature range.

The FPP is designed for industrial applications, and in particular the automotive market where future responsibility for warranting emission components for up to 150,000 miles has coincided with the drive for efficiency. As a result, the demand has increased for sensors with longer life and higher temperature tolerance. The FPP thus replaces what the company considers to be unreliable and expensive noncontact sensor technologies.

The device comprises a Silver-in-Glass matrix wiping surface with individual contact bars skewed so that the hoe-shaped contacts are always in contact with the resistance element in the series of voltage taps. As the contact moves, either one or two contact bars are engaged at any time, providing a clean and solid "staircase" voltage output. The number of bars can be increased for finer output resolution, but the output will always be a series of finite positions. Pricing starts at $8 each in quantities of 1000.

Spectrol Electronics Corp.
4051 Greystone Dr.
Ontario, CA
(909) 923-3313, ext. 111
CIRCLE 711
PATRICK MANNION

Domed LEDS Have High Output

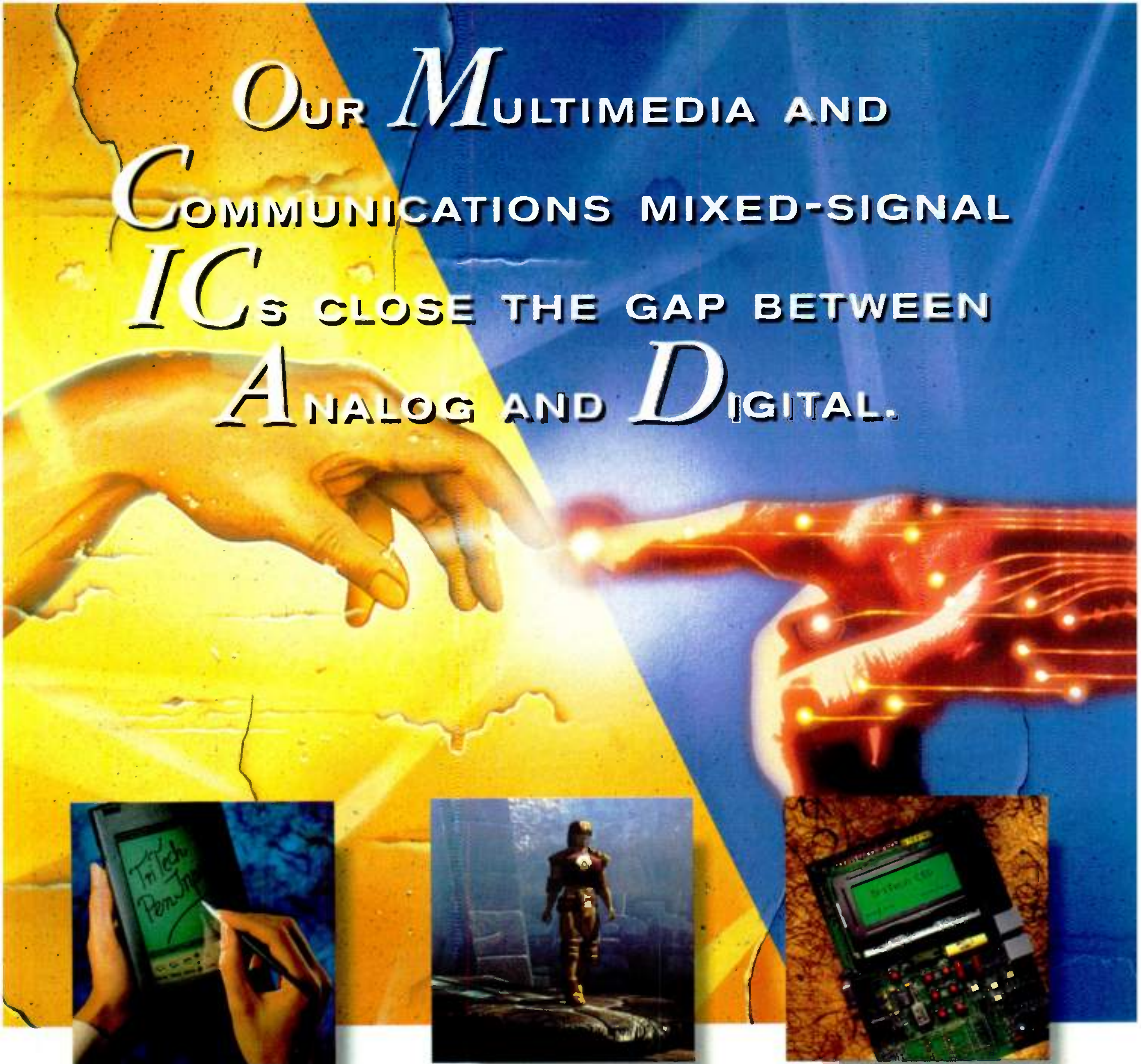
Comprising of seven colors, from red (GaAlAs), through orange (InGaAlP), to pure green (GaP), the AND5 Series of round-domed LEDs measure 3.2 (L) by 2.4 (W) by 2.5 (H)-mm and come in a range of intensities from 12 to 450 mcd. Requiring 10 mA of current, the devices use a 2-mm transparent plastic molded domed lens and can withstand surface-mount soldering. Alternatively, the devices can be hand soldered. Pricing is from $0.24 to $0.45 each in quantities of 10,000, and delivery is from stock.

Purdy Electronics Corp.
720 Palomar Ave.
Sunnyvale, CA 94086
Bill Otsuka (408) 523-8210;
fax (408) 733-1287
CIRCLE 712

Molded Tantalum Caps Have Small Footprint

Part of Sprague's 293D series of molded tantalum-chip capacitors, the "R" case (0805) size devices are available in a range of capacitance from 0.10mF to 6.8mF. Measuring 0.80 by 0.050 by 0.047 in., the capacitors target PCMCIA and hearing-aid applications. All types in the 293D series have standard tolerances of +/- 20 % and +/-10 % and are compatible with high-volume automatic packaging equipment. Pricing for a typical device in the 293D series, with a B case and a value 10mF at 16 V, is $0.080 each in 100,000-unit quantities. Delivery is stock to six weeks.

Sprague
678 Main St.
Sanford, ME 04073
Spencer Simons (207) 490-7224
FlashFax: (800) 487-9437, doc.#2409
http://www.vishay.com
CIRCLE 713



PEN INPUT

3D GRAPHICS

CALLER ID

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TriTech Microelectronics

A Member of Singapore Technologies

READER SERVICE 227

Optocoupler Replaces TLP 251 For Control

The HCPL-3150 is a drop-in replacement for the Toshiba 251 gate-drive optocoupler. The device is optimized for variable-speed ac motor-control and power-inverter applications using IGBTs or MOSFETs at ratings of up to 1200 V and 50 A. Features include a common-mode rejection of 15 kV/ms (minimum), a low-level output voltage of 0.5 V, a minimum output current of 0.5 A, a maximum supply current of 5 mA, and an operating temperature range of -40° to 100°C. The device comes with under-voltage lockout, over- and under-current protection, and isboth UL1577, CSA, and VDE0884 approved. Pricing is from $1.40 ea/10,000 and delivery is from stock.

Hewlett-Packard Co.
5301 Stevens Creek Blvd.,
P.O. Box 58059
Santa Clara, CA 95052-8059
(800) 537-7715 ext.2113
http://www.hp.com
CIRCLE 714

Ceramic Capacitors Suit RF Applications

Claimed to feature ESR and Q performance similar to porcelain capacitors, but at lower cost, this series of NPO multilayer ceramic chip capacitors specifically target RF applications. The capacitors come in values from 0.5 to 1000 pF and in several case sizes, including 0603, 0805, and 1210. Voltage ratings are from 100 to 500 V dc, depending on capacitance. Pricing ranges from $0.10 to $0.20 each in 100,000-unit quantities, and delivery is from stock to eight weeks.

Johanson Technology
931 Via Alondra
Camarillo, CA 93012
Steve Cole; (603) 433-6328
fax (603) 433-6329
CIRCLE 715

Low-Cost Resistor Is Heatsink Mountable

The MP925 is one of three TO-220-style, heatsink-mountable resistors. Rated at 25 W at 25°C, the 100-kW resistor has a tolerance of 1% and a voltage rating of up to 500 V. Two other versions are the 0.010-W MP916 and the 0.020-W to 4.99-kW MP930. These are rated at 16 W and 30 W, respectively.

Caddock Electronics, Inc.
1717 Chicago Ave.
Riverside, CA 92507-2364
(909) 788-1700
fax (909) 369-1151
CIRCLE 716

Accelerometers Have Integral Electronics

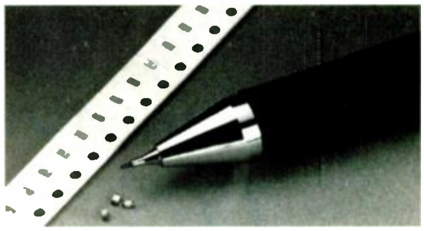
The 751 and 752 are low-cost lightweight accelerometers with integral electronics. Designed to measure vi-

bration on small structures, the devices have a resolution of 500 mg and a bandwidth that is flat to 15 kHz. The hermetically sealed devices are based on the company's Piezite Type P-8 crystal element, come in a titanium alloy case, and weigh 7.8 g. The 751 has a side connector, while the 752 has a top connector—both are available with 10- or 100-mV/g sensitivity. Pricing is $300 each in quantity.

Endevco Corp.
30700 Rancho Viejo Rd.
San Juan Capistrano, CA 92675
Anthony Chu; (800) 982-6732
fax (714) 661-7231
CIRCLE 717

Multilayer Chip Inductor Handles High Current

The LL1608-FH Series of multilayer chip inductors are claimed to have up to three times the current-handling capability of standard multilayers and come with typical Qs of over 35 at 800 MHz. Targeting high-frequency RF and wireless applications, the devices use the company's laminated ceramic material, allowing self-resonant frequencies of over 6 GHz. The devices are available in inductance values ranging from 1.2 to 100 nH, with tolerances of 5 or 10%. Packaging is tape-and-reel in

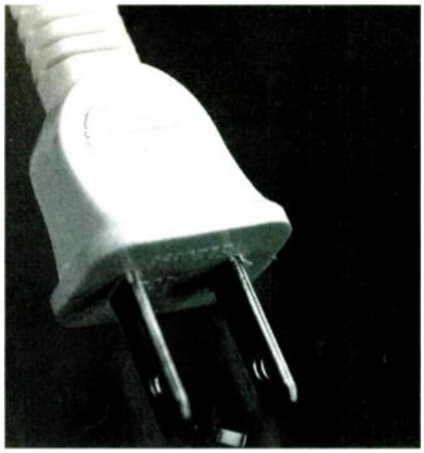


quantities of 4000 per reel. Prototyping kits are available.

Toko America Inc.
1250 Feehanville Dr.
Mount Prospect, IL 60056
(800) PIK-TOKO
fax (847) 699-7864
CIRCLE 718

SMD Fuse Targets 125-V Applications

The 3216LV chip fuse is intended for 125-V applications. Measuring 3.2 by 1.6 by 0.9 mm, the fuse complies with EIA package standard SOCM-3216



and uses various combinations of thick and thin metal film on a ceramic substrate with a fused glass coating. Thick-film end terminations are plated with nickel and tin-lead, and comply with EIA-576 terminal adhesion and solder leach resistance requirements. Available current ratings are 250 mA, 375 mA, 500 mA, 750 mA, and 1 A. The devices are UL and CSA recognized and meet EIA PN-3737 standards. Pricing is $0.22 each in high volume.

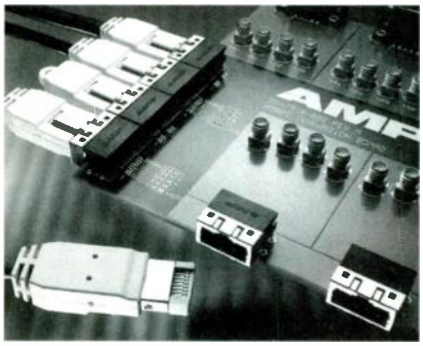
Cooper Industries
Bussmann Div.
P.O. Box 14460
St. Louis, MO 63178
Steve Whitney, (314) 527-1663
CIRCLE 719

Interconnect Handles Gigabit Serial Data Transfers

The High-Speed Serial Data Connector (HSSDC) is a controlled-impedance, fully-shielded interconnect system for applications requiring serial data transfer rates up to 2.125 Gbits/s through copper cable over distances of 30 m or more. Approved by the ANSI X3T11 committee for Fibre Channel, the HSSDC system also is being considered by ANSI X3T10.1 for Serial Storage Architecture and by IEEE 802.3 for gigabit Ethernet.

The system comes in an eight-position housing using the CHAMP 0.050 Series II contact interface with high-durability contacts on 1.25-mm centerlines. Board-mount receptacles are available in straddle-mount or right-angle versions with six or eight contacts. The receptacles' profile meets the 10-mm height requirement for the PCI Common Card specification, with up to four receptacles able to fit on a single PCI board.

Plug connectors, which are factory terminated to 24 through 30 AWG, 150-Ω, low-skew, shielded quad cable,



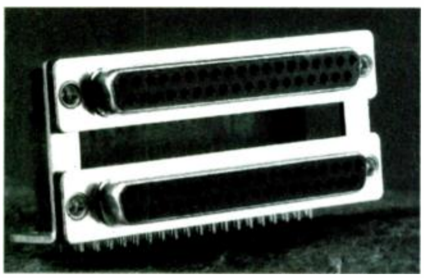
incorporate a small pc board. This board can provide compensation circuitry to optimize high-speed performance and maintain signal integrity over longer transmission distances. The contacts use make-first/break-last mating, while polarization and positive latching ensure reliable connections. Pricing is below $40 in lots of 5000.

AMP Incorporated
PO Box 3608
Harrisburg, PA 17105-3608
Jennifer Mosey (717) 780-6876
CIRCLE 720

Patrick Mannion

37-Pin Stacked Subconnector Is Versatile

The K42-C37 37-pin dual-port D-subconnector comes with phosphor-bronze stamped socket pins and

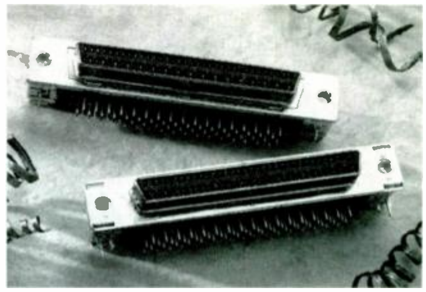


mounting options that include riveted threaded inserts, 4-40 hex jack screws, and board locks. Plug shells come with indentations for grounding and mating retention. Available in various plug-and-receptacle combinations with a center-to-center distance of 0.750 in., the devices have an operating temperature range of -55° to 125°C. Pricing is $5.48 in lots of 5000 and delivery is six to eight weeks.

Kycon Cable & Connector Inc.
1810 Little Orchard St.
San Jose, CA 95136
(800) 544-6941
CIRCLE 721

SCSI-3 Connector Has Improved EMI/RFI Shielding

Using a seamless design, Fujitsu's new line of SCSI-3 connectors improve RFI and EMI shielding effectiveness by 7.6 to 10.2 %. Conventional SCSI I/O connectors comprise a stamped metal shell joined to a die-cast body by small tabs. The shells leave slight gaps around the tabs that are large enough to permit the escape of shorter wavelengths. The company's seamless design prohibits this by extending the stamped shell over the entire face of the die-cast housing and by moving the attachment holes to the extreme ends of

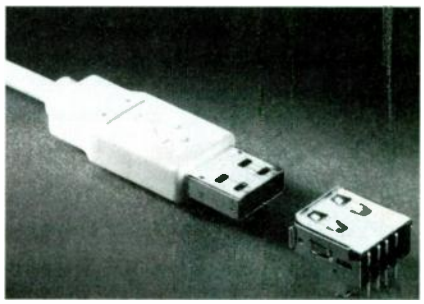


the connector. When the connector is mounted to the host system, the chassis overlaps the gaps and blocks the propagation of EMI. The design also provides a continuous ground path from the cable assembly to both the chassis and pc board. Pricing is $3.12 in lots of 10,000 with delivery from stock.

Fujitsu Takamisawa America Inc.
250 E. Caribbean Dr.
Sunnyvale, CA 94089
800-380-0059
http://www.fujitsufta.com
CIRCLE 722

USB Connector Simplifies PC Interconnections

This line of USB connectors is compatible with the "A" version of the standard and comes with four in-line



pins of brass or phosphor bronze that are plated with nickel and finished with a gold flash. Two pins are for power and two are for signal transmission over twisted pair wires. The connectors feature a bandwidth of 12 Mbits/s or better. Pricing is $0.48 in 50,000-unit lots and delivery is from stock to 4 weeks ARO.

Ranoda Electronics Inc.
2315 NW 107th. Ave.
Miami, FL 33172
Lawson Williams (305) 593-0129
fax (305) 594-3973
CIRCLE 723

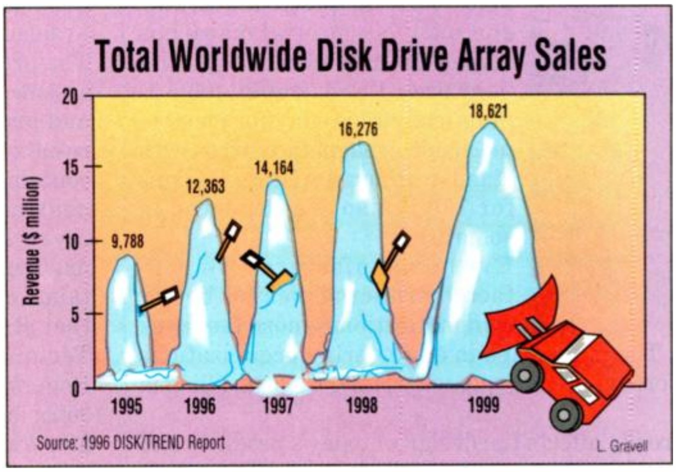
ELECTRONIC DESIGN QUICK LOOK

■ Edited by Mike Sciannamea and Debra Schiff

MARKET FACTS

A Blizzard Of Activity

Reminiscent of the snowhills by the side of the road that grow to the size of snowmen with every snowfall, disk drive array sales are projected to rise geometrically. According to the 1996 DISK/TREND report on disk drive arrays, the market will continue to grow rapidly and steadily throughout 1999. Strong sales in the categories of single user systems, networks and midrange systems, mainframe systems, and very high performance systems pushed total worldwide revenues to $9788.8 million in 1995. DISK/TREND forecasts sales revenues in 1996 to increase to $12,363.5 million. The report further predicts that in 1997 worldwide disk drive arrays sales revenues will rise to $14,164.8 million. In 1998 and 1999, sales revenues are expected to hit $16,276 and $18,621 million, respectively. In the evolution of disk drive arrays in the computer industry, the survival of the fittest manufacturing firms has begun to show in the number of companies still competing in the industry. The report lists 158 firms offering disk drives under their own name in 1996, as opposed to 179 companies in the market one year ago. The worldwide study notes that the companies headquartered in the U.S. were responsible for 92% of last year's total revenues. Sales leaders were Compaq Computer, Digital Equipment, EMC, and IBM. In terms of sales of different types of arrays, those arrays used with mainframes were the fastest growing category, skyrocketing up 130% in 1995, driven by EMC's, Hitachi Data Systems', and IBM's offerings. But, this trend has been projected to plateau in 1996 at $4.4 billion, slipping steadily thereafter. Expected to rise at an annual rate, disk storage capacity used with mainframes will be sold at increasingly lower prices, melting the sales revenue worldwide at an average rate of 6.2% during 1997, 1998, and 1999. DISK/TREND's report shows that the largest market for disk drive arrays is in network server and midrange system applications. This market comprises 55.4% of 1995's sales revenues and 91.8% of total unit shipments. This sector of the array market is expected to rise from $5.4 billion in 1995 to $14.7 billion in 1999. The category of array controller boards has traditionally been the favorite of computer do-it-yourselfers, integrators, and OEMs. Growing at a very fast pace, unit shipments climbed 54.3%, further reinforcing the growth rate of the past few years. There is a dark cloud to this silver lining, however. With the introduction of single chip and chip set array controllers capable of being mounted on controller boards, the need for separate array controller boards in many array subsystems for PC networks has been eliminated. As a result, the DISK/TREND forecast shows a dim future ahead for board-level array controllers after 1998. Ranking the major players in the array markets, the report notes IBM's status as the continued leader of total disk drive array sales revenues. Big Blue grabbed 33.7% of the 1995 worldwide total, clocking in at $3.3 billion in sales. The report attributes IBM's success to established midrange array product lines as well as large sales increases for new mainframe arrays. EMC also held their position of second place, owning 16.1% of overall array revenues. According to the report, the company owes its standing to continued drive by the midrange and OEM markets, as well as requests for IBM mainframe array subsystems. There also is an array system consideration review, an array selection checklist, a listing of manufacturers' market shares, and a data storage technology review in the report. Additionally, specifications of 694 disk drive array models are included, as well as 182 profiles of existing and former array manufacturers. The 1996 DISK/TREND Report on disk drive arrays is priced at $1475. For more information, contact DISK/TREND Inc., 1925 Landings Dr., Mountain View, CA 94043; (415) 961-6209; fax (415) 969-2560; Internet: http://www.disktrend.com.



40 YEARS AGO

Editorial: Between The Lines of Design '57

We became so immersed in documenting details in preparing this issue's features, Design '57, that we're not sure that some very important overall aspects stand out so as to be self-evident. There are several facets which made their mark on our minds.

Transistors are being investigated by practically every equipment manufacturer. Mostly for one reason. Not so much for the advantages in size, weight and power (mobile and aircraft design excepted) but in the search for greater reliability. It is not only the military that is pushing reliability. Instrumentation and control people designing for automatic process systems are looking for 100 per cent reliability. Computer people find reliability becoming more pressing. By programming advances, computer problem-solving duty cycle is increasing and there is less free time for maintenance. Faced with nonskilled maintenance people in the field, all commercial equipment designers are shooting for greater dependability and simplicity.

Needless to say, new tube developments are being spurred on by the military requirement for high temperature components. Transistors will not fit all bills. The demand for high-temperature components brings us to almost an impasse. Today's insulating materials, magnetic materials, and many structural materials cannot withstand the high temperatures. For example, 400 F is practically top today for electromechanical magnetic devices with standard characteristics. Designs for 750 F also are expected in some areas.

Every manufacturer we contacted made the plea for better communications--more feedback of test and application data. The fast tempo in engineering organizations seems to be the reason why more time is not spent in writing reports, filling in suppliers questionnaires, etc.

The engineering shortage really affects the design of today's products and equipment. Many chief engineers frankly stated that their products were not being improved as much as they could be simply because they didn't have enough competent engineers. Apparently talent exists in the engineer who has recently graduated out of college, but the competence which comes with experience is lacking.

The most alarming factor, though, might well be the general harassed state of practically all chief engineers. There's just too much to be done with too little time. No solution or even partial remedy comes to mind. Isn't this suggestion worthwhile though? Instead of worrying about so many details, we should set aside some time each day developing assistants to take on more responsibility.

All in all, though, the activity manifest in the industry should result in great progress for Design '57.*(Electronic Design, January 1, 1957, p. 4)*

This editorial introduced Design '57, Electronic Design's annual survey of electronics technology. The Design '57 report itself took up nearly 16 magazine pages, and also covered trends over a broad range of topics, including digital and analog computers, printed circuits, instruments, automatic assembly, servomechanisms, components, network synthesis, vacuum tubes, tv and audio equipment, transistors, microwaves, military electronics, and standards.--SS

FREE STUFF

Intusoft has released a CD-ROM with a variety of information for all SPICE users. The CD contains SPICE models, applications on how to model different electronic devices, and technical articles on how to simulate various types of designs. System requirements for the CD include Windows 3.1x, Windows 95, or Windows NT; a CD-ROM drive; 8 Mbytes of RAM; and a sound card. The CD is available free of charge from Intusoft, P.O. Box 710, San Pedro, CA 90733-0710; (310) 833-0710; fax (310) 833-9658; Internet: http://www.intusoft.com.

Rogers Corporation is offering flexible circuit analysis software free of charge. With the software, users will be able to sufficiently estimate the physical behavior of typical flex circuits by evaluating the relevant equations. The program allows for rapid assessment of various constructions, and provides numerous graphic results for comparison. Equations contained in the program include neutral axis, moment of inertia, layer stress/strain, and thermal/hygroscopic expansion. To obtain a copy of the software, contact Rogers Corporation, One Technology Dr., P.O. Box 188, Rogers, CT 06263-0188; (800) 774-9605; fax (860) 779-5509; Internet: http://www.rogers-corp.com/cmu.

Two new integrated circuit databooks are available free of charge from Burr-Brown Corp. The Linear Products and Mixed-Signal Products databooks feature over 60 new high-performance and mixed-signal solutions, plus complete product descriptions, applications tips, performance graphs, detailed specifications, and ordering information for the company's line of high-performance linear and mixed-signal products. For more information, contact Burr-Brown Corp., 6730 S. Tucson Blvd., Tucson, AZ 85706; (520) 746-1111; fax (520) 746-7401.

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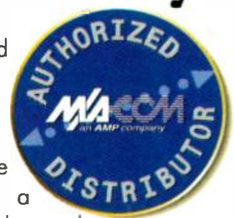

You know that M/A-COM has earned a reputation as a world leader in RF Devices. And at Penstock, we make it our business to be the leader in product availability, ease of ordering, on-time delivery and customer service. It's a combination that OEMs of any size demand today. What's more, our technical support and product knowledge are unmatched in the industry.

