

A PENTON PUBLICATION \$10.00

OCTOBER 1, 1996



Single-Chip Codec Brings Advanced Multimedia to PCs p. 67

Speech Recognition Has Come A Long Way, But It Still Isn't Ready For Prime Time p. 37
Bipolar Conference Details Performance Improvements That CMOS Can't Touch p. 48
Smart Modems Harness New Technologies To Deliver Voice, Video, And Data p. 77
How To Improve Control System Performance By Using Relay-Based Controllers p. 105
ICs Obsolete Magnetic Amplifiers In Multiple-Output, Regulated Power Supplies p. 127
High-Efficiency GaAs Single-Rail RF Amps Target DCS And PCS Bands p. 131

World Radio History

The 100,000 Gater.



Introducing Altera's EPF10K100. The highest-density Programmable Logic Device ever.

With 100,000 gates, Altera signals a new era for programmable logic. Big enough to handle most gate array designs and larger than any FPGA, the EPF10K100 satisfies even the most ferocious appetite for density. From prototyping through production, you get all the benefits of programmability plus new design capabilities.

The secret to the EPF10K100 is below the surface.

The EPF10K100 features the industry's first embedded array architecture. Fast and efficient embedded array blocks can pack up to 24K bits of on-chip RAM, with room for other complex megafunctions such as microcontrollers and DSP

and PCI functions." These megafunctions shorten design cycles and allow for design re-use and re-targeting.

To help you attack your high density designs, our MAX+PLUS II development tools are completely compatible with leading EDA vendors, such as Synopsys, ensuring seamless integration with your existing design environment.

It's time to give your designs more bite.



If high density, exceptional performance, and megafunction support will help you tackle your biggest design challenges, you're ready for the 100,000 Gater. Call us today at 800-9-ALTERA (800-925-8372),

Dept. A10NAP2. We'll send you a free FLEX 10K information kit. Or, find us at http://www.altera.com on the world-wide web.



Corporation 1996 Alrea Corporation Altera, ALEX, and MAXAPLUS are expisitered trademarks and RLEX 10K, MAXAPLUS II and EPF10K100 are tracements of Altera Corporation AMP?, Altera Mirgalunction Partners Program, and The Altera Advantage are service marks of Altera Corporation All other trademarks are the property of their respective holders. All rights reserved

> READER SERVICE 123 World Radio History

^{*}Developed through AMPP (Altern Megafunction Partners Program)



From the bus to the media, you can count on a full range of HP's low-cost Fibre Channel components now available in volume production.

Whether you need a single protocol IC, a complete Gigabit Link Module, or anything in between, HP has the high performance components you need to get your Fibre Channel products to market quickly.

Take the GLM, for example. This cardlevel solution incorporates all high-speed IC and optical design right on the card, converting parallel data to serial Gb/s signals for transmission over fiber or copper. And the Tx/Rx ICs integrate parallel-to-serial functions for lower-cost copper connections. There are even lowcost, low-power single chip transceivers that are ideal for transferring files in RAID systems.

Not only that, our protocol ICs, which connect the bus to the physical layer, include FC1-4 layers integrated on a single chip.

With these advanced component products, HP continues its leadership and longstanding commitment to the Fibre Channel market. From our experience with high-speed circuit design using mature, 25 GHz silicon processes to our Gb/s optics/packaging and our protocol ICs, we offer the most extensive product line in the industry.

And that means everything.



READER SERVICE 109

Call 1-800-537-7715 ext. 1591 for *free* product literature and information on

Fibre Channel Component

discounted samples.

Call 1-800-450-9455 for a list of technical literature available by fax (U.S. and Canada).

CGOC9603

Environ_{iron}. Re³Search

rt

Video

D PestPester

r

1

my

- Antonio and

Till Harden

© 1996 Advanced Micro Devices, Inc. AMD the AMD logo, and combinations thereof, and Run With It are trademarks of Advanced Micro Devices, Inc. All other names are the property of their respective holders. World Radio History

SINGLE POWER-SUPPLY FILASH BECAUSE YOU HAVE BETTER THINGS TO DO.



AMD's 5.0 volt-only and 2.7 volt-only Flash families give you an extensive range of flash memory options.

When you want to create revolutionary products, you need innovative components. That's why we created 2.7 volt-only flash memory. Requiring only a single power supply, it also features low power consumption, high speed and an extended operating range from 2.7V-3.6V. Use it for today's portable, battery-powered applications and tomorrow's hand-held products like digital cameras, digital voice recorders, multimedia PDAs, or wherever else your imagination takes you. Call us today and we'll send you a detailed information pack.

1-800-222-9323 Internet: http://www.amd.com



The Sensu PDA from Design Edge features a collapsible thin-film color display, audio and video compression, a wireless modem, and CCD camera. It's not available today, but AMD's 2.7 volt-only Flash technology is.



Mini-Circuits

Mini-Circuits

(up to +19dBm output) Mini-Circuits ushers-in a new era of technology and economy with ERA monolithic GaAs amplifiers. Just check the specs! These surface mount and drop-in amplifiers cover your applications to 8GHz with higher gain, more output, and flatter response. Characterized with S-parameter data, these amplifiers are very easy to use. Simply sketch an interconnect layout, and the design is done. And ERA's are engineered with wider bandwidths to eliminate your need for costly compensation networks and extra gain stages. So, review your present design and replace with Mini-Circuits new ERA technology. Lower overall cost, wide bandwidth stability, and lots to ... gain!

Mini-Circuits...we're redefining what VALUE is all about!

(1000 qty.)

	*Fred	Gain	Max Power Out	Dynamic Range		OPrice
Model	(MHz)	(dB)	(dBm, @ 1dB Comp)	NF(dB)	IP3(dBm)	\$ ea. (10 Qty.)
ERA-1	DC-8000	11.6	13.0	7.0	26	1.80
ERA-1SM	DC-8000	11.0	13.0	7.0	26	1.85
ERA-2	DC-6000	14.9	14.0	6.0	27	1.95
ERA-2SM	DC-6000	13.1	13.0	6.0	27	2.00
ERA-3	DC-3000	20.2	11.0	4.5	23	2.10
ERA-3SM	DC-3000	19.4	11.0	4.5	23	2.15
ERA-4	DC-4000	13.9	▲19.1	5.2	▲36	4.15
ERA-4SM	DC-4000	13.9	▲19.1	5.2	▲36	4.20
ERA-5	DC-4000	19.0	▲19.6	4.0	▲36	4.15
ERA-5SM	DC-4000	19.0	▲19.4	4.0	▲36	4.20
Note: Specs	typical at 2GHz,	25°C.				

Typ. Imbers tested at 1612. At 2GHz, Max. Pwr. Out may decrease by 0.4dB & IP3 by 3 to 4dB.
 Low frequency cutoff determined by external coupling capacitors.

D Price (ea.) Oty.1000: ERA-1 \$1.19, -2 \$1.33, -3 \$1.48, -4 or -5 \$2.95. SM option same price.

DESIGNER'S AMPLIFIER KITS:

K1-ERA: 10 of each ERA-1,-2,-3 (30 pieces) only \$49.95 K1-ERASM: 10 of each ERA-1SM,-2SM,-3SM (30 pieces) only \$49.95 K2-ERA: 10 of each ERA-4,-5 (20 pieces) only \$69.95 K2-ERASM: 10 each ERA-4SM,-5SM (20 pieces) only \$69.95

Chip Coupling Capacitors at 12¢ each (50 min.)

Size (mils) Value 10, 22, 47, 68, 100, 220, 470, 680, 1000, 2200, 4700, 6800, 10,000 pf 80x50 120x60 .002, .047, .068, .1 µf



ni-Circuits®

ERA-1 ERA-1SM

ACTUAL

SIZE

US 🅬 INT'L CIRCLE READER SERVICE CARD

P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661 INTERNET http://www.minicircuits.com For detailed specs on all Mini-Circuits products refer to • 740- pg. HANDBOOK • INTERNET • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM CUSTOM PRODUCT NEEDS Let Our Experience Work For You.



October 1, 1996 Volume 44, Number 20



Single-Chip Codec Brings Advanced Multimedia To PCs p. 67

Delivers CD-quality audio, telephony, and a V.34bis modem for simultaneous voice/data.

FEATURES

TECHNOLOGY ANALYSIS

Did You Hear What I Said? p. 37

Speech recognition continues to evolve, but work still needs to be done.

BCTM Shows Off Advanced BJTs and MOSFETs For ICs p.48

The 1996 BCTM presents high-voltage and fast ICs with performance pure CMOS can't touch.

ELECTRONIC DESIGN REPORT

Advanced POTS Modems: Mr. Moore, Meet Mr. Shannon p. 77

Smart modems harness new technologies to deliver voice, video and data.

PRODUCT INNOVATIONS

Controller Simplifies A Multi-Output Power Supply p. 127 Single-Rail RF Power Amps Target DCS And PCS Bands p. 131

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., Cleveiand, OH 44114-2543. Paid rates for a one year subscription are as follows: \$105 U.S., \$185 Canada, \$210, \$255 International. Periodicals Pastage Paid at Cleveiand, OH and at additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 611 Route #46 West, Hasbrouck Heights, NU 07604. Telephone (201) 393-6060. Facsimile (201) 393-0204. Printed in U.S.A. Title registered in U.S. Patent Office. Copyright 1996 by Penton Publishing Inc. All rights reserved. The contents of this publication may not be reproduced in whole or in part without the consent of the copyright owner. For subscriber change of address and subscription inquiries, call (216) 696-7000. Mail your subscription requests to: Penton Publishing Subscription Lockbox, P.O. Box 96732, Chicago, IL 60693.

POSTMASTER: Please send change of address to ELECTRONIC DESIGN, Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114-2543.

ELECTRONIC DESIGN/OCTOBER 1, 1996

When you think of QT Optoelectronics, you probably think of optocouplers. But, QT is also a leading supplier of LEDs.

We've got a complete line of high-quality, reliable LED lamps and displays. And our authorized distributors — in hundreds of cities around the world — can deliver the products you need on time and at a good price.

Don't go barking up the wrong tree for your LEDs.

Call **800-LED-OPTO** today for more information and the phone number of your nearest QT Optoelectronics distributor.



United States 800-533-6786 France 33 01/43.99.25.12 Germany 49 089/96.30.51 United Kingdom 44 01296/39.44.99 Asia/Pacific 603/735-2417

© 1996 QT Optoelectronics

YOUR TOP DOG FOR LEDS



FS F R

October 1, 1996 Volume 44, Number 20

DEPARTMENTS

Analog computing systems: compact, wide range in- struments; New books: Pulse & Digital Circuits, Jacob Millman & Herbert Taub, McGraw-Hill Book Co., New York, N.Y., 687 pages; \$12.50 Portable radio transistors may last forever
Upcoming Meetings 12, 22, 64BB, 64FF, 64HH
Editorial
Technology Briefing 20 40 years of storage 20
Technology Newsletter25Protection on tap for GPS signaling25IP modules gain official recognition25Electronic tags stop PC-board thefts25ITU council looks to convergence matters25Package garners support as fiber-optic standard26Optical bus to send 1 Gbyte/s over 30 M26Supercomputer aids nuclear testing26Specialized radiometer for Q-switched lasers26
Technology Advances 31 Humanitarian conference looks at technology to solve abandoned land mines program 31 Two-chip analog/digital solution simplifies the design 31 of a low-cost screenphone system 32
Quick Look.63Market Facts63Off The Shelf.63Tip\$ On Investing.64Trudel To Form64DFlipping Through The Internet Rolodex64EHot PC Products64FA Three-Peat For Motorola64GInternet News.64I, 64OModem Microcontrollers64KLetters From London64PTerminator Crazy.64TAnalyzing The Telecom Test Equipment Market64X
Analyzing the telecom test Equipment Market



Jesse H. Neal Editorial Achievement

Awards: 1967 First Place Award 1978 Certificate of Merit 1968 First Place Award 1980 Certificate of Merit 1986 First Place Award 1972 Certificate of Merit 1975 Two Certificates of Merit 1989 Ceritficate of Merit 1976 Certificate of Merit 1992 Certificate of Merit

Pease Porridge	91
ldeas For Desian	97
Two wires carry power and data	97
Active load resistor	<i>98</i>
Simple wideband noise generator	102
PIPS Special Editorial Section	105
Improving relay-based control systems	105
Manufacturers of solid-state relays	114
PIPS Products	120
Products Newsletter	133
EDA tool delivers Spice at low price	133
Content-addressable RAM targets mainstream use	133
IC offers wireless LAN transceiver functions	133
Multiprocessor DSP targets imaging	133
New Products	135
Components	135
Packaging	136
Power	137
Digital ICs	. 138
Software	139
Index of Advertisers	152
Reader Service Card 152	A-D

COVER ART: BRUCE JABLONSKI

Permission is granted to users registered with the Copyright Clearance Center Inc. (CCC) to photocopy any article, with the exception of those for which separate copyright ownership is indicated on the first page of the article, provided that a base fee of \$2 per copy of the article plus \$1.00 per page is paid directly to the CCC, 222 Rosewood Drive, Darwers, MA 01923 (Code No. 0013-4872/94 \$2.00 +1.00). Can. GST #R126431964. Canade Post Interna-tional Publications Mail (Canadian Distribution Sales Agreement Number 344117). Copying done for other than personal or internal reference use without the express permission of Penton Publishing, Inc. is prohibited. Requests for special permission or bulk orders should be addressed to the editor.





Analog Computing Systems: Compact, Wide Range Instruments

Complete analog computing facilities capable of operating at speeds 3000 times faster than real time are now available in the form of General Purpose Simulators, Models GPS-6 and GPS-12. A wide variety of linear and nonlinear computing elements and special function generators are available for use with these basic systems, allowing a wide class of design problems to be handled.

GPS General Purpose Simulators can perform complete problem solutions up to 50 times per second, allowing the research operator to change problem parameters, and observe instantaneously and continuously the resulting changes in problem solutions. They are particularly useful for the rapid study of alternative system configurations, for optimizing the parameters of a defined system, for the solution of boundary-value problems, and for trial-and-error design. The GPS-6 system consists of a Master Generator and a Basic Com-



puting Unit capable of solving problems up to sixth order. The GPS-12 system consists of a Master Generator and two Basic Computing Units, and is capable of simulating linear physical systems up to twelfth order. Basic Computing Units are 29 x 13 x 36 in. high and weigh 60 lb each. GPS Instrument Co., 811 Boylston St., Boston, Mass.(*Electronic Design, October 1, 1956, p. 49*)

The magazine probably covered more analog computers than digital computers in the 1950s because analog computers were primarily engineering tools, while digital systems aimed mostly at business applications.—SS

New Books: Pulse & Digital Circuits, Jacob Millman & Herbert Taub, McGraw-Hill Book Co., New York, N.Y., 687 pages; \$12.50.

Response of linear networks, both active and passive, to the types of waveforms commonly encountered in pulse circuits is analyzed in the beginning of this book. Basic nonlinearities of tubes and semiconductor devices are described, and the effects of these nonlinearities on waveform transmission are studied. Waveform generating circuits are analyzed, and the basic building blocks are assembled into pulse and digital systems such as radar, television, and digital computers. A number of illustrative examples are worked out in detail. (Electronic Design, October 1, 1956, p. 94)

Back in 1956, "Millman and Taub" was one of the few books that covered state-of-the-art pulse circuitry from a practical as well as theoretical viewpoint, and thus was used by designers in the emerging field of digital circuits.—SS

Portable Radio Transistors May Last Forever

Replacement of transistors may never be necessary if they are used within the limits set by the manufacturer. Speaking to a transistor reliability symposium sponsored by a DoD advisory group, C.H. Zierdt, Jr., engineering consultant in GE's Semiconductor Products Dept., reported that life tests started in 1954 on transistors picked at random from regular manufacturing lots show no failures after 18,000 working hours at full power. This is equal to maximum load on the transistors eight hours a day for six years. Results showed that only 0.25% of the transistors could not be operated at peak ratings after 1000 hours at full power. The other 99.75% showed no signs of wear. All transistors were still usable in portable radios.(*Electronic Design, October 15, 1956, p. 12*)

This conclusion should raise no eyebrows. Today, more equipment probably is replaced because of obsolescence rather than device failure.—SS

There's Only One

Digi-Key's commitment to service is verified once again! *EE Product News* surveyed its readership of 103,000 engineers over a three-month period to find out what companies they ranked first in terms of technology, cost-performance and service. Of the more than 1,500 distributors in the United States, Digi-Key was the Readers Choice Winner in EEPN's (December 1995) "Readers Pick the Leaders" survey. When it comes to service, there's only one leader–Digi-Key!

aeaders Choice M

Call, write, fax, or visit us on the Internet for your free catalog today!

1-800-344-4539

Digi-Key Corporation, 701 Brooks Ave. South, Thief River Falls, MN 55701 Sav



PC based \$139.95, Parallel port connect \$449.95, Stand alone models \$550.00 or \$750.00 gang *Read, Pgm and verify 2716 - 8 Megabit EPROM, all models *Support for micros, Flash, EPROM, 16 bit, PALs, Mach (call for specific models support list or download demos via BBS or internet) 30 day money back guarantee, FREE software updates *Technical support by phone Mon - Fri 8am to 5pm PST 'Made in the USA, 1 or 2 year warranty on all parts and labor "Easy to use menu driven software, on line "help" full screen editor MACROS, Read and save to disk, Split and set options 'Internet ftp://ftp.crl.com/users/ro/needhams

FOR MORE INFORMATION CALL

NEEDHAM'S ELECTRONICS, INC.

VTSA 4630 Beloit Drive #20 Sacramento, CA 95838 (Monday-Friday, 8 am-5 pm PST) C.O.D. FAX (916) 924-8065

🛢 (916) 924-8037 BBS (916) 924-8094

READER SERVICE 140



Quality CRYSTAL Products of ; Units, Oscillators & Filters

KYOWA RIKA COMPANY LIMITED Saito Bldg. 2-17-15. Yusima, Bunkyo-ku, Tokyo, Japan Tel:81-3-3814-3081 Fax:81-3-3814-3088

READER SERVICE 120



Editor-in-Chief: Jack Shandle Executive Editor: Roger Allan Managing Editor: Bob Milne

Technology Editors:

Analog Semiconductors: Paul McGoldrick Analog & Power: Frank Goodenough Communications: Lee Goldberg Components & Packaging: Patrick Mannion Computer Systems: Richard Nass Design Automation: Cheryl J. Ajluni Digital ICs: Dave Bursky New Products: Roger Engelke Jr. Test & Measurement: John Novellino

Editorial Headquarters: 201 393-6060 P.O. Box 821, Hasbrouck Hts., N.J. 07604

Field Correspondents: West Coast Executive Editor: Dave Bursky Western Regional Editors: Cheryl J. Ajluni Paul McGoldrick 2025 Gateway Place, Suite 354 San Jose, CA 95110 (408) 441-0550

London: Peter Fletcher 16 Maylons Road Hextable, Kent. UK 44 1 322 664 355 Fax 44 1 322 669 829

Munich: Alfred B. Vollmer Eichenstr. 6 82024 Taufkirchen (near Munich) Germany 49 89 614-8377 Fax 49 89 614-8278

Chief Copy Editor: Michael Sciannamea Copy Editor: Debra Schiff

Consulting Editor/EDA: Lisa Maliniak

Ideas For Design Consulting Editor: Jim Boyd

Contributing Editors: Ron Kmetovicz, Robert A. Pease

Editorial Production Manager: Pat A. Boselli Production Coordinator: Wayne Morris

Group Art Director: Peter K. Jeziorski

Associate Group Art Director: Tony Vitolo Staff Artists: Linda Gravell, Jay Stavalo, Cheryl Gloss

Editorial Support Supervisor: Mary James

Editorial Assistant: Ann Kunzweiler Editorial Assistant: Bradie Sue Grimaldo

Advertising Production: (201) 393-6093 or Fax (201) 393-0410

Production Manager: Eileen Slavinsky Assistant Production Manager: Joyce Borer Production Assistants: MyLan Chu, Barbara LaTorre, Doris Carter, Lucrezia Hlavaty

Circulation Manager: Barbara Tillett

Reprints: Anne Adams Penton Reprints 216-696-7000, ext. 2626

Published by Penton Publishing

Electronic Design Information Group: Editorial Director: Stephen E. Scrupski

Publisher: John G. French



THINNEST, FASTEST, MOST EFFICIENT boost converter ever.

The Si9160 IC / Si6801 MOSFET synchronous boost converter chip set. Finally, a PA supply that runs off a single cell LiIon battery.



We know single-cell lithium ion designs are at the top of your list for the new generation of portable phones. That creates the challenge of using that high power density efficiently. Our new boost converter chip set is the first full-silicon, standard solution for power amplifiers – combining high-frequency operation with high efficiency over a wide range of load currents and full voltage range.

Our DC/DC chip set's high-frequency operation (up to 1.7 MHz) really simplifies noise management too. It allows simple synchronization with the system clock – above the signal and processing frequencies, but well below carrier frequencies. This is good news for the RF stages, where a random noise spectrum can cause problems. Add the fact that the Siliconix DC/DC chip set has the smallest footprint and the lowest profile available, and you've got the most compact and efficient solution available today.

So take the first step toward your next big idea. Contact your local TEMIC sales office or call 1-800-554-5565 ext. 510 today for more information.



TEMIC is a company of Datmler Benz, Memoers of TEMIC Semiconductors, Tell Junken Semiconductors, Silicenix, Natra MHS, Dialog Semiconductor, 2201 Latvelween Read, Santa Jura, CA 95054 Fax, 408 567 8995 TEMIC European Sales: GERMANY: 0130 857 320, ENTEE KINGDOM, 01344 707300, FRANCE, 1-30-00-71.07. ITALY, 02-332-121. SCANDINAVIA, 00-733-0090, © 1995 TEMIC All rights reserved.

World Radio History

UPCOMING MEETINGS

OCTOBER

IEEE International Conference on Computer Design (ICCD 96), October 7-9. Omni Hotel, Austin, TX. Contact Jacob Abraham, Computer Engineering Research Center, University of Texas at Austin, ENS 424, Austin, TX 78712-1014; (512) 471-8983; fax (512) 471-8967; e-mail: ICCD96@cerc.utexas.edu.

International Conference on Signal Processing Applications and Technology (ICSPAT), Oct 7-10. World Trade Center, Boston, Massachusetts. Contact Miller Freeman Inc., (415) 356-3391; fax (415) 905-2220; e-mail: dsp@mfi.com.

Microwaves & RF 96, Oct. 8-10.Wembley Conference & Exhibition Center, London, U.K. Contact Gillian Shinar, M+RF '96, (44) (0) 1322 660070; fax (44) (0) 1322 661257.

Second European Workshop on Mobile & Personal Satcoms (EMPS 96, Oct. 9-11.

Rome, Italy. Contact Francesco Vatalaro, Universita di Roma Tor Vergate, DIE, Via Della Ricera Scientifica, 00133 Roma, Italy; (39) 6772599 4464; fax (39) 6 2020519; e-mail: vatalaro@tovvxl.ccd.utovrm.it.

Third International Conference on Electronics, Circuits, and Systems (ICECS 96), October 13-16. Rodos, Greece. Contact ICECS Secretariat, Electrical Engineering Department, University of Patras, 26500, Greece; (30) 61 997 283; fax (30) 61 994 798; Internet: http://www.vlsi.ee.upatras.gr/ICECS96/.

15th IEEE International Semiconductor Laser Conference, Oct. 13-18. Dan Carmel Hotel, Haifa, Israel. Contact Samantha H. Padilla, IEEE/LEOS, 445 Hoes Lane, Post Office Box 1331, Piscataway, NJ 08855-1331; (908) 562-3894; fax (908) 562-8434; e-mail: s.padilla@ieee.org.

19th IEEE/CPMT International Elec-

tronics Manufacturing Technology Symposium, October 14-16. Austin, Texas. Contact E. Jan Vardaman, TechSearch International, 9430 Research Blvd., Bldg. 4, #400, Austin, Texas 78759; (512) 343-4508; fax (512) 343-4509; e-mail: j.vardaman@ieee.org.

ANSI World Standards Week, Oct. 14-17. Renaissance Hotel, Arlington, VA and Marriott at Metro Center, Washington, DC. Contact Michael F. Hoynes, Vice-President of Marketing and Communications, (212) 642-4950; mhoynes@ansi.org.

IEEE International Conference on Systems, Man, and Cybernetics, October 14-17. Beijing International Convention Center, Beijing, China. Contact Jian Chen, School of Economics and Management, Tsinghua University, Beijing, 100084, China; (8610)-2595536; fax (8610)-2595876; e-mail: smc96@mail.tsinghua.edu.cn.



SEE US AT WESCON '96 - BOOTH #2815 - ANAHEIM, CA - 10/22-10/24 READER SERVICE 118

Shifting up to 15 x more PERFORMANCE has never been easier.

With the turbo-charged TSC80251, you're geared to win-while getting more mileage out of your existing 8-bit μ C investment.



Here are 10 good reasons why you should shift up to today's most advantageous family of high-performance 8-bit microcontrollers:

- up to 15 x greater performance,
- total 80C51 binary code
- and library compatibility,
- 40% code savings using new 16/32-bit instructions,
- C-language optimization,
- up to 16 MByte memory space,
- 3V and 5V versions designed for low power & low RFI,
- OTP, EPROM, ROM and ROMless versions,
 full hardware/software development tools support,

- the only Intel-licensed product in its category,

 15 years experience in C51 family architecture.

And our long-term commitment means you'll enjoy through TSC80251 support for years to come.

For more, call us at: 1-800-554-5565, ext. 585



TEMIC is a Company of Daimler-Benz - Members of TEMIC Semiconductors : Telefunken Semiconductors, Sillcon x, Matra MHS, Dialog Semiconductor

TEMIC Sales Offices - North America

Central: Tel. (810) 244-06 18 - Fax. (810) 244-08 48 - Eastern: Tel. (908) 735-61 00 - Fax. (908) 735-22 58 - Western: Tel. (408) 970-57 00 - Fax. (438) 970-39 50 - Mexico: Tel. (52) 5 566 08 400 Faxback number: USA: 1-408-970-5600 / EUROPE : 49-7131-99 33-97/98 - WWW; http://www.temic.de

READER SERVICE 121

The New Choice In Data Conversion: Linear Technology.



High performance, low power, small size data conversion solutions.

When it comes to data conversion, you may be missing the best combination of performance, power consumption and size. Now there is a new choice for high performance data conversion solutions. Linear Technology Corporation.

Since our first A/D was introduced in 1987, we have delivered millions of 8, 10 and 12-bit high performance cost effective data converters. And this year we are on track to double the number of products in our portfolio.

Our new choices include the industry's widest selection of 3V and 5V 12-bit A/D and D/A converters. These low priced solutions combine the lowest power, smallest size and highest performance available on the market today. Choose the industry's first 12-bit A/D or dual 12-bit DAC in SO-8 packages. Or choose the best 1.25Msps 12-bit A/D on the market. Need speed? Choose the industry's fastest 12-bit A/D in an SO-8 package.

LTC is the new choice in data converters. Call for our new Data Conversion Solutions brochure and see for yourself. Make Linear Technology your next choice for high performance data converters.

C, LTC and LT are registered trademarks of Linear Technology Corporation. MICROWIRE is a trademark of National Semiconductor Corporation.



AND EVERYTHING IN BETWEEN.

World Radio History

Why Linear Technology Is The Best Choice In Data Conversion:

Linear Technology is developing and delivering some of the industry's most innovative products, addressing a wide range of challenging data conversion applications.

High Performance A/D Family Offers Best Performance and Smallest Size

Our high performance 12-bit A/Ds are the best performers at any speed, from 100ksps to 1.25Msps.

LINEAR TECHNOLOGY

1996 DATA CONVERSION

These products have excellent linearity, outstanding AC performance and no missing codes. We also have the smallest footprints available with SO, SSOP and SO-8 packages.

- The 12-bit 1.25Msps LTC1410 has an unprecedented 71dB S/(N+D) at Nyquist, and is only \$16.60 at 1000-piece quantities.
- The LTC1400 is the world's fastest SO-8 12-bit A/D, sampling at 400ksps, and is only \$9.95 at 1000-piece quantities.

All parts are complete with wide band sample-and-holds, precision references and DSP friendly interfaces. These features make this family of A/Ds the new choice in demanding communi-

cations, telecom, instrumentation, test equipment and DSP applications.

Micropower Family of 12-bit A/Ds Solves Space and Power Problems

Our micropower 12-bit A/Ds have the lowest power and smallest footprints available in the industry. These converters have microamp current levels as well as Nap, Sleep and automatic shutdown modes to provide the lowest power consumption for any given application.

• Our LTC1298 is the world's first 2-channel 12-bit A/D in SO-8, requiring just 250µA of quiescent current, and is only \$5.60 at 1000-piece quantities. • The 4-channel LTC1594 and 8-channel LTC1598 are the lowest power multiplexed 12-bit ADCs available and are only \$6.15 at 1000-piece quantities.

Features include SPI, QSPI and MICROWIRE[™] compatible serial interfaces and versions designed for 3V operation. This combination of performance, power and size make

them the best choices for pen screen interface, remote process control, portable data acquisition and other space conscious, power sensitive applications.

The Most Advanced Rail-to-Rail DACs

TUNKAR

We have the leading family of compact, rail-torail, 12-bit DACs. We offer the smallest size, the lowest power and the best DNL.

• The LTC1446 packs two complete voltage out, 12-bit DACs in an SO-8 package—the world's first! at \$6.50 for 1000-piece quantities.

• The lowest power 3V 12-bit DAC in SO-8, the LTC1453 draws only 250µA and is only \$4.85 at 1000-piece quantities.

Our 12-bit DACs have rail-to-rail voltage output amplifiers, internal references and parallel or serial interface options. The outputs drive capacitive



loads up to 1000pF, over twice that of competitive solutions. The easy-to-use serial interfaces allow daisy-chaining multiple DACs on one serial port. These are the best choices for digital calibration, industrial process control, automatic test equipment and other portable, battery-powered applications.

Converter Performance with No Unpleasant Surprises

In development we pay special attention to performance issues not always specified on the data sheet i.e. spurious noise, sparkle codes, layout and power supply sensitivities, and interfacing quirks which can create nightmares for the user. Our converters are designed and characterized thoroughly to prevent these problems and

documented on the most complete data sheets available.



It's a New Choice

For high performance data conversion solutions, make your next choice Linear Technology: The New Choice in Data Conversion. For more details, contact Linear Technology Corporation, 1630 McCarthy Blvd., Milpitas, CA 95035-7417. 408-432-1900. Fax: 408-434-0507. For literature only, call 1-800-4-LINEAR.



Linear Technology Products Address Data Conversion General Purpose Applications

"We needed a DSP Solution that would dramatically increase talk time, reduce size and still meet standards worldwide."

Pekka Ala-Pietilä, President, Nokia Mobile Phones

Maximize your power with DSP Solutions from TI. Longer talk and standby times, smaller hardware, global platforms. These breakthroughs are coming from leading wireless communications manufacturers like Nokia. And DSP Solutions from Texas Instruments are making them happen.

TI has the key technologies for innovative wireless designs. High-performance, low-power DSP and microcontroller cores on a high-density ASIC backplane reduce chip count. On-chip memory, including flash, allows reprogrammable DSPs for evolving standards. Extensive mixed-signal portfolio with RF provides glueless conversions and filtering. And software modules unleash your system expertise to pull it all together.

World Radio History

"I go for days without the opportunity to recharge, so I need a phone with the power to keep up."

Frank Webber, Sales Manager, Network Systems



ASIC BACKPLANE

Mixed-Signal Components

The global manufacturing and technical support capabilities of TI ensure on-time delivery and facilitate rapid ramp to volume in fast-paced markets. So maximize your market power with TI DSP Solutions.

For free data sheets and technical information, contact us at 1-800-477-8924, ext. 4056, or http://www.ti.com/sc/4056 on the Internet.

EXTENDING YOUR REACH



EDITORIAL

CY233 Serial/Parallel Conversion or Networks

CY233 connects up to 255 computers, peripherals, or remote sites, 5v CMOS 40-pin IC works with RS232/422 drivers. 300 baud to 57.6K baud. Supports a token in Peer or Host ring LAN modes. Numerous other operational modes:



READER SERVICE 174

New Faces

Change is inevitable, and more often than not, change also is good. Some interesting personnel changes are on tap for *Electronic Design*, and I'm quite sure they will work out well for the people involved because they represent opportunities for career growth. I am not an advocate of the "indispensability" argument. In my view, if a person is doing a good job in their present position, that is the best possible recommendation to move the person into one that is more challenging. That way, both the employee and the company have a chance to be better off than before.

The most significant change in our lineup of editors is the promotion of David Maliniak, our Components and Packaging editor, to Editor-in-Chief at *EE Product News*, a sister publication. He has been with us for about nine years, and capably managed the PIPS (Power, Interconnects, Packaging, Switches, and Relays) section, taking it from a quarterly to a monthly feature. Along the way, he's gained much knowledge about packaging, power supplies, and passive components that will serve him well in his new job. We wish him the best, and since he's only moving to the other side of the building, it will be easy to keep track of him.

Stepping into David's shoes is Patrick Mannion, an accomplished editor in his own right. His special interest is in optoelectronics, which is good news because that was one of those pesky holes in our coverage that we wanted to fill. The cadre of editors who work for the magazines that cover the OEM electronic industry is fairly small, and since Patrick and David shared many industry contacts, the transition should not be difficult. We're expecting a lot from Patrick, and we wish him well.

Other changes include EDA Editor Lisa Maliniak moving to a part-time role to spend more time with Sophie, her new baby. (Yes, David is Sophie's dad.) Taking her place is Cheryl Ajluni, one of our West Coast editors, who authored an upcoming EDA report while Lisa was on maternity leave. To smooth the transition, Lisa and Cheryl will be working together on the first couple of 1997 EDA articles. Lisa will then assume the role of a contributing editor.

Although the people on the copy desk are not highly visible to readers, they are important in our scheme of things. Copy Chief Roger Engelke has assumed the New Products Editor position, Mike Sciannamea moves up from Copy Editor to Copy Chief, and a new face, Debra Schiff, has come on board to take Mike's job. Let's wish them all the best of luck. *jshandle@class.org*



In 3 Volt Wireless, Only One Company Can Take You All The Way.



In wireless design, only Oki can help you power past your competition and get to market fast. Because nobody offers you wireless systems experience as deep. Design support as tireless. Or 3 Volt technology so far ahead. Today, only Okl delivers a complete 3 Volt wireless system — all field-proven 3 Volt devices across the board, from CMOS baseband to the most efficient GaAs RF. And the freedom to pick and choose your specific devices to achieve unique, highly competitive feature sets.

Then Oki's 115 years of communications experience, around-theclock design support and International manufacturing muscle pull together to get your production on-stream fast. Want to learn more advantages of partnering with Oki in wireless communications? See our communications products corner, including application notes, on our Web site at http://www.okisemi.com. Or call 1-800-OKI-6388.



©1996 Oki Semiconductor, 785 North Mary Avenue, Sunnyvale, CA 94086-2909 Phone 408-720-1900 Fax 408-720-1918

TECHNOLOGY BRIEFING



Low Profile .2" ht. Surface Mount Transformers & Inductors



All PICO surface mount units utilize materials and methods to withstand extreme temperature (220°C) of vapor phase, IR, and other reflow procedures without degradation of electrical or mechanical characteristics.

AUDIO TRANSFORMERS

Impedance Levels 10 ohms to 10,000 ohms, Power Level 400 milliwatt, Frequency Response ±2db 300Hz to 50kHz. All units manufactured and tested to MIL-T-27.

POWER and EMI INDUCTORS

Ultra-miniature Inductors are ideal for Noise, Spike and Power Filtering Applications in Power Supplies, DC-DC Converters and Switching Regulators. All units manufactured and tested to MIL-T-27.

PULSE TRANSFORMERS

10 Nanoseconds to 100 Microseconds. ET Rating to 150 Volt-Microsecond. All units manufactured and tested to MIL-T-21038.



40 YEARS OF STORAGE

eptember 13, 1956 is remembered by IBM historians as the day that changed the storage industry forever. It was the day that a team of engineers introduced the first disk storage system for computers, called the 305 RAMAC (Random Access Method of Accounting and Control). The RAMAC's 50 disks, each 24 in. in diameter, could store five million characters of data. As its name implies, the 305 RAMAC's significance was based on its ability to randomly access data on any part of the disk. As reported in *Electronic Design's* September 1955 issue, "Information is stored as magnetized spots on the illustrated stack of magnetic disks. The units can be combined to constitute a memory of vast capacity for the largest businesses."

The 305 RAMAC development was followed a year later by IBM's "writewide, read-narrow" technology, which made the accurate reading of data possible, even if the heads were slightly out of alignment. This development led to a wider use of the drives, but, for many years, hard-disk drives were confined to mainframe and minicomputer installations,

mostly due to their cost and size. They also had to be stored in an air-conditioned room.

With the introduction of the first removable disks in 1962, IBM ended the punch card era. So they claim. Having attended engineering school during the mid 1980's, I can vouch for the fact that punch cards didn't die in the 1960's. I have many not-so-fond memories of times I waited to have my cards read by the school's mainframe, only to be told afterward, there was an error. If you had a 100-line program, you had to go look back at all 100 lines to find your "error." A missed or moved comma was often the cause of many hours of poring through cards.



RICHARD NASS COMPUTER SYSTEMS

The Winchester drive, known by many as the father

of today's hard-disk drives, was invented in 1973. Built with two spindles, each with a storage capacity of 30 million characters (30-30), the first Winchester's 30-30 specification reminded the drive's designers of the famous rifle, hence the name. That drive contained a head that carries a resemblance to today's heads, riding on an air bearing above the disk.

These technology "breakthroughs" have led to some of the technologies that form the backbone of today's disk drives. These include magnetoresistive (MR) heads; partial-response, maximum-likelihood (PRML) read channels; no-ID sector formatting; predictive failure analysis (PFA); and adaptive battery-life extenders (ABLEs). Each of these technologies has provided the newer generations of disk drives with higher capacity and reliability, smaller size, lower power consumption, and a reduced parts count.

Advancements in storage technology went hand-in-hand with other developments. In fact, in some instances it depended upon them. When looking at some of the other significant milestones in the electronics industry, it's interesting to note that the IC wasn't invented until 1958, two years after the first disk drive. Obviously, no ICs were employed in that drive.

IBM takes credit for the introduction of the first floppy-disk drive, an 8-in. model, in 1970. This advancement led to real "portability" of data. The 5.25- and 3.5-in. floppies followed, as did flash memory (in 1986).

While all these innovations played an important role in the development of the personal computer, the microprocessor was the final piece to the puzzle. Intel's 4-bit 4004 microprocessor debuted in 1971, quickly followed by the 8-bit 8008 a year later. It took another six years to get to 16 bits, with the 8086 in 1978. It was the 8-bit 8088 microprocessor that drove the first PC, introduced by IBM in 1981.

The 80286 arrived in 1982, with the 386, Intel's first 32-bit microprocessor, coming in 1985. Finally, the 486 and Pentium processors hit the streets in 1991 and 1993, respectively.

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

OVER 100,000 PARTS IN STOCK, OVER 275 MANUFACTURERS, OVER 80 OFFICES NATIONWIDE!

1-800-433-5700



A lied Engineering Manual and Purchasing Guide



Multimedia Catalog on CD-ROM



24-Hour Modem Instant Access to Stock Inventory and Pricing: 1-800-433-5003



Same Day Shipment



On The Internet — Order Entry, Stock Inventory and Pricing: http://www.allied.avnet.com



READER SERVICE 95 World Radio History

UPCOMING MEETINGS

OCTOBER

Information Systems, Logistics Integration, Concurrent Engineering, and Electronic Commerce (ILCE 96), Oct. 14-17. Mercure Hotel, 69 Boulevard Victor, 75015 Paris. Contact ILCE Initiatives, 87/89 Rue du Gouverneur General Eboue, 92130 Issy-les-Moulineaux, France; (33) (1) 40 93 46 43; fax (33) (1) 40 93 03 22.

T&E: Answering The Challenges, Oct. 14-18. Red Lion Hotel, Seattle/Tacoma International Airport, Seattle, Washington. Contact Symposium Technical Program Chairman Tom Clark or Symposium Chairman Dennis Floyd, (206) 655-4832; fax (206) 655-7929; e-mail: tethc@pony5.express.ds.boeing.com; http://www.boeing.com/itea.

96, October 19-24.Re-**IPCWorks** gency Hotel, Naples, Florida. Contact David Bergman, IPCWorks '96; fax (847)509-9798; e-mail: David-Bergman@ipc.org.

IEEE International Test Conference (ITC 96), Oct. 20-24. Washington Sheraton Hotel, Washington, DC. Contact Doris E. Thomas, ITC, 205 Tennyson Ave., Suite C, Altoona, PA 16602; (814) 941-4666; fax (814) 941-4668.

IEEE Military Communications Conference (MILCOM 96), Oct. 21-24. Reston, VA. Contact John S. Quilty, The Mitre Corp., 7525 Colshire Drive, McLean, VA 22102-3481; (703) 883-6071; fax (703) 883-3397.

WESCON 96, Oct. 22-24. Anaheim Convention Center, Anaheim, California. Contact Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, California 90045-3194; (800) 877-2668; fax (310) 641-5117.

Fall VHDL User Forum (VIUF) Conference, Oct. 27-30. Omni Durham Hotel, Durham, NC. Contact David W. Allenbaugh, VIUF Publicity Chair,

mechanical

encoders

VEDA Design Automation Inc., (408) 496-4516; allenbaugh@usveda.com.

IEEE Electrical Performance of Electronic Packaging, Oct. 27-30. Inn at Napa Valley, Napa, CA. Contact Paul Baltes, Harvill Bldg., Box 9, University of Arizona, P.O. Box 210076, Tucson, AZ 84721-0071; (520) 621-5104; fax (520) 621-1443; e-mail: baltes@bigdog.engr.arizona.edu.

Fifth Symposium on the Frontiers of Massively Parallel Computation (Frontiers 96), October 27-31. Loews Annapolis Hotel, Annapolis, Maryland. Contact Michele O'Connell, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771; (301) 286-8830; e-mail: oconnell@cesdis.gsfc.nasa.gov.

IEEE/AIAA 15th Digital Avionics Systems Conference, Oct. 27-Nov. 1. Sheraton Colony Square Hotel, Atlanta, GA. Contact Ellis F. Hitt, Battelle, 505 King Ave., Columbus, OH 43201-2693; (614) 424-6595; fax (614) 424-3962.

Both the Series 25 and 25L are a part of Grayhill's family of rotary switches, optical and mechanical encoders, pushbutton switches, keyboards, keypads and custom front panels. 150-9001 certified, Grayhill manufactures to Industry and Military standards to assure quality and reliability.

AFFORDABLE MECHANICAL ENCODERS When reliability and cost-value WITHOUT COMPROMISE. matter, turn to Gravhill's

> family of rotary Priced around \$1 in quantity, the single deck design Series 25L is a reliable drop-in replacement.

> > Select multiple code outputs, up to 36 positions per revolution in less than a 1" square package.

Reliability assured, the Series 25 is a competitive drop-in, multi-deck replacement.

Choose from one to four decks, multiple codes, up to 36 positions per revolution and terminal options.

> Our Bulletin #716 describes the Series 25L encoder; Bulletin #698, the Series 25 encoder.

Visit Us At WESCON, Booth #2447



561 Hillgrove Avenue P.O. Box 10373 LaGrange, IL 60525-0373 USA Internet: http://www.grayhill.com DATA [] Faxback Info 1-800-244-0559 Phone: 708-354-1040 Fax: 708-354-2820

READER SERVICE 107 ELECTRONIC DESIGN/OCTOBER 1, 1996

More Relays. No Headaches. Have A Nice Day.



I t's your job to choose relays along with a whole bunch of other components. And you're under the gun to get it done now. How can you make your day go smoother?



Start by calling Omron, the supplier with the world's largest selection of relays. Low signal, general purpose.

General Purpose

power PCB and solid state. Packed the way manufacturing wants them. Pre-inspected if QC needs it.



This new third generation. G6S SMT relay bas long, bent lead sets mounted on the sides to transfer more heat and provide shock absorption to protect the solder joints.



 network of stocking

 distributors can shorten your

 ver PCB

 search even more. Just tell 'em

 what the relay needs to do, and they'll find

Our own sales engineers and

a solution. It's the easy way to solve even the toughest application problems.

Let's say you design

compact computer peripherals, telecom or office automation equipment. We recommend surface mount and other ultra miniature, low signal, through hole relays.

Lour Signal

For appliances and HVAC, we've got power PCB relays in space saving shapes with Class B insulation that save energy and tolerate high inrush currents. And that's just for starters. If you're building control panels, you'll find plenty of general purpose and solid state relays In "sugar cubes" or with



Solid State

push-to-test buttons or indicators.

Whatever you need.

So make it a nice day. Call Omron for relays. Ask for our Standard Products Catalog. Need a selection guide right now? Call *ControlFax* anytime. Dial 1-708-843-1963 and request document #1014.



VE HAVE THE FUTURE IN CONTROL



KEALT CAPACITORS HAVE THE ELECTRONIC INDUSTRY BEATING A PATH TO OUR DOOR.

At KEMET, manufacturing a good capacitor

has never been "good enough." To compete worldwide, we developed a process of product enhancement that relies on managment leadership, employee involvement, advanced technological planning and total process control. We can't predict the future. However, we can shape it. We produce smaller and smaller devices with higher capacitance values and better response to the increased thermal and mechanical stresses of the surface mount process.

> KEMET is ready for the future. We aren't in the mouse trap business, but with our people, our technology and our constantly improving product line, we do have the electronic industry beating a path to our door.

Our partnership with our customers is one of the major driving factors in our business of product enhancement. This partnership is instrumental in our efforts to anticipate our customers' requirements. Our process improvement methodology eliminates problems, while our supplier quality system insures we purchase only the finest raw materials, providing the best product at the best possible cost.

> KEMET on the INTERNET http://www.kemet.com E-Mail: capmaster@kemet.com



P.O. Box 5928 Greenville, SC 29606 864 / 967-6875

NEWSLETTER

PROTECTION ON TAP The rapid rise in commercial products that utilize Global Positioning System (GPS) technology has focused attention on a threat that always existed: The FOR GPS SIGNALING potential use of GPS as a battlefield technology against the U.S. and its allies. In an early step to neutralize such a threat, the U.S. Air Force has commissioned a \$3.6 million study to develop a system-level architecture intended to prevent the enemy from using the GPS signal while minimizing the system's disruption of legitimate civilian use. The 13-month contract is the first phase in a program code named NAVWAR. It was awarded to Lockheed Martin Federal Systems, Gaithersburg, Md., and will leverage Lockheed Martin's knowledge of GPS spacecraft and ground systems, anti-jam antenna, and systems integration, as well as theater command-and-control systems. The overall project could eventually lead to deploying a system that jams battlefield GPS signals but provides an anti-jam or decryption for friendly parties. The Air Force will use the study results to establish an acquisition strategy and system-level requirements for the engineering, manufacturing, and development (EMD) phase of the NAVWAR program. JS

While recognized by many as an industry standard, IP modules never received IP MODULES GAIN While recognized by many as an industry standard, while recognized of "official standardization." That's not the case anymore. The ANSI Board of OFFICIAL RECOGNITION Standards recently approved ANSI/VITA 4-1995, making the IP modules an American National Standard. This specification was developed under the auspices of the VITA Standards Organization (VSO). The VSO is the standards committee of VITA (the VMEbus International Trade Association), an accredited ANSI standards developer. IP modules offer a convenient method of implementing I/O, control, interface, slave processor, analog, and digital functions. IP modules, about the size of a traditional business card, mount in parallel with a host carrier board. This provides host processor or primary bus interfacing, as well as a mechanical means for connecting the module's I/O to the outside world. Typical carrier cards include standalone processors, DSP-based boards, desktop buses, and VMEbus boards. This specification contains mechanical, host-bus electrical, and logical definitions of I/O; memory and identification space; interrupts; direct memory access; and reset functions. Two physical sizes, two fixed clock rates, and multiple data-width sizes up to 32 bits are defined. To request a copy of the standard, call VITA at (602) 951-8866 in the U.S., or +44 1329 841272 in Europe. RN

ELECTRONIC TAGS STOP High-tech theft in the workplace is estimated to cost \$8 billion annually, according to a study conducted by the Engineering and Safety Service of the PC-BOARD THEFTS American Insurance Services Group. As a result, technology is increasingly being called upon to solve the problem; one such initiative now in beta testing is the Electronic Article Surveillance System. EAS implants invisible "tags" on valuable computer components to detect when they're removed from a protected area. The technology is being tested in pc boards developed by five major manufacturers. A piece of EAS material is embedded into the epoxy glass core of the circuit board prior to manufacture, rather than affixed externally to the device. As a result, it's virtually impossible to identify or remove the tags. The EAS-enhanced core can be masked, etched, placed in a black-oxide treatment, and laminated as if it were a conventional core. The EAS system was developed by Knogo North America Inc., Hauppauge, N.Y. For more information, contact the company at (516) 232-2100. RN

ITU COUNCIL LOOKS TO

National Institute of Standards and Technology (NIST) scientists have come up with a specialized radiometer for measuring the low levels of pulsed radiation CONVERGENCE MATTERS generated by Q-switched lasers operating at 1064 nm. The instrument is needed because Q-switched Nd:YAG lasers are replacing traditional arc-lamp pumped Nd:YAG lasers. The instrument combines peak power and pulse-energy measurements, improving responsiveness by two orders of magnitude over previous designs. It also uses an infrared-enhanced silicon avalanche photodiode with 100 mm diameter full aperture collection optics. Other optics and filters can extend the measurement range and beam size collection. The unit outputs a waveform for oscilloscope analysis. Calibration uncertainty is typically ±8%. To obtain a paper (number 22-96) describing the new radiometer, call Sarabeth Harris at (303) 497-3237, or arabeth@micf.nist.gov. PM

TECHNOLOGY NEWSLETTER

PACKAGE GARNERS SUPPORT The telecommunications industry is gearing up for installation of networks to support higher-bandwidth, added-value services such as fast data, Internet AS FIBER-OPTIC STANDARD access, and interactive TV. Part of that process involves ironing out some of the infrastructure issues to make that huge task a bit easier to handle. As a result, three major vendors have thrown their support behind a standard package for standard laser components for access networks. Northern Telecom; Hitachi, Tokyo; and Lucent Technologies' Microelectronics Group, Berkeley Heights, N.J., have settled on the 8-pin mini-DIL (dual-in-line) package, which at 13.2 by 7.6 mm is one of the smallest telecommunication lasers available. It is pin-compatible with the 14-pin DIL style, providing an easy end-product upgrade through drop-in replacement. Because the package is flat, it reduces customers' manufacturing costs. End products are much easier to assemble because no lead bending is required and no heat sinks must be fitted. All three of the vendors have indicated their individual commitment to supply laser components with a common footprint and standard pinout, thus giving users multiple sourcing. More information can be obtained at the vendors' Web sites (http://www.nortel.com, http://www.hitachi.com, and http://www.lucent.com). DM

OPTICAL BUS TO SEND An optical bus now being developed is expected to meet the bandwidth and distance requirements for next-generation "cluster-of-workstation" platforms. 1 GBYTE/S OVER 30 M Dubbed the Jitney, the architecture is the product of three companies--IBM Corp., Yorktown Heights, N.Y.; 3M, Austin, Texas; and Lexmark International, Lexington, Ky. Jitney increases the speed and distance by a factor of 10 over today's copper connections. It will find a home in mainframe, midrange, and workstation cluster applications, and later move to PC-based clusters and ATM switches. The optical link employs parallel optical interconnects (POIs) to support data rates up to 1 Gbyte/s at distances up to 30 m. It combines highly integrated optoelectronic integrated circuits with inexpensive IC packages. This includes an optical adaptation of the plastic molded leadframe chip carrier, which makes it possible to press an inexpensive plastic optocoupler onto pins that are molded into the package. The coupler also supplies the receptacle for the optical cable that's plugged directly in to the module. Jitney is expected to appear in the market in 1998. Additional information about Jitney is available on the Internet at http://www.research.ibm.com, or contact IBM at (914) 945-3584. RN

SUPERCOMPUTER AIDS IBM Corp., White Plains, N.Y., and Lawrence Livermore National Laboratories, Livermore, Calif., have joined forces to create what they're calling the NUCLEAR TESTING world's fastest supercomputer. The RS/6000 SP system will be installed as part of the U.S. Department of Energy's Accelerated Strategic Computing Initiative (ASCI). The goal of ASCI—a 10-year, \$1 billion program—is to design a platform capable of computing one trillion calculations per second. Such levels of computing are useful for applications ranging from medical simulations and global climate modeling, to aerospace and automotive design. The high-performance system also would be an integral factor in three-dimensional modeling and simulation techniques employed in maintaining the nation's nuclear arsenal in the absence of nuclear testing. The RS/6000 SP platform will be based on a building-block approach using clusters of shared-memory processors, with a maximum of 512 CPUs to perform numeric and data intensive calculations. The platform's scalability is one of its key features, since computing demand is guaranteed to grow. A production-model system, capable of computing 3 teraFLOPS (TFLOPS), is slated for delivery by the end of 1998. Additional information is available on the Internet at http://www.rs6000.ibm.com, or call IBM at (914) 766-3835. RN

SPECIALIZED RADIOMETER FOR Q-SWITCHED LASERS The ITU Council, the governing body of the International Telecommunications Council, provided guidance during its 1996 session on the creation of the ITU's next Strategic Plan covering the period 1999-2003. Issues to be considered in the next plan will include the impact of telecommunications liberalization and globalization at the national and international levels, the impact of the convergence of telecommunications, computer, and broadcasting technologies, and the development of the Global Information Infrastructure and the Global Information Society. The next session of the Council will be held June 18-27, 1997 in Geneva, Switzerland. During its 1996 session, the council offered recommendations for synchronous digital hierarchy (SDH), and for asynchronous transfer mode (ATM) for bit rates up to 9953 Mbits/s. Future plans include further development of audio/visual systems, with a primary focus on mobile and ATM environments, and of optical system aspects (for example, test methods of optical amplifiers and optical components for both terrestrial and submarine applications). PM

S SEED

The UC3638 Advantages

- True 4 Quadrant Modulation
- Single Supply Operation from +9V to +40V
- Dual Supply Operation from ±4.5V to ±20V
- Programmable Oscillator
 Amplitude and PWM Deadband
- Differential X5 Current Sense Amplifier
- Bidirectional Pulse-by-Pulse Current Limiting

When Precise Motor Control Means Everything

When your DC motor drive or audio amplifier applications demand precise control, turn to Unitrode. Our new UC3638 PWM Motor Controller performs in either unidirectional or bidirectional drive circuits. The programmable high speed triangle oscillator and a X5 differential current sensing amplifier provide smooth operation to 500kHz switching frequency.

To receive free samples of the UC3638 give us a call. We'll provide you with our new catalog detailing Unitrode's complete line of motor control products.

All this functionality



... in one package



TEL: (603) 429-8610

http://www.unitrode.com • FAX: (603) 424-3460 7 Continental Boulevard • Merrimack, NH 03054

> READER SERVICE 165 World Radio History

Introducing the SPARC[®] hyperSTATION. Design and architecture so advanced...



World Radio History

years from now, you'll still marvel at your applications' monumental performance.

THE SUNOS[®] AND SOLARIS[®] SOLUTION.

lust because the Sun is setting on your current operating system, it doesn't mean you're left in the dark. ROSS, the sole supplier of hyperSPARC" CPUs to the SPARC market worldwide, creates hyperSTATION 20 and hyperSTATION 30-the dawn of a brand new day in SPARC workstation performance. Today, you can have the power you need to run SunOS 4.1.3 SunOS 4.1.4, and Solaris applications at speeds faster than you'd ever imagined possible. And you have the power to maintain that edge in the future.

ROIS

THE LONG-TERM SOLUTION.

Our high performance SPARC microprocessor architecture is housed in a new chassis specifically designed for future generations of exactly what ROSS is famous for ... multiprocessor upgrades. Shining examples of ROSS' forward-thinking approach, both hyperSTATIONs feature an advanced thermal management system, a stronger power supply, options for a 6X CD-ROM drive, 24-bit 2-D and

INTRODUCING THE HYPERSTATION 20 AND 30.

HYPERSTATION 20. MORE SPARC FOR YOUR BUCK.

hyperSTATION 20 has more features than Sun's SPARCstation 20 for a lot les money. Dual 50 MHz MBus slots support up to four hyperSPARC processors and up to 512MB of RAM, so you can pick the level of speed you need. And with our 6X CD-ROM drive, ISDN and high performance graphic accelerator options, the hyperSTATION 20 gives you features the competition doesn't even offer.

HYPERSTATION 30. THE MASTER OF SPARCS.

P#/STATION

InperSTATION 30 is as fast as it gets. It features a new 66 MHz MBus for high-throughput multiprocessing and a 1GB physical system memory for advanced ECAD and database applications. Combine our current microprocessor speeds from 133 to 166 MHz and ROSS' evolutionary history of advanced hyperSPARC performance, and you'll start-and stayon the fast track.

3-D graphics accelerator, and enough real estate for up to 6GB of hard disk space.

EXTENSIBLE, **UPGRADEABLE**, CONNECTABLE, RATIONAL AND AFFORDABLE.

You can always extend your performance level with our high speed single, dual- or quadprocessor upgrades. And you can rest assured that our SPARCbased and UNIX-compliant open systems solutions will provide high connectability. When you think about it, ROSS hyperSTATIONs are the only way to go if you want to put your company's future on a predictable path for growth-without buying into the high costs and inevitable headaches of moving to alternative platforms.

OTHER MARVELS OF ROSS TECHNOLOGY.

If you're in the market for memory, motherboard upgrades or microprocessor upgrades, from 90 to 166 MHz, we have them. Call us today for specifications and prices!

CALL 800-ROSS-YES.



5316 Highway 290 West Austin, Texas 78735 800.ROSS.YES International 512.349.3108 FAX 512.349.3101

http://www.ross.com

•1996 ROSS Technology Inc. All rights reserved. ROSS Technology and the ROSS logo are registered trademarks, and hyperSTATION is a trademark of ROSS Technology. Inc. All SPARC trademarks are trademarks or registered trademarks of SPARC International, Inc. hyperSPARC is licensed exclusively to ROSS Technology. Inc. HyperSPARC trademarks are based upon an architecture developed by Sun Microsystems. Inc. All other product or service names mentioned herein are trademarks of their respective owners.

READER SERVICE 154

TECHNOLOGY ADVANCES

THE CONFERENCE PROGRAM

The EUREL International Conference on The Detection Of Abandoned Land Mines runs Mon. through Wed. Oct. 7-9, at the Edinburgh International Conference Centre, Morrison St., Edinburgh, Scotland. The city is well served by air (one hour from London's Heathrow airport), rail (approximately five hours from London's King Cross to Edinburgh Waverley), and connectors to the M6 Motorway. The registration desk (in the Strathblane Hall) will be open starting 4:00 P.M., Oct. 6. For more information, call +44(171) 344 5472, or e-mail: <conference@iee.org.uk>, or see the latest conference detail on the IEE's home page at http://www.iee.org.uk.

field. Session 5 will cover novel sensors, with papers on gas sensors, electricalimpedance tomography, nuclear techniques, neutron interrogation, and nuclear quadrupoleresonance. Meanwhile, Session 6 will discuss a biosensor and various types of electromagnetic solutions.

Session 7 introduces a paper from England's Thorn Missile Electronics, where a recent demonstration of a millimetric radiometric system showed the feasibility of detecting both metallic and plastic (because of the dielectric change) devices in the 95-GHz and 140-GHz The frequency ranges. range would require larger hardware but would provide better clutter performance. Heat-transfer simulations also offer the ability to detect surface and even buried objects.

On another front, the National Defence Research Establishment of Sweden has been working with SAAB Dynamics on the behavior of thermal radiation and correlation with results in the 8-to-12- μ m waveband. A neural network was trained to increase the probability of a correct classification.

A separate paper describes the possible use of a line-scanning infrared camera with high resolution and a wide field of view. Airborne trials by SAGEM S.A., France, confirmed that the results were better than with the simultaneously mounted framing cameras. Mines laid to a depth of 35 cm were located from an altitude of a few hundred meters; the thermal visibility of the mines appeared to be extended in time with the downward vertical view.

Ground-penetrating radar, which is perceived as one of the most promising sensor systems, occupies Session 8 through most of Session 11. A key to all of the work being described. which looks-with refinement-to be very promising, is in the performance of the antenna. A low-cost printed, active microwave antenna is described by the British Royal Military College of Science. Other session papers cover multispectral signatures, and stepped-frequency continuous-wave (CW) polarimetric, wave-scattering, spotfocused, and post-reception focusing.

Algorithms are not ignored, either. Three Australian papers provide a complete overview on ground-penetration detection techniques for systems operating between 800 MHz and 3.5 GHz, with the highest pulse-repetition frequency being 65 kHz. It's demonstrated that some anti-personnel mine work will need operating frequencies from 4 to 6.5 GHz and in any hostile environment, mixed systems will be essential with suitable data-reduction techniques.

Such mixing of techniques, even with other sensor formats, has been dubbed "fusion". For instance, another Australian paper gives some insight into the theory of combining data. Other fusion papers will be in the last session as well.

A noteworthy presence in Session 11 is a paper from the U.S. Army describing a program to assess different combinations of sensors, including a ground-penetrating radar system with a metal detector on a handheld wand. These are combined with an infrared sensor on the operator's helmet. The fusion process takes place in a computer located in the operator's backpack. The system is called HSTAMIDS (handheld standoff mine detection system.)

Three late entries are among the 48 papers: A security paper from the United Kingdom's Ministry of Defence, one on identification and classification from the University of Alabama in the U.S., and a mine-clearance operational paper from the Mine Clearance Department of the International Development Council of France.

Overall, the program gathers together a unique, wide-ranging mix of technologies under one roof, and should prove to be quite eye-opening. A report on the conference proceedings is scheduled to appear in the Dec. 2, 1996 issue of *Electronic Design*.

PAUL McGOLDRICK

TWO-CHIP ANALOG/DIGITAL SOLUTION SIMPLIFIES THE DESIGN OF A LOW-COST SCREENPHONE SYSTEM

Pelephones that incorporate a large LCD capable of showing 1/4, 1/2, or full VGA resolution are being adopted by many companies as a quick and simple means to access information. Instead of having to listen to a synthe-

sized voice or a recorded menu of options, users can have the options displayed on the screen. That allows for faster selection, especially if a touch screen is used. Another screenphone application might be e-mail send and receive capabilities, as well as Internet access applications.

Philips Semiconductors, Eindhoven, The Netherlands, has developed a pair of ICs that together can be used to form the basis of a screenphone, including a built-in software modem. The UCB1100H, an analog interface chip, and the PR31100, a digital chip, handle all the processing, integrating virtually all the interfaces and functions within them. As a result, the pair requires only a handful of external compo-

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History

MACHINE CONTR INSTRUME

Visualize the World

inte

pentium



Fortunately, you won't have to experience a world without GESPAC. **CompactPCI**

GESPAC... the innovative leader enlightens the market with the new CompactPCI Pentium PC system. The PCIMPU-56 is a highly integrated board that offers Pentium processors in a variety of speeds, 75 MHz to 166MHz, two standard 72-pin SIMM modules, and Intel's "TRITON" chip set. Manufacturers of industrial machine and process control systems, telecommunications, medical and other real-time system applications will find that CompactPCI meets their stringent demands for a rugged, powerful, space saving format.

GESPAC's rugged CompactPCI bus meets PCI bus specification 2.0 on a 3U form factor. CompactPCI optimizes system performance by permitting the board to communicate at very high speed with high band-width peripherals.

> GESPAC's customers can also buy completely assembled microcomputers or individual boards and software products. GESPAC also provides a full range of custom services, ranging from custom design to technical support and education.

Experience the World With GESPAC



Innovative Embedded Solutions

PICMG executive member since 1995

Europe 18 Chemin des Aulx 1228 Geneva Switzerland Tel: (41 22) 794 3400 Fax: (4) 22) 794 6477 World Radio

N & S America 50 West Hoover Ave Mesa, Az 85210 1 (800) 443 7722 Tel: (602) 962 5559 Fax: (602) 962 5750

Japan Minami Aoyama 1-15-18, Minato-ku Tokyo 107 Tel: (81 3) 3470 0640 Fax: (81 3) 3478 8648

Visit our web site for details to win a free Swiss Army Knife! http://www.gespac.com

TECHNOLOGY ADVANCES



nents to make a full working system (i.e. an LCD, a telephone-line interface, an ac-line power adapter, and some ROM, RAM, and flash memory.) A loudspeaker and microphone can be directly connected to the ICs if required (see the figure).

The basic configuration can be easily expanded by using features that are already built into the ICs. These include a PCMCIA interface, infrared links to be able to connect to printers, a direct connection to the LCD with full touch support, and smart-card reader connection.

The UCB1100H analog interface chip provides the interfaces to the analog world. It includes a telecom codec, an audio codec. a touch-screen interface, a four-channel analog-todigital converter (ADC). and a general-purpose programmable digital 10bit I/O port. Also on the chip is a direct connection for a speaker and microphone, eliminating the need for external amplifier stages.

The 12-bit mono audio codec for audio input and output uses state-of-theart oversampling techniques and has a programmable sample frequency, digital volume control, digital noise shaper, antialiasing filters, and mute and loopback functions.

The 14-bit sigma-delta telecom codec provides 14.4-kbit/s, V32.bis modem support via a line interface to the telephone network. Philips Semiconductors also can supply components for the necessary line interface for any country in the world, as well as a programmable solution for multi-country use. The codec features a programmable sample frequency, digital attenuation control, a digital noise shaper, echo cancellation, and mute and loopback functions.

A 10-bit, 4-wire touchscreen interface provides a direct connection to a resistive touch screen and measures the X and Y positions. The interface incorporates a switch matrix, voltage/current generation, and sensing and control logic. It also can generate an interrupt signal when a touch is sensed. The interface thus enables touch-input capability to be employed, typically costing around \$8 at OEM prices.

A Serial Interface Bus (SIB) provides a highspeed, 4-wire data link with the PR31100 digital chip. It is capable of speeds of up to 15 MHz.

The second chip, the PR31100 digital chip, handles the digital environment. It has a 40-MHz, 32bit MIPS RISC processor that is capable of 40 million instructions/s, a fast multiplier-accumulator to run the software-based digital signal processing required for, say, modem-emulation speech-coding 01 functions, a 1-kbyte data cache. 4-kbyte instruction a cache, and a number of built-in modules that give designers the ability to easily add features to differentiate the product.

Included is an I/O module capable of driving the RC5 and RC6 infrared communications standards at distances of 10 m and beyond, but at relatively low data rates of up to 1 kbits/s. With the help of the UART, the I/O module is capable of IrDA interfacing, providing a bidirectional serial interface for high-speed data transfers at a data rate of 115 kbits/s and at a distance of up to 1 m.

The UART module provides both single-buffered transmit and double-buffered receive registers, an adjustable baud-rate counter from 230 kHz down to 225 Hz, full-duplex operation, and a pulse-option mode to support the IrDA protocol. The baud rate-the number of bits per symbol-parity type—and line polarity apply to both transmitter and receiver and are selected from a control register. In the case of IrDA transmissions, both transmit and receive signal paths are directed via the IR module.

Both the data and instruction caches can be programmed on or off, with the bus-interface circuit adjusting the bit width to 16 or 32 as appropriate. The cache can be configured in a variety of ways, providing the flexibility to tradeoff performance and functions against cost and power consumption. Other memory and CD-ROM or hard-disk drives can be accessed via the 32-bit bus. In theory, up to 4 Gbytes of address space is possible.

The architecture can support a number of operating systems. In fact, Philips Semiconductors has already ported several operating systems, including NUCLEUS and pSOS.

This two-chip solution fully supports the Analog **Display Service Interface** (ADSI) specified by Bellcore and currently provided by regional Bell operating companies in the U.S., and an increasing number of European telecom providers. ADSI provides an easier-to-use interface for caller identification, selective call blocking, interactive voice-response systems and voice mail, home banking, and home ATMs (automatic teller machines) for charging up smart cards with electronic money, and a variety of different information services.

It is even possible to connect a TV, a keyboard, or a joystick to this two-chip screenphone solution, making it possible to create a low-cost machine for games or Internet applications. In this case, an additional, small, low-cost interface is needed to produce an NTSC- or PAL-compatible output as required.

The complete package consisting of the two ICs and software modem is priced at around \$40 in volume quantities.

For more information on the two-chip screenphone, contact Philips Semiconductors, Eindhoven, The Netherlands at +31 40 2 722091; fax +31 40 2 724825. PETER FLETCHER

Our Gen 3 IGBTs are no longer the world's most efficient.

Generation 4 IGBT technology from International Rectifier delivers $V_{CE(on)}$ versus switching loss improvements of 20-40%. With essentially the same drive requirements, switching behavior and thermal characteristics as our current industry-leading Gen 3 IGBTs. So now you can get a drop-in replacement that upgrades performance for your IGBT designs.

And there's even more good news to come. Because more performance is on tap as the Gen 4 product family expands.



I O N

GENE

Dramatically lower $V_{CE(en)}$ at comparable switching loss make Gen 4 IGBTs more efficient. So they're the ideal way to improve performance.



Improved efficiency and drop-in compatibility make IR IGBTs ideal for nearly any motor control or power conversion application.



Gen 4 IGBT wave form characteristics are virtually identical to Gen 3. Re-design and re-qualification? You're already done.



Fewer manufacturing steps and the world's largest and most advanced power semiconductor fab mean tighter specs and higher quality. And an astonishing 75% reduction in cycle time.

Introducing Gen 4.

Get instant response to your IGBT performance and delivery requirements. Log on to our Website or use our Fax-On-Demand service today.



Fax-On-Demand: Doc #160 U.S. 310-252-7100 U.K.44 1883 733 420 Internet: http://www.irf.com

©1996 International Rectifier Corporation.

READER SERVICE Typrid Radio History

Lattice ISP. The Speed Leader!



- **■** 8 Families of ISP[™] devices in production, NOW
- Millions of ISP[™] devices shipped
- **5V** or 3.3V operation
- Highest performance from 10 to 256 macrocells
- Turbo ispDOWNLOAD[™] for ultra-fast programming
- All popular third party CAE tools supported
- ATE programming for low-cost manufacturing
- Boundary Scan Test



Why wait? Get Lattice ISP^{**} on board! Call us at 1-888-ISP-PLDS and ask for information packet 329 or contact us at www.latticesemi.com!

Copyright @1996, Lattice Semiconductor Corp. ispLSI is a registered trademark of Lattice Semiconductor Corp. ISP and ispDOWNLOAD are trademarks of Lattice Semiconductor Corp. All brand or product names are trademarks or registered trademarks of their respective holders. Corporate Headquarters: Tel: (503) 681-101%, Fax: (503) 681-3037 • France: Tel: (33) 159 33 22 77, Fax: (33) 150 19 05 21 • Germany: Tel (49) 8165-9516-0, Fax: (45) 8165-9516-3 Hong Kong: Tel: (652) 2319-2929, Fax: (852: 219-2750 • Japanitice 161) 4552-05335, Fax: (13) -5520-03531 • Kroses: Tel: (42) 784-4886, Fax: (322) 784-7257 Talwan: Tel: (8862) 577-4352, Fax: (8862) 577-0260 • United Kingdom: Tel. (44) 1932 831180, Fax: (44) 1932 831181

FREE ISP^{**} Design Software & Lattice ISP^{**} Encyclopedia



Includes: Software, Data Book, Handbook, ISP Manual on CD-ROM


TECHNOLOGY ANALYSIS

Did You Hear What I Said?

Speech Recognition Continues To Evolve, But Work Still Needs To Be Done So It Can Understand Us Enough Of The Time.

PAUL MCGOLDRICK

hose of us who have dreamed of the ultimate dictation system— Star Date: Chicago, 1920s, Kirk and Spock hunt an unidentified alien, with a mystified Betty Crocker-like assistant dictating to a typewriter—will have to wait a bit longer. But systems are growing up at a rapid pace, while the field of aggressive players does, in fact, seem to be dwindling, or consolidating. But gradually, the dream of being able to effortlessly communicate with earing reality.

machines is nearing reality.

The commercial implementation of speech recognition started in 1992 when AT&T introduced keyword spotting in its operator service. Looking for only five key words, the service is extremely reliable and speaker-independent. Later services, such as those being introduced on some area codes' directory services, are now giving high-percentage results on company names. Larry Rabiner, head of research in speech and image processing for AT&T Labs, Murray Hill, N.J., sees the company's directions as being in five focus areas:

• Agent technology. The system is personalized for a particular user giving responses that do not jar with expectations. If "Sorry, I did not understand that" doesn't suit you, then change it to "Missed that" or whatever else you want.

• Forms filling. Getting services through a pyramid of details, where your data may already be on file, but if not you will create them the first time that you use the system. This is the kind of service we will see for voice-car rental or airline reservations when we will only have agent interruption if something is out of whack, or where a user is technophobic about such systems. The use will not be limited to plain old telephone systems (POTS). There will also be audio/video connections through your PC and the World Wide Web.

WEB SUPPORT

In a search engine such as AltaVista, you will get back about 20,000 matches with "Speech Recognition" and another 15,000 with "Voice Recognition." Define your needs much more specifically. There's an extremely useful link page at http://www.itl.atr.co.jp/comp.speech/Section6/Q6.5.html with up-to-date hardware and software links; and look at other Section6/*.* documents.

In addition, look for some of the DSP chip manufacturers' home-page information. Texas Instruments, for example, has a library of standard DSP building blocks and speech-recognition algorithms on http://www.ti.com/sc/docs/dsps/softcoop/speech.htm.

And check out the public pages of Cambridge University's recorded work at ftp://svr-ftp.eng.cam.ac.uk/pub/comp.speech/info/ and Stanford's Applied Speech Technology Laboratory at:

http://csli-www.stanford.edu/users/bscott/ SRTech.html.

· Messages. If you're an average individual, you now have multiple message centers. For example: Office voice-mail, two e-mail addresses, two fax machines, an answering machine, a note left on a desk, chair, or computer (or the forgotten one left on a support person's desk), the board on the refrigerator, voice-mail on the car phone, plus conventional mail and memos. If it isn't a mess already, it's getting there. Larry Rabiner sees these as being integrated, getting all the interfaces organized so that they are all connected-as much or as little as we want.

• Registry services. The registration of your needs in communications.

SPEECH RECOGNITION TODAY

In the simplest cases, this would be the people who can get to you easily, when you want them to, or never. For instance, your spouse can always get to you, but people try to sell you services don't. The system would learn by repetition, so it would look into your cache for which John Smith you are calling because that's the one you have been talking to most recently, or most often. Here, again, all the interfaces will be needed including those to the PC.

• Security and verification. The obvious ones in communications are for fraud prevention on calling cards and cellular telephones. Multilingual needs also are going to expand, including translation services, particularly after deregulation takes place in Europe in 1998/99.

GET SMART STAR WARS

On the agent technology front, AT&T is testing a system in-house. *Maxwell* (as in agent Maxwell Smart in *Get Smart*) is sitting in an Indigo computer under AT&T researcher's Candace Kamm's desk. She is learning what features she is using, and not using, what interfaces look like, how to make them more natural, how to cope with accents, what the personality interface should be like. Maxwell sounds rather like Hal (from the movie 2001) and is responsive to the majority of Candace's whims. The next stage will be to increase the population testing the system and that will likely be the whole of the AT&T Labs staff across their communications systems. The general demo, with the in-house moniker of *Star Wars*, will be personalized by the individuals involved to be speaker-dependent to their needs.

Work also is being done by AT&T in the area of translation combined with form filling. Researcher Adam Buchsbaum has in front of him a computer that is loaded with 30 Mbytes of voice recognition, and 80 Mbytes of English to Mandarin (and vice versa) translation set up as an air-travel information service (ATIS). There are 20,000 sentences of passengers making verbal airline reservations being loaded. With statistical systems and training, a choice is derived and the request is converted to Mandarin. The system worked well, although when it was tested with the words Dulles and Dallas, it statistically much preferred the Texas destination. Funding for this project started with money from the U.S. Defense Advanced Research Projects Agency (DARPA). Certainly the ATIS use is a large niche and AT&T sees other such niches in small applications like video-on-demand and Internet browsing.

The AT&T Watson system (named after Alexander Graham Bell's assistant, Thomas Watson) was commercialized in April 1995 with the technology being licensed to help independent software vendors develop products for the home, small business, and telecommuting markets. Text-to-speech is now available for this speaker-independent, wordspotting system, and verification is coming shortly.

MEDICAL TRANSCRIPTIONS

The opposite conversion, the dream of voice-to-text, is the next major push that needs to be perfected. Dictation systems are being implemented in areas where the vocabulary is relatively limited, such as in medical transcription and legal work. In the case of the former, it is an attractive

A GLOSSARY OF SPEECH-RECOGNITION TERMS

Following is a glossary of the most commonly used speech-recognition words and terms:

• ASR. Automatic speech recognition.

• Barge-in. AT&T's version of interrupting prompts.

• Continuous. Usually continuous digits uttered into a system. No pauses between utterances or words. May also cover the smarter "eight hundred" phrasing recognition instead of "eight-zero-zero".

• Cut-through. VCS' version of interrupting prompts.

• Discrete. Normally having to wait for a prompt to end to allow you to give a single-word answer. Also, the leaving of periods of silence between utterances.

• Digitized speech. The creation of speech from stored, and compressed, voice samples.

• Enrollment. The training of a system for speakerdependent phrasing.

• Interrupting prompts. The ability to get your verbal instruction understood even while a list is still being read to you.

• Name tags. Usually short names or phrases that can be recorded and played back. Often used in cellular calling systems to confirm recognition.

• Speaker dependent. Refers to technology that's capable of recognizing a speaker after the system is trained (enrollment).

• Speaker independent. Technology capable of recognizing any user with any accent, and so on.

• Speaker verification. Normally a system that is trained by a phrase to verify the identity of the speaker. Different levels of verification may exist for different levels of security.

• Speech recognition. Incorrectly applied to the whole technology. More accurately applied to speaker-independent recognition, as compared to voice recognition in general.

• Speech synthesis. Machine generation of speech by arrangement of phonemes into words.

• Talk-over. VPC's version of interrupting prompts.

• Voice activation. The control of just about anything by voice recognition.

• Voice recognition. When accurately used, it is a system that recognizes only a voice it has been trained for—speaker-dependent recognition.

• Word spotting. Looking for particular words and phrases and ignoring all else. "I'd like a collect call, please" is polite and conversational; the system only wants to hear and interpret "collect."

• Zoning. Setting up a prompt menu to limit the choices of the speaker in the paticular phrases that might be used.

A D A P T A B L E

CUSTOM AND SEMI-CUSTOM AC/DC POWER SUPPLIES

There's a world of difference between providing a product and providing a solution. At CELESTICA, we first provide solutions. And then, we deliver the optimal products. Our proven technical expertise goes into every one of our high-quality AC/DC Power Supplies. This means you're always guaranteed the very best solution. Looking for reliability and adaptability in your supplier relationship? Look to CELESTICA. Quality. Responsiveness. On-time delivery. ISO 9001-registered. CELESTICA – we're more than just another option. CALL: **1-800-461-2913** to explore the possibilities CELESTICA offers.





³⁰ Celestica is a trademark of Celestica, Inc. 4^o Copyright Celestica Inc., 1996, Photo courtesy of NOAQ.

READER SERVICE 125 World Radio History

LOW-POWER DESIGN A Collection of CSEM Papers



- General Tutorial Papers
- Digital Circuits
- Devices and Analog Circuits
- Low-Power Systems

Ver the past decade, minimization of power consumption has become a critically important task in the implementation of electronics systems of all kinds, and especially for portable and battery-powered functions. The requirements for low-power will pervade systems and IC design to an ever increasing extent.

This collection of landmark CSEM (Center Suisse d'Electronique et de Microtechnique SA) papers has been produced as a handy, basic reference book.

	Now Ava	ilable	For \$12	5
LOW-POWE Single order, \$ Multiple order:	R DESIGN 125 Quantity: x \$125 = For S & H please add \$6 for dor or \$25 for international per book	nestic Total	Amount	Mail to: ELECTRONIC DESIGN 611 Route 46 West Hasbrouck Heights, NJ 07604 Attn: Jeanne Sico or fax: 201/393-6073
□ Master Charge	American Express UVISA	Check (payable to Elec	tronic Design)
Account Name		Acco	unt #	
Signature		Expira	ation Date	
Name		Title		
Company				
Company Addres	S			
City			_ State	Zip
Phone	Fax		E	-mail
World Radio History				

1996 Proceedings NOW AVAILABLE

A valuable tool for design engineers of portable, nomadic, mobile and transportable products.

From low-power system design to low-cost solutions, the *Proceedings of the Third Annual Portable by Design Conference* offers over 600 pages of vital, timely and usable information for the portable OEM designer.

For the price of \$160 per copy plus \$10 shipping and handling fee, you can receive the *Electronic Design* magazine-sponsored conference proceedings bound in one volume for handy reference. If you order now, you can receive the 1994, 1995 and 1996 Proceedings for only \$260 plus \$22 S& H. A single copy of the 1994 or 1995 Proceedings is available for \$100 plus \$10 S& H. Stay on the cutting edge of today's innovative portable technology and order your copies now, while supplies last.



The following is a sampling of topics from the 1995 Second Annual OEM Designers' Conference:

- Power-Control Circuits
- Connectivity and Communications
- Display and Input Devices
- Design Team Management
- Expandability, PCMCIA, and Mass Storage
- Time-To-Market
- High-End Low-Power Microprocessors
- Power Management Techniques
- **Operating Systems and BIOS Issues**
- Battery Technology
- Low-Power Analog Design
- · Packaging and Assembly
- Battery Management
- System Design Issues

Portable by Design Proceedings Order Form						
□ 1996 Proceedings: □ 1995 Proceedings:	\$160 + \$10 s/h; # of copies \$100 + \$10 s/h; # of copies	Make checks payable to: PORTABLE BY DESIGN				
 1994 Proceedings: 1994, 1995 and 1996 Proceedings: 	\$100 + \$10 s/h; # of copies \$260 + \$22 s/h; # of copies	□ Check Enclosed □ MasterCard □ Visa □ American Express				
NAME		ACCT. NAME				
TITLE		EXPIRATION DATE				
COMPANY		ACCT. #				
ADDRESS		SIGNATURE				
CITY	STATE ZIP					
Please return this form to: PORTABLE BY DESIGN • 611 Route 46 West • Hasbrouck Heights, NJ 07604 or call: 201/393-6075 • Fax: 201/393-6073						

World Radio History

SPEECH RECOGNITION TODAY

market because it is currently so labor-intensive, and the price constraints of a system are quite flexible. Philips Dictation Systems, San Francisco, Calif., is, arguably, the furthest ahead in this field and they have applications for thirteen different medical transcription areas and two different legal areas (bankruptcy and litigation).

The Philips' systems are based on PCs and use the company's familiar four-position dictation microphone. The SpeechMagic processor and SpeechNote dictation systems recognize 60,000+ word vocabularies and have context-based shortcuts for faster recognition. These large vocabulary systems use phoneme recognition. Phonemes are the smallest acoustical components of a language, with roughly 80 of them making up the needs of the spoken English language.

The digitized audio signal is passed through a Fast Fourier transform in 25-ms segments, with 10-ms overlaps. The resulting vectors are compared with prototypes, and HMM (Hidden Markov Modeling) is used to compensate for an individual's use of word duration and pitch. The prototype that is established is then used for the word search. Probability searches are used in a language model for the likelihood of one word following another, so that the perplexity of the search is reduced. Without a language model, the perplexity would be equal to the vocabulary size!

Philips' researchers are constantly seeking improvements in the systems and their focus is on:

• Recognition speed, which is currently 1 to 1.5 times real time.

• Error rate, currently between 5 and 15%.

• Vocabulary size, currently up to 70,000 words.

• Perplexity, currently up to 250.

HMM was brought to the field of speech recognition by Dr. James Baker, founder and chief executive officer of Dragon Systems, Newton, Mass. It is now a widely accepted tool in the field. The latest version of DragonDictate (v.2.5) announced this past June gives users complete control of their PC by voice, including the entry of data, text, and commands into virtually any Windows (including NT) application. It also is the first product to open up another interface, this time with Netscape support for the Internet. The product was developed in conjunction with Centigram Communications Corp., San Jose, Calif. The systems provide a back-up dictionary of 120,000 words to the active vocabulary of 10,000 to 60,000 words.

Three versions of DragonDictate are available—the Personal Edition priced at \$395, the Classic at \$695, and the Power Edition at \$1695.

RISC INSTEAD OF A DSP

Hitachi, Brisbane, Calif., sees the two commercial areas of voice recognition as being in voice-to-text and command and control, where the voice is captured and interpreted. Hitachi's system development manager, Dr. Yashvant Jani, indicates that the company is emphasizing consumer applications. They have implemented their algorithms on the FH-1 Super RISC processor, avoiding the use of DSPs. The implementation requires 2 to 3 MIPS of power and ports to either 8-16-bit devices. Hitachi sees or speaker-dependent systems as easy to implement while speaker-independence requires much more data, looking for commonality in signatures, which should be longer rather than short.

With friendly algorithms, Jani notes that their system requires only one or two samples to be trained, and that 40 commands in 10 kbytes is practical, with a voice signature requiring about 250 bytes. For portable designs, he points out, low price and high performance are key, and they are now surveying customers for uses in cellular telephones, PDAs, and other mobile appliances. Hitachi feels that voice recognition might add \$2 to \$4 to the price of a cellular telephone, and might even use the processor already onboard. They currently use 8-kHz, 8-bit sampling of the voice, but it could be 16 bits, and the algorithms are flexible with the user choosing different sampling frequencies, or their own analog-to-digital converters (ADCs).

Lexicus, Palo Alto, Calif., a division of Motorola, has developed a sound reputation as a leader in handwriting recognition. Their first offering in speech recognition is a system porting to the Motorola 56166 and 56800 DSP ICs for recognition in high-noise environments, such as in a vehicle with the stereo on and the windows open. Using less than 13.5 kbytes, this speakerdependent and language-independent system boasts recognition rates of 99.8% in quiet and 96% in high-noise environments.

The vocabulary is quite small (10 words), but is still enough for a number of operational needs. Training requires just two repetitions of a name or phrase, and the processor is required to have 20 MIPS, 16 bits, fixedpoint arithmetic, with 2 kbytes of ROM and 3.5 kbytes of RAM. Dr. Ronjon Nag, general manager of Lexicus, says, "This new combination of low memory, high accuracy, and noise robustness will enable a new generation of inexpensive consumer products with accurate speech recognition for voice dialing, and command and control."

Also working on the problems of noise being present on voice channels, and on overcoming the differences between one handset and another, and telephone system's characone teristics and another, is Devang Naik, engineering scientist at Apple Computer, Cupertino, Calif. Naik finds the area of his research "very compelling" and feels that they have come up with simulations, through adaptive algorithms, which will be robust enough to work through high-ambient-noise conditions, interference on the channel, linearity changes from a moving vehicle source, and different microphones. The theory of the algorithms being developed is to match the background, not the perturbations.

The statistical functionality needed for the image-processing routines is to replicate the same ideas through pseudo-codes and a core software engine being used, the Signal Processing Toolbox from Matlab, Natick, Mass., to analyze the speech sounds and to offload data and store them. Naik feels, pessimistically, that it will be 5 to 10 years before we will see full-interpretation, speaker-independent, speech-recognition system.

Other work was done by Malcolm Slaney while he was at Apple. Slaney who is now at Interval Research, Palo Alto, Calif., has done considerable re-



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



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

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

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

Check out the LM2650. And get high 3A converter efficiency—without a high 3A converter price.

FREE SAMPLES-FAST.

For datasheets, free samples, and application support, contact us at: **WEB:** http://www.national.com/ LM2650.

CALL: 1-800-272-9959 Ext. 606. **INFO CARD:** Mail or Fax



National Semiconductor

Moving and shaping the future.[™]

SPEECH RECOGNITION TODAY

search into the areas of modeling for sound separation and, with Richard F. Lyon, in the areas of time-domain processing for models. Matlab functions also are included in some toolboxes that he developed, including an Auditory Toolbox available for Macintosh and Unix as Apple Computer Technical Report #45. It includes code for Lyon's passive long-wave model, Patterson's gammatone filter bank, Meddis' hair-cell model. Seneff's auditory model, the speech recognition world's MFCC, and conventional spectrogram processing. (Apple Technical Reports are available on the Apple FTP server, ftp.apple.com, or by e-mailing a snail-mail address to corp.lib@applelink.apple.com).

FISHING WITH ZEBCO

The road to a speech-recognition product can be a little convoluted. One such road is OKI, VCS and Zebco. Fishermen will immediately recognize the Zebco name, as the world's largest manufacturer of fishing tackle.

OKI Semiconductor, Sunnyvale, Calif., designed the MSM6679 voicerecognition processor (in some applications, it has been known to live under the alias of VRP6679), and that chip will be discussed in more detail a little further on. For the Zebco application, Voice Control Systems (VCS), Dallas, Texas, embedded their speech technology in the MSM6679 to produce a unit that is functional for the voice control of a trolling motor for fishing. The Zebco MotorGuide Voice-Activated Control (VAC) systems will be offered in the 1997 catalog as an accessory to any previous or current Lazer RF trolling motor. The retail price of the kit is expected to be about \$439, and it consists of a small, durable transmitter (about the size of a pager) to be attached to the belt, and a small, waterproof, microphone attached to the shirt. When the user speaks commands into the microphone, the transmitter sends an RF signal to the motor. VCS uses speaker-independent technology so no voice training is necessary. The roughly 30-word vocabulary consists of a series of easyto-remember directives such as Motor On, Speed (in varying increments), Left, Right, Stop, Forward, Reverse, Faster, Slower. The system has a keypad to provide full override capability.

Anglers can now navigate and fish simultaneously. Prentice Moore, R&D manager at Zebco MotorGuide, Starkville, Miss., comments, "A more convenient approach to fishing! The VAC system provides the extra maneuverability when pursuing those hard-to-catch fish." Peter Foster, president and CEO of VCS says, "The introduction of this system into the market is a further indication of the way in which speech-recognition technology can be used in applications not even imagined ten years ago."

The OKI MSM6679 is a remarkable catch-all IC. It is a slave-mode device with five functions-both speaker-dependent and speaker-independent voice recognition, sound recording, sound playback, and speech synthesis. The latter may be a surprise, except that when you think about it, there is nearly always a need to confirm an instruction, so speech synthesis becomes an essential partner to the recognition process. For speaker-independent recognition, the chip provides a pre-trained vocabulary of up to 20-25 words in each vocabulary, the number of which depends on the memory provided. Background noise protection is claimed to be good with accuracy greater than 95% using OKIdefined tests. Speaker-dependent vocabularies can be up to 61 words each. with each word needing about 50 bytes in external SRAM.

The MSM6679 can respond to spoken commands, verbally or with tones, via an on-chip speech synthesizer and tone generator. Frank Thorley of OKI explains that an evaluation kit is available for around \$1000. The 84-pin PLCC part can interface to any application or personal computer via a parallel or serial interface, and the evaluation kit includes assembly and C language programs.

SMART INTERACTIVE TOYS

Another dedicated processor is from Sensory Circuits, San Jose, Calif., where the RSC-164 has become the microcontroller of choice in many pieces of consumer electronics. Sensory is a company where a lot of speech and voice skills have come together from diverse backgrounds, and the first silicon of December 1994 has growth. The RSC-164 combines an 8bit microcontroller with high-quality speaker-dependent and speaker-independent speech recognition, speech synthesis, four-voice music synthesis, and voice record and playback. All that is needed to implement the features in an interactive educational toy is the chip, microphone and pre-amp, a crystal, loudspeaker, and any required external memory. A lower-cost version, the RSC-164i, has a reduced number of I/O lines and has no external memory bus facilities.

been a fertile base for the company's

Sensory also announced at the last Winter Comsumer Electronics Show the Voice Password IC, a device that is always listening to hear a verbal password. The IC can be used to protect/restrict the use of just about any consumer device, and will allow up to four users with up to fifteen different passwords.

Sensory recently announced its Voice Direct IC designed for cost-sensitive applications. It has the capability of recognizing up to 4 sets of 15 words/phrases with a claimed accuracy of greater than 99%, and a response time of less than one second. Like all of the previous Sensory products, the quality-to-price ratio is very high.

There are other dedicated voicerecognition processors (see "Dedicated voice-recognition processors," p.46). But the majority of applications are written on standard digital signal processors from Motorola (like Lexicus, earlier), Texas Instruments, Dallas, Texas, or Analog Devices, Norwood, Mass. There also are many applications that are based on just a few software/algorithm speech-recognition technologies, systems, and solutions. Among these companies are Lernout & Hauspie Speech Products, headquarted in Leper, Belgium (located in North America in Burlington, Mass.), a major player in the supply of tools to developers.

The L&H ASR1500 uses a combination approach of phonetic and word models that are transparent to the developer; extensive sharing of models takes place so that memory requirements are minimized. A high accuracy also is obtained with this sharing for digits and command and control applications.



INTRODUCING THE ADC12762 A/D CONVERTER, VERY **HIGH PERFORMANCE AT A VERY LOW PRICE.**

Clara Ca



There are basically two ways to get a high speed 12bit A/D converter. Spend too much. Or buy the ADC12762.

The ADC12762 delivers a sizzling 1.4MHz conversion rate. As well as excellent numbers in every other performance category-+-0.95 LSB DNL, 67.5dB SNR and low power operation (170mW from 5V).

All for \$12*. Which means the ADC12762 is perfect for CCD color scanners, and a host of highspeed communication applications. Where the only thing as important as very high perfomance is very low cost.

ADC12762

Info Kit

FREE INFO KIT-FAST.

For free datasheets, a selection guide, and application support; contact us at:

WEB: http://www.national.com/

ADC12762

CALL: 1-800-272-9959 Ext. 606.

INFO CARD: Mail or Fax

In Europe, fax us at +19 (0) 180-5-12-12-15, in Japan, call 81-13-299-2300, in Southeast Asia, fax us at 852-2376-3901.



Moving and shaping the future.[™]

3482

JN. LL LA AFEL

und.

Z

AUTOVAL SEMICONDUCTOR

SPEECH RECOGNITION TODAY

Once the basic engine has been determined by the developer, additional features can be added to suit the intended application. The L&H solution is versatile and universal. Founded in 1989, the company acquired the exclusive rights to the speech research of a group of Belgian universities. The hardware requirements for their systems are broad, and they support Intel 486 and Pentium processors, Analog Devices' ADSP21XX DSPs, Texas Instruments' TMS320CXX, AT&T's DSP32C, Motorola's 5600X, and others.

Voice Processing Corporation (VPC), Cambridge, Mass, also has an extensive licensee list that includes Creative Labs, Milpitas, Calif., Dialogic, Parsippany, N.J., Digital Sound Corp., Carpinteria, Calif., Hewlett-Packard, Sunnyvale, Calif., and IBM Communications Systems, Santa Clara, Calif. All VPro speech-recognition systems are AT-compatible. While the focus of the systems has been on telecommunications, there also are other uses, such as Creative Labs' use in Sound Blaster. On cellular systems, VPro is used, for example, by Southwestern Bell in their Cellular One Chicago service for voice-dialing by digits or from the user's personalized directory. The system also is used by Contel Cellular in the Kentucky market. NYNEX uses the system to respond to callers to unavailable numbers, leaving the human operator to perform other functions.

Wildfire Communications, Lexington, Mass., was the first company to offer the idea of a "digital assistant" built with VPro speech-recognition technology. The idea behind Wildfire is that it should behave like a human assistant through simple spoken requests. The voice interface is intuitive and there are selections for either beginner- or expert-level prompts. It allows everything from multiple calls, the setup of conference calls, following your schedule and associated instructions, even to the discrete whisper in your ear of the name of an incoming caller while you are on the telephone, to allow you to decide whether you want to take it or have Wildfire take a message.

BBN Corp.'s BBN Speech Products Group, Cambridge, Mass., is another supplier of software to the developers

DEDICATED VOICE-RECOGNITION PROCESSORS

A number of dedicated voice-recognition processors are available from the following sources:

OKI Semiconductors, Sunnyvale, Calif.; (408) 720-1900; fax (408) 720-1918—products discussed in the text.

Sensory Circuits, Inc., San Jose, Calif.; (408) 452-1000; fax (408) 452-1025—products discussed in the text.

DSP Communications, Inc., Cupertino, Calif.; (408) 777-2700; fax (408) 777-2770—the DVC306 and D6106.

Hualon Microelectronics Corp., Taiwan, distributed by Images Co.; (718) 698-8305—the HM2007.

Toshiba America, Santa Clara, Calif.; (800) 879-4963; Internet: www.toshiba.com/taec--the TC8864F-00 and TC8865F-00.

Ricoh Corp., San Jose, Calif.; (408) 432-8800; fax (408) 432-8375—the 5A128, 5S830 and RF5A65.

Votan will be using, according to

president John White, the verification

systems already developed as initial

product offerings. The major features

of the Votan verification systems are

that they are a combination of gate-

keeper techniques with a magnetic,

smart, or bar-code card as an initial

step that also recovers the voice file

on the individual claiming entry. The

cardholder is then prompted to say

his or her pass-phrase that verifies

the identity with the enrollment re-

cording. Remote verification sys-

tems also are available. Developers'

kits and training are available from

processing into a single PC could be a

major challenge for voice recognition.

Companies such as Ariel Corp., High-

land Park, N.J., are addressing these

problems with offerings like their TeraDON ISA Bus carrier card,

which crams up to 16 AT&T DSP3210

floating-point digital signal proces-

sors and up to 256 Mbytes of DRAM

102447.346@compuserve.com.

Paul McGoldrick's e-mail address is:

CIRCLE

543

544

545

Cramming sufficient channels of

the company.

on one card.

of end products. The BBN Hark Recognizer, version 3.0, is a robust, speaker-independent continuousspeech-recognition software product. Simple and complex vocabulary needs can be supported with modeling for wireline and cellular applications, personal vocabulary, security, and out-ofgrammar rejections. It is available for Unix-based workstations and PC hardware platforms including IBM's RSC6000/AIX and Intel's Pentium/SCO Unix. Typical memory requirements are 4 to 8 Mbytes of physical memory and 5 to 20 Mbytes of disk storage. Telephone interfaces are supported with Dialogic, IBM DirectTalk, and Voicetek.

BANK VERIFICATION

Moscom, Pittsford, N.Y., has developed a verification engine that consists of three components-a patternprocessing VLSI chip, a DSP chip (TI TMS320C51), and the governing algorithm producing a verification system that is driven by *phrases* chosen by the speaker. The difficulty level for a successful fraud by impersonation in such a system is very high. The system has been tested by Citibank, and is now in use by Chemical Bank in New York City. Moscom is the beneficiary of over fifteen years of voice-recognition research by its Votan Division. Votan has now spun off as a separate corporation in Pleasanton, Calif.

by Citibank, and nemical Bank in om is the benefiears of voice-recits Votan Divipun off as a sepa-SLIGHTLY

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History

16



INTRODUCING THE LM7301. THE MOST ROBUST, BULLETPROOF GENERAL PURPOSE OP AMP AVAILABLE TODAY.



Remember the `60s? Those were the days. When no application was so specialized that it couldn't make use of a simple, reliable, and versatile amplifier like the LM741.

Well, today, the applications may be much more complex. But with the new **LM7301**—a wide voltage range op amp with all the features you need for today's demanding applications—you get the same dependable versatility. In a Tinypak[™] package, no less.

With the LM7301, you won't have to worry about oscillations when your device is driving heavy loads of up to 1,000 pF. Or—thanks to a low 600µA supply current—worry about your battery running low. Add rail-to-rail I/O for high signal-to-noise ratio and dynamic signal range and there's only one thing left to say. Cool. The LM7301, from National.

FREE SAMPLES—FAST

For datasheets, free samples, and application support, contact us at: **WEB:** http://www.national.com/LM7301 **CALL:** 1-800-272-9959 Ext. 606. **INFO CARD:** Mail or Fax



In Europe, fax us at -49 (0) 180-5-12-12-15; in Japan, call 81-43-299-2300; in Southeast Asia, fax us at 852-2376-3901.



Moving and shaping the future.[™]

TECHNOLOGY ANALYSIS

BCTM Shows Off Advanced BJTs And MOS-FETs For ICs

The 1996 Bipolar/BiCMOS Circuits And Technology Meeting Presents High-Voltage And Fast ICs With Performance Pure CMOS Can't Touch.



he adage "old soldiers never die, they just fade away" seems to be what many MOS aficionados think about bipolar-transistor technology. If the two-day 1996 Bipolar/BiCMOS Circuits and Technology Meeting is any indicator, the bipolar junction

transistor (BJT) is *not* sitting still awaiting an early obituary. Rather, it's creating siblings and MOS hybrids at a rapid pace. This year's conference, Monday Sept. 30 and Tuesday Oct. 1, in Minneapolis, Minn., spreads 50 carefully selected papers (including the keynote address) over 13 sessions.

In many ways, the BCTM combines aspects of the International Electronic Devices Meeting (IEDM), the International Solid State Circuits Conference (ISSCC), and the Design Automation Conference (DAC). Its papers delve into advanced processes and devices, ICs, and modeling and simulation (usually of discrete devices or processes). The BCTM, as it has done over the past few years, added a day of tutorials (short courses). If you didn't make it this year, plan to be in Minneapolis in 1997, Sept. 28-30.

BCTM papers run the gamut from silicon-germanium (SiGe) devices (subject of the keynote speech) to lateral DMOS devices, and range in frequencies from dc to RF to microwaves. Telecom/communications papers fill several sessions. However, unlike last year's BCTM, purely digital circuits—with the exception of a single SRAM—were conspicuous by their absence. This year's conference was mainly "analog," describing circuits, devices, processes, and simulation techniques featuring critical analog characteristics. It should be noted that one paper mentioned a counter and another described a bus transceiver. True, these are digital ICs, but like most high-speed digital



1. THE PERFORMANCE of silicon and silicon-germanium structures (circles) from IBM track the exponential "Johnson limit". The limit states that the product of a BJT's breakdown voltage BV_{CEO} (vertical axis) and its unity short-circuit current gain f_t (horizontal axis) are a constant.

B(I)

www.national.com

So you're trying to find the right part. You can hunt through databooks and app notes till you finally get somewhere. But now there's a fast, efficient way to get everything you need to work with: Datasheets. Application notes. Samples. Price/availability. **24 hours a day.**

Just bookmark **www.national.com,** and go straight to our web site. Where you're never more

than 4 clicks from the exact information you need. And to give you powerful, customized access to over 14,000 products, we've built in a parametric search engine. It's fast, simple, and totally up to date.

No wonder design engineers have called this one of the best sites in the industry. If

- PARAMETRIC SEARCH ENGINE
- 4,000 DATASHEETS
- FREE SAMPLES
- 1,500 APP NOTES
- FREE ANALOG DATA BOOKS
- SOFTWARE-BASED DESIGN TOOLS
- PRICING ON
 8,000 PRODUCTS

you haven't tried it yet, we think you should pay us a visit immediately. It's the best way there is to get some work done.

FREE LINEAR SEMINAR HANDBOOK.

As an extra reason to bookmark this site, we're offering our 350-page **Linear Seminar Handbook**. To prove how simple this site is to use, there's no business reply card to fill out. No 800 number to call. Just go to

www.national.com/design, and the book is free. Offer limited to first 10,000 visitors, so hurry.



Moving and shaping the future.[™]

1996 IEEE BCTM

circuits, both need all the analog help they can get.

In a similar scenario, SiGe heterojunction bipolar transistors (HBTs) dominate many sessions, an indication that SiGe technology is maturing. For example, several companies other than IBM (one of the early players in SiGe technology) offer papers. In all, 11 SiGe papers are distributed over 8 of the 13 sessions.

A number of papers spread throughout the sessions cover the modeling and/or simulation of new processes and new devices, and several new transistor structures are described. MOSFETs snuck into the conference via several dc power/highvoltage papers, indicating BJTs are still finding homes in low-frequency tasks. Several papers describe highvoltage biCMOS processes and ICs. And, to coin a phrase, at least one biDMOS process is covered. Four of the five papers in one particular session cover 8- and 10-bit high-speed analog-to-digital converters (ADCs). The fifth paper discusses a 14-bit, 100-MHz, IC digital-to-analog converter (DAC). Another session carries several papers describing "electrothermal" effects, and advanced processes show up everywhere.

According to researcher Bernie Meyerson of IBM, SiGe technology is



3. VERSIONS OF THE SIGe transistor in Figure 2 helped to build this low-noise amplifier. It combines 14-dB gain at 2 GHz with a noise figure of 1 dB at that frequency.

evolving slowly into a commercial technology for RF and microwave ICs. Meyerson developed the proprietary process with which IBM builds SiGe devices and ICs. Further reinforcing the advances in SiGe technology, Lawrence Larson of Hughes Research Laboratories, Malibu, Calif., presents an invited paper that reviews recent accomplishments in pure



2. THIS SELF-ALIGNED SIGE HBT structure from Temic/Telefunken combines a BV_{CED} of 6 with an f_t of 30 GHz.

silicon BJTs and in SiGe devices.

Larson also points out that device design and modeling to achieve the best microwave performance from monolithic silicon BJTs often differ substantially from those required for high-speed digital or precision analog circuits. He expects to soon see SiGe devices with both an f_t and an f_{max} beyond 100 MHz, which until recently was the venue of GaAs devices. Note: f_t is defined as the frequency where short-circuit current gain equals unity, while f_{max} is defined as the frequency of maximum power gain.

Both of these "figures of merit" are important when optimizing BJTs for use in microwave ICs. Larson goes on in his paper and describes modeling and scaling techniques for these devices, taking into account device parasitic capacitances.

Unlike typical analog ICs, Early voltage isn't critical in RF ICs, especially in SiGe devices where it tends to be high enough. However, the improvements in f_t and f_{max} have occurred at the expense of breakdown voltage, which is governed by the so-called Johnson limit. It states that the product of f_t and the breakdown voltage (BV_{CEO} runs approximately 300 GHz × V). A plot of f_t versus breakdown voltage measured on a number of silicon and SiGe devices from IBM (circa 1993) cluster along the Johnson

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



had more than 80 percent of a full charge.

that Mark carried 1,500 feet up the tower.

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

make your battery packs intelligent.

At Benchmarg, we specialize in battery management technology. And our fully tested, ready-to-install battery capacity modules can save you time and money, and shorten your time to market.

Our engineers work directly with you to address your most challenging problems. We can customize our modules to

> NASDAD RMRD narg sa mg

accommodate your space and power requirements. And because all components are included on a small board, your buying and manufacturing processes are simple. You buy, inventory, and assemble a single part.

16-Pin IC Part No.	Description	Battery Technology	Module Part No.	
bq2010	Gas Gauge IC	NiMH and NiCd	bq2110. bq21101	
bq2011/J	Gas Gauge IC for Power Tools	NiMH and NiCd	bq2111L	
bq2012	Gas Gauge IC	NiMH and NiCd	bq2112, bq2112	
bq2014	Gas Gauge IC with Ext. Charge Control	NiMH and NiCd	bq2114, bq2114 bq2164	
bq 205 0	Power Gauge [™] IC	Li-Ion	bq2150, bq21501 bq2165	
bq2090	SMBus v.95 Gas Gauge IC	NiMH, NiCd, Li-Ion	bq2190L	

So call Benchmarq for a turn-key solution to your bat-

tery monitoring and charging needs. Because when you offer reliable smart power with your product, guys like Mark step up and buy.



BENCHMARQ Microelectronics, Inc. 17919 Waterview Parkway Dallas, Texas 75252 U.S.A 800-966-0011 or 214-437-9195 Fax: 214-437-9198 Email:benchmarg@benchmarq.com WWW:http://www.benchmarg.com



MARQY'S Message: "Ask about our readyto-use gas gauge modules and reduce design time!

BENCHMARQ...THE BRAINS BEHIND THE BATTERY

READER SERVICE 152

A COMPARISON OF NOVEL PNP STRUCTURES				
Parameter	PFET	GLPNP	LPNP	
Beta @10 µA	-	340,000	4.4	
Beta @100 µA	-	230	3.2	
Gm (µs) @10 µA	97	210	520	
Gm (us) @ 100 µA	330	860	2000	

limit (Fig. 1).

While the Johnson-limit-imposed trade-off tends to limit BJT circuit performance at microwave frequencies, all is not lost. Like Early voltage, a high dc value of current gain β is not crucial for these circuits, because at high frequencies current gain is largely set by f_t . Therefore, increasing the base doping at the expense of β and f_t can raise breakdown voltage and f_{max} .