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Send me more info	Part Number	Application	Frequency MHz	Conversion Loss	RF LO Isolation
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☐	EMD40-1800L	Handsets	1400-2000	8.0dB	25dB
☐	EMS-1X	Base Station	10-1000	6.0dB	30dB
☐	ESMD-C1	Base Station	1-1000	6.5dB	40dB

TRANSFORMERS

Send me more info	Part Number	Application	Frequency MHz	Ratio	Insertion Loss
☐	ETC1-1-13	Wireless	4.5-3000	1:1	3 dB
☐	ETK4-2T	Wireless	2-1000	4:1	3 dB
☐	ETC1.6-4-2-3	Wireless	500-2500	4:1	3 dB
☐	ETC4-1-2	Wireless	2-800	4:1	3 dB
☐	ETC9-1	Wireless	70-220	9:1	2.5 dB

COUPLERS

Send me more info	Part Number	Application	Frequency MHz	Ratio	Insertion Loss
☐	ESDC-7-2-75	CATV	5-800	7±1	2.8 dB
☐	EMDC-16-2-75	CATV	40-1000	16±1.1	1.0 dB
☐	ESDC-20-2-75	CATV	5-1000	20±1	1.1 dB

SPLITTERS/COMBINERS

Send me more info	Channels	Frequency MHz	Isolation (dB)	Insertion Loss (dB)	Package	P/N
☐	2	824-960	23	0.5	SOIC-8	DS52-0001
☐	2	1850-1990	21	0.5	SOIC-8	DS52-0002
☐	2	1510-1660	20	0.4	SOIC-8	DS52-0004
☐	3	824-960	18	0.6	SOIC-8	DS53-0001
☐	4	824-960	23	1.0	SOW-16	DS54-0001
☐	4	1200-1660	23	1.0	SOW-16	DS54-0003
☐	6	824-960	25	1.3	SOW 16	DS56-0001

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HOT PC PRODUCTS

SUPPORTABILITY for Visual Basic is South Wind Design's first in a series of products designed to reduce the cost of technical support. The software embeds a diagnostic engine in Visual Basic applications and checks for software problems each time an application is launched. The software cuts support costs in two ways: call avoidance and faster problem resolution. Tech support calls are avoided because in many situations the user can resolve the problem directly using the diagnostic data provided by SUPPORTABILITY. Support workers can improve resolution times using faxed or e-mailed SUPPORTABILITY diagnostic reports. Unlike knowledge bases used by other diagnostic engines, the SUPPORTABILITY knowledge base is automatically generated in minutes. Both Visual Basic 3 and 4 are supported. Customers are provided free Internet distribution services. SUPPORTABILITY for Visual Basic is available for $249. Contact John R. White, South Wind Design Inc., 255 E. Liberty St., Ste. 291, Ann Arbor, MI 48104; (800) 897-9463; fax (313) 213-0155; Internet: http://www.swdi.com.

Web Studio is an all-in-one integrated suite of applications that may make it easier for users to create web sites with any programming. At the heart of Web Studio is WebEdit, a full-featured editor for designing HTML web pages. The software allows direct editing of HTML code with support for the latest tags up to HTML 3.2. Also included in the suite is Crystal Reports, a database access and report-generating program for publishing data on the Internet. It allows information to be extracted from a database, then manipulated with the program's built-in logic and mathematical functions. Web Studio includes a Java authoring toll that adds sound and animation to web pages. The suite is priced at $129. For more information, including system requirements, contact Luckman Interactive Inc., 1055 W. 7th St., Los Angeles, CA 90017; (213) 614-0966; fax (213) 614-1929; Internet: http://www.luckman.com.

Motorola's Mobile Computing Products Division has released Montana, a 28.8 modem/fax PC card, and Mariner, a modem/fax LAN adapter card. Both cards are available with 33.6 kbits/s performance, the industry's fastest rate. Under industry standard tests, the cards consistently connected at rates up to 15% faster than current 28.8 modems. The PC cards include new cellular performance and connectivity features for use with all Motorola data-ready cellular phones. They include credit card "bong" detection, cellular signal strength indication, cellular service status/roaming, and Personal Identification Number (PIN) enabled remote-access systems. The cards are equipped with Enhanced Throughput Cellular (ETC) error correction protocol and are software upgradeable to ETC2 when it becomes available. The cards are bundled with the QuickLink data/fax software package, Netscape Navigator Internet web browser, Spry Mosaic Internet-in-a-Box, and special offers from Compuserve and America Online. Montana is available for $309. For an additional $10, users can purchase Montana bundled with a MicroTAC cellular phone cable. Mariner is available for $399. Contact Motorola Mobile Computing Products Division, Schaumburg, IL; (800) 4A-PCMCIA

Honorable Mentors

Created in 1983, the Semiconductor Research Corporation (SRC) Industrial Mentor Program provides industry scientists and engineers to SRC-funded research projects at a number of North American universities.

In recognizing the winners of its Outstanding Industrial Mentor Awards for 1996, SRC honored seven semiconductor industry scientists and engineers out of its over 450 mentors in the program.

Here are the winners:

Motorola's Erik Egan mentored at the Massachusetts Institute of Technology, lending his expertise on modeling to graduate student teams and researchers.

Avatar Jassal from SEMATECH mentored at both Arizona State University and the University of Texas, providing a range of support from financial to data.

Mentoring at the University of Florida, Paul Packan of Intel collaborated with researchers on transient enhanced fusion mechanics.

IBM's Mario Pelella mentored the Process Integration and Device Sciences contract at the University of Florida.

Karl Puttlitz of IBM mentored at Northwestern University, providing information on new lead-free solders and innovations in component manufacturing.

University of Texas mentor, Rob Ramage from Intel arranged for the donation of a multiwavelength, thickness/dissolution rate measurement tool from Intel to the school and set up summer internships for students.

S. Deo Singh of Intel mentored at the University of Southern California. Mr. Singh arranged summer job opportunities at Intel for graduate students and guided research in the SRC Design Sciences contract.

SRC's mentors represent 23 member companies. A consortium that consists of over 60 semiconductor industry companies and government agencies, SRC has invested and managed more than $340 million in semiconductor research since 1982. For more information on the program, contact Semiconductor Research Corporation, P.O. Box 12053, Research Triangle Park, NC 27709-2053; (919) 941-9400; fax (919) 941-9450.

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http://www.dadisp.com: Stop off at DSP Development's DADiSP site and download a 30-day licensed trial version of the DADiSP Worksheet. The software, used for acquisition, analysis, and display of scientific and technical data, is normally priced for Windows at $1895, but can be used for free for 30 days. Students may download a Student Edition for unlimited educational use. Add-on modules, manuals, and support may all be requested at the site. DADiSP allows users to work with data series, images, matrices, signals, and waveforms through an intuitive, spreadsheet, icon- and menu-driven environment.

http://www.rayovac.com: Charge up your batteries at Rayovac's new site on the World Wide Web. Rayovac's site uses color coding, frames, and an internal search engine to bring information about news, products, spokespeople, and technology to visitors. Targeted to both general and business consumers, the site provides technical data on lithium, rechargeable alkaline, computer clock, and zinc air batteries. OEM's as well as designers and engineers can use the internal search engine to find industry-specific products.

http://connect.amp.com/fiberoptics: Surf into AMP's specialized optical interconnection solution site for the most recent information on fiber optic networking. The site is updated on a regular basis, featuring colorful graphics and point-and-click navigation. Linked to the AMP on-line electronic catalog, visitors can find engineering diagrams as well as product specifications. Product literature requests and technical support information is available through e-mail at the site.

http://www.cooperindustries.com: Drive on into the Cooper Industries home page for the latest in automotive, electrical, hardware, and tool products. Jumping on-line to offer value-added services, Cooper has brought information about the company and its business activities to the web. The page offers an overview of the company, including its history and financial information. An on-line annual report and press releases also can be found at this site. The home page is linked to Coopers other divisions including Bussmann, Cooper Automotive, Cooper Hand Tools, Cooper Power Systems, Crouse-Hinds, and Moog Automotive.

http://www.statpower.com: Try this address for information on Statpower Technologies' battery inverters and chargers. The site includes descriptions, photographs, and specifications of product lines. The site features an e-mail link to the company and a section on the most-frequently asked questions about inverters and chargers. Statpower intends to give site users high quality customer service, offering 24-hour service, seven days a week. Information on the PROwatt line of dc-ac inverters and the TRUECHARGE line of battery chargers can be found at the site.

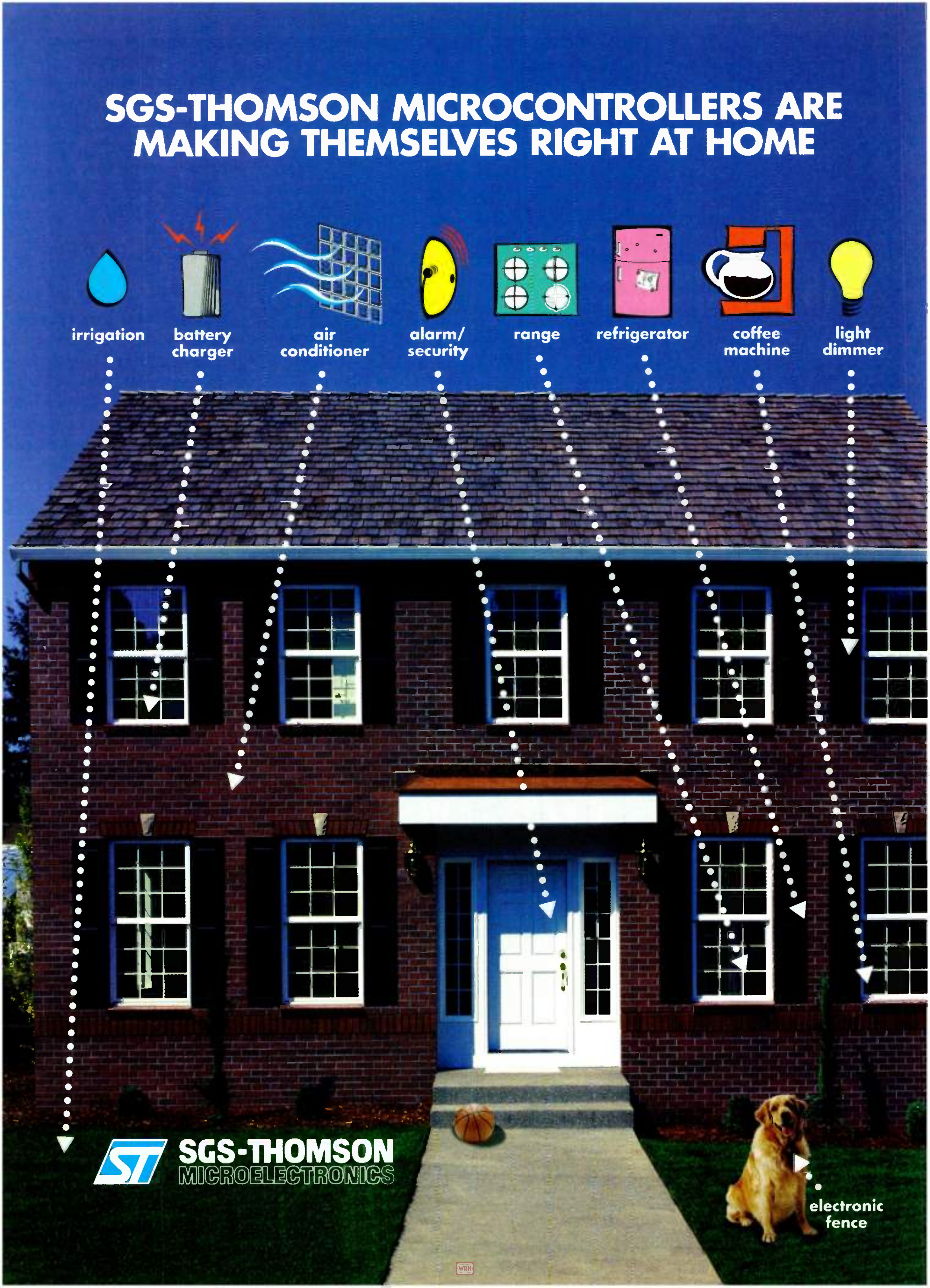
http://www.stanfordresources.com: Click on this URL to reach information on the global electronic display industry. Stanford Resources now features its market data and sector information via this World Wide Web site. The five sections found at the site are: Cathode Ray Tube Reports (summaries of annual and quarterly global CRT industries and graphs of pertinent display data), Flat Panel Reports (summaries of reports), Custom Reports (information about custom market research services), FID Conference (information about the 13th Annual Flat Information Display Conference), and Display News (developments in the industry).

http://www.aice.com: The American IC Exchange has brought its technology clearinghouse to the World Wide Web. The site offers up-to-date pricing information on dynamic random access memory (DRAM) chips for OEMs as well as industry analysts. Providing a look at current open market DRAM pricing, American IC Exchange clues analysts in on the future production costs for OEMs. The web page is updated daily, featuring current pricing and 52-week highs and lows. There also are easy-to-follow graphs for each device. The web service is offered free to OEMs, but analysts pay a monthly fee of $79 (after a free 30-day trial).

http://www.leviton.com: Establish a connection with Leviton Manufacturing via Leviton On-Line. Designed for electrical professionals, media, and the general public, the site features information about Leviton, its family of companies, the product line, and late-breaking industry news. Members of the Leviton family comprise Leviton for wiring devices, American Insulated Wire for cable, Electricord for cord sets and wire, and Leviton Telecom for data/voice devices. The page offers product information, recent press releases, and industry trends. Feedback is the page's e-mail capability, providing a method for users to submit suggestions to or request information from Leviton. There also is a query engine called Search that allows visitors to perform keyword searches from any location of the site.

http://www.qualcomm.com/ProdTech/asic: New to the QUALCOMM web site is the ASIC products page. The newest addition features the complete QUALCOMM line of automatic gain control, CDMA, forward error correction, synthesizer, and voice compression ASIC products. The site gives an overview of each product. Other features of the site include worldwide sales information, new product releases, and technical data sheet or application note downloading capabilities.

http://www.wolfson.co.uk: Fabless fans with space in their bookmarks can visit this URL for information on mixed signal semiconductors. Wolfson Microelectronics recently launched the homepage at the Japan Electronics Show in Tokyo. The site provides browsers with information on the company, its products, and worldwide sales contacts. Also featured is information on Wolfson's Quality System and career opportunities within the company. The company specializes in communications and EDP peripheral products.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LET OUR MICROS MAKE YOUR PRODUCT A HOUSEHOLD WORD

The reason SGS-THOMSON's 8-bit ST62 family of MCUs is making itself at home in so many household appliances can be summed up in one word: *Value.* ST62 devices deliver more performance in less space for less money. Even the core is optimized for cost-effective operation. Add ESD protection and unmatched noise immunity and you begin to understand why the ST62 is opening doors to consumer applications that remain closed to ordinary MCUs.

All ST62s contain ROM, RAM, an 8-bit timer with 7-bit programmable prescaler and multifunctional individually programmable I/O ports. Also available: Devices with high-current buffers to directly drive LEDs or TRIACs, along with a wide range of peripherals such as PWM and LCD drivers. A wide operating voltage range and robust design allow ST62 microprocessors to be powered directly from a battery or the main with minimum external components.

In addition to the extensive ST62 family, SGS-THOMSON offers other 8-32 bit micro solutions such as ST7, ST9, ST10 and ST20 families. All of these products are fully supported with extensive development tools including C compilers for most families. So why not let our micros help make your product a household word. To find out more fax 617-259-9442, write SGS-THOMSON, 55 Old Bedford Road, Lincoln, MA 01773, or e-mail: info@stm.com. And visit our web site at **http://www.st.com**

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- heater
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- thermostat
- scale
- programmable timer
- vacuum cleaner
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Service and Technology

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*	ST6201	2K ROM	64		4x8-Bit	1x8-Bit		9	DIP/SO16	
*	ST6203	1K ROM	64			1x8-Bit		9	DIP/SO16	
*	ST6208	1K ROM	64			1x8-Bit		12	DIP20/SO20	
*	ST6209	1K ROM	64		4x8-Bit	1x8-Bit		12	DIP20/SO20	LED or TRIAC driver
*	ST6210	2K ROM	64		8x8-Bit	1x8-Bit		12	DIP20/SO20	
*	ST6215	2K ROM	64		16x8-Bit	1x8-Bit		20	DIP28/SO28	
*	ST6220	4K ROM	64		8x8-Bit	1x8-Bit		12	DIP20/SO20	
*	ST6225	4K ROM	64		16x8-Bit	1x8-Bit		20	DIP28/SO28	
	ST6240	8K ROM	216	128	12x8-Bit	2x8-Bit	SPI	16	QFP80	
	ST6242	8K ROM	152		6x8-Bit	1x8-Bit	SPI	10	QFP64	LCD driver (segment) + LED or TRIAC driver, 32KHz oscillator
	ST6245	4K ROM	140	64	7x8-Bit	2x8-Bit	SPI	11	QFP52	
*	ST6253	2K ROM	128		7x8-Bit	2x8-Bit		13	DIP20/SO20	
*	ST6260	4K ROM	128	128	7x8-Bit	2x8-Bit	SPI	13	DIP20/SO20	auto-reload timer + LED or TRIAC driver + PWM
*	ST6263	2K ROM	128	64	7x8-Bit	2x8-Bit		13	DIP20/SO20	
*	ST6265	4K ROM	128	128	13x8-Bit	2x8-Bit	SPI	21	DIP28/SO28	
	ST6280	8K ROM	320	128	12x8-Bit	2x8-Bit	SPI, UART	22	QFP100	LCD driver (dot matrix) + auto-reload timer + LED or TRIAC driver
	ST6285	8K ROM	288		8x8-Bit	1x8-Bit	SPI, UART	12	QFP80	
	ST7291	8/16/24K ROM	256/384			1x16-Bit		19	DIP28/SO28	wake-up function + power saving & standby modes + power supply monitor
	ST7294	6K ROM	224	256		1x16-Bit		22	DIP28/SO28	wake-up function + power saving & standby modes + WDG
	ST9036	16K ROM	224+256		8x8-Bit	2x16-Bit	SPI+SCI	56	LCC68	WDG + handshake + Direct Memory Access
	ST9040	16K ROM	224+256	512	8x8-Bit	2x16-Bit	SPI+SCI	56	LCC68	
	ST90R50		224		8x8-Bit	3x16-Bit	SPI+2xSCI	56	LCC84	WDG + 2 handshakes + Direct Memory Access + 16 M Bit address
	ST90R52		224		8x5-Bit	3x16-Bit	SPI+2xSCI	52	QFP80	

Abbreviations:

ADC = Analog to Digital Converter
SCI = Serial Communications Interface
WDG = Watchdog
SPI = Serial Peripheral Interface
USART = Universal Synchronous/ AsynchronousReceiver/Transmitter

Packages:

DIP = Dual In Line
QFP = Quad Flat Pack
S = Shrink
LCC = Leaded Chip Carrier
SO = Small Outline

Also check out our new ST62 REALIZER

The ST62 REALIZER is a user-friendly tool that assists designers in developing applications based on the ST62 family. A graphical schematic description of the application is used to automatically generate the executable code for the ST62 and to run simulations for verification of the program function. The complete tool set runs under Microsoft WINDOWS® environment.

*More Gold Standard devices available from ST (OTP versions only)

For more information fax 617-259-9442
Complete product information at http://www.st.com

SGS-THOMSON MICROELECTRONICS

READER SERVICE 142

CONFERENCE CALL

The Association for Configuration and Data Management (ACDM) is holding its second annual conference at the Marriott Hotel, Santa Clara, Calif., on March 16-19. The theme of the conference is "Pathways to Progress," which highlights the importance of accurate product and plant documentation in worldwide quality initiatives, such as ISO 9000. Technical sessions will offer papers on data management and configuration control practices, evolving industry and government standards, and the impact of data automation on engineering disciplines. Also featured will be vendor exhibits, the ACDM national membership meeting, and the ACDM executive board meeting. For more information, contact ACDM, P.O. Box 5888, Salt Lake City, UT 84158-0888; (800) 738-8500; Internet: http://www.vegas.com/acdm.

The Wiring Harness Manufacturers Association (WHMA) will be holding its seventh annual conference in El Paso, Texas, following the Borderland Show, on March 12-15. On the agenda are educational sessions, exhibits, and plant tours. For more information, contact the WHMA, 3335 N. Arlington Heights Rd., Suite E, Arlington Heights, IL 60004; (847) 577-7200; fax (847) 577-7276; Internet: http://www.whma.org.

A Secure Metamorphosis

In 1994, Chrysalis-ITS began spinning its cocoon, developing cryptographic Application Specific Integrated Circuit (ASIC) technology that could be applied to Internet security protocols. In 1995, the company's digital signature and encryption token technology was licensed by Nortel Secure Networks for use with the Entrust network security product line. That same year, Chrysalis garnered the Canadian federal government's contract to develop and manufacture the Government Electronic Services Card (GESC) and other embedded cryptographic products for Canada's Information Technology Security and Public Key Infrastructure initiatives. GESCs are now used by the Canadian Department of National Defense, Royal Canadian Mounted Police, and the Canadian Communications Security Establishment.

Now, Chrysalis has emerged to introduce the Luna data encryption token, along with a Luna Developer's Kit, to OEMs and VARs. Using asymmetric or public key encryption, the Luna family of PCMCIA security tokens provide users with a higher level of security found in software.

Standalone systems, as well as networks, are not secure. They can easily become prey for hackers and viruses. By keeping the private encryption keys and digital signatures on the token, the Luna system assures a secure environment. The token also is important in applications requiring encryption of sensitive information over the Internet, private intranets, the World Wide Web, and public e-mail services.

The Luna token features on-board processing technology that uses a 32-bit cryptographic processor, dual-port memory systems, Flash PROM, and Static RAM memory. The Flash PROM module is a reservoir for Luna's algorithms and cryptographic keys. The module, used for long-term data storage, is nonvolatile. Supporting 8 kbytes of Static RAM, the other memory system is designed to carry cryptographic algorithms (only while the card is processing cryptographic information), private keys, and secure information. The Static RAM is volatile, therefore, when the user removes the token from the computer, all information within the Static RAM is erased.

Speaking of memory, the Luna card uses dual-port memory (a two-chip subsystem) to isolate the buses on the card from those on the computer. This system prevents the PC from accessing the algorithms on the card, further protecting the user's keys from viruses or hackers.

The Luna token is a standard Type 2 PCMCIA or PC card that inserts directly into any laptop PC card slot. Desktop PCs also can be outfitted with PC card interfaces. The Luna architecture is industry standard compliant, adhering to PCMCIA 2.1, Type II; FIPS 140-1, Level II; PKCS#11; Microsoft Crypto API; Intel CDSA; and Entrust from Nortel. The card supports the following encryption algorithms: DES, Triple DES, MD2, MD5, RC2, RC4, RSA, and SHA-1. Chrysalis recently paired with DEW Biometrics to develop another token capable of meeting the FIPS 140-1, Level III standard. Level III qualifiers feature tamper-evident protection, on-card processing of encryption algorithms, on-card storage of private keys, and biometric confirmation.

Chrysalis' Luna Developer's Kit features the Chrystoki open API. Allowing users to create their own personal firewalls, Chrystoki supports encryption and decryption functions; general purpose, session management, slot, and token management; message digesting; object and key management; and random number generation.

The kit includes demo source code, documentation, Dynamic Linking Library, two Luna tokens and Luna card readers with an ISA interface into a PC-based development system, and 60 days of technical support. Available to end users, OEMs, and secure system integrators, the kit runs under Windows 3.x, 95, and NT platforms. Contact Chrysalis-ITS Inc., 380 Hunt Club Rd., Suite 200, Ottawa, Ontario K1V 1C1; (613) 731-1013; fax (613) 713-1013; Internet: http://www.chrysalis-its.com.—DS

Kids Put Their Cities On The Map

Imagine if all of your city's planning was performed by seventh and eighth grade kids. It's not that far fetched, really. After all, given the right training, software, and encouragement, anything is possible.

Trying their hands at civil engineering, around 150 Michigan teenagers are now competing in the Detroit Regional Future City Contest. The contest asks participants to design their visions of what cities will look like after the year 2000. Engineering teams from 48 schools in the state will be determining ideal environments, manufacturing areas, and transportation systems for their impression of what the most livable city of the future will be.

The children are using SimCity 2000 design software with the Urban Renewal Kit add-on package to optimize their efforts. A useful innovation recently added to SimCity 2000 is the 3D feature. Contest organizers have included the software to motivate young people to participate in the competition. The youngsters are learning a wide variety of skills by participating in the Future City Contest, such as computer design, manual skills, oral presentation, research and writing, and teamwork.

Intended to encourage kids to take an active interest in their math and science curriculum, the competition exposes middle schoolers to engineering through hands-on, real-world applications.

Volunteer industry professionals referred by the Society of Manufacturing Engineers (SME) are assigned to each of the teams for the duration of the contest. These adult engineers venture into the classrooms to help teachers instruct the student teams in designing and building their future cities.

To fulfill contest requirements for their cities of the future, student teams must include plans for commercial, industrial, and residential areas. The future cities also must include power distribution networks, power plants, and roads.

The competition consists of four components: design, model, presentation, and essay. Each student team must use the SimCity 2000 software to design their future city. All participants must construct a section of their city. The models are presented to the judges and other viewers at the competition. Each team composes a 500-word essay concentrating on a predetermined topic.

The intent of this year's essay is to have students examine how engineers address the challenges brought about by natural disasters. The topic of the essay is Florida's Hurricane Andrew which occurred in 1992. The teenagers will be instructed to focus on the engineer's responsibility in examining damaged buildings, reestablishing or setting up new transportation routes, restoring power, setting up communication links, and testing the area's water supply.

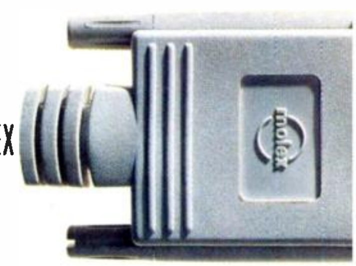
The Detroit Regional Future City Competition is coordinated by the SME and the Engineering Society (ESD). Judging will take place on January 23 at the Henry Ford Museum, Dearborn, Mich.

Founded in 1932, SME is an international professional society with over 70,000 members in 70 countries. Sponsoring more than 300 chapters, districts, and regions, the society also supports 240 student chapters worldwide. ESD, a multidisciplinary engineering and scientific society, has members located throughout the Great Lakes region.

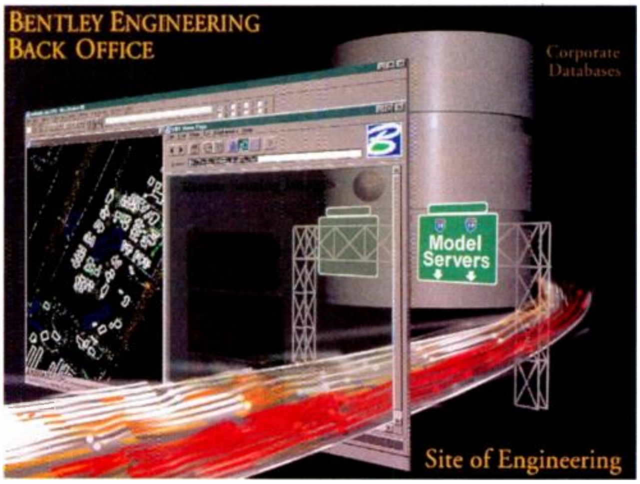
The following is a list of schools participating in the contest: Abbott, Academy for African-American Students, Middle Years Alternative, Anderson, Derby, Eton Academy, East Hills, Beach, Cedar Crest Academy, Home School Outreach for Model Education, Bryant, Divine Child, Stout, Ann Arbor Trail, Barbour Magnet, Burton International, Butzel, Foch, Grant, Hally Magnet, Hamilton, Nolan, Peter Vetal, St. Leo, Whitney Young, William Howard Taft, Power, Coolidge, Webb, Ida, Gardner, Otto, Pattengill, St. Edith, Cooke, Meads Mill, Novi, Marist, Holy Family, St. John Lutheran, Keller, Shrine Academy, Levey, Smith, Orchard Lake, and Lincoln.