1996 IEEE BCTM

Due to their good noise figure and low 1/f noise, Larson sees applications for SiGe HBTs in low-noise amplifiers from a few gigahertz to at least 20 GHz. He also sees applications for power amplifiers of less than 1 W between 1 and 10 GHz and at frequencies above that to power outputs below 100 mW. In fact, Larson has built 100-mW SiGe power amplifiers running at a fequency of 12 GHz. At lower frequencies, these devices offer outstanding "power-added efficiency" (PAE). For example, a similar amplifier running at 900 MHz demonstrated 22-dB gain and 70% PAE while putting out 20 mW.

Bipolar transistors sport an intrinsic advantage over FETs of any kind, including GaAs MESFETs. Why? Because when operated in Class B mode,

In the "Radio" session of BCTM, Toshiba reports on its continuing work to develop a singlechip transceiver (plus RF power amplifier) for the 1.9-GHz Personal Handy-Phone System. Their latest target is the variable attenuator placed between the quadrature modulator and power amplifier to attain low-power operation and the resulting conservation of battery power.

The model for the attenuator is the Stetzler attenuator used at IF and configured with a pair of differential amplifiers (Trudy D Stetzler et al., "A 2.7-to-4.5-V Single-Chip GSM Transceiver RF Integrated Circuit," IEEE J. Solid-State Circuits, Vol. 30, No. 12, p. 1421-1429, Dec. 1995). Their solution for transposing the circuit to 1.9 GHz involved splitting the attenuator into three stages-the first switched 0 to 4 dB, the second 0 to 8 dB, and the third 0 to 16 dB-giving a total attenuation of 28 dB in 4-dB steps. The implementation used unbuffered circuitry, providing the large attenuations with low-power dissipation, working down to 2.7 V with 21 mA of current drain. Control of the attenuator is from a feedback loop. which takes an RF "sniff" from the power amplifier's output.

Another team-effort paper, this from the University of California at Los Angeles, discusses Philips Semiconductor's QUBiC process used in a low-distortion bipolar

<u>BIPOLAR STILL DOMINATES RF PAPERS</u>

mixer. The mixer's general structure consists of a Gilbert cell with a transconductance cell, which replaces the differential pair typically used as the bottom of the tree. This cell is ultralinear, employing feedback-enhanced degeneration. The current loop causes a virtually stable current, with no penalty for the linearity. Two such transconductance cells are used to form a differential feed for the baseband signal input. With the low 2.7 V, second-order harmonic distortion is -60 dBc. modulation bandwidth is 950 kHz. and the maximum usable local oscillator frequency is 500 MHz.

The same group reports on their work in the "VCO/gyrators" session concerning an adjustable I and Q local oscillator that employs an improved divide-by-two stage. Lowfrequency use of divide-by-two stages has been limited by their unhappiness at operating with low amplitudes of the clock signal—when they go unstable, or even oscillate. Latching problems also may occur.

To improve the situation and make things happy, the team established a way in which clocks can't overlap, and a variable duty cycle generation with a dc level on one side of a comparator determining the clock output from a sinoidal input on the other side. As with their other designs, this part was implemented using Philips QUBiC process.

GEC Plessey researchers designed a silicon-on-insulator (SOI) active filter for radio applications, particularly for RF front-end selectivity. The biquadratic active filter uses transconductance and capacitance (i.e., avoiding inductors) with active gains of more than 20 dB/stage and noise figures as low as 2.75 dB. The devices were tested over the range of 500 to 1100 MHz. The authors felt that although large-signal handling in the process is limited, designs optimized for specific applications show great promise.

A theoretical paper from Northern Telecom describes the design of a very-low phase-noise integrated microwave bipolar VCO. The circuit was verified using alternative simulation techniques and then by a physical implementation in 0.8-µm biCMOS. Measured phase noise was -92 dBc/Hz.

Low phase-noise also is the subject of a paper from IBM's T. J. Watson Research Center, which describes the implementation of an 11-GHz VCO in SiGe bipolar technology and achieved oscillator phase noises of better than -78 dBc/Hz at a 100-kHz offset. A 4.7% tuning range, with an on-chip varactortuned resonator, was obtained and the circuit consumes less than 24 mW from a 3-V supply. Good negative resistances were noted across the target frequencies. Also, the onchip inductor required a Q at least 4.5 and was implemented at 8.

PAUL MCGOLDRICK

SIEMENS

To see how fast you can reprogram our 16-bit microcontroller,



blink.

Introducing the SAB88C166 with on-board flash EPROM.

If you're looking for the ultimate in 16-bit microcontrollers, feast your eyes on the brand new SAB 88C166 from Siemens.

Siemens 16-Bit µControllers							
Part	Clock (MHz)	RAM KB	ROM	16-Bit Timer/ Counter	Serial I/O	A/D Inputs/ Reso.	Pins
SAB C163	25	1	-	5	1 USARTs 1 Sync (SSF)		P-MQFP 100 (EIAJ)
SAB C165	20/25	2	-	5	1 USARTs 1 Sync (SPI)		T-MQFP-/ P-MQFP- 100 (EIAJ)
SAB 88C166	20	1	32K	7	2 USARTs	10/10	P-MQFP- 100 (EIAJ)
SAB C1675R-LM	20	4		9	1 USARTs 1 Sync (SPI)	16/10	P-MQFP- 144 (EIAJ)
SAB C167CR-LM	20	4	-	9	1 USARTs 1 Sync (SPI) Full CAN 2.0B	16/10	P-MQFP- 144 (EIAJ)

Its 32K of flash EPROM can be completely or partially erased in about a second. Special connections allow in-system programming. And with up to 1000 write/erase cycles, it's the ideal development tool for Siemens' new SAB 83C166-5M 16-bit microcontroller with 32K ROM.

At Pioneer, we're proud to offer the SAB 88C166, along with Siemens' full line of 16-bit microcontrollers. With 53 offices in the US and Canada, and the industry's highest ratio of application engineers to sales people, Pioneer offers the support you need for cutting-edge technology.

So what are you waiting for? Contact Pioneer today for an evaluation kit with socketed sample and programmer.

Call 1-800-657-0168, or e-mail us at http://www.pios.com.



Solutions for a changing world

©1996 Siemens Components, Inc. 1-800-77-SIEMENS http://www.sci.siemens.com





the BJT's collector efficiency is higher than the drain efficiency of a FET. That's due to the exponential nature of the BJT's collector current versus base-emitter voltage characteristic. The peak efficiency of a FET with a constant gmruns 78.5%. It rises to 85% for a FET with a linearly increasing gm. A BJT, regardless of process, displays a peak collector efficiency of 90.4%. That translates into at least 5% more talk time on the battery of a cellular telephone, in which the power amplifier runs in Class B mode.

The trade-off battles between the SiGe HBT and the GaAs MESFET are significant from an economic point of view: The MESFET is built on a five-mask process, while the HBT is built on a fine-geometry CMOS process requiring more than a dozen masks plus the special SiGe deposition.

Larson concludes his paper with a discussion of a number of problems with the available models used to simulate these BJTs and HBTs in RF/microwave ICs. They include modeling the rapid drop-off in ft as emitter current densities become critical, modeling the "quasi saturation" region, and modeling breakdown phenomena. Help appears to be on the way, though.

For example, a team from Northern Telecom (along with an IBM member) presents a paper describing a fully scalable, high-frequency noise model that was tested on silicon and SiGe technologies. The paper also describes a technique that extracts a set of BJT noise parameters from measurements of the transistor's classic Y

parameters.

In addition, an NEC team's invited paper describes object-oriented data modeling in electrical parametric data management and analysis. They drew

real-life examples from an advanced SiGe technology.

While Meyerson and Larson provide an optimistic overview of SiGe HBT technology, other papers de-







Source Stereo Audio D/As Deliver the Highest Performance for the Lowest Price!



Complete "Sound Solutions"

PCM1717 and **PCM1718** are new **SoundPLUS**^{••} stereo audio D/As—fabricated using a highly advanced 0.6µ CMOS process and, packaged in a small 20-pin SSOP. They're complete sound solutions—including digital interpolation filter, 3rd-order $\Delta\Sigma$ D/A, on-board 8x oversampling digital filter, analog low-pass filter, and analog output amplifier. PCM1717 accepts 16- or 18-bit I²S or normal data formats. Special functions include soft mute, digital attenuation (256 steps), digital de-emphasis, and output modes—L, R, Mono, Mute. Use them for cost-sensitive consumer applications such as set-top boxes, MPEG audio, keyboards, automotive and bookshelf CD players, BS tuners, MIDI applications, and CD-Interactive and CD-Karaoke systems.

High Performance at +3V Operation

PCM1718 is the best performing +3V D/A available today! It accepts 16- or 18-bit I²S data format, as well as 18-bit normal input data format without bit-mapping. It has a wide supply range— +2.7V to +5.5V. Other selectable functions include soft mute, digital de-emphasis (32kHz, 44.1kHz, 48kHz), and zero flag pin for external analog mute circuit. PCM1718 is perfect for set-top boxes, keyboards and synthesizers, PC sound cards, and PCMCIA ZV port cards.

PCM1717/PCM1718 Key Specifications:

8dB
OdB
6dB
+5V
5.5V

Pricing from \$3.15 in 1000s.

Sounds Better for FREE!

Try the best performing stereo audio D/As...FREE! Just call (800) 548-6132 for your FREE SAMPLE, Audio Products brochure, and detailed data sheets. Or, contact your local sales representative for more information. Need information FAST? Check out our website at http://www.burr-brown.com/ for all the latest on our high performance audio products.

Reader No. 80 FAXLINE No. 11289, 11325



BURR - BROWN®

Burr-Brown Corporation

Burr-Brown Corporation • P.O. Box 11400 • Tucson, AZ • 85734-1400 • Call (800) 548-6132 or use FAXL/NE (800) 548-6133 • http://www.burr-brown.com/

1996 IEEE BCTM

scribe advances in SiGe process/device technology as well as SiGe ICs. Some combined a device/process advance with an IC built on the process.

An IBM team took their "standard" 60-GHz SiGe HBT process, put a "resonator" on it, and built a 10.5-to-11-GHz voltage-controlled oscillator (VCO) that runs off 3 V. Its phase noise runs a mere –91 dBc/Hz at an offset of 100 kHz. Its tuning range, close to 5% with an on-chip varactor-tuned resonator, uses 0 to 3 V for control.

A team composed of members from the Research Center of the Temic subsidiary of Daimler-Benz (formerly Siliconix in the U.S.), Ulm, Germany; Telefunken, Heilbron, Germany; and the University of Ulm, developed a SiGe process producing HBTs with an f_t and an f_{max} of over 50 GHz (*Fig. 2*). The process, a modification of Temic's conventional BJT process, doesn't require a fabrication facility equipped for submicron lithography.

The Temic team lists several unique advantages offered by SiGe. In addition to its high-frequency performance, its compatibility with silicon BJT technology, and its efficiency at low voltage, Temic feels that the ability to work off low voltage is an advantage. In other words, it performs efficiently in a cellular telephone off a single lithium-ion cell. GaAs cannot. In addition, they point out that the thermal conductivity of SiGe is a factor of three better than that of GaAs.

It's noted in their paper that SiGe HBTs with a breakdown voltage of 40 V and an f_t of 22 GHz have been built, thus indicating the "Johnson limit" can be attacked. Finally, the low sheet resistance of their HBT's SiGe bases (compared with those of silicon BJTs), which can run as low as 500 Ω per square, offers advantages in power applications. Moreover, it lets Temic build devices with a high f_t using emitter stripes wider than 2 μ m.

Other specifications for low-power HBTs from the process include a BV_{CEO} of 6 V, a current gain of greater than 200 over 9 decades of current, and a noise figure of 2.4 dB at 1.8 GHz while operating at a gain of 14 dB in a

PROCESS ADVANCES YIELD LOWER OPERATING VOLTAGES, INCREASE FREQUENCIES

B iCMOS technology has experienced an up-and-down history, enjoying brief periods of popularity until CMOS catches up, then waning until the next spurt of process improvements arrive. Just such improvements are around the corner, stemming from research conducted at NEC Corp., and Hitachi Ltd., both based in Tokyo, Japan.

First, NEC provides details of the process integration it went through to produce $0.3-\mu$ biCMOS that can operate at 1.5 V. Then it goes into how the process was used to develop a 4-Mbit static RAM that accesses in less than 6 ns. One key problem arose that limited circuit performance—the voltage drop across the collector resistance in the bipolar transistors. The drop causes bipolar saturation during low collector-emitter voltage conditions.

To get around this problem, NEC's process engineers added an arsenic-implanted buried layer (rather than antimony) and a thin 1- μ m n-type epitaxial layer to lower the collector resistance and avoid bipolar saturation. To suppress boron upward diffusion, p-type isolation and a p-type buried layer were formed by a high-energy implant after local oxidation of the silicon. That minimizes the body effect of the source-follower transfer MOS-FET used in the memory cell.

For the memory cell design, a symmetrical cell layout with a high cell ratio of 4.8 was employed to reduce the imbalance of paired cell drivers and provide a stable structure. Also, a boost technique was applied to the word line to compensate for the lowvoltage design, and boost-biNMOS gates were employed in the addressdecoding circuits.

To implement its 0.3-um bipolar and biCMOS circuits, Hitachi developed an in-situ phosphorous-doped polysilicon emitter to form narrow and flat emitter regions. One problem, though, was inconsistent device performance, which was traced to varying values of hFF. That variation was due to the quality of the polysilicon/silicon interface and the stress it places on the emitter layer. Attention to detail, such as cleaning the region with deionized water, which ensures that no atomic oxide layer forms prior to polysilicon deposition, helps reduce the stress and improve consistency.

In another development, to improve the maximum operating frequency of bipolar transistors, designers at Hitachi created a scheme that employs lamp-heated rapid vapor-phase doping (RVD) to achieve 100-GHz cutoff frequencies for silicon bipolar transistors. The RVD approach allows researchers to form very shallow-base transistors and implement devices with very small base widths, improving the cutoff frequency.

The actual structure combines silicon homojunction transistors that employ shallow junctions and selfaligned metal/in-situ doped polysilicon to form the base electrode structure. In this structure, base resistance can be reduced by using the stacked in-situ doped polysilicon and a tungsten metal layer to overcome the trade-off between a narrow base profile and an increase in base resistance. Consequently, a shallow base region is required.

To determine the base resistance. researchers at the Laboratory of Microelectronics ICL at the University of Bordeaux, Talence, France, and System Microelectronic Innovation, Markendorf, Germany, came up with a simple dc measurement method. Unlike other commonlyused dc methods, this scheme doesn't require knowledge about emitter or collector resistances. To perform the computations, the researchers based the scheme on monitoring the substrate current of a parasitic vertical pnp transistor when the intrinsic npn transistor is saturated. Resulting values are in good agreement with measured and simulated device characteristics achieved with the standard bipolarjunction-transistor model developed by Gummel and Poon.

DAVE BURSKY

Designing for 300 Mbit/s is one thing. Delivering is another.

The world's fastest read channels, preamps, interface controllers and servo/spindle controllers just keep getting faster. We consider it a Silicon Systems tradition.

Of course, helping you design in awesome performance is one thing. Getting into volume production is quite another. That's where, together, Silicor Systems and Texas Instruments technologies make a big difference. We deliver the fastest integrated chipset solutions. With the fastest ramp up to production.

In a word, performance. Backed up by global manufacturing, service and support.

For a partnership that will help you improve your next design, talk to a company that's going places. Fast. Call 1-800-624-8999, ext. 151. And visit our website at http://www.ssi1.com





A Texas Instruments Company

1996 IEEE BCTM

2-HBT circuit (*Fig. 3*). Noise figures of just 1.5 are expected in the future. Highpower HBTs off the Temic process, running class B at 900 MHz, exhibited a PAE of 72% for input power ranging from -5 to +2 dBm.

In addition to HBTs, the process also offers IC designers polysilicon resistors, nitride capacitors, and spiral inductors reaching 10 nH with Q factors up to 8. Passive parts, particularly stable inductors, are vital to the design of RF circuits. An IBM team presents a paper describing the results of temperature tests on experimental inductors laid down on a conductive SiGe biCMOS die. Q increased with temperature over the frequency

range of interest, up to the frequency where it peaked, and then dropped rapidly. Inductance, on the other hand, changed very little with temperature up to 1/2 the coil's self-resonant frequency.

A NEW KIND OF PNP

BJTs have been around for some time. So who would have thought anyone *could*, let alone *would want to*, come up with a new kind of pnp transistor? That's exactly what a joint



7. THIS UNIQUE OUTPUT STAGE for a 100-MHz, current-feedback op amp enables it to put out 100 mA while operating on a quiescent current of just 1 mA.

> IBM-Analog Devices development team accomplished—and for a good reason. They needed an active load (current source) for SiGe HBTs in analog applications such as bias circuits for VCOs and low-noise amplifiers. And they needed it on the IBM process that builds the HBTs. In fact, the team came up with a number of unique structures on their way to achieving the gate-assisted lateral pnp, or GLPNP (*Fig. 4*). (Actually, the *GLPNP structure has been around*

for a couple of years. It was written up early in 1994 by K. Jorder in the IEEE Transactions of Electron Devices.) The IBM/Analog Devices team built the first one on a SiGe process and used it as a current source for SiGe HBTbased circuits in the 1-to-2-GHz frequency range.

The GLPNP operates in three different modes as three different kinds of devices. Depending on how it's connected, it can form a pFET (p-type JFET), a conventional lateral pnp (LPNP), or the GLPNP of Figure 4. After building and characterizing all three structures, the team chose the GLPNP for their current source because of its high current gain, β , and rela-

tively high g_m at currents of 10 and 100 μA (see the table).

The team implemented their lownoise amplifiers and VCOs with bias circuits based on both the pFET structure and the GLPNP. These bias circuits consist of a bandgap cell followed by either pFET or GLPNP current mirrors. They work off 3 V. Looking at Figure 5, the npn transistors are SiGe HBTs, and the pnps are GLPNP devices. The high performance of both current mirrors provides



8. SIMULATIONS OF BREAKDOWN VOLTAGE versus drift-region length depicted here were performed on a model of this lateral DMOS structure. The simulated results (upper curve), agree closely with measured results (lower curve).

ELECTRONIC DESIGN/OCTOBER 1, 1996

World Radio History



The easiest mixed-signal testing for \$4,995.*

The HP 54645D Mixed Signal Oscilloscope (MSO): Finally, seamless integration of real scope and real timing analysis on the same scope screen.

Here's a perfect example of why the whole is greater than the sum of its parts.

The HP 54645D MSO integrates two 100 MHz, 200 MSa/s analog channels with 16 digital channels for easier mixed-signal measurements. So much easier, in fact, you can measure up to 18 channels simultaneously, and trigger on complex timing conditions. Try doing that with a 4-channel scope.

It's still the scope you know and love.

The HP 54645D looks, feels, and runs like a scope. So, just because we've added new logic analysis capability doesn't mean you have to acquire new skills.

It's also the first scope to offer our new

HP MegaZoom technology. If you think the name sounds impressive, wait'll you see HP's 54645D MSO pan through its Meg of captured data and zoom in on points of interest.

On second thought, why wait?

Call for your free demo.

Check out this new breed of Mixed Signal Oscilloscope for yourself. For a free demo on CD-ROM or floppy disk, call HP DIRECT at **1-800-452-4844****; **Ext. 1822**. Or ask for Ext. 1852 to speak to an on-line engineer.

And discover the most integral part of your mixed-signal testing solution.

Download the demo from our website at http://www.hp.com/info/mixsig1 Faxback: 1-800-800-5281, Document 10105

There is a better way.



©1996 Hewlett-Packard Co. TMEMD610/ED

READER SERVICE 108 World Radio History

1996 IEEE BCTM

enough power-supply rejection so that the gain of the HBT low-noise amplifiers varies less than 0.23 dB/V and the VCO frequency less than 2.5 ppm/V. Not having these complementary p-type devices would make a significantly more complex circuit that consumed more power and precious chip area.

As the previous SiGe HBT application made apparent, complementary (p- and n-type) devices are always needed in analog circuits from dc to microwaves. A few years ago, virtually all analog IC suppliers came up with fast, complementary bipolar processes for the high-speed analog ICs required in telecom, consumer, and data storage mixed-signal applications. It seemed that each new process tried to top the others in performance while hopefully minimizing cost.

Now a team from Sony Corp., Kanagawa, Japan, has come up with a process aimed at this very broad niche (Fig. 6). The basic process provides high-speed (30-GHz ft) vertical npn transistors as well as high-beta (β = 700) vertical npn transistors whose ft runs 12 GHz. Just two additional process steps provide the much-slower complementary vertical pnp transistor with its 4-GHz ft. To handle logic, the process provides 1²L circuits with a packing density of 3000 gates/mm². It also supplies pFETs with a gate length of a mere 0.3 µm and polysilicon resistors with sheet resistances of 80, 400, and 2000 Ω /square.

A REAL DESIGN

The Sony team built an 89-stage current-mode-logic ring oscillator with the fast npn transistors. Propagation delay per gate ran just 21 ps at a gate current of 3.5 mA. In a similar circuit, the pnp transistor showed a propagation delay of 240 ps at a current of 0.35 mA. The I²L-based 11stage ring oscillators provided propagation delays as low as 10 ns/gate. To prove out the process, the Sony team built a hard-disk-drive read/write amplifier from the high- β npn transistors and an I²C bus decoder IC for a digital satellite tuner PLL using I²L. Both worked.

A current-feedback op amp designed by Jim Bates of Comlinear, Fort Collins, Colo., a National Semiconductor Co., illustrates the power of high-speed complementary bipolar processes. In fact, these processes made possible today's generic current-feedback IC op amp. Bates' major innovative contribution to his design was the class-AB output stage (Fig. 7). The basic op amp, connected for an inverting gain of 2, provides a 3-dB bandwidth of over 100 MHz and a 2-V pulse rise time of just 7 ns—and that's while running off split ±2.5-V rails. Bates' novel output buffer stage lets the op amp combine this power bandwidth with the ability to put out over 100 mA while the output swings to within 1

The lead paper in the "ADC and DAC" session, from Harris Semiconductor and Spectrum Services, is a follow-up from their previous work (*IEEE J. Solid-State Circuits*, Vol. 30, p. 443-452, April, 1995). In that case, they showed that the error terms in high-resolution, pipelined, multistage ADCs are the DAC and interstage gain errors, which result in either dropped codes (differential nonlinearity, DNL = -1) or overlapped codes (DNL = +1).

Conventionally, component measurement/calibration is used to improve linearity. The authors propose a method of monitoring the converter histogram change with respect to the reference-voltage calibration. It's a closed-loop calibration scheme with good linearity achieved because the histogram, which is a statistical measure of the converter, has a one-to-one correspondence to the linearity.

Motorola researchers report on their work in increasing the sample rates of conventional algorithmic (cyclic) ADCs. Sample rates have been low because the serial nature

NOVEL APPROACHES IN CONVERTERS

of the converter allows the determination of only one bit in every clock cycle. With the architecture described, two bits are resolved per clock cycle. Also, the effects of gain and offset errors are minimized through digital correction based on the redundant signed-digit (RSD) principle. The 10-bit, 2-Msample/s ADC dissipates 15 mW from a 3.3-V supply, making it ideal for embedded ADC applications in portable products. It was fabricated in a 0.8µm biCMOS process.

A student paper from the University of Parma, Italy describes a current-mode latched comparator for high-speed, low-power applications, avoiding the problems with low-voltage operation of latched bipolar comparators. The architecture consists of a differential input amplifier, latch driver, and the latch itself.

This is an evolution of work previously reported by the paper's authors (*Proceedings of the IEEE VLSI Design '96 Conference*, 1996), and was simulated with the Spectre program, considering both 2x and 4x interpolation. The device will be in 0.8-µm biCMOS within the year, and 8-bit, 200 Msample/s performance from 3.3 V is expected at 0.55-mW power dissipation.

A partial-response, maximumlikelihood (PRML) read channel requires a high-speed, low-power ADC in the DSP chip. Hitachi's researchers explain their work on new folded differential logic techniques (FDLs) that can be applied to a fullflash ADC. Conventional FDLs can eliminate error codes with Gray encoding. However, the full encode block must be subdivided, and the resultant, smaller blocks can have errors between them.

The new scheme covers the entire encode block and eliminates such errors. It's being dubbed "folded *cascoded* differential logic" (FCDL). The measured error rates of an IC implemented in 0.7-µm biCMOS was less than 10⁻¹⁰ times per sample.

The last paper in the session is from Harris Semiconductor. It covers a low-glitch, 14-bit, 100-MHz DAC previously described in *Electronic Design (Aug. 5, 1996, p. 135). PAUL MCGOLDRICK*

1996 IEEE BCTM



9. THE TRANSIENT RESPONSE of the lateral DMOS structure in Figure 8 (top) agrees closely with the results of simulation.

V of the supply rails. However, its quiescent current is a tiny 1.5 mA.

BIPOLAR POWER PLAY

While some think MOS technologies now dominate the world of power control, system designers can be sure bipolar structures will stick around for a long time. Remember that the IGBT, which owns the motor-control arena. consists of a MOS-FET integrated with, and driving, a power bipolar device. In fact, a pair of researchers, one from the University of Wisconsin in Madison and the other from the University of Illinois in Chicago, present a paper describing the internal dynamics of an IGBT during short-circuit switching conditions. Results of measurement and simulation were similar. They considered self-heating and diffusion equations as well as charge-balance and transport equations. What showed was hot spots and impact ionization causing IGBT breakdown under short-circuit conditions. To increase ruggedness in future IGBT designs, they recommend using a wider base.

Two designers from Texas Instruments, Dallas, describe the task given to bipolar structures in their proprietary 1-µm power IC process called Prism. The process, based on 40-to-80-V lateral and vertical DMOSFETs, is compatible with CMOS technology. Where necessary, IC designers using the process can access less than optimum npn transistors for bandgap references. In addition to describing a family of circuits used to enhance these npn transistors, the paper delves into the building of other functions/circuits requiring BJTs. They include current limiters, temperature sensors, and Zener diodes. Current limiters can prevent the fusing of bond wires if a load is shorted. Zener diodes are needed for non-precision voltage references and safe-operating-area (SOA) DMOS clamps. The npn transistors also can provide ESD protection up to 4 kV on input lines.

Lateral seems to be the way to go in power ICs. One reason is that the backside of a lateral DMOSFET (LDMOS-FET) is usually at ground potential and thus easy to heat sink. In addition, voltage ratings to 60 or 80 V are easy to obtain with "resurf" techniques. That's achieved by increasing the so called drift region between the polysilicon gate and drain (*Fig. 8*). This lateral DMOS structure was developed from research done by a team from Motorola, Toulouse, France, and their Logic and Analog Technologies group in Tempe, Ariz. Additional members were from the Laboratoire d'Analyse et d'Architecture des Systemes in Toulouse. The work resulted in a detailed electrical model of the structure. Simulation results, using the model (top), agreed closely with the results (bottom) of measurements made during a gate charge test of the device (*Fig. 9*).

Researchers from the Materials and Devices Lab of Toshiba Corp., Kawasaki, Japan, indicate that lateral structures offer major advantages over power ICs based on SOI technology. Conventional high-voltage (above a few hundred volts) circuits integrated on SOI substrates require an oxide coating running 10 or more µm thick. However, They built 600-V breakdown lateral devices on SOI



10. CALLED A double-gate lateral-inversion-layer emitter transistor, or DG LILET, this novel BJT structure offers power-IC switching far superior to that of a lateral IGBT.



SURFACE MOUNT

3.3 to 5000 VDC Output Standard



1996 IEEE BCTM



11. THE EQUIVALENT CIRCUIT of the double-gate LILET shown in Figure 10 indicates it uses four active devices: an npn, a pnp, and a pair of MOSFETs.

substrates on the order of 1 μ m thick and feel 1000-V devices are possible.

In the same paper, the Toshiba team describes power ICs using a new breed of high-voltage lateral IGBTs (LIGBTs) running at higher than conventional current densities. These 1-A, SOI-based IGBTs stood off 500 V and ran at a current density of 175 A/cm². According to the researchers, the maximum practical current rating of power ICs using LIGBTs is limited by silicon area and not by the device's actual current capability. Thus, for cost reasons, their operating current density must be maximized.

Also described in the paper is their SOI-based process, which places a 4bit CMOS CPU on a die with 60-V lateral NMOS power FETs. These NMOS FETs are built in a p-well, and they employ a drift region similar to that in high-voltage lateral devices. Moreover, the process builds highperformance vertical npn and pnp transistors in p and n wells, respectively, where the wells substitute successfully for the more conventional buried layers. ICs from the process aim at automotive applications.

Earlier in this report, you were promised several new-type transistors. One such device is the doublegate lateral-inversion-layer emitter transistor, or DG LILET (Fig. 10). It was conceived by two designers, one from Cambridge University in England, and the other from Liverpool University, also in England. It too is a power device recommended for power ICs. Furthermore, though built on a CMOS process, it uses bipolar technology's strong point for power: conductivity modulation.

A close cousin of

the lateral MCT (MOS-controlled thyristor), the DG LILET offers advantages over the MCT as well as over the LIGT and LDMOSFET. Faster than the LIGT (its speed approaches that of an LDMOSFET), easier to control than the LMCT, having an SOA superior to all but the LDMOSFET, and featuring a lower forward drop than the FET, the DG LILET adds no on-state resistance. device area, or process complexity (Fig. 11). The DG LILET uses the MOS inversion layer under the gate for a new form of minority carrier injection. A simulated 100 A flowing through a 200-V, 1-cm² DG LILET dropped to less than 10 A in under 60 ns. A simulation of an anode-shorted IGBT under comparable conditions took over 125 ns for a similar current drop.

Frank Goodenough's e-mail address is: goodenuf@class.org.

HOW VALUABLE?	CIRCLE
HIGHLY	546
MODERATELY	547
SLIGHTLY	548

READER SERVICE 146 ELECTRONIC DESIGN/OCTOBER 1, 1996





Like **BIG** numbers? How about 80 billion? No, we're not talking about how many commercials we've seen during one hour of watching television. We're talk-

ing about the projected sales figure for the world mobile computer market. According to Frost & Sullivan's study "Pen, Palmtop, and Notebook Computers," sales will grow at an 18% compound annual rate, going from \$30 billion in 1995 to \$80 billion by the year 2001. PC cards will increase their share of market revenues from 4% in 1995 to 9% in 2001, while pen and palmtop computers hold steady at 2% each. The large majority of revenues, however, will rest with portable computers, though percentage of share will drop from 91% in 1995 to 87% in 2001. The prominent driver in this category will be notebooks, though smaller subnotebooks really make their mark, growing at a 21% compound annual rate (compared to 18% for notebooks). Sagging laptop sales were revived with the introduction of multimedia laptops, but that may be short-lived as manufacturers attempt to squeeze multimedia features into notebook form factors. It's anticipated that pen technology will evolve as an increasingly popular complementary input



method as it fights for acceptance outside the health-care and insurance vertical markets. Part of the reason for the rise is improved pen handwriting recognition. As for the palmtop industry, the HP 200 LX and its two-way wireless communication ability breathed much needed new life into that market. Nonetheless, palmtops still are looking at rather intense competition from PDAs as well as subnotebooks. PDAs will continue to find success in niche markets, but for them to grab the lion's share, improvements must be made. For more information contact Frost & Sullivan at (415) 961-9000, or fax (415) 961-5042. They're located at 2625 Charleston Rd., Mountain View, CA 94043.-RE

> W. 103rd St., Indianapolis, IN 46290; (800) 428-5331; Internet: http://www.mcp.com/que.

"Creating Innovative Products Using Total Design: The Living Legacy of Stuart Pugh" is an expanded and updated version of the late Mr. Pugh's "Total Design" published in 1991. It offers readers a comprehensive overview of the entire design process from concept selection, to the uses and limitations of CAD systems, to the dynamics of the design team. The 592-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.aw.com/cp/.

"Cable Modem Report: Business **Dimensions and Market**

Opportunities" contains research that documents the value of cable modems to consumers in their homes. Readers can use the report to understand what the advan-

tages of cable modems are: discover the vendor opportunities — from the head-end to cable modem; and understand the

technological requirements to install a cable modem network. Multimedia tools such as Macromedia Director and Java are evaluated, as well as content services like TCI-Reuter's Ingenious. The report is priced at \$995. Contact SIMBA Information Inc., P.O. Box 7430, 213 Danbury Rd., Wilton, CT 06897-7430; (203) 834-0033; fax

(203) 834-1771; e-mail info@simbanet.com.

"Platinum Edition Using

Windows 95" provides users with upto-date and comprehensive information on



Microsoft's operating system package. It offers coverage of some the latest Windows 95 topics including Service

Pack Update, the Internet, the Windows 95 registry, and Microsoft Exchange Client. The book comes with two CDs that offer a variety of Windows 95 tools and add-ons that are currently available including WinBench 96 and Winstone 96 benchmarking software. The book/CD-ROM set sells for \$60. Contact Que, 201

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History

A 62-page tutorial entitled "Understanding Device Level Buses" provides a thorough overview of device level buses.



It provides historical background and an overview of the currently available systems. The tutorial covers the early buses and principles including serial data transfer, types of signals, transmission distance, data encoding, and protocol and messaging. It describes the most currently available buses



UICKLOOK

to all qualified respondents by contacting TURCK Inc., 3000 Campus Dr., Minneapolis, MN 55441; (612) 553-7300.

OEMs may be interested in getting a copy of Philips Key Modules' M&D Business Unit's brochure describing Solid-State Audio Message Systems. It discusses how MPEG technology enables the storage of highquality audio in a relatively limited amount of memory space. Four products are described in the brochure: The SSR-2 Solid-State Audio Playback Module, the SSR-3 Solid-State Audio Playback and Record Module, the ISP 3002 Solid-State Multichannel Playback System, and a Digital Workstation.

For a free copy of the brochure, contact Mackenzie Laboratories, 1163 Nicole Court, Glendora, CA 91740-1416; (909) 394-9007.



ngineers and technicians all want to earn more on their investments. An attractive opportunity now exists in preferred securities.

Preferred stocks and related securities have become the investments of choice for those seeking higher yields, solid credit quality, and name recognition in the taxable fixed-income markets. Preferred issues are particularly appropriate for those in low- to moderateincome tax brackets who want a higher current income, like many retirees. They also make a lot of sense in tax-deferred accounts.

Preferred stocks are nonvoting equity securities in a corporation, but have debt-like characteristics—a fixed dividend, for instance. Most preferred securities are perpetuities, but are callable at par, generally about five years from issuance. Some of the newer hybrid preferred structures are not technically considered preferred stock, but they perform similarly. Features common to all structures in the preferred securities sector include:

• Attractive yields relative to other fixed income alternatives and common stock equivalents.

- •Monthly or quarterly income stream.
- Solid credit quality.
- •Low minimum investment.

•Liquidity in the secondary market. Most preferred issues are listed on the New York Stock Exchange, enabling investors to price and trade their preferred securities conveniently.

The most traditional preferred stock structure is perpetual, meaning that there is no stated maturity and the fixed dividends will be paid indefinitely unless the issue is called. However, issuers can retire outstanding preferred issues through call provisions, usually in five to ten years after issuance. If interest rates are lower once the security becomes callable, the call will undoubtedly be exercised.

Besides "straight" Perpetual Preferred Stocks, there are Adjustable Rate Preferred Stocks, Yankee Preferred Stocks, and several newer structures:

Exchangeable Capital Securities (ECS) Monthly Income Preferred Securities (MIPS) Monthly Income Debt Securities (MIDS) Quarterly Income Capital Securities (QUICS) Quarterly Income Debt Securities (QUIDS) Trust Originated Preferred Securities (TOPrS)

These newer hybrid structures are either technically considered debt or are comprised of debt components, and are structured with maturities ranging between 20 and 50 years. These issues tend to be priced to yield 1/2% to 3/4% more than similar "straight" preferred stock.

Note: MIPS, MIDS, and QUIDS are service marks of Goldman, Sachs, & Co.; TOPrS is a service mark of Merrill Lynch & Co.; and QUICS is a service mark of Lehman Brothers Inc.

Henry Wiesel is a Vice President, Financial Consultant, and Qualified Pension Coordinator with Smith Barney. He provides investment accounts nationally and internationally for individuals and corporations. Readers are invited to contact him to receive a free copy of the Smith Barney Brochure on "Preferred Securities." Mr. Wiesel may be contacted at Smith Barney, 1040 Broad St., 2nd Floor, Shrewsbury, NJ 07702; (800) 631-2221, Ext. 8563.







Whatever your performance needs, Tl has a logical solution. Whether your design demands are high performance, low cost or a price/performance combination, Tl offers more than 20 logic families, from TTL to ABT and LV to ALVC. Choose from over 5,000 logic products, including specialty products such as clock drivers, boundary scan logic and GTL bus interfaces. No matter how big or small your logic needs, call Tl, your One Stop Logic Shop.



TI offers the widest selection of logic products.



TI has the worldwide manufacturing and service to support your needs.



Call TI, or for free on-line information visit us at http://www.ti.com/sc/3051



Back To SCHOOL

ERGONOMICS INC. IS OFFERING

two seminars in the Washington, D.C. area at the end of this month. "Testing Product Power Quality— Meet EMC Directive for Harmonics and Flicker" is a two-day seminar that details the standards and test procedures required to meet the EMC directive for electronics headed for the European marketplace. Key elements include theory, technology, and test methodology for harmonic and flicker product emissions, along with a discussion of the controversy surrounding standards implementation. The seminar will be held Oct. 28-29, and the fee is \$695, which includes educational materials, breakfasts, lunches, and coffee breaks.

"ELF/VLF MAGNETIC FIELDS

and the New MPR3—A Technical Update of EMF Standards and Testing" details the new MPR3 Swedish standard, test methodology, information on worldwide industry standards, and the mitigation of magnetic fields. The seminar will be held on Oct. 30. The fee is \$395, including educational materials, continental breakfast, and lunch.

Both seminars will take place at the Sheraton Reston Hotel, 4 miles east of Dulles International Airport. For more information, contact Ergonomics Inc., P.O. Box 964, Southampton, PA 18966; (800) 862-0102; fax (215) 364-7582.

therefiel these and for

to form

y last thread for this column—Where did the good jobs go? Where does prosperity lie?—provoked an unusually deep response. I got some VERY

thoughtful three- and four-page letters. Thank you for sharing your thoughts and concerns.

Some seemed to think, incorrectly, that the Information Age precludes building things. They see it as a virtual wasteland of techno-geeks moving bits around and generating only printouts and pretty screens. A typical comment, received by snail mail, was "Computers and the information web may do wonders on a screen or in a printout, but some time later, something has to be fabricated out of some material."

Perhaps the end products are built, at least in part, from physical things. What matters is that the value is added through knowledge.

Imagine a company staffed by a band of competent, but naive, engineers. They invent the "better mouse trap." They get lucky. The world covets their device and a huge market exists. Unfortunately, the creators neglect to protect their intellectual property though patents, copyrights, and trade craft. What is the likely outcome? A) The company prospers, or B) The company goes bankrupt or is acquired.

In most cases the correct answer is "B." Consider the devices that have made the most money in the past few decades: fax machines, CD-ROMs, and VCRs. These were physical products invented and productized by Western firms. In all cases, the creators were driven from the market and the money was made by others.

In today's world of fast communications and global competition, it is often cheaper to clone products than to develop them. Technology theft and reverse engineering have become an art form. The Patent Sell-Out that I have been warning about will make these rip-offs easier. There are three proven ways to steal products. The Chinese way is simplest. They just copy the products and build them with slave labor. That's illegal, but it works.

The U.S. way is clumsy, but legal. First you hire a bunch of lawyers. Then you form a team of "dirty" engineers to copy the product and reduce it to a functional spec. You have your lawyers form a "clean" team of "virgin" engineers, who can testify under oath that they have no knowledge of the product being copied. They work in a "clean room" and implement only from the functional spec. In a few months or years, a copy emerges.

The Japanese way is effective, elegant, and legal. They protect their local market through subtle "understandings." They ensure that their patent system favors national interests. They lobby aggressively and place agents in our top commerce positions. They relentlessly seek cheap technology access and early warning of key inventions. They "cluster patent" around competitors. In key cases, they "dump" (sell below cost) to destroy competition. This forces Western competitors to exit the market, pay royalties for their own inventions, or license their rights cheaply.

Firms damaged or workers that were laid-off because products were pirated don't get much sympathy. Intel, the inventor of DRAMs, got no help from Washington, even when the Japanese were flagrantly dumping memory chips. Intel prospered by moving to microprocessors—physical products defended in depth by strong "Information Age" intellectual property protection.

Note that nowhere have I suggested isolationism or more government regulation. The present bipolar political debate on this topic is hollow. Megastate bureaucracy is not the answer.

John D. Trudel, CMC, provides business development consulting and is the author of the book "High Tech with Low Risk." He is founder and director of The Trudel Group, 33470 Chinook Pl., Scappoose, OR 97056; phone (503) 640-5599; fax (503) 543-6361; e-mail john trudel@aol.com; Internet: http://members.aol.com/johntrudel/index.htm.

FLIPPING THROUGH THE INTERNET ROLODEX

...numbers you need to know

http://www.cetc.com: Get the latest information about Lucent Technologies CETC's (Component Evaluation Technology Center's) semiconductor test and evaluation services. Links to semiconductor supplier and industry sites also are provided.

http://www.omega.com: Tap into Omega Engineering's web site for solutions to process measurement and control. Technical and product information is presented on temperature, humidity, pressure, force, strain, flow, level, pH and conductivity, electric heaters, and data acquisition.

http://www.teknor.com: See Teknor Industrial what Components has to offer from their broad range of industrial single board computers and industrial computer system products for **OEM** applications and industrial systems integrators. Users can browse through recent press releases and general company information, and may request sales and marketing information as well as technical and engineering support electronically.

http://www.vishay.com: Access comprehensive information on Vishay Intertechnology and its global family of passive component organizations. Users also can download information including data sheets, news releases, and technical bulletins on products including capacitors, connectors, resistor networks, and transformers.

http://www.cherry-semi.com: Get the details on the new application note from Cherry Semiconductor on their Secondary Side Post Regulator (SSPR) control IC. The note details the pros and cons of different techniques to regulate multiple-outbit power supplies.

http://www.inter-quest.com/interquest.html: Point your browser at Interquest Ltd.'s site for up-to-date information on their latest video, "Print-On-Demand: A New Business Process." The video provides details to understanding the print-on-demand market. See what else the company has to offer in the area of electronic printing and publishing materials.

С G S Y S Т F Μ L 0 Ν С F D А D Α



To advance your designs, call 1-800-477-8924, ext. 3051.

Advanced HCMOS without advancing costs.

AHC. Advanced because you need higher speed. HCMOS because you need easy. Low priced because you need the competitive edge. Best of all, with a rapidly advancing family of over 40 devices, AHC products from TI are available now.

- Gates, flip-flops and bus functions
- Available in TTL and CMOS compatible versions
- Low noise; high noise immunity
- 2.0 to 5.5 V supply voltage
- 5 ns typical propagation delay, 8.5 ns max ('244/'245)





© 1996 TI

64E

Worldgroup v2.0 is an online software package designed to bridge the gap between the World Wide Web (WWW) and on-line systems or workgroups. It includes a freely-distributable plug-in for Netscape Navigator 2.0 that enables users to launch a suite of off-theshelf multimedia client-server applications directly from a company's WWW site. WWW-enabled applications include multimedia databases, video teleconferencina, document management tools, and newsfeeds. The software is priced at \$476. For more information, contact Galacticomm Inc., 4101 SW 47th Ave., Suite 101, Fort Lauderdale, FL 33314; (954) 583-5990; fax (954) 583-7846; Internet: http://www.gcomm.com.



AN advanced Evolutionary Algorithm Tool, called "e" is designed to solve difficult problems with software specially developed for the engineering and scientific industries. It is a standalone tool that is capable of outputting in C, FORTRAN, or BASIC. It encapsulates programs into reusable components and stores them in

a library representing accumulated learning. A demo version of e, with full programming capabilities, is available that comes with all program features, including the ability to configure all customization parameters to solve a particular problem. For more information, contact SDI/St. Louis, 512 Rudder Rd., St. Louis, MO 63026; (800) 792-9258; fax (314) 343-9703; e-mail sdi@mo.net.

F rgoBreak for Office v1.1 is software on CD-ROM that combines ergonomics, education, and animated entertainment to help computer operators avoid computer-related Repetitive Strain Injury (RSI). By automatically tracking keystrokes, mouse activity, and time, ErgoBreak reminds users to take a break from typing at regular intervals. Each break consists of simple stretching exercises covering various body parts subject to strain from typing. Also included is an on-screen "BreakBoard" area which can be used to create e-mail style messages. System requirements include a 386 processor; Windows 3.x, Windows 95, or Windows NT; and 4 Mbytes of RAM. The software is priced at \$59.95, with corporate network site licenses available at lower cost. Contact Vanity Software Publishing Corp., 119 Spadina Ave., Suite 305, Toronto, Ontario M5V 2L1, Canada; (416) 204-1999; fax (416) 204-1760.



QUICK-TURN PROTOTYPES

Superior Quality/Superior Service

Call For A Quote!

Explore our new Internet Home Page!

Internet Home Page: http://www.murrietta.com E-Mail Address: pcboards@murrietta.com File Transfers: ftp://www.murrietta.com



"Your Satisfaction is our No. 1 Concern!"

4761 E. Hunter Ave. Anaheim, CA 92807 Phone 714-970-2430 Fax 714-970-2406 Modem 714-970-5015

PCB MANUFACTURING

- **2** Day Turn On Multi-Layers
- Prototype & Production
- Fast Quotes
- FR4 & Polyimide
- PCMCIA up to 8 Layers (.018 Thk)
- Blind & Buried Via's
- Backplanes
- UL Approved
- Modem 24 Hours a Day, 7 Days a Week

PCB DESIGN LAYOUTS

- Auto-Routing Services
- Cooper-Chyan Auto Router
- Analog & E.C.L.
- Impedance Control

PCB ASSEMBLY

- Fine Pitch Surface Mount
- Thru-Hole

READER SERVICE 135

ELECTRONIC DESIGN/OCTOBER 1, 1996

World Radio History

A Three-Peat For Motorola

fter the Los Angeles Lakers won two consecutive NBA championships in the mid-1980's, coach Pat Riley coined the term "three-peat" to urge his team to win a third consecutive NBA Championship. Although the Lakers' were unsuccessful in accomplishing that notable feat, it hasn't stopped others, particularly in industry, from achieving that goal.

For the third consecutive year, **Motorola's Fast Static RAM** Division remains number one in the world in fast static RAM (SRAM) semiconductor sales, according to Dataquest, an electronics industry market research firm. In 1995, Motorola finished with a 51.6% share of the very fast SRAM market (9 ns or faster) and an industry leading 12.8% share of the 10 ns to 19 ns market.

Dataquest's study included SRAMs with access times of 44 ns or faster. Motorola is listed in the study with 1995 sales exceeding \$510 million, which comes out to a 14.3% share of the market.

According to Barry Waite, senior vice-president and general manager of Motorola's **Microprocessor and Memory** Technologies Group, the company has dedicated its entire manufacturing team in their MOS 11

wafer fab facility located in Austin, Texas, to providing customers with a constant supply of SRAM products. MOS 11 is the world's first production 8-in. wafer plant, and is currently Motorola's most advanced full production semiconductor manufacturing facility.

For more information on Motorola's fast SRAM products, contact the Microprocessor and **Memory Technologies Group**, 6501 William Cannon Dr. W., Austin, TX 78735-8598; (512) 505-8823; Internet: http://www.mot.com/FastSRAMs. MS

G

TI Low-Voltage Logic

LVC

C



Conquer the 3.3 V world; call 1-800-477-8924, ext. 3051

Conquer the 3.3 V world, remain 5 V tolerant.

TI's LVC logic family offers you the broad spectrum of functions you need, at the price/performance you want. From gates to octals and Widebus, TI has more than 50 LVC products available now. It's easier than ever to get your pure 3.3 V and mixed 5 V/ 3.3 V applications to market faster.

 5 V tolerance enables reliable 5 V/ 3.3 V interfacing

F

M

- 4 ns typical propagation delay, 6.5 ns max ('244/'245)
- · 24 mA output drive
- Low static current at 20 µA
- Optional bus holds eliminate need for input pull-up resistors





08-2011R

IV 15 05

10

ELECTRONIC DESIGN/ OCTOBER 1, 1996

World Radio History

ALLEGRO HALL-EFFECT SHOWCASE

Allegro manufactures and designs a full line of Hall-Effect switches, latches and linear devices that are extremely sensitive, with guaranteed operation at temperature ranges of -40°C to

+150°C. Our latest edition to the latch family, the A3197, continues the strong tradition of Allegro products, and is now fully protected. We invite you to call Allegro for the

latest technical details and other requirements for your sensor application.

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

New From Allegro

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

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

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

(508)

Worcester,

READER SERVICE 150



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

The A3506 linear Hall-Effect sensors provide an output voltage (4.5 V to 5.5 V) that is proportional to the incident magnetic field. On-chip processing circuitry provides the user with an amplified low-impedance output signal that minimizes the need for external circuitry. Internal temperature compensating circuitry lowers the intrinsic sensitivity drift of the Hall element, allowing it to accurately operate continuously over extended temperature ranges -40°C to +150°C. 1.1 **Increased Sensitivity** Superior Temperature Stability No Moving Parts Solid-State Reliability Small Size Ratiometric Rail-to-Rail Output Small Packaging Size lleo croSystems, Inc

Hall-Effect Switches For High Temperature — A3141 thru A3144

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

- Superior Temperature Stability for Automotive or Industrial Use
- Open-Collector 25 mA Output Compatible with Digital Logic
- **Reverse Battery Protection**
- Activate with Small, Commercial Available Permanent Magnets

ALLEG





Massachusetts 01615

R



pany of Sun Microsystems Inc., has announced SunPlaza for Internet business. A new set of Internetbased services, SunPlaza allows customers to access detailed, up-todate information on product pricing and availability, place orders over the Internet and check the status of their own orders, regardless of how they have been placed with SunExpress.

These services expand the existing SunExpress Internet site, which provides information on more than

QUICKLOOK

3500 aftermarket products and services offered by SunExpress. SunExpress originally launched its Internet site to offer Sun-installed base customers the most complete product information and to provide them with an easy, direct method for contacting the company. Customer feedback from focus groups, web comments, and e-mail have given SunExpress in-depth knowledge of its customers' business processes, allowing it to tailor SunPlaza for business-to-business settings.

SunPlaza is updated daily to guarantee that customers have instant access to special offers, product availability, and pricing. A full-text search engine helps customers easily locate the products they need. Customers enter SunPlaza through http://www.sun.com/sunexpress.

SunPlaza has a number of built-in security measures. The SunExpress connection to the Internet is protected by the Sun Solstice FireWall-1 product, and the site is authenticated using digital certificates. The services offer support for secure sockets layer (SSL) protocol, providing highly secure encryption and authentication of all data transmission. The registration process includes unique account names chosen by the customer.

For more information, contact SunExpress Inc., Five Omni Way, Chelmsford, MA 01824-4141; (508) 442-0005; fax (508) 250-5536.





For single-gate solutions, call 1-800-477-8924, ext. 3051.

AHC MicroGate. Single gate. Simple solution.

Introducing AHC MicroGate. The single-gate logic device with the higher speed and lower power consumption of Advanced HCMOS in an extremely small 5-pin package. Reduce space, simplify circuit board layouts, modify system designs and accelerate your time to market. MicroGate is the simplest solution in the industry, and it's available now in over a dozen AHC devices.

MicroGate Logic Functions

- 5 V or 3.3 V supply voltage
- CMOS and TTL versions
- 3x the speed of HCMOS
- Low static power consumption
- Low noise
- Space-saving 5-pin package



INVERTER

64 I

08-2031C

ITT-TRIGGER

There's a little bit into every


OF YOU embedded

PRODUCT YOU DESIGN.

It grows out of you.

This complex design you are working on. Numerous pieces, each with separate functions. But you make it whole. And then, you send it out into the world. A part of you that will become an extension of someone else. In some ways, it resembles you. Which is why you shed the ordinary. And look for the best ways to

Choose your embedded processor wisely.

improve your design. Of course, you can choose any embedded processor. Or, you

can do what the leading printer, internetworking and video game companies have done—select the 64-bit V_R Series^m from NEC.

So what, exactly, led them to the V_R Series? Maybe it's the fact that NEC's V_R4300TM and V_R5000TM deliver far better MIPS per dollar than the PowerPCTM 603 or 604---providing remarkable performance for less than they ever imagined.

Or could it be our programs for companion chipsets? With NEC's V_R Series, you will get a comprehensive solution, including support for PCI Bus interface and laser printer control peripherals. We even assemble the third-party tools. So companies are able to bring their designs to market much faster.

But there's another reason forward-thinking companies select the V_R Series: Scalability. The V_R Series uses a common code library which enables "forward compatibility." So it's easy to upgrade to the latest generation of processor. That's important for two reasons. First, the incredible investment you have in developing code.

And second, you can expect several new processors in the $\ensuremath{\mathsf{V}_{\mathsf{R}}}$ Series line.

For more information, call 1-800-366-9782. And ask for Info Pack 195. It really is the wise thing to do. Especially when you consider what really gets embedded into your design.

	V _R 4300	PPC603	V _R 5000	PPC604
Frequency	133MHz	80MHz	200MHz	100MHz
Bus Interface	32-bit	32/64-bit	64-bit	64-bit
l-Cache Size D-Cache Size	16KB 8KB	8KB 8KB	32KB 32KB	16KB 16KB
Pin Count/Package	120 PQFP	240 COFP 256 BGA	272 BGA 223 CPGA	304 CQFP 256 BGA
SPECint92/SPECfp92	80/60	75/85		
SPECint95/SPECfp95			5.5/5.5	3.29/n/a
Price in 1,000 Qty *	\$45	\$195	\$300	\$549

*PowerPC prices from PowerPC FAQ, 12/17/9.5. Prices subject to change.

V_R5000. Paramount performance, incredibly affordable. This is the ultimate embedded processor for advanced applications like internetworking.



NEC

Vishay Electronic Components. Passives are our business. Our only business. This focus allows us to channel resources into the development of new components and technologies. Our commitment to passives is manifest in a broad product portfolio of both through-hole and surface mount configurations, as well as in a global network of production facilities. When you need passives, think of the only broad line dedicated passives company: Vishay Electronic Components with components from Dale[®], Roederstein, Sprague[®], Vishay Resistive Systems and Vitramon[®].

INFO IN A FLASH

To access Vishay on the Internet: http://www.vishay.com

For Literature, Call Vishay's FlashFax[®] Service at 1-800-487-9437. Request Document #1000.

C O M M I T T E D T O P A S S I V E S

Developing an Efficient Way to Sense Current Flow

Dale[®] Low Value Power Metal Strip[®] Resistors



Project teams seeking improved battery life and DC-DC control circuit performance are focusing on Dale[®] Power Metal Strip[®]

technology. Available in a versatile family of current sensing resistors, Power Metal Strip enhances the performance advantages of a wirewound resistor (superior accuracy and precision) — and translates them into a high performance chip package.

Although they represent a new surface mount technology, Power Metal Strip resistors have been proven in sensing applications for more than a decade.

They were introduced in axial lead form by Dale in 1983 and have steadily evolved as the most



efficient way to achieve low values (typical .005Ω) for current sensing. Surface mount styles

available include WSL-1206 (.25W), WSL-2010 (.5W), WSL-2512 (1W) and WSR-2 (2W). Axial lead styles include LVR-1 (1W), LVR-3 (3W) and LVR-5 (5W).

For data sheets call Vishay's FlashFax[™] Service at 800-487-9437. Request Document #1000.

statement of the local division in which the local division in the	Designed to be a set of the set o		STREET, STREET
туре	Power Rating	Resistance Range	Construction
WSL-1206	.25 watt	.005Ω-200mΩ	SMD, Coated
WSL-2010	.5 watt	.005Ω-500mΩ	SMD, Coated
WSL-2512	1 watt	.005Ω-500mΩ	SMD, Coated
LVR-1	1 watt	.01Ω-100mΩ	Axial, Molded
WSR-2	2 watt	.005Ω-1Ω	SMD, Molded
LVR-3	3 watt	.005Ω-200mΩ	Axial, Molded
LVR-5	5 watt	.005Ω-300mΩ	Axial. Molded

The Strengths of Power Metal Strip[®] Technology

Power Metal Strip[®] technology offers engineers benefits that aren't possible with other technologies: low resistance value, low resistance temperature coefficient (RTC), tight resistance tolerance, low thermal EMF and fast response time.

Low Resistance Value—A low value resistor allows designers to establish a very tight sensing window and minimize energy loss. Power Metal Strip technology eliminates the need for multiple resistors in parallel to meet the desired resistance value.

One $.025\Omega$ resistor = Four $.1\Omega$ resistors in parallel

Low RTC—A low RTC minimizes the resistance change caused by self-heating and high temperature

Total Response Time vs. Switching Current



environments. Power Metal Strip technology provides designers with greater accuracy in specifying sense voltage levels at elevated temperatures.

0 400mA

Voltage

Witching

Tight Resistance Tolerance — A tight tolerance (± 1%) provides the designer with a narrow resistance window and aids in specifying the sensing voltage. A wide tolerance reduces circuit's response time and contributes to excessive energy loss.

Low Thermal EMF --- A

low thermal EMF is required when the circuit is in an inactive mode. The thermal effects

TYPE	EMF
WSL	< 1µV/°C
WSR	< 1µV/°C

caused by the connection of dissimilar metals must be minimized to provide component accuracy.

Fast Response — Power Metal Strip technology resistors stabilize their sensing voltage more than 2.5 times faster than comparable thick film chip resistors. The result is improved voltage sense accuracy and enhanced battery life.











VISHAY ELECTRONIC COMPONENTS, NORTH AMERICA/ASIA: DALE®, ROEDERSTEIN, SPRAGUE®, VISHAY RESISTIVE SYSTEMS, VITRAMON®

READER SERVICE 171 World Radio History e resistance temperature nments. Power Metal Stript 200PPM/C RTC Power Metal Stript: 70p. ± 300PPM/C RTC Power Metal Stript technology provides

RTC Effects on

Switching Voltage



a World Wide has Web(WWW) site that provides easy access to information on StateCharts (also known as Harel Diagrams or Extended State Diagrams) and related top-From http://www.ract ics. ive.com/ractive, users can download an in-depth tutorial titled "Introduction to Designing with StateCharts" and a live version of BetterState Pro, the company's StateChart design tool with C, C++, and Visual Basic code generators (VHDL, Verilog HDL, MFC, and Delphi coded generators are also available). The live version of BetterState Pro includes all the design examples discussed in the tutorial, and it can be used to design state charts, of any complexity, and then generate code from the StateChart design. The combination of the tutorial with real, hands-on software can be used as a state charts training tool.

The www site also links to a live client-server application example developed using the company's NetState, a web clientserver application development tool. With NetState, the developer uses familiar flowcharts and state charts (or combinations of the two) to graphically design query/response relationships between a web server and the server's clients. Once the graphical design is completed, the CGI script for the design is implemented using a C or PERL code that is automatically generated by NetState.

R-Active's web site includes information on using the company's automatic code generators along with application notes on design topics such as state

QUICKLOOK

machine hierarchy, multireading, using decision polygons with state charts, Petri Nets, and more. The web site includes a section for frequently asked questions and a listing of consultants and design services using the BetterState tool. The site links to the company's technical support ftp site (ftp.ractive. com).

For more information, contact R-Active Concepts Inc., 20654 Gardenside Circle, Cupertino, CA 95014; (408) 252-2808.



Since our new 32Mb NAND EEPROM can replace existing 16Mb NAND parts, it's easy to get double the density.

And for where space is the issue, designing in 32 megs takes half as much room.

With fewer parts, you'll also get better reliability and lower system costs.

Plus, our 32Mb NAND has the same pinout as its predecessor, so upgrading is virtually plug-and-play. It's even available in 3.3V and 5V, and with TSOP Type II packaging.

All of which makes Toshiba 32Mb NAND the ideal choice for portable designs, solid state file storage, voice recording, image storage – or any other sequential data application.

For more information, call us at the number below, or visit our Web page at http://www.toshiba.com/taec.

Double the density, or half the space.

Choices like that make it twice the memory.

540



QUICKLOOK

Betters Up On The Roof

A nother hard hat to wear for an outdoor gathering. This time, though, it was on a rooftop—the highest in the city of Glasgow, Scotland, 18 floors up on St. Andrew's House. The occasion was to view the domain and antennas of one of Britain's newest telephone companies.

Atlantic Telecom is worthy of note because it reckons it can build a complete digital telecommunications network for a mere \$7.5 million and in less than six months. It also claims to have the highest central office in Europe, even if it doesn't exactly inhabit the continent's highest building.

It will all be done with radio, of course, and within strictly limited ambitions. According to Executive Chairman Graham Duncan, if he ean achieve a 5% market share among the half a million households in his territory, then the company will be turning a profit in a couple of years.

The low cost results from Atlantic's sheer nerve in choosing to use radio frequencies and equipment intended to be used for wireless local-area networks rather than high-quality voice and data telephony. It took the authorities quite by surprise when a year ago, the company first sought permission to build a wireless-local-loop network operating in the unlicensed Instrumentation, Scientific, and Medical (ISM) band at 2.54 GHz. Every other company that wants to use fixed radio access system in the U.K.—and there are seven at the last count has followed "proper channels" and applied for one of the frequency allocations specially set aside for the purpose. Most have grandi-

ose plans to cover the whole of the United Kingdom. Most are talking in terms of raising several hundreds of millions of dollars to do it. And most are still in protracted negotiations with the powers that be about the fine print of their operating licenses.

But Atlantic had surprise on its side. After thinking about it for a bit, the Radiocommunications Agency—the U.K.'s equivalent to the FCC—appears to have concluded "Why not" and allowed it to go ahead. The only constraint is that the equipment used meets all the technical requirements for frequency etiquette and power output set by European Telecommunications Standard (ETS) 300/328. That calls for a spread-spectrum system, either frequency hopping or direct sequence, and with a transmitter power of 10 mW—enough for around 2 kilometers line of site transmission.

Duncan says that the low power suits him fine, since he plans to use a series

of transmitter sites arranged in concentric circles around the St. Andrew's House hub. These will connect with small, shoebox-sized, selfcontained combined antenna and electronics units that will be installed on subscribers' rooftops. Each central transmitter will provide capacity for several hundred users, so by keeping "cell" size small and carefully syn-

chronizing them, he can cover the densely-populated business and suburban areas of Glasgow at low cost and quickly.

Each of the 47 transmitter sites in operation will be linked to the central office using with a high-capacity 38 GHz point-to-point radio link. Synchronization signals will be extracted from the high-precision GPS service.

Duncan says he knows the system will work. The spread-spectrum radio and GPS systems were supplied by the Tadiran company from Israel—and is almost exactly the same as deployed by the U.S. Army in the Gulf War.

Peter Fletcher is Electronic Design's U.K. correspondent. His e-mail address is: panflet@cix.compulink.co.uk.

Just A Reminder...

You only have a few weeks left to submit an abstract for a proposed paper for the Portable By Design Conference, sponsored by *Electronic Design*, which will be held at the Santa Clara Convention Center, Santa Clara, Calif., Mar. 24-27, 1997. Designers are invited to share their expertise in papers that emphasize problem solving and provide insights regarding the design of portable products.

Some of the topics that will be presented at the conference are:

Current and future battery technologies High-end/low-power CPUs 16-bit and smaller CPUs for portable designs Smart-battery management Charging circuits Software issues, including BIOS and PC cards Mass storage and I/O, including PC card issues IR and RF connectivity issues Power management Packaging Displays and input devices Buses and system-level architectural issues

The deadline to submit an abstract describing a proposed paper is October 11. To submit an abstract, or for more information, contact the Program Chair, Portable By Design Conference, c/o *Electronic Design*, 611 Route 46 West, Hasbrouck Heights, NJ 07604; (201) 393-6090; fax (201) 393-0204; e-mail portable@class.org.

ELECTRONIC DESIGN/OCTOBER 1, 1996

SIEMENS

T9A series relays have just raised the standard for compact 30-amp relays!



Single-pole, 30-A switching

Produced on fully automated lines, T9A relays represent the next generation of compact 30-amp relays. UL recognized and CSA certified, they are well-suited for use in appliances, HVAC equipment, industrial controls and more.

More than 350,000 operations

T9A relays deliver longer life than you might expect. For example, when switching 3/4 HP, 120VAC fan motor loads, they achieved >350,000 operations. Compare that to the life delivered by competitive units, and we think you'll find it impressive.

The quality you need

100% functional, hi-pot and seal integrity testing assures the high quality you demand. A high-integrity grid sealing method uses minimal epoxy, reducing terminal wicking. And, a laser marking system ensures clear, consistent product markings.

We've tried to think of everything

We've even considered our packaging material. Environmentally-friendly, returnable plastic containers help hold down packaging costs and reduce cardboard clutter in our factories and yours.

Find out more...

From the U.S. and Canada, use a touch-tone phone and our automated fax-response system. Simply dial 812.386.2561 and request document #1601. 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

Potter & Brumfield Products Division Siemens Electromechanical Components, Inc. READER SERVICE 147



C RAMSUNG SEMICONDUCTOR, INC., 1996.

World Radio History

In itself it's a superior ASIC. But



it carries memory right on board.

ASIC is the first in a series of advanced new ASIC products from our company, and as you can see, it's a pretty unusual one.

Because EDL60 does in fact give you memory—*big* memory right on the chip. While also giving you all the multipurpose functionality of an ASIC. Right along beside it.

We'll be the first to admit the idea is somewhat outrageous. But it's also startlingly useful.

Because in fact, EDL60's I megabit of DRAM, combined with the .5-micron standard-cell library that supports the chip, makes it one of the first ASICS that really will let you create a system-on-a-chip.

What else is on Samsung's long-term road map for highintegration ASIC? We've already begun development on a 16M-DRAM-embedded ASIC in .35micron technology. We'll follow the .35-micron process technology with .25-micron and expect to be at .18-micron by 1999.

With that kind of integration and our high DRAM densities, you're going to find that our embedded memory is indispensable for numerous applications in the consumer, communications, and computer arenas. Among them: set-top boxes, DVD systems, interactive video games, Ethernet/ATM switches, graphics/MPEG frame buffers, on-chip cache for CPU subsystems—the list goes on.

And besides embedded memories, we're also offering a number of powerful processor cores right now—including ARM7 RISC, 80C5I, PINE and OAK DSP. Our library also includes MPEG compression, PC1, RAMDAC, CODEC, and signal-conversion blocks.

All of which means we can help nearly *anyone* with their ASIC needs. And of course, in every instance, we at Samsung will support you with fab capacity virtually no one can match.

Given all the things we can do for you, there's really only one question remaining. Why not get in and ride with us yourself?

For a brochure on our entire ASIC program, please call I-800-446-2760 today. Or write to ASIC Marketing, Samsung Semiconductor Inc., 3655 North First Street, San Jose, CA 95134.

SAMSUNG SEMICONDUCTOR STILL A Generation Ahead.

QUICKLOOK

Terminator CRAZY

ave you ever had to add terminators to a high-speed board in order to get it to work? If your answer is "yes," do not despair you are not alone. In my highspeed design workshops, I hear engineers constantly gripe about terminators. Why are terminators so frequently needed? The root cause is the fantastic improvements in rise/fall times we are now enjoying in modern logic families.

When I started working with digital logic, a 10 ns rise time was considered fast. Today, the situation is completely different. Now there are logic families that can transition ten or twenty times within 10 ns. For example, the output rise time specified on the PCI bus can be as fast as 500 ps. When working with such fast drivers, a risingedge waveform has plenty of time to finish its business, roll over, and smoke a cigarette long before it smashes into the far end of a printed-circuit board trace. If the far end is unterminated, the signal will overshoot, reverse course, and then come roaring back toward the driver. At the driver end, the returning signal will bounce around some more. settling down only after making several round-trip tours of the neighborhood. In other words, an unterminated trace with a fast driver will ring like crazy.

Because the drivers available today are getting so much faster, the percentage of traces susceptible to ringing is skyrocketing. To cure ringing problems, most fast boards



are sprinkled with terminating resistors. The terminators are selected to have an impedance in the 10 to 100 ohm range, something that (hopefully) matches the actual transmission characteristics of the printed-circuit board. When a fast signal hits a terminator, it acts like a sponge, absorbing just enough of the signal energy to prevent reflections. Traces with properly en-

FACTORS AFFECTING RINGING PERFORMANCE



gineered terminators don't ring, overshoot, or undershoot.

How do you know when a terminator is needed? The ratio of trace delay to rise time is the first clue. Terminations are almost always required when the trace delay exceeds the logic rise time. Many people take an even more conservative approach, installing terminations when trace delay exceeds one-fourth, or even one-sixth, of the logic rise time.

The second most important factor in the ringing equation is capacitive loading. A capacitively loaded line, even when short, sometimes requires a terminator. This happens because the capacitance gives the line an apparent delay longer than the bare unloaded line. When the apparent delay goes up, so does the need for a terminator. At the same time, capacitive loading lowers the apparent characteristic impedance of a short line. Sometimes as little as 10 or 20 pF can make a noticeable difference. The best terminating value is a function of line length, line impedance, and capacitive load.

Every designer should establish clear rules for when terminators are required. These rules put the designer in control, where the actions are taking place, actively managing signal integrity instead of the other way around. The rules

should take into account the trace impedance, length, and topology, as well as the driver rise time, its output impedance, the position and size of capacitive loads, and some measure of your tolerance for overshoot and undershoot. Use a trace simulator, or actual laboratory measurements, to double-check all calculations. With a little planning, ringing need not become a serious problem.

Dr. Howard Johnson is president of Olympic Technology Group Inc., a high-technology consulting firm specializing in solving high-speed digital design problems. He is also the author of "High-Speed Digital Design: A Handbook of Black Magic" (Prentice-Hall, 1993), and regularly presents technical workshops for digital engineers, including courses for Oxford University. He may be reached at 16541 Redmond Way, Suite 264, Redmond, WA 98052; (206) 556-0800; e-mail howiej@wolfenet.com.



RF POWER TEAM For Wireless Communication



To receive your NEW RF Selector Guide, Fax to 602-966-6122



In Northern California Call 408-745-8100 In Canada call 613-592-6088 Today.

N STOCK

For Your Local Sales

Office Near You call

1-800 PENSTOCK.

© 1996 MOTOROLA, INC. ALL RIGHTS RESERVED. MOTOROLA AND 🛞 ARE REGISTERED TRADEMARKS OF MOTOROLA.

Visit Penstock's Website: WWW PENSTOCK.AVNET.COM READER SERVICE 145

QUICKLOOK

QUICK NEWS

SPREADING THE KNOWLEDGE-

Technical courses, speeches, symposia, and other programs videotaped at Stanford University, Stanford, Calif., will be broadcast across the campus and into the local community with the help of a new video distribution software product from start-up company Precept Software Inc.

Stanford has recently purchased a site license for Precept's IP/TV, an application that transmits live or prerecorded multimedia (video and audio) data to individual desktop PCs over private networks or the Internet using a technique called multicasting. Programming to be distributed includes continuing-education courses, lectures, and events such as graduation ceremonies, currently broadcast by the Stanford Channel, and advanced technical courses produced by the Stanford Center for Professional Development.

The programs will initially be transmitted throughout the campus over SUNet, Stanford's internal network, and later to the general public over the Multicast Backbone (MBONE), the portion of the Internet that supports real-time audio and video.

Multicasting is a technology designed to conserve valuable network capacity, or bandwidth, by sending out a single stream of data that can be picked up by any user who wants it. This technique contrasts with the conventional "bandwidth-hogging" approaches of network broadcasting, which sends data to everyone on the network, and unicasting, which sends data to individual users consecutively.

IP/TV includes a Program Guide, a web-based tool for multicast program setup and management, including capability for near video-ondemand scheduling; a Server, which delivers multicast programs according to parameters specified in the Program Guide; and a Viewer, which presents a list of scheduled multicasts and provides controls that let the user channel-surf among programs.

Precept Software was formed back in March 1995 to develop and market standards-based networking software that addresses the emerging demand for local- and wide-area networking of real-time multimedia

THIRD PCS SYSTEM IS LAUNCHED—Western Wireless has launched the nation's third personal communications services (PCS) system in Salt Lake City, UT. Utah is the second major metropolitan area where Western Wireless has launched VoiceStream Wireless service. Western Wireless became the first company to be awarded a license in the Federal **Communications Commission's** PCS spectrum auctions to begin commercial service when it launched its VoiceStream system this past February in Hawaii.

VoiceStream customers in northern Utah will join a global community of more than 13 million people in over 85 countries around the world that use PCS. The next-generation technology combines a wireless phone, pager, and answering machine in one pocket-sized handset. Other advanced features of VoiceStream's state-of-the-art, completely digital network including caller ID, call waiting, and 24-hour text messaging.

The Personal Communications Industry Association (PCIA) preinformation. Precept's software products provide desktop video broadcasting to Windows PCs over both the global Internet and private IP networks.

For more information on this product, contact Precept Software Inc., 1072 Arastradero Rd., Palo Alto, CA 94304; (415) 845-5200; fax (415) 845-5235.

dicts that PCS will combine with existing wireless services to fundamentally change the way Americans communicate. The PCIA estimates that, within the next decade, about 40 million Americans will be using a PCS telecommunications system.

VoiceStream's digital network provides users with improved sound quality, digital encryption to prevent fraud and eavesdropping, and the simplicity of all-inone communications. The VoiceStream Smart Card, a computer microchip embedded in a plastic card, must be inserted into the phone to make it work.

VoiceStream Wireless is Western Wireless Corp.'s brand name for personal communications services. Based in Issaquah, WA, Western Wireless is one of the leading providers of wireless communications services in the western United States.

For more information on PCs, contact Western Wireless Corp., 2001 NW Sammamish Rd., #100, Issaquah, WA 98027; (206) 313-5200; fax (206) 313-5520.

YOU GET TO THAT POINT IN THE PROJECT AND IT HITS YOU.

YOU HAVE THE POWER TO Change SOMEONE'S LIFE.

ROGER BRINGMANN, Ph.D. Precutive Director of Research, QMS



"Sounds pretty noble, doesn't it," Roger Bringmann said. "But that's the motivation."



"In typical QMS[™] fashion, we set the goals high for our new printers: make our customer's job easier, help them do it faster, or in the case of a network administrator, painlessly. To get there, we needed twice the performance of the fastest controller card. But it absolutely had to be cost effective.

It all came down to one processor: NEC's 64-bit V_R4300 .TM Don't think we handed it to them on a silver platter. We went through an extensive evaluation process.

And after rigorous testing of three processors--on real world applications--it became clear that NEC would blow the market apart. None of the other processors came close to NEC's price delta and performance. Not Intel^{1M} or PowerPC!^M In fact, the VR4300's 64-bit architecture with the 32-bit interface not only reduced our system costs, it also allowed us to use existing 32-bit code.

The other thing that impressed us was the great things we saw coming down the road for the VR4300. For the entire VR Series,⁷⁴ in fact. But let me tell you, there are innovative ideas running throughout that entire organization.

Which is why we're putting our brains together--QMS and NEC. Creating new ways to make someone's job a little better."

Call for more information about the VR Series at 1-800-366-9782. Ask for Info Pack 195.

The QMS 2425 printer with NEC's V_R4300 processor received the PC Magazine Editors' Choice award.



READER SERVICE 138

QUICKLOOK ANALYZING THE TELECOM TEST EQUIPMENT MARKET

apidly spreading networking. The demands of multiple new communications technologies. These and other factors will push sales of telecommunications and data-communications test equipment to over the magical \$1 billion mark by the year 2001, according to Frost & Sullivan, a high-technology research firm. New technologies requiring protocol analysis, such as ATM, ISDN, FDDI, SONET, and Fast Ethernet are stimulating market development. The proliferation of local- and wide-area networks also is increasing the use of protocol analyzers. Needless to say, protocol analyzers had 73% revenue share of the total market in 1995, and that number is expected to climb to 75% by 2001. Bit- and block-error-rate testers accounted for 21% in 1995, while transmission impairment measurement sets and butt sets garnered 3% each.

Perhaps the biggest contributors spurring on testequipment market growth are private networks, with the Pacific Rim showing the greatest gains. On top of that, carrier networks are expanding service



regions and offerings, and governments worldwide are sponsoring major upgrades of national communication infrastructures. And, because government agency and defense end users continually face the dreaded budget cuts, there's added responsibility for network maintenance—thus the need for more test equipment.

On the technological front, there are a number of trends defining this market niche:

ATM test equipment has entered the market.

The manufacture of telecom and datacom test equipment in several sizes, ranging from standalone units to handheld and portable testers.

Software-only protocol analyzers are becoming increasingly popular as microprocessors become more powerful.

Smaller and faster microprocessors and circuitry have brought about smaller test units. They've shrunk from portable to pocket-sized devices. Another feature of this equipment is its increasing

> multifunctionality. For instance, field-service people are looking for alternatives that can reduce the number of separate items technicians need to take to job sites. One particular example is the mini-optical time-domain reflectometer, which has made quite a significant impact in the fiber-optic industry.

> As software-only protocol analyzers continue to attract more followers, dedicated analyzers are becoming less and less necessary to meet demands of most end users. However, their higher capture and decode rates will be valued still because they have a dedicated microprocessor specifically designed for that function.

> If you'd like the full report on these findings or just more information, contact Frost & Sullivan at 2525 Charleston Rd., Mountain View, CA 94043; (415) 961-9000; fax (415) 961-5042.

Put some distance between you and the competition.



If you're looking to get your designs on the fast track, look no further than Toshiba Rambus DRAM.

By incorporating a high-speed, narrow Rambus interface into our DRAM architecture, RDRAM[™] now offers data transfer rates up to 600MHz.

That results in the highest bandwidth per pin you'll find. As well as performance that's over ten times faster than standard DRAM, and three times the speed of VRAM.

Which means more than just an express ride for high-bandwidth applications.

It means an end to system-slowing memory bottlenecks. Lowered costs, thanks to fewer signal layers, reduced components and less board space. And with so much throughput packed into so little memory, smaller designs, too.

Toshiba 8Mb RDRAM provides excellent granularity as a single-chip solution for PC graphics applications. Our 16Mb generation is ideal for high-end graphics, and includes both standard (16Mb) and parity (18Mb) devices.

They all run on 3.3V power supplies, and use proven CMOS technology.

And they're all from Toshiba, the company that owns the road when it comes to memory technology. To find out more, call us at 1-800-879-4963. Or

URL your way directly to our memory section at www.toshiba.com/taec/components/mem3a.html. Oh, and don't forget to fasten your seat belt.



NAiS[°] relays from Aromat

No single ad can do justice to our entire NAIS brand relay lineup. So we ve listed a few of our more popular relays to whet your appetite. Remember, the relays shown represent only "a drop in the bucket compared to our full line (and we ve got a mighty big bucket!).

In fact, we manufacture over 85 different varieties of relays: electromechanical signal relays, SMD, solid state, high frequency, power, general purpose, plug in and specialty relays to meet European standards - to name a few

With millions of pieces in stock at hundreds of distributor locations nationwide, Aromat can fulfill your orders quickly. And our trained customer service personnel and application engineers are just a toll free call away whenever you need assistance.

To see more of what Aromat has to offer, request our NEW Aromat Relay Catalog. Only then will you appreciate the superior performance, reliability and selection of NAIS brand relays from Aromat.



Just a drop in

PHOTOMOS Solid State Relays										
		AOV 210E (H)	AQW 210S	AC 210	ow ots	AQZ 102	AQV 254			
		~		NE	W!	1				
		General usage	Smollest 2 channel milay	Rel	ay & ouple	High cupiedy	Low on- resistance			
		346L 369L 369L 552W 173W 173W 134H 083H 083H		369L 9271 173W 138W 083H 413H		877 L 138W 433H				
		YES	NO	N	0	YES	YES			
		Standard	SOP	S	OP	NO	YES			
Officesistance (Detector soce - Seturation voltage)		25(3	750	Relay side	Detector side	0.050	7.00			
				35Ω	5V		1.000			
		130m A 350V	100mA 35.0V	120mA	-	4.0A. 60V	150mA 400V			
		.5mme	6-29msec	0.23 mscc	.01 metric	1.06/maine.	0.8minc			
		0.05msec.	0.04msec	04 mised	.03 meec	0.15mbeic	0.057880			
COR state leak		1µA	Aut	1µA	500nA	10pA	?µA			
IO senation		1500V AC (5000)	1500V AC	1500	W AC	2500V AC	150DV AC			
		550mW	650mW	650	ImW	1.35VV	410mW			
	enance.	1 5pF	1 50F	1.5	õpF	1.5pF	βρF			
		50mA	5 JmA	50	mA	50mA	50mA			

NAiS PhotoMOS solid state relays are the world's smallest!

Only Aromat offers hundreds of types of PhotoMOS solid state relays. And only NAiS brand PhotoMOS relays can offer you:

- World's smallest 2 channel relay perfect for PCMCIA fax/modems
- World's smallest relay perfect for space saving applications
- World's lowest on-resistance (90mΩ)
- World's highest I/O isolation (5000V)
- World's highest sensitivity (0.5mA)
- World's highest power (4A)

COMING In JULY: www.aromat.com

the bucket!

ELECTROMECHANICAL RELAYS									
Туре	of relay	тх	TXD	TRS	πN	TQ		JS	JW
			NEW!	NEW!	ø	4	>	Ø	
F	atures	Most advanced relay	Meets EN41003	Highent sensitivity	Ummate Space saver	Utomate Low-out Space Saver profile		Ministure power relay	Simal power relay
D men	sions (inch)	.591L 291W 323H	591L 291W 331H	591L 291W 121H	551L 220W 395H	.55 .35 .19	11. GW 714	8951. 630W 630H	1.126L .504W .803M
	Thru-hole	Yes	Yes	Ye	Yws	Ye		Yen	Yers
Mounting Configurations	Standard SMD	Yes	Yes	Yens	Ho	. Ye	rd III	No	No
	High reliability SMD	Yes	Yes	Yes	No	Yins Yets		No	140
	Space saver SMD	Yes	Yes	Yens	No			No	No
Latching		Yes	1 coll only	Yimi	Yos	N	4 (F) (6		
Con	act rating	2A, 30V DC	2A, 30V DC	1A 30V DC	1A 30V DC	Thru Nolli M, MV DC	840 54,501 50	10A 125V AC	10A, 250V AC
	Open contacts	1000Vrm	1000Vnme	750Vrms	750Vrm	TStvime	10001/111	750Vrmil	1000 Vrms
Breakcown	Contact sets	1000Vrins	1000Vima	1000Vrims	1000Vrms	1000Witten	1500Vinter		15 121 1
	Contact & Coll	2000Vrms	2000Vrms	1000V-m	1500Vrm	1000100	1500Vintes	1500Vrms	50(V3Vmm
Surge	Open contact	1500V IFCC Part 68)	1500V (FCC-Part 685	1500V (FOC Part 68)	1506V (FOIC Plint 68)	1500V (FCC Part 60)	1500V (FOC Perl 68		
voltage	Contact & Coi.	2500V (Bellcord)	2500V (Builcore)				2500V (Deltani)		10000V
Coll vo	itages (DC)	5 3 4 5 5 8 9 12, 24, 48	15.2.45.5.4. 3.12.24	15,3,45,3,8 9,12, 34	3, 4, 5, 5, 6 1, 12, 24, 49	2.45.5.6 R 12.34	1534551 民间2364	5.6.6, 12.24.48	54,512,34,48
Opera	ating power	140mW	200mW	50mW	140mW	140mW	340mW	360m%/V	Windez

NAiS electromechanical relays drive your most demanding applications.

Advanced designs require a relay source that can provide the right product for any application. Aromat is that source. Here are just a few reasons why:

- Aromat is "the industry standard" in signal relays
- New surface mount technology
- Variety of terminals to fit various SMD applications
- The ultimate space saving "TN" relay
- Power PCB and Automotive relays in ultra-miniature sizes
- Electric vehicle and other specialized relays

To get the whole story, call now for our NEW Relay catalog and put the full power of Aromat in your next design!

1-800-AROMAT-9

Aromat Corporation. 629 Central Avenue, New Providence, NJ 07974

Pour Partner for the 21st Century

READER SERVICE 101

UPCOMING MEETINGS

JANUARY 1997

USELINUX: Linux Applications Development & Deployment Conference, Jan. 6-10. Marriott Hotel, Anaheim, CA. Contact USENIX Conference Office, 22672 Lambert Street, Suite 613, Lake Forest, CA 92630; (714) 588-8649; fax (714) 588-9706; e-mail: conf e r e n c e @ u s e n i x . o r g ; http://www.usenix.org.

USENIX Technical Conference, Jan. 6-10. Marriott Hotel, Anaheim, CA. Contact USENIX Conference Office, 22672 Lambert St., Suite 613, Lake Forest, California 92630; (714) 588-8649; fax (714) 588-9706; e-mail: conference@usenix.org; http://www.usenix.org.

Annual Reliability & Maintainability Symposium (RAMS), Jan. 20-23. Philadelphia Marriott, Philadelphia, PA. Contact V.R. Monshaw, Consulting Services, 1768 Lark Lane, Cherry Hill, NJ 08003; (609) 428-2342.

Second Annual Pan Pacific Microelec-

tronics Symposium, Jan. 29-31. Sheraton Maui Resort, Maui, HI. Contact JoAnn Stromberg, Pan Pacific Symposium, 5200 Wilson Rd., Suite 215, Edina, MN 55424; fax (612) 929-1819.

FEBRUARY

IEEE Aerospace Conference, Feb. 1-8. Snowmass at Aspen, CO. Contact Stephen Franklin, deputy program chair, 4800 Oak Grove Dr., Pasadena, CA 91109; (818) 393-0814; fax (818) 393-0530; e-mail: stephen.f.frankl i n @ j p l . n a s a . g o v . ; http://chirp.plk.af.mil:1050/ieee/inde x.html.

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

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.

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, California 90045; (800) 877-2668 ext. 243; fax (310) 641-5117.

MARCH 1997

IPC Printed Circuits Expo 97 & 40th Annual Meeting, March 9-13. San Jose Convention Center, San Jose, California. Contact JoAnn Galluzzi (847) 509-9700; 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.



You'll receive a free autographed keepsake collection of columns from *Electronic Design's* well-read "Pease Porridge." Ask Bob questions on technology — or even humanity, and you'll receive an answer filled with wit, wisdom,

and waggish observations.

PEASE IS COMING!



CONFERENCE & EXHIBITION

presents BOB PEASE in a special appearance at the 1997 show.

WEDNESDAY, MARCH 26, 1997 • Exhibition Hall • 11:00 a.m.

For technical conference or exhibition attendee information, call Betsy Tapp at 201/393-6075; Fax 201/393-6073; E-mail: portable@class.org



Worldwide partners in power

INTRODUCING THE KESTREL Power Supply Family

Advance Power applies its most innovative and reliable engineering to the design and manufacture of its new product family of Kestrel VWF350 switch-mode power supplies. Convenient to use, these compact and versatile units provide expectional, "beyond-spec" EMC performance while powering up your most demanding loads.

- 350W continuous output power, 500W surge enables 200% current surge capability for cisk-drive start up
 - Power factor corrected, universal input with no derating of continuous power down to 85V ac
 - Meets EN55022 curve B
 as standard
 - Up to 5 fully regulated outputs with current limits, overvoltage protection,

and no minimum load requirements





Advance Power Inc. 32111 Aurora Rd., Solon, OH 44139 For the latest information about Advance Power Inc., visit us on line at http:/www.advanceint.com/advance-int. For the new full line catalog, call (216) 349-0755, FAX (216) 349-0142,

or E-mail 104436.1621@compuserve.com

UPCOMING MEETINGS

MARCH

Communication Design Engineering Conference, Mar. 24-26. Washington D.C. Convention Center, Washington, D.C. 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, ivcinfo@ivcconf.com.

APRIL

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; http://www.ies.uci.edu/infocom/ (North America); http://arpeggio.ics.es.osakau.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.

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

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

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

64HH

MAY

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.

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.

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

IEEE International Conference on Neural Networks, June 1-5. Houston, TX. Contact Nicolaos B. Karayiannis, Dept. of Electrical & Computer Engineering, University of Houston, Houston, TX; 77204-4793 (713) 743-4436; fax (713) 743-4444.

IEEE International Conference on Communications (ICC 97), June 8-12. Montreal, Canada. Contact Celia Desmond, Stentor, Fl. 6b, 33 City Center Dr., Mississauga, Ontario L5B 2N5, Canada; (905) 615-6507; fax (905) 615-8421; email: celia.desmond@tc.resonet.com.

IEEE/MTT-S International Microwave Symposium (MTT 97), June 8-13. Convention Center, Denver, CO. Contact John Dunn, Dept. of Electrical & Computer Engineering, University of Colorado, Campus Box 425, Boulder, CO 80309; (303) 492-5920; fax (303) 492-5323; e-mail: dunn@boulder.colorado.edu.

34th Design Automation Conference (DAC 97), June 9-13. Anaheim Convention Center, Anaheim, CA; Contact MP Associates Inc. 5305 Spine Rd., Suite A, Boulder, CO 80301; (303) 530-4333; fax (303) 530-4334.

IEEE International Conference on Consumer Electronics (ICCE), June 11-13. The Westin Hotel O'Hare, Rosemont, IL. Contact Diane D. Williams, 67 Raspberry Patch Dr., Rochester, NY 14612-2868; (716) 392-3862; fax (716) 392-4397.

International Solid-State Sensors and Actuators Conference (Transducers 97), June 15-19. Hyatt Regency Hotel, Chicago, IL. Contact Kensal D. Wise, 1246 EECS Building, University of Michigan, 1301 Beal Ave., Ann Arbor, MI 48109-2122; (313) 764-3346; fax (313) 747-1781.

Digital Cross Connect Systems Workshop (DCS 97), June 16-19. Banff, Alberta, Canada. Contact Richard Hamley, Stentor Resource Centre Inc., Room 500, 160 Elgin St., Ottawa, Ontario KIG 3J4, Canada, (613) 763-4591; fax (613) 781-2023; e-mail: hamleyrd@stentor.ca.

IEEE Sixth International Fuzzy Systems Conference, June 20-25. Barcelona, Spain. Contact Ramon Lopez De Mantaras, IIIA-CSIC Campus U.A.B., 08193 Cerdanyola del Valles, Spain; (34) 3-580-95-70.

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History



No matter what form convergence takes, it's going to have some recognizable parts.

As computers, telecommunications and entertainment media merge into new products, Murata will be there. We support innovative designs with three strong lines: capacitors, EMI filters and piezoelectric components.

Featuring the newest surface mount designs many invented by us - and the right performance for the job, Murata passives give you dependability, wide range and competitive price. After all, we pioneered ceramic technologies, lead in miniaturization and brought the first economical piezoelectric products to market.

If your newest design calls for, say, high frequency and high voltage capacitors, low distortion capacitors and trimmer capacitors. Or chip inductors and noise suppression filters. Or ceramic resonators, discriminators and ceramic 2nd IF filters. Then you know what to do. It's easy as one, two,

three. Well, almost. For free technical manuals or more information, just call



If it's not in the source, It's not in the sound.



For high-end audio or portable variable gain applications, the DS1802 Dual Digital Audio Taper Potentiometer delivers all of the sound and none of the noise. The DS1802 features two potentiometer channels, each with 63 1 dB steps. Keep the clean, true sound with a mere .002% THD at 1 kHz.

Whether your application is audio, telecommunications, multi-media, industrial or PC, Dallas has what you need with the most complete line of Digital Potentiometers in the marketplace. Dallas pots give you advantages in device control, reliability, power consumption, accuracy, and available packaging options.

Here are some of the choices you get:

- Linear or non-linear characteristics
- 3V, 5V or dual ±5V operation
- Volatile and nonvolatile devices
- 10K, 50K and 100K versions
- Singles, duals and hextets
- Commercial and industrial temperature grades
- Five interface control options



Sound good? Just give us a call at (214) 450-0448 to hear more.

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



Visit our Web site at http://www.dalsemi.com/

4401 South Beltwood Parkway, Dallas, Texas 75244-3292 & Phone: 214-450-0448 & Fax: 214-450-3715

READER SERVICE 104 World Radio History

COVER FEATURE

64-Pin TQFP Device Integrates All Of The Necessary Analog Functions, Including CD-Quality Audio, Telephony, And A V.34bis Modem That Handles Digital Simultaneous Voice And Data.

Single-Chip Codec Brings Advanced Multimedia To PCs

PETER FLETCHER

he word "multimedia," when appended to the words "personal computer," has by now virtually taken on the status of a "cliché"—it's so often used that it is in danger of becoming

worn out. Nevertheless, there are still a few tricks and twists that may serve to keep the word alive. Until recently, the emphasis has been on adding peripherals and chips to a PC with the intent of making it behave like a videocassette recorder or a graphics workstation. In fact, the word multimedia seemed destined to become synonymous with graphics and visual effects.

But many people believe that there are other significant, if rather less flashy, aspects to developing PCs into general-purpose work and entertainment machines. They have noted that both sound and communications are equally as important. Sound because if the PC is to make its way into the more lived-in parts of a house, or to win out over the telephone in the fight for crowded desk space, then audio versatility is a must. Not only in terms of sound quality, but more notably in terms of versatility—the ability to manipulate input and output sound streams simultaneously from a variety of sources.

At the same time, communication links are vital in order to access and interact with many sources of information, whether multimedia, plain ordinary voice, data, or fax. As a result of this need to make a PC into a flexible and easy-to-use communications terminal, modems, which not so long ago were regarded as temperamental specialist items of professional data-communications hardware for use only by those trained in the "black arts," have become commodity items.

That's precisely what SGS-Thomson Microelectronics had in mind a few years back when it began work on a single-chip solution. The result is the STLC-7549 single-chip multime-



dia codec that includes all of the necessary analog functions to give the PC advanced multimedia capabilities (*Fig. 1*).

In developing the chip, a highly integrated analog part, SGS was betting on the fact that the PC of the future will be at the center of a complex audio, telephony, and data communications subsystem. When using such a chip, an "average" PC can sport advanced multimedia capabilities that will allow it to play back audio, video, and data-compact disks. It will be able to connect to the Internet and deal with multi-

SINGLE-CHIP MULTIMEDIA CODEC

media pages from the World Wide Web, and can send and receive fax messages. Perhaps it might even act as a hands-free telephone, fax transceiver, and voice-mail system.

Until the advent of the STLC-7549, achieving this level of functionality required the addition of a number of internal and external peripheral equipment and plug-in cards to a desktop PC, a costly and inconvenient complexity. As for portable PCs, adding such features was often impractical.

A number of companies-both semiconductor manufacturers and others with an interest in sound and communications systems-have applied their expertise to defining exactly how to integrate many of the necessary analog functions for advanced multimedia into silicon. In particular, they've been examining the various standards that apply to playing back and recording audio. and sending data and fax transmissions. A group comprising of chip makers Intel, National Semiconductor, and Analog Devices, together with audio systems specialists Yamaha and Creative Laboratories. has issued a specification dubbed "AC'97"—short for Audio Codec for 1997. The group issued its first detailed standard last May, and expects the first devices to become available early next year (*Fig. 2*).

Apart from defining a series of functions that comply with existing digital audio system and modem standards, the most important decision this group made was to separate the analog and digital functions into two chips. This was done for several reasons. First, it was to avoid compromising the performance of the analog circuits that might arise if they had to use a fabrication process suitable for mixed-signal circuits. It would also ease the isolation of analog circuits from electrical noise generated by high-performance digital circuits. Finally, it was to allow systems designers a free choice of a host processor that can perform the compute-intensive digital signal processing functions that many applications require.

The AC '97 Group also specified that communications between the two chips—analog and digital—should be by means of a high-speed serial interface, rather than via the PC's internal bus, to ensure a degree of "platform



1. IELET HONT AND MODEN subsystems are integrated on this single chip from SGS-Thomson Micrelectronics. Aimed at advanced multimedia features for the PC, the STLC7549 needs only a digital controller and a data-access arrangement to form a multimedia motherboard system. independence." In particular, this independence from PC bus standards allows parts made to conform with the specification to be applied in a variety of applications other than PCs—game consoles or pure audio and communications systems.

Although the group has sought to take the limelight, it turns out that SGS-Thomson started work on a similar concept two years ago. According to Antonio Visconti, market development manager for telecommunications products, San Jose, Calif., the result of SGS-Thomson's development program is remarkably similar to the AC '97. But the essential difference is that Visconti claims to be at least six months ahead of the AC '97 Group members. "The AC '97 Group published its specification on May 28 1996," he says, "but we had the first silicon for our analog part-the STLC-7549-a day earlier.'

There are technical differences from the specification set out by the AC '97 Group. "Since we designed the part independently, we are not exactly like the AC '97 proposal," Visconti admits. However, a comparison of the reference schematics of the STLC-7549 and the one proposed for the AC '97 part shows that, in fact, SGS-Thomson's device may be over-specified, providing a superset of the functions called for by AC '97, rather than falling short of the standard (*Fig. 3*).

HIGHLY INTEGRATED

The STLC-7549 integrates all of the analog functions for an advanced multimedia PC, including CD-quality audio, telephony, and a V.34bis digital simultaneous voice/data (DSVD) modem into a 64-pin TQFP. The controller uses a 16-bit sigma-delta architecture that gives a dynamic range exceeding 90 dB for the modem section and 85 dB for the audio part, with a sampling frequency programmable up to 48 kHz.

Inside the chip, the audio section includes full-duplex stereo channels that allow independent output mixing and recording of multiple inputs, each of which can be amplified, attenuated, or muted independently. The telephony section provides mono mixing of two mono inputs from a second telephone line, a headset and three mono outputs for the telephone speaker.

600 WATTS

4.6" x 2.2" x .5" 375V IN/48V OUT

- DC Input Range: 250V 425V (Surge Withstand: 550V for 100 mS)
- DC Output: 48V ± 1% (Programmable: 5V - 50V)
- Regulation: ± 0.1% No Load to Full Load
- Efficiency: 90%
- Maximum Operating Temperature: 100°C at 600W
- Power Density: 120W/in³ (Other Package Configurations to 150W/In³) Parallelable with N+M Fault Tolerance
 - Parallel:
 - Single Wire or Fault
 - **Tolerant Interface**
 - DC or AC Coupled Bus

Primary Control: • On/Off • 5.9V Bias Supply Module OK

Call Today 1-800-735-6200

http://www.vicr.com



VICOR

Component Solutions For Your Power System 23 Frontage Road, Andover, MA 01810 Tel: (508) 470-2900 Fax: (508) 475-6715

READER SERVICE-166

5A48C600A

0903102

670

A REAL PROPERTY AND

275

- **ZCS / ZVS Low Noise Architecture**
- Model Number: V375A48C600A

0.43"

Single Piece Price: \$248

Secondary Control:

• Trim

81

- Program
- Module OK

SINGLE-CHIP MULTIMEDIA CODEC

headset speakers, second line modem, fax, or rear-game channel. The modem section includes a differential mono input and output line for the V.34bis standard. The telephony and modem parts are independent of the audio section due to a second sampling clock and serial port. On the other hand, all clocks also can be controlled from a master clock providing a quadraphonic mode for surround-sound and 3D sound applications.

The STLC-7549 internal structure is composed of three main sections audio, telephony, and modem, each with dual serial ports and dual programmable sample rates. Each part provides a digital-to-analog converter (DAC) channel that converts data from the digital interface to analog signals, and an analog-to-digital converter (ADC) that converts analog input signals to digital data to feed the digital interface. Loopback capability for ADC digital paths to DAC digital paths is supported.

Major inputs for the part include three main stereo input lines that can derive inputs from devices such as a CD player, an MPEG audio signal, a VCR recording, an FM synthesizer, and a MIDI application (L1, L2, L3, R1, R2 and R3); a stereo microphone input from a desktop computer and/or a headset, including a selectable +20dB pre-amplifier (MICL and MICR); and a mono input for a PC speaker (MONO_IN).

Each source can be amplified, attenuated and muted independently. Two stereo outputs (LOUT1, LOUT2, ROUT1, and ROUT2) provide the resulting audio mixing to two stereo line outputs through a volume-control block directly set by pushbutton or dc potentiometer pins, or by a serial-port register command. An additional summer provides to the PC speaker (MONO_OUT) a mixing of the stereo outputs with MONO_IN.

In addition to the audio part of the circuit, the telephony part provides mixing of two mono inputs from a second telephone line and a headset (TP2Rx and HANDRx2) with a stereo microphone line to the ADC channel. The DAC channel drives three mono outputs to telephone speaker, headset speakers, a second line modem, a fax or a rear-game channel (HandTx1, HandTx2, HandTx3).



2. THE AC '97 specification defines a series of existing digital audio system and modem standards. The specification separates the analog and digital functions into two chips.

The modem part includes a differential mono input and output line, and an additional output line that is filtered and optimized for the V.34bis standard. Visconti says that both the telephony and modem parts of the circuit are independent of the audio parts by use of a second sampling clock and serial port. All clocks also can be controlled from the audio master clock (MCLKA), providing a quadraphonic mode for surround-sound and 3D sound applications.

Further flexibility is provided by eight general programmable I/Os that can be used for functions such as ring detect, LED driving, pushbutton control, and audio or telephone source presence. "With full-duplex mixing features, a quadraphonic mode, independent audio and communication serial ports and programmable sample rates, the STLC-7549 is a simultaneous modem/telephony/stereo audio codec," Visconti concludes.

In contrast, the AC '97 specification calls for a single mixer and a multiplexer in the audio section, compared with the STLC-7549's two mixers and multiplexers. This is the fundamental difference between the two chips. The extra mixer allows more things to be done at the same time, claims Visconti. "On the 7549 with two mixers, there is a full-duplex capability which means that audio capture and playback are independent." This makes the 7549 a superset of AC 97 as far as audio abilities are concerned, although Visconti concludes that neither one is necessarily better than the other.

"We have four stereo inputs. This is the same as AC '97. But we have only one mono input, whereas AC '97 defines two mono inputs; but we do not see that as a problem because there are more inputs—four stereo and one mono—than anyone will want to use at the same time. So the flexibility that derives from our mixing capability allows some of the stereo channels to be used as mono channels, with as much flexibility as you could want," he explains.

Visconti stresses that telephony modem and audio sections are completely independent of each other, allowing the three sections of the chip to simultaneously operate relatively low-quality mono audio for telephony, and at same time, run a CD at 48 kHz for "music on hold." For example, while receiving a fax transmission or using the modem at 33.6 kbits/s. Visconti says that it is this capability that allows the chip to be used in the DSVD mode. In this mode, the modem will adjust data speed automatically to provide bandwidth allocation between voice and data.

The modem section is fully compli-

In telecom, wherever you go,

there we are.

Just ask DSC Communications. For years this global supplier of digital switching, transmission, access and private network systems has turned to AMI for its custom ASIC designs. With decades of telecom experience, AMI does what others are reluctant to do—we adapt our design and manufacturing processes around our customers' needs.

AMI understands typical 15- to 20-year telecom product life cycles. So, while we push state-of-the-art submicron processes, AMI remains dedicated to processes that will support the product life cycle of telecom parts.

From simple FPGA-to-digital conversions, to elaborate mixed-signal designs, AMI offers a huge library of digital and mixed-signal megacells, specifically for telecom. And with nine design centers worldwide, AMI has the initiative and resources to work side-by-side with telecom companies—from concept to final production. Where downtime can't be tolerated, AMI exceeds quality requirements. For flexible inventory management, AMI delivers products Just-In-Time (JIT).

Flexibility underlines AMI's relationship with DSC Communications. Flexibility ensures wherever you go in telecom, there we are.

To receive a FREE copy of the AMI/DSC case study call: 1-800-639-7264



READER SERVICE 1957

SINGLE-CHIP MULTIMEDIA CODEC

ant with international telecommunications union (ITU) specification V.34 and with the expected extension to 33.6 kbits/s, V.34bis.

FEATURES FOR PORTABLES

Two other essential differences will make the STLC-7549 attractive to portable computer makers, Visconti believes. First, the chip has a provision for a very simple method of audio volume control, either by pushbuttons to set a range of incremental volume steps, or by a simple potentiometer. Also, the STLC-7549 can be set to use digital audio sampling rates of either 41.1 kHz or 48 kHz. The AC '97 specification calls for a fixed sampling rate of 48 kHz, which detracts from the flexibility. While the AC '97 requirement undoubtedly sets a standard for CD-quality audio reproduction, in practice, this may not always be necessary-for example, for telephony applications.

"Running only at 48 kHz will use more MIPS for applications where 41.1 kHz will suffice. With AC '97, there is no choice other than 48-kHz sampling. This is fine for high-quality audio. But if it is used for telephony or for an application that needs only lowquality audio, then DSP computing power can be saved, either freeing the host processor for other work, or allowing use of a lower-cost CPU," Visconti asserts.

The STLC 7549 can be set under software control to a variety of sampling rates ranging from 3 kHz through 48 kHz, or from 5.51 kHz through 44.1 kHz. This depends on whether the audio circuits are set for the full quadraphonic mode or the modem mode.

Programming is effected with 22 internal control registers, all accessible through the serial interface. The method for setting volume is typical of the method used. Volume control functions are set via pushbuttons, a potentiometer, and a trio of control registers that respectively set audio line output attenuation control, audio output mute, and mono I/O control. A fourth register acts as a general digital control register.

By setting the bits +PBVOL (pushbutton volume circuitry) or +DCVOL (dc volume control circuitry), the output attenuators will be made to increment or decrement the current 4-bit value of the volume-control register by 1 LSB. This is achieved when the pushbuttons (VOL_UP or VOL_DOWN) are activated or by the potentiometer dc voltage range pin (DC_POT) to determine a 4-bit value.



3 A SUPERSET OF THE AC '97 SPECIFICATIONS is provided by the STLC7549 multimedia codec from SGS-Thomson Microelectronics.

The 4-bit value from the dc potentiometer can be read from bits 4 to 7 of an index register. If the bits +PBVOL and +DCVOL are both set to "1", then priority is given to +DCVOL. In the pushbutton mode, the serial interface is still able to modify the volume setting of its register although in the potentiometer mode the serial interface is inhibited from modifying the volume-control register. The idea is that for portable computers, a master volume control can be implemented by means of a simple manual pushbutton or a thumbwheel control that will override software settings. The logic is described below.

Pushbutton volume circuitry (VOL_MUTE, VOL_UP and VOL_ DOWN) will affect the main left/right output attenuator and mute blocks, and do not mute the PC speaker. When switching from the serial interface control mode to the pushbutton control mode, the contents of the registers are retained. If more than 1 pushbutton is pushed, then priority is given to the one pushed first.

With the internal dc-to-4-bit value converter, output volume can be controlled with a single potentiometer of 100 k Ω . When switched to the dc volume-control mode, the contents of the volume are up-dated with the 4-bit converter value of the potentiometer circuitry at least every 100 ms. A mute function allows each input and output channel to be silenced independently. This function maintains the configuration (gain, attenuation, mixing configuration) during the mute and unmute phases. The output channels should be muted when the sampling frequency is changed.

The STLC-7549 can play music in the quadraphonic mode, providing surround-sound capability using the RQ1 (Right Quadraphonic 1 output) and the LQ1 (Left Quadraphonic 1 output), along with the normal stereo outputs of LOUT1 and ROUT1. This mode causes the two modem codec clocks to be controlled from the audio master clock to provide a back channel.

All programming is carried out through the serial interface, allowing the chip to be totally under software control from the host. The serial interface provides a bit clock, a frame clock, and four time slots. Each clock frame sends 4 by 16 bits defined as left audio,

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History

The scope can be held with one hand. The awards can't.







The TekScope[®] Handheld Digital Oscilloscope has won virtually every major award a handheld scope or DMM can. Because it allows you to sample at 500 MS/s on both of its channels simultaneously. Because it comes with Isolated Channel[®] Architecture. Because it has a True RMS DMM. All surrounded by an intuitive, rugged package that will rest comfortably in the palm of your hand. For these reasons and more, TekScope has repeatedly been voted number one by customers like yourself.

Awards can be a handful, sure. But we're not complaining. For more information, call 1-800-479-4490, Action Code 722, or visit us at www.tek.com.



NEED THE KEY TO CUSTOM I/O WITH OFF-THE-SHELF AVAILABILITY?



Whatever your data acquisition needs are, chances are that Pentek already has the I/O product you thought you'd have to build yourself.