For more information, contact SME, One SME Dr., P.O. Box 930, Dearborn, MI 48121-0930; (313) 271-1500; fax (313) 271-2861; Internet: http://www.sme.org.


Never underestimate
the power of one|


molex

Engineering Automation Goes On-Line



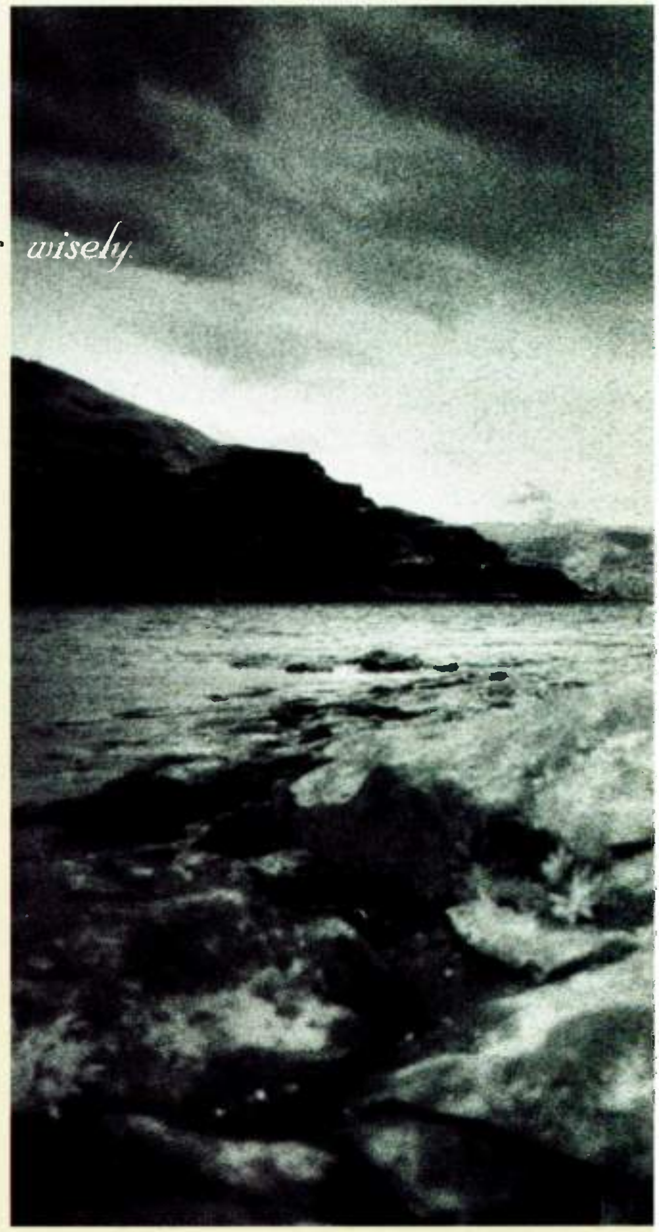
Bentley Systems' new line of engineering middleware, Engineering Back Office, is uniting desktop systems with enterprise IT systems and databases. The web-centric server products are based on the IT infrastructure of the Internet paired with three-tier client/server technology to produce high connectivity and information sharing. The flagship products in the line, ModelServer Publisher and ModelServer Continuum, are based on technology from Netscape and Oracle, respectively.

ModelServer Publisher electronically publishes Bentley's MicroStation or Autodesk's AutoCAD drawings, maps, and models to any desktop browser. The middleware pulls information from server-stored data, without requiring file conversion plug-ins. Publisher works within intranets, requiring no changes to existing workflows.

ModelServer Continuum is designed to store engineering drawings and maps in corporate IT databases and send data to MicroStation applications and World Wide Web clients. Incorporating geographic information system, engineering, and enterprise data, the middleware creates a contiguous database containing engineering, enterprise, and spacial data. The nature of Continuum eliminates map file boundaries, allowing users to access full networks of information without breaks in the data. The server product also has advanced transaction management features that prevent the collisions often present in file-level locking multiuser environments.

Other products in the Engineering Back Office line include ModelServer TeamMate, an engineering document and workflow management product, and the Open Engineering Connectivity specification, open APIs. For more information, contact Bentley Systems Inc., 690 Pennsylvania Dr., Exton, PA 19341; (610) 458-5000; fax (610)458-1060; Internet: http://www.bentley.com.

STARING INTO THE FACE
SHOULD MAKE YOU FEEL AS



For an engineer, each project should be a new beginning. A time when you can reach again for something that has never been done before.

Choose your embedded processor wisely.

It will, however, take a particular kind of embedded processor to break the dam—to let the best thinking move from your mind to the application. NEC's 64-bit V_R Series™ is that processor. The remarkable MIPS™ RISC architecture that can release you from what has been and move you to where things could be.

So what, exactly, makes NEC's MIPS RISC architecture the most sensible choice for office automation, consumer and internetworking designs? First and foremost, the price/performance issue. The fact is, no other processors provide better MIPS per dollar than our V_R4300,™ or V_R5000™ processors. And no other processor in its class offers more MIPS per watt than the V_R4100.™

NEC's MIPS RISC architecture also enables forward compatibility. It's extremely scalable and uses common code libraries. In other words, this is an architecture with a sharply defined migration path. Giving you a connection to future processors and backward compatibility to existing code.

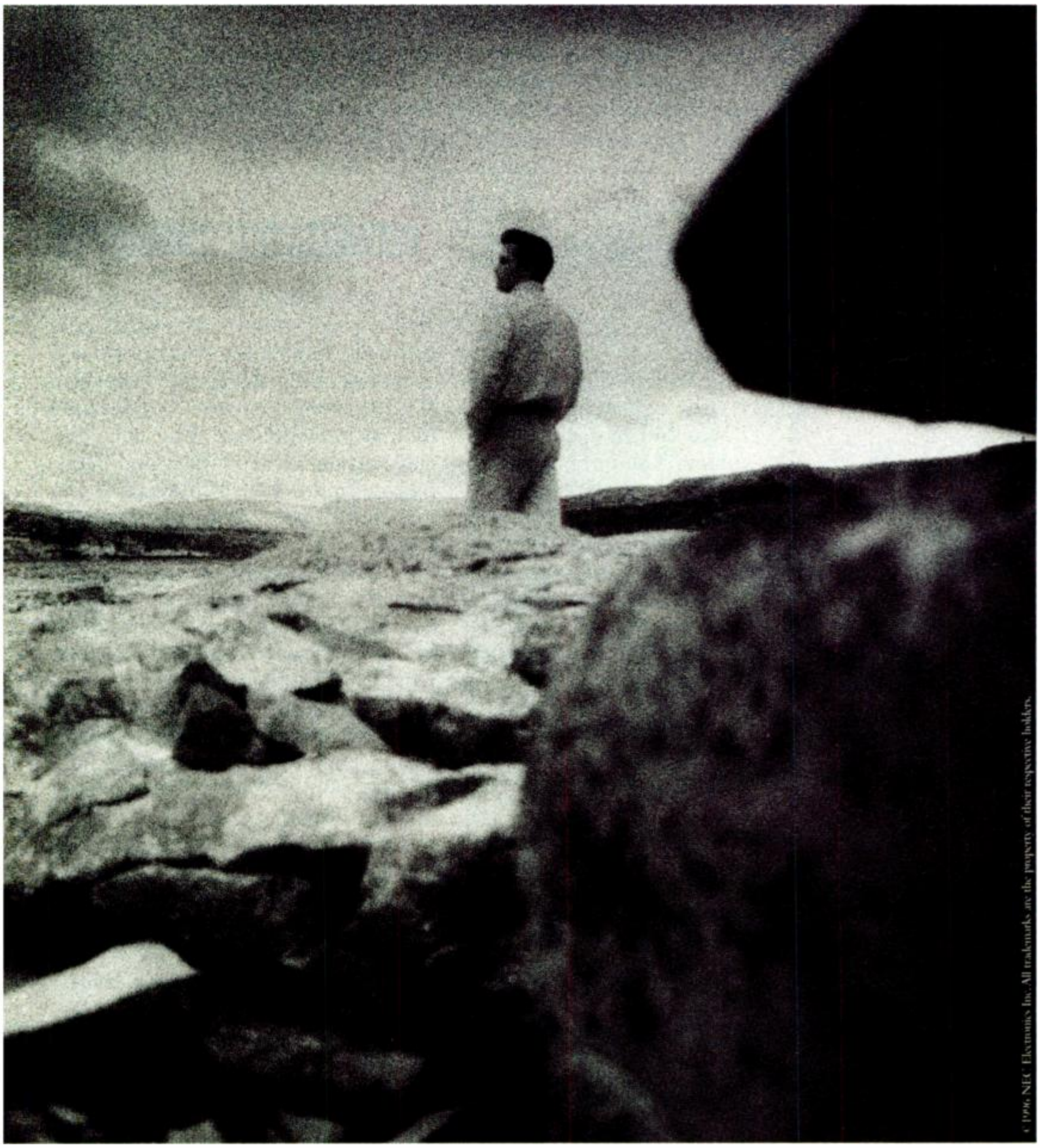
It is an amazing thing to create a successful design. The only problem is, you're being asked to do it faster than ever. Which is why NEC offers a comprehensive solution, including support for PCI Bus interface and laser printer control peripherals. We also provide companion chipsets and third-party tools.

When you think about it, finishing a project in record time is a pretty good thing. Because it means you get to move on to the next one.

Call us for more information about the V_R Series at *1-800-366-9782*. Ask for Info Pack 195.

OF YOUR NEXT *project*

IF ANYTHING IS POSSIBLE.



V_R5000. Paramount performance, incredibly affordable. This is the ultimate embedded processor for advanced applications like internetworking.

V_R4300. A high level of performance at an extremely low price. Ideal for office automation products, video games and X-terminals.

V_R4100. An uncompromising combination of performance and serious power management makes this a perfect choice for personal digital assistants and hand-held terminals.

	V_R4100	PPC403GA	V_R4300	PPC603	V_R5000	PPC604
Frequency	40MHz	25MHz	133MHz	80MHz	200MHz	100MHz
Bus Interface	32-bit	8/32/64-bit	32/64-bit	32/64-bit	64-bit	64-bit
I-Cache Size D-Cache Size	2KB 1KB	2KB 1KB	16KB 8KB	8KB 8KB	32KB 32KB	16KB 16KB
Pin Count/Package	100 PQFP	160 CQFP	120 PQFP	240 CQFP 256 BGA	272 BGA 223 CPGA	304 CQFP 256 BGA
SPECint92/SPECfp92	45 VAX MIPS	---	80/60	75/85	---	128/120
SPECint95/SPECfp95	---	---	---	---	5.5/5.5	---

NEC

READER SERVICE 190

On With The Show!!

It's Friday night and you've decided to rent the latest "hot" movie. After a long, tough week of work, you treat yourself to a little entertainment. You've got your sandwich, potato chips, and beverage at the ready. You pop in the cassette into your VCR. On with the show!

Hold everything. As you anxiously await the beginning of the movie, you have to sit through at least three commercials and two previews of coming attractions. You try to fast-forward to the beginning of the movie, but you never quite get there. Has this happened to you?

Arthur D. Little Enterprises Inc. (ADLE) knows how you feel. That's why they've developed MOVIE>>ADVANCE, a feature that makes it possible for viewers to skip through all of the previews that usually precede rented and store-bought videos. It's done with just the push of a button.

Based on ADLE's archetype feature COMMERCIAL>>ADVANCE, viewers push a button on their remote control at the onset of the previews that precede a rented or purchased movie. Through a software-based proprietary process, the VCR searches for the end of the previews, cues up the beginning of the movie, and an on-screen display tells viewers that the movie is about to begin.

According to ADLE, manufacturers can incorporate the technology into their VCRs. Among the companies who have received licenses to implement the technology are Thomson Consumer Electronics, Victor Company of Japan Ltd. (JVC), and Samsung. Inventor Jerry Iggulden is credited with the inventions of both COMMERCIAL>>ADVANCE and MOVIE>>ADVANCE.

For more information, contact ADLE, Acorn Park, Cambridge, MA 02140-2390; (617) 498-5000; fax (617) 498-7025.—MS

TIPS ON INVESTING

HENRY WEIZEL
CONTRIBUTING EDITOR

You may have heard of the "Dow Ten" list of stocks, sometimes called the "Dogs of the Dow." This contrarian strategy for investing in the Dow Jones Industrial Average (DJIA) looks for value in stocks by investing in established companies whose prices may be depressed. Why? To a contrarian investor, bad news can be good news, and unfavorable developments may create special opportunities.

It's a strategy that may be effective for other reasons as well. For one, high-dividend yields from established stocks can add to your investment return, especially if you reinvest dividends. Also, the DJIA offers opportunities in companies that tend to be survivors, by virtue of their size and strength.

So how can you put these observations into action? One way is through our Select Ten Portfolios. These unit trusts buy and hold for approximately one year the 10 highest-dividend-yielding stocks of the DJIA (they can be referred to as the "Strategy Stocks"). Then, as that portfolio liquidates, you can reinvest the proceeds into a new portfolio of Strategy Stocks for the nest year, if available. Or, you can take the proceeds in cash.

Let's take a look at how this strategy has worked in earlier series. The chart below shows average annual total returns for each of the three series, which assume an annual "rollover" into the next portfolio. Also included are returns for the most recently completed portfolio of each series:

Series from Inception through 9/30/96. Most Recently Completed-Portfolio

Inception Period	Return	Return
A Series—1/3/92	34.72%	14.30%
1/9/95-2/23/96		
B Series—5/17/91	25.32%	14.48%
5/10/95-6/30/96		
C Series—9/1/92	24.41%	16.90%
9/7/94-9/30/95		

Be aware that past performance is no guarantee of future results.

Henry Wiesel is a Vice-President/Financial Consultant and Qualified Pension Coordinator with Smith Barney. To obtain a free brochure on "The Dow Ten," contact Mr. Wiesel at Smith Barney, 1040 Broad St., Shrewsbury, NJ 07702; (800) 631-2221, ext. 8653.

OFF THE SHELF

"Understanding Digital Signal Processing" gives readers the tools to develop a fundamental understanding of digital signal processing (DSP) theory. Featured is a detailed look at periodic sampling with discussions on both low-pass and bandpass signals. Also explained is the discrete Fourier transform and its fast Fourier transform (FFT) implementation. In addition, the book examines various methods for signal averaging, and discusses the benefits of exponential averaging. The 544-page book is priced at $55.90. Contact Addison-Wesley Publishing Co., Corporate & Professional Publishing Group, One Jacob Way, Reading, MA 01867; (800) 822-6339; Internet: http://www.am.com/cp/.

"America's Best—IndustryWeek's Guide to World-Class Manufacturing Plants" profiles 62 leading-edge manufacturing companies judged as "Best Plant" by IndustryWeek editors. The book explains the essential components of world-class manufacturing, their individual make-up, and how they interact with each other. Each company profile includes coverage of the programs, tools, and techniques currently in use at each plant, and a listing of contact information for individual plants. Also included is a set of the winners' statistical measurements that can be used in benchmarking a particular organization. The 430-page book is priced at $27.95. Contact John Wiley & Sons Inc., 605 Third Ave., New York, NY 10158-0012; (212) 850-6336.

INTERNET NEWS

Shedding Light On Software Solutions—Encouraging the continuing evolution of smart consumers, Firefly Network has opened up its software tool suite to developers and advertising companies throughout the World Wide Web. Some of the companies that have already licensed the tool suite include NewMedia, Reuters, Yahoo!, and ZD Net.

The tool suite is based upon the Firefly Passport technology. The Passport is carried by users throughout Firefly-enabled sites. It holds demographic and preference information that helps in identifying the particular user. A total of about one million people have already registered for the Firefly Passport. The tool suite will allow webmasters to recognize and register Passport holders, send out personalized recommendations, organize communities of like-minded individuals with common interests, provide directed advertisements, and also monitor site activity.

For more information on the tool suite, readers should contact The Firefly Network, 17 Sellers St., Cambridge, MA 02139; (617) 234-5400; fax (617) 234-5414; Internet: http://www.firefly.net.

Video And Voice Communications To Improve—DataBeam Corp. and Intel have teamed up to develop, distribute, and market new technology that is compliant with the H.323 standard.

The H.323 standard is aimed at video and voice communications over packet-switched networks. The two corporations' efforts will be targeted at third-party developers who intend to formulate real-time conferencing applications.

DataBeam is currently planning to incorporate Intel's H.323 software within its cross-platform developer toolkits. The software supports call setup and multipoint conference control. The kits come complete with fully-documented APIs, customer support, and interoperability test harnesses.

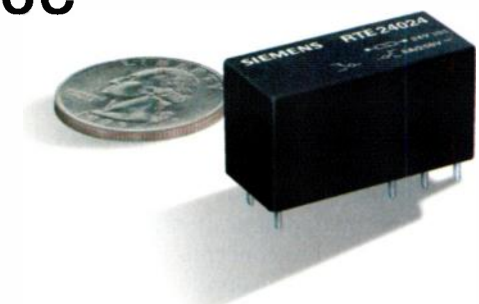
For more information, contact DataBeam Corporation, 3191 Nicholasville Rd., Lexington, KY 40503; (606) 245-3517; fax (606) 245-3528; Internet: http://www.databeam.com.

Correction

In the "Offers You Can't Refuse" section of QuickLook in the Nov. 18 1996 issue, an incorrect phone number appeared in the story regarding Heurikon Corp.'s free offering of a white paper entitled "A Vision for the Advanced Intelligent Network." The correct phone number is (608) 831-5500. The editors apologize for the error.

SIEMENS

RT series relays are small in size, but deliver big performance



RT series relays rise only 0.62" (15.7mm) above the PC board, but they switch up to 16A at 240VAC. And they provide 8mm spacing between contacts and coil for more than 5kV isolation. That's a level of performance you might not expect from a relay this small.

The RT doesn't sacrifice life expectancy, either. Life at various loads is appropriate for appliances, HVAC systems, industrial controls, and computer peripherals.

Check out these features:
- Silver-nickel 90/10 contacts
- SPST-NO through DPDT contacts
- 8, 12, and 16 amp models
- Choice of immersion cleanable or flux-tight enclosure
- Withstands 10kV surge
- Sensitive, 400mW coil
- UL Class F insulation system
- UL recognized, CSA certified, VDE approved

How do we top all that? Easy. We produce the RT on fully automated lines for consistent quality, then use environmentally-friendly, returnable plastic shipping containers. And we provide the level of service you've come to expect from Potter & Brumfield Products Division, an ISO9001/QS9000 company that's been delivering dependable, innovative switching solutions for more than 60 years.

Find out more. From the U.S. or Canada, use a touch-tone phone and our automated fax-response system. Simply dial 812.386.2561 and request document #7800. Or, follow the prompts to speak with your sales representative.

Siemens Electromechanical Components, Inc.
Potter & Brumfield Products Division
200 South Richland Creek Drive
Princeton, IN 47671-0001
Fax 812.386.2072
e-mail: info@ae.sec.siemens.com

Potter & Brumfield Products Division
Siemens Electromechanical Components, Inc.

QUICKNEWS

Multisite Manufacturing And Distributing Driven By The Information Bus—Fourth Shift Corporation has banded together with TIBCO to produce next generation manufacturing software. Incorporating TIBCO's The Information Bus (TIB) technology within Fourth Shift's new OBJECTS Enterprise software, allows TIB to become the messaging backbone for company-wide communications.

OBJECTS Enterprise software is based on the Windows NT environment and functions as an object-oriented application, enabling TIB to act as publish-subscribe middleware. The OBJECTS software was designed to help multisite manufacturing and distributing companies globally interconnect via dial-up line, Internet, LAN, WAN, or wireless means. Concentrating on the trend of companies moving their manufacturing processes and distribution networks far from headquarters, Fourth Shift used the decentralized philosophy to design the new software.

Using the TIB platform, OBJECTS enables event-driven information exchange among distributed applications throughout the company, establishing a unified system for the users. This publish-subscribe communications technology uses a patented subject-based addressing scheme to allow professionals to receive the information they need without having to request it each time they need it. It also allows users to utilize the system without having to know where the information originates.

Over the last decade, TIB has been used in the financial services market to manage information integration. More recently, the TIB technology has been a resource for non-stop manufacturing operation in the semiconductor and electronics industries.

For more information, contact TIBCO Inc., 3165 Porter Dr., Palo Alto, CA 94304; (415) 846-5000; fax (415) 846-5005; Internet: http://www.tibco.com.

Production Quantities Of PCI Controllers Ready for Embedded Systems Market—Expanding its product line further to include a newly emerging standard, V3 Semiconductor has introduced the PBC family series of I20-ready peripheral component interconnect (PCI) bridge controllers. The intelligent I/O controllers are offered in single and dual configurations.

According to V3 Semiconductor, the new controllers are the first I20-ready PCI bridge controllers on the market to support Intel's I960 processors in embedded systems applications. The I20-ready PCI bridge controllers also directly support several other reduced instruction set computing (RISC) processors for embedded systems.

The highly integrated V96X PBC and V29X PBC product lines of single PCI bridge controllers are now being offered by V3 Semiconductor in production quantities. The dual bridge controller product line, V96X DPC also is available in production quantities.

Some intended applications for the PCI bridge controllers include ATM switches, facsimile machines, image processing systems, intelligent network cards, laser printers, multimedia applications, network communications equipment, PCI-based desktop subsystems, robotics and industrial controls, and telecommunications switching equipment.

The benefits of the Plug and Play PCI standard have also been seen in high end printers and intelligent PC add-in cards.

For more information, contact V3 Semiconductor, 2348G Walsh Ave., Santa Clara, CA 95051; (800) 488-8410; fax (408) 988-2601; Internet: http://www.vcubed.com.

CD-ROM Technology Links With Internet—Dublin, Ohio-based Metatec Corporation has announced the availability of Metatec Access. The new service from the information technology and CD-ROM replication house combines production capabilities and software tools with the experience of Metatec's stable of engineers to help companies create multimedia-based information networks.

Metatec Access uses CD-ROM, Internet, server technologies, and the experience of Metatec professionals to provide a method for business professionals to create new and innovative electronic information distribution systems. These systems bring animation, audio, data, images, text, and video to businesses that need to deliver their information in a easy-to-use and compelling format.

The company expects the widening bandwidth projected in the future to benefit Metatec Access customers. Currently, the CD-ROM side of the applications provide the lion's share of the capacity, multimedia capabilities, and speed needed to drive the exchange of information. Combining those advantages with the immediate updating capability of Internet connections, Metatec uses the now-limited bandwidth of the Internet to provide the most flexibility to information providers.

In addition, Metatec Access offers users concept-to-design and production-to-implementation services. These services are offered as part of Metatec's full management services.

Using the Metatec Access service puts businesses in touch with professional animators, graphic artists, multimedia designers and producers, and systems programmers and developers. Software included in the Metatec Access package features advertising applications, bulletin boards, chat centers, a customizable CD-viewer interface, database access, e-mail, transaction tracking, usage tracking, and web page development. All of Metatec Access' components are compatible with industry standards.

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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.

Sixth System Administration, Networking, & Security Conference, Apr. 21-26. Baltimore Inner Harbor, MD. Contact USENIX Conference Office, 22672 Lambert St., Suite 613, Lake Forest, CA 92630; (714) 588-8649; fax (714) 588-9706; e-mail: conference@usenix.org; http://www.usenix.org.

IEEE International Conference on Robotics and Automation, Apr. 21-27. Albuquerque Convention Center, Albuquerque, NM. Contact Jerry Stauffer, Intelligent Systems and Robotics Center, Program Office, MS0949, Sandia National Laboratories, Albuquerque, NM 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, California 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 1997

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, MD 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, PA. Contact Barry Hornberger, Philadelphia Electric Co., 2301 Market St., Bldg N3-1, Philadelphia, PA 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, CA 90034; (310) 287-1463; fax (310) 287-1851; e-mail: bob.myers@ieee.org.

OEMed Midwest, May 21-22. Rosemont Convention Center, Rosemont, IL. Contact Exposition Excellence Corp., 112 Main St., Norwalk, CT 06851; (203) 847-9599; fax (203) 854-9438.

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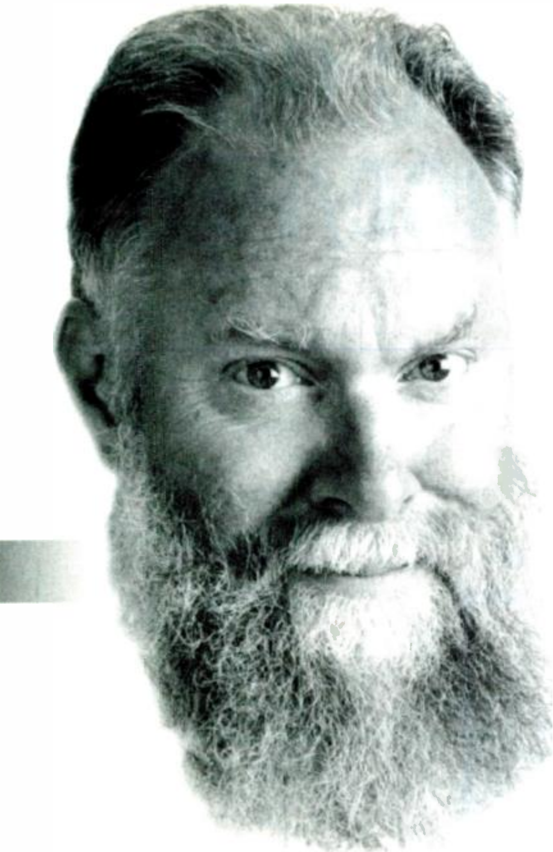
Canadian Conference on Electrical & Computer Engineering, May 25-28. Delta Hotel, Newfoundland, Canada. Contact David Collett, Newfoundland & Labrador Hydro, P.O. Box 12400, St. Johns, NF, A1A 4K7, Canada; (709) 737-1372; fax (709) 737-1782; e-mail: t.d.collett@ieee.org.

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, Department of Electrical Engineering, Kwangwoon University, 447-1 Wolgye-Dong, Nowon-Ku, Seoul, 139-701, Korea; (82)-2-910-5144; fax (82)-2-942-0107.