We not only offer the industry's largest selection, all of our standard products are modular and fully customerconfigurable. With a wide range of interface functions and support for numerous data transfer schemes, including

the high-performance MIX mezzanine bus, Pentek puts you in the driver's seat.

To help you unlock all the potential of every

Pentek I/O product, we also include software drivers and example code—and we stand behind it all with a free one-year warranty and a staff of experienced application engineers ready to assist you at a moment's notice.

For a datasheet, free catalog of our extensive product line and related application information, call us today at



- VME, VXI and Multibus II architectures
- Up to 70 MHz for A/D and D/A
- Up to 18-bit accuracy and 32 channels
 SCSI, TI/CEPT Telecom, Digital I/O
- Digital Receivers, TAXI, RS-232

Ext. 539. And open the door to the largest I/O product selection in the industry.



One Park Way, Upper Saddle River, New Jersey 07458-2311 • 201-8 (8-5900 • Fax: 201-767-3994 • e-mail: inio@pentek.com Worldwide Distribution and Support

SINGLE-CHIP MULTIMEDIA CODEC

right audio, control register, and general purpose input-output.

Audio analog inputs and outputs provide full 16-bit ADC or DAC resolution with a differential nonlinearity for both the ADC and DAC of ±0.9 LSB. For inputs, the dynamic range is claimed to be 85 dB over the full bandwidth from 0 Hz to 24 kHz-equivalent to one-half the maximum sampling rate on all channels, with interchannel isolation specified at a minimum of 85 dB at 1 kHz. Input resistance is designed to be 100 k Ω for line inputs and 10 k Ω for microphone inputs, with maximum capacitance of 15 pF for both types. The audio-output channels provide similar channel isolation. The full-scale output voltage is 3.0 V maximum with load resistance and capacitance specified at $10 \, k\Omega$ and 20 pF, respectively.

Modem and telephony channels have similar electrical characteristics, with input dynamic range at 90 dB for the first modem line and 85 dB for the second line. The device requires a 5-V power supply for its analog sections, with a 3.3-V supply for digital functions. It can be operated with a single 5-V supply or with dual 3-V and 5-V supplies. Total power consumption is specified at 1500 mW. Three power-down modes can be set by software control.

In addition to the STLC-7549, SGS-Thomson plans to introduce a number of related devices, including two parts which separate the telephony and modem and audio function from the STLC-7549. Visconti says that this approach will allow manufacturers to incorporate either sound-system or telephony functions onto a motherboard, with the remaining functions on a daughterboard or plug-in card.□

PRICE AND AVAILABILITY

The STLC-7549 is scheduled for volume manufacture during September and is now available in OEM quantities. Pricing is negotiable. Depending on quantity, the STLC-7549 should sell for between \$10 and \$15 each.

For more information, contact Jean Pierre Rossome, SGS-Thomson Microelectronics, 55 Old Bedford Rd., Lincoln North, Lincoln, MA 01773; (617) 259-2534; e-mail: simon.loe@st.com. CIRCLE 502

How VALUABLE?	CIRCLE
HIGHLY	537
MODERATELY	538
SLIGHTLY	539

READER SERVICE 176

World Radio History

If you're designing wireless communications devices, we're the antenna and battery pack specialist you need.

An impossible deadline. A shrinking budget. And the antenna and battery pack are critical to the success of your design. You need Centurion International right *now*.

Every battery pack we design and manufacture meets or exceeds all electrical, mechanical and functional specifications.

> This PCMCIA application demanded the performance of a 17 cm antenna in a 7 cm package design.

We designed these 2.4GHz antennas for wireless LAN applications.

- RF engineering experience from 3MHz to 94GHz
- Custom battery pack assemblies incorporating nickel cadmium, lithium ion, nickel metal hydride or alkaline cells
- Full range of frequencies from 27MHz to 6GHz

Our customers-many of the leading wireless manufacturers in the worldhave grown to trust our ability to design, engineer and manufacture antennas and battery packs to tight tolerances. In high volume. On time. And on budget. We developed this connector for spread spectrum applications in compliance with FCC Part 15.

 Let's talk. Tell us what antenna and battery pack you need right now (or more likely, yesterday).

Call us today for a FREE Custom Antenna And Battery Pack Design Specifications Kit.

800-228-4563 Fax: 800-848-3825

On time... at the right price... and it'll work."



Centurion International, Inc.

Wireless Components • Antennas and Batteries P.O. Box 82846 Lincoln, Nebraska 68501 800-228-4563/402-467-4491 FAX: 800-848-3825/402-467-4528

READER SERVICE 102

World Radio History

Lucent Digital Cellular Telephone 6720 Centurion International has developed antennas for many Lucent Technologies Inc. wireless terminals which meet Bell Labs specifications.

Enbance Your Cable Modem Performance

with Upstream Modulator and Demodulator Products from Stanford Telecom

ow, Stanford Telecom offers a complete modulator / demodulator solution for upstream transmission and reception of data in HFC networks. Stanford Telecom products are being used by major Internet access product manufacturers and are now in field trials at key locations throughout the United States.

STEL-1108

A complete QPSK modulator in a single-chip ASIC, specifically designed for the transmission of data from the subscriber modem to the headend. The STEL-1108 incorporates an integral numerically controlled oscillator and outputs a spectrally shaped and filtered signal, tunable between 5 and 40 MHz.

STEL-1208

A board level assembly for evaluation of the STEL-1108 modulator ASIC.



STEL-9244 Burst Demodulator

A board level receiver assembly for demodulation of upstream burst QPSK signals at the cable headend site.

STEL-9251

The easiest, most cost effective way to evaluate Stanford Telecom cable modem products. This complete "Upstream Kit" includes the STEL-9244, the STEL-1108 in an STEL-1208 evaluation assembly board, software, cabling and instructions.

Our cable products are available now!

Contact Us Today for Complete Information.



480 Java Drive Sunnyvale, CA 94089

Tel: (408) 745-2660 Fax: (408) 541-9030

E-mail: tpg_marketing@stelhq.com Internet: www.stelhq.com

READER SERVICE 100 World Radio History

ADVANCED FEATURES GIVE NEW LIFE TO POTS MODEMS



COURTESY: LUCENT TECHNOLOGIES

Advanced POTS Modems: Mr. Moore, Meet Mr. Shannon

he explosive growth of the electronics industry in the last four decades has been fueled by seemingly limitless horizons in all directions. This has been especially true in the communications sector, where even the most conservative business plans are based on the assump-

tion that communications will become faster, cheaper, and better over time. One notable exception in this age of growing expectations is the humble plain old telephone service (POTS) modem, which, in all likelihood, will not see any quantum leaps past the recently introduced 33.6-kbit/s transmission rate.

Since it will be at least five years until a significant fraction of the U.S. population has a fatter data pipe (ISDN, broadband telephony, or cable modem) coming into their homes, the

ELECTRONIC DESIGN/OCTOBER 1, 1996

LEE GOLDBERG

The New Generation Of Feature-Laden Modems Is Much Smarter, Thanks To New Technologies And Standards That Will Help Them Deliver Voice, Video, And Data Well Into The Next Century.

modem will continue to play an important role in connecting people to data. Although they cannot get much faster, they can get a whole lot smarter, and they will offer users a wide array of features that will make the best use of the relatively slow data rates afforded by POTS connections.

By taking advantage of the rapid doubling of computing power postulated by Moore's law, we have been able to cram enormous amounts of digital signal processing (DSP) into today's modem chips. This allows them to push the envelope of the ITU's V.34 modem standard to deliver a maximum transmission speed of 33.6 kbits/s, very close to the theoretical limit predicted by Claude Shannon. This same processing capability has now made it feasible to incorporate such features as the recently approved V.70 specification for the simultaneous transmission of digital voice and data (SVD) on the same telephone line.

Manufacturers also are beginning to equip their modems with provisions for the H.324 specification that standardizes the protocols and techniques for video conferencing over POTS lines. In this next generation of products, full-duplex speakerphones and telephone answering machines are becoming standard features since they can be implemented by simply adding more software to a product's design.

Since it's not possible to fully explore these advanced modems in a sin-

ADVANCED FEATURES GIVE NEW LIFE TO POTS MODEMS

gle article, we will make seperate, detailed examinations of simultaneous voice/data and videoconferencing in two contributed pieces to be published in subsequent issues. In this article, we'll get an overview of the technology and some of the issues engineers will be facing when designing products with these increasingly sophisticated little critters.

IT'S THE LAW

Unless the laws of physics change suddenly, we appear to be approaching the limit to how much data can be squeezed down the 3.5-kHz bandwidth of a typical POTS telephone line. While the wires themselves can carry higher frequencies, the current telephone infrastructure is not prepared to handle them. This is because the telephone system is over 100 years old, and carries with it vestigial remnants of its earliest incarnations.

Back in the exciting times of steam locomotives, five-cent movies, ice delivery wagons, and live telephone operators, technological limits and problems with crosstalk kept a telephone line's bandwidth at around 3 to 4 kHz. The more recent 8-kHz clock and sampling rate employed by the telephone company's digital backbone network was selected to match the earlier system's bandwidth, and dictates that the signals it carries stay under 4 kHz. Any higher-frequency components are stopped cold by steeply skirted low-pass "brick wall" filters attached to the lines at the first point that they enter the telephone switching network. A similar high-pass filter keeps signals below 150 Hz from entering the system. This gives a typical telephone line a working bandwidth of 3.5 to 3.8 kHz, depending on line conditions and how much equalization you care to apply.

Shannon's theorem tells us that the highest number of bits per second that a line can support is a function of the line's bandwidth and signal-to-noise ratio. Applying this to the common telephone line, we can guess that the highest data rate we can ever hope for will be somewhere around 40 kbits/s.

In order to approach this limit, today's modems use sophisticated trellis-code modulation schemes that employ multi-level phase and amplitude modulation on each quadrant of a waveform. This allows transmitted data to be represented within a "constellation" of multibit symbols, each corresponding to a particular phase/amplitude combination.

The ITU's original V.34 modem specification called for a constellation consisting of a bit over 1000 phase/amplitude points to support a 28.8-kbit/s data stream, but provisions were left to accommodate future expansion. A more sophisticated version of V.34 (V.34-1996) has been approved recently that crunches a 1664 constellation of points inside the same amplitude/phase envelope. If the telephone lines are clean enough to support it, this new specification can encode 33.6 kbits/s worth of data on the same telephone line (Electronic design, *Aug.* 22, 1994, p. 47).

Unfortunately, as the constellation points get closer together, it takes smaller amounts of noise or line distortion to make one point indistinguishable from another. Eventually, the 39-dB quantization noise floor inherent to the telephone system's PCM encoding process begins to be enough to interfere with recognizing constellation points, rendering any further encoding useless.

STRETCHING BANDWIDTH

We are going to have to live with the limited bandwidth afforded by telephone lines for a while, but there are many ways to make better use of it. For example, one annoying aspect of sharing a telephone line with your computer is that until now, only one of you could use it at a time. This meant that any data or faxes had to be sent before or after a teleconference unless there was a second line close by.

Several solutions have appeared over the years, ranging from the Radish alternate voice-or-data protocol, to a recently introduced collection of simultaneous voice/data (SVD) technologies currently battling for supremacy in the marketplace. The two leading contenders are the V.70 digital SVD (DSVD) standard, and the V.61 analog SVD (ASVD) standard which is being heavily promoted by Rockwell Semiconductor.

The V.61 ASVD system uses a second modulation scheme to actually

<image>

TWO EXTREMES OF COMPLEXITY are illustrated with these two V.34 modems. The PCtel modem card (left) uses the host-PC's CPU to perform all speech processing, filtering, and modem functions, leaving only an analog-to-digital interface and a handful of PSTN interface components on the card. Where maximum performance is desired, a full hardware implementation of a modem can free the host CPU for other tasks. In this case, the modem card (right) uses Lucent Technology's AVP architecture to do all the processing required for V.70 DSVD and H.324 video conferencing, as well as all other V.34 modem functions.

HE WORLD BECOMES A SMALLEP PLACE WITH EVERY PRODUCT YOU DESIGN.











You have a remarkable power.

It is the power to bring people together, by allowing them to be farther apart. And it is a power that, while firmly grounded, is nothing less than nomadic in spirit.

Choose your embedded processor wisely.

PDAs are now reaching their full potential. And you have the power to make the world a smaller place. But can you really find an embedded processor that can keep up with the shrinking size of reality? The

answer, of course, is a resounding "yes." You need look no further than NEC's V_R4100^{100} core technology as your solution of choice.

The V_R4100 Series frees you from the constraints of time and space with a unique, customized "system on a chip," allowing you to create a more streamlined design and send it off to find its place in the world in record speed. And for the more pressing deadline, the V_R4101 offers a built-in memory controller for up to 8Mb DRAM/ 16Mb MROM.

But is all that enough to change the world? When combined with full 64-bit performance (with a 32-bit interface) and more MIPS/mm² in a low-priced, small die size package, it is very possible indeed. Then, factor in low power consumption, on-board Multiply Accumulate Instruction, plus on-chip management features such as the ability to operate at 3.3 volts, and changing the world of PDAs is virtually assured.

In all, NEC offers significant performance, flexibility and serious power management features in a compact, affordable embedded processor. All of which offers you a chance to bring the world a little closer together.

For more information about the V_R4100 Series, call 1-800-366-9782.

Ask for Info Pack #165. It's a small step to take for something that could go so far.

NEC's V_R 4100 processor is uniquely designed to power the next generation of PDA products.



READER SERVICE 139 World Radio History

ADVANCED FEATURES GIVE NEW LIFE TO POTS MODEMS

	Color William Color State	-	-	-	_	-	_		-		-
TABLE 1:						55/2	6. A	5	hone	Mail	nelan
ADVANCED MODEM ICS					4		50' Or	to la	9	Voice .	
			13/8	2	foot	ertac	e.e.	Spea		dech.	1
		04	10.0	500	à. 0	320	D/0.	* *	145	*	Price
Company	Product	ŝ	7.	7.	7.	Y	0	40	A	Comments	& Avail
Analog Devices Inc.	ADSP-2181/2183	Y	Y	н	Y	H/S	Y	Y	Y	3 computation units, 33 MIPS, 80 k RAM Requires	\$30
One Technology Way Norwood, MA 02064	Fixed Point DSP									host to do H.324 video. Uses 3rd party software.	Qty 10K Now
(617) 461-3881; fax 461-3010 http://www.analog.com	ADSP-2106X Floating Point DSP	n/a	n/a	na	Y	н	n/a	n/a	n/a	Currently used to perform video codec functions for H.324. Next revision of software may let it become a 1-chip V.34/H324 modem.	\$132 Qty 10K Now
Brooktree	Bt848	n/a	n/a	n/a	Y	S	n/a	n/a	n/a	Complete video capture processor with on-chip PCI	\$19.50
San Diego, CA 92121-3707 (619) 452-7580; fax 452-1294 apps@brooktree.com	video Capture Chip									Also has 5-tap vertical filter. Works with ProShare and H.324 standards. Requires software codec.	Now
Chromatic Research	MPACT	Y	Y*	H/S	γ.	H/S	Y	Y	Y	Outboard media processor works with X86 CPUs to	\$125-
615 Tasmin Drive Sunnyvale, CA 94809-1701	Media Co-Processor								1	support modem functions plus video, MPEG-1 decoding, 2D/3D graphics, VoiceView, and digital	\$170 for total
(408) 752-9100; fax 752-9101										sound. Host CPU performs floating point ops. *Software to support V.70, V.80, and H324/323/320	BOM
1.										will be released in early 1997.	Now
Cirrus Logic 3100 West Warren Ave	CL-MD3462/463 FastPath Modem	ř	Ÿ	н	Ÿ	5	Y	Y	Ŷ	-462 has parallel/serial host interface, -463 has PCMCIA host interface. Supports TAPI interface	\$53 Oty 10K
Freemont, CA 94538-6423 (510) 623-8300; 800-359-6414	Chip Sets									and VoiceView. Reference designs, evaluation kits and reference s/w available. Next generation to	Now
attn: Raphael Mehrbians http://www.cirrus.com										include ISDN. Requires host for H.324 video processing	
IBM Microelectronics	2780pro/37801	Y	Υ	н	Y	S	Y	Y	Y	Fixed-function DSP has V.70 speech processing	\$22/\$45
www.chips.ibm.com	Modem Chip Sets								1	and V.80 support for Intel's videophone. Aimed at motherboard applications. Uses host for H.324	3Q:4Q-96
Lucant Technologies	122045-490110	Y	Y	н	Y	S	Y	Y	Y	video processing. Firmware included.	560
Microelectronics Division 555 Union Boulevard Boom 200 050PA	Data/Fax/Voice Modem Chip Set					0				V.70 speech processing on-chip. Excellent on-chip echo cancellation.	Qty 10K Now
Allentown, PA 18103	AVPIII Audio A (idea	n/a	n/a	n/a	Y	н	n/a	n/a	n/a	Programmable DSP and microcode host chip	\$98 On 101
610-712-4106	Processor Chip Set					-				with APOLLO or other V 80 modems.	Now
Motorola Netcom Operations 6501 William Cannon Dr. West	MC68DP356 V.34 Modem	Y*	Y**	H**	N	N	n/a	Y	Y	2-chip set includes programmable controller, DSP and PCMCIA interface, *33.6 kbit available by	\$50 Otv 10K
Austin, TX 78735 (512) 891-2429: Bex Liang	Chip Set			100						12/96. ** Requires external speech processor from DSP Group for speech processing and V 70	Now
rex liang@oakqm3.sps.mot.com					-					functions.	NOW
PCtel 1885 Lundy Ave., Suite 206	PCtel HSP Modern Reference design,	Y	Y*	S	N	N	n/a	Y	Y	Minimal hardware design uses host signal processing (HSP) for most functions. Supports	\$35-\$45 for total
San Jose CA 95131 (408) 383-0452, fax 383-0455	software, and HSP chip.									Radish VoiceView. Software to support *V.70 DSVD ready 12/96 **V.80/H.324 software for MMX	BOM. Includes
										processor now under development	PCB.
Phylon 4027 Clipper Court	PHY2000 Communications	Y	Y*	S	Y	Y**	S	Y	Y	2-chip set supports several DSVD standards, including PlayLink, a low-latency link for telegaming.	>\$45 Qtty 10K
Fremont, CA 94538 (510) 656-2606; fax 656-0902	Chip Set for PC Applications									*Requires host for V.70 voice processing. ** VideoLink supports H.324 video via a V.80 interface.	Now
Rockwell Semiconductor Systems	RCV336ACF/SP	Y	N.	н.	N	N	n/a	Y	N	*Not V.70 capaple, but supports V.61 and V.34Q	\$79 80
4311 Jamboree Road M/S 501/300	Integrated SAVD Speakerphone,									SAVD, plus VoiceView. No host support required for speech processing. Single-chip modem comes with	Qty 10K
Newport Beach, CA 92658 (800) 854-8099	Modem Device									configuration software for custom Windows applications. World-class option handles most	Now
				0						international telephone standards	
Sierra Semiconductor 2075 North Capitol Ave.	SQ3845 V.34 Speakerphone	Y	Y	5	Y	N	n/a	Y	Y	2-chip modem plus Plug and Play (PnP) host interface controller. Supports WAV sound files plus	\$60 Qty 10K
San Jose, CA 95132 (408) 263-9300; fax 263-3337	Chip Set with Plug-and-Play									host-based V.70 voice processing. PnP and Windows 95-ready software comes with chip set.	
Texas Instruments	TMS320C82	Y*	N	n/a	Y	н	Y	Y	N	The 2 DSPs and 1 RISC controller in theC82 de liver	\$82
Literature Response Center	USP									 Software to concurrently support all V 34 modem 	Qty 10K
P.O. Box 172228 Denver, CO 80217										& data pump functions in developement . Extensive software library available.	E. Frenk
(800) 477-8924, ext 4500	in coltword on heat			U	Err	notion	- Der	form	od or	chin's hardware, p/a - not applies his	
o = runcion penormed on-chip	in sonware on nost p	oces	550ľ	H =	- rur	ICTION	per	orme	ed on	chip s hardware hira = not applicable	1000

ELECTRONIC DESIGN/OCTOBER 1, 1996



ATM opens communications bottlenecks. And with a broad line of transceivers, Synergy Semiconductor simplifies your ATM/SONET designs. SY69612 OC-

Synergy's highly integrated transceivers minimize your component count. So your

designs can be both efficient and affordable. They're Bellcore, ITU/CCITT and ANSIcompliant. And all of Synergy's transceivers

SY69612OC-12 TransceiverSY69712OC-12 Transceiver with Clock RecoverySY69743Quad OC-3 Transceiver with Clock RecoverySY69951/2OC-3 Transceivers with Clock Recovery

are available now. So you can get your system to market in a hurry.

If you're ready to design systems that open performance bottlenecks, get more information about Synergy Semiconductor's transceiver

solutions by calling 800-788-3297 (or outside the United States 408-730-1313). Or look us up on the web at http://www.synergysemi.com.



© Synergy Semiconductor Corporation 1996. All rights reserved.

READER SERVICE 160 World Radio History

ELECTRONIC DESIGN REPORT

ADVANCED FEATURES GIVE NEW LIFE TO POTS MODEMS

move the points within the constellation to impress a voice channel on top of the data. The V.70 DSVD protocol simply creates a second channel within the existing data stream to pass highly compressed digital speech. Both standards have advantages and drawbacks that give them an edge in different applications.

Because it uses so much less speech processing, the V.61 standard is less expensive to implement. The G.729-A standard for CELP-based speech coding used by V.70 requires a significant amount (10 to 15) of MIPS that must be supplied by the modem or offloaded to the host processor. The V.70's speech processing also may introduce more latency than the Rockwell scheme, a potential drawback for telegaming or other real-time activities. This makes ASVD ideal for low-end applications such as video games and student computers. On the negative side, V.61 is only capable of supporting a 14.4-kbit/s rate, but V.34Q, an updated specification capable of 28.8 kbits/s, is pending review in the ITU.

DSVD also offers some powerful arguments in its favor, including higher overall data rates during SVD operation. Among other claims, DSVD's advocates say that it provides better sound quality and noise immunity for the voice channel.

Perhaps most important, V.70's digital-based architecture also makes it more flexible and easier to upgrade as new requirements arise. The underlying handshake, multiplexing, and voice-processing mechanisms also can be used as the foundation for videoconferencing. Because V.70 handles speech as part of the digital data stream, it will be easy to reduce the cost of a DSVD modem by absorbing more tasks into the main CPU. In addition, the new MMX processors introduced by Intel will offer extended instruction sets that handle some DSP functionality. This means that relatively straightforward software upgrades could be used to track evolving standards with either standard X86 or MMX CPUs.

While there are compelling arguments for both technologies, only one standard can prevail if SVD is to become a universally deployed technology. While V.61/V34Q ASVD is a wellconceived technology and excellent

TABLE 2. ADVA	NCED MODEM SOFTWARE SUPPLIERS
Company	Products
GAO Research & Consulting Ltd. 55 Nugget Ave. Unit 204 Scarborough, Toronto, Ontario, Canada M1S3L1 (416) 292-0038; fax 292-2364 gao@io.org	Software and algorithms for advanced modern functions including V.34 and V.70 DSVD. H.324 software for host (NSP). DSP applications also are available. Also has fax, caller ID, speakerphone, and echo cancellation functions. Can supply code in assembly or C for ADI 2181, TI C54x, MIPS, ARM, and Pentium (NSP) processors.
VoCAL Technologies Ltd. 1576 Sweet Home Road Buffalo, NY 14228 (716) 688-4675	Licensable software for ADI DSPs as well as DSP's Oak and Pine processors. Some support for TI DSPs. Supplied in ANSI C and assembly. Current modem software supports all V.34 functions plus V.70 DSVD and V.80 interface for H.324 videoconferencing. Codec software can interface to POTS T1/E1, switched 56, and ISDN. Supports G.721/6/8 speech compression plus most error correction protocols.

for less demanding niche applications, it does not possess the flexibility and extensibility that its digital cousin has. Hopefully, we will not have to witness the same kinds of fractious "standards wars" that have delayed or completely sabotaged the rollout of other promising technologies.

The first generation of SVD products is already on the market. Current prices for a complete bill of materials is hovering around \$150, which translates into a street price of about \$300 to \$450 for a SVD modem. Newlymanufactured computers will provide integrated SVD at an even lower cost, since they can take advantage of many elements (microphone, speaker, speech codec, etc.) that are already in place for other multimedia functions.

I.C.U.—U.C. ME

Beyond simple teleconferencing lies the world of videoconferencing, a technology that, until recently, was prohibitively expensive for most ap-

TABLE 3. A SAMP	LER OF ADV	ANCED MODEM PRODUCT	S
Company	Product	Description	Price
Ariel Corp 2540 Route 130, Suite 128 Cranbury, NJ 08512 (609) 860-2900	T1-Modem Server Card	Single-slot ISA card holds up to 24 V.34 fax/modems.Uses fixed-function Rockwell DSPs for low cost per line. MVIP and SCSA busses. Programmable DSP version using Lucent chips also available.	\$13,500 Qtty 50
Boca Research Inc. 1377 Clint Moore Road Boca Raton, FL 33847-2722 (407) 977-6227; fax 994-5848	Video Phone Elite H.324 Interface Card	PCI-bus card provides H.324 videoconference capability. Upgradable to H.320 for ISDN. Works with V.34 modern s with V.80 interface. Bundled with multimedia access application and call control software. Uses Lucent AVPIII.	\$399 Retail
JAC Electronics 4404 Technology Drive Fremont, CA 94538 (510) 651-6922	PHY2000 PC Internal DSVD Modem Card	Complete 28.8 kbit/s DSVD modem uses the host processor for speech processing. Comes with PhoneLink software, cabling, and headset. Uses Phylon chip.	\$169 Retail
Motorola Information Systems Group 50 E. Commerce Dr, M5 Schaumburg, IL 60173 (800) 4A-PCMCIA; fax (847) 538-4801 www.mot.com/MIMS/ISG/	Montana and Mariner PCMCIA Modern Cards	Complete 33.6 kbit/s modem and 14.4kbit/s fax has ETC error correction for better cellular data connections. Can communicate Tango with 2-way pagers. Available for both Mac and PC. Mariner card has all features plus 10-Mbit Ethernet capability.	Montana \$289 Mariner \$469 Retail
Multitech Systems 2205 Wood Dale Dr. Mounds View, MN 55112 (800) 328-9717; (612) 785-3500	MT2834 Internal DSVD Modem	Complete V.34/V.70 DSVD echo-cancelling speakerphone/modem. Bundled with Trio dialer / voicemail / fax software. Uses Lucent processor to perform all voice processing on oard. External version in development.	\$599 List
Telecom Analysis Systems POB 497, Industrial Way East Eatontown, NJ 07724 (908) 544-8700; fax 544-8347	TAS Series II Telephone Network Emulator TAS 100GT	Fully programmable units perform complete end-to-end simulation of any network condition/line impairment for testing of phone, modem, fax, or cellular products. 100 GT tests modems only. Both units easily adapt to computerized test set-ups.	Series II \$20- \$35K 100GT \$4- \$14K

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History


CLOCK IN AT A LOWER VOLTAGE.

System power supply voltages are going down, yet clock system performance keeps going up. You can thank Synergy Semiconductor for that. ■ Our 3.3-volt ClockWorks[™] family provides a building-block approach to low-voltage system design. At very low power levels, you get the high performance of ECL while meeting the low jitter and skew your system requires. ■ And ClockWorks chips interface seamlessly

with other low-voltage ICs. Get more information about 3.3-volt ClockWorks solutions by calling 1-800-788-3297 (or 408-730-1313). Email us at info@synergysemi.com. Or click your way to http://www.synergysemi.com.



ClockWorks is a trademark of Synergy Semiconductor Corporation Synergy Semiconductor 1995. All rights reserved.

READER SERVICE 161 World Radio History

ADVANCED FEATURES GIVE NEW LIFE TO POTS MODEMS

plications. After much struggle, the ITU has released the H.324 standard which lays down a collection of specifications for every aspect of videoconferencing, from image compression and transmission to call negotiation and multiplexing between speech, video, and data. Wherever possible, the H.324 specification is designed to work with existing modem standards. This approach allows a video modem to, at the very least, exchange data with non-video modems, and cuts product development efforts by reusing existing technology.

One exception to this is in speech coding. Since they were developed in parallel, H.324 uses a slightly different speech compression standard (ITU's G.723 specification) from the V.70's H.729 specification. This makes things somewhat redundant and potentially awkward, since an H.324 modem could, in theory, place a data-andaudio-only call that would be the equivalent of a V.70 connection. It should be noted, however, that the H.324's speech processing algorithm (which produces a higher compression factor) does require significantly more MIPS (over 50%) to implement.

While the picture quality of H.324 is far below that of television, or even LAN-based videoconferencing tools, it is surprisingly good considering that it is using 20 kbits/s (or less) to construct its images. Its slow frame rate and inability to track rapid motions are less than ideal but more than acceptable for many applications.

One very exciting aspect of the H.324 specification is that it has been designed to be compatible with H.320 and the soon-to-be-released H.323 standards that permit videoconferencing over ISDN lines and LANs. A properly designed product should be easily upgradeable to use the higher bit rates and consequently higher-quality video and audio that these new services will provide (For further information on H.320, H.323 and other desktop video conferencing technologies, see ELECTRONIC DESIGN, Aug. 19, 1996, p. 55).

Manufacturers are rushing to introduce consumer-grade videoconferencing equipment in time for the 1996 Christmas season. Instead of waiting for a "killer app" in the business community, they are counting on the appeal of POTS videoconferencing to families who will be able to keep in close touch with distant relatives using standardized H.324 products.

Even in their first incarnations, home teleconferencing will be reasonably priced. Andrew Davis, a noted telecommunications consultant, estimates that it will cost between \$600 and \$900 to retrofit a Pentium-class computer for video telephony. Much of the cost differences will be in the quality of the camera, which can range in price from \$80 to over \$300.

Davis also notes that building videoconferencing capability into a new computer can cost even less. By reusing the internal modem, speaker, microphone, codecs, and other multimedia components, a software-intensive solution could add as little as \$250 to \$300 to the price of a new machine.

BELLS AND WHISTLES

Once you have the kind of DSP power required to drive an SVD or video modem, it's a shame to let it go to waste. Designers have found that they can add some intriguing features to modems at little or no cost by soaking up any spare MIPS that a processor has to offer. One popular feature is the full-duplex speakerphone. By running an echo-cancellation algorithm on top of the modem's normal software, it's possible to eliminate the annoying echoes induced by slight imbalances in line matching. It also can get rid of the screeching feedback that would normally occur when a microphone is within range of a speaker that is connected to it. This permits full-duplex conference calls, a massive improvement over the annoying "you talk-I talk" half-duplex systems that were the only game in town until a few years ago.

With digitized voice capability and a hard drive, it's pretty easy to turn your friendly desktop computer into a telephone answering machine. The new modem chips make it even easier by including many of the functional blocks required for recording, playback, and indexing of a compressed voice file. Some chips even come with reference design software and rapid playback capability that allows messages to be played at double (or more) normal speed with no change in pitch or intelligibility.

With all the bells and whistles, it's easy to see how a user might get lost among them. That's why it is becoming increasingly important to provide a unified way of accessing and controlling all communications functions. Several software vendors are currently offering unified communication software packages, such as Ring Central, Synchro, and Phoenix, which manage telephone calls, voice mail, faxes, and e-mail from a single user interface. Products like these could make the lives of communication-dependent people (such as journalists) much simpler by letting them manage all their communications with a single address book/telephone book/contact manager.

Most of these applications take advantage of the telephony applications programming interface (TAPI) that is included in Microsoft Windows products. Although there are many of us who consider Windows to be an illconceived, overhead-laden operating system that burdens the entire industry with it's self-serving limitations, it is the law of the land in the 90s. Consequently, it's important to make sure that any telephony products you design or buy have a Windows/TAPIcompliant software interface.

But things are not all that rosy in the TAPI world. The TAPI interface in the current version of Windows is not capable of making use of the extended capabilities of these new modems. Dave McLean, product manager for IBM's M-Wave modem division, explains, "TAPI must learn to use the extended modem commands that switch between voice and voice data within the CTI (computer telephony integration) environment." Until this disconnect is resolved, designers and users will be forced to resort to proprietary solutions, an unhappy state of affairs in a world that is increasingly dependent on open communications standards.

ARCHITECTURAL CHOICES

When designing an advanced modem, you face several choices that trade off cost against performance. Depending on how much processing you wish to task a host CPU with, you can implement a few, many, or nearly all modem functions in software. This, of course, comes at a price, since it

BREAK OUT OF YOUR GATE ARRAY DESIGN CONSTRAINTS.

Are your design requirements making your gate array designs obsolete? Need the density of a standard cell with the flexibility of a gate array? Then you need CBA (Cell-Based Array).

Break out of your gate array design constraints with a whole new ASIC architecture that's metal programmable and process portable. CBA enables the quick design turns you're used to with gate arrays, and gives you the performance, power and density characteristics previously limited to all-layer standard cell implementations.

Now you can deliver more complex ASICs in record time. And with significant savings. Call us now. We'll get you up and running with one of our CBA foundry partners — Fujitsu, Hitachi, Kawasaki, Matsushita, Mitsubishi, NEC, Toshiba, TSMC or TriTech Microelectronics (Chartered Semiconductor). Get CBA and break out of the gate fast!

1-800-669-1083 Dept. F31 or designinfo@synopsys.com or www.synopsys.com/gaed/

BREAK OUT OF THE GATE FAST.

Call now for a free CBA library on CD. 1-800-669-1083

SYNOPSYS®

ADVANCED FEATURES GIVE NEW LIFE TO POTS MODEMS

may be impossible for a mid-range Pentium machine to do anything but support the modem during an H.324 video session, unless it has some hardware assist. Nevertheless, the software-intensive approach will probably be quite popular among frugal non-power users who don't feel an overwhelming need to run graphics programs, spreadsheets, and groupware during a teleconference.

Many manufacturers with programmable DSP-based solutions are rolling out first-generation products that farm out speech coding to the host processor, but are working towards taking it on within the DSP as their software matures and more DSP MIPS become available. Others companies such as Analog Devices Inc. and Lucent Technologies have sufficient "crunch" to support concurrent speech compression. Some dedicated modem chips like Sierra Semiconductor's SQ3485 also have hardware speech-coding functions. For lower cost applications, many chips perform the basic modem functions and rely exclusively on the host system's processor to handle the speech coding andprotocol controller tasks.

Taking the software solution to its extreme, one could theoretically perform all the control, speech processing, modulation, and protocol functions on the host processor, leaving little more than a handful of components on the modem card. This is exactly what the folks at PCtel, San Jose, Calif., have done.

By incorporating all the functions of a 33.6-kbit/s, V.34 data/fax modem in a software stack, the only hardware required is an audio chip or sound card, and the few components needed to make an interface to the telephone line (*See the figure*). A 75-MHz Pentium with cache is all that is required to comfortably support the software modem, unless heavy-duty multimedia applications are run concurrently.

Navin Rao, director of product marketing, estimates that the total bill of materials (including software license) for a PCtel-based modem is around \$35 in large OEM quantities. This includes the microphone for its full-duplex speakerphone function. Currently, it only supports the Radish alternate voice-or-data protocol, but Rao expects to release a V.70 DSVD version of the PCtel product in early 1997. With the V.70 voice codec software added, the modem will probably run on faster (166 MHz) Pentium machines, but will be more comfortable in an MMX environment.

Video coding for H.324 is a formidable task that most manufacturers prefer to implement in software on the host system and pass to the modem via the V.80 interface. Inexpensive hardware assists like Brooktree's Bt848 video-capture processor and PCI bus master can ease the load somewhat by handling the raw video and putting it into RAM in a fast, efficient manner. If, however, performance is essential, it's time to break out the heavy silicon. The extensive bit-by-bit comparisons, motion estimation, and other computation-intensive tasks can be performed by high-powered processors, such as Analog Devices' SHARC series of DSP ICs and Lucent's new AVP, the AV4400A audio/video processor (See the figure, again).

One alternative to full hardware support is the MPACT multimedia processor from Chromatic Research, Sunnyvale, Calif. Media processors specialize in processing the natural data types common to all multimedia applications, including video, graphics, audio, and communications. The host is still responsible for some of the speech and image coding but, much like a math coprocessor, a media processor is designed to offload the main CPU by handling many of the computationally intensive tasks associated with multimedia.

The MPACT is a very long instruction word (VLIW) processor, capable of sustaining up to 2 billion operations per second. With 5 concurrent I/O and memory controllers and a 132-Mbit/s PCI interface, it communicates with any X86 PC to perform MPEG 1 and 2 decoding, MPEG 1 encoding, 2D and 3D graphics acceleration, Dolby AC-3 audio processing, speakerphone, and fax/modem functions at up to 33.6 kbits/s. While it is not currently capable of supporting V.70, V.80, or H.324, software updates for these functions are anticipated by mid-1997.

PLAYS WELL WITH OTHERS

No matter how many cool things a modem can do, it's utterly useless if it has problems talking to other modems or to the telephone network. Nevertheless, there are several brands on the market today that seem to be fussy about who they talk to, and rarely, if ever, deliver connections at their advertised top speeds. Many of the problems lie in the fact that although the ITU specifications for modems are quite stringent, there is always some room for interpretation.

Unless your particular design is rigorously tested, there is a significant chance that it will work under "most" conditions, but will perform poorly under certain line conditions and refuse connections with a small, but critical, portion of the existing modem population.

According to W. David Tarver, president of Telecom Analysis Systems (TAS), Eatontown, N.J., testing a modem's performance involves both verifying its compatibility with other modems, as well as analyzing its ability to perform under a variety of line conditions, and the galaxy of different switching and transmission environments found within the public telephone network. Tarver notes that a single interstate or overseas call might be routed through four or more different switches across optical, wired, and microwave trunk lines, each adding its own transmission characteristics to the modem's signal.

In order to verify full functionality, the EIA (Electronic Industries Association) has developed the TSB-37A specification. It is a suite of 168 combinations of line impairments that define the full range of conditions that a modem is expected to operate under. The ITU has released a similar specification titled V.56bis.

Several annexes to TSB-37A can be used to test performance under less frequently occurring line conditions such as the ADPCM transmission systems found in some PBXs and local subscriber loops, cellular back-haul lines, and undersea cables. The TSB-38 specification also defines the actual test methodology, configuration files, and sequences for call-connect reliability testing.

To help engineers complete this exhaustive testing procedure, TAS has developed a full line of automated test equipment that can be used to test for compatibility between modems, as well as for performance with line im-

BREAK OUT OF YOUR STANDARD CELL DESIGN CONSTRAINTS.

Need to get a complex design to market faster? Want the density of a standard cell with the flexibility of a gate array? Then you want CBA (Cell-Based Array).

Break out of your standard cell design constraints with a whole new ASIC architecture that's metal programmable and process portable. With CBA you can satisfy the performance, power and size constraints of your most challenging designs without building all-layer standard cells. Quicker design turns and libraries optimized for synthesis ensure that your design will be ready for market in record time.

THROUGH WITH CBA TODAY. Call now for a free CBA library on CD. 1-800-669-1083

BREAK

Call us now. We'll hook you up with one of our CBA foundry partners — Fujitsu, Hitachi, Kawasaki, Matsushita, Mitsubishi, NEC, Toshiba, TSMC or TriTech Microelectronics (Chartered Semiconductor). Break through with CBA today!

1-800-669-1083 Dept. F32 or designinfo@synopsys.com or www.synopsys.com/sced/

SYNOPSYS[®]



ADVANCED FEATURES GIVE NEW LIFE TO POTS MODEMS

pairment. Since they are softwarebased, the standard test suites supplied with the products can be easily configured for custom test requirements or any subset of the EIA or ITU specifications. For further information, see the accompanying product listings in table 3.

WHERE NEXT?

The limitations encountered by advanced modems begs the question: "Is the copper telephone line finally obsolete?" The answer is probably both yes and no. We can expect to see fiber or coaxial lines making their appearance in some households before the turn of the century, but it will be decades before the task of rewiring the nation is anywhere near complete.

Hidden bandwidth can be extracted from today's phone lines by removing the antiquated brick-wall filters from the central office. Doing this allows the twisted copper lines to accommodate much more bandwidth (up to several MHz) for short distances (1 to 5 miles). ADSL (asymmetric digital subscriber loop), HDSL (high-speed digital subscriber loop), and several other broadband technologies are under development. Using CAP (carrierless amplitude and phase), QAM (quadrature amplitude), or DMT (discrete multitone) modulation, they are able to use much more of the bandwidth available in the twisted pairs that connect subscribers to the central offices (For further information on broadband delivery systems, see ELECTRONIC DE-SIGN, Oct. 2, 1995, p. 67).

Wide-scale deployment of these megabit technologies, however, will probably not happen until some time early in the next century, because it will take lots of time and money to install the extensive/expensive upgrades required to support broadband telephony throughout the network. During this time, we can expect continued reliance on the humble POTS modem for pointto-point data communications when we are beyond the reach of a LAN. □

Lee Goldberg's e-mail address is: leeg@class.org

HOW VALUABLE?	CIRCLE
HIGHLY	540
MODERATELY	541
SLIGHTLY	542



When it comes to solid state relays, we've got the whole megilla!

Not only do our relays have the whole functional megilla, but they eliminate system's headaches. Our relays switch, isolate and control your critical circuit functions. We provide short circuit, overload and thermal protection. Add indication of on-off, switch, trip and flow status and you have the whole megilla.

Teledyne serves up DC, Bi-Directional and AC SSRs. These state-of-the-art relays are optimized to reduce on resistance and power dissipation. They run the gamut from Low Level to 40 amps current switching capability. Teledyne SSRs are ideal for ATE, Industrial and Process Control, Medical and Aerospace applications. Our AC commercial relays are capable of handling 400Hz and our products are available from 6-pin Mini-DIPs to industry standard Hockey Pucks.

Today, Teledyne Relay's leadership position is recognized worldwide, thanks to innovations such as our product assurance program. It includes ISO-9001 and ISO-9002, Statistical Process Control and employee empowerment through our Total Quality Management System. Just as important, we're there when you need us. We have worldwide manufacturing facilities located in California, Mexico, Scotland and India, insuring production costs that precisely reflect customers' requirements.

So if you want your SSRs with everything on them, call (800) 594-0855. Nobody else has a menu...at least for relays...that gives you the whole megilla!

TELEDYNE RELAYS 12525 DAPHNE AVENUE HAWTHORNE, CALIFORNIA 90250-3384 TEL: (213) 777-0077 • FAX: (213) 779-9161 http://www.teledynerelays.com



Enhanced VHDL Synthesis for \$99

It's surprising, but true. For only \$99, Cypress's new Warp2™ Release 4.0 offers better behavioral synthesis than tools costing more than \$20,000! New UltraGen™ technology uses module generation to provide the best VHDL synthesis for FPGAs and CPLDs, as well as providing area and speed optimization for precise synthesis control.

Everything You Need for Real VHDL Designs

Warp2 is a complete development system for all high-performance Cypress PLDs, CPLDs, and FPGAs.

The *Warp2* kit includes:

- IEEE standard behavioral VHDL synthesis
- Automatic fitting and place-and-route
- VHDL & Verilog timing simulation output
- NOVA functional waveform simulator
- "VHDL for Programmable Logic" book

Order the New \$99 Warp2 Kit Now! Platform:

- PC (Windows 3.1, Win'95, NT)
- UWorkstation (HP-UX, SunOS, Sun Solaris)

Please bill my:

VISA



Name
Title
Company
Address
City State Zip
Phone
FAX
E-Mail
Credit Card #
Exp. Date
(Sales tax will be added as appropriate. \$10 shipping & handling in the U.S., \$15 in Canada)
FAX to: 1-408-943-6848

or call: (800) WARP-VHDL, Kit #U021



The subscription of the su		Company of Company of Colors		NIG
Contraction of the local division of the loc	the second s	Carlotteren and and and and	Barris and B	HI-S AL
ALC: CONTRACTOR OF THE OWNER OF T			The Statement	
			and the second second	
		-	the new of form other, would change with	
			The Street	
	-		- 104 s	
		Contraction of the local division of the loc	The Party of Lot	
	1			
	P			EEL EEL
and the second se	and the second division of the second divisio		a started	
	No. of Concession, Name		(Married)	Ha Elina with
	Contraction of the local division of the loc	Contraction of the local division of the loc	Burglanding & Lincols Burgland	And a strength of the
		and the second second		
		And in case of the local division of the loc		

\$20,000 VHDL SYNTHESIS FOR \$99[™]

Warp2 Release 4.0 Supports:

Warp2 RELEASE 4.0

pASIC380" FPGAs	7C381/2 (1000 gates) 7C383/4 (2000 gates) 7C385/6 (4000 gates)
FLASH370i [™] CPLDs	7C387/8 (8000 gates) 7C371i (32 macrocells) 7C372i (64 macrocells)
	7C373i (64 macrocells) 7C374i (128 macrocells) 7C375i (128 macrocells)
MAX340" CPLDs	7C344 (32 macrocells) 7C343 (64 macrocells) 7C342 (128 macrocells) 7C346 (128 macrocells) 7C341 (192 macrocells)
Simple PLDs	PALCE16V8 PALCE20V8 PALCE22V10

FLASH370r, MAX340, pASK3300, UltraGen, and Warp2 are trademarks of Cypress Semiconductor. All others are trademarks of their respective manufacturers.

Order Warp2 today and receive a free copy of "VHDL for Programmable Logic," a comprehensive college textbook written by Cypress and published by Addison-Wesley.



PEASE PORRIDGE

What's All This **COMMON-CENTROID STUFF, ANYHOW?**

nce upon a time, we designers of op amps used to locate as many of the critical transistors as we could along the axis of symmetry. We put the input transistors right along the Center Line (CL) of the chip, or on a pc board along the CL of the board. We tried to put the output transistors on the CL, too, down at the far end of the layout. We realized that any heating from the output stage could cause significant, serious input errors. For my discrete layouts, I designed "ISIS Clips" and "Omega Clips" to keep the input transistors at the same temperature (Fig. 1).



BOB PEASE OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL OR CORP., SANTA CLARA, CALIF.

Egyptian Goddess, was George Philbrick's inspiration. The K7-A6R array of op amps was called the "ISIS" computer. The symbol S with an I

ISIS, the old

across it was a neat symbol for ISIS. Look at it again, and it's the PHI that's symbol for the PHIlbrick. And if vou are a fan of Positive Feedback. SEMICONDUCT- George Philbrick used to say that ISIS was her own mother. So I designed some little

clips made of soft aluminum, with green paint for insulation all over them, in the shape of S-an ISIS clip. This clip has rotational symmetry.

Conversely, an "Omega Clip" has mirror symmetry, like the Greek letter ω . We made these of the same soft 010/145 SALION 2904 AN "ISIS CLIP" (\$) AND AN "OMEGA CLIP" (W) HOLDING MATCHED PAIRS AT EQUAL TE MPE RATURES Figure 1

aluminum, and the same green paint.

along, there were some influences to

"keep it simple, stupid." I designed a

T52AH-also labelled as Amelco's

809BE—with just 10 transistors,

which worked pretty well. But op

amps with 20 or 30 transistors soon

had just as good a yield. And they

offered more features. So, we kept

learning how to add more transistors

came along, we designers were re-

ally puzzled. Why would anybody

use FOUR input transistors? What

the heck was George Erdi smoking?

If you set up a diff amp with two

transistors in parallel at the plus in-

put and two transistors paralleled

on the minus input, why would that

give an advantage? But the specs

showed real superiority-low offset

voltages, good bias currents, and

low offset current. Hey, this was

about 1971. Not many engineers were climbing inside their suppliers'

ICs and studying the layouts. If you

But when the Fairchild µA714

for better performance.

When monolithic op amps came

Walter Kern made them up.

with a lousy layout. I know.

The basic feature of the µA714 was the common-centroid layout of the input transistor "pair" (Fig. 2). If you took those four input transistors and laid them out in an X pattern, it would be denoted by:

AB BA

Connecting them properly in paral-

lel, you can get the linear gradients of Vos to cancel. And the gradients in beta to cancel. Gradients caused by heating from the output stage-and even from other asymmetrical sources of heat-tend to cancel. Any linear gradients caused by imperfect die attach tend to cancel. (Nonlinear gradients do NOT get cancelled,

of course, but these are usually small.) And these cancellations all happen thanks to a common-centroid layout, which is just another way to say that the "Center of Gravity" (CG) of one input "transistor" is at the same place as the CG of the other transistor. (I bet you can figure out that any geometry that is connected to metal labelled "B1" is a base - if something is connected to "C2," that must be a collector....)

There are many kinds of commoncentroid layout, in addition to cross-coupling. You could lay out a "pair" of npns as ABBA. The "B" transistors in the middle not only reject gradients, but they can have smaller output capacitance, since they only need one tub. And in some cases, this long, skinny circuit (Fig. 3) may fit in your layout better than:

AB BA

In this example, the transistors are still connected as an ordinary differential pair. But if you connect the transistors to act as a current reflector by shorting C1, B1, and B2 together, and merging that metal, the interconnec-

didn't, though, you could be stuck ELECTRONIC DESIGN/OCTOBER 1, 1996

PEASE PORRIDGE

tions become very simple.

Recently, I saw a technical article by some engineers¹, claiming that they had a computer program that automatically provided good interdigitated and crosscoupled common-centroid layouts. "ALAS!" was what they called the program. I looked at their results. All I could say was, "Alas!!" The authors appeared to think that a layout of ABAB or AABBAABB or ABABABAB or even:

ABAB BABA ABAB

makes a "common centroid." When I apprised them of their error, they tried to argue that the magazine's computers had misrepresented their results. Uhuh. They did not understand that *their* computers were clueless. Not only was



TYPICAL METAL INTERCONNECTIONS FOR A PROPERLY CROSS-COUPLED NPN "PAIR".... (WITH SOME DUMMY METAL) Figure2

it a bad program that generated poor layouts, but they did not even recognize that it was a bad lavout. And, heck, you don't need a fancy computer to set up pairs or groups of transistors with common centroids. I do it all the time with groups of resistors, using just pencil and paper-and lots of symmetry.

The Editor at the Journal of Solid State Circuits was a good sport, and gave me space for my criticism of that paper²,

d a PAIR', WITH SOME DUMMY METAL, AND a LOW COUT ON COLLECTOR #C2 Figure 3 2

GROUND OR -VS OR

and the authors' efforts to rebut my criticism³.

B1

B2

Often, there are significant matching errors when using transistors, or resistors, or capacitors, if common-centroid layout isn't used. There are always more-or-less linear gradients across a die. Bipolar transistors have gradients of V_{be} and beta. If there's any temperature gradient caused by output device dissipation, that's going to hurt the V_{be} matching by 2 mV/°C, if the input transistors aren't at identical temperatures. MOSFETs are afflicted by gradients in etching, in V_t , and in oxide thickness. Adjacent resistors can have poor matching due to gradients in etching and in sheet rho. If you want your capacitor sets to match well, you must beware of gradients in etching and oxide thickness. Die stresses cause shifts that relate to linear gradients. Proper understanding of cross-coupling or other forms of "common-centroid" layout can be very valuable to help reject linear gradients across your die. An improper understanding of "commoncentroid" layout can be amusing—or pathetic. If you insist on cross-coupling components that are *not* critical, you can waste lots of die space.

CI

CARRENT SOURCE

TYPICAL METAL INTERCONNECT

FOR A GOOD COMMON-CENTROID NPN

C2

Back in 1972, on Jim Pastoriza's AD550 Quad Current Switch, I observed some of the limitations of laying out a DAC's transistors all in a linear row. When some bits were switched ON or OFF, there were significant thermal tails. Linear mismatches also occurred, due to linear gradients in V_{be} and beta.

I made my own layout for a monolithic Quad Current switch, with good common-centroid layout. It had 8, 4, 2, and 1 emitters—and 2 emitters for the reference. What was the Patent number? 3,995,304? You can tell that it's an old number—the patent has expired already. The emitters were laid out with the Most Significant Bit (MSB) emitters being A, the LSB as D, and the reference as R:

AAAA BBCR D RCBB AAAA

I was able to convince myself that the V_{be} matching of this kind of layout was adequate for at least an 8-bit DAC—without any emitter resistors. It may be as good as 10 bits, if I did some trimming. And much better, if emitter resistors

Think Analog Arrays save time & money



COMPARE & SAVE

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

*Design completion to silicon

Rapid Analog Design-to-Silicon Gets Your System to Production Faster

Orbit's analog and mixed-signal CMOS arrays speed the development of your end product. We offer over 25 array sizes which contain 50 to 5,000 gates, 5 to 50 Op Amps, plus many other analog components and operation down to 1 volt. We also provide discrete KIT parts for breadboarding. Our arrays allow faster layout, shorter fab cycle times and reduced non-recurring engineering (NRE) costs compared to a full custom. Working jointly with our experienced analog design engineers, you can achieve design-to-silicon in as little as six weeks. And if any iteration is required, Orbit can provide turnaround in just two weeks. For high volumes, further cost reduction can be achieved by converting the array into a low NRE (\$35K-\$50K) Orbit full custom mask set.



FREE DESIGN GUIDE 800-331-4617 800-647-0222 CA http://www.orbitsemi.com



Orbit Semiconductor, Inc. 169 Java Dr. Sunnyvale, CA 94089; 408 744-1800, fax 408 747-1263

READER SERVICE 144



tors were used. Heck, the first DAC I ever built was 15 bits *plus sign*.

If you use resistors, you should be aware that resistors made in a batch process tend to have linear gradients. So if you have four resistors in a row, and you want a good ratio, such as 1:1 (or 4:1), choose the two resistors in the MIDDLE. Put them in series, and take the resistors on the ends, and put them in series (or in parallel) and the ratio will tend to be more accurate. The tempco will be, too. This tends to hold true for thick-film, thin-film, or monolithic resistors. If you have eight resistors, the matching can get even better (Fig. 4). Back in '86, Dennis Monticelli asked me which layout I would recommend for the input of his LMC660 op amp:

ABAB		ABBA
BABA	vs.	BAAB
ABAB		BAAB
BABA		ABBA

Where's the advantage?



offset of this op amp set new standards for accuracy of MOSFET inputs. Never a dull moment!!!!

All for now. / Comments invited!

State Circuits, Sept. 1996, p. ??. Note: I say "??" because we don't yet know what pages those letters will be on. /rap



Excess inventory today....student opportunity tomorrow

ATS-1 Audio Test System





AMPLITUDE **ATS-1**, The Audio Testing Solution.

Need a high speed IFEE-188 tester or powerful, flexible front panel instrument? The ATS-1 Audio Test System from Audio Precision is the solution.

- Measures amplitude, signal-to-noise, distortion, SINAD, IMD*, frequency, wow & flutter, input impedance, plus AC mains check AUDIO
- True 2 channel (stereo) modes measure 2 channel level, phase, real-time amplitude ratio, real time crosstalk
- GPIB and front panel operation, including National Instruments LabWindows[®] and LabView[®] drivers
- GPIB command set includes both IEEE 488.2 and HP 8903B emulation mode

Br 7ERO

- Internal Sweeps, Graphs and Printouts, including single and dual channel graphs and tables with a broad choice of units: V, dBV, dBu, dBm, Watts, dBr, % and dB
- ATS-1 Bright front panel display is easy to read; shows three simultaneous instrument readings, sweep graphs or bargraphs
- Package optimized for **rackmount** or bench use, with front or rear modular connectors, monitor speaker

Audio Precision is the world's largest company dedicated solely to manufacturing and supplying audio frequency testing solutions, with a worldwide installed base of thousands of units. Our international force of Audio Precision representatives will be pleased to provide further information and an onsite demonstration. "Options include IMD, rack mount kit., special filters.

precision

P.O. Box 2209 Beaverton, OR 97075-3070 (503) 627-0832, 1-800-231-7350 FAX: (503) 641-8906

READER SERVICE 124



DISTRIBUTORS: Australia: IRT Electronics Pty. Ltd., Tel: 2 439 3744 Austra: ELSINCO GmbH, Tel: (1) 815 04 00 Beigh 5-9221 Bulgaria: ELSINCO, h.e. Streibisha, Tel: (2) 566 31 Canada: GERRAUDIO Distribution. Tel: (416) 596-2779 China Tel: (41) 524 522 Czech Republic: ELSINCO Praha spol. s r.o., Tel: (2) 49 66 89 Dermark: npn Elektronik aps, Te 1 45 83 64 Garmany: RTW GmbH, Tel: 221 70913-0 Greece: KEM Electronics Ltd., Tel: 01-647851345 Hungary: 1 45 83 64 53-73478 Maintysia: Tel: 3-6478770 Italy: Link Engineering St.n. Bhd., Tel: 3 734 1017 Netherlands: Heynen rate: Dan-Elfecthonologies, Ltd., Tel: 3-6478770 Italy: Link Engineering St.n. Bhd., Tel: 3 734 1017 Netherlands: Heynen rwsy: Lydconsult, Tel: (47) 66-888333 Poland: ELSINCO Polska sp. z.o., Tel: (2) 49 69 79 Portugal: Acutron Electron Sitovakia: ELSINCO Braitsiava spol. z.c., Tel: (7) 7.7. 55 South, Trica, Ord Medica, Braccast, Tel: 11 477-1415 31 80 36 20 Switzerland: Dr. W.A. Gurther AG, Te 11 477-1215 S

LabVIEW[®] 4.0



Designed for Test

Introducing LabVIEW 4.0 – the industry's most innovative, powerful instrumentation software. It's easy to use, yet versatile enough to solve your most demanding test applications.

Designed for Complete Test Management

LabVIEW 4.0 integrates a complete graphical test development environment, a test executive, and analysis capabilities into a single package – giving you all the tools you need for rapid test development. To meet your diverse requirements, LabVIEW is available on Windows NT, Windows 95, Windows 3.1, HP-UX, Sun Solaris, and Macintosh.

Designed for Productivity

Now, with LabVIEW 4.0, you can be more productive than ever before. New time-saving editing and debugging tools streamline large test system development.

Plus, the 32-bit graphical compiler and test optimization tools empower your organization to build higher quality products.



libraries into LabVIEW.

It's Designed for You!

Call **(800) 433-3488** today for a **FREE** LabVIEW demonstration package.

Designed for Industry-Standard Connectivity

of I/O devices, from plug-in data acquisition boards to

Using LabVIEW 4.0, you can communicate with hundreds

serial, GPIB, and VXI instruments. You can rapidly develop distributed test systems throughout your organization using

built-in OLE automation, DDE, TCP/IP, and SQL database

application, you can seamlessly integrate existing C-based

To discover why LabVIEW is the leading instrumentation

software package, give us a call. You'll discover that LabVIEW 4.0 is not just designed for test -

calls. To leverage existing work and create a unified test



Corporate Headquarters • 6504 Bridge Point Parkway • Austin, TX 78730-5039 USA Tel: (512) 794-0100 • Fax: (512) 794-8411 • E-mail: info@natinst.com • WWW: http://www.natinst.com

Branch Offices: Australia 03 9 879 9422 • Austria 0662 45 79 90 0 • Belgium 02 757 00 20 • Canada 519 622 9310 • Denmark 45 76 26 00 Finland 90 527 2321 • France 1 48 14 24 24 • Germany 089 741 31 30 • Hong Kong 2645 3186 • Italy 02 413091 • Japan 03 5472 2970 Korea 02 596 7456 • Mexico 95 800 010 0793 • Netherlands 0348 433466 • Norway 32 84 84 00 • Singapore 2265886 • Spain 91 640 0085 Sweden 08 730 49 70 • Switzerland 056 200 51 51 • Taiwan 02 377 1200 • U.K. 01635 523545

© Copyright 1996 National Instruments Corporation. All rights reserved. Product and company names listed are trademarks or trade names of their respective companies. *1995 PC-Based Test Market Insight Study – Test & Measurement World, September 1995

See us at Wescon, booth 3393

READER SERVICE 136

IDEAS FOR DESIGN



Two Wires Carry Power And Data

BOB HANRAHAN, National Semiconductor Corp., 50 Tice Blvd., Woodcliff Lake, NJ 07675; tel. (201) 782-9002; fax (201) 476-9200.

t times designers are faced with a limited amount of wire and/or a limited cost to communicate with a remote device such as a sensor. Many devices, such as the LM2893 and other carrier-based technologies, exist that allow communication over an ac or dc power line employing an AM or FM modulation scheme. However, they tend to be costly.

The design presented here is a simple, low-cost method for sending data across the same wire as is being used to supply power. The scheme is based on modulating current from a remote device back to a host. A later example shows how the host also can modulate voltage to the slave. The host decodes the data by sensing current changes to the slave and recovering the data with an analog comparator. The scheme will cause a small drop in the supply voltage to the remote device that is insignificant in most applications.

The remote microcontroller sends data by sinking current through an output port and series resistor to ground. The resistor value is chosen by calculating the maximum current required by the remote circuit and choosing a resistor that will increase the current required by an amount that can be easily measured with the shunt circuit shown (*Fig. 1*). Designers must ensure that normal operation of the slave doesn't cause current excursions that get interpreted as data, otherwise they must filter these conditions (explained later). In some cases, hysteresis may be necessary and can be added with a bit of positive feedback.

The recovery circuit in Figure 1 utilizes a single comparator that senses the amount of current passing through the shunt resistor. If a UART is being used, such as provided in the COP984 8-bit microcontroller, the comparator is configured to provide a logic low when a data bit is on (mark). The comparator is biased with the divider R2/R3 so that the data output from the comparator is stable logic high during normal no-data-flow operation. When a start bit is sent from the remote, the increase in current is sensed by the host and the comparator drives a logic low into the host UART or other recovery device. When the output data is off, the output from the remote device is off and thus not sinking current.

The Figure 1 circuit employs a National Semiconductor LMC7211 comparator. The part was chosen because, unlike traditional comparators, the



device back to a host. Here, a single comparator senses the amount of current passing through the shunt resistor.

common-mode input range extends to the positive rail. This is required when sensing a voltage with a potential at or near the positive rail. Other reasons for selecting this part include its low operating voltage (down to 2.7 V), its push-pull output (saves a pullup), and an extremely small SOT23-5 package.

This implementation has been optimized for a total slave current load of 9 mA. The comparator reference voltage is set a 4.84 V with R2 and R3. With Vin set at 5.0 V, the drop across the shunt R1 will result in the voltage at the noninverting input being either 4.87 V when the signal from the microcontroller is off (high) or 4.77 V when the signal is on.

Many microcontrollers, such as the NSC COP8 shown, will operate properly with voltages as low as 2.5 V. In this example, the slave voltage will stay within 5% of the 5-V V_{CC} if the slave doesn't generate significant load change. Designers must consider the minimum and maximum slave current when choosing the bias resistor values, as well as the current variation generated by the internal operation of the microcontroller.

With this circuit, the slave current can vary between 6 mA and 10 mA without significantly affecting operation. Larger variations may require a larger shunt R1 (and thus a larger VCC drop), and an appropriate change in reference resistor R2. Fast transient current changes also may be filtered by adding hysteresis with a positive feedback resistor ($R_h \ge$ 47k), and/or by adding a filter capacitor (C1) from the noninverting input to ground (0.1 μ F). Slave V_{CC} decoupling capacitors must be carefully selected to ensure that the total capacitance doesn't distort the relatively slow current modulation. A value of $1 \ \mu F$ will limit the data frequency to about 10 kbits/s.

In some applications, slave circuits may not tolerate the V_{CC} noise generated by the modulator. This may be seen in situations where a large variation occurs at the slave and an analog

IDEAS FOR DESIGN



2. A SIMPLE VOLTAGE DIVIDER (R1/R4) modulates the voltage from the host to the slave. The slave circuit compares the voltage being provided to the voltage stored in C2.

block is being employed. In these situations, either a voltage reference (such as an LM4040/4041) if the current required is limited, or an LP2951 low-dropout regulator can be used if the current requirement is up to 100 mA (LP2952 or LP2960 for current up to 0.5 A). This regulator circuit is able to generate a stable voltage a few hundred millivolts below the lowest slave voltage, or set at a standard fixed voltage of 3.0, 3.3, 4.1 V, etc. Both the LMC7211 and LMC6772 feature delay times that enable them to be used for frequencies up to about 128 kbits/s, depending the value of the capacitor required at the slave. For higher-frequency applications, a faster device can be used. In addition, the Figure 1 circuit may be used when operating with a 3-V power source.

A bidirectional circuit also can be implemented by modulating the voltage from the host to the slave and modulating current from the slave back to the host. This design may require a greater variation in voltage to the slave to ensure adequate margins. The recovery circuit for the slave can employ the same single comparator. In this case, however, the comparator is looking at the absolute voltage change from the host.

In another configuration, a simple voltage divider (R1/R4) can modulate the voltage from the host to the slave (Fig. 2). The slave circuit simply compares the voltage being provided to the voltage stored in C2. The C2/R8/R9 time constant is set much longer than 8 bit times so that the reference level will be stable for this worst-case situation. When the host sends a bit, R4 will pull the slave voltage down and the slave comparator will pass a logic low back to its UART or other receiving device. The host will see its own transmitted data looped back into its recovery circuit. This is typically ignored or can be used for error checking (compare transmitted to received data).

The circuits shown are meant to be foundations for a circuit that will work in a particular system. They may not be optimum for a particular design, but by utilizing the concepts and variations described, designers may implement this extremely small and low-cost communications scheme with great results. \Box

521



RAE PERALA, Luukintie 28, FIN-02940 ESPOO, Helsinki, Finland; tel. 358-9-8552741.

he design idea presented here concerns an active power resistor. It can be used as a load resistor when probing or servicing power supplies. The circuit can work in three different modes. It can act as a constant-resistor (mode CR), or as a constant-current (CC) drain, which sinks a constant current from a supply of any positive voltage. Finally, it can be in constant voltage mode (CV), in which the circuit loads the voltage across supply terminals to a constant value adjusted by the user.

The power MOSFET transistor Q1 works as a resistive component (Fig.

1). The transistor gate is controlled by an op amp (U1B). The feedback voltage, which can be selected by switch SW2, is connected to the amplifier's inverting input. In CC and CR modes, the feedback voltage is the voltage between the source resistor R1 terminals, which is proportional to the transistor current. In CV mode, the feedback voltage is proportional to the amplifier supply voltage VB through a voltage-divider circuit (R4-R5).

The amplifier noninverting input is controlled by a control voltage. The control voltage input can be selected by switch SW1. In CR and CV modes, that input is the resistor input voltage (V_{in}) , and in CC mode, it's the amplifier supply voltage (V_B) . The control voltage is set in voltage divider R2-R3 to a proper value to control the amplifier.

The other op amp (U1A) protects the MOSFET transistor. It's controlled by a resistor bridge circuit consisting of three resistors (R7 through R9) and an NTC resistor. The NTC is in contact with the transistor cooling element. With moderate element temperatures, the output voltage of U1A is high, thus having no effect on the transistor gate because of the reverse-biased diode D1. If the element

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History

RFTRANSFORMERS Over 80 off-the-shelf models... 3KHz-2000MHz from \$195 UNRAL 15642

Having difficulty locating RF or pulse transformers with low droop, fast risetime or a particular impedance ratio over a specified frequency range?....Mini-Circuits offers a solution.

Choose impedance ratios from 1:1 to 36:1, in connector, TO-, flatpack, surface-mount, or pin versions (plastic or metal case built to meet MIL-T-21038 and MIL-T-55631 requirements*). Coaxial connector models are offered with 50 and 75 ohm impedance; BNC standard, other types on request.

T. TH. 1 Ultra-wideband response achieves low droop and fast risetime for pulse applications. Ratings up to 1000M ohms insulation resistance and up to 1000V dielectric voltage. For wide dynamic range applications involving up to 100mA primary current, use the T-H series. Fully detailed data appear in our 740-pg RF/IF Designer's Handbook.

Need units in a hurry?...all models are covered by our exclusive one-week shipment guarantee. Only from Mini-Circuits. *units are not QPL listed.



US 132 INTL 133 CIRCLE READER SERVICE CARD

bent lead vers

style KK81

P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661 INTERNET http://www.minicircuits.com For detailed specs on all Mini-Circuits products refer to • 740- pg. HANDBOOK • INTERNET • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.

version style)

Circle No. 181 - For International

F71 REV F

IDEAS FOR DESIGN

Simple Wideband Noise Generator

WALT JUNG, Analog Devices Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; tel. (617) 329-4700; fax (617) 326-8703.

hile most electronic designs seek noise minimization, there are occasions where a known quantity or quality of spectrally flat (white) noise is desirable. One such example is a dither source for enhanced dynamic resolution analog-todigital conversion. For such applications, it's useful to able to predict the output of a noise generator. It turns out that a carefully chosen decompensated op amp set up to amplify its own input noise becomes quite handy as a wideband noise generator.

This technique simply employs op amp U1 (see the figure) as a fixed gain stage amplifying its input noise by the factor G, which is:

G = 1 + R1/R2

By purposely selecting R2 and R3 values less than 10 Ω , their Johnson noise contribution is forced less than the voltage noise of the amplifier. Similarly, the amplifier's current noise components in R2-R3, when converted to voltage noise, also are negligible. In this manner, the dominant noise of the circuit is reduced to

U1's input voltage noise.

Choosing a bipolar input voltagefeedback amplifier for U1, which uses a single effective gain stage, results in a flat, frequency-independent noise response (i.e., a white-noise characteristic). In contrast, multistage polezero-compensated amplifiers can have peaks in the output noise response, due to frequency-compensation effects. In selecting a part for U1, look for a noise characterization plot that shows flat input-referred voltage noise over several decades. The AD829 device shown features flat voltage noise from below 100 Hz to more than 10 MHz. Within the circuit, the upper limit of useful bandwidth will be gain/compensation-dependent, which is under user control as described below.

To scale to a given level of V_{noise} across R_L, select a gain that produces a noise density at V_{out} that's 2G times the typical U1 noise of 1.7 nV/ $\sqrt{\text{Hz}}$. This produces a V_{out} of twice V_{noise} For example, for a V_{noise} of 50 nV/ $\sqrt{\text{Hz}}$, make:

$$R1/R2 = (2 \times V_{noise}/1.7) - 1$$

where V_{noise} is in nV/\sqrt{Hz} , and the



THIS RELATIVELY SIMPLE op-amp noise generator amplifies the input voltage noise of a wideband, decompensated op amp. By selecting a device with a single gain stage, the output noise will be spectrally flat up to the closed-loop bandwidth. 1.7 represents the U1 voltage noise (nV/ \sqrt{Hz}). With a fixed R2 value of 10 Ω , the required R1 is computed as:

$$R1 = 10 \times ((2 \times V_{noise}/1.7) - 1)$$

This computes to 576 Ω (nearest standard value) for a wideband 50 $nV/\sqrt{Hz}~V_{noise}$

The output is coupled through a blocking capacitor (C3), which removes any amplified dc offset at Vout. The value should be large enough to pass the lowest noise frequencies of interest. As shown, the response of this network is -3 dB at about 100 Hz, but C3 can be changed for other low-frequency limits. Source termination resistance R4 allows standard 75- Ω cables to driven, providing distribution to a remote 75- Ω load (RL). Alternately, an audio range noise source of 1000 nV/\sqrt{Hz} V_{noise} with several hundred kilohertz of bandwidth is achieved with $R1 = 11.8 \text{ k}\Omega$, and $C3 = 100 \mu F$.

The general utility of the technique is enhanced by using a decompensated (or externally compensated) op amp to take advantage of the maximum bandwidth. For U1, bandwidth is maximum with minimal pin 5 capacitance (i.e., no pc-board pin 5 pad, or cutoff). Conversely, C4 can be used to reduce bandwidth if desired. With minimum pin 5 capacitance, the gain bandwidth of U1 can be about 500 MHz. The stage effective -3-dB bandwidth will vary in inverse proportion to stage gain G. For example, a bandwidth of about 5 MHz can be expected in the circuit as shown. Some variation of noise can be expected from IC sample-sample. Therefore, the optional R1 trim method can be used to set a desired output.

Bipolar input amplifiers such as U1 typically employ PTAT biasing for the input stage tail current. Because their equivalent input noise varies as the square root of this tail current, this makes noise vary somewhat with temperature. The net effect will cause noise to change less than 1 dB for a 50° C temperature change. \Box

LOWEST POWER MULTI-CHANNEL 8-BIT ADCs HAVE 1µA SHUTDOWN

Single +3V or +5V Supply—Ideal for Portable Applications





The MAX114/MAX118 are 8-bit, 4-channel (MAX114) and 8-channel (MAX118) ADCs designed for a wide range of data-acquisition/data-processing applications. They feature fully tested DC and dynamic specifications and a TUE of ±1LSB (max). These devices operate from +5V and sample at up to 1.2Msps. At the maximum sampling rate, the MAX114/MAX118 dissipate only 40mW. At slower sampling rates, the 1µA shutdown mode cuts supply current even more. The MAX113/MAX117 are intended for +3V low-power applications. They sample at up to 400ksps and dissipate 7.5mW.



LOW-POWER 8-BIT PARALLEL-OUTPUT ADCs

PART	NO. OF CHANNELS	SUPPLY VOLTAGE	MAX. SAMPLING RATE (sps)	PACKAGE	
MAX117	8	3	465k	28 DIP/SSOP	8
MAX118	8	5	1.2M	28 DIP/SSOP	
MAX113	4	3	465k	24 DIP/SSOP	NEW!
MAX114	4	5	1.2M	24 DIP/SSOP	NEW!
MAX152		3	465k	20 DIP/SSOP	
MAX153		5	1.2M	20 DIP/SSOP	5



FREE A/D Converter Design Guide—Sent Within 24 Hours! Includes: Data Sheets and Cards for Free Samples

To receive your design guide, simply circle the reader response number, or contact your local distributor.





Maxim Integrated Products (Taiwan) 886-2-558-6801, FAX 886-2-555-6348

China: P & S. (Wuhan) (86) 27 7885651, FAX (86) 27 7802985, (Be jing) (86) 1 2536518, (Shanghai) (36) 21 63732879, (Shenzhen) (86) 755 3223285, (Chengdu) (86) 28 5211423; India: Sritech Information Technology Pvt Ltd., (Bangalore) 30-640661,640386, FAX 80-6633508; Hong Kong: Maxim Integrated Products, Inc; 852-2376-3000, FAX 852-2376-3001; Korea: Maxim Integrated Products (Korea) 82-2-508-1171; Taiwan: Max m Integrated Products (Taiwan) 886-2-558-6801, FAX 886-2-558-6801, FAX 886-2-558-6801, FAX 886-2-558-6801, FAX 886-2-558-6801, FAX 886-2-558-6801, FAX 888-2-556-6348, Solomon Technology Corp., (02) 788-8939, FAX (02) 788-8039; Singapore: Maxim Singapore: (Singapore) 65 841-7117, FAX 65-841-7227, Electronic Resources Pte. Ltd., (5-2980888, FAX 65-2981111; Malaysia: Electronic Resources SciD, BHD, (Kuala Lumpur) 7038448, FAX 7038526, (Penang) 8828872; Thailand: Electronic Resources, Pte. Ltd., (Bangkok) 5384600, FAX 5387118; Japan: Maxim Japan Co., Ltd., (03) 3232-614*, FAX (03) 3232-6149; Internix, (03) 3369-1105, FAX (03) 3363-8486; Easton (03) 3279-1920, FAX (03) 3279-1935, Sil Walker (03) 3341-3651, FAX (03) 3341-3974; Microtek (03) 5300-5535, FAX (03) 5300-5515; Australia: Veltex Pty. Ltd., (Victoria) (03) 9574 9300, FAX (03) 9574 9300, FAX (03) 9574 9773.

MAXIM is a registered trademark of Maxim Integrated Products. @ 1996 Maxim Integrated Products.

Circle No. 178 For U.S. Response Circle No. 179 - For International

STEPPED ON,

TWISTED, RUN OVER,

PULLED, TORQUED, SLICED

AND STERILIZED. JUST ANOTHER

DAY IN SURGERY.

The high performance interconnect systems that deliver power, light, and signal to hand-held and portable surgical devices must meet precise electronic requirements. And tolerate the abusive environment of the operating theater. Precision Interconnect cable assemblies perform day after day, each one engineered, manufactured, and tested to meet your electrical and mechanical needs. Because only the strong survive.



PRECISION INTERCONNECT an AMP company

Precision Interconnect, 16640 S.W. 72nd Avenue, Portland, OR 97224 (503) 620-9400 Fax (503) 620-7131. Sales offices in U.S., Europe and Japan.



Improving Relay-Based Control **Systems** The installation of relays can have a significant impact on the performance of industrial control systems.

JOE PICKELL

Phoenix Contact, P.O. Box 4100, Harrisburg, PA 17111; (717) 944-1300.

ectromechanical relays are frequently installed in indus-Itrial control systems, and for good reasons. They can provide 1. Most relay packa higher current-switching capacity than is available with today's terminations for the controller I/O cards. They also can provide isolation between field devices and controllers, as signers to route coil well as an interface between 120or 230-V ac field devices and the high-density, 24-V-dc I/O cards coil and contact conprevalent in modern controllers.

Unfortunately, the use of exist-"industry-standard" ing relay packages may be limiting the effectiveness of your control-system designs. Many octal-socket and ice-cube relay packages, which have become the product of choice over the last 30 years, have serious deficiencies. These styles of relay packages can have adverse effects on control-system reliability, system installation and start-up time, system downtime, and the efficient use of panel space. Fortunately, several manufacturers are now offering relay packages which improve the situation.

One common problem stems from most relay packages physically intermixing the wiring terminations for the coil and contacts on one side of the relay base. This forces designers to route coil and contact wiring in the same wireway (Fig. 1). In the case of an output relay, the contact wiring is typically used to carry higher currents and voltages than coil wiring. For example, a coil may be rated for 30

ages physically intermix the wiring coil and contacts on one side of the relay base. This forces deand contact wiring in the same wireway. In addition, nections are not clearly marked.

mA at 24 V dc while contacts are carrying 10 A at 120 V ac. This intermixing of connections for coil and contact on one side of the relay base counteracts system designers' efforts to maintain separation of potentials throughout an installation. With the coil and contact wiring in such close proximity, it's possible for the coil wiring to have sufficient voltages induced upon it to prevent the relay from dropping out even though the controller is telling it to turn off.

We can calculate that as much as 2.4 V would be coupled into the coil circuit of a relay using:

 $\mathbf{V}_{1} = \frac{(\mathbf{d}) \times (2\pi \mathbf{f}) \times (\mathbf{L})}{(\mathbf{L})} \times (\mathbf{I})$ where V₁ = induced voltage, $d = 1.25 \times 10^{-6}$. f = frequency on primary conductor = 60 Hz, L = length of parallel conductors = 1 meter, C = current on primary conductor = 10 A, and r = distance between conductors = 2 mm Thus $V_{t} = \frac{(1.25 \times 10^{-6}) \times (2\pi 60) \times (1) \times (10)}{(100)}$ (2×10^{-3})

This voltage level may seem



RELAY PACKAGES



insignificant, but it isn't. Most relays require at least 80% of their rated voltage to be present to energize the coil and activate the contacts, but they require much less energy to remain in the energized state. For example, a relay with a 24-V dc coil may require only 30% of its rated voltage to keep the relay energized. Thus, for a 24-V dc relay, 3.6 V is enough to keep its coil energized. In this example we have thus far only considered the effects of inductive coupling from one set of contacts to one coil. When multiple relays are used in a control cabinet, the inductive effect could potentially be multiplied by the number of relays in the cabinet. Given this scenario, it's easy to understand how the 3.6-V threshold can be exceeded. This is also a difficult problem to troubleshoot because it can be somewhat intermittent depending on the activity of multiple relays and loads in a system.

Fortunately, several manufacturers offer relays which physically separate the coil and contact connections, enabling wiring of various potentials to be kept far enough apart so that this induced noise is not a problem (*Fig. 2*). Doing so eliminates

One additional benefit of this separation of coil and contact connections is that wiring is much more organized. Therefore, the total control-cabinet assembly time, system start-up time, and system troubleshooting time can be reduced.

There are two other characteristics of a control-system layout that can cause problems with relays remaining in the energized (or pulled-in) state when they should be in the de-energized (or dropped-out) state. One is very similar to the example discussed earlier. If power and control-signal wiring are run in close proximity to one another anywhere in an installation, voltages can be induced on the control wiring which exceed the rated dropout voltage of the relays. Attention should be paid to the routing of wires. Wherever possible, differing potentials should be physically isolated from one another

2. Low-voltage control and field wiring should be kept in separate wireways. Doing so eliminates the possibility of crosstalk caused by capacitive or inductive coupling from high-current field wiring being located next to low-voltage control wiring. or adequate shielding should be applied to control-circuit wiring.

Another problem frequently overlooked by system designers is caused by controller output cards that use triacs to perform the switching operation. Triacs have an inherent leakage current when they are in the off or open state. If not accounted for, the leakage current can cause relays to remain pulled in while the triac is in the off state. A typical fix for this problem is to install dropping resistors across the coil circuits of the relays to dissipate the leakage current. However, the heat dissipation of the resistors can be substantial, creating problems for any other heat-sensitive devices in the cabinet. Therefore, it's critical to examine what type of output device will be used to drive the relay. If this device is to be a triac, a relay package with integral leakage-current dissipation devices should be used to avoid problems with excess heat in the panel.

While electromechanical relays can act as a buffer between electrically rough field devices and sensitive electronic controllers, they also can present a hazard to the controller. When a relay coil is energized, it sets up a magnetic field which causes the relay's contacts to operate. Upon de-energization, the magnetic field collapses back into the coil rapidly and can cause a high-voltage spike to be generated. This phenomenon is known as inductive kickback. If this induced kickback spike is not handled properly, it can flow back into the controller and cause serious damage. To prevent this problem, a clamping device such as a diode for dc coils or a metal-oxide varistor for ac coils should be placed across the coil. This will dissipate the inductive kickback spike at the relay coil where it will not cause damage. While these protective components can certainly be wired to any relay package, system assembly time can be saved by using a package with built-in protection against inductive-kickback spikes.

Careful consideration should also be given to how a control

'Glad I thought of that!"

"Upgrading boards already in production used to be a nightmare. Then I discovered ARIES Correct-A-Chip™ technology. Now it's a dream."

THE PROBLEM

"Things change fast in this business...too fast, sometimes. Just when I'd get a new board into production, my phone would ring. The chief designer just had a vision! The boards must change!...we had some pretty hot discussions, let me tell you. *They* had a new toy -I had a new headache.

THE SOLUTION

"A friend at another company told me she used to have the same problem, and solved it with Aries Correct-A-Chip technology. She said Aries could let me change from through-hole to SMT, work with any kind of footprint, even crank up performance in the same board space. And she was right! Those design changes don't bother me anymore. In fact, now that I'm plugged into Correct-A-Chip, I sleep like a baby. Thanks. Aries!"



P.O. Box 130 Frenchtown, NJ 08825 (908) 996-6841 FAX (908) 996-3891 e-mail: info@arieselec.com

Visit us on the Web: www.arieselec.com

<u>ISO 9002</u>

THE PROOF Look in the Correct-A-Chip Catalog, visit us on the Internet, or call our fax-on-demand at (908) 996-6841. You'll find plenty of sensible solutions to your problems...FAST.





Sensible Solutions. . . Fast!

READER SERVICE 967





SURFACE MOUNT



BOARD-TO-BOARD

Lister and

APPLICATION SPECIFIC

WHEN OTHERS SAY, "NO WAY," SAMTEC SAYS, "WAY!"

Support Support Samuel Selector

Whether you need design flexibility in micro, surface mount, board-to-board, or application specific interconnect solutions, or service solutions that include one day samples and 3 to 5 day lead times, Samtec has the way.

Find your way to Sudden Solutions. Call 1-800-SAMTEC-9 for our new Sudden Systems Atlas and Sample Selector.

World Radio History



RE World Radie History

RELAY PACKAGES

system containing relays will be maintained. An inherent consequence of a relay's repeated breaking of arcs is contact contamination. In some cases, the result is contacts with excessive resistance. In others, the contacts may become welded shut. Pluggable relays are easily replaced without disturbing wiring connections when the contacts are no longer functioning properly. System troubleshooting time can be further reduced by installing relays with LEDs in the case of de-control circuits or neon lamps in the case of ac control circuits. Typically, these indicators are connected across the coil circuit and are illuminated when the circuit is energized.

Another factor to consider is Designers should labeling of the wiring connections to the relay. Standard octalsocket relay bases have no cal when there are terminal markings, making life very difficult for the system installer as well as maintenance personnel. When evaluating various relay packages, examine how the connections are labeled. Does the installation require that each contact be given a unique identifier? In some applications, it may be sufficient for each connection to be labeled NO, NC, or 11,14, and so on. Designers should also evaluate how each relay will be labeled (Fig. 3). This is critical when there are several relays in a control cabinet.

Panel space is a major concern for control-system designers. Depending upon the application, control-panel space can be valued as high as \$1,000 per square foot. In the semiconductor-processing industry, for example, the exorbitant cost of the clean-room environment can make use of panel space a paramount consideration. In some applications, 4. Power-distribution such as retrofit or upgrade jobs, there simply is no room to use a the relay package, larger cabinet. As a result, all space must be used to its fullest potential. This is frequently the case in upgrading of control systems in petrochemical refineries, ated with the relays for example. But regardless of the can occupy signifiapplication, when space is a concern and multiple relays are required, system designers are

3. When evaluating various relay packages, examine how the connections are labeled. In some applications, it may be sufficient for each connection to be labeled NO, NC, or 11,14, and so on. Designers should also evaluate how each relay will be labeled, which is critical when there are several relays in a control cabinet.





ELECTRONIC DESIGN • PIPS SPECIAL EDITORIAL FEATURE • OCTOBER 1, 1996 World Radio History

FREE CD-BASED BESIGNER'S GUIDE AND DATA BOOK.



CD-based Designer's Guide and Data Book for Windows[™] includes:

- Latest information on all Mixed-Signal and Analog products
- Concise descriptions and parametrics for all orderable parts
- Application reports, full data sheets and macro models
- Powerful search functions
- Worldwide sales and distribution contacts
- Information on TI events and seminars

The new CD-based Designer's Guide and Data Book from Texas Instruments is your single source for Mixed-Signal and Analog products information. Its powerful search engine helps you locate the parts that meet your design criteria and places over 10,000 pages of technical data at your fingertips. Put time on your side with this all-in-one technical design and information source.

For your free CD-based Designers Guide and Data Book, contact us at:

1-800-477-8924, ext. 5022 or http://www.ti.com/sc/5022

EXTENDING YOUR REACH



READER SERVICE 189

Extending Your Reach is a trademark of Texas Instruments Incorporated. Windows is a trademark of Microsoft Corporation 1996 TL

World Radio History

SanDisk Flash Data Storage Cutting-edge technology that sharpens your competitive edge

Today's design engineering requirements put high-tech data storage to the test. Fortunately, one solution meets the challenge: SanDisk Flash. Our solid-state Flash data storage leads the industry with unparalleled compatibility, intelligent features, and rugged reliability-just what you need to shorten design time and make products that work better. SanDisk Flash offers:

- ▲ Full compliance with the PCMCIA PC Card ATA open industry standard, providing interoperability with virtually all major platforms and operating systems that support PCMCIA, including DOS, Windows^{*}, Windows 95, OS/2, Apple System 7, PSOS, GEOS, and most types of Unix.
- ▲ Direct portability from one device to another, with no need for custom software like Flash File System or File Translation Layer software.
- ▲ Dual voltage support that allows your Flash devices to be interchanged between 3.3V and 5V systems.
- ▲ 32Mb Flash technology that enables a wide range of costeffective, high-capacity data storage solutions.



Make the right choice. Call SanDisk today.

SanDisk leads the industry in innovative technology, and has consistently ranked first in sales of Flash card data storage units, according to Dataquest and In-Stat. For more information on how SanDisk Flash can help sharpen your competitive edge, call us at:



SanDisk Corporate Headquarters 140 Caspian Court Sunnyvale, CA 94089 http://www.sandisk.com SanDisk International Offices Europe Phone: 49-511-8759185 Japan

Phone: 81-45-474-0181 Asia/Pacific Rim Phone: 852-2712-0501

READER SERVICE 158



faced with a challenge which requires breaking away from the familiar. Industry standard octal-socket relays are rather bulky, occupying almost 5 in.² of panel space. Some manufacturers are now supplying higher-density relay packages to ease space-constrained applications. Some relay packages available today can fit two, three, four, or even up to eight relays in the same amount of space as one octal-socket relay.

One item typically external to the relay package is the powerdistribution terminals that provide power to field devices. When multiple relays are used in a cabinet, the power-distribution terminals associated with the relays can occupy significant amounts of panel space (*Fig. 4*). It also takes extra labor to install and wire these terminals.

One relay package eliminates these power-distribution blocks by incorporating them into the relay housing. A special bridging system is used with this new package to eliminate the labor involved in wiring power distribution. This new 6.2-mm-wide relay package with integral power-distribution terminals enables panel designers to fully use cabinet space, resulting in lower installed system cost.

In summary, relay manufacturers have made many advances in the packaging of their products that enable users to improve their overall control system designs. When faced with the task of integrating relays into a system, it can be beneficial to consider using something other than the industry standard designs.

Joe Pickell is interface products manager at Phoenix Contact. He holds a BSEE from Texas A&M University, College Station. Overall, Pickell has eight years of experience in the application of industrial control equipment.

HOW VALUABLE?

HIGHLY CIRCLE 549 MODERATELY CIRCLE 550 SLIGHTLY CIRCLE 551

SanDisk and CompactFlash

are trademarks of SanDisk.

All other trademarks or

registered trademarks are

property of their respective owners. Specifications and

product offerings subject

to change without notice. ©1996 SanDisk Corporation

DC/DC Just Got Better.



Introducing <u>DC/DC</u> from the number one name in AC/DC...Power-One.

READER SERVICE 148

POWER-	POWER-ONE DC/DC CONVERTER AVAILABLE OUTPUTS										
Series	Max Watts	Vin Range	Vout 3.3V	Vout 5V	Vout 5.2V	Vout 7V	Vout 12V	Vout 14V	Vout 15V	Vout 17V	
Single Ou	Single Output products										
DSP1	1	4.5-5.5		•							
DFA6	6	9-27, 20-60							•	1	
DFC6	6	3.5-16		•	•				•		
DFC10	10	9-18, 18-36, 36-72					•		•		
DGP12	12	3.5-16		•			•		•		
DFC15	15	20 60					•		•		
DSN17	17	4.5-6, 6.5-15.5		•							
DFA20	21	9-18, 18-36, 36-72		•			•		•		
DGP30	30	36-72		•			•		•	100	
Dual Outp	ut prod	lucts provide the indic	ated V	out as	one po	sitive a	and one	e negal	ive out	put	
DSP1	1	4.5-5.5		+/-		+/-	+/-	+/-	+/-	+/-	
DFC10	10	9-36, 18-72		+/-			+/-		+/-		
DGP12	12	3.5-16		+/-			+/-		+/-		
DFC15	15	20-72				1	+/-		+/-		
DFA20	20	9-18, 18-36, 36-72		+/-			+/-		+/-		
Triple Out	tput pro	oducts provide a main	output	(•) and	two s	ymetrie	al out	outs (+,	(-)		
DGP20	20	9-18, 18-36, 36-72		•			+/-		+/-		

- 100% dynamic load burn-in.
- CE Marking pending.
- ISO 9000 approved quality.
- Stocked by your distributor.
- Industry standard footprints and pinouts.
- Over 100 models.



Visit our web site at http://www.power-one.com 740 Calle Plane, Camarillo, CA 93012 (800) 765-7448 • FAX (805) 388-0476

Power-One logo and ISO 9000 logo are trademarks of Power-One, Inc.



SOLID-STATE RELAYS

▼ POWER RELAYS SWITCH UP TO 3 AND 4 A

The AQZ Series of power PhotoMOS relays comprises four ac/dc and four dc types that can switch up to 3 and 4 A, respectively, at 60 V (or 0.5 and 0.7 A at 400 V). Housed in a slim 3.5-mm package with a footprint of 21 by 12.5 mm, the single-in-line relays have an I/O isolation of 2500 V and an on resistance as low as 0.05Ω for increased low-level switching capability. The offstate leakage current is 10 µA maximum. The devices can be mounted in any position, are immune to magnetic fields, and turn on in 0.83 ms. In lots of 1000, prices start at \$5.26 with delivery from stock to 16 weeks.

Aromat Corp.

629 Central Ave. New Providence, NJ 07974 (908) 464-3550 ► CIRCLE 640

PC-MOUNTED RELAYS CONTROL AC LOADS

The Series E22 miniature solid-state relays are pc-board-mounted types with photoisolation and voltage turn-on at zero crossing. The devices control ac loads up to 4 A at 240 V ac. They're well suited for interfacing computers and microprocessors to external ac loads. Other features include a built-in snubber and TTL-logic compatibility. Four versions are offered with dc control voltages of 5, 12, 24, and 32 V. Operating voltage range for all types is 90 to 280 V ac rms. Maximum ac leakage is 5 mA rms and maximum on-state voltage is 1.6 V rms. Input-to-output isolation is specified at 2500 V.

Allied Controls Inc.

150 E. Aurora St. Waterbury, CT 06708 (203) 757-4200 ► CIRCLE 641

PC-MOUNT RELAYS TARGET TELECOM USES

UL and CSA approvals as well as compliance with FCC Part 68 specifications are featured in the R40 Series of pcmountable relays. The devices are designed for use in telecommunication and security systems as well as computer peripherals. The 2-A relays offer high coil sensitivity, compact design, epoxy-sealed construction, and low power consumption. They operate from dc coil voltages of 5 or 6, 12, 24, and 48 V and come in a DPDT contact configuration. Dielectric strength is 1000 V rms between coil and contacts. Insulation resistance is 100 M Ω at 500 V dc. Pricing in lots of 1000 is under \$2.85.

NTE Electronics Inc.

44 Farrand St. Bloomfield, NJ 07003 (800) 683-6837 ▶ CIRCLE 642

	MANUFACTURERS OF SULID-STATE RELAYS						
Manufacturer	Contact configurations	Special- purpose types	Load voltages	Continuous load currents	On-resistance ratings (typ./max.)	Switching speeds	I/O-isolation voltages
Allied Controls Waterbury, Conn. (203) 757-4200 CIRCLE 626	Forms A and B	N.S.	100 to 280 V ac	10 to 25 A	Voltage drops of 1.6 to 2 V	N.S.	2500 V
Aromat Corp. Precision Components Div. New Providence, N.J. (908) 464-3550 http://www.aromat.com CIRCLE 627	1 Form A, 1 Form B, 2A, 2B, 1A1B, 4A, 1A plus one optocoupler, 1 plus two optocouplers	RF, high-sensitivity, low on-resistance. varistor-protected, voltage-sensitive. power (up to 9 A), slow-on/slow-off, visible LED	40 to 1500 V	Zero to 700 mA dc; zero to 500 mA ac (standard DIP package), zero to 4 A dc; zero to 3 A ac (power package)	 33 mΩ to 345 Ω typical; 90 mΩ to 800 Ω maximum 	0.03 to 5 ms	1500 to 5000 V
CP Clare Corp. North American Sales Arlington Heights, III. (800) 272-5273 http://www.cpclare.com CIRCLE 628	1 Form A, 1 Form B. 1 Form C, 1A/1B, 2 Form A, 2 Form B	Telecom switches, linear optocouplers, linear isolation amplifiers, ICs	60 to 600 V	0.05 to 3 A	0.3 to 50 Ω typical; 0.5 to 100 Ω maximum	25 μs to 5 ms	2500 to 37 50 V rms
Coto Wabash Providence, R.I. (401) 943-2686 CIRCLE 629	1 Form A, 2 Form A, dual Form A, 1 Form B, dual Form B, 1A/1B, 1 Form C	High-sensitivity, high-frequency	Up to 400 V dc/ac peak	Up to 500 mA ac peak or 1 A dc	3 to 20 Ω typ., up to 450 Ω max.	0.1 to 3.5 ms typ.	3750 V ac
Crouzet Corp. Carroliton, Texas (800) 677-5311 CIRCLE 630	Form A	N.S.	48 to 660 V ac	100 mA to 35 A	1.6 V peak on-state voltage drop at 35 A	8.33 ms and 0.1 ms	2500 V
Crydom Glendale, Calif. (818) 956-8900 e-mail: sales@crydom.com http://www.crydom.com CIRCLE 631	1 Form A, 2 Form A, 1 Form B, 1 Form C, 3 Form A	High-voltage, system monitoring, time delay, soft start, phase control, proportional control, and temperature control	12 to 660 V ac, 3 to 500 V dc	10 mA to 150 A	0.05 to 5.5 Ω	100 μs to 40 ms	2500 to 4000 V rms

N.A. = not applicable, N.S. = not specified

MEGA-SIMMS

STACK / EM. BARAGE / EM.

Up to 256 MByte DRAM Memory Modules

Our new stacked DRAM makes the most of precious board space. 32 MB (8M x 36) and 64MB (16M x 36) 72-pin SIMMs. 16MB (2M x 72), 64MB (8M x 72), and 256MB (32M x 72) 168-pin DIMMs. FPM or EDO DRAM with access time of 60nS.

OTHER QUALITY MEMORY PRODUCTS FROM WHITE MICROELECTRONICS:

• 80-pin SIMM Flash Family

4-, 8-, 16-, and 32MByte SIMMs in x32 organizations. 5 volt operation. Access times of 70 to 120nS. JEDEC standard pinout.

• 68-lead PLCC Packaging

4-, 16-, and 32Mbit Flash with access times as low as 55nS 4- and 16Mbit SRAM with access times as low as 17nS

• 32Mbit Flash MCM in an 84-ball BGA Package

1Mx32 organization. 35mm square BGA. Read access times of 90 to 150nS. Upgradeable to $2M \times 32$ in the same footprint.

V

HITE MICROELECTRONICS

4246 E. Wood Street ■ Phoenix, Arizona 85040 TEL: 602-437-1520 ■ FAX: 602-437-9120 ■ http://www.whitemicro.com

- Increased memory density
- Upgradeable
- **FAST**
- Saves board space
- Reliable

ISO 9001 CERTIFIED QUALITY SYSTEM

SOLID-STATE RELAYS

▼ RELAYS MOUNT EASILY ON PC BOARDS

Designed with OEM assembly in mind, the Quick Mount line of solidstate relays reduces install costs. Screw terminals are replaced by 1/4in. quick connects and mounting is ac-



complished with one screw. The Quick Mount package measures $2 \ge 2 \ge 1$ in. and has a molded-in heat-transfer plate for thermal dissipation. Among the Quick Mount relays is the NIF Series of latching solid-state relays. Each time a control voltage is applied, the output changes state and latches, providing a flip-flop function. Control voltages are optically isolated from the output (operating) voltage. Operating voltages of 24, 120, or 230 V ac, 50/60 Hz, and input coil voltages of 9 to 290 V ac/dc are standard. Call for pricing and delivery information.

SSAC Inc. P.O. Box 1000 Baldwinsville, NY 13027 (800) 377-7722 ► CIRCLE 643

RAIL-MOUNT RELAYS SAVE SYSTEM SPACE

The DEK-REL...AKT and DEK-REL...SEN relays use just 6.2 mm of DIN-rail space. They feature physically separated coil and contact connections to prevent inductive-coupling problems from developing. Other features include an LED to indicate when the coil circuit is energized and a diode placed across the coil to prevent inductive kickback problems from developing once the relay is de-energized. In addition, the relays offer the ability to provide power distribution to field devices without use of external terminal blocks. The result can be a great sav-



ing in panel space. A further benefit is that power distribution is accomplished by means of a special bridging system which saves labor as no jumper wires need be installed. The DEK-REL...ART model is designed for use with actuators with power distribution on the contact side of the relay, while the DEK-REL...SEN model is for use with sensors and has power distribution on the coil side of the relay.

Phoenix Contact P.O. Box 4100 Harrisburg, PA 17111 (717) 944-1300 ► CIRCLE 644

MANUFACTURERS OF SOLID-STATE RELAYS								
Manufacturer	Contact configurations	Special purpose types	Load voltages	Continuous load currents	Oneresistance ratings (typ./max.)	Switching speeds	I/O-isolation voltages	
Gentron Corp. Scottsdale, Ariz. (602) 443-1288 http://www.gentron.com CIRCLE 632	Form A in pole configurations of single, dual, three-phase, and quad; Form B on request	MOSFET and IGBTs standard and fast-switching mode; three-phase SSRs to 150 A	120 to 660 V ac (PIV ratings to 1600 V)	10 to 1000 A	Dc models: R _{DS(ON)} = 10 mΩ; Ac models: 1.4 to 12.5 V drop	4 μs (max.) to 8.3 ms (max.)	2500 to 4000 V	
Grayhill Inc. Control Products Div. LaGrange, III. (708) 354-1040 http://www.grayhill.com CIRCLE 633	Form A	N.S.	24 to 140 V ac; 24 to 280 V ac; 3 to 60 V dc	65 mA to 3 A; 75 mA to 25 A; 75 mA to 4 A; 75 mA to 10 A; 75 mA to 6 A; 100 mA to 12 A; 100 mA to 25 A	1.5 V p-p min. (Grayhill uses transistors and triacs as switching devices)	Dc: 75 µs max.; Ac: 8.3 ms max. (half-cycle)	3000 V rms minimum	
Micropac Industries Inc. Hybrid Products Div. Garland, Texas (214) 272-3571 e-mail: 104437.365 @compuserve.com CIRCLE 634	SPST, SPDT	I ² T capability, custom configurations	Up to 400 V	Up to 80 A	Varies with applications	Low- microsecond to millisecond range	Up to 1500 V	
NTE Electronics Inc. Bloomfield, N.J. (201) 748-5089 http://www.nteinc.com CIRCLE 635	1 Form A	Internal snubbers on ac models; MOSFET dc versions	24 to 530 V ac, zero to 100 V dc	10 to 75 A	N.S.	Zero-crossing and random switching	4000 V rms	
Opto 22 Temecula, Calif. (909) 695-3051 e-mail: bsmith@opto22.com http://www.opto22.com CIRCLE 636	Normally-open, single-contact types	Zero-resistance mercury-wetted contacts in standard-I/O module and G4 I/O module formats	12 to 575 V ac in five voltage ranges	Power series: 10, 25, and 45 A; PCB-mount: 2 and 4 A	Power series: 1 V peak forward drop at any current level	Zero-voltage switching with turn-on times of from less than 1 ms to 8.33 ms maximum	4000 V rms minimum	

N.A. = not applicable, N.S. = not specified

This interactive, easy-to-use productivity tool is an EE's guide to the future.

1990-1994 SGGG Five years of ELECTRONIC DESIGN on CD-ROM

Electronic Design on CD-ROM includes all of the articles, illustrations and line drawings that appeared on the pages of *Electronic Design* between 1990 and 1994. Complete with a search engine and hypertext links, it is a compendium of value added design information available nowhere else.

To order, simply complete, mail or fax this card or call: 201/393-6062; Fax 201/393-6073.

ELECTRONIC DESIGN'S CO)-ROM		Amount	Mail to:
 Single order: Multiple order: Qua 	□ Single order: □ Multiple order: Quantity: x \$95 = Please add \$5 for S & H per			Electronic Design CD-ROM 611 Route 46 West Hasbrouck Heights, NJ 07604 Attn: CD-ROM Order Dept.
Method of Payment:	□ Master Charge	American Expres	s 🗆 VISA	or fax: 201/393-6073
Account Name		Accou	int #	
Signature		Expira	tion Date	
Name		Title _		
Company				
Company Address				
City			_ State	Zip
Phone	Fax		E	-mail
		(Allow 6 to 8 weeks for World Radio Histor	delivery)	

SOLID-STATE RELAYS

▼ DIN-RAIL RELAYS COME WITH HEAT SINK

Heat-sink calculation, application of thermal grease, and the added assembly time of heat-sink installation are all eliminated with a DIN-rail-mounted



solid-state relay with integrated heat sink. The 45-mm unit is designed around a rugged back-to-back SCR which accommodates both resistive and inductive loads. It's rated at 35 A, 48 to 660 V ac single phase. The relay also features a regulated input with an "input-activated" LED indicator. All major safety-agency approvals apply, including UL, CSA, and CE low-voltage directive compliance. Call for pricing and delivery information.

Crouzet Corp. 3237 Commander Dr. Carrollton, TX 75006 (800) 677-5311 ▶ CIRCLE 645

▼ TRANSIENT-PROOF RELAYS HANDLE HIGH CURRENT

Industrial lighting, heating, or motor control, or other high-load applications are all suitable uses for the 575D45-12 solid-state relay. Developed as a 45-A device for up to 277-, 480-, and 575-V systems, the relay's high current capacity and high-volt-



age transient protection are combined in a single, high-reliability package. The device is rated at 2 kV in transient environments and gives designers an adequate margin of operational safety while eliminating other protective devices and circuitry. Other features include 4000-V photoisolation, a zero-voltage turn-on, builtin snubber. and a rugged encapsulated body and die-cast mounting base. Pricing is \$34 in single quantities. Delivery is from stock.

OPTO 22

43044 Business Park Dr. Temecula, CA 92590-3665 (800) 321-6786 ► CIRCLE 646

PLASTIC-CASED RELAY BLOCKS SHORT CIRCUITS

A 320-V power MOSFET switch is combined with true short-circuit protection and optical isolation in the



SR75-2 solid-state relay. The plastic 16pin DIP allows users to source or sink the load while isolating control logic from harsh load transients. It's said to provide better performance than electromechanical relays in power-control applications of up to 0.75 A. Short-circuit protection is provided for either switching into a dead short or shorting the relay under load. Either way, the relay will sense the short-circuit condition and initiate a shutdown within 5 µs. The relay blocks the short-circuit condition until the short is removed and the input control is recycled. Ratings include a continuous output load current of 0.75 A at 300 V. The unit meets MIL-STD-704A transients to 600 V peak for 10 µs. The input incorporates a constant-current regulator. Pricing is \$19.70 in OEM lots with delivery within four weeks.

Teledyne Relays

12525 Daphne St. Hawthorne, CA 90250 (213) 777-0077 ▶ CIRCLE 647

MANUFACTORERS OF SOLID-STATE RELATS								
Manufacturer	Contact configurations	Special- purpose types	Load voltages	Continuous load currents	On-resistance ratings (typ./max.)	Switching speeds	I/O-isolation voltages	
SSAC Baldwinsville, N.Y. (800) 377-7722 e-mail: ssacm@ssac.com http://www.ssac.com CIRCLE 637	1 Form A, 1 Form B	N.A.	24, 120, and 240 V ac (±20% tolerance)	1, 3, 6, 10, and 20 A	Voltage drops of 2.5 V for 1-A output, 2 V for 3-, 6-, 10-, and 20-A outputs	Random switching: 10 to 15 ms; Zero-voltage switching: 20 to 25 ms	9 to 30 V ac/dc; 90 to 150 V ac/dc; 190 to 290 V ac/dc	
Siemens Electromechanical Components Inc. Potter & Brumfield Div. Princeton, Ind. (812) 386-1000 e-mail: info @ ae.sec.siemens.com CIRCLE 638	1 Form A, 2 X 1 Form A, 4 X 1 Form A	N.A.	24 to 480 V ac, 3 to 250 V dc	50 mA to 125 A	N.S.	0.02 ms, 8.3 ms	2500 and 4000 V rms	
Teledyne Relays Hawthorne, Calif. (213) 777-0077 http://www.teledynerelays.com CIRCLE 639	1 Form B	Low on-resistance, short-circuit- protected	Through ±400 V dc, 280 V ac	Low level to 40 A rms or 35 A dc	0.07 Ω through 1.5 Ω	10 μs to 8.3 ms	1000 V ac through 3750 V ac	
NA = not applicable NS =	not enacified						4	



The editors of *Electronic Design* magazine are soliciting technical papers for presentation at the 1997 Portable By Design Conference. Designers are invited to share their expertise by submitting proposals for papers that emphasize problem solving and provide insights regarding the design of portable products.

TYPICAL TOPICS TO BE PRESENTED

- Current and future battery technologies
- High-end/low-power CPUs
- 16-bit and smaller CPUs for portable designs
- Smart-battery management
- Charging circuits
- Software issues, including BIOS and PC Cards
- Mass storage and I/O, including PC Card issues
- IR and RF connectivity issues
- Power management
- Packaging
- Displays and input devices
- Buses and system-level architectural issues



A conference for designers of OEM portable, nomadic, mobile, and transportable products

> Conference Dates: March 24 - 27, 1997

Conference Site: Santa Clara Convention Center Santa Clara, Calif.

"Delivering the multidisciplinary knowledge needed by engineers and engineering managers involved in the next generation of portable design."