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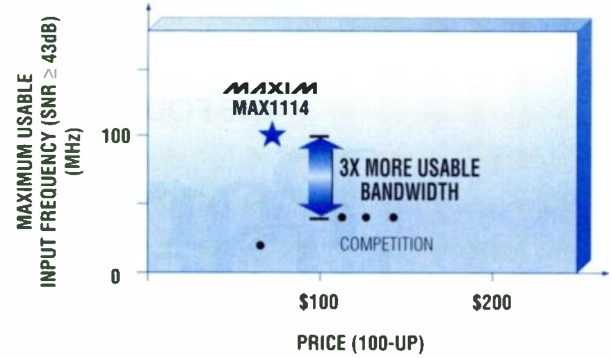

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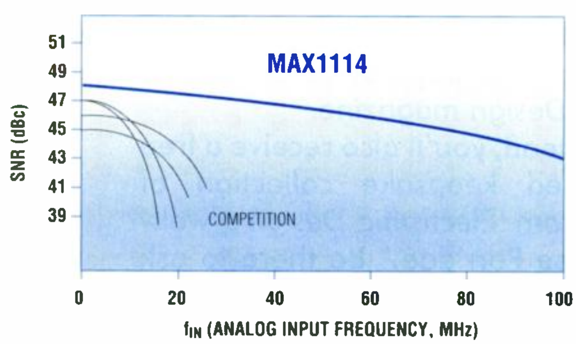

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Circle No. 125 - For U.S. Response
Circle No. 126 - For International

Circle 520

RTD To RS-232 Interface

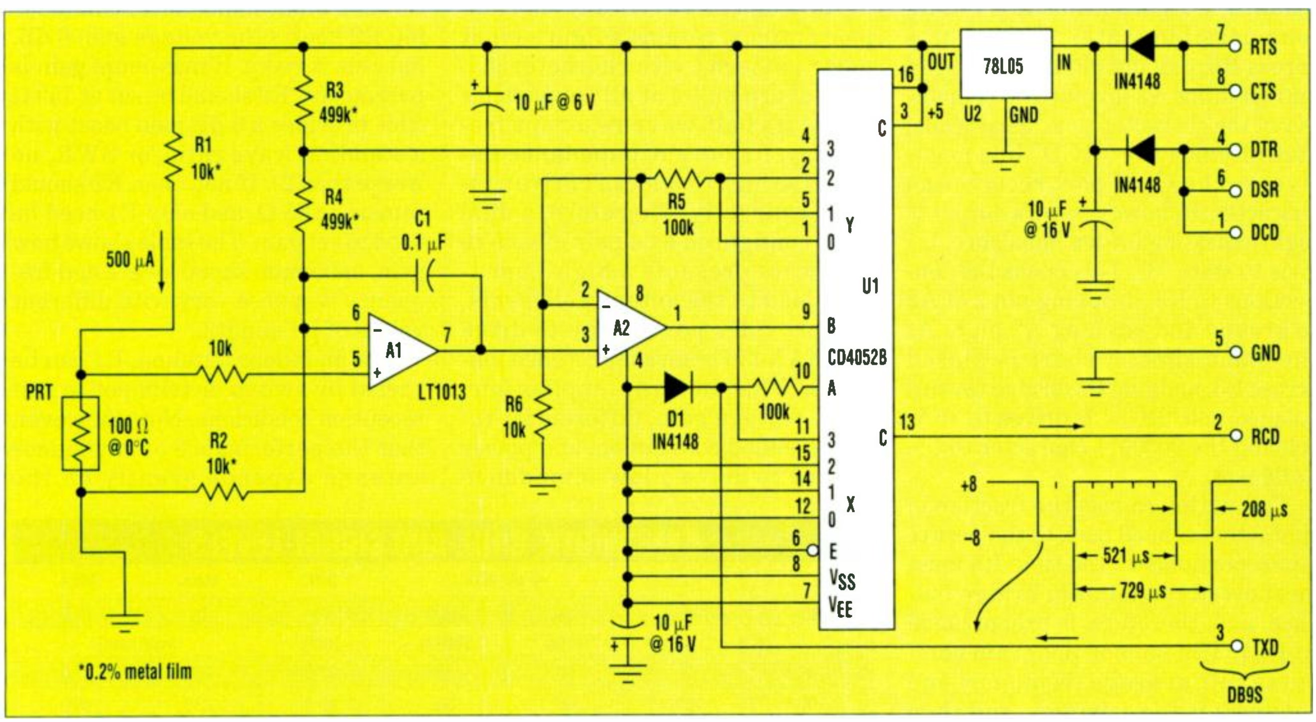
W. STEPHEN WOODWARD
Venable Hall, CB3290, University of North Carolina, Chapel Hill, NC 27599-3290; Internet: woodward@net.chem.unc.edu.

A popular type of precision temperature sensor is the "100-W" platinum resistance thermometer (PRT) or resistance temperature device (RTD). The well-characterized, highly-stable and nearly-linear temperature response (usually 0.385% per °C) of these sensors, combined with their ability to work over a -200°C to +200°C range (much higher in some packages), makes them versatile and robust.

The circuit shown *(see the figure)*, combined with simple software *(see the listing)*, represents an accurate, simple, and inexpensive interface that works with any MS-DOS-compatible PC with an RS-232 port. The transducer obtains operating power from the port, so no additional power supply is needed. It achieves accuracy to better than ±1°C with no internal precision components, except for four resistors.

The values given cover the 0 to 180°C temperature range and achieve nearly 0.1°C resolution at a 1-Hz conversion rate. "Four-wire" excitation and sensing of the PRT reduces errors from sensor lead resistance by a factor of 100. Sensor excitation current is a low 500 µA, limiting sensor power dissipation to

```
SCREEN 1:
CLS : PRINT "  ***************************************"
      PRINT "  ******  PRT "; CHR$(196); CHR$(16); " RS232 demo  ******"
      PRINT "  ***************************************"
      LOCATE 6, 1: PRINT "RTD Temp, Ohms =";

'   18.2065 ... #  of MSDOS-compatible Time-of-Day "ticks"/second
DEF SEG = 0: 'T.O.D. clock lives at memory addresses (&H46C,D)

' Generate PRT readout string
prt$ = "": FOR i% = 1 TO 1342: prt$ = prt$ + CHR$(&H10): NEXT

DIM t%(1342), r%(1342): ' Generate temperature and resistance lookup tables
FOR i% = 0 TO 1342
   rtd = .0522 * (1900 + i%): ' convert index to resistance
   r%(i%) = 100 * rtd
  t%(i%) = ((((((2.24696.E-06 * rtd) - 1.06721E-03) * rtd) + .287283) * rtd) + 221.574) * rtd - 24189.1
   NEXT

' Setup COMport to accept PRT character stream
    OPEN "COM1:9600,N,5,1,BIN,RB2000,TB2000" FOR RANDOM AS #3

Thermometer
 PRINT #3, prt$; : ' Drive PRT resistance -> digital conversion
 sum% = 0: ' Reset PRT character tally
 FOR tclk% = 1 TO 18: ' Sum PRT pulses for 18/18.2065Hz = 0.9887 second
    y% = PEEK(&H46C): WHILE PEEK(&H46C) = y%: WEND: ' Await a T.O.D. tick
    x% = LOC(3): sum% = sum% + x%: a$ = INPUT$(x%, 3):
    NEXT
 LOCATE 6, 17
 temp = t%(sum%) / 100: PRINT USING "###.#": temp; : PRINT CHR$(248); "C ";
 PRINT USING "###.#"; temp * 1.8 + 32; : PRINT CHR$(248); "F ";
 PRINT USING "###.##"; r%(sum%) / 100; : PRINT CHR$(234);
 GOTO Thermometer
```



COMBINED WITH SIMPLE SOFTWARE, this circuit becomes an accurate, inexpensive RTD interface that works with any MS-DOS compatible PC with an RS-232 port.

25 μW, thus holding self-heating error to << 0.1°C.

The PRT is connected in a bridge consisting of R1, R2, and the series combination of R3 and R4. LT1013 integrator A1 accumulates any imbalance signal from the bridge, which nulls when $R_{prt}/R1 = R2/(R3 + R4)$. This occurs near $R_{prt} = 100\ \Omega$ for the values shown: 100/10k = 10k/1M. For higher temperatures, $R_{prt} > 100\ \Omega$ and A1's output ramps up. Comparator A2 combines with the dual CD4052B multiplexer U1 to close the feedback loop around A1 by periodically shorting across R2, thus increasing the average value of the denominator in the right side of the bridge equation. This restores bridge balance for temperatures as high as 180°C. The ratiometric nature of the bridge topology makes conversion accuracy insensitive to power-supply drift, so no precision voltage reference is needed.

Digitization of sensor resistance is driven by RS-232 characters of the binary pattern (including start/stop bits) of 0000011, transmitted by the PC COM port on "TXD." As usual, "0"s are represented by positive voltage on the RS-232, and "1"s by negative voltage. With the arrival of each character, U1 samples the state of A2's output. If low, indicating bridge balance, U1 goes into state 1 of its four possible states. This shorts across R5, driving pin 2 of A2 to 5 V and latching A2 low for the remainder of the character time. Meanwhile, state 1 holds the "RCD" line negative, so the COM port receives no character. If, however, A2's output is high, indicating bridge imbalance, U1 goes to state "3". This opens the connections to R5, dropping pin 2 of A2 to ground and latching A2 high. At the same time, a short is placed across R3, nudging the bridge toward balance, and "RCD" is driven to +5 V, echoing the 0000011 character to the COM port.

This action causes the fraction of characters echoed back to the port to be proportional to the time R3 must be shorted to maintain bridge balance, and, therefore, is proportional to R_{prt}. The sensor program computes this average frequency and converts it to resistance and then temperature using a 4th-order linearizing polynomial.

Circle 521

High-Gain Broadband Active Antenna

M.J. SALVATI
150-46 35th Ave., Flushing, NY 11354; (718) 358-0932.

Presented here is a high-performance, general-purpose version of the application-specific antenna Idea for Design published previously ("A Miniature Broadband Antenna," *Electronic Design*, Feb. 20, 1995, p. 107). Though based on the same principles, this new implementation provides the weak-signal reception characteristics desired by the readers who inquired about the original design.

What resulted is a high-gain, low-noise, active antenna covering the 100 kHz to 40 MHz frequency range that's capable of nulling out on-frequency interference *(see the figure)*. Because it's untuned, it can be either manually rotated indoors, or electrically rotated on an outdoor mast. Also, since the device works into a 75-Ω load, it can be connected to the receiver with any length of RG59U cable.

Although an electrically short dipole antenna retains a figure-eight polar pattern (with characteristically sharp nulls) at all frequencies below its half-wave resonant frequency, its output impedance becomes so high that it can't drive a receiver directly. Therefore, a dual FET configured as a pair of source followers presents a high-impedance load to the antenna elements, and provides power gain to drive the MAX436 transconductance amplifier. This, in turn, supplies low-noise voltage gain, differential-to-single-ended conversion, and power output to drive a low-impedance load. The amplifier's output is coupled via a toroidal transformer. This multiplexes the output signal and dc supply voltage on the coax connecting the antenna unit with the power-supply/receiver end of the system, where a similar transformer separates power and signal.

The circuit is configured for single-supply operation of the MAX436 by biasing its inputs (pins 2 and 6) at approximately +5 V, and returning its on-board load resistor (R2) to a virtual ground set at half the 10-V supply voltage (via the LM759 and its voltage divider).

The differential voltage gain of the entire circuit is set somewhere in the 13-30 dB range by gain-set resistor R1 and on-board load resistor R2. The ideal value of R2 is 75 Ω, as this value back-matches the connecting cable, and ensures stable operation of the MAX436 regardless of the receiver's input impedance. Eliminating R2 boosts the voltage gain 6 dB, but this is risky. If maximum gain is paramount, R2 should be set at 150 Ω (this provides a 3-dB gain boost with a standing wave ratio, or SWR, no worse than 2). If not, then R2 should remain at 75 Ω, and only R1 need be used to set gain. The table shows how gain, maximum signal levels, and frequency response vary with different values of R1 and R2.

For an indoor antenna, R1 can be varied by switch or trim pot to suit reception conditions. Note, however, that the performance of any indoor antenna depends greatly on the

BANDWIDTH, GAIN, AND SIGNAL LEVELS

R1	R2	-3 dB BW Low	-3 dB BW High	Diff. V_G	Max. In	Max. Out
(Ω)		(kHz)	(MHz)	(dB)	(mV rms)	
100	75	50	39	12.8	233	510
100	150	56	36	15.3	230	670
27	75	50	31	23.9	62	490
27	150	56	29	26.4	61	640

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Model	Freq. Range (MHz)	Phase Noise (dBc/Hz) SSB @10kHz Typ.	Harmonics (dBc) Typ.	Current (mA) @ +12V DC Max.	Price (Qty.5-49) $ ea.
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POS-75	37.5-75	-110	-27	20	11.95
POS-100	50-100	-107	-23	20	11.95
POS-150	75-150	-103	-23	20	11.95
POS-200	100-200	-102	-24	20	11.95
POS-300	150-280	-100	-30	20	13.95
POS-400	200-380	-98	-28	20	13.95
POS-535	300-525	-93	-26	20	13.95
POS-765	485-765	-85	-21	22	14.95
POS-1025	685-1025	-84	-23	22	16.95
NEW POS-1060	750-1060	-90	-11	30*	14.95
NEW POS-1400	975-1400	-95	-11	30*	14.95
NEW POS-2000	1370-2000	-95	-11	30*	14.95

*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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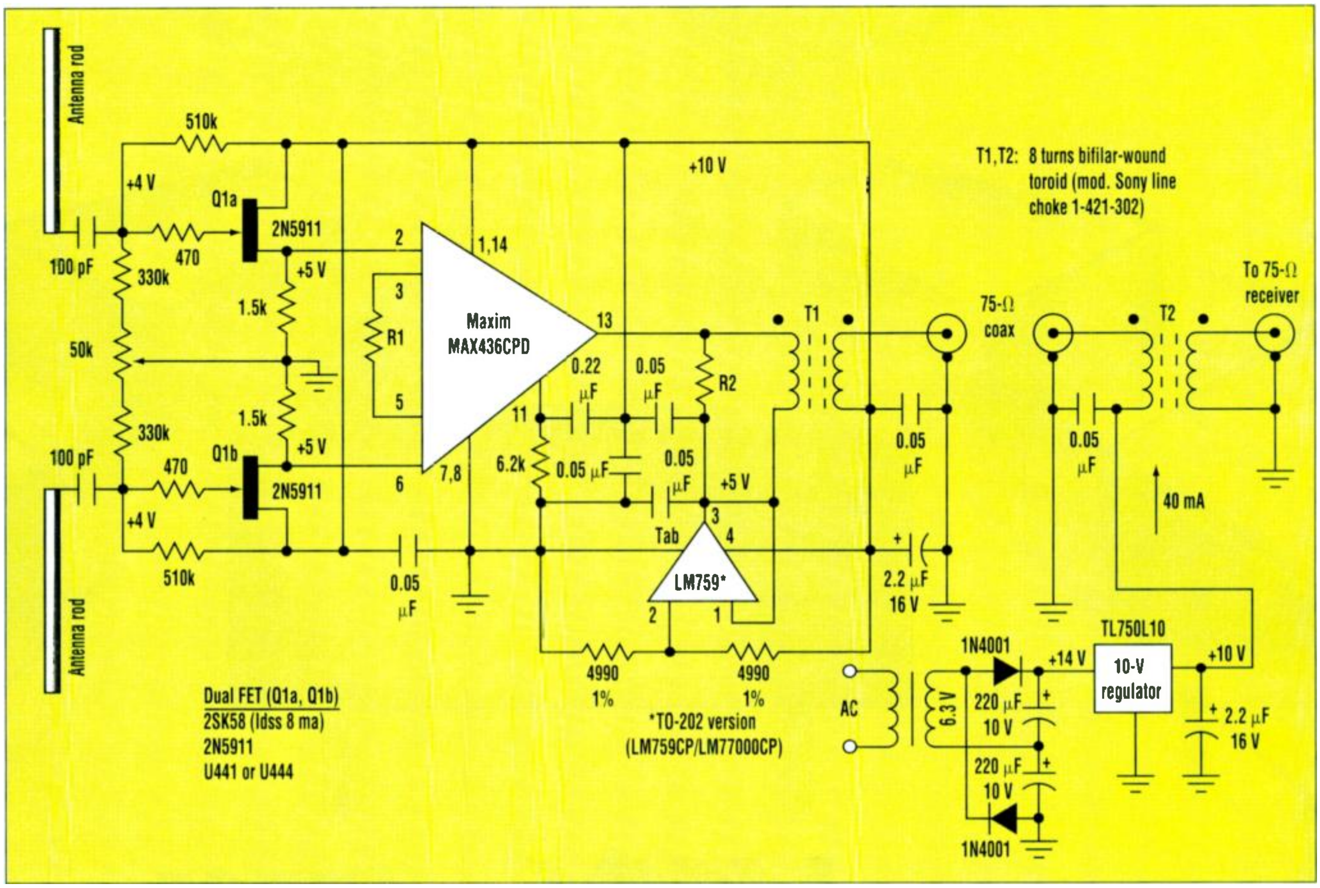
noise environment at the antenna site, and the degree of signal attenuation produced by the building's walls.

For indoor use, telescoping antenna elements (salvaged from TV "rabbit ears") are recommended so that they can be adjusted to fit the space available. For outdoor use, two six-foot lengths of 1/4-inch O.D. (outside diameter) aluminum tubing are ideal. Because it's important to minimize the input capacitance of the source followers, miniature carbon-film resistors as well as minimal board footprints should be used for the gate connections. The 50k trim pot should be adjusted for equal clipping of the output signal peaks at just past the maximum output. For additional construction details and operating instructions, refer to the Feb. 20, 1995 article in *Electronic Design*.



THIS HIGH-GAIN, LOW-NOISE version of an active antenna published previously in *Electronic Design's* Ideas For Design section covers the 100-kHz to 40-MHz frequency range and can null out on-frequency interference.

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Circle 522

Diff Amp Acts As Load For Mixer

JIE ZHOU and JAN VANDEWEGHE

INTEC, University of Gent, St. Pietersnieuwstr, 41, B-9000, Gent, Belgium, telephone: +32-9-2643338; fax: +32-9-2643593.

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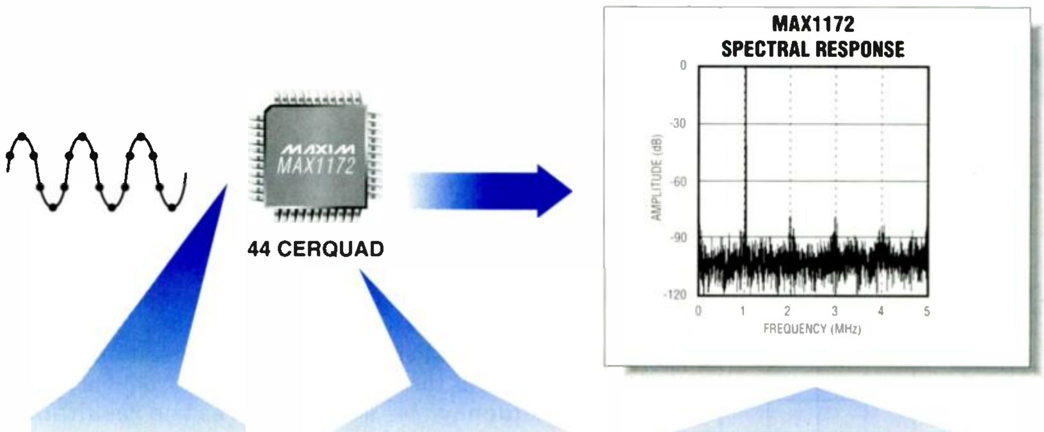

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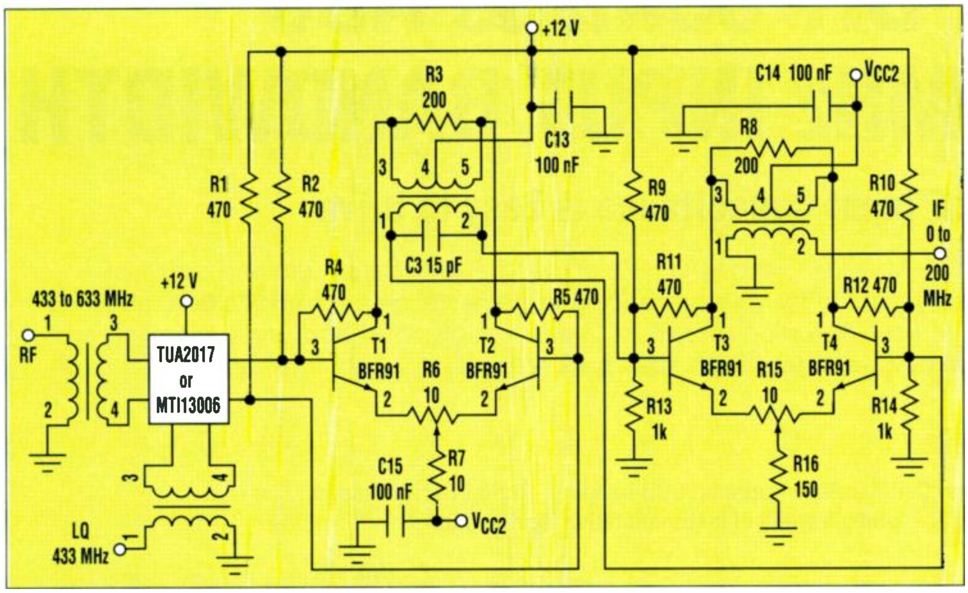
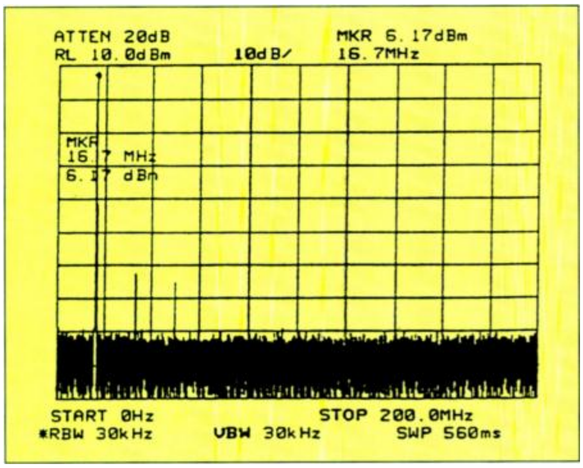
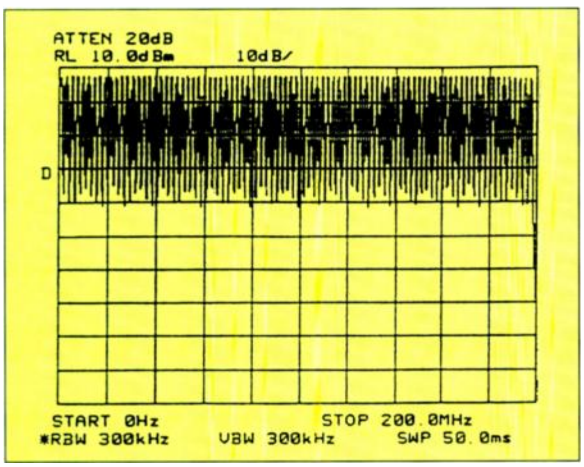


1. A DIFFERENTIAL AMPLIFIER, which is configured to be the load of a mixer, can suppress the distortion products in the IF bandwidth as the RF input frequency is swept across a particular range.



2. THE MEASURED frequency results at the IF output (IF frequency is 16.7 MHz and RF frequency is 449.7 MHz) proves that the harmonic and intermodulation products are well-suppressed.



3. WHEN THE RF FREQUENCY IS SWEPT, amplitude ripple within the IF bandwidth (0 to 200 MHz) is less than 0.5 dB.

the IF filter. But the performance of the mixer can be dramatically affected by the mismatching and conversion loss because of a changing operating point. In a broadband system, as the RF input frequency is swept across a certain range, it's very difficult to keep all of the distortion products out of the IF bandwidth. In this case, a method for suppressing the distortion products becomes significantly important.

This Idea for Design provides a simple, low-cost method for solving this problem *(Fig. 1)*. Two different amplifier stages are used as the load of the mixer TUA2017 or MTI3006 (products developed by Siemens Co.). The LO frequency is fixed at 433 MHz, because a commercial SAW oscillator at 433 MHz can be used as a local oscillator (it's not included here). If the RF frequency is swept from 433 to 633 MHz, then the IF frequency also is swept from 0 to 200 MHz.

It's well known that a differential amplifier has good balance characteristics. Its high common-mode rejection ratio (CMRR) makes it possible to further suppress harmonic and intermodulated products. Compared to a passively loaded mixer, this combination of mixer and differential amplifiers exhibits excellent performance. The relative amplitude (amplitude difference between the fundamental frequency and the largest distortion frequency) is typically at least 50 dB. But it's only 30 dB or less in the case of a passive load mixer. Figure 2 illustrates the measurement result when the IF frequency is 16.7 MHz (RF frequency is 449.7 MHz). This result measured by the HP spectrum analyzer proves that the harmonic and intermodulation products are well-suppressed.

Resistors R4, R5, R11, and R12 are used as the shunt feedback to obtain the flat output amplitude when the RF frequency is swept. Figure 3 gives the result measured by the spectrum analyzer. The amplitude ripple with the IF bandwidth (0 to 200 MHz) is less than 0.5 dB.

AUTHORS

Ideal submissions contain 1 - 1 1/2 pages of single-spaced typewritten text and one or two circuit diagrams, tables, plots or listings.

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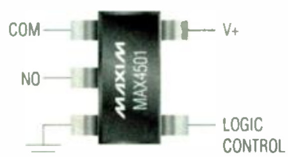

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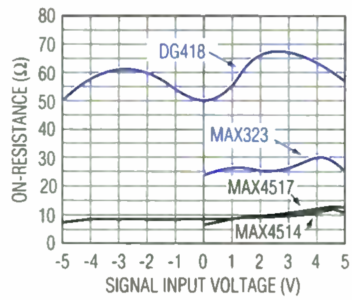
	MAX4501/14	MAX4502/15
Low	OFF	ON
High	ON	OFF

ON-RESISTANCE vs. SIGNAL VOLTAGE



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MAX4503	SPST (NO)	±2 to ±6	250	1	DG418DY
MAX4504	SPST (NC)	±2 to ±6	250	1	DG417DY
MAX4514	SPST (NO)	+2 to +12	20	1	TC7S66F
MAX4515	SPST (NC)	+2 to +12	20	1	TC7S66F
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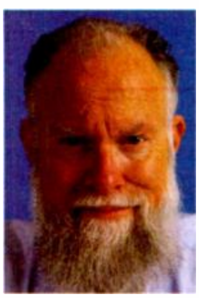
BOB PEASE

What's All This Thermistor Stuff, Anyhow?

Well, I must admit that I almost never used thermistors, over the last 30 years. I knew some guys that *did* use them, but the things they were doing, I was *not*. Finally in 1980, a friend of mine was having a lot of trouble, trying to make some temperature-compensated log amps. Since he was only trying to cover a moderate temperature range, I figured I could get some thermistors to help him out. He had some bad temperature drift problems. His circuits were not behaving as expected. It turned out that he had some 1.5-Meg resistors that looked just like metal films—but they weren't. They were carbon films, with a horribly big tempco. When he put in good metal film resistors (better than 100 ppm/°C), his problems went away. We didn't need thermistors, after all. But if I did need them, I could have used them.



BOB PEASE OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

More recently—yesterday, in fact—a guy asked me, how can he make a precision current meter at the 10-pA level? He needed to do 0.1% accuracy. I asked him, surely the LMC662 is inexpensive and has low-enough I_b? He said he had just discovered that amplifier, and it would improve both his error budget and his cost budget—EACH by a factor of 10 over the amplifier he had been using. Now all he had to find was a good resistor with low tempco. He had been using some 100 gigohm (100k megohm) resistors, but the tempco was –2500 ppm/°C. Then he found that these resistors had bad voltage coefficients—in the range of 0 to ±10 V, the resistance varied 30 percent. Hey, we all take Ohm's Law for granted, but not all resistors obey it!

He had already figured out that he had to buy some resistors that were stable *and* linear. He told me that he knew he could get an effective feedback resistance of 100k megohms, by getting some good 1000-megohm resistors, and connecting them with a Noise Gain of 100, using the classical TEE network *(Fig.1)*. The Noise Gain is 1 + R_b/R_c, so the effective feedback resistor = R_a × Noise Gain. (This is assuming R_a is MUCH higher than R_b or R_c; then you don't have to compute the Wye-Delta Transforms of every resistance.)

I figured I might be able to give him some advice on how to get better results, using available resistors. I suggested that a Noise Gain of 1.1 to 2 is fine; a Noise Gain of 2 to 12 may be livable; but a Noise Gain of 100 was usually not a great idea. On the other hand, he did have to get resistors that were at least LINEAR. The temperature coefficient didn't have to be *low*, but at least it should be well-behaved. Then after he had a resistor that was working *rationally*, he could, I suggested, (all this was by e-mail) easily use a TEE network to correct the tempco of his main resistor.

In the case of Figure 1, I told him he could set up a wirewound resistor with a linear tempco of +3400 ppm/°C, in the upper leg of his TEE network. If you choose the right values of the other resistors, you can do a pretty good approximation of flattening out the tempco of the gain. For example, if R_a is 10k megohms at –250 ppm/°C, a 1-kΩ temperature-compensating resistor R_{b1} will work with $R_{b2} = R_c$ = 7.5 kΩ to cancel out the tempco of R_a. Cancelling out the tempco of even a –2500 ppm/°C resistor is feasible. Try R_{b2} = 0, and R_c = 499 Ω. As this Z is kind of low to drive, you might try a 5-kΩ temp compensating resistor as R_{b1}, and 2.49 kΩ at R_c.

I explained that these little temperature-compensating wire-wound resistors are available from the same guys that make precision wirewound resistors—just look them up in EEM. They're likely to cost as little as $2 (so long as you don't ask for an R value higher than a few kohms). I said that these special wirewound resistors would surely help him a lot. But he might be able to get the same job done with thermistors that cost as little as a dollar.

NOW, hasn't National been running some advertising recently, saying that thermistors are obsolete? Well, yes, for linear temperature sensing applications. If you just want a sensor to put out 5 or 10 mV/°C, you can do it with thermistors, sort of, but only over a narrow temperature range. Outside of a 30° temperature range, you lose linearity rapidly, because thermistors are inherently logarithmic. The new LM45, LM50, and LM60* are much more linear over a wide temperature range (-40 to +125°C). Even over just a 40° span, thermistors don't give as good linear results.

On the other hand, in a narrow temperature range, you can use thermistors to compensate in ratiometric circuits, such as the one shown in Figure 2. Integrated Circuit temp sensors don't help you there! For example, if you have the case of R_a = 10k megohms at –250 ppm/°C, you can use a thermistor as shown to fix that. First I put a 1-kΩ metal-film (low tempco) resistor R_{c2} across a thermistor R_{c3}** that is 1 kΩ at +25°C and changing exponentially at (-4.9%/°C). This means that at 35°C, the thermistor's impedance decreases to 1 kΩ × $(1.049)^{-10}$. Conversely at +20°, the impedance rises exponentially to 1 kΩ × $(1.049)^5$. At 15° it will rise to 1 kΩ × $(1.049)^{10}$. (At 0°C, it would get up to 3.3 kΩ, and at –25° C, to 11 kΩ!)

I made a list of the impedance of the 1-kΩ parallel to the thermistor, as a function of temperature. Some people might use a spread sheet, but I would never do that, because I want to get a feel for the numbers. The result is that the nominal 500-Ω resistance changes linearly at –9.91Ω/°C, with a fairly small deviation from that

BOB PEASE

slope (perhaps as big as 1 Ω) in the 18 to 37°C range. Hey, that is a useful amount of linear resistive change!

Now in Figure 2, if you install 10 k as R_{c1} and R_b, the tempco of R_c would be –940 ppm/°C. By inspection, this would tend to cancel out the tempco of a –470 ppm/°C resistor at R_a. Therefore, with 10 kΩ, we are overcompensating. Try 19.1-kΩ metal films at R_b and R_{c1}. Bingo! (Note, the computations are easier if the total value of R_c and R_b are the same, but I prefer to make R_b and R_{c1} of equal value, because the tempcos of metal film R's from the same batch tend to match—they track better than randomly chosen resistors of different values.) (Works even better if you select adjacent resistors off the tape!!)

So if you have a consistent, small tempco in one resistor, the TEE network lets you correct the gain's tempco over a moderate temperature range. Admittedly, this is likely to work well only over a small temperature range, perhaps from 15 to 45°C, but this engineer had explained that range was plenty good enough.

On the other hand, one advantage of thermistors is, that you can do some nonlinear corrections. What if the actual tempco of R_a was –230 ppm/°C at +15°C, and –270 at +35? (Or, vice versa??) It's well known that if you get very far away from the linear zone of a thermistor circuit, its gain becomes nonlinear. If instead of putting a 1-kΩ thermistor across a 1-kΩ film, you use a 1.5-kΩ film or a 750-Ω film resistor, I'm sure you'd get some dandy curvature. Something like this would be very helpful to cancel out a case of nonlinear tempco of R_a. If you want to know what the temperature *is*, IC temp sensors are quite linear and easy to apply. No computations required, no resistor networks needed.

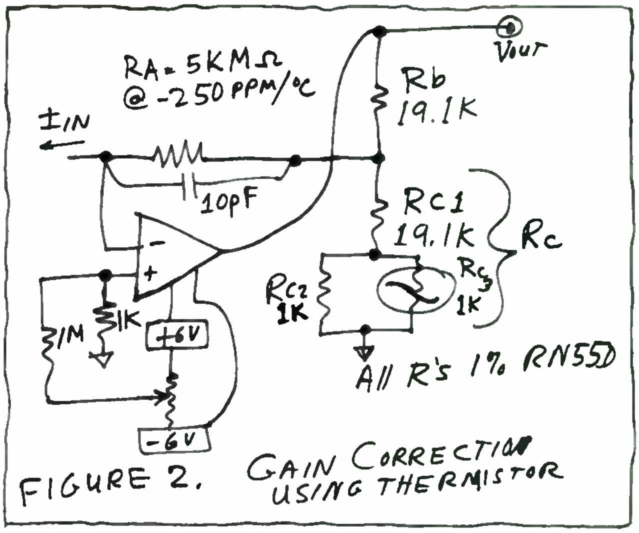


FIGURE 2. GAIN CORRECTION USING THERMISTOR

But if you want to correct for the gain of an imperfect resistor network, thermistors can be pretty *useful*.

What about the case where R_a has a big tempco of –2500 ppm/°C? That is pretty easy to fix, too. If you set R_b and R_{c1} = 1.21 kΩ, the tempco of the R_b is about –6000 ppm/°C, and this is enough to fix the gain. NOW, in some cases, an impedance of 2.9 kΩ is kind of heavy for the op amp to drive, and you might even get some self-heating in the thermistor. NOT a good idea. So you might raise the impedance of all those resistors by a factor of 5, and use a 5-kΩ thermistor.

Minor item of bad news: the tempco of a 5-kΩ thermistor is usually *not* exactly the same as for a 1-kΩ thermistor, so you might have to compute the network all over again. Still, a fairly minor amount of work. Less than an hour on your calculator. Much less than that, when you get in practice!

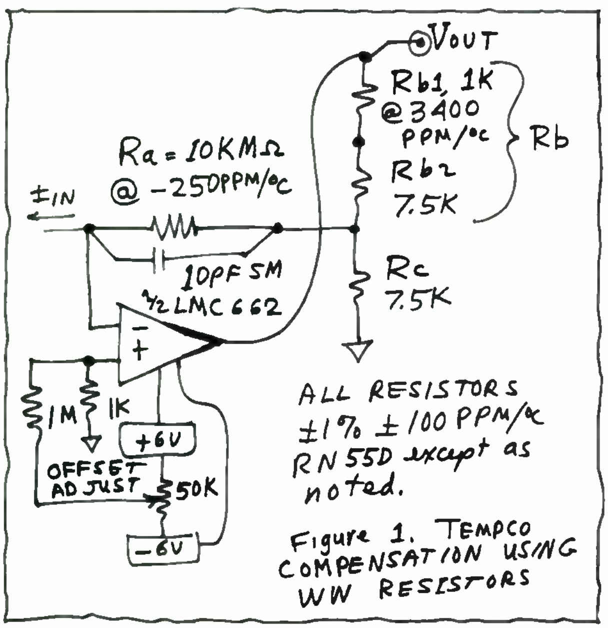


Figure 1. TEMPCO COMPENSATION USING WW RESISTORS

Or, since the tempco of R_a was so big, it's not critical if R_b does not perfectly match R_{c1}. In this case, you could try R_b = 20 kΩ, and R_{c1} = 3.01 kΩ, and you can keep the 1 kΩ at R_{c2} and the 1-kΩ thermistor at R_{c3}.

So the general rules of thumb I am proposing here are:

A. Temperature-compensating wire-wound resistors can have big linear tempcos such as 3400 ppm/°C (or more, or less) and you can use these to compensate for undesired tempco errors in a circuit's gain, over a broad temperature range.

B. If you put a thermistor in parallel with a resistor of about the same value, at the temperature of interest, the parallel impedance will change at about –2000 ppm/°C, fairly linearly for a narrow temp range. If you need *less* tempco than that, add a resistor in series. And:

C. If you have a TEE network, and a high-value resistor R_a is changing at a certain negative rate TC_a, you can compensate this with a resistor at R_b with a *positive* tempco about twice as big: choose $TC_b = -2 \times TC_a$, OR, a resistor at R_c with a big *negative* tempco $TC_c = + 2 \times TC_a$. This rule-of-thumb is applicable if $R_b = R_c$. If the ratio of R_b/R_c changes away from 1, that factor of 2 will change. So, you shouldn't think that I don't LIKE thermistors. Actually, they are quite handy and useful, if you know where and how to use them! And the engineer tried out this compensation, and he agrees it works well.

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

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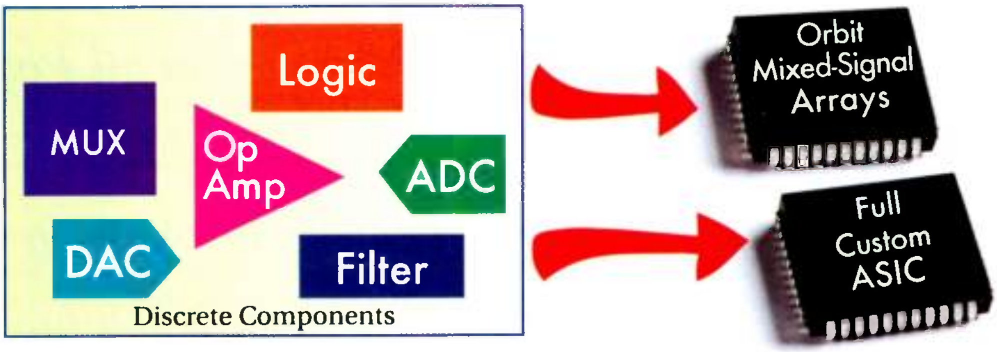

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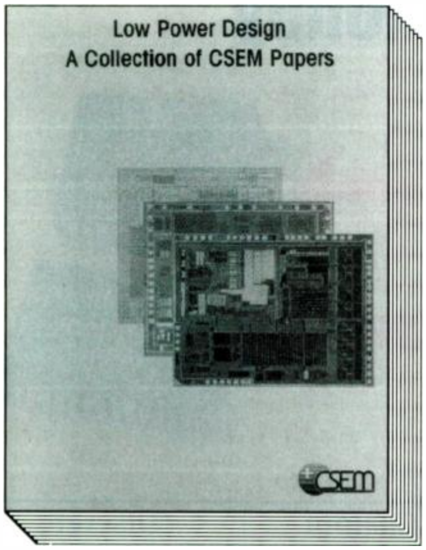

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WALT JUNG

Getting Net Connected: Some Sage Advice On Ins And Outs Of Going On-line

Are you on-line yet? If you believe all of the Internet hype, you'd think that access today was like telephone or TV. As of this writing, the frenzy hasn't abated—it has escalated. Given that, a "how-to" article risks instant obsolescence. Yet, even as things change, much stays constant. Below are my experiences from a year plus of Net connection. It was enough time for me to sample two major on-line services and seven Internet Service Providers (ISPs), and also learn about what mistakes not to repeat. It may help some newcomers to be spared from "Net connection" pains.

There are about five general considerations involved with successful Net connection. Here, we deal with them from a newcomer's Windows 3.1 perspective. For MAC users, and/or a broader view, I can recommend Paul Gilster's *The SLIP/PPP Connection* (Wiley, 1995). These considerations include type of service, software/hardware requirements, cost and obligations, support issues, and dial-in access points.

The type of service required for full *graphical* Internet access is either a Serial-Line Internet Protocol (SLIP) connection, or Point-to-Point Protocol (PPP). These allow your computer to talk to a chosen ISP through a standard dial-up modem to Internet-connect. Either can suffice, but PPP seems to be moving to a de facto standard. PPP is also a preferred choice because its PAP and CHAP login options eliminate scripting. You also need software on your computer to provide a Transmission Control Protocol/Internet Protocol (TCP/IP) interface and Windows Socket (WINSOCK). This is usually handled by software known as "WINSOCK.DLL" (also known as the "dialer," even though it does much more than dial and connect). You don't want "Shell" access either, which is more limited than SLIP or PPP. The latter two provide full Internet services such as World Wide Web (WWW) browsing and graphical display, as well as POP-server e-mail.

Your ISP can be local, regional, or national. In theory, all provide basic service, but your best choice will be based on all points covered below. National on-line services such as America On-Line, CompuServe, and Prodigy also act as ISPs, so an account with one also gets you net connected. For many beginners this could be the best route, and you'll also have their proprietary services. This point is significant, as some (such as CompuServe) provide valuable hardware and software support functions via on-line forums. These on-line services all provide easily-installed software, with one-button "turnkey" access. For installation software, just call the listed 800 number. Previously, typical monthly charges were about $10 for five hours, with additional hours $2 to 3 more. At the end of last year, these services all began offering a $19.95/month "unlimited Internet" plan.

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The minimum **software requirements** for Net access are a Winsock/dialer package, plus a *browser* that includes e-mail. That's it! The browser basically allows you to access (browse) web sites (computers on the NET). It also allows file transfer via FTP, and to send/receive e-mail from your personal address (jdoe@yourisp.com). The standard Netscape (recommended) browser is available on-line from the Netscape site:

http://home.netscape.com

and is found bundled with many ISP starter software packages. Netscape has built-in e-mail and *newsreader* functions. The latter allows access to USENET news, a "bulletin-board" service of about 15,000 plus subjects.

As for the Winsock/dialer software, this is definitely a getting connected task that separates the strong from the faint-hearted, should you "do-it-yourself." For minimum startup hassle, choose one of the major ISPs below. This gets you a self-installing package that includes a Winsock/dialer program. But, if you choose to go with a local or regional ISP, the Winsock/dialer may be left for you to configure from printed or on-line instructions, using a package such as the shareware Trumpet Winsock available at:

http://www.trumpet.com.au/

While viable, this can be daunting the first time, especially with cryptic script commands and esoteric Internet numeric addressing. If not sure, ask the ISP help desk about log-on specifics or recommended packages.

In Windows 95, Winsock hassle is minimal, because this capability is built in. Just follow the prompts under "My Computer/Dial-up Networking."

Hardware requirements are a 28.8 kbits/s V.34 modem on a 16550A COM port, and a fast Pentium or 486 computer with lots of RAM, and (fast) hard-disk space, with sound card and speakers optional. A fast video system is useful, as is 2 Mbytes of VRAM, with Windows tuned for peak efficiency. But few of these are absolutes; you can (slowly) cruise the Net with a 14.4 kbits/s modem, slow hard disks, and 8 Mbytes of RAM.

The **monthly cost** of Internet service dropped dramatically, beginning with AT&T's March 1996 entry. Quite simply, their $19.95/month time-unlimited rate for long distance customers set a new standard. Accordingly, others such as MCI have followed with similar plans. Both AT&T and MCI also have plans

WALT JUNG

where 5 hours/month is free (for now) to their customers. IBM's global network is accessible around the world, at a (new) $19.95/month rate. And, as mentioned above, the national on-line services have begun offering similarly priced "unlimited Internet" options.

Be careful when shopping around, as you might be able to find an ISP to better this unlimited monthly rate--but be wary! Don't sign up with an unknown ISP for a special yearly rate without a trial and cancellation option. Too many things can happen to sour you--poor (or no) phone support, your local node is consistently down, the e-mail server goes down--these things do happen. Beware of setup charges, as these seem to be going away for ISPs with automated account creation systems. And, if you need e-mail while traveling, an 800 access phone number is a real help. Some ISPs offer it for $6/hour, but AT&T's $4.50/hour rate is a plus. Many small ISPs simply have no 800 service.

Support can be a real critical item with an ISP; when you need it, you need it bad. Potentially best is a 24-hour, 7-days-a-week 800 number, but that isn't everything. Hold time is a key factor, as is on-line help proficiency. Sometimes you need a 1-on-1 to resolve an issue. The worst form of help is the local ISP's "black hole" answering machine where your questions just (sadly) disappear, or black hole e-mail. I've dumped three ISPs with those help systems, so be wary! Do try and gauge just what sort of help is available before signing up with any ISP, as you'll be living with it. Many ISPs also have their own newsgroups, useful for broadcasting network information, and sharing user tips and experiences.

A local dial-in access number is a final criteria which can be crucial in ISP selection. Make sure that a potential ISP is a local call! Further, call the number several times on different days/times, noting connect speed. If it isn't always 28.8 kbits/s, don't be totally disheartened. On the other hand, if you never see anything higher than 14.4 kbits/s, don't consider that ISP. Also, note if you ever get a busy signal. You shouldn't if the ISP has sufficient lines/modems.

The World Of Internet Providers Is Unfortunately Still One Of Caveats And Cautions.

For travel access, look either for a substantial U.S. city number list or a reasonably priced 800 service. TIP: Try *http://www.thelist.com/* which itemizes rate structures and services.

So, what's it boil down to? Pick your provider on overall specifics. While personal experiences are useful, remember, all ISPs have a bad day now and then! Of those listed in the table, I have used AT&T Worldnet, InternetMCI, and IBM, with generally good experiences *(see the table).*

I don't care for the InternetMCI setup, which rearranges your system for a special boot configuration, possibly conducive to conflicts. On my system, I had to reboot (via a multiple CONFIG.SYS) to select InternetMCI. But once it was up and running, the software performed well. InternetMCI comes with a customized Netscape, an e-mail package, E-mail Connection, plus FTP and Telnet applications.

The AT&T Worldnet setup installs easily, with no special boot setup. I'd rate the AT&T setup as good in some regards, but with a strong caveat if you deem e-mail service critical. In mid-July 1996, the AT&T E-mail system suffered an "E-mail horror," with numerous outages and mailing errors. Due to a flood of new users, they initially had delays in delivering setup diskettes. AT&T Worldnet comes with a customized Netscape, and Eudora Lite for e-mail.

I had first tried IBM's network about a year ago, when it was more expensive and not fully 28.8 kbits/s Upon return, I now find it generally better, and less expensive. The IBM package comes with a dialer and customized Netscape, all of which install hassle-free. Of the "Big 3" ISPs, I found IBM overall the most responsive to questions. But, they also suffered serious news and e-mail problems late last year.

To put the service outage horrors into an overall perspective, it appears that with AT&T and IBM, just being big is no guarantee of flawless service--perhaps to the contrary. It is likely that the operating glitches have come due to thousands of new users. While over time the problems ultimately get addressed, it sure is frustrating in the short term. In truth, we are still very much in the "growing pains" days of Internet service.

NATIONAL INTERNET SERVICE PROVIDERS

Service	800 #	Website
America Online	1 800 827-6364	http://www.aol.com
Compuserve	1 800 336-6823	http://www.compuserve.com
Prodigy	1 800 PRODIGY	http://www.prodigy.com
AT&T	1 800 WORLDNET	http://www.att.com
IBM Global Netwowk	1 800 821-4612	http://www.ibm.net.access
MCI	1 800 955-3565	http://www.internetmci.com

At this point in the article, it would be reassuring to just unconditionally recommend one provider. But, given my experiences (and those of others), the world of Internet providers is unfortunately still one of caveats and cautions. In fact, many heavy Net-users maintain more than one account, to buy some degree of problem immunity. Such are the ISP facts of life in early 1997.

While the tips above aren't the final word on getting Net connected, they certainly should start you off. Do let me know of your own Internet experiences, and any questions/ideas for future columns

Walt Jung is a Corporate Staff Applications Engineer for Analog Devices of Norwood, Mass. A longtime contributor to Electronic Design, he can be reached via e-mail at Walter.Jung@Analog.Com.

New Player Enters Audio-Codec Field

The ST1675 multimedia audio codec is the first in a line of PC-based multimedia products from a company that previously created custom designs for others. The IC offers a full-duplex, 16-bit stereo ADC and DAC with a two-channel DMA interface. The codec, which is compatible with industry standards, features an on-chip FIFO for uninterrupted sound, a byte-wide integrated ISA interface, and ADPCM compression and decompression. In addition, the codec makes it possible to mix four stereo and one mono channel. Additional components for interfacing to an ISA bus aren't required thanks to 24-mA bus drivers. The chip does need a single supply between 3.0 and 5.5 V. A power-down mode is included. It comes in 68-pin PLCC packages and 100-pin TQFPs. Samples are available now with production shortly; pricing for the PLCC is $8.00 each in 10,000 lots. PMCG

SigmaTel Inc., 6101 W. Courtyard Dr., Bldg. 1, Austin, TX 78730; (512) 343-6636; fax (512) 343-6199.
CIRCLE 825

Precise FET-Input Integrating Amplifier

The IVC102 is a precision FET-input integrating amplifier with on-chip integration capacitors and low-leakage analog switches that convert low-level input currents into output voltages. The input current is integrated for a user-determined period and holds the resulting voltage on the integration capacitor as a lower noise alternate to transimpedance amplifiers using op amps.

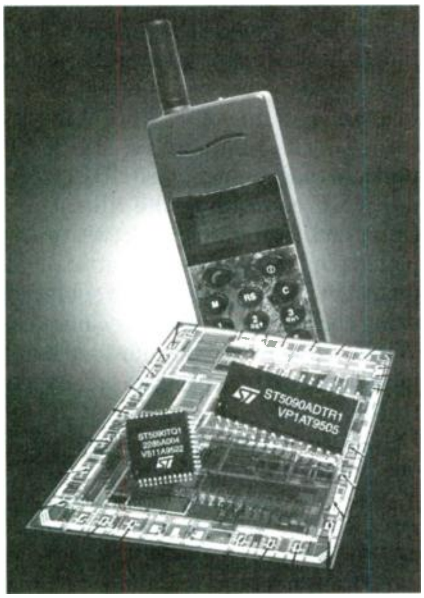
The IVC102 can integrate positive or negative input currents, allowing various sensors and biasing techniques to be used. Integration capacitors can be combined up to 100 pF, and external capacitors also can be added. Input bias current is typically 100 fA, enabling extremely low input currents to be measured. Nonlinearity is low at 0.005% and noise voltage is 10 nV/$\sqrt{Hz}$ for 100-pF integration and an input capacitance of 10 pF. The amplifier's gain-bandwidth product is 2 MHz, with the gain being programmed by timing.

Application areas include measurements of photodiodes, ionization chambers, and leakage currents. Package options include the 14-pin plastic DIP and the surface-mount SO-14. The IC is priced at $4.25 in 1000s and is available immediately. PMCG

Burr-Brown Corp., 6730 S. Tucson Blvd., Tucson, AZ 85706; (520) 746-1111; fax (520) 746-7401.
CIRCLE 826

Low-Voltage Voice Codec For Portables

The 3.3-V ST5090 voice code/decoder (codec) features 21-mW operating dissipation and 0.5-μA standby current. It includes the filter system for transmit and receive, an active antialias noise filter, a 14-bit linear ADC and DAC, and 8-bit μ-law or A-law companding converters. The chip



also incorporates other front-end functions needed in a telephone terminal, such as microphone selection switch, preamplifier, earpiece driver, side-tone circuit, transient suppressor turn-on and -off, ring-tone generator, and buzzer output. The serial control is MicroWire-compatible, and control registers can be changed while the device is in standby. Transmit gain is fully programmable up to 42.5 dB, and the microphone and earpiece circuits can be adapted for any kind of transducer. The built-in tone generator can be programmed to produce DTMF and musical tones. Among its applications will be GSM digital cellular, CT2 digital cordless, and DECT digital cordless telephones, as well as other digital, mobile, battery-powered equipment. The chip can be configured as either a 14-bit linear or an 8-bit companded PCM coder. Now in production in a 28-lead SO-28 and 44-lead TQFP, the SO-28 version sells for $4.96 in 10,000 lots. A bare die version also is available, as is an evaluation board where all of the programmable features can be set with mouse clicks on the on-screen interactive schematic. PMCG

SGS-Thomson Microelectronics Inc., 55 Old Bedford Rd., Lincoln, MA 01773; (617) 259-0300; fax (617) 259-4420, Internet: http://www.st.com.
CIRCLE 827

Transimpedance Amplifier Offers High Accuracy

The IVC102 FET-input integrating amplifier has on-chip integration capacitors and low-leakage analog switches that convert low-level input current to an output voltage. The amplifier integrates the input current for a user-determined period and holds the resulting voltage on the integration capacitor for measurement. Typical applications include amplifying sensor current from photodiodes, ionization chambers, and other current/charge-output sensors for medical diagnostic instruments, industrial measurement equipment, and analytical and scientific equipment.