To participate, submit an abstract describing your proposed paper before October 11, 1996. Send your proposal to: Program Chair, Portable By Design Conference, c/o Electronic Design, 611 Route 46 West, Hasbrouck Heights, NJ 07604 Call: 201/393-6090; Fax 201/393-0204; or E-mail to: portable@class.org for more information.

World Radio History

▼ RELAY LINE MEETS MIL STANDARDS

As a QPL supplier of solid-state relays to MIL-R-28750 standards, Micropac offers both standard and custom products built in accordance with that military standard as well as with specific MIL-STD-883 screening. Products include SPST, SPDT, DPST, and DPDT types in both ac and dc versions.

The lightweight relays are resistant to damage from shock and vibration and are immune to contact-related problems such as contamination and arcing associated with mechanical equivalents. Either optical or inductive coupling between the input and output stages provides effective isolation of up to 1500 V rms. Power-FET outputs eliminate bipolar offset, and minimize output-voltage drop. Control logic is TTL- and CMOS-compatible. Applications include general-purpose signal switching and electronic load control. Call for pricing and delivery information.

Micropac Industries Inc. 905 E. Walnut St. Garland, TX 75040 (214) 272-3571 ► CIRCLE 548

TELECOM CIRCUIT OFFERS DAA SOLUTION

The model ITC117P integrated telecommunication circuit is an integrated solution for Data Access Arrangement (DAA) circuits. Claimed to represent a 60% savings



on board space over discrete designs, the 16-pin SOIC combines a Form A solid-state relay for use as a hookswitch; a bridge rectifier; a Darlington transistor; and an optocoupler that can function as a ring detector or loop-current detector.

Optically coupled MOSFETs function as a 2-mW hookswitch in the DAA circuit. With a blocking voltage of up to 350 V, isolation voltage of up to 3750 V rms, a 15- Ω R_{DS(on)} and a maximum switching current of 120 mA, the hookswitch is well-suited for tip-and-ring applications. It's controlled by an LED that requires just 5 mA for operation, making the device a candidate for battery-powered applications. The device dissipates 1 W, has an operating temperature range of -40 to 85°C, and exceeds FCC Part 68 requirements. Pricing is \$4.18 in lots of 10,000 and delivery is from stock to 12 weeks.

CP Clare Corp. 107 Audubon Rd., 8 Corporate Pl. Wakefield, MA 01880 (847) 797-7000 ▶ CIRCLE 649

▼ RELAY LINE FILTERS INSTALL EASILY

Two line filters have been designed to significantly reduce EMI noise generated by solid-state relays to help systems meet electromagnetic-emission requirements. All ac solid-state



relays using thyristor switching generate some low-frequency noise. This noise often appears as conducted emissions on the main supply-line connection.

The filters' patented design offers simple installation into new or existing equipment. Relay current need not pass through the filter because the connection is across the incoming supply line. Two models include the IF25 for single-phase systems and the 3F20 for three-phase systems. Call for pricing and delivery information.

Crydom 411 N. Central Ave. Glendale, CA 91203-2020 (800) 827-9366 ► CIRCLE 650

AUTOMOTIVE RELAY SUITS GENERAL NEEDS

A variety of automotive and transportation after-market applications are satisfied by the G8J general-purpose automotive relay. Available in pc-board,



plug-in, and plug-in weatherproof types, the relay features a wide temperature range of -40° to 125°C, a standard ISO-terminal footprint, and insert-molded terminals for mechanical stability. With maximum inrush currents of 100 A inductive (normally open) and 300 A capacitive (normally open), the relay is built to handle heavy loads. Maximum resistive load is 30 A (SPST) and 35 A normally open and 20 A normally closed for an SPDT type. Pricing starts at \$2.78 in lots of 1000. Call for delivery information.

Omron Electronics Inc. One E. Commerce Dr. Schaumburg, IL 60173 (800) 556-6766 ► CIRCLE 651

ROTARY DIP SWITCHES GRAB ONTO PC BOARDS

The RDS10-432 knob-type and RDS10-122 flat-type rotary DIP switches come in BCD Real and BCD Complement code versions. In addition, both offer kinked terminals that hold the devices in place to prevent lift-off during wave soldering. They can also be plugged into sockets. The -122 flat type switch is adjustable by a tuning tool, while the -432 knob type is hand-adjustable. The switches are offered in red, black, or green. Applications include communication and control switches. Right-angle sockets are optional. Pricing in lots of 1000 is \$2 for the flat type, \$4 for the knob type, and \$4.96 for the sockets. Delivery is from stock.

Purdy Electronics Corp. 720 Palomar Ave. Sunnyvale, CA 94086 (408) 523-8200 ► CIRCLE 652
SWITCHES & RELAYS

▼ CIRCUIT BREAKER MEETS MANY STANDARDS

The NEW AM/S Series of hydraulic, magnetic circuit breakers is UL 489listed as a branch circuit breaker, UL 1077-recognized for appliance protec-



tion, and CSA-certified for industrial controis. Available in a wide variety of configurations, the breaker is rated for currents as high as 100 A at 250 V ac or 80 V dc. The device addresses demanding dc applications and has a 10,000-A interrupting capability. The units are insensitive to ambient temperatures and consume little power (low voltage drop). Other features include mid-trip alarm, remote trip, and a variety of colored handles with international markings. Prices range from \$7.05 to \$18.60 in lots of 500. Delivery is in four weeks.

Eaton Commercial Controls 310 E. Johnston St. Smithfield, NC 27577 (800) 526-5476 ► CIRCLE 653

▼ 265-A CONTACTORS MEET AEROSPACE NEEDS

In the Czonka II contactor, designers will find the smallest 270-V dc package available that's capable of managing difficult dc power at up to 265 A at 270 V dc with a 1000-A overload rating. This is made possible by the company's power-switching technology, which uses a super-sealed switch and solenoid-style motor design. From the core Czonka II switch, three products have evolved: the AP265P latching contactor, the AP265X electrically held contactor,



and the EPCXXXP electronic power controller. Other features include two auxiliary contacts, a built-in coil economizer for electrically held and latching types, and overload trip protection available in currents from 25 to 250 A. The devices are suited to applications requiring bus-tie, linegenerator, and safety-disconnect contactors and remote-control circuit breakers. Call for pricing and delivery information.

Kilovac Corp. P.O. Box 4422 Santa Barbara, CA 93140 (805) 684-4560 ▶ CIRCLE 654



ELECTRONIC DESIGN - PIPS SPECIAL EDITORIAL FEATURE - OCTOBER 1, 1996

Silent Switcher.™



The ML4890 combines the **high** efficiency of a switching regulator with the **low noise** of a LDO in a single package.

Our proprietary Silent Switcher technology minimizes output voltage ripple, while keeping the power dissipation in the built-in LDO at a minimum.

Keeping the overall size and component count low, while keeping silent. Now that's a switch.

- Integrated synchronous rectifier eliminates a Schottky diode and increases efficiency.
- Guaranteed start-up and operation at 1V input.
- Up to 200mA of output current.
- 5mV output ripple.
- 5V, 3.3V, 3V, and adjustable output versions.

For more information contact Micro Linear at: Tel: (408) 433-5200 ext. 403 Fax: (408) 432-1627 e-mail info@ulinear.com http://www.microlinear.com

Distributed by: Insight Electronics, Interface Electronics

Micro Linear

© 1995 Micro Linear Corporation

READER SERVICE 172

SWITCHES & RELAYS

▼ INTELLIGENT RELAY CONTROLS, PROTECTS

Control and protection circuitry are integrated within the VN370B intelligent solid-state relay. Built with second-generation VIPower M0 process technology, the device includes three power DMOS transistors configured as independent high-side drivers.



Key features include active current limiting, fast demagnetization of inductive loads, and reduced RF emissions. The unit provides one high-current channel (1-A nominal current) and two identical low-current channels (0.3 A). Each channel is independently controlled by a TTLcompatible input signal and drives a resistive or inductive grounded load. Active current-limiting circuitry restricts inrush or short-circuit current. to 4.4 A for channel 1 or 0.72 A for channels 2 and 3. In the event of a sustained fault condition, temperature-protection circuitry shuts down all channels or the offending channel only until the chip cools to the appropriate temperature. Pricing is \$1.18 in lots of 100,000. Delivery of small lots is from stock.

SGS-Thomson Microelectronics Inc. 55 Old Bedford Rd. Lincoln, MA 01773 (617) 259-0300 ► CIRCLE 655

RELAY PROVIDES TELECOM INTERFACE

The PVT312 Series telecommunication interface relay offers high load currents of up to 190 mA ac at 250 V ac or dc peak. In dc-only mode, it can switch up to 320 mA dc at up to 250 V dc. In addition, the unit's $R_{DS(ON)}$ is specified at just 10 Ω maximum in ac mode and 3 Ω maximum in dc mode. It takes just 2 mA of LED drive to turn the relay on, making them TTL- and CMOS-compatible. High input-to-output isolation of 4000 V rms is a standard feature. The relay complies with all interna-



tional electrical safety regulations and will soon carry UL recognition and CSA certification. Typical applications include use as an on/off hookswitch, ringer injection, ground start, and general switching. The device comes in a 6-pin DIP with either gullwing SMT or through-hole leads. Call for pricing and delivery information.

International Rectifier 100 N. Sepulveda Blvd. El Segundo, CA 90245-4359 (310) 252-7161 ► CIRCLE 656

▼ TACTILE KEYSWITCHES SURVIVE SOLDERING

Suitable for single-key or matrix mounting, the RAFI Racon 8 and Racon 12 Series tactile keyswitches are offered with through-hole and SMT terminals and are sealed to withstand wave soldering and cleaning processes. The Racon 8 types are about 5 mm tall by 8 mm square. The Racon



12 type is about 5 mm high and 12 mm square with an optional plunger that increases the height to 12.5 mm. SMT models also can withstand reflow, vapor-phase, hot-stamp, and laser soldering. Electrical ratings are 2 W maximum at 42 V ac or dc maximum. Switch function is SPST (normally open) and momentary. The switches have tin-plated terminals and gold contacts. Pricing starts at \$1.22 in lots of 1000 for both models. Delivery is from two to six weeks.

C&K Components Inc. 8182 U.S. Hwy. 70 West Clayton, NC 27520 (800) 334-7729 ► CIRCLE 657

POWER SOURCES

HIGH-POWER CONVERTERS SPORT FOUR OUTPUTS

The HD Series of dc-dc converters now offers a quad-output version in addition to existing single-, dual-, and triple-output types. The converters operate from wide input-voltage



ranges of 18 to 36, 20 to 60, and 36 to 72 V dc and offer various dc output voltages. They provide up to 50 W of output power at typical efficiencies of 80%. Encapsulated in standard 4.6by-2.4-by-1-in. cases, the units deliver 500-V dc input-to-output isolation, tight regulation, six-sided shielding, continuous short-circuit protection, overvoltage protection, and thermal shutdown. Baseplates are designed to accommodate chassis, cold-plate, pcboard, or heat-sink mounting. Unit prices start at \$198 with OEM pricing at \$149. Call for delivery information.

Wall Industries Inc. 5 Watson Brook Rd. Exeter, NH 03833 (603) 778-2300 ► CIRCLE 658

▼ POWER DISTRIBUTORS PASS EUROPE'S MUSTER

Compliance with EMC Directives is offered by the three-phase PC 301-I/MTD power-distribution system. Therefore, the unit carries the CE



mark for export to Europe. The system handles 20 A/phase with inputvoltage selection between 120/208 V and 220/308 V and the correlating single-phase output for either 120 or 220 V. Also included is EMI/RFI filtering, spike/surge suppression, remote on/off control, remote emergency power-off, and the company's automatically sequenced Multiple Time Delay power-up feature. The front panel carries twelve IEC 320 outlets, four each for the three single-phase output sections, a power-on indicator light per section, a master power on/off overload circuit breaker with power-on indicator, a remote/off/local selection switch, and three remote connectors. The rear panel includes two unswitched IEC 320 outlets, the voltage-selection switch with indicator lights, and a 15-foot harmonized power cable input. Pricing is \$970 each in single quantities.

Pulizzi Engineering Inc. 3260 S. Susan St. Santa Ana, CA 92704-6865 (714) 540-4229 ► CIRCLE 659

▼ 800-V MOSFETS HAVE LOW RDS(ON)

Five high-voltage parts have joined IXYS's line of power MOSFETs. All five new devices offer a minimum blocking voltage (BV_{DSS}) of 800 V and are fabricated on the company's HiPer-FET process. That guarantees a high avalanche-energy rating and a faster-switching intrinsic rectifier, providing higher reliability while reducing component cost in power-switching circuits.

The devices range in current from 8 to 27 A and are offered as having the industry's lowest R_{DS(ON)} specs and highest current ratings in their respective 15-A packages. The IXFH15N80 offers an RDS(ON) of 0.6 Ω in a TO-247 package, which is said to be 20% lower than the closest competitive device. This low on-resistance translates into increased circuit efficiency, which in turn means cooler and more reliable operation in power-conversion circuits. Pricing for the devices ranges from \$5.30 for the 8-A part to \$31.35 for the 27-A device, in lots of 1000. Samples available now.

IXYS Corp. 3540 Bassett St. Santa Clara, CA 95054 (408) 982-0700 ► CIRCLE 660

HOT-PLUG SUPPLIES OFFER FIVE OUTPUTS

Five outputs, hot pluggability, and a maximum power-output rating of 750-W are features of the 186 Series supplies. The first model in the series will have outputs of 5 V dc at 100 A, +12 V

dc at 12 A, -12 V dc at 10 A, 5 V dc at 5 A (floating), and 3.3 V dc at 30 A. Input voltage is universal from 90 to 264 V ac, 47 to 63 Hz. The supplies also feature power-factor correction of 0.99 at full load. They're designed for N+1



redundant operation with +5 V dc at 100 A and the 3.3-V dc outputs current-sharing with like outputs on similar models. Operation is at a fixed switching frequency of 100 kHz. Two built-in cooling fans make the supplies independent of system cooling. Pricing is \$627 each in lots of 1000 with delivery in six to eight weeks.

Conversion Equipment Corp. 330 W. Taft Ave. Orange, CA 92865 (714) 637-8654 ► CIRCLE 661

CONVERTERS SERVE HIGH-REL APPLICATIONS

Four models have been added to the MFL Series of dc-dc converters. The new models provide outputs of 2, 3.3, 8, and 28 V dc in a variety of military, aerospace, industrial, and other highreliability applications. All feature a wide input range of 16 to 40 V dc with a nominal input voltage of 28 V. Converters are fully isolated to at least 100 $M\Omega$ at 500 V dc and incorporate a synchronization feature for added flexibility. Conversion frequency for all models is from 550 to 650 kHz. The units, which measure just 3 by 5 by 0.4 in., save board space. Other features include current-limiting short-circuit protection, input line-transient protection, and low-voltage lockout to prevent damage to the converters and shield systems from voltage irregularities. Pricing starts at \$840 in lots of one to 24. Call for delivery information.

Interpoint Corp. P.O. Box 97005 Redmond. WA 98073-9705 ((206) 882-3100 ► CIRCLE 662

D-SUBMINI CONNECTOR HOLDS DOWN COSTS

Copper-allov contacts are used in place of beryllium/copper material in the 636 Series D-subminiature connectors. The IDC-terminated units are designed to meet the cost and performance requirements of the PC and peripherals markets. Optionally, users can specify 15- or 30-µin. gold plating in the contact area. Overall, the connectors offer up to 30% cost savings compared with conventional Dsubmini types, it's claimed. Four standard sizes are 9, 15, 25, and 37 pins. A variety of mounting options, threaded including #4-40 and through-hole versions, is offered. Connectors are rated for 1 A. Typical pricing for a 25-pin connector is \$2.19 in lots of 5000 with delivery from stock to four weeks.

Thomas & Betts 1555 Lynnfield Rd. Memphis, TN 38119 (800) 344-4744 ► CIRCLE 663

COAXIAL SYSTEM HANDLES 250 LINES

High density and controlled impedance for up to 250 coaxial lines are provided by the CP-50 I/O closepitch, 0.050-in.-centerline connector system for coaxial and twinaxial cables. The cable connectors and recep-



tacles are fully shielded and feature both polarized keying and jack screws. Standard shielded and jacketed cables are terminated with a computer-controlled welding process to provide high reliability. The system is offered in 50- Ω coaxial, 100- Ω twinaxial, and controlled-impedance twisted-pair types. Call for pricing and delivery information.

Meritec P.O. Box 8003 Painesville, OH 44077 (800) 860-9014 ► CIRCLE 664

▼ PC-MOUNT LINE FILTER ACCEPTS INPUT POWER

The Combifit pc-mount line filter combines a power-entry module and line filter. The filter conveniently snaps onto the rear of the power-entry module. The unit's pc-board terminals provide effective EMC grounding and generate fewer emissions than wire connections. Moreover, the design eliminates potential crosstalk between filter components. Ac interference is minimized between 10 kHz and 300 MHz. The power-entry module is offered in three configurations: inlet/switch, inlet/outlet, and inlet/fuseholder. Snap-in stabilizing legs quickly mount the unit for wave soldering. Slotted bezels on the module's face secure it to the panel. UL, CSA, and VDE approvals are in place to 6 A/250 V and up to 10 A without the filter. Pricing for the base unit is \$1.94 in lots of 1000. Delivery is from stock to six weeks.

Schurter Inc. P.O. Box 750158 Petaluma, CA 94975-0158 (707) 778-6311 ► CIRCLE 665

MODULAR HEADERS BOOST DENSITY

End-shroud and ejector-shroud options have been added to the FTSH Series of microminiature 0.050-in. headers to boost performance in extremely dense board-stacking applications. End shrouds are used for low-profile blind mating of boards without misalignment. Ejector shrouds assure positive mating of cable with the added capability of quick disconnect without damage to the IDC contact-cable interface. The terminal strips are offered in both straight and right-angle through-hole designs as well as a vertical SMT version. Their modular design permits any pin count from five to 30 pins per row. When mated with the company's CLP Series socket strips, the headers form an impedance-matched connector system for high-speed applications. Pricing is as low as \$0.04/pin with delivery in five working days.

Samtec Inc. P.O. Box 1147 New Albany, IN 47151-1147 (800) 726-8329 ► CIRCLE 666

ANALOG DEVICES North American Seminar Locations and Dates

ALABAMA	
ALADAMA	
Huntsville	October 11
ADIZONIA	
ARIZUNA	
Phoenix	October 25
CALIFORNIA	0000001 20
CALIFORNIA	
Invine	November 12
IIVIIIC	INOVEINDEL 13
Santa Clara	November 15
C D'	0 1 24
San Diego	October 24
San Jose	October 22
Sull Jose	0000001 22
Woodland Hills	October 23
COLORADO	
COLOKADO	
Denver	November 12
COMPLECTICUT	
CONNECTICUT	
Trumbull	October 24
ITumbun	0000001 24
FLORIDA	
Orlando	Ostohan 7
Uriando	October /
GEORGIA	
Aller	0 1 10
Atlanta	October 10
ILLINOIS	
Arlington Heights	November 13
Nanomillo	Ostober 17
INapervine	October 17
INDIANA	
E W	0 1 11
Fort wayne	October 31
IOWA	
10 WA	
Cedar Rapids	October 21
LOUISIANIA	
LOUISIAINA	
New Orleans	November 11
NA DVI AND	i to temper i i
MAKYLAND	
Baltimore	November 7
Daltinore	INOVEHIDEI /
MASSACHUSETTS	
Noodham	Ostabas 15
Inceutiant	October 25
Woburn	November 14
MOUNCAN	riorember ri
MICHIGAN	
Holland	October 30
1 Ionand	October 50
MINNESOTA	
Plaamington	Ostahan 16
bioonington	October 16
NEW HAMPSHIRF	
NI. L.	D 1 12
Nashua	December 12
NEW IERSEY	
Saddlebrook	October 22
NEW YORK	
NEW IOKK	
Rochester	October 15
Contal comme	0 1 22
Smithtown	October 23
NORTH CAROLINA	
B 1 1 1	
Kaleigh	October 8
01110	
Cleveland	October 29
Cleveland	October 29
Cleveland OREGON	October 29
Cleveland OREGON Tigard	October 29 October 11
Cleveland OREGON Tigard	October 29 October 11
Cleveland OREGON Tigard PENNSYLVANIA	October 29 October 11
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia	October 29 October 11
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia	October 29 October 11 November 5
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS	October 29 October 11 November 5
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS	October 29 October 11 November 5
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin	October 29 October 11 November 5 November 6
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas	October 29 October 11 November 5 November 6 November 7
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas	October 29 October 11 November 5 November 6 November 7
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston	October 29 October 11 November 5 November 6 November 7 November 5
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA	October 29 October 11 November 5 November 6 November 7 November 5
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA	October 29 October 11 November 5 November 7 November 5
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church	October 29 October 11 November 5 November 7 November 5 November 6
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON	October 29 October 11 November 5 November 6 November 7 November 5 November 6
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON	October 29 October 11 November 5 November 7 November 5 November 6
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville	October 29 October 11 November 5 November 7 November 5 November 6 October 10
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville	October 29 October 11 November 5 November 7 November 5 November 6 October 10
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN	October 29 October 11 November 5 November 7 November 5 November 6 October 10
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee	October 29 October 11 November 5 November 7 November 5 November 6 October 10 October 18
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANIADA	October 29 October 11 November 5 November 7 November 5 November 6 October 10 October 18
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA	October 29 October 11 November 5 November 6 November 7 November 5 November 6 October 10 October 18
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby	October 29 October 11 November 5 November 7 November 5 November 6 October 10 October 18
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby	October 29 October 11 November 5 November 6 November 7 November 5 November 6 October 10 October 18 October 9
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby Calgary	October 29 October 11 November 5 November 7 November 5 November 6 October 10 October 18 October 9 October 8
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby Calgary Montreel	October 29 October 11 November 5 November 7 November 7 November 5 November 6 October 10 October 18 October 9 October 8
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby Calgary Montreal	October 29 October 11 November 5 November 7 November 5 November 6 October 10 October 18 October 8 October 8
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby Calgary Montreal Ottawa	October 29 October 11 November 5 November 7 November 5 November 6 October 10 October 18 October 8 October 18 October 18
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby Calgary Montreal Ottawa Tenser	October 29 October 11 November 5 November 7 November 7 November 5 November 6 October 10 October 18 October 18 October 8 October 18 October 17
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby Calgary Montreal Ottawa Toronto	October 29 October 11 November 5 November 7 November 5 November 6 October 10 October 18 October 8 October 18 October 17 October 16
Cleveland OREGON Tigard PENNSYLVANIA Philadelphia TEXAS Austin Dallas Houston VIRGINIA Falls Church WASHINGTON Woodinville WISCONSIN Milwaukee CANADA Burnaby Calgary Montreal Ottawa Toronto	October 29 October 11 November 5 November 7 November 7 November 5 November 6 October 10 October 18 October 18 October 8 October 18 October 17 October 16

Analog. Digital. Solutions





Shift into gear and set a new pace for leading highspeed design solutions. All the short-cuts and moneysaving techniques you need to create winning products on schedule will be available at Design Seminar '96.

And we're not talking theory. This is a smart pit stop for designers who are constantly maneuvering around those elusive clock speeds. Gain invaluable insights and practical information from Analog Devices, a world leader with over 30 years experience in analog/digital design.

No matter where your expertise lies, you can renew your "pro" status with our full-day seminar series (starting in October) on these and other high-speed topics:

- · High-Speed Switching
- Video Multiplexing
- Low-Distortion, High-Bandwidth Voltage and Current-Feedback Op Amps
- Wideband, Single-Supply Systems
- Wide Dynamic Range A/D Conversion
- Narrowband and Broadband Receivers
- DDS Systems





Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106. Distribution, offices and application support available worldwide.

Admission is just \$30, which includes lunch, refreshments, a 500-page "High-Speed Design Techniques" handbook and a tote bag filled with free gifts.

Reserve your seat now by mailing a check payable to Analog Devices, Inc. Attn: Design Seminar '96, Ray Stata Technology Center, 804 Woburn Street - MS-124, Wilmington, MA 01887.

Call 1-800-ANALOGD (262-5643)[†] today for more information or to charge your ticket. For a registration

form, dial AnalogFaxTM 1-800-446-6212, then enter Faxcode "1996". Or simply contact us on the World Wide Web.

But hurry, because seating is

limited. And to stay ahead of

high-speed design, you'll have

to move fast.



Reserve your place by calling 1-800-ANALOGD (262-5643)[†] today. Seminar locations and dates listed on opposite page.

World Radio History



Finally! A line of SPDT absorptive, reflective and transfer switches that appeals to your technical side, and business side as well! It's Mini-Circuits GaAs switches...providing outstanding performance features such as very high isolation (up to 60dB), superfast 3nsec switching speed and excellent compatibility with surface mount soldering techniques. Additionally, the entire series is built extremely tough and is immediately available from stock with a 1 week shipment guarantee. At only \$2.95 (gty.10), this top-of-the-line value is priced with your bottom line in mind! To order, call or Fax Mini-Circuits with your requirements today.

Mini-Circuits...we're redefining what VALUE is all about!

Model No.	Freq. (GHz)	Insertion Loss ① dB (max.)	1dB Comp. dBm (typ.)	In-Out Iso. ① dB (typ.)	Price Sea. (qty.10)		
MSW-2-20 (Reflective)	DC-2.0	1.0	+24	34	2.95		
MSWA-2-20 (Absorptive)	DC-2.0	1.3	+27	40	3.45		
MSWT-4-20 (Transfer)	DC-2.0	1.8 TX @ 2.0 RX ③	+28 TX @ +27 RX ③	30	3.95		
U Midband, 5	500-1000N	IHZ (2) Iran:	smit (3) Rece	ive	-		
All Units: SOIC 8pin Package							

SPOT REFLECTIVI

SPDT ABSORPTIVE

Ant TRANSFER





For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBOOK. CUSTOM PRODUCT NEEDS Let Our Experience Work For You. F 174 Rev A

PRODUCT INNOVATION

Controller Simplifies A Multi-Output Power Supply

Phase-Modulating IC Controller-Based Circuits Obsolete The Magnetic **Amplifiers** Now Used In Multiple-Output, Regulated Power Supplies.



rent, isolated, power rails. For example, they may need a primary rail providing 20 A at 5 V, a 3-A rail at 12 V, and now, as supply voltages plunge, they may require another "clean" 5-A rail at 3.3 V. In most of these systems, the primary 5-V, 20-A power comes from an off-line PWM buck-topology switching regulator (a flyback or forward converter) in the so-called "silver box." Most silver boxes also provide regulated power for the auxiliary

FRANK GOODENOUGH

systems two or

(secondary side) supply rails.

Many power-supply vendors employ one or more magnetic amplifiers to provide these auxiliary regulated power rails (see "Designers still use magnetic amplifiers," p. 129). On the other hand, magnetic amplifiers, or "mag amps," have a few drawbacks. For starters, they are very expensive-in order of magnitude more than an off-line switcher. In addition, they are bulky, slow, and inefficient.

Linfinity Microelectronics has now come up with a MOSFET-based switching-supply architecture as an alternative to mag amps for multipleoutput power supplies. To implement the architecture, they developed a



ELECTRONIC DESIGN/OCTOBER 1, 1996

CONTROLLER-BASED SWITCHER REPLACES MAG AMPS



2. THE GATE OF POWER MOSFET Q1 is driven by the 50% duty-cycle square-wave output of the controller (waveform B). It maintains the 50% duty cycle at low current (a) and at high current (b) (waveform C).

pair of virtually identical controller ICs, the LX1570 and the LX1571. Each controller, combined with a MOSFET and a handful of passive parts, can create a regulated power rail based on the architecture.

The LX1570 handles currents greater than 4 A, while the LX1571 handles currents less than 4 A. Along with the controller, this phase-modulating PWM switcher also requires an additional active 3-terminal power semiconductor—a low-on-resistance power MOSFET (switch Q1) (*Fig. 1*). The controller ensures inherent synchronization of all added power switches with the primary PWM switch, even while switching at rates above 100 kHz.

Other approaches to eliminate mag amps have their own stumbling blocks. For example, in lieu of mag amps, the low-current auxiliary outputs (less than 3 A) of most power supplies today are handled by grossly inefficient linear post regulators running off the primary 5-V rail. In addition, a few supplies run buck or boost switchers off the primary rail to handle high or low currents or voltages. These types of PWM supplies are quite complex and expensive, particularly when providing isolation. They also are difficult to synchronize with each other and with the primary PWM switcher. And they may put switching noise on the primary rail that would degrade its line or load regulation.

On the other hand, supplies based on the phase-modulated MOSFETs driven by the LX1570 or the LX1571 controller can handle both low and high currents efficiently. They synchronize the MOSFET switch drive, and to boot, are low in cost (under \$3).

While it is true that mag amps are more efficient than linear regulators, particularly when the input voltage is much higher than the output voltage, no one yet knows how to get a 12-V rail from a 5-V rail with a linear regulator. And, while PWM switchers are more efficient than linear regulators, mag amps are much more efficient than linear regulators.

MORE MAG-AMP "WARTS"

As was mentioned earlier, mag amps have a number of drawbacks. They couple a demand for bulky, expensive magnetic cores with a high level of design expertise. Though mag amps have been around in many forms for over 50 years, they never been used on a widespread basis. This means that there aren't many designers around that have mag amp knowledge.

The magnetic core's poor switching characteristics limits the mag amp's frequency of operation, necessitating overly-generous design margins. These design margins, in turn, increase the size (and cost) of the mag amp's main transformer and its output inductor. The limited operational frequency also limits the response time of the final regulator.

In addition, mag amps must take the maximum input voltage (usually the rectified ac line voltage) during short-circuit conditions. That condition requires the supply designer to "overdesign" the mag amp coretypically by a factor of two-to achieve short-circuit protection. This overdesign increases the size and weight of the components of the supply, which in turn adds to the supply's final cost. For example, in the late 1940s and early 1950s, the military tried to replace vacuum tubes with mag amps when Westinghouse built a mag-amp-based autopilot for a U.S. Navy fighter plane. The autopilot took up about one cu-



3. THIS EVALUATION BOARD available from Linfinity implements a dual-output regulator.

ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History

CONTROLLER-BASED SWITCHER REPLACES MAG AMPS

bic foot (small for that day), but due to its iron and copper content, it must have weighed over 100 lbs. It operated on 400-Hz sine waves.

Mag amp efficiency is low because it is usually triggered on the leading edge of the primary switcher's PWM waveform. Consequently, it inherently transfers only a portion of the incoming energy. The Linfinity LX1570/LX1571 phase-modulating controllers essentially replace the costly mag-amp magnetic cores with low-cost power MOSFETs (*Fig. 1, again*). Moreover, their unique circuit turns on MOSFET Q1 before the PWM voltage from an isolated winding on the primary supply's PWM transformer T1, and it hits the drain of MOSFET Q1 (*Fig. 1, again, and Fig. 2*). The converter thus provides the 100% duty cycle operation required for obtaining a 100% energy transfer.

According to Linfinity, a power supply that's based on the LX1570/LX1571 controllers saves up to 70% in parts cost over a similarly rated mag-amp-based supply. The company also claims that the design effort can be cut by a factor of two and pc-board area can be cut by at least 50%.

Other features of supplies based on these current-mode controllers include pulse-by-pulse and hiccup current limiting. Hiccup-type current limiting offers long off times

DESIGNERS STILL USE MAGNETIC AMPLIFIERS

between cycles which in turn cuts power dissipation and thus improves efficiency. To further raise efficiency, the controllers also implement an under-voltage lockout feature which keeps the output drive off until the input voltage reaches the start-up threshold.

DETAILS, DETAILS, DETAILS

While the LX1571 was designed to simplify the design of switching-type post regulators, it also solves some of the problems present in similar types of switching-post regulator architectures. The following describes how this phase-modulated switching regulator works.

Power transfers from the supply's

ag-amps (magnetic amplifiers) are typically used in switching power supplies, before the output rectifier, to regulate secondary output voltages. They regulate (control) the output with a saturable core reactor that exhibits square B-H characteristics. That is, the core material has a very high permeability when it is not saturated but it switches to a very low permeability when saturated. By controlling the amount of magnetic dc flux inside the core, the mag amp controls the amount of time, or volt-seconds, that it takes for the core to saturate under a given input-voltage pulse. When mag amps are used as secondary post regulators in switching power supplies, they employ this control method (see the figure).

Although the block diagram looks simple, there are several aspects of the design that must be considered

for proper operation. The volt-second withstand (V-s withstand) capability of the mag amp is directly proportional to the number of turns of wire on the core and its cross sectional area. This is expressed by:

 $V \times t$ (V-s withstand) =

$B_s \times N_m \times A_e$

where

 B_s is the saturation flux density of the core;

 N_m is the number of turns of wire on the mag amp;

 A_e is the effective cross-sectional area of the mag amp core.

To achieve wide-dynamic-control range demands that the mag amp have both a large number of turns and a large core. The large size exacerbates the problem when the design must limit output current.

In addition, the mag amp exhibits a residual inductance even after it saturates. To complicate matters, the large number of turns on the core exaggerates this residual inductance. This residual inductance reduces the effective maximum duty cycle that is available to transfer power to the output. The effective-duty-cycle-reduction is proportional to the output current. The output voltage is then expressed approximately as follows:

$$V_{OUT} = V_s \times 5d - (I_{OUT} \times 5L_{mr})$$

where

V_{OUT} is the regulated output voltage from the supply;

 $V_{s}\,is$ the secondary voltage of transformer T1;

d is the switch duty cycle on from the primary of T1;

 $I_{OUT}\xspace{ output current; } L_{mr}\xspace{ is the mag-amp's residual inductance. }$

Therefore, T1 and the mag amp power switches in the primary side have to be overdesigned to endure the higher RMS currents that will result.



ELECTRONIC DESIGN/OCTOBER 1, 1996 World Radio History

CONTROLLER-BASED SWITCHER REPLACES MAG AMPS

input to its output only when the output from the LX1571 controller is high, turning on MOSFET Q1, and when the voltage across the secondary of the power transformer T1 (V_{ba}) is positive. Energy is only transferred to the output when the voltage applied to the drain of Q1 is positive with respect to Point A on T1, and when Q1 is turned on by the output of the controller.

When both of these voltages are high, the voltage from transformer T1 minus the supply's output voltage V_{OUT} develops across the energy storage inductor L_{out} and the current ramps up. Diode D1 conducts. The current-sense transformer picks up the inductor current and scales it up or down (as required) by its turns ratio. The current-sense transformer's output develops a voltage across the current-sense resistor proportional to the inductor current.

The chip's current-sense comparator compares the voltage across the current-sense resistor with the output of the error amplifier. This error voltage is a function of the amplified difference between the power-supply's output voltage (the negativevoltage feedback set by resistors R1 and R2) and the LX1571 controller's 2.5-V reference. This voltage feedback, including resistive divider R1 and R2, sets the output voltage of the power supply.

The architecture's current-mode control offers fast transient response. It feeds forward input-voltage changes, and its control loop is easier to compensate since it contains one less pole than a voltage-mode switcher. These features are not available from mag-amp-regulated power supplies.

Supplies based on these controllers are unique because they apply gate drive to MOSFET Q1 before the secondary voltage of T1 goes positive at Point B (T1's connection to drain of Q1). The controller phase-modulates (duty-cycle modulates) the gate of Q1 by turning it off when the peak inductor current reaches the level set at the output of the error amplifier. In contrast, most other switching-post regulators, including mag amps, employ leading-edge modulation. The LX1570/71's duty-cycle modulation scheme makes simple current-mode control possible.

SYNCHRONIZATION

As noted earlier, a multiple-output supply based on the LX1570/1571 substitutes a power MOSFET for a mag amp. Much of the controller chip's duty cycle, timing, and logic-control circuitry is unique. The controller's duty cycle modulates the secondary voltage of T1 (waveform A) by phase shifting the gate-drive waveform to

SUPPLY BASED ON THE LX1570/ LX1571 SAVES UP TO 70% IN PARTS COST OVER A SIMILARLY RATED MAG-AMP SUPPLY. THE DESIGN EFFORT CAN BE CUT BY TWO AND PC-BOARD AREA BY AT LEAST 50%.

the power MOSFET (waveform B) in relation to the secondary voltage of T1 (*Figs. 1 and 2, again*). In the logiccontrol block, the LX1571 controller's oscillator is synchronized with the main PWM oscillator on the trailing edge of the current waveform (waveform C). That's when the peak inductor current has reached the level set by the error amplifier and the output latch has been set by the PWM (current-sense) comparator.

Unlike most PWM switchers, the LX1571 drives (phase/duty-cycle modulates) power MOSFET Q1 with a transformer (gate-drive transformer T2). To simplify the coupling of the LX1571 controller's output to Q1, it drives T2 with a 50% duty cycle square wave (waveform B), ensuring that it will never be saturated with a dc current. The controller's circuit produces this 50% duty cycle drive by creating a symmetrical (triangle) waveform across the PWM oscillator's external timing capacitor, C_T (waveform D). The circuit sets the capacitor's charge and discharge currents equal to each other to create the symmetrical triangular wave.

The circuit synchronizes the oscillator and terminates the timing capacitor's charging on the falling edge of the waveform across the currentsense resistor (waveform C). Notice that the controllers output duty cycle (waveform B) does not change-the current-sense voltages (waveform C) have different duty cycles (Fig. 2, again). The minimum-current comparator has a lower reference voltage (0.25 V) than the current-sense comparator (1.5 V). It helps synchronize the oscillator when the output of the error amplifier slews faster than the inductor current.

The voltage mode hiccup comparator monitors the two inputs of the error amplifier. If the inverting input of the amplifier drops 0.5 V below the non-inverting input (which might happen if the output is overloaded), this comparator sets the hiccup latch which forces a soft-start by discharging the soft-start capacitor with npn transistor Q2. The current mode hiccup comparator also forces the soft-start capacitor to discharge if the voltage across the current-sense resistor exceeds 1.5 V. These multiple soft-start circuits virtually eliminate overshooting regardless of the size of the load. They are unique to the LX1570/71 controller's architecture and patents for the approach are pending As the Linfinity evaluation board shows, a dual, high-output-current power supply, built with the LX1570/1571 controller requires only a few, small (including the inductors), external components (Fig. 3). \Box

PRICE AND AVAILABILITY

The controller comes in 8-pin DIP and SOIC packages. In quantities of 1000, the LX1570 and the LX1571 are priced at \$2.65 each.

Linfinity Microelectronics, 11861 Western Ave, Garden Grove, CA 92641; Reza Amirani, (714) 372-3566. CIRCLE 501

HOW VALUABLE?	CIRCLE
HIGHLY	534
MODERATELY	535
SLIGHTLY	536

PRODUCT INNOVATION

Single-Rail RF Power Amps Target DCS And PCS Bands

New Levels Of Power And Efficiency Are Achieved With GaAs-Fabricated Parts.

PAUL MCGOLDRICK

he digital and personal communication services (DCS and PCS) demands for RF power continue to fan the creative flames of the RF design engineer. A case in point: Anadigics' AWT1901X, which features a 4.8-V single power rail operation, and its companion 6-V part, the AWT1900X—the first products by the company to support the U.S. and European PCS markets. Covering the DCS 1800 band (1710-1785 MHz)

and the PCS 1900 band (1850-1910 MHz), the monolithic GaAs AWT1901X IC produces an output signal of 32 dBm with a power-added efficiency (PAE) of 45%.

With 25 dB of power gain, the IC needs just 7 dBm of RF drive. Gain is achieved over three stages (*Fig. 1*). The control of input attenuation and the bias to each stage are actively adjusted for optimum conditions by a reference voltage ($V_{\rm REF}$). The reference is a pulsed source between 0 and +4 V, as specified in the DCS1800 system specification. Typically, the pulse would have about a 575-µs duration with a 12.5% duty cycle (the $V_{\rm REF}$ input point is a high impedance). The negative supply of V_{SS} is between -4.0 and -4.8 V, and is derived from the on-board dc-dc converter from the +4.8-V supply rail (V_{GEN}). The converter is rated at 3 mA. The bias voltage is supplied as V_{DB} at +4.8 V.

When the IC is powered, up the V_{GEN} supply must be activated before any of the +4.8-V rails to the three drain terminals are applied. Maximum



World Radio History



The Flash Data Storage Leader

SanDisk Corporate
Headquarters
140 Caspian Court
Sunnyvale, CA 94089
http://www.sandisk.com

SanDisk International Offices Europe: 49-511-8759185 Japan: 81-45-474-0181 Asia/Pacific Rim: 852-2712-0501

SanDisk is a trademark of SanDisk. All other trademarks or registered trademarks are the property of their respective owners. Sarcifications and product offerings subject to change without notice. @1996 SanDisk Corporation.

SINGLE-RAIL MMIC RF POWER AMPLIFIERS



2. MAXIMUM POWER OUTPUT AND EFFICIENCY from the chip occur when the reference voltage is at about 2.5 V.

ratings are +7.5 V, so considerable tolerance is available for the design of the part into battery-powered applications. Input impedance to the chip is 50 Ω , with a typical input return loss of 10 dB. Output loading for the device for 50 Ω usually occurs through a 5:1 (length:width) microstrip and a shunt of about 3 pF. Output matching is, of course, critical in achieving the rated power output and efficiency.

Harmonics at the output, with good matching, fall below -35 dBc for the second harmonic, and below -45 dBc for the third harmonic. Spurious outputs will fall below -80 dBc for 6:1 voltage-standing-wave ratios (VSWRs) at any phase angle.

Using Anadigic's reference design, the output power reaches +32 dBm when V_{REF} is at about 2.5 V (*Fig. 2*). The efficiency peaks at the same point. The efficiency curve's linearity is impressive from the 0% point (where output equals the input) to the maximum. The noise produced in the receive channel should be lower than -80 dBm in a 100-kHz band.

The small SSOP28 package used has the space occupied by the four central leads on each side, forming two "batwing" conductors for RF and dc ground. These conductors also assist in heat conduction. In addition, the bottom of the package contains a "heat slug" that reduces the thermal resistance to less than 30° C/W.

Pricing of the part makes it an economic alternative to discrete and hybrid solutions. On top of that, it saves space and power-supply rails. Like all GaAs products, the part's performance results are highly reproducible and cost-effective.

The IC is manufactured with Anadigic's 0.5-µm MESFET technology at their GaAs facility in Warren, NewJersey. Apart from the chip's role as the final device in cellular and personal communications devices at the 1.9-GHz level, it's expected to be used as a 1-W driver for high-power levels in base stations, and as a medium power amplifier in nonlinear modulation systems. □

PRICE AND AVAILABILITY

The AWT1901X is packaged in a 28-pin SSOP plastic package with pins 6 through 9 and 20 through 23 being solid "batwings" for heat-sinking and acting as RF and dc grounds. Pricing is \$7 each in quantities of 10,000 and \$4 each in quantities of 100,000. Production quantities are available now.

Anadigics Inc., 35 Technology Dr., Warren, N.J. 07059; telephone (908) 668-5000; fax (908) 668-5132. CIRCLE 500

How VALUABLE?	CIRCLE
HIGHLY	525
MODERATELY	526
SLIGHTLY	527

ELECTRONIC DESIGN/OCTOBER 1, 1996



EDATOOL DELIVERS A Spice-based, full-featured simulation tool that offers 14 types of analyses and over 8000 device models is available at a price as much as 10 times lower than competing solutions. Besides the expanded range of analyses options, the most recent version of Electronics Workbench EDA developed by Interactive Image Technologies Ltd., Toronto, Canada, is claimed to run simulations 10 times faster than its predecessors. With this added functionality, designers now can, for example, use the Monte Carlo function to analyze the transient, ac, and dc circuit response to random variation of device parameters within a distribution of tolerances. Additional features include: click-and-drag schematic editing; scrollable waveforms and autoscaling graphs; export to standard pe-board layout packages; and import and export of standard Spice net lists. The software runs on the Windows 95, Windows NT and Windows 3.1 operating environments. It is priced at \$995. For more information call (800) 263 5552. *Js*

CONTENT-ADDRESSABLE RAM TARGETS MAINSTREAM USE With the advent of ATM switching as a practical reality, interest in content-addressable-memory (CAM) technology has risen. Now, a proprietary CAM design promises to bring their prices down to a practical level as well. The key to the cost reduction, according to Motorola's Fast Static RAM Div., Austin, Texas, is the use of a four-transistor SRAM cell instead of a six-transistor cell. Prices for the chip will start at less than \$20 each, compared to today's average industry price of \$80 for a 4k-by-64-bit solution. Functionally, a CAM provides the reverse of ordinary memory access. Instead of a memory address or addresses being used to find data, the data itself provides the address. This comes in handy in large, sparsely populated address spaces because a small chip can be used to handle what would appear initially to require a much larger memory. Motorola will soon sample the 4k-by-64 bit MCM69C232 and the 16k-by-64 bit MCM69C432. In each part, the widths of the match field and the output field are programmable, and the match time is designed to be 160 ns. For more information, call (512) 933-7726 or visit the web site www/mot.com/FastSRAMs. JS CIRCLE 691

IC OFFERS WIRELESS LAN TRANSCEIVER FUNCTIONS Controller chip and an intermediate-frequency (IF) modulator/demodulator. Integrated on Harris Corp.'s (Melbourne, Fla.) HSP3824 processor are ADCs, an IEEE 802.11 packet-generation state machine, a DBPSK/DQPSK differential data encoder, a PN-code data spreader, and a media-access-control-to-physical-layer (MAC-to-PHY) interface optimized for IEEE 802.11. The chip handles up to 4-Mbit/s continuous or packetized data at a 22-Mcps chipping rate and can generate its own synchronization preamble or header, or accept the preamble and header information in the MAC. The DSSS wireless LAN utilizes the license-free 2.4-GHz ISM band. Packaged in a 48-lead ultra-thin quad flat pack, the HSP3824 is available now for \$21.36. For more information, contact Harris at 1 800 4-HARRIS, ext. 7497. JS

MULTIPROCESSOR DSP TARGETS IMAGING Designers of digital video, graphics, imaging, and other high-speed visual communications applications should find their jobs easier thanks to a new digital signal processor that offers 1.6 billion operations/s performance and typical power dissipation of less than 3 W. Integrated on the TMS320C82 developed by Texas Instruments Inc., Dallas, are two on-chip DSP engines, a RISC microprocessor core with a floating-point unit, an advanced memory-transfer controller, and large instruction and data caches. Fabricated in 0.5-µm technology, initial versions of the TMS320C82 will run at 50 MHz and won't require an external heat sink. The chip's architecture also will help reduce system costs. It interfaces to extended-data-out (EDO) memory for faster access while still maintaining compatibility with popular memory types, such as DRAMs, SRAMs, VRAMs, and SDRAMs. The chip is packaged in a 352-pin, small-footprint ball-grid array (BGA) and will be available now in sample quantities. When production quantities become available in the first quarter of 1997, their price will be \$82 in quantities of 25,000. For more information, visit TI's web site at www.ti.com. JS

INCREASE YOUR REACH into important wireless markets... ...with WIRELESS SYSTEMS DESIGN.

Wireless Systems Design is in a class by itself. The first design magazine to serve the wireless industry, it is the only monthly magazine devoted to the wireless systems



designer—that engineer tasked with creating some of the hottest new elec-



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.

Published since April 1994 Wireless Systems Design reaches more than

50,000 design engineers. Starting with the April 1996 issue, you can reach these wireless systems designers every month. You'll find more of them



reading Wireless Systems Design than any other monthly publication. For advertising rates call Matt Carey National Sales Manager at (201)393-6229



FOR DESIGNERS OF COMMUNICATIONS AND COMPUTER SYSTEMS A PENTON PUBLICATION 611 ROUTE #46 WEST HASBROUCK HEIGHTS, NJ 07604 TELEPHONE 201-393-6229 FAX 201-393-6297



COMPONENTS LINEAR OPTOCOUPLER SUITS ISOLATION AMPS

The LOC Series of linear optocoupler is intended for isolation-amplifier designs for the automotive, telecom, medical, and instrumentation industries. Applications include process control (isolated 4-20 mA loops), iso-



lated power-supply feedback, motor speed control, and audio signal coupling. Its design uses an infrared LED coupled with two phototransistorsone in a servo-feedback loop that generates a control signal to compensate for the LED's nonlinear temperature characteristics, and the other to provide an output signal that's linear with respect to the servo LED current. The LOC features a wide (200 kHz) bandwidth to couple analog and digital signals, and has low input/output capacitance. It is certified to EN41003 and EN60950 specifications and is designed for use as a transformer replacement for telephone-line coupling. VB

CP Clare Corp., 430 Bedford St., Lexington, MA 02173-1548; (617) 863-8707. GRELTOO

DESIGN SYSTEM DELIVERS MEMBRANE SWITCHES FAST

Design issues can be worked out early for membrane switches, prior to expensive tooling and production, using Steven Label's in-house Rapid Prototyping System. Starting from a sketch or from an existing Mac or PC file. the system can produce parts nearly indistinguishable from those in the final production run. Intricate shapes to within ± 0.002 in. can be secured by utilizing the system's computer-controlled laser-cutting facility. Combined with advanced color printing and laminating technologies, the system can deliver near-production quality prototypes in a matter of days. All cutting and assembly takes place in a single session, and on the same day if required. VB

Steven Label, P.O. Box 3688, 11926 Burke St., Sante Fe Springs, CA 90670-2508. (310) 698-9971.