The IVC102 can integrate positive or negative input current. Separate 10-pF, 30-pF, and 60-pF integration capacitors can be connected in combinations up to 100 pF. External integration capacitors also can be used. TTL/CMOS-compatible timing inputs control the integration period, hold and reset functions that determine the effective transimpedance gain, and reset the integration capacitor. Typical input bias current is 100 fA and linearity is 0.005%. The amplifier is available in a 14-pin plastic DIP and SO-14 surface-mount packages for the industrial temperature range. Pricing is from $4.25 for lots of 1000. ML

Burr-Brown Corp., 6730 S. Tucson Blvd., Tucson, AZ 85706; (520) 746-1111. CIRCLE 828

16-Bit Sampling ADC Boasts 4-Channel Multiplexer

The ADS7825 16-bit sampling analog-to-digital converter (ADC) comes complete with a four-channel input multiplexer, sample/hold, reference, clock, and a parallel/serial output microprocessor interface. It can be configured in a continuous conversion mode to sequentially digitize all four channels for industrial process-control, test and measurement, and analytical instrumentation applications. The ADS7825 can acquire and convert 16 bits to within ±2 LSB in 25 µs while consuming only 50 mW. Laser-trimmed scaling resistors provide a ±10-V input range and channel-to-channel matching of ±0.024%. Key specifications include ±2 LSB maximum INL, 16-bit DNL with no missing codes, operation from a single +5-V supply, and a 50-µW power-down mode. Priced at $34.50 each in lots of 1000, the converter is available for the industrial temperature range in a 28-pin, 0.3-in. plastic DIP or a 28-lead SOIC. ML

Burr-Brown Corp., 6730 S. Tucson Blvd., Tucson, AZ 85706; (800) 548-6132. CIRCLE 829

RS-232 Transceiver Runs At 1 Mbyte/s

The MAX3237 data transceiver uses internal dual charge pumps and a low-dropout output stage to ensure RS-232 output levels for data rates up to 1 Mbyte/s and higher. The charge pumps require only four small external 0.1-µF capacitors. In its normal mode with a worst-case load of 3 kΩ in parallel with 1000 pF, a guaranteed 250-kbit/s data rate makes it compatible with PC-to-PC communication software such as Laplink. In its Mbaud operating mode and a maximum load of 3 kΩ in parallel with 250 pF, the guaranteed data rate is 1000 Mbytes/s. Guaranteed slew rate is 24 V/µs in the Mbaud mode. The MAX3237 contains five drivers and three receivers to provide a complete serial port for notebook, subnotebook, and palmtop computers. Modems are supported by a 1-µA shutdown mode in which all receivers remain active. The transceiver comes in a 28-pin SSOP for commercial and extended-industrial temperature ranges. Prices start at $3.29 each in quantities of 1000 and higher. ML

Maxim Integrated Products, 120 San Gabriel Dr., Sunnyvale, CA 94086; (408) 737-7600. CIRCLE 830

Real-Time Clock Is Surface-Mounted

The M48T86 from SGS-Thomson consists of a lithium battery, a quartz crystal, and CMOS circuitry that includes a 128-by-8 static RAM, a power-fail circuit, and a real-time clock/100-year calendar circuit with programmable alarms. The power-fail circuit monitors V_{CC} and automatically switches to the battery when an out-of-tolerance condition occurs. At the same time, the chip switches to its write-protect mode to prevent spurious write cycles. Predicted worst-case battery life is over 10 years at 25°C. The equivalent of up to 20 discrete components, the device is intended primarily for use in PC motherboards to provide the time and date functions, interrupt generation, and a scratchpad memory for storing configuration parameters. The M48T86 comes in the company's SNAPHAT package that comprises a JEDEC 330-mil SOIC containing the silicon circuitry and a removable pack (with gold-plated pins) containing the battery and quartz crystal. The SOIC is soldered using conventional reflow techniques. When all board components are attached, the battery package is snapped to the SOIC sockets. The M48T86 PC1/MH1 is available in 10,000-unit open order entry for $3.25 each. ML

SGS-Thomson Microelectronics Inc., 55 Old Bedford Rd., Lincoln, MA 01773; (617) 259-0300.
CIRCLE 831

Chip Set Eliminates Jitter In CRT Monitors

Two ICs from National Semiconductor offer a complete deflection solution for continuous-sync CRT monitors. The LM1292 is a horizontal time-base solution for controlling the CRT horizontal scan rate of continuous-sync video monitors with stringent time-base requirements (763 ps at 125 kHz). The chip contains a frequency-to-voltage converter that controls the frequency tracking of an on-chip voltage-controlled oscillator to the incoming horizontal signal. The device automatically captures the incoming horizontal signal over the frequency range of 22 kHz to 125 kHz with a single set of external components.

By accepting all common computer sync signals without switching between sync sources, the LM1292 eliminates the need for external sync-stripping circuitry. Other features include video mute during resynchronization, undervoltage lockout, and an automatic shutdown latch mechanism that protects against CRT anode overvoltage. The companion part, the LM1295, is a dc-controlled geometry-correction system that synchronizes all output waveforms to the input voltage sync over the refresh-rate range of 50 to 125 kHz, with up to 125 kHz of bandwith for dynamic input signals. The chip provides sawtooth waveforms for East-West pincushion, E-W bow, and trapezoid and parallelogram correction in either positive or negative polarities. For quantities of 1000, unit pricing is $2.75 for the LM1292 and $2.54 for the LM1295. ML

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95052-8090; (800) 272-9959. CIRCLE 832

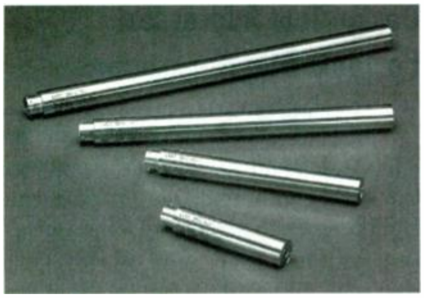
Triple Op Amps Offer 120-MHz Bandwidths At $1/Channel

The EL2344C, a low-power triple op amp built on the EL2044C family, features a conventional voltage-feedback topology (so it can be used in feedback networks with reactive or nonlinear elements). It will find applications in video designs, buffers for ADCs and DACs, and high-speed signal processing. Each amplifier channel has a current consumption of 5.2 mA and will operate on split supplies in a range from ±18 V down to ±2 V, and on a single supply down to 2.5 V. The output voltage swing goes up to ±3.8 V on 5 V supplies and ±13.6 V on 15 V supplies. Settling time is 80 ns to 0.1% with a 10-V step; at unity gain, the 3-dB bandwidth is 120 MHz with a phase margin of 50°. The IC is packaged in 14-lead PDIP and SO and is available now, with prices of $3.30 for 1000 lots. PMcG

Elantec Semiconductor Inc., 675 Trade Zone Blvd., Milpitas, CA 95035; (408) 945-1323; fax (408) 945-9305; Web: http://www.elantec.com.
CIRCLE 833

Position Transmitters Integrate Conditioning

The HCT line of two-wire, loop-powered, linear position transmitters include the sensor and signal-conditioning electronics within a 0.75-in. diameter hermetically-sealed housing for remote operation in 4- to 20-mA

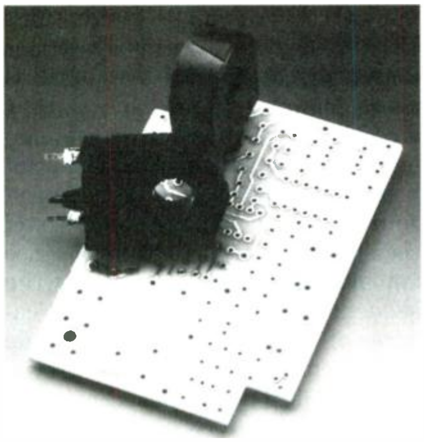


current-loop applications. The design eliminates zero and span potentiometer adjustments while providing linearity better than 0.5% for standard linear ranges of 0.25 to 5.00 in. and 1.0% for 10.00 in. Custom ranges are available upon request. Typical applications include valve-position sensing in process control, roll-gap measurement in rolling mills, and slice-lip applications in paper mills. Unit pricing starts at $300.00. ML

Lucas Control Systems Products, 1000 Lucas Way, Hampton, VA 23666; (800) 745-8008 or (804) 766-1500. CIRCLE 834

Current Transformer Is Pc-Board-Mountable

The SO3006-1 high-ratio (1000 turns) toroidal current sensor provides a linear output voltage (with a low impedance connected across its output) proportional to the ac pass-through current. The single pass-through ac current range is 2 to 50 A at 50 to 60 Hz. Lower currents can be monitored by passing the monitored conductor through the sensor two or more times. The maximum current is 50 ampere-turns continuous or 300 ampere-turns inrush for 10 sec. Designed for pc-board mounting, the SO3006-1 is terminated by two 0.73-in. (1.85-mm) solderable pins for electrical connections, and one 0.79-in. (2.0-mm) plastic anti-rotation pin. The hole for the pass-through conductor is 0.360-in. (9.14-mm) in diameter. Overall dimensions



are 1.50 by 1.0 by 0.45 in. (38.1 by 25.4 by 11.6 mm). ML

SSAC Inc., P.O. Box 1000, Baldwinsville, NY 13027; (315) 638-1300. CIRCLE 835

VCSEL Combines LED And Laser Features

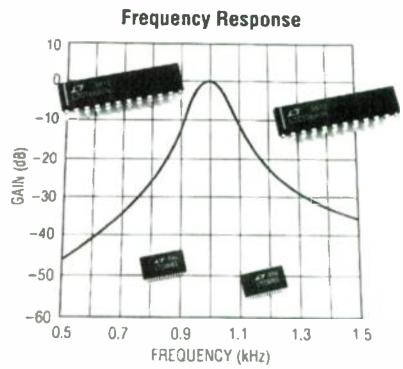
For use in high-speed data communications, the HFE4080-321 VCSEL (Vertical Cavity Surface-Emitting Laser) combines many desirable features of an LED with those of a laser diode. For example, it operates in a single longitudinal mode but with multiple transverse modes that reduce coherence and consequent modal noise

in multifiber applications. The device converts electrical current into optical power for use in fiber-optic communications, sensing, and similar applications. It can operate with inexpensive silicon or GaAs detectors, and performs well with some InGaAs detectors. Packaged on a TO-46 header, the VCSEL has data rates from dc to over 2 Gbits/s and produces a circularly symmetric, narrow-divergence beam. The low current requirement allows direct drive from PECL, ECL, or TTL logic gates. Operating temperature range is 0 to +70°C. The HFE4080-321 is available from stock for $24.00 each. ML

Honeywell Micro Switch Div., 11 W. Spring St., Freeport, IL 61032; (800) 367-6786. CIRCLE 836

Building Blocks Implement Switched Capacitor Filters

The LTC1068 quad universal filter IC consists of four identical 2nd-order filters. Each building block, together with three to five resistors, can provide various 2nd-order filter functions such as low-pass, high-pass, bandpass, or notch filters. Up to an 8th-order filter can be designed



using a single power source as low as 3.3 V. The quad filter building block can be used in any application having a cutoff frequency of less than 56 kHz. The center frequency of each 2nd-order section is tuned by an external clock, with the clock-to-center frequency ratio set to 100:1. Using a double-sampling technique, the maximum input frequency can approach twice the clock frequency before aliasing occurs. Input noise is less than 40 µV rms per 2nd-order section, resulting in a dynamic range exceeding 80 dB even with a 3.3-V supply. Power-supply current typically is 8 mA at ±5 V, and drops to 2.5 mA at 3.3 V. Available in a 24-lead PDIP and 28-pin SSOP, the device has starting prices of $6.15 and $6.35, respectively, in quantities of 1000. ML

Linear Technology Corp., 1630 McCarthy Blvd., Milpitas, CA 95035-7417; (408) 432-1900, ext. 2456. CIRCLE 837

VX-Window System Builds Graphical Displays

VX-Windows 3.0 is an X Window and OSF/Motif environment for developing complex graphical displays for real-time applications created using Wind River Systems' VxWorks operating system. Version 3.0 provides all of the capabilities needed to develop real-time embedded graphical displays on advanced hardware platforms. Application areas include medical imaging, simulation, monitoring systems, communications, and aerospace/defense. VX-Window 3.0 incorporates X version 11, release 6 (X11R6) and Motif 2.0. X11R6 supports new features, extensions and performance improvements such as security, multi-threading, internationalization support and desktop management. Version 3.0 is compatible with the Wind River Systems Tornado release of VxWorks, which can be networked with any BSD or Unix host system, or any other operating system with TCP/IP networking facilities. The VX-Windows X Server provides a standard interface with a driver that can be customized for any specific graphics hardware. VX-Windows X and Motif libraries are reentrant, with library elements provided as archive collections and loadable images. Available for Motorola PowerPC, Heurikon MIPS, Motorola 680x0, Sparc, and x86 CPUs, VX-Windows 3.0 pricing ranges from $3750 to $5000. Quantity discounts apply. ML

VisiCom Laboratories Inc., 10052 Mesa Ridge Ct., San Diego, CA 92121; (619) 457-2111. CIRCLE 838

Development Tools For Motorola 68xxx Families

For prices starting at $1700.00, Cosmic Software Inc. is offering a complete Motorola 68HC12 C cross-compiler package that includes an optimizing cross-C compiler, macroassembler, linker, librarian, object inspector, and hex-file generator. Also provided are object format converters, debugging support utilities, run-time library source code, and a multipass compiler command driver. The package also supports nonintrusive C source-level debugging with Cosmic's ZAP for Windows and OSF Motif. Designed for embedded-systems development, Cosmic's C tools run on PCs under MS-DOS/Windows and Unix workstations under OSF Motif. Features of the C cross compiler include support for ANSI/ISO syntax and constructs, single- and double-precision floating-point math, full reentrance and recursion of source code, zero-page objects, and code-bank switching. The compiler also automatically generates a special write sequence for EEPROM objects. Features of the ZAP debugger include ANSI debugging, source-code browsing, graphical performance analysis, chronograms, C trace, and on-line help. In addition to the 68HC12, support is available for Motorola's 6809, 6805, 6808, 68HC11, 68HC16, 68000, and 68300 microcontroller families. ML

Cosmic Software Inc.,100 Tower Office Park, Suite C, Woburn, MA 01801; (617) 932-2556. CIRCLE 839

Enhanced Software Creates MAC Applications

VIP-BASIC 2.0 is an upgraded version of the Rapid Application Development (RAD) environment of Mainstay for creating Macintosh and Power Macintosh applications. The new release supports applications development through a direct, forms-based visual design environment. Included is a code translator that converts code written in Basic to C code for compilation by Metrowerks Codewarrior, or for future use. VIP-BASIC 2.0 allows developers to create applications directly from a Form editor window. A palette of FIX tools add interface functions, such as radio buttons, check boxes, tables, graphics, editable and styled text, and sounds. VIP-BASIC 2.0 gives the user a royalty-free path to relational database applications. A new built-in mini-version of VIP-BASIC Database Manager provides access to relational database functions. Up to 32 kbytes of data can be entered into the included mini database without having to purchase the full VIP-BASIC Database Manager, which costs $195. VIP-BASIC 2.0 runs on 68000-based Macintosh or PowerPC-based Power Macintosh platforms for programming with form-based FIX tools, precoded functions, integrated resource editors, and a Dispatcher-based application framework. Programmers can work in a bottoms-up fashion. Power Macintosh native applications can be as small as 10 kbytes. The upgrade is available to registered users of VIP-BASIC for $95. VIP-BASIC sells for $195. ML

Mainstay, 951-A Constitution Ave., Camarillo, CA 93012; (805) 484-9400; fax (805) 484-9428.
CIRCLE 840

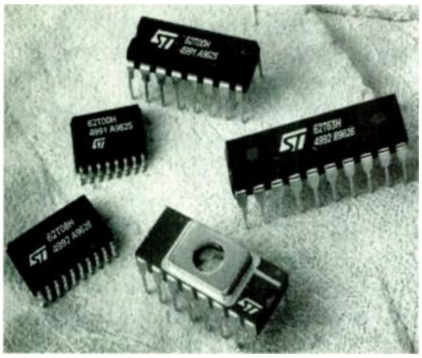
Design Tool Addresses Portable DSP Applications

The Hypersignal RIDE visual DSP design tool has been enhanced with PCMCIA support for portable DSP applications. By combining the tool with the Bulletdsp PC Card from Communication Automation & Control Inc., custom DSP applications can be designed and run on a laptop computer at remote sites and in mobile environments. Bulletdsp is a 50-MFLOPS Type III PCMCIA card for high-performance audio applications. Based on TI's TMS320C32 floating-point DSP, it has two stereo CD-quality audio I/O channels, 1 Mbyte of SRAM, 4 Mbytes of DRAM, and 512 kbytes of flash memory. Hypersignal RIDE can auto-boot the Bulletdsp at power-up via a real-time application stored in the flash memory. The Bulletdsp also can operate external to a PCMCIA slot with only power and ground connections for embedded designs. RIDE provides complete control over real-time design, including memory-map definition, linker options, and hardware configuration. RIDE also provides visibility into real-time DSP designs with memory-map usage, dynamic code profiling, memory dump/plot, symbol table, and design statistics displays. Other features include hardware support for simultaneous data conversion with data streaming to the screen and disk, and a graphical operator interface for completed applications like audio processing, signal monitoring, spectral analysis, control systems, and field testing. Hypersignal RIDE is available for Microsoft Windows 3.1x and 95 for prices starting at $1995. The Bulletdsp is priced at $895 with 256 kbytes of SRAM and 128 kbytes of flash memory. ML

Hyperception Inc., 9550 Skillman LB 125, Dallas, TX 75243; (214) 343-8525; e-mail: info@hyperception.com.
CIRCLE 841

8-Bit Microcontrollers Cost Under A Dollar

Seven new devices have been added to the ST62 family of low-cost 8-bit microcontrollers. All of the devices are available in a one-time-programmable (OTP) form, as well as ROM and



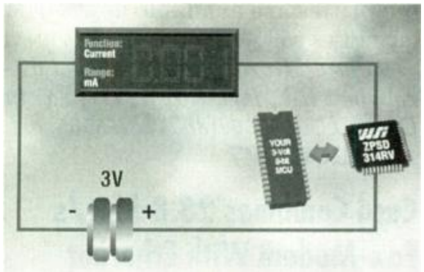
EPROM versions. Named the ST6200, ST6201, ST6203, S6208, ST6209, ST6253, and ST6263, the parts aim at cost-sensitive applications, starting at $0.77 in high volumes (for the ST6203). With 1 or 2 kbytes of program memory, the chips are housed in 16- or 20-pin SO and DIL packages. In addition, all of the devices contain the ST62 core processor, 64 bytes of data RAM, an 8-bit timer with 7-bit programmable prescaler, and individually programmable I/O ports.

Specifically, the parts are an EPROM microcontroller (MCU) with analog-to-digital converter (ST6200 has 1 kbyte and the ST6201 has 1.5 kbytes); an MCU (ST6203); an OTP MCU (ST6208); an OTP MCU with an analog-to-digital converter (ST6209); an OTP MCU with an analog-to-digital converter and auto-reload timer (ST6253); and an MCU with an analog-to-digital converter, auto-reload timer, EEPROM, and an 8-bit synchronous peripheral interface. Complete development tools and environments are available. RN

SGS-Thomson Microelectronics Inc., 55 Old Bedford Rd., Lincoln, MA 01773; (617) 259-0300.
CIRCLE 842

Low-Power Support Packs Logic And Memory

Offering a standby current drain of just 1 µA, the ZPSD304RV programmable system device (PSD) provides a



low-power collection of resources for 16- or 8-bit systems. On the chip are 256 kbytes of EPROM, a programmable address decoder, 19 individually programmable I/O port pins, and a programmable interface that can be configured to any 16-bit processor from Philips, Motorola, Intel, and other companies. The chip also includes I/O port reconstruction logic and a memory mapper that allows the EPROM to be placed anywhere in the memory-address space. Furthermore, a 4-bit page register can be read from or written to via the chip's data bus, and it allows the host processor to enlarge its address space by a factor of 16. Also on the chip is a security bit, which when set allows designers to prevent the configuration information from being read out. When operating, the ZPSD304RV can run from supplies that range from 2.7 to 5.5 V. At the 2.7-V level, the chip consumes just 0.9 mA/MHz. But at 3.3 V, the current drain increases to 1.2 mA (with a 1-MHz clock). However, that's still 77% less than the power consumed by most 3.3-V EPROMs alone. In lots of 5000 units, the 250-ns version of the ZPSD304RV sells for $14.43 each and comes in 44-lead PLCCs or TQFPs. Versions are available for both commercial and industrial temperature ranges. DB

WSI, 47280 Kato Rd., Fremont, CA 94538; Dale Prull, (510) 656-5400; Internet: http://www.wsipsd.com. CIRCLE 843

Build Multimedia PCs, Including DVD

DVD is just one of the applications that's suited for a hardware-assisted MPEG-2/AC-3 multimedia architecture. To build the complete multimedia PC, designers need only couple the architecture with a graphics controller and a microprocessor. The approach taken in the architecture cuts the DVD audio and video decoding costs by integrating motion compensation into the core graphics engine. It also performs many of the tasks previously handled by the host processor, thus freeing up that CPU to perform other operations. This eliminates the need for a stand-alone decoder and its associated 2-Mbyte video buffer. The approach reduces power, board real estate, and overall system cost. The architecture will be available in early 1997. RN

Trident Microsystems Inc., 189 North Bernardo Ave., Mountain View, CA 94043; (415) 691-9211.
CIRCLE 844

Pipelined-Burst SRAM Doubles Cache Density

Providing 2 Mbits of cache storage, the M5M5V2132 synchronous pipelined burst static RAM can operate on cache buses that run at up to 133 MHz. The chip is organized as 64 kwords by 32 bits and includes a 2-bit burst counter as well as input and output registers. Thanks to its 2-Mbit density, the burst SRAM can double the level-2 cache-memory size without increasing motherboard real-estate. To get the high density and speed, the chip is manufactured in the company's SuperCMOS process, which combines the best characteristics of bipolar and CMOS technology with minimum feature sizes of 0.4 µm. Also included in the chip is a snooze-mode, suiting the chip for portable applications because it turns off the memory when it's not being accessed. The burst mode also can be switched between the interleaved mode needed for Pentium CPUs or the linear mode used by PowerPC CPUs. I/O pins on the chip are low-voltage TTL-compatible and the chip operates from a 3.3-V power supply, consuming 790 mW when clocked at 100 MHz and 870 mW at 133 MHz. In the snooze/standby mode, the power drops to 3.3 mW. Housed in a 100-lead TQFP, the chip fits in a 14-by-20-mm board footprint with a lead pitch of 0.65 mm. Samples of the chip are available immediately; in sample quantities the 133-MHz version sells for $19 each. DB

Mitsubishi Electronics America Inc., 1050 East Arques Ave., Sunnyvale, CA 94086; Narayan Purohit, (408) 730-5900.
CIRCLE 845

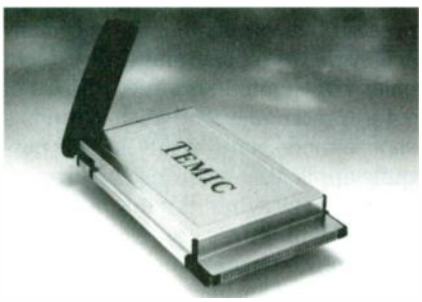
CD-ROM Drive Offers 12X Speed

CD-ROM-drive rotational speed continues to bump up. Although many thought that the 8X speed was the point where manufacturers would bog down because of mechanical and physical limitations, Toshiba has proved otherwise. The company developed a 12X drive that offers a 1.8-Mbyte/s sustained transfer rate, a 115-ms average random seek time, and a 125-ms average random access time. Performance is further enhanced using a 256-kbyte cache buffer. The drive is available with either an ATAPI or SCSI interface. The ATAPI model is the XM-5702, and the SCSI version is the XM-5701. RN

Toshiba America Information Systems Inc., 9740 Irvine Blvd., Irvine, CA 92618; (714) 457-0777. CIRCLE 846

PC Card Holds Cellular Phone, Fax-Modem

Modems that transmit data, fax, and voice information are fairly common in a PC Card format. Now designers at Temic Microsystems have added a cellular phone into the mix. The APM391



features an analog AMPS cellular and land-line compatible phone along with a fax-modem that can transmit data at rates up to 14.4 kbits/s. Compliant with the PC Card standard, Rev. 2.1, the card fits into a Type III form factor. Weighing less than 3 oz., the APM391 ships with a miniature, removable antenna and three accessory connectors. An earphone-microphone jack lets users plug in a hands-free headset. A 15-pin Honda connector allows land-line data-access-arrangement (DAA) operation. Four default operational modes are employed: AMPS cellular modem, AMPS voice, PSTN voice, and PSTN fax-data modem. Production quantities are available now. OEM quantities will sell for under $500. RN

Temic Microsystems, 2201 Laurelwood Rd., P.O. Box 54951, Santa Clara, CA 95056; (800) 554-5565, ext. 11. CIRCLE 847

Card Combines 28.8-kbit/s Fax-Modem With Ethernet

Two functions are combined on the SmartLink Type II PC Card. The card offers a 28.8-kbit/s fax-modem and Ethernet capabilities. With the card, a PC Card-equipped system can connect remotely to a LAN, or directly to the network through 10Base-T. The card supports Novell Netware, IBM LAN Server, Banyan Vines, and Microsoft Windows For Workgroups. The EIA Class 1 and 2 modem supports full-duplex operation, while the fax portion complies with the Group III standard. The card also is compatible with most cellular phones. Low power consumption (750 mW) combined with an automatic sleep mode (less than 70 mW) help extend the battery life of the portable system. Available now, the SmartLink combination 28.8-kbit/s fax-modem and Ethernet card is priced at $399. RN

Archtek America Corp., 18549 Gale Ave., City of Industry, CA 91748; (818) 912-9800. CIRCLE 848

MO Drive Measures Just One Inch High

In a package that measures just 1 in. high, the MOS330E is a 3.5-in. form factor, 230-Mbyte, rewritable magnetooptical (MO) disk drive. Powered by a 5-V source, the drive can be integrated into small fanless designs. The drive's random seek time is rated at 27 ms, with a sustained data-transfer rate of 2.4 Mbytes/s. Because the unit is 100% ISO-standard compatible, it operates with all standard 128- and 230-Mbyte media in both read and write modes. The MOS330E employs the patented Super Fine Pickup (SFP) mechanism. This device incorporates one servo that handles both the course and fine positioning. The servo is built without any analog circuitry, resulting in a reduced parts count and power draw. The drive is rated for 50,000 power-on hours. With built-in SCSI termination and a 256-kbyte cache buffer, the MOS330E MO drive sells for $260 each in large quantities. RN

Olympus Image Systems Inc., Two Corporate Center Dr., Melville, NY 11747; (800) 347-4027 or (516) 844-5000. CIRCLE 849

Network Computer Works With Dual Displays

With the ability to support two 21-in. monitors, the XP400D network computer doubles the screen area of traditional high-resolution X terminals. Designed for mission-critical applications, the XP400D is aimed at such markets as process control, finance, and banking. The two displays can be housed either side by side or stacked, with the data scrolling seamlessly using one keyboard and mouse. The system is designed so that there's no compromise of performance. With two complete video subsystems and twice the normal amount of video RAM, the XP400D offers up to 1600-by-1200-pixel resolution at 75 Hz and 8-bit color on each monitor, for a total resolution of 3200 by 1200 pixels in horizontal arrangement or 1600 by 2400 pixels in vertical arrangement. Other features include a 40-MHz R3000 RISC processor, 8 Mbytes of RAM (expandable to 136 Mbytes), 4 Mbytes of VRAM, and a twisted-pair 10Base-T Ethernet interface. Available now, prices start at $3345 for a single-monitor configuration or $7145 for a dual-monitor setup. RN

Tektronix Inc., P.O. Box 500, Beaverton, OR 97077; (503) 627-2779. CIRCLE 850

ZV-Enabled PC Card Permits MPEG-1 Video

The Media Express MPEG-1 PC Card connects to a Zoom Video-enabled PC Card slot to deliver full multimedia functions, such as 30-frame/s video and CD-quality sound. The Zoom Video (ZV) specification offers a 1.2-Mbit/s bandwidth for full-screen video and 250 kbits/s for two-channel, 32-bit stereo audio. The card attains the high performance by connecting directly to the PC's graphics subsystem. The card is built with the Explorer chip set from Sigma Designs. Available now, the Media Express MPEG-1 card sells for $249. RN

Apex Data, 4305 Cushing Pkwy., Fremont, CA 94538; (510) 623-1231. CIRCLE 851

Broad Battery Options Power Portables

A line of battery options for portable communication devices gives designers the flexibility to customize power sources for specific applications. The Energizer power options include custom battery-pack designs, assembly capabilities, and a broad aftermarket. Currently offered are five battery-power options including two battery-pack choices—nickel cadmium and nickel metal hydride—as well as three single-cell choices, including alkaline, lithium, and NiCd. Call for samples, pricing, and delivery information. DM

Energizer Power Systems, P.O. Box 667850, Charlotte, NC 28266-7850; (800) 677-6937.
CIRCLE 852

Lead-Acid Battery Has 8-Year Expectancy

The CFM12V29, a 12-V, 29-Ah battery, has an 8-year life expectancy at 25°C for standby applications. The battery provides hundreds of

charge/discharge cycles for portable or cyclic use. It's available in a fire-resistant case material for UPS and telecom applications. The fire-resistant version fits in many telecom cabinets, including the SLC96 series. VB

Eagle-Picher Industries Inc., P.O. Box 130, Seneca, MO 64865; (417) 776-2256. CIRCLE 853

Step-Up Converters Use Single NiCd Cell

The MAX848 and MAX849 step-up dc-dc converters each generate a fixed 3.3-V or adjustable 2.7- to 5.5-V output from an input of one lithium-ion cell or one to three NiCd/NiMH cells. Either IC enables a portable phone to operate on one cell instead of two. Synchronous rectification provides an efficiency gain of 5% over comparable devices operating with simple diode rectifiers. Current capability of the internal n-channel MOSFET power switch is 0.5 A for the MAX848 and 1 A for the MAX849. Input voltages can range from 5.5 V down to 0.7 V. A dual-mode operation offers a selection of pulse-frequency modulation or pulse-width modulation at a fixed frequency of 300 kHz. For tighter noise control, the internal switch can be synchronized to an external clock of 200 kHz to 400 kHz. In standby, a pulse-skipping mode maintains a voltage output while drawing a quiescent current of 150 µA. The converters each include a two-channel, serial-output ADC for monitoring battery voltages. A comparator function monitors the converter's output voltage and generates a power-good output. MAX848 and MAX849 come in 16-pin narrow SO packages for the extended-industrial temperature range. Prices start at $2.50 each for quantities of 1000 and higher. ML

Maxim Integrated Products, 120 San Gabriel Dr., Sunnyvale, CA 94086; (408) 737-7600, ext. 6272.
CIRCLE 854

PCMCIA Power Switches Boast Low Cost

Two PC Card power-interface switches provide a PCMCIA integrated power-management solution for interfacing to PC Cards used in applications such as desktop and portable computers and PDAs. The TPS2205I has a parallel control interface that is compatible with controllers from Texas Instruments, Cirrus Logic, and Intel, while the TPS2206I has a serial control interface for use with CardBus controllers. The LinBiCMOS devices allow the distribution of 3.3-V, 5-V and/or 12-V card power to PCMCIA cards. Both ICs meet the proposed industry standard for a 3-W (600-mA) limit to the amount of power a PC Card can draw. A 3.3-V mode of operation allows 3.3-V switching without the need for 5 V for low-power system designs such as sleep mode and pager mode. Packaged in a 30-pin SSOP, the power switches are priced at $3.61 (TPS2205I) and $3.87 (TPS2206I) for lots of 1000. ML

Texas Instruments Inc., P.O. Box 172228, Denver, CO 80217; (800) 477-8924, ext. 4500. CIRCLE 855

Triple Supply Controller For Portable Computers

The L4992 triple power-supply controller is a power-management package that includes synchronous rectification, PWM switch-mode power-supply controllers for 3.3 V, 5.1 V, and 12 V, and a linear regulator. The switching regulators operate at 200 kHz or 300 kHz using the internal oscillator, or an external synchronization source for higher frequencies. Synchronous rectification and a selectable pulse-skipping mode provide high efficiency over a wide load range.

Peripheral functions include under- and overvoltage protection and a power-sequencing circuit that provides proper power sequencing under any fault condition. The chip also provides a power-good signal and an enable-disable function. A programmable soft-start circuit is also included. Typical standby current is 50 µA. Overall efficiency of the switching regulators tpically exceeds 95% in nominal load conditions, and better than 90% at light loads. Pricing is $4.20 each in quantities of 25,000. ML

SGS-Thomson Microelectronics Inc., 55 Old Bedford Rd., Lincoln, MA 01773; (617) 259-0300.
CIRCLE 856

MOSFETs Run Off 5-V Supplies

Two 30-V power MOSFETs can be driven directly from a 5-V microcontroller in desktop computers. Housed in surface-mount DPAKs, the n-channel SUD50N03-10 and p-channel SUD45P03-15 exhibit very low on-resistance compared to typical power MOSFETs. At a 4.5 gate drive, on-resistance is just 19 mΩ for the n-channel part and 24 mΩ for the p-channel device. With the same gate drive, maximum current handling is 15 A for the SUD50N03-10 and 8 A for the SUD45P3-15.

Samples and production quantities of both devices are available now, with lead times of six to eight weeks for larger orders. Prices for 100,000-piece quantities are $1.37 for the SUD50N03-10 and $1.53 for the SUD45P03-15. ML

Temic Semiconductors, 2201 Laurelwood Rd., P.O. Box 54951, Santa Clara, CA 95054-1595; (408) 567-8220. CIRCLE 857

EE CURRENTS & CAREERS

Exploring employment and professional issues of concern to electronic engineers

Employment Picture Is Looking Up In The Rte.128-Boston Area

Mike Robinson

Good times have returned to the Route 128-Boston area in Massachusetts. The job market for electronics engineers has picked up over the past few months, and the demand is now strong. What's more, it's expected to continue for at least another year.

"The situation's the best I've seen it in a few years," says Norm Davis, an account executive at the Kleven Group, Lexington, Mass. Davis, who has been recruiting for 25 years, specializes in placing digital and analog engineers with a hardware background. "For the past three to six months, and especially right now, we are in an extremely candidate-short market. There are many more jobs than we have candidates to fill them," says Jeff Rudzinsky, senior vice-president at Louis Rudzinsky Associates (also in Lexington). Rudzinsky specializes in placement in the electronics and opto-electronics industries and has been in the business almost 14 years *(see Table 1)*.

Alive And Kicking

Indeed, Massachusetts' economy has finally completely revived from the last recession. "Right now, the economy in Massachusetts is doing very well," notes Gerald Fahey of the state's Department of Employment and Training. Statewide, the unemployment rate for August and September has been the lowest in years, going back to 1991, he points out. The rate for September (the latest month for which individual state figures are available) was 4.2%, seasonally adjusted, compared with the current U.S. rate of 5.2%. A year ago, the rate for the state was 5.3%, versus 5.5% nationwide. On an unadjusted basis, the Bureau of Labor Statistics of the U.S. Department of Labor cites a rate of 3.7% for the Boston metropolitan area, compared with 4.1% for Massachusetts and 4.9% nationally. A year ago, the comparable figures were 4.8%, 5.3%, and 5.2% *(see Table 2)*.

"The majority of the jobs are software-related, but generally, companies want EE backgrounds," Rudzinsky notes. Nevertheless, he says, "the classic digital design engineers that we couldn't do a thing with two years ago are now back in demand, and the demand is great in all parts of the electronics industry." Davis agrees. "It's gone from pretty much a total buyers' market down the scale toward the sellers. "Right now, we're seeing all these ads in the papers where they're sucking up to engineers, telling them how wonderful they are, whereas a few years ago they were saying, if you don't have the exact qualifications we want, plus you have to be left-handed, don't even bother sending in a resume." But, he continues, "you've still got to be a fairly good person." "Everybody wants a three- to five-year or to seven-year individual," Rudzinsky says.

The demand is there for new engineers as well. At the Massachusetts Institute of Technology in Cambridge, "we're seeing record numbers of employers in every industry sector looking for EEs and computer scientists," says Marianne Wisheart, associate director of recruiting. "Last year we had 637 companies come on campus to interview our students, and 80% of them were looking for EEs. Right now, we already have a little over 550 companies scheduled," she reports, and about 150 of them are local companies or locally based divisions, or groups of companies whose headquarters are elsewhere.

It comes as no surprise that the majority of jobs are for software people. "The ratio of software to hardware jobs is, I'd say, 5:1 or 4:1," Davis notes. "The people recruiting software engineers are running into one guy with ten offers, whereas we're having one hardware guy with maybe two or three offers." "For hardware folks," he continues, "it's not boom time, as it is for the software guys, but it's a strong, steady market."

As for the types of hardware engineers, "ASIC people have always been in demand, especially those who are up to date on the latest tools," Davis says. Other areas of demand are for FPGA and board designers. "But there's been a really big increase in the demand for analog circuit engi-

TABLE 1. TOTAL EMPLOYMENT GROWTH AT ELECTRONICS COMPANIES IN NEW ENGLAND

Sector	1994–95	1994–95	Forecast
Factory automation	6.4%	3.5%	—
Computer hardware	3.4%	7.8%	—
Defense	—	1.8%	2.7%
Medical*	—	4.9%	3.4%
Photonics	3.9%	4.8%	—
Computer software	11.8%	10.9%	—
Subassemblies and components	6.6%	3.7%	—
Test and Measurement	2.8%	1.2%	—
Telecommunications	8.1%	9.0%	—

Note: Figures are for New England companies with under 1000 employees, and for New England divisions or other units of companies based elsewhere with local employment of less than 1000 employess, based on company data as of November 1995.

**Includes makers of nonelectronic equipment and devices.*

Source: Corporate Technology Information Services Inc.

TABLE 2. 1996 UNEMPLOYMENT RATES FOR ALL CIVILIAN WORKERS—U.S. BUREAU OF LABOR STATISTICS

Area	Month	Current	Previous	Year Ago
SEASONALLY ADJUSTED				
U.S.	October	5.2%	5.2%	5.5%
New England	September	4.5%	4.4%	5.4%
Connecticut	September	4.9%	4.7%	5.6%
Maine	September	5.1%	5.5%	5.7%
Massachusetts	September	4.2%	4.0%	5.3%
New Hampshire	September	4.3%	3.8%	4.1%
Rhode Island	September	5.1%	5.2%	7.1%
Vermont	September	4.4%	4.3%	4.3%
NON-SEASONALLY ADJUSTED				
U.S.	October	4.9%	5.0%	5.2%
New England	September	4.3%	4.2%	5.1%
Connecticut	September	4.4%	4.9%	5.1%
Maine	September	4.1%	4.4%	4.7%
Massachusetts	September	4.1%	3.9%	5.3%
New Hampshire	September	4.0%	3.6%	3.7%
Rhode Island	September	5.1%	4.7%	7.0%
Vermont	September	3.9%	3.8%	3.7%
Boston metropolitan area	September	3.7%	3.4%	4.8%

Unemployment rates for the U.S. were updated on Friday, December 6, 1996. Unemployment rates for New England, states and metropolitan areas were updated on Tuesday, November 26, 1996. (Both updates were too late for inclusion in this issue.)

neers pretty much across the high-tech biz," he says. "It's kind of a surprise, but not really, because wherever the real world meets the electronic [digital] world, analog's important."

Davis also says that there's a very strong demand for developers of real-time embedded firmware and that companies are mostly looking for BSEEs. "We're also seeing a demand for diagnostic people again, the guys who develop the software that tests the hardware so that the customer can run the diagnostics and swap in a board or a few boards. There's always been a demand, but it waned somewhat the past couple of years. Now it's starting to rise again. "There's also a new type of profession," Davis says, "a hybrid of a diagnostic person and a design verification type."

Everyone agrees the demand is across the board in all sectors of electronics. Data communications and telecommunications are very strong, Davis says, despite the consolidations that have taken place. "Companies keep buying companies, but the employment situation is still strong."

Wisheart sees a lot of activity in the multimedia and Internet areas, as well as in data communications and telecommunications. "I think the defense area's pretty strong," Rudzinsky says. "There's been a great misunderstanding. People think the defense industry's way off; in reality, it's not. The building of offensive weapons has been curtailed and the military budgets have dropped, but some of the defense companies are now finding ways to transfer the technology they've developed to the commercial market. They're all trying to branch out and diversify."

Both Rudzinsky and Davis point out that Raytheon's Electronic Systems Group in Tewksbury has a big contract from the Federal Aviation Administration for air-traffic control systems in the U.S. and a major contract from Brazil for a surveillance system to monitor the Amazon rain forest. "They're hiring like crazy," Davis says. Despite the consolidations, "my activity with Raytheon has remained steady," says Rudzinsky. "The computer industry is not downsizing as it has in the past. It's continuing to move along at a nice level pace," says Rudzinsky.

To Davis, it looks as if "the computer industry is starting to come back. We're seeing more activity there." Sun Microsystems, for one, "is looking around for a few places here to put some engineering groups," he notes. In fact, in mid-November last year, Sun announced an agreement to buy land in Burlington, Mass. to house as many as 4000 employees. (Sun currently has 1000 emplyees in Chelmsford, Mass.) The company said it would grow gradually as needed "Data General made some money this year(1996)," he continues, "and it has all kinds of things going on, including joint ventures with the likes of Intel and Compaq." He also says that Stratus Computer is hiring. MIT's Wisheart notes that Digital Equipment is doing well and recruiting, but, she adds, "Digital, which used to be known as a hardware company, is looking for more software engineers."

Davis also says that Stratus Computer is hiring. MIT's Wisheart notes that Digital Equipment is doing well and recruiting, but, she adds, "Digital, which used to be known as a hardware company, is looking for more software engineers." "We're also seeing more activity in companies that build systems for process control and medical uses," says Davis, and Wisheart reports that Hewlett-Packard's medical group in Andover is hiring. In addition, Davis says that "the instrumentation business is always there(it doesn't have the big peaks and valleys that other segments have."

Rudzinsky and Davis believe the strength of the electronics industry and the job market for EEs locally will continue. "Last year we saw the job market pick up to where it was reasonable, and this year and maybe for another year, maybe 16 months, we'll have boom times. Then maybe it will slow down for a year or two, then flatten out for a year, year and a half, then go back up again."

Davis believes there's reasons for optimism beyond the economy's health in general. "The Internet's going to take a tremendous amount of hardware to make it happen," he says. "Even an optical cable's not going to be enough." "You'll definitely see growth in multimedia and telecom, particularly wireless for the next one to two years, even five years," predicts Wisheart. Rudzinsky is more cautious . "I see the situation continuing for at least the next six months or a year. Beyond that, we'll have to see, with the elections over, what happens with the economy."

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Job Hunting on the Internet: All Sorts of Opportunities abound

Eric L. Hausler

Type *http://www.engineeringjobs.com* into your web browser and you will arrive at the Engineering Jobs.Com web site, a career clearinghouse tailored especially for engineers. A click on the company employment pages and you are greeted with this message. "The companies listed here all have permanent hiring pages and most of them are always hiring." What follows is a seemingly endless list of links to the Engineering Openings pages at companies around the globe. Searching for a job on the World Wide Web can be that easy.

The Internet is revolutionizing the way that employers and job candidates find each other. Today's headhunter is a search engine that accepts keywords and returns an armload of job opportunities. According to John Sumser, editor of Electronic Recruiting News, an online newsletter:

(http://www.interbiznet.com), "there are over 3,500 employment related websites, listing over 1 million jobs around the net." Job hunting on the World Wide Web is becoming a valuable tool for employment seekers—"over 40% of all new users cite finding a job as a primary reason for getting on the Internet, while at least 95% of all college job searches include the Internet at some level."

As search engines become more sophisticated, employers are able find job candidates that meet their qualifications using keywords or phrases that search through mountains of online resumes. Until recently, the Internet has been most often used by high-tech people to find jobs with other high-tech companies. However, Sumser sees a good future for all job hunters on the Web, both technical and non-technical. He points to the increase in non-technical employment opportunities listed at sites such as AT&T and JP Morgan as a positive sign that the Internet is becoming the place to find jobs.

Sumser cites a number of factors as contributing to the increased role of the Internet in today's employment market. "We will be facing white-collar labor shortages shortly. Demographic shifts, plus decreased loyalty, plus increased projectization, will equal shorter tenure jobs for at least a generation. The web has emerged just in time to resolve this economic transition."

Low-Cost Search

The average job seeker can post his or her resume on one of the Internet's many recruiting sites for only a few dollars per month if that. It is a passive way to monitor and apply for better opportunities, stay abreast of the job market, and still remain safe in a current job.

Employers are also citing other reasons why the Internet works for them. They are using the net to go right to the market with their needs. This translates to money saved on hiring costs, and streamlines the search process.

Companies can find candidates that match their needs profiles right away, instead of having to weed through an endless sea of resumes. Many companies, including Compaq Computer, Microsoft, IBM and Texas Instruments,to name a few, scan the resumes they receive into a huge database which can be searched by key word or phrase.

Bill Looney, vice president of Photon Technology International, Inc., a New Jersey manufacturer of proprietary electro-optical instruments, recently advertised a position for a Senior Electronics Engineer on The Monster Board:

(http://www.monster.com).

The Monster Board is a massive career site on the web that offers the gamut of employment-related services. It currently has more than 50,000 job postings. Visitors to the site can upload or build a resume, find employer profiles, search job listings by state, industry, company, discipline or a keyword, or tap into the Monster Board's vast career-support databases.

"The whole process is more flexible on both sides," says Looney, explaining why his company has opted to post job openings on the Monster Board. "It allows us to find a person who more closely meets our needs. With the newspaper we get too diverse a population of returns. Here we can target specific areas for expansion, and weed out candidates that don't meet our credentials."

So far, Photon Technology has received high-quality responses from their Monster Board listings. He attributes this to the fact that the company is allowed to post much more detail about the job, the company, and the qualifications they seek in a candidate, than in the traditional classified ad.

IEEE Offers Help

One of the best places to begin a job hunt on the Web is the employment assistance pages of the IEEE-USA:

(http://www.ieee.org/jobs.html).

The IEEE has a national job listing service available to its members that are posted on nine autoresponse files. The job listings are broken down by eight regions within the United States, and one file with jobs outside the United States. To gain access to the service, job seekers send email to the designated Internet addresses, and the requested files will be sent within a few minutes. The listings are updated weekly, and remain posted for 30 days.

The employment assistance pages also provide links to other employment resources and resume databases, an entry-level assistance page, employment assistance help files, and a regularly updated schedule of technical job fairs around the United States. Also listed are numerous publications, videos and guides that will help members identify various skills and talents, develop a job market, write resumes, improve interviewing techniques and survive changing job markets.

IEEE-USA also has an agreement with Resume Link:

(http://www.resume-link.com/ or call Resume-Link at (614) 529-0429). Members can submit their re-

EMPLOYMENT OPPORTUNITIES

sumes along with an information form that will be placed on a national database used by employers to fill job openings.

"The web is increasingly incorporated into the job hunter's tool kit," says Electronic Recruiting News Editor John Sumser. He envisions a future that may include something like electronically managed online guilds that provide skilled labor where and when it is needed. Perhaps someday in the not-so-distant future, a search engine will be able to comb all the sites by keyword or phrases; for now, you're stuck searching each career site individually. Whatever the future may hold for the job market on the web, there is a bonanza of opportunity available now. Happy hunting.

Optimizing your search

Here are some quick hints to optimize your search:

•Keep track of the sites you visit by bookmarking them.

•Start out your search on a particular site at the Help desk or What's New area to learn about their services.

•Find out what keywords or phrases are the industry buzzwords employers are looking for and include them on your resume.

•As always, an error-free and easy to read resume is essential.

•Keep written notes of the resumes you email or fax including dates and addresses, so you can track how your job hunt is going.

•Stay up-to-date on interviewing and hiring practices in your industry by using resources available on the Internet. These career support resources used to cost hundreds of dollars; now they are mostly free.

•Set up personal search engines on sites such as Career Builder and the Monster Board. They will notify you of new openings in your field.

•The employment resources on the Internet have been designed to help you find a better job. Most of them are efficient and easy to use. The way to find out what works for you is to explore the services at a number of different sites.

Searching out the Sites

There are over 3,500 employment related sites on the World Wide Web with more going online everyday. Here are a few of them to start you out in your search.

•IEEE USA:
http://www.ieee.orgs.jobs.html
The IEEE's employment assistance site has links to a National Job Listing Service, Resume Referral Services, a special entry-level assistance page, employment assistance help pages, job fair listings, and other Internet career resources.

•Engineering Jobs Com:
http://www.engineeringjobs.com/
This site is a mecca for engineering career information. The site has resume linking, job database searches, links to other engineering-related sites, information on professional societies, and reference help for engineers.

•The Monster Board:
http://www.monster.com
Aptly named because it has over 50,000 job listings. It will track and find your own personal job listings by region, state or keyword. It allows you to build resume and cover letter online, will notify you of new listings in your field and offers a wealth of career support help. No fee for use.

• Employment Edge:
http://www.employmentedge.com/employment.edge/
This site has job listings that can be searched by specific field. Be sure to stop and read the daily comics on your visit.

•Career City:
http://careercity.com/
Career City lists thousands of jobs, and provides career support information on interviews, writing resumes and dressing for success.

•Job Banks USA:
http://jobbankusa.com/
Job Banks provides employment and resume information to employers, candidates and recruiters.

•CareerBuilder:
http://www.careerbuilder.com
This site has listings and links, but also allows you to format a personal search engine that will notify you of new listings by e-mail.

•Career Mart:
http://208.193.201.5/
Career Mart has listings and career support. Career Mart also has a resume bank.

•National Ad Search:
http://www.nationaladsearch.com
This site, from the publishers of National Ad Search Weekly, offers access to some 8,000 to 12,000 help-wanted display ads from around the country. Subscribers can purchase blocks of ads of 100 for just $10.

•E-Span Career Connection:
http://www.espan.com/
E-Span is an all-around career site. It has job listings and career support services with a wealth of information. This information includes travel and relocation help, local city news abstracts, business indexes, site links and an online human resources center.

•HEART/Career Connections:
http://www.career.com/
This site has job listings, hot jobs, interactive job fairs and employer services.

•Jobtrak:
http://www.jobtrak.com
Jobtrak is a good career resource for students and recent college/university graduates. Employers have teamed up with college/university career centers to target graduates or students from specific schools. Students and alumni must contact their university or college career center for a password to access employment opportunities on Jobtrak.

•Yahoo- Employment:
http:www.yahoo.com/Business/Corporations/Employment_Services
Yahoo is a giant search engine that combs the Web for information. This is their employment services link. It is a good starting point for a more general search of the World Wide Web for employment opportunities.

Eric Hausler is a freelance writer specializing in writing on issues of concern to electrical and electronic engineers. He can be reached at (201) 635-0311. His e-mail address is: erich@openix.com.

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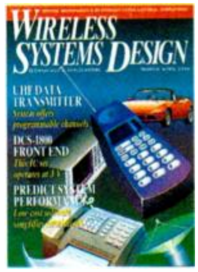

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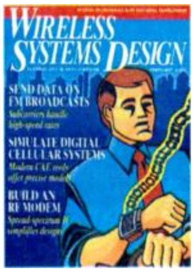

tronic systems on the market, including portable computers, cellular telephones, and wireless data communications systems. Wireless Systems Design's applications-based technical articles and product reviews guide these engineers to market with practical, time-saving ideas.

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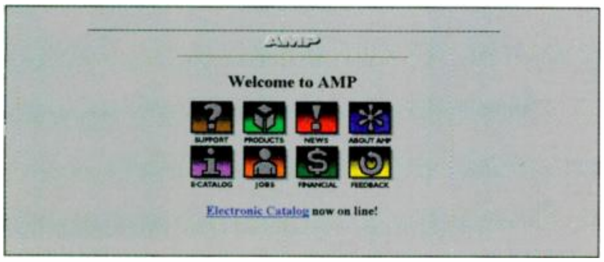

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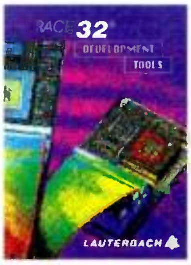
ELECTRONIC DESIGN CATALOG/LITERATURE REVIEW

TRACE 32 DEVELOPMENT TOOLS

Lauterbach, Inc.'s TRACE32 development tools cover a wide range of CPU families for embedded systems. The scaleable tool set includes In-Circuit Debuggers, In-Circuit Emulators, a Fully Integrated Risc emulator, and a Debugger.



CIRCLE 250

LAUTERBACH, INC.

SINGLE BOARD COMPUTERS

ICP Acquire Inc. is a manufacture of single Board computers, provide Backplane, rackmount 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 251

ICP ACQUIRE, INC.

PRODUCT LITERATURE AD

Gage Applied Sciences Inc. is the world leader in ultrafast data acquisition products for IBM PC. Gage offers the world's fastest 12 bit A/D card for the ISA and PCI bus, with sampling speeds up to 100 MSPS and 8 bit A/D cards up to 250 MSPS (2 GS/s for repetitive signals). Also available are complete turnkey systems and extensive software drivers. For more information call 1-800-567-4243

CIRCLE 252

GAGE APPLIED

SHARP FIFOs

First-in, First-out memories are just the stuff the no-nonsense design environment of the '90s is meant to build on. Used as data buffers between systems operating at different speeds, FIFOs conserve valuable board space, streamline design tasks and reduce system cost.Sharp's new 1997 IC Short Form Catalog is packed with information about Sharp FIFOs, as well as details about our entire range of memory product.

CIRCLE 253

SHARPMICROELECTRONICS

Free Instrumentation Reference

The National Instruments 1997 catalogue features the latest versions of the company's LabVIEW, LabWindow/CVI, and HiQ application software products. New products include Bridge VIEW TM and LookoutTM software packages for industrial automation. In addition, our new line of IMAQTM products features a complete hardware, software, and driver software solution for imaging.

CIRCLE 254

NATIONAL INSTRUMENTS

har-pak® Mini Coax Connectors

HARTING is offering a new 4 color brochure that graphically illustrates the new harpak® 50Ω MINI Coax Connectors System. Detailed technical data, drawings and part numbers provide comprehensive information. The system, which provides more space efficiency , easy handling, low applied cost and application, is design for high speed data transfer rates, and allows transmissions of high frequency signals up to 2.5 GHz.

CIRCLE 255

HARTING ELEKTRONIK, INC. Of North America

KEPCO POWER SUPPLIES

Kepco's Catalog Handbook 146181 on digital and analog instrumentation and modular power supplies offers many new control options to Automatic-Test systems designers including: VXI, RS 232, IEEE 1118 and IEEE 488.2; wideband analog programmable supplies may be used as power amplifiers. Email: hq@kepcopower. com http://www. kepcopower. com

CIRCLE 256

KEPCO INC.

FAIR-RITE SOFT FERRITES

New in this edition is our 85 material, a square loop material with good temperature stability, available in toroidal configuration for a variety of applications including converters and inverters. Our ferrite tile absorber for EMC test chamber applications is described in detail. Also note the additions of a "hybrid" surface mount bead offering greater impedance in a smaller package capable of carrying 5 amps of current.

CIRCLE 257

Fair-Rite Products Corp.

INTERNATIONAL SOURCE BOOK

The International Source Book offers detailed specifications on Ecliptek's through-hole and surface-mount crystals, oscillators, and inductors. Visit our internet site at http://www.ecliptek.com/ ecliptek/. Phone (714) 433-1200, Fax (714) 433-1234, or E-mail ecsales@ ecliptek.com

CIRCLE 258

ECLIPTEK CORPORATION

SWITCH CATALOG

APEM's 212 page catalog contains many extensive product lines. Included are the following categories: DIP & Rotary DIP switches, Toggle, Rocker & Lever switches, and more. A wide selection of process compatibles and SMT models are offered as well as numerous options and accessories. A broad family of Control knobs is also offered. Complete specifications and detailed ordering guides for all products greatly simplify selection.

CIRCLE 259

APEM

NEW TEST & MEASUREMENT

Bozell offers its new 1997 catalog of test and measurement instruments including DMMs, electrometers, precision sources, voltmeters, source-measure units, power supplies, switch systems and more. Phone: 800/552-1115. FAX:216/248-6168 http://www.keithley.com

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KEITHLEY INSTRUMENTS

FFT SPECTRUM ANALYZERS

SRS spectrum analyzers offer 90 dB dynamic range, frequency spans from 191 MHz to 100 kHz and a fast 1000 kHz real time bandwidth. The SR770's low distortion (-80 dBc) source generates sine waves, two-tone signals, white and pink noise, and chirps which allow frequency response measurements (to 100 kHz) with 0.05 dB precision. Standard features on both analyzers include THD, 1/3 octave, band and sideband analysis, GO/NO GO testing.

CIRCLE 261

STANFORD RESEARCH SYSTEMS

1997 SELECTION GUIDE

Pentek's new pocket-size 1997 Product Selection Guide describes Digital Signal Processing and Data Acquisition products for VMEbus, VXIbus and PCI/PMC bus. You'll find quick selection guides, capsule specifications and functional block diagrams. Get the latest information on the broadest line of DSP processor, I/O peripherals and world-class software tools. Call (201) 818-5900, Ext. 532

CIRCLE 262

PENTEK, INC.

BATTERY HOLDERS

Featured products: SMT button cell holders, battery snaps, case hardware, computer clock back-up holders, multi-cell holders with covers, auto cigarette lighter plugs. For computers, alarms, controls, instruments, toys, appliances, ect.

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MEMORY PROTECTION DEVICES

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LCD LIQUID CRYSTAL DISPLAY

Optrex's 92-page 1997 LCD catalogue offer is the right choice of LCD, to support your business. Optrex can meet all your requirements from standard to custom designs in LCD panels and modules. Application includes telecommunication, automotive, Office Automation, Home Appliance, T&M instruments and much more. Optrex Europe GmbH has achieved ISO 9001 certification in 1995.

CIRCLE 265

OPTREX EUROPE

CRYSTAL OSCILLATOR CATALOG

A new product catalog and selection guide from Champion technologies features their full line of crystal oscillators. Technical information, specifications and mechanicals are featured in this catalog for over 60 of Champion's VXCOs, TCXOs, VCTCXOs, data clocks and related products. Frequency ranges up to 155.52 MHz for general purpose to high frequency or tight stability applications. Phone: 847/451/1000

CIRCLE 266

CHAMPION TECHNOLOGIES

MicroSim DesignLab™

Interface Technologies distributes Version 7.1 of MicroSim DesignLab and MicroSim Pspice A/D with Schematics. Version 7.1 supports long file names in Windows 95 and Windows NT, includes DXF export, enhanced simulation libraries, library browser and search engine, and automated move, select and edit in MicroSim PCBoards. Call 1-800-357-1636 or browse http://www.i-t.com for more information.

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INTERFACE TECHNOLOGIES

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MECHANICAL ENCODER

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 269

GRAYHILL

OMRON RELAYS, SWITCHES

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 270

OMRON ELECTRONICS, INC.

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-made power supplies. Catalog also features a complete line of rectifiers for telecom applications.

CIRCLE 271

ADVANCE POWER, INC.

The WavePlex Family

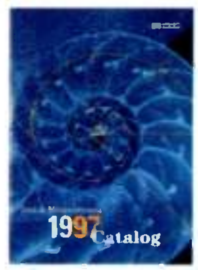
The WavePlex Family from American Microsystems, Inc. are highly programmable baseband CMOS ICs use to create low-cost remote wireless links. The WavePlex Family includes transceiver, transmit-only, receive-only and 802.11 compliant wireless ICs, as well as supportive development boards and evaluation radios. For more information on the WavePlex family, call (208) 234-6920 or visit our home page http://www.amis.com

CIRCLE 272

AMERICAN MICROSYSTEMS INC.

TEST & MEASUREMENT

With 656 pages, the 1997 HP Test & Measurement Catalog is heftier than ever before. It's loaded with tutorials, descriptions, specifications and prices for more than 1,500 HP products and services. And it's free. Call (800) 452-4844, Ext. 5034



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HEWLETT-PACKARD Co.

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 274

INTUSOFT

"X86 and 683xx/HC16 Design Tips"

Free application note shows how to use in-circuit emulation to isolate real-time events. Set clock-edge triggers, and then use trace to display system status and the source code leading up to the event. For immediate response: WEB page: www.microtekintl.com Voice: 800-886-7333

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MICROTEK INTERNATIONAL

ON-LINE CATALOG

Visit http://www keyelso.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 are clearly defined.

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KEYSTONE ELECTRONICS CORP.

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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 high quality tools to you need. Call 1-800-332-8246, ext. 806

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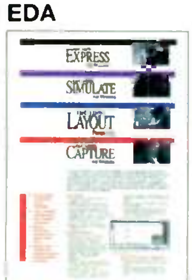
Integrated Suite Of EDA Applications

OrCAD's integrated suite of EDA applications give you the full advantage of 32 bit performance under all versions of Windows. They unite your entire design flow, from design entry to simulation to board layout; into a single, seamless process. Call OrCAD DIRECT at 1-800-671-9505 or visit our web site at http://www.orcad.com



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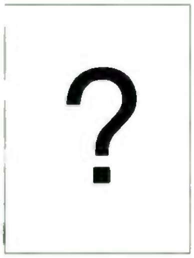

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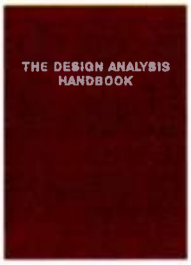
TERN, INC.

DESIGN ANALYSIS HANDBOOK

"A book that should be on the shelf of every digital or analog electronic-system designer." Frank Goodenough, Electronic Design. $49 plus $8.50 s&h. Call 800/780-8331 or visit DAC's website: www.cyberspy.com/~daci



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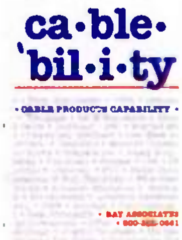
DACI

CABLE PRODUCTS CAPABILITY GUIDE

Designed to aid engineers in their cable, wire, assembly, and high-tech interconnect applications, this free Cable Products Capability Guide from Bay Associates, Menlo Park, CA, features the company's unique products, services, materials and processes.



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BAY ASSOCIATES

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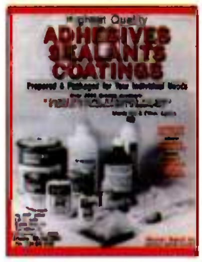
Master Bond Inc., Hackensack, NJ manufactures over 3000 grades of adhesives, sealants and coatings. Line cosists of epoxies, anaerobics, cyanoacrylates, silicones and acrylics. One and two part systems are available. Tel 201-343-8983.



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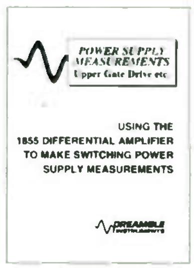
CACTUS LOGIC

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 quantity measurement corruption caused by high dv/dt common mode. 1-800-376-7007



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PREAMBLE INSTRUMENTS

ELECTRONIC DESIGN CATALOG/LITERATURE REVIEW

THERM-O-DISC

This new 20 page catalog showcases Therm-O-Disc's full line of NTC and PTC thermistors including disc, rod, glass encapsulated, and the new surface mount configurations, plus inrush current suppressors, ceramic current limiters, linear PTC's, temperature switches, varistors and NTC assemblies. Phone: 616-777-4100. Fax: 616-773-4214

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THERM-O-DISC.

80186, 80196, 8051 EMULATION

Signum Systems has released its 1996 catalog of in-circuit emulators. This full line catalog includes Intel processors, Texas Instruments DSP's Zilog controllers, and National Semiconductor HPC family. Call (800) 838-8012 for information. Internet address: ww.signum.com

CIRCLE 296

SIGNUM SYSTEMS

NETRANS™

NETRANS™ and NETRANSplus™ from American Microsystems, Inc. provides proven netlist conversion technology. With over 800 FPGA to ASIC conversions to date, AMI has the most experience and greatest success rate for netlist conversions. For more information on NETRANS products, call (208) 233-4690 or visit our home page http://www.amis.com.

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AMERICAN MICROSYSTEMS INC.

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ROLYN OPTICS CO.

Flat Panel Display Systems

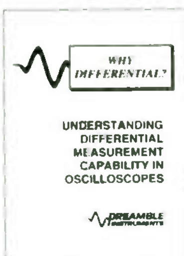
The best selection of flat panel display systems available! Our new 1997 edition "Designer's Guide to Flat Panel Display systems and single Board Computers" offers an extensive range of OEM/end user flat panel display solutions: complete flat panel computers, plug-in flat panel monitors, the latest displays and several touch-screen technologies. Includes complete information on our PC-compatible single board computers.

CIRCLE 301

COMPUTER DYNAMICS

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



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PREAMBLE INSTRUMENTS

NEW SWITCHING REGULATORS

Power Trends Inc., has released a new 80 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 303

POWER TRENDS INC.

Telecom Solutions Databook

Teltone's 224-page Databook features a wide range of products for network interface applications, including: DTMF Receivers, DTMF Transceivers w/Call Progress Detection, MF Trunk Signaling ICs, Call Progress Tone Detectors, Line Sensing Relays, test tools including Telephone Line Simulators and ISDN Line Simulators, application notes, and more. For your copy call 1-800-426-3926 or 206-487-1515.

CIRCLE 304

TELTONE

1997 FLASH DATA BOOK

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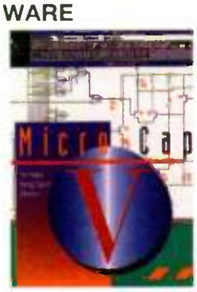

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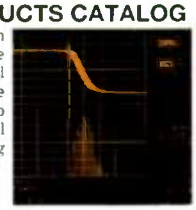

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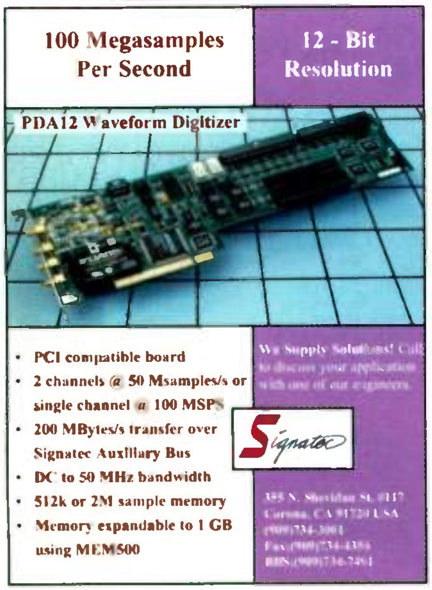

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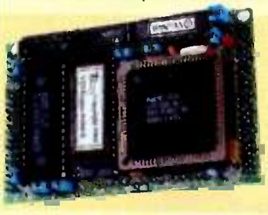

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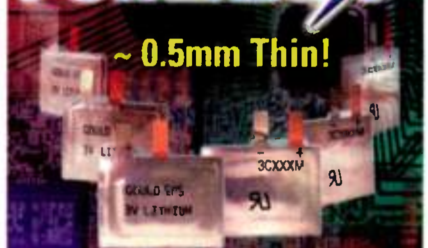

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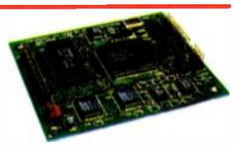

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February 17	1/7/97
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March 17	2/5/97
April 1	2/20/97
April 14	3/5/97
May 1	3/21/97
May 12	4/2/97
May 27	4/17/97
June 9	4/30/97
June 23	5/14/96
July 7	5/29/97
July 21	6/11/97
August 4	6/25/97
August 18	7/9/27
September 2	7/24/97
September 15	8/6/97
October 1	8/22/97
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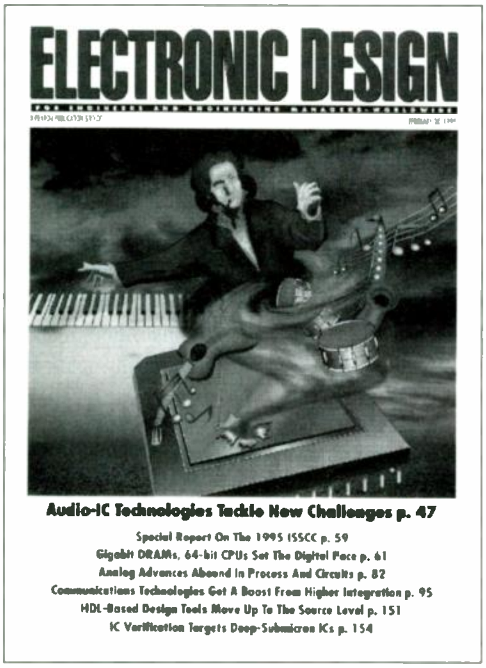

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   3. ☐ General Corporate Management
   ☐ Other (please describe) ______

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   12. Design & Development Engineering (including R&D - circuits)
   11. Executive & Operating Management (engineering/technical)
   01. Corporate & Operating Management (non-engineering)
   03. Manufacturing & Production Management (non-engineering)
   13. Engineering Services Engineering (evaluation, quality control, reliability, standards, test)
   08. Engineering Services Management (evaluation, quality control, reliability, standards, test)
   14. Manufacturing & Production Engineering
   09. Manufacturing & Production Engineering Management
   23. Other (please be specific) ______

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   22. PCs, Workstations, Servers
   23. Laptops, Notebooks, Hand-helds, and other mobile computers
   24. Other Computer/Computer Systems
   02. Computer peripherals: disk drives, terminals, printers, plotter
   03. CAE/CAD/CAM systems
   04. Software manufacturer/developer
   05. Computer systems integrator
   06. Office & business machines
   07. Communications systems & equipment
   30. Networks/Software - LAN, WLAN, WAN, etc.,
   31. Cellular, Consumer Phones, RF & Microwave Systems
   08. Industrial controls, systems, equipment & robotics
   09. Electronic instruments, ATE systems, design/test equipment
   10. Medical electronic equipment
   11. Avionics, marine, space & military electronics
   12. Government & military
   13. Automotive and other ground vehicles
   14. Consumer electronics & appliances
   15. ICs & Semiconductors
   16. Other components, materials, hardware & supplies
   17. Electronic sub-assemblies (boards, modules, hybrids and power supplies)
   28. Other (please be specific) ______

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8. Do you have or have access to a CD ROM? ☐ Yes ☐ No
9. Do you subscribe or have access to the Internet? ☐ Yes ☐ No
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A Digital ICs
01 ☐ Microprocessor Chips & Support ICs
02 ☐ 4/8/16 bit uPs/uCs
04 ☐ 32-bit and larger CISC uPs/uCs
08 ☐ RISC uPs/uCs
16 ☐ Digital Signal Processors
32 ☐ Video Controller

A2
01 ☐ Video Compression/Decompression
02 ☐ Logic ICs
04 ☐ Storage Controller
08 ☐ Memory - DRAM, SRAM
16 ☐ Memory - ROM, PROM, EPROM, EEPROM, Flash
32 ☐ Memory Modules

A3
01 ☐ ICs, other

B Analog/Mixed-Signal Circuits
01 ☐ Mixed Signal Devices
02 ☐ Converter ICs & Modules
04 ☐ Linear ICs & Modules
08 ☐ Communications ICs
16 ☐ Audio Processing
32 ☐ Power Semiconductor Devices

B2
01 ☐ RF Devices
02 ☐ Hybrid Devices
04 ☐ OP Amps

C ASICS
01 ☐ Gate Arrays
02 ☐ FPGA
04 ☐ Programmable Logic Devices (PLD)
08 ☐ Standard Cells
16 ☐ Custom LSI/VLSI
32 ☐ Megacell Functions (CPU cores, etc.)

C2
01 ☐ Analog Cells

D Components
01 ☐ Capacitors, Resistors, Potentiometers
02 ☐ Display Devices
04 ☐ Relays, Switches, Keypads
08 ☐ Fans
16 ☐ Sensors & Transducers
32 ☐ Microwave Components–Hardware & Crystals

D2
01 ☐ Fiber-optic/Optoelectronics
02 ☐ Transformers & Inducters
04 ☐ Fuses
08 ☐ Blowers & Fans
16 ☐ Circuit Breakers

E Interconnections & Packaging
01 ☐ Connectors & Sockets
02 ☐ Wire & Cable
04 ☐ Fiber-optic Cable
08 ☐ Enclosures
16 ☐ Materials
32 ☐ Printed Circuits

E2
01 ☐ EMI/EMC Components & Materials

F Power
01 ☐ Power Supplies
02 ☐ Batteries

G Test & Measurement
01 ☐ Logic Analyzers
02 ☐ Development Systems
04 ☐ Oscilloscopes
08 ☐ Other Test Instruments
16 ☐ ATE
32 ☐ Field Test & Service Equipment

G2
01 ☐ Communications/Test Equipment
02 ☐ Data Acquisition Hardware/Software
04 ☐ EMI/EMC Test Equipment

H Computers & Workstations
01 ☐ Minicomputers
02 ☐ Workstations
04 ☐ Personal Computers

I Computer Boards
01 ☐ CPU Boards
02 ☐ Analog I/O & Converter Boards
04 ☐ Memory
08 ☐ Disk/Tape Controllers
16 ☐ Communication/Interface
32 ☐ Graphics & Imaging Boards

I2
01 ☐ DSP Boards
02 ☐ Other Special Purpose Boards

J Communications
01 ☐ Modems
02 ☐ LAN/WAN Hardware & Software
04 ☐ ISDN Hardware

K Design Automation/CAE/CAD
01 ☐ Digital/Analog Simulators
02 ☐ PCB Layout Tools
04 ☐ IC Design Tools
08 ☐ Design Entry Tools
16 ☐ Synthesis Tools
32 ☐ CASE Tools

K2
01 ☐ HDL Based Tools
02 ☐ Workstation Based Tools
04 ☐ PC Based Tools
08 ☐ CAE/CAD Software

L Software
01 ☐ Software Tools, Dev. Systems and/or High-Level Language
02 ☐ Utility Software Packages & Serv.
04 ☐ Operating Systems
08 ☐ Real-time Operating Systems
16 ☐ Productivity Tools
32 ☐ Compilers/Interpreters

L2
01 ☐ Emulators/Debuggers

M Computer Peripherals
01 ☐ Disk/Tape Drives
02 ☐ Computer Terminals
04 ☐ Monitors
08 ☐ Graphics Terminals
16 ☐ Printers/Plotters
32 ☐ I/O devices (Mice, keyboards, etc.)

M2
01 ☐ PCMCIA Cards
02 ☐ CD-ROM, including WORM & R/W
04 ☐ Multimedia Peripherals

☐ **NONE OF THE ABOVE**

11. Number of employees in your company? ______

12. Please check the publications that you receive personally addressed to you by mail: (check all that apply)

N
01 ☐ Computer Design
02 ☐ ECN
04 ☐ EDN
08 ☐ EE Times
16 ☐ Electronic Product News

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01 ☐ Electronic Products
02 ☐ PC Week

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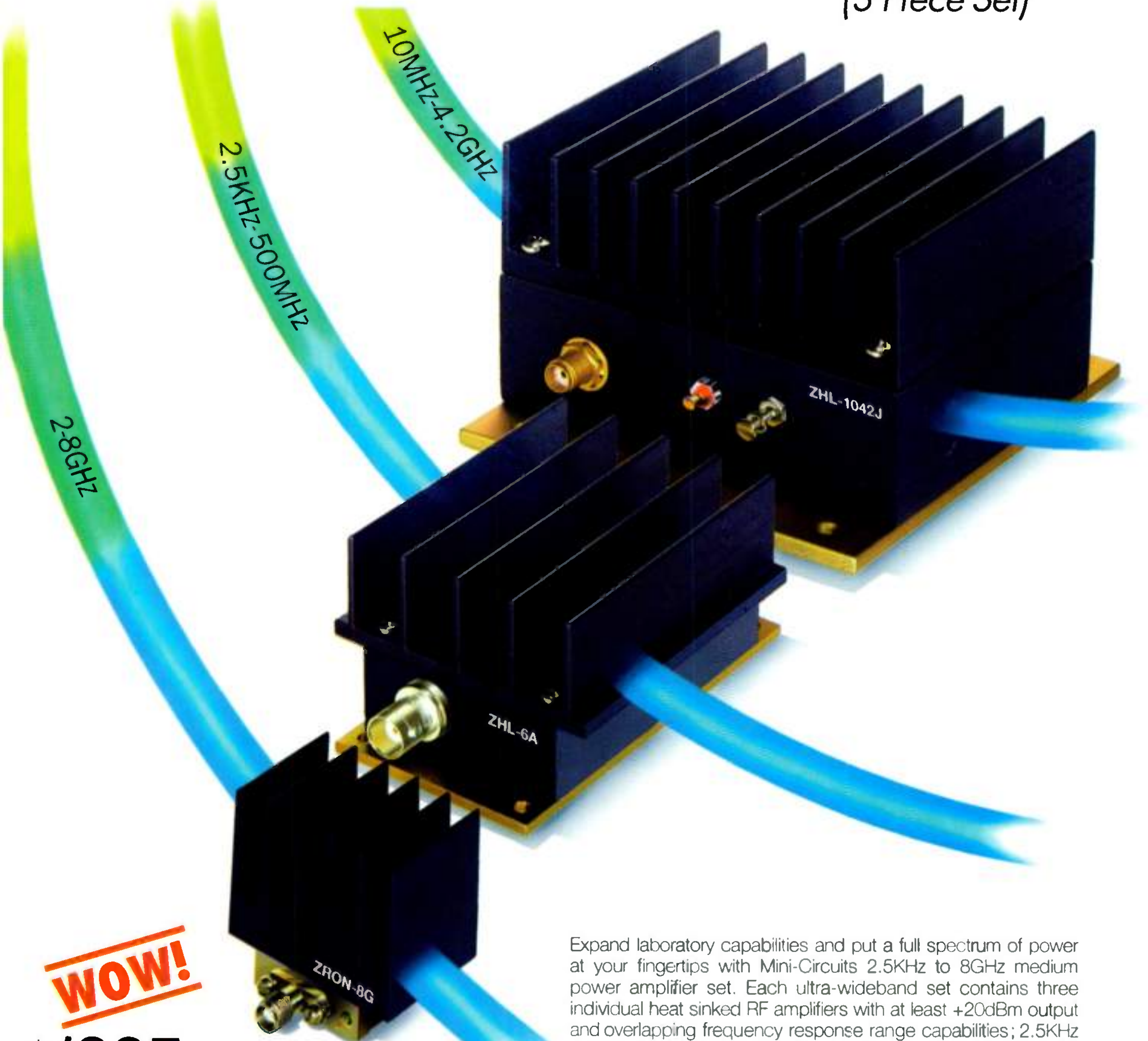

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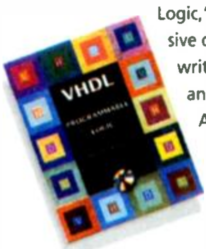

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