ROCKER SWITCHES MEET EUROPEAN STYLE

The New Generation Rocker (NGR) Series of rocker switches from Eaton incorporate European styling and ergonomic design. The switches include a new design of rocker shape and bezels. They are molded from thermo-



plastic in a soft matte finish to reduce glare and improve aesthetics. The replaceable rockers snap on and off the switch body. They feature a set of small dimples across their top edge to ensure a positive tactile feel during activation. Illuminated versions accommodate two 14- or 28-V dc dependent or independent lamps, with illumination supplied through snap-in lenses or a onepiece backlighted construction. Snap-in lenses are available in red, green, amber, and blue, with engrave, hotstamped, or pad printed legends. Single-piece backlighted rockers are available with custom colors and legends. A variety of standard legends, as well as custom features, are available. The NGR Series feature a standard ten-terminal configuration that provides a full range of popular switching circuits, including SPST, SPDT, DPST, and DPDT, with maintained or momentary action. Available ratings include up to 15 A at 125 V ac, 15 A at 28 V dc, and 10 A at 250 V ac, with a slow-make/slow-break contact mechanism specifically de-

ELECTRONIC DESIGN/OCTOBER 1, 1996

signed for use in ac and low-voltage dc applications. The switches meet UL and CSA standards. VB

Eaton Commercial Controls, 310 East Johnston St., Smithfield, NC 27577; (800) 526-5476. GRGLE 702

RELAYS SUIT TEST AND MEASUREMENT APPS

The fully sealed R72 Series of subminiature 1-A relays is designed specifically for use in office-automation and testand-measurement instruments, where high sensitivity and low power consumption is a must. It has a DPDT con-



tact arrangement, and is available in a dual coil latching type. The R72 offers coil voltages of 5, 6, 12, and 24 V dc. Dielectric strength is 1000 V ac between coil and contacts, 250 V ac (latching) between set and reset coils, 750 V ac between contacts of the same polarity, and 1000 V ac between contacts of different polarity. VB

NTE Electronics, Inc., 44 Farrand St., Bloomfield, NJ 07003; (800) 631-1250. CHELTOS

RELAYS MOUNT ON DINRAIL

The MS11-CX240D5 Series of solid-state relays offers the reliability of the company's Series CX for printed-circuit boards with clip-fastened DinRail mount-



ing. In addition, the MS2-D2420 features the panel-mount Series 1 with a factory matched heat sink for thermal management. A wide range of relay options are available. VB

Crydom, 411 N. Central Ave., Glendale, CA 91203-2020; (818) 956-3900. EHELE 704



PACKAGING MEZZANINECARD CONNECTOR STACKS VME

The 5015 series of connectors supports the IEEE's P1386 standard for mezzanine-card installation in industrial computer applications, such as VME, Futurebus+, and other host



cards. It can be used with standard PCI and S-bus mezzanine cards in 64-, 128-, 192-, or 256-circuit combinations, with stack heights of 8 through 15 mm. The mezzanine-card connection system supports both the CMC (common mezzanine card), and PMC (PCI mezzanine card) standards, as well as those adopted for S-bus cards. The two-piece plug-and-receptacle connector series uses the company's leaf style contact design to ensure mating integrity and repeated mating cycles. Contacts are phosphor-bronze with gold plating in the mating area, with tin-lead solder tails. VB

ELCO/AVX Corp., P.O. Box 867, Myrtle Beach, SC 29578; (803) 448-9411. EFELE705

MODULAR ENCLOSURESFIT MULTIBAY APPLICATIONS

The PS Plus line, part of the PS 4000 series of enclosures, is designed specifically for multi-bay applications and accommodates various mounting-panel installation methods. The PS 4000 family is based on a patented 9-fold frame profile, which provides strength and stability to the overall enclosure. The unique hole pattern of the frame facilitates the installation of mounting panels, cable-collecting rails, swing frames, and hundreds of accessories, and also makes it possible to interconnect enclosures. The PS Plus line features heavy gauge walls and a roof that enable the enclosure to be laid on its back for mounting, panel installation, and transport. It also includes an integrated modular plinth that allows for easier



transportation and system expansion. Other features include heavy-duty lifting brackets, mounting-panel lifting blocks, and integral door stops. Refined flange-mounted disconnect hardware offers a smooth, multi-door interlock system with decreased friction. VB

Rittal Corp., One Rittal Pl., Springfield, OH 45504; Robin Coffey, (513) 399-0500. CHELE 706

SOCKETS, HEADERS PITCH 2 MM FOR HIGH DENSITY

Quad-row sockets, headers, and board stackers with a contact pitch of 2 mm significantly increase boards densities and stacking flexibility. The SQT Series of phosphor-bronze tuning-fork contacts are for low-profile and perpendicular-to-board contact applications,



and mate with 2-mm headers in the TMM Series. These interconnects are available in either two- or four-row designs. For high-density applications, both elevated sockets (ESQT Series) and elevated board stackers (TW Series) are available with either two or four rows. Body position on board sockets and stackers may be specified on the posts or tails in 0.005-in. increments. This arrangement achieves mated board spacings of up to 1.40 in. with 0.090-in. tails for soldering in throughhole boards. These sockets have 0.020in. square tails and accept standard 0.020-in. square post terminals, allowing them to self-nest. VB

Samtec, P.O. Box 1147, 810 Progress Blvd., New Albany, IN 47151-1143; (812) 948-5047. EFECE 107

SENSOR TERMINAL BLOCK DETECTS OPENS, SHORTS

False signals caused by broken wires or short circuits in proximity-sensor applications create unwanted downtime. The EIK, inserted between the input terminal and sensor/limit switch, detects these opens and shorts. Other features include the mechanical advan-



tages of a terminal block, multipoint bridging, and LED signaling of the sensor's switching state. VB

Phoenix Contact, P.O. Box 4100, Harrisburg, PA 17111; (717) 944-1625. **EHELE 708**

LAN AND ISDN Connectors Oust EMI

The one-piece construction of the plug shell and clamp in the TM11 line of modular connectors provide excellent EMI protection for ISDN applications. To protect equipment circuitry, the jack shielding engages and locks first upon mating. A metal shell offers ESD protection, and a plastic cover is provided for added strain relief. Available in either 6 or 8 positions, the plug is fully compatible with the current line of TM connectors, which in turn replaces the unshielded industry-standard RJ11 and RJ45. The TM11 also is intermateable with other commonly used shielded jacks. Plugs are available in a variety of colors and jacks with a black molding and beige panel. VB

Hirose Electric Inc., 2688 Westhills Court, Simi Valley, CA 93065; (805) 522-7958. GIRCLE 709



POWER DIODE BRIDGE SUITED FOR DYNAMIC BRAKING

The VUB 60 3-phase ac-dc diode bridge includes a high-voltage IGBT and free-wheeling diode for motor controls that feature dynamic braking. Output current rating is 59 A dc at a heat-sink temperature of 110°C. Voltage rating of the input diodes is 1200 V (VUB 60-12N01) or 1600 V (VUB 60-16NO1), which allows the bridge to be used on line voltages up to 600 V rms. The IGBT can carry up to 11 A at the same heat-sink temperature, or 21 A at 80°C. Its isolation voltage rating is 1000 V for controlling bus voltages up to 750 V. Th 1000-V. 21-A free-wheeling diode handles any reactive currents from the braking resistor. The module can be wave-soldered to a pc board and additionally secured by four self-tapping screws. The isolation-voltage rating of the mounting baseplate exceeds 3600 V rms. Creepage and strike distances meet UL, CSA, and VDE requirements. Pricing for 100-piece quantities is \$56.55 for the VUB 60-12NO1 and \$65.16 for the VUB 60-16NO1. ML

IXYS Corp., 3540 Bassett St., Santa Clara, CA 95054; (408) 982-0700. CEELE 710

TRIPLE-OUTPUT CONVERTER KEEPS A LOW PROFILE

With a footprint of just 2 by 3 in. and a profile of only 3/8-in. high, the NB50T pc-board-mounted supply is perhaps the industry's smallest triple-output 50-W dc-dc converter. The 200-kHz converter accepts 28 V dc with a range from



14 to 40 V, and provides triple output voltages of 5 and ± 12 , or 5 and ± 15 V. Line and load regulation are better than 0.1% over the entire range for all outputs. Remote sensing is standard to compensate for up to a 0.5-V dc drop in leads when remotely located from a load. A built-in test feature provides an output power good signal for fail-safe operation, and an output trim pin is

provided to further compensate or fine-tune the output voltages. TTL on/off logic is standard, and a sync pin is provided for frequency synchronization to other modules or a system clock. Also available are the NB50TI converters for industrial applications, which operate without derating over a 70°C temperature range. NB50TM military units deliver full output power without derating from -55 to +100°C. All versions offer power densities approaching 30 W/in.³ and 90% efficiency, which eliminates the need for heat sinking or special cooling. VB

Abbott Electronics Inc., 2727 S. La Cienega Blvd., Los Angeles, CA 90034-2643; (310) 202-8820. [EEEE711]

SINGLE CHIP CONTROLS BRUSHLESSDC MOTORS

The ML4428 single-chip, sensorless, brushless dc-motor controller has a fast-starting circuit that determines a rotor's position and applies the optimal waveform to bring the motor up to speed with minimum delay. The chip contains all of the circuits needed to start and run the motor in forward or reverse, and maintain preselected speed within ±5%. A back-EMF sensing circuit maintains selected speed without the use of Hall-effect sensors or microprocessors. Speed is set by a resistor divider, potentiomenter, or an external analog voltage. In fractional-horsepower applications, the ML4428 can begin motor rotation in as a little as 100 ms. The controller uses pulse-width modulation for maximum efficiency, or linear control for minimum noise. For quantities of 1000, the device is priced at \$7.50 each in a 28-pin plastic DIP and \$7.70 each in a 28-pin SOIC. ML

Micro Linear Corp., 2092 Concourse Dr., San Jose, CA 95131; (408) 433-5200. ERGLE 712

IGBT CHALLENGES MOS-FETS FOR POWER CONTROL

The industry's first 600-V, 3-A IGBT built on size-1 die challenges size-3 MOSFETs in fractional-horsepower motor-control and line-voltage switching power-supply applications. Since size-1 IGBT die are smaller than size-3 MOSFET die, cost is 20% to 25% less. The new UFS (ultrafast switching) IGBTs are rated for 6-A and 600-V breakdown at a 25°C case temperature (3 A at 110°C). At 25°C, guaranteed

ELECTRONIC DESIGN/OCTOBER 1, 1996

maximum saturation voltage is 2.2 V. For ultrafast switching at 150°C, with 480 V driving 3 A and a 15-V gate drive, maximum guaranteed current fall time is 275 ns, and maximum guaranteed turn-off energy is 245 µJ. Power tools and small appliances are typical end applications in motor control. Switchingsupply applications include PCs and home-entertainment systems, uninterruptible power supplies, portable welding equipment, and battery chargers. Low conduction and switching losses enable the IGBT to switch at rates of 50 kHz up to 2.9 A at 180 V, and up to 2.1 A at 480 V. In quantities of 1000, two devices without anti-parallel diodes-the HGTD3N60C3 (TO251AA) and HGTD3N60C3S (surface-mount TO-252AA)-cost \$0.79 and \$0.81 each, respectively. Three devices with internal ultrafast diodes-the HGTP3N60C3D (TO220AB), HGT1S3N60C3D (TO-262AA), and HGT1S3N60C3DS (surface-mount TO263AB)-cost \$1.18. \$1.38, and \$1.48 each, respectively. ML

Harris Corp., P.O. Box 883, Melbourne, FL 32902-0883; 1-800-4-HARRIS, ext. 7490. CECLE 713

FAST BUCK CONVERTER SUITS HIGH-END MPUS

The SI9140CY buck converter from Siliconix (a member of Temic Semiconductors) provides a 5-µs transient recovery time for power conversion in high-end microprocessor applications. With a 100-kHz feedback bandwidth, it regulates within a \pm 7-mV (or a \pm 2.25%) margin, which is within the range specified for the Intel Pentium microprocessor. The converter requires four external low-on-resistance power MOSFETs and three 330-uF OSCON capacitors on the power-supply output to meet the demands of submicrosecond current transients up to 10 A. The input voltage range is 3 to 6.5 V, high-frequency switching capability exceeds 1 MHz, and a wide bandwidth feedback loop provides tight, absolute static, and transient load regulation. Conversion efficiency exceeds 85% from a 10-A peak load down to 0.5 A. The Si9140CY comes in an SOIC-16 package and is priced at \$1.75 each in 100,000-piece quantities. Availability is 8 to 10 weeks for large orders. ML

Siliconix, 2201 Laurelwood Rd., Santa Clara, CA 95054-1595; (408) 567-8220. CRELE 714



DIGITAL ICS

SINGLE CHIP INTEGRATES MPEG-1 VIDEO, VGA GRAPHICS

PEG-1 technology could be considered as being fairly matured, relative to PC lifetimes. Likewise, 2D graphics technology is ready to apply for Social Security. But the two technologies haven't yet crossed paths, at least not in the same piece of silicon. That's changed with the development of the RealMagic64/GX video and graphics accelerator.

The 64-bit VGA graphics accelerator integrates a RAMDAC and video processor that combines high-performance graphics with full-screen real-time video playback. It offers both horizontal and vertical video scaling with linear X-Y interpolation as well as YUV-to-RGB color-space conversion and a BitBLT engine. As a result, systems can run interactive multimedia applications with MPEG-1 video content. The chip takes advantage of Microsoft's DirectX acceleration in hardware. The RealMagic64/GX DirectX drivers and CD Station software allow existing MPEG software titles and Video CD movies to run at 30-frame/s fullscreen resolutions.

Designed for the desktop PC market, the chip is pin-compatible with S3's Trio64V family, making it a simple upgrade. From 1 to 4 Mbytes of fastpage, EDO, or burst-mode DRAM are supported. The chip's pixel clock is programmable up to 135 MHz, while the memory clock can be programmed up to 80 MHz. Software drivers are included for Windows 3.1, WIndows 95, and Windows NT.

Sigma Designs Inc., 46501 Landing Pkwy., Fremont, CA 94538; (510) 770-0100. €EEEE 715 ■ RICHARD NASS

HIGHLY INTEGRATED RISC ENGINE DELIVERS 15 MIPS, TRIMS POWER

highly-integrated solution for portable computing and personal electronic systems, the CL-PS7110 CPU delivers the highest MIPS/W rating of any available 32-bit RISC processor-15 MIPS with a power drain of just 66 mW. The integrated CPU is based on the ARM-7100 processor core and integrates a full complement of peripheral support functions that will suit the chip for applications such as high-end palm-top computers, and mobile web browsers. Developed by Cirrus Logic, the CL-PS7110 also includes full system support for the recently released EPOC/32 operating system from Psion Software PLC. That software provides a full operating system environment that supports all operating systems announced for the ARM processor-the JavaOS from JavaSoft, Tornado from Wind River, and VRTX/mc from Microtec.

The processor delivers the equivalent performance of a 33-MHz Intel 486based PC and includes a unified on-chip instruction and data cache of 8 kbytes with an integral memory-management unit, and the ability to address up to 256 Mbytes of DRAM as well as offchip SRAM, ROM, and flash memory. The memory controller allows the processor to easily interface to 8-, 16-, or 32-bit memory subsystems, thus eliminating the need for glue logic.

Peripheral support functions integrated on the chip consist of an LCD controller, a PCMCIA card interface controller, asynchronous and synchronous serial interfaces for communications, an IrDA-compatible protocol controller, a dc-dc converter, and a codec interface for audio and telephony applications. Power management logic on the chip keeps the active current to just 20 mA and the idle-mode current to only 4 mA. The standby mode consumes the least current—a bare 3 µA. The LCD controller can interface to single-scan monochrome panels. The panels can be any width from 16 to 1024 points (in 16-pixel increments), with 1, 2, or 4bits per pixel for gray-scale control. Two 32-bit palette registers support 4-, 2-, or 1-bit pixel values for mapping to any of the 16 gray-scale values. The EPOC32 OS licensed from

ELECTRONIC DESIGN/OCTOBER 1, 1996

Psion provides a full multithreaded, preemptive multitasking microkernel that also includes fast message handling, dynamically installable device drivers, and execute-in-place capability. For software development, all the programming tools previously available for the ARM processor—compilers, debuggers, languages, etc.—can be used to develop new code.

Housed in a 208-lead very thin quadsided flat package, the CL-PS7110 is available in production quantities and sells for \$18 apiece in lots of 100,000 units. For development needs, an evaluation card that includes an LCD panel, PCMCIA interface, 1 Mbyte of flash memory, 2 Mbytes of DRAM, an RS-232 interface, an IrDA interface, an analog audio interface, and a speaker will sell for about \$950 each.

Cirrus Logic Inc., 3100 West Warren Ave., Fremont, CA 94538-6423; Ashis Khan, (510) 226-2373.

Psion Inc., 150 Baker Ave., Concord, MA 01742; (508) 371-0310.

DAVE BURSKY

8-BIT MICROCONTROLLER CARRIES LCD DRIVERS

The PIC16C9XX family of 8-bit, onetime-programmable microcontrollers include an integrated LCD controller for use in medical instruments, power meters, toys, voice recorders, and appliances. The PIC16C923 and PIC16C924 have an 8-MHz clock input speed and a 500-ns instruction cycle with a 4k-by-14-bit on-chip EPROM program memory and 176-by-8-bit general-purpose SRAM registers. Other features include 60 special-function hardware registers, 8-level-deep hardware stack, interrupt capability, 25 I/O pins, and a PWM output port. The devices operate on 3.0 to 6.0 V and consume under 2.0 mA at 5.5 V and 4 MHz. The programmable LCD timing module offers multiple timing sources and can drive an LCD panel while in the sleep mode. Available in 64-lead TQFPs and 68lead PLCCs, unit pricing in 1000-piece lots of commercial temperature versions is \$7.09 for the PIC16C923 and \$7.84 for the PIC16C924.ML

Microchip Technology Inc., 2355 West Chandler Blvd., Chandler, AZ 85224-6199; (602) 786-7200.

CIRCLE 718



SOFTWARE SOFTWARE ADDS PHONE FUNCTIONS TO WINDOWS95

Add-in board developers can increase the functionality of their products by bundling version 2.0 of the Phoenix Telephony Suite. The software, which is designed to work with Windows 95, features a full-duplex speaker phone, a voice-mail system with 99 mailboxes, a fax center, a speed-dial list, call screening, and a personal address book. The Telephony Suite takes advantage of some of Windows 95's features, such as the Telephony Application Program Interface (TAPI). Using the Microsoft TAPI, the software works seamlessly with all TAPI-compliant products from third-party vendors. One piece of the Telephony Suite is the Secretary, a voice-enabled remote-access system that lets mobile users access their mailboxes from the road; manage the mailbox and change the greeting; "listen" to and forward faxes; and review address-book information. The software is power-management-aware, meaning that an incoming call can "wake up" the system. RN

Phoenix Technologies Ltd., 846 University Ave., Norwood, MA 02062; (617) 551-4000. CEELE 719

OS SUPPORTS RECON-FIGURABLE COMPUTING

Giga Operations Corp. has released new MS-DOS and WindowsNT versions of its Reconfigurable Computing Development Software for Xilinx software developers and the Spectrum Reconfigurable Computing Platform. Release 3.0 is the 16-bit MS-DOS version, and Release 3.1 is the 32-bit WindowsNT version. The Spectrum architecture uses Xilinx FPGAs in plug-andplay modules. The open architecture is modular, scalable, reconfigurable, and is supported by third-party developers. Performance gains of 1X to 100X have been demonstrated over conventional CPUs and DSPs. Both releases facilitate the software control of Xilinx chips for data-processing and data-routing applications by providing an OS, a compiler, languages, diagnostic tools, and I/O and monitor libraries. Releases 3.0/3.1 offer several enhancements over Release 2.2. A new XGEN program adds FPGA logic-generation capability for memory interfaces, reading and writing variables from the host, FPGA function calls, FPGA/FPGA communications, and debugging functions. Also added are runtime debugging of FPGA registers, new automatic module memory initialization and retrieve routines, and the allocation of FPGA processing elements at run time. A new version of diagnostics (gdiag.exe) checks system I/O performance. The prices of Release 3.0/3.1 are \$1750 and \$2500, respectively. Tutorials (including realtime video) are included. ML

Giga Operations Corp., 2510 Martin Luther King Dr., Berkeley, CA 94704; (510) 848-5446; fax: (510) 848-5667<u>: e-mail: g</u>oteam@gigaops.com.

CIRCLE 720

SOFTWARE-DEVELOPMENT KIT SUITS WINDOWS 95

The IA-SPOX software developer's kit for Windows 95 is a real-time enabling software that provides access to the Pentium processor's MMX (Multimedia Extensions) instructions from Windows Ring 0. Target PC-based applications include multimedia, computer telephony, communciations, industrial control, data acquisition, instrumentation, and test and measurement. IA-SPOX allows ISVs, IHVs, OEMs and



system integrators to deploy realtime applications that run native on Pentium processors and DSPs under Windows 95. Developers can migrate SPOX code to DSP add-in cards and/or accelerate Windows 95 applications originally designed to run native on the Pentium processor. The kit includes a library of IA-SPOX real-time system services, a WinSPOX interface and utilities for integrating IA-SPOX services into the user's Windows 95 applications, a Native Audio subsystem, and a task-aware sourcelevel debugger. Also included are a library of C standard functions; a library of over 100 vector, matrix, signal-processing and logical functions; and source code for sample drivers. The kit sells for \$4995. Run times are free

ELECTRONIC DESIGN/OCTOBER 1, 1996

when distributed by any licensee.ML

Spectron Microsystems, 315 Bollay Dr., Santa Barbara, CA 93117; (805) 968-5100. **CHEFT21**

GRAPHICAL DEVELOPMENT FOR MULTIPROCESSOR DSP

BetterState4SPOX (BS4SPOX) combines multiprocessor development with real-time multitasking facilities to simplify the development of realtime software for multiprocessor DSP networks. BS4SPOX supports the entire DSP software development cycle, including graphical design, code generation, simulation, and test. The soft-



ware automates the design of signalprocessing functions, which can be used standalone or within a main C program via function calls. BS4SPOX projects are implemented as a collection of controllers that are defined at the behavioral level using either Extended State Diagrams or multirate firing Petri nets. Supporting both parallel processing and multiprocessing, the code generator automatically produces C source code for each controller. Extended State Diagrams support hierarchical and top-down statemachine design, multiple levels of internal concurrency, visual synchronization, and visual priorities. Petri nets provide a diagrammatic approach for defining complex systems with high levels of concurrency. BS4SPOX can automatically calculate average and commutative state visitation statistics and present them in various display formats. BS4SPOX costs \$3950 in the Pro version and \$1495 in the Lite version, ML

Co-Active Concepts, Ltd., P.O. Box 633, Ofakim 80300, Israel; telephone: 972-7-961434, 960641; fax: 972-7-926581; e-mail: coactive@netvision.net.il. In the United States, telephone (408) 252-2808; fax: (408) 777-8615; web site: http://www.ractive.com/ractive. EEEL 722



World Radio History

CTRONIC DESIGN CATALOG/LITERATURE REVIEW ON-LINE CATALOG SWITCH CATALOG SINGLE BOARD COMPUTERS

APEM's 212 page catalog contains many extensive product lines. Included are the following categories; DIP & Rotary DIP switches, Toggle, Rocker & Lever switches, Pushbutton switches and more. A wide selection of process compatibles and SMT models are offered as well as numerous options and accessories. In addition, a broad family of Control knobs is also offered. Complete specifications and detailed ordering guides for all products greatly simplify selection.

Total Impact 1960®RP

Flexible tool set for 80960 RP embedded development includes full-featured CodeICE emulator and low-cost CodeTAP® emulator. PCI supported with high-and PCI supported with high-and low-level views and PCI trace showing PCT/CPU bus corre-lation. Included are an error-checking CPU Browser register configuration tool, in-teractive RTOS support, For SUN, HP 9000 and Windows PC hosts. Call 1-800.012.325 for keep infer 800-426-3925 for free infor-

APPLIED MICROSYSTEMS CORPORATION

OMRON RELAYS, SWITCHES, MORE

Standard Product Catalog shows Omron's most popula 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 EDLit@oei or e-mail omron.com

OMRON ELECTRONICS, INC.

Micron Technology, Inc. quality, and brings productivity innovation together to provide advantages for you. This book contains product and technical DRAMs, including FPM, EDO an Burst EDO DRAMs; modules; and SGRAM.

MICRON TECHNOLOGY. INC. _____

For information For information regarding this section, circle the number below, or call your local sale representative. Our SALEs Offices are in the back of the magazine



YOUR CATALOG COULD BE HERE



YOUR COMPANY



CIRCLE 250



CIRCLE 253

CIRCLE 256

1996 DRAM DATA BOOK

ICP Acquire Inc. is a manufac-ture of single Board computers, passive Backplane, rackmount chassis, and Industrial Power supplies. Including: 3-20Slot BP, 386/486/Pen-tium SBC, 3-20Slot chassis, DC-12V/24V/-48V PS and 85-265V AC PS. Contact Allen, phone: 415-967-7168



CIRCLE 251

ICP ACOUIRE, INC.

DATA CONVERSION SOLUTIONS

This 52 page collection of data conversion products and selection guides serves as excellent reference material for the data acquisition system designer. Over 60 products are showcased solving problems in low power, small size and high performance data conversion applications with actual performance graphs and specifi cations. /topics covered include ADCs, DACs, voltage references and analog multi

LINEAR TECHNOLOGY

FFT SPECTRUM ANALYZERS

SRS spectrum analyzers offer 90 dB dynamic range, frequency spans from 191 mHz to 100 kHz and a fast 100 kHz real time bandwidth. the SR770's low distortion source generates sine waves, two-tone signals, white and pink noise, and chirps which allow frequency response measurements with 0.05 dB precision. Standard features on both analyzers include THD, 1/3 octave, band and sideband analysis



CIRCLE 254

(TURP

CIRCLE 257

GO/NO GO testing STANFORD RESEARCH SYSTEMS

NEW SWITCHING REGULATORS

Power Trends Inc., has released a new 72 page full line catalog for its Integrated Switching Regulators (ISRs) and DC to DC Converters. The catalog introduces significant new products along with extensions to existing product lines. Complete specifications, photos and standard applications are provided for each product, along with mechanical configuration options and ordering informatic **POWER TRENDS INC.**



HANDY POCKET GLOSSARY OF TERMS

Techron, a manufacturer of power amplifiers and related systems for commercial applications, has developed a glossary of power amplifier terms. The illustrated illustrated document, available free from Techron, contains over 300 definitions-helping to provide a common ground of understanding among people with varying degrees of technical knowledge. For more information call (219)294-8300 TECHRON



CIRCLE 263

Visit http:// www. keyelco

com and quickly locate up-todate Electronic Hardware and Interconnect Components. Website includes photos, drawings and specifications. Listings include PCB Components & Hardware, Interconnect Components, Battery Connectors & Holders, Mechanical Hardware, Panel Hardware plus a monthly product spotlight. General information such as capabilities and ISO 9002 are clearly defined. Phone: (718) 956-8900



CIRCLE 252

KEYSTONE ELÉCTRONICS CORP.

COMMERCIAL RELAY SELECTION GUIDE

Informative 12-page relay selection guide features Midtex's broad line of industrial and general purpose relays. Midtex designs, manufactures and markets low-level relays, PC board power relays, general purpose relays rated at 3 Amps to 15 Amps, power relays rated at 15 Amps to 30 Amps, time delay relays and solid state relays. Call Midtex for a free Commercial Relay Selection Guide. (915) 772-1061



CIRCLE 255

SWITCH MODE INDUCTOR HANDBOOK

This 2nd edition of Torotel's Switch Mode Power Supply Inductor Handbook provides design guidance for over 600 Inductors for power output filters, series mode power, common mode filtering and current sense Phone: applications. (816) 761-6314



TOROTEL PRODUCTS

AUDIO FREQUENCY TEST SETS

AUDIO PRECISION offers technical catalogs covering the system One & the ATS-1 audio test systems. The system One is available in GPIB & PC-based versions. The new ATS-1 provides GPIB & manual front panel control. Both instruments offer extremely low residual noise 8 distortion for high performance measurements on audio & low frequency systems.

AUDIO PRECISION



NEW APP NOTE-FREE FROM LECROY

A new application note on the measurement of timing jitter is intended for design and test engineers. Error sources are discussed and measurement methodologies to improve the accuracy and repeatability of jitter measurements are suggested. Phone: (914) 578-6021

1 FCROY



CIRCLE 264

ELECTRONIC DESIGN/OCTOBER 1, 1996



CIRCLE 260

FRANIC OFSIGN CATALOG/LITERATURE REVIEW INTERNATIONAL SOURCE BOOK WIN-BASED CAE/CAD S/W TOOLS TEST & MEASUREMEN

design

The International Source Book offers detailed specifications on Ecliptek's through-hole and surfacemount crystals, oscillators, and inductors. Visit our internet site at http://www.ecliptek.com/ at ecliptek/. Phone (714) 433-1200, Fax (714) 433-1234, or E-mail ecsales@ecliptek. com

H) 0 RO. 0 9 1

CIRCLE 265

ECLIPTEK CORPORATION

ILLINOIS CAPACITOR'S CATALOG

Illinois Capacitor's and Engineering Guide contains complete information on company's aluminum electrolytic, film, ceramic and power capacitors. It's all you make need to a knowledgeable capacitor selection. Available capacitance range, voltage ranges, operating temperature, case styles, IC authorized distributor listings, 208 pages.



CIRCLE 268

ILLINOIS CAPACITOR, INC.

P&BORELAYS & BREAKERS

Catalog lists stock relays and circuit breakers from Potter&Brumfield® products Division. Describes electromechanical, solid state and time delays, as well as thermal and magnetic circuit breakers. Numerous op-tions. Fax: (812) 386-2072, e-mail: nfo@ae.sec.siemens.com



SIEMENS ELECTROMECHANICAL SAMSUNG PRODUCT SELECTION GUIDE

The latest catalog is available on request by calling 1-800-446-2760. It contains product and ordering information on Memory, Micro, TFT-LCD, ASIC and LCD, ASIC and RE/Microwave products offered by Samsung Semiconductor, the world's leader in memory products.



SAMSUNG SEMICONDUCTOR

Take OrCAD's Software for a Spin The OrCAD Desktop Solutions demo CD is filled with everything you'll need to evaluate out solutions, and

try them out with your own designs: product overviews, data sheets, third-party information, evaluation versions of OrCAD's software, and more, Call OrCAD DIRECT at 1-800-671-9505 or visit our web http://www. site at orcad.com

OrCAD



CIRCLE 274

SOLUTIONS

CIRCLE 277

retain information even when system power is lost or turned off. In-the-system programmability enables telecommunications, consumer, computer in-dustrial, automotive and military products to adapt to changing software and operation environments. Call (408) 432-8888 Ext. 3336.

XICOR

0

OFF-THE-SHELF-OPTICS

Free 130-page product catalog from Rolyn, largest supplier of off-the -shelf optics. 24 hour delivery of simple or compound largest filters compound lenses, filters, prisms, mirrors, beamsplitters, reticles, objectives, eyepieces & thousands of other stock items. Custom products & coatings also. Phone: (818) 915-5707 Fax: (818) 915-1379

ROLYN OPTICS CO.



CAD-MIGOS SOFTWARE TOOLS, INC.

SPICE-IT! for Windows, a

powerful integrated CAE

electronic circuit design and simulation system. THE simulation system. THE WHOLE ENCHILADA for

Windows, a complete CAE/CAD tool system-from

HDL/Mixed-mode simulation

to PCB verification. Contact:

conceptual

www.cadmigos.com

info@cadmigos.com

Fax:(415)568-5989

HI PERF CABLE ASSEMBLIES

Brochure for engineers needing to know the current level of advanced capabilities in the integrated design and manufacture of microminiature cables and hiah density terminations.

PRECISION

INTERCONNECT

NEW TRIMMER CATALOG

C&K's new Trimmer

Catalog has single & multi-turn models, top and side actuated, thr-hole or 3mm & 4mm

surface mount models.

All have cermet resistive

All have cernet resistive elements & tin-lead terminals with epoxy seal. C&K Components, Inc. 57 Stanley Ave. Watertown, MA 02172-4802. Phone: (800) 635-5936



CIRCLE 272



CIRCLE 275

CIRCLE 278

Protel

V-SYSTEM/VHDL

PROTEL TECHNOLOGY

Model Technology offers simulation solutions for VHDL, Verilog and mixed-HDL on workstation and PC platforms. Model Technology provides technology-leading solutions for all your ASIC and FPGA needs. Model Technology's suite of HDLtools are fully compliant with leading industry standards. For more information, call 503-641-1340 or our home visit page http://www.model.com MODEL TECHNOLOGY



CIRCLE 267

HEWLETT PACKARD CO.

Just because your budget is

limited doesn't mean your test equipment has to be

limited, too. By leveraging

technology from HP's high

performance instruments, the HP Basic Instruments

collection offers tools that fit

compromising quality. You will find all the fundamentals,

from power supplies to

DMMs to scopes. Phone: (800)452 4844

without

budget

YOUT

LIQUID CRYSTAL DISPLAYS

World renowned leader and innovator of LCD and innovator of LCD technology, LXD Inc., details their broad line of indoor and outdoor displays in this 25-page catalog guide. Included is LCD technology information, standard illustrations, performance specifications, functional descriptions and ordering information. Phone: 216-786-8711.

LXD INC.



CIRCLE 270

THE MULTICHIP PRODUCTS DIVISION

The Multichip Products Division of American Division of Microsystems, Inc. provides design, manufacture and test services to customers needing a multichip solution. AMI offers a full range of substrate, die attach and packaging for multichip products. For more products. For more information on MPD, call (208)233-4690 or visit our home poge http://www.amis.com



CIRCLE 273

AMERICAN MICROSYSTEMS INC.

WHO MAKES DESIGN EASY?

eoses complex electronic design easy by providing the only fully-integrated environment that supports the entire process from schematic capture and circuit simulation, through PCB layout and artwork generation. To learn more about this revolutionary system, contact Protel at 1-800-544-4186 or visit our website at www.protel.com.





CIRCLE 279

ELECTRONIC DESIGN/OCTOBER 1, 1996

C&K COMPONENTS, INC. FREE! FREE! FREE! Xicor's broad line of in-thesystem programmable semiconductor integrated circuits

FRONIC DESIGN CATALOG/LITERATURE REVIEW CATALOG OF EMBEDDED CONTROLLERS **RELIABILITY PREDICTION** Integrated Suite of EDA Applications Catalog describes the RelCalc2 software pack

Micromint, Inc. is a leading supplier of single-board com-puters, controllers and peripheral controllers to the worldwide OEM market, as well as providing custom-engineered computer solutions to consultants.

Phone: (860)871-6170. Fax: (860) 872-2204. Internet address http://www.micromint.com

MICROMINT

CIRCLE 280

MICROMINT, INC. _ _ _ _ _ _ _ _

INNOVATIVE INTEGRATION

Innovative Integration sells Blazingly Fast Data Acquisition Products. FREE DSP & Data Acquisition Products Catalog CALL 818-865-6150 Fax: 818-879-1770. EMAIL: techsprt@innovativedsp.com or web:http://www.innovativedsp.com



INNOVATIVE INTEGRATION

OFF-THE-SHELF-OPTICS

UFF-INC-SNELF-UF II Free 130-page product catalog from Rolyn, largest supplier of off-the -shelf optics. 24 hour delivery of simple or compound lenses, filters, prisms, mirrors, productor filters, mirrors, prisms, mirrors, beamsplitters, reticles, objectives, eyepieces & thousands of other stock items. Custom products & coatings also. Phone: (818) 915-5707 Fax: (818) 915-1379

BOLYN OPTICS CO.

APPLICATION NOTE

Covers how to make safe and reliable measurements on switching power supplies operating on line, Includes such difficult measurements as upper gate drive and transistor saturation characteristics. Tells how to quantify measurement corruption caused by high dv/dt common mode. 1-800-376-7007

PREAMBLE INSTRUMENTS

Get a copy of our new guide to Electronics Design on the Apple Macintosh. Features D e si g n W o r k schematic capture, simulation. PCB simulation, PCB layout, FPGA design and other solutions. Call (800) 444-9064



MACINTOSH-BASED EDA TOOLS





CIRCLE 292

CAPILANO COMPUTING

DIIIVE IT IN HERITAGE ALL

OrCAD's integrated suite of

EDA applications give you the full advantage of 32-bit per-formance 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 web our site at http://www.orcad.com.



CIRCLE 281

Unteractive SPICE

CIRCLE 284

R

FREE SPICE NEWSLETTER

The Intusoft newsletter is a free publication dedicated to discussing topics related to the spice circuit simulators. Each issue contains application notes, technical articles, and modeling techniques that help engineers simulate.

OrCAD



MADE TO ORDER

The Data I/O catalog is the direct-order source of affordable tools for users of programmable devices. From design software to device software to programming and automated handling systems, the Data I/O cotalog offers catalog offers unbeatable values on the the high quality tools you need. Call 1-800-332-8246, ext. 806.

DATA I/O

80186. 80196.8051 EMULATION

Signum Systems has released its 1996 released its 1996 catalog of in-circuit emulators. This full line catalog includes Intel processors, Texas Instruments DSP'sZilog controllers, and National Semiconductor HPC family. Call (800) 838-8012 for information. Internet address: ww.signum.com



SIGNUM SYSTEMS

"X86 and 683xx/HC16 Design Tips"

Free application note shows to use in-circuit how 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 Email: info@microtekintl.com Voice: 800-886-7333

MICROTEK

INTERNATIONAL



CIRCLE 293



Andrea I dan vers

Nuclear and an enter the last of the same backy initial arrays to consider an enter of the last of the last of the set from part of the last of the last of the last of the

An Andrew Stand Stand

Award winning quick turn multilayer prototype manufacture specializing in 24 hour to 5 day turns, for commercial and milspec boards (Mil-P-55110E) on FR4 and polyimide materials. Our capabilities also include "blind and burjed" vias, full body gold, carbon baste, metal core boards, small hole drilling, and net list testina.

age, which automotes Mil-HDBK-217 or Bell-core on your PC, and al-lows quick and easy reli-

ability analysis of your

electronic products. Phone: (818) 991-0057 Fax: (818) 991-1281

T-CUBED SYSTEMS



CIRCLE 285

ADHESIVES AND SEALANTS

manufactures over 3000 grades of adhesives, sealants and coatings. Line cosists of epoxies, cyanoacrylates, silicones and acrylics. One and two part systems are available. Tel. 201-343-8983.



Tanner Research offers affordable, easy to use design tools for PC, MAC and Unix and Unix MAC and office platforms. Send for our brochure that includes a free demo disk and pricing. PH: 818-792-3000. Fax: 818-792-E-mail: SALES @TANNER. COM



YOUR CATALOG COULD BE HERE

For information regarding this section, circle the number below, or call your local sale representative. Our SALEs Offices are in the back of the magazine



ELECTRONIC DESIGN/OCTOBER 1, 1996



SIGNUM In Circ

TANNER RESEARCH INC.



ASIC-MCM-MEMS



Ber timerat **CIRCLE 290**

Ind Clock-Belge Bugs



0300





DATA I/O CATAIO

PROTO EXPRESS AUHEDIVED Inc., Master Bond Inc., NJ

Kepco's Catalog/Handbook 1461811 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:hg@kepcopower.com http://www.kepcopower.com

1996 SRAM Data Book

In a continuing effort to provide advantages to its Micron customers, Technology, Inc. , Boise, ID, recently published its 1996 SRAM Data Book. The updated edition includes pipelined and flow-through Micron's sections for Micr SyncBurst SRAMs, a Synchronous SRAM Modules section, and several new technical notes and data sheets

MICRON TECHNOLOGY,





CIRCLE 308

AMERICAN ADVANTECH

Advantech's mission is to provide high quality, cost effective PC-Based industrial automation products to customers worldwide. Product lines worldwide. Product lines include Industrial PCs, Panel PCs & MMI, Embedded/SBCs, DA&C, Application DA&C, Application Software. Phone 1-800 800-6889.

AMERICAN ADVANTECH

V-SYSTEM/VLOG

Model Technology offers sim-ulation solutions for VHDL, Verilog and mixed-HDL on workstation and PC platforms. Model Technology provides technology-leading solutions for all your ASIC and FPGA needs. Model Technology's suite of HDLtools are fully compliant with leading industry standards. For more information, call 503-641-1340 or our home page visit http://www.model.com

MODEL TECHNOLOGY

Interface Technologies dis-tributes the newly released

Version 6.3 MicroSim PSpice

A/D with Schematics. Version 6.3 supports network licens-

ing for Windows 95 and Windows NT, IGBT device models, TOM-2 GaAs model,

AMD MACH5 support, library browser and search engine, and full cross probing

with MicroSim PCBoards. Call 1-800-357-1636 or

browse http://www.i-t.com

for more information.



CIRCLE 296

ESIGN CATALOG/LITERATURE REVIEW

CIRCLE 299

MicroSim PSpice @ A/D

INTERFACE TECHNOLOGIES

ITT POMONA ELECTRONIC, 2-2-2 ITT Industries consits of three advanced manufacturing companies providing

quality automotive, commercial and defense electronics systems and services, and pumps and other fluid handling products.ITT Industries three primary businesses, ITT Automotive, ITT Defense & Electronics and ITT Fluid Fluid Technology.

ITT POMONA ELECTRONICS

OSCILLATORS FOR SONET

VCXO & Crystal clocks No phase jitters pullability Wide ±1000ppm Tight stability ±20PPM · IND temperature 40°C to + 85°C Standard and custom



VALPEY-FISHER CORP.

CIRCLE 309

BE/JE DESIGNER'S GUIDE

180 page RF/IF Designer's Guide is loaded with informative features such as practical articles, definitions of terms, environmental and reliability test procedures, answers to frequently asked surface mount technology questions, and more! It also contains the most complete and up-to-date specifications and price information about all Mini-Circuits signal processing components. To receive a free Designer's guide, simply call (718) 934.4500 **MINI-CIRCUITS**



CIRCLE 297

SWITCHING WITH THE TIMES

Within the familiar cove of the new E-Switch catalog lies an all new interior-now in full colorf The redesigned catalog contains product descriptions.

and dimensions for push button, toggle, rocker, power, lever, slide, rotary, keylock, and tact switches. Illuminated, sealed. and SMT versions are available.

E-SWITCH





TOOLS, TOOL KITS, CASES

Installation/repair tools, tool kits, test equipment, telecom equipment, LAN testers & instrument/shipping cases are detailed iñ 300+page full-color catalog. Includes products for field service and depot repair. Indexed catalog features over 100 standard tool kits and complete information on "customizing" specific requirements



NETRANSTM

and NETRANSplusTM 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 inforno noitom NETRANS products, call (208) 233-4690 or visit our home page http://www.amis.com



AMERICAN MICROSYSTEMS INC.

C-PROGRAMMABLE CONTROLLERS

Save time and money. Our controllers are ideal for control, test or data acquisition applications with a mix of analog/digital I/O , relays, RS232/485 serial ports, LCD/keypads, & pro-grammed with Dynamic C[™]. From\$79,Qty.1. (916) 757-3737, or Fax: LCD/keypads, & (916) 753-5141. For 24 Hr data, call from Fax:(916)753-0618. YOUR http://www.zworld.com **Z-WORLD ENGINEERING**



CIRCLE 310

ELECTRONIC DESIGN/OCTOBER 1, 1996

144



CIRCLE 298

CodeTEST

CIRCLE 295

Memory and Trace information with the new CodeTEST family of tools from Applied Microsystems. There's nothing else like them. Call for a data sheet today. 1-800-895-0831 **APPLIED MICROSYSTEMS CORPORATION.**

KEPCO POWER SUPPLIES

POWERFUL, AFFORDABLE EDA

a new

generation of powerful, affordable desktop EDA

Analog Circuit Master (ACM) for Windows and Windows95, Sagebrush puts fast, powerful, simulation and analysis,

and features until now

only found on high-end

programs, right on your

The PADS-PowerPCB

The PADS-PowerPCB design tool catalog from PADS Software, Inc. highlights the PowerPCB product line, including the Dynamic Route Editor and Database Viewer

PowerPCB is a function-

rich PCB design tool suite for Windows.

PADS SOFTWARE, INC.

Now developers and testers can perform unit, integration and system

testing quickly and reliably. Get comprehensive

Performance, Coverage,

INTRODUCING CodeTEST TM

SAGEBBUSH SYSTEMS

Systems

PRINTED CIRCUIT BOARD DESIGN

PADS-

Sagebrush

introduces

desktop.

features.

KEPCO INC.



CIRCLE 306



CIRCLE 303

NETRANS



ECTRONIC DESIGN CATALOG/LITERATURE REVIEW **OrCAD Layout Products RELIABILITY SOFTWARE** OrCAD Layout Products are full featured PCB layout and

Samtec's Sudden Solution Guide F-196 features an all new applications section with Micro Pitch and Surface Mount, Board-to-Board and Application Specific interconnects. System capabilities in-clude Pass Through, Ultra Low Profile, Ultra High Density, Flexible Stacking, Skyscraper and Micro I/O on 1 mm, .050", 2mm and .100" pitch. For more information contact Samtec.

Phone: 800-SAMTEC-9 SAMTEC

CIRCLE 311

APEX

DATA

BOOK

CIRCLE 316

POWER INTEGRATED CIRCUITS

The 7th edition Apex Power Integrated Circuits data book contains com-plete product data sheets and applications notes for Apex Microtechnology's Power Amplifier, PWM Amplifier and DC/DC Converter prod-uct lines. Call: 1-800-862-1021; FAX: 1-520-888-3329; E-MAIL: Prolit@TeamApex.com.

APEX

TOKO'S INDUCTOR SELECTION GUIDE

FREE Selection Guide provides information on provides information on Toko's wide range of high Q, ceramic and ferrite chip inductors as well as SMD fixed inductors featuring low profile, high current and multipurpose chokes. Call 1-800-PIK-TOKO or visit our web site at http://www.tokoam.com



CIRCLE 325

Top 10 Ways to Speed Board Design

More designers use OrCAD Layout for Windows to get their job done faster. The "Top Ten" tips in this booklet are based on the experience of OrCAD Layout users. They're the key ways you can use our software to complete your boards faster. Contact OrCAD DIRECT at 1-800-671-9505 or visit our site web at http://www.orcad.com

TOKO AMERICA, INC.

OrCAD

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

PREAMBLE INSTRUMENTS



WHY DIFFERENTIAL?

NDERSTANDING DIFFERENTIAL MEASUREMENT

CAPABILITY IN CILLOSCOPES

CIRCLE 321

The Relex Reliability Software

for Microsoft Windows and the Mac provides Reliability Predictions per the Mil-HDBK-217, Bellcore, HDBK-217, Bellcore, Mechanical, and CNET standards, as well as FMEA/FMECA analysis and Maintainability Predictions. The new four color 20-page catalog describes the flexible CAD Interface, extensive parts libraries, and stunning araphics.

INNOVATIVE SOFTWARE

Relex CIRCLE 312

Free CD-ROM Instrumentation Reference

The windows-compatible Instrupedia - Your Interactive Encyclopedia for Instrumenta-tion - features more than 60 tutorial and "how-to" application notes to help users learn how to combine hardware and software to build computer - based systems for instrument control and data acquisition, analysis, and presentation. Instrupedia includes more than 20 User Solutions

phone: 1-800-433-3488. http://www.natinst.com NATIONAL INSTRUMENT

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.





MEMORY PROTECTION DEVICES

All new Catalog 105 has 72 pages featuring the new sealed rocker K Series and detailing an in-depth line of precision snap-action pushbutton, toggle, rocker, limit and basic switches. All feaure OTTO's unique design assuring low contact resistance, high contact pressure and long cycle life. Quality made in the U.S.A.



CIRCLE 319

OTTO CONTROLS

TRANSFORMER CATALOG

Signal Transformer Co., an operating unit of the Insilo Technologies Group, has just released a new 40-page, 4 color catalog that is an ideal reference source for engineers and buyers. Signal Transformer offers the most extensive line of 50/60 Hz transformers available in a power range of 1 VA to 10 KVA.



CIRCLE 322

and interactive polar place-ment support for circular boards. Contact OrCAD DI-

routing systems that include

new features such as a grid-

less, shape-based autorouter, full computer-aided manufac-turing (CAM) capabilities, a new 3,000 footprint library

with complete documentation

RECT at 1-800-671-9505 or visit our web site at http://www.orcad.com

OrCAD



CIRCLE 313

понац

IN CIRCUIT EMULATORS Nohau Corporation is a manufacturer of In-Circuit Emulators for the following families: 8051, MCS251, P51XATM, 80C196, 68HC16, and 683XX families. Web Site Address: http://www.nohau.com



CIRCLE 314

V-SYSTEM/PLUS

Model Technology offers sim-ulation solutions for VHDL, Verilog and mixed-HDL on workstation and PC platforms. Model Technology provides technology-leading solutions for all your ASIC and FPGA needs. Model Technology's suite of HDLtools are fully compliant with leading industry standards. For more information, call 503-641-1340 or visit our home page http://www.model.com



MODEL TECHNOLOGY

A 60 page, four color catalog from Intermec Corp. Everett, WA, the world leader in Automatic Data Collec-tion technology. This new catalog includes thermal transfer bar code printers, scanners, handheld computers, network controllers, radio frequency data collection systems and much more.



FOUNDRY

American Microsystems, Inc. has offered custom and semicustom foundry expertise for over 30 years. AMI supports 0.35m through >1m design and will increase its production capacity by 3x with the completion for FAB 10. For more information on AMI's foundry, call (208) 233-4690 or visit our home page http://www.amis.com

AMERICAN MICROSYSTEMS INC.



CIRCLE 318

CIRCLE 323

SIGNAL TRANSFORMER

TAF







CIRCLE 324

SNAP-ACTION SWITCHES

DIRECT CONNECTION A D S





Plug our C-programmable SmartCore Microprocessor Core Module into your custom-designed application for the fastest product development

- On-board processor, power control, time/date clock, timers, UARTS, DMA ... Everything you need to design now!
- Flexible memory configurations allow for up to 20,000 lines of C code
- Our integrated Dynamic C[™] development system eliminates costly emulators and debuggers. \$29 in volume

1724 Picasso Ave. Davis, CA 95616 WORLD 916.757.3737 916.753.5141 FAX brain@zworld.com

Call for your SmartCore Evaluation Kit today! Z-WORLD CIRCLE 415





CIRCLE 412

DIRECT CONNECTION A D S





DC 64

- 60 MHz (30 MIPS) TMS320C32, 32-bit foating point DSP
- Half-size, IBM PC Plug-in Card (PCI Bus) 132 Mb/sec, 32-bit Plug-n-Play interface
- 128-512 Kbytes, zero-wait SRAM
- . 4 Kb bidirectional FIFO
- . Instrumentation-grade analog 1/O: 16-bit digital I/O
 - Eight, 100 kHz, 16 bit A/D channels Programmable gain: 1,2,4,8 120 dB/decade anti-alias filter

INNOVATIVE INTEGRATION



Ultimate DSP

Debugger

Package

innovative-dsp.com

CIRCLE 402



DIRECT CONNECTION ADS



Make Tracks...

... to your nearest mailbox and send for the latest copy of the **free** Consumer Information Catalog. It lists about 200 free or low-cost government publications on topics like health, nutrition, careers, money management, and federal benefits. Just send your name and address to:

Consumer Information Center Department MT Pueblo, Colorado 81009 A public service of the U.S. General Services Administration.

WE SAVE YOU TIME AND MONEY 3 DAY PROTOS, INC.

"LIGHTNING AND QUALITY SERVICE ARE OUR CAPITAL CONCERNS."

3 DAY PROTOS was created to meet the growing demand for quick-turn prototype printed circuits boards.

CAPABILITIES: . Buried & Blind Vias

. Polyimide Multilayer . Soft & Hard Gold . PCMCIA Smart Card . SMT- SMOBC

LOWEST PRICE IN TOWN GUARANTEED

NOBODY CAN BEAT THIS : UP TO 60 SQUARE INCH. . 4 LAYERS - 5 PIECES - 3 DAYS TURN -\$950* . 2 LAYERS - 5 PIECES - 3 DAYS TURN -\$450*

*TOOLING AND TESTING INCLUDED. (GOLD TIPS, SMT TEST, PHOTO PLOTTING EXTRA)

> Call : Tel: 408-894-0130 FAX: 408-894-0620 Modern: 408-894-6685

3 DAY PROTOS, INC CIRCLE 401



154 Hobart Street, Hackensack, New Jersey 07601 (201) 343-8983

MASTER BOND, INC.

CIRCLE 416

"YOUR FREE CATALOG KNOCKED MY SOCKS OFF"

Our free Catalog of free and low-cost government booklets will very likely impress you, too. But first you have to get it.

Just send your name and address to:

Consumer Information Center Department KO Pueblo, Colorado 81009

A public service of this publication and the Consumer Information Center of the U.S. General Services Administration

1996 DIRECT ACTION CARD SCHEDULE

September November August 5, 1996 October 4, 1996

To reserve space please call Kimberly Stanger 201- 393-6080

LOW-POWER DESIGN A Collection of CSEM Papers



- General Tutorial Papers
- Digital Circuits
- Devices and Analog Circuits
- Low-Power Systems

Ver the past decade, minimization of power consumption has become a critically important task in the implementation of electronics systems of all kinds, and especially for portable and battery-powered functions. The requirements for low-power will pervade systems and IC design to an ever increasing extent.

This collection of landmark CSEM (Center Suisse d'Electronique et de Microtechnique SA) papers has been produced as a handy, basic reference book.

Now	Avail	able .	For	<i>\$125</i> .
-----	-------	--------	-----	----------------

LOW-POWE Single order, \$ Multiple order:	R DESIGN 125 Quantity: × \$1: For S & H please add \$6 or \$25 for international p	25 = for domestic er book Total	Amount	Mail to: ELECTRONIC DESIGN 611 Route 46 West Hasbrouck Heights, NJ 07604 Attn: Jeanne Sico or fax: 201/393-6073
□ Master Charge	American Express	🗆 VISA 🛛 Check (p	bayable to Electro	nic Design)
Account Name _		Accou	int #	
Signature		Expira	tion Date	
Name		Title		
Company				
Company Addres	S			
City			_ State	Zip
Phone	Fax_		E-m	ıail
		World Radio Histor	Y	



The editors of *Electronic Design* magazine are soliciting technical papers for presentation at the 1997 Portable By Design Conference. Designers are invited to share their expertise by submitting proposals for papers that emphasize problem solving and provide insights regarding the design of portable products.

TYPICAL TOPICS TO BE PRESENTED

- Current and future battery technologies
- High-end/low-power CPUs
- 16-bit and smaller CPUs for portable designs
- Smart-battery management
- Charging circuits
- Software issues, including BIOS and PC Cards
- Mass storage and I/O, including PC Card issues
- IR and RF connectivity issues
- Power management
- Packaging
- Displays and input devices
- Buses and system-level architectural issues



A conference for designers of OEM portable, nomadic, mobile, and transportable products

> Conference Dates: March 24 - 27, 1997

Conference Site: Santa Clara Convention Center Santa Clara, Calif.

"Delivering the multidisciplinary knowledge needed by engineers and engineering managers involved in the next generation of portable design."

To participate, submit an abstract describing your proposed paper before October 11, 1996. Send your proposal to: Program Chair, Portable By Design Conference, c/o Electronic Design, 611 Route 46 West, Hasbrouck Heights, NJ 07604 Call: 201/393-6090; Fax 201/393-0204; or E-mail to: portable@class.org for more information.

World Radio History

CAREER OPPORTUNITIES

RATES

Effective January 1, 1996

\$170 per column inch

Commissionable to agencies

DEADLINES

Space reservation: 4 weeks preceding issue date Ad material to: Penton Publishing, Classified Department, Attn: Sharon Potoczak 1100 Superior, Cleveland, OH 44114

EMPLOYMENT

ENGINEERING SERVICES

SALES STAFF

Recruitment Sales Rep. Sharon Potoczak 800-659-1710 Ext. 9342 (216) 931-9342 Fax: (216) 696-8206

INVENTIONS WANTED

DESIGN/DEVEL. ENGRS./MGRS. \$30,000-\$70,000+

30+ yrs. in placing Electrical/Electronic Engrs. Nationwide client list and 200 associate office resources. All fees Co. paid. Contact Gordon Hassell with resume/salary/location data.G.E. HASSELL ASSOCIATES, 913 MAIN PLACE, P.O. BOX 471, NILES, OH 44446. (330) 652-5871

750 ENGINEERING AND AutoCAD PROG'S ON CD-ROM

\$83 INCL. SHIPPING

SECTOR SYSTEMS COMPANY, INC. 416 OCEAN AVENUE MARBI EHEAD, MA 01945 (617) 639-2625 email: 2084932@mcimail.com

Circle no. 242 on reader service card



2000000000



DESIGN/DEVELOPMENTENGINEERS Professional Recruiters coordinates searches for over 350 search offices Nationwide. Current heavy aemand for Sensor Design, Analog/Digital, Controls, Consumer and Automotive Electronics and other design . \$40-80K range. FEE PAID. Contact Jerry or Mark, Professional Recruiters, Inc., Dept. N, P.O. Box 24227, Omaha, NE 68124. Phone: 800-225-2885, FAX: 402/397-7357. ·····NATIONWIDE SERVICE·····

Circle no. 240 on reader service card

ELEC DSGN ENGINEERS

Professional representation from award-winning recruiting firm with 355 alfiliate offices in the U.S. & Canada. On-going needs for BSEE's experienced in PLC/DCS controls, PCB & Wire Hamess Dsgn, Analog/Digital HW & SW Dsgn Engrs. Salaries \$45-65K. FEE & RELOCATION PD. Current resume to: J. GIFFORD INC., 5310 E. 31st St, #514, Tulsa, OK 74135, 918-665-2626, FAX 918-665-2800 Web Address: www.jgifford.com E-Mait.jobs@jgifford.com

Circle no. 241 on reader service card

R & D ENGINEER

Dynamic Berkeley area international R&D firm seeks creative, independent Engineer with 5+ years experience in analog (min 10 MHz), digital, and signal processing. Fax/Email: 510-232-7998 / engr@imagem.com

www.imagem.com

Electronic Design wants to be your company's professional recruitment specialist!

Reach decision-makers in the areas of Design & Development Engineering and **EOEM Management!**

Take advantage of all Electronic Design has to offer! Place your recruitment ads in Electronic Design & on the Internet for one month for only an extra \$100/ad!!!

Please contact: Sharon Potoczak (216) 931-9342 Fax: (216) 696-8206

Visit our site today at http://www.penton.com/corp/classifieds e-mail:careerlink@penton.com

Chairman	and (CEO:	Tkomas	L.	Kemp
Provident.	and C	00.1	Desial I	0	- lla

Group President, James D. Atherton

Vice President Ancillary Product & Sales: Drew DeSarle

NATIONAL SEMICONDUCTOR

Publisher: John French Hasbrouck Heights, NJ; (201) 393-6060 National Sales Manager: Russ Gerches Hasbrouck Heights, NJ; (201) 393-6045 Production Manager: Eileen Slavinsky Hasbrouck Heights, NJ; (201) 393-6093 Marketing Research Adr or: Deborah Eng Hasbrouck Heights, NJ: (201) 393-6063

Advertising Sales Staff

Hasbrouck Heights: Judith L. Miller Sales Asst.: Judy Stone Hernandez 611 Route #46 West, Hasbrouck Heights, NJ 07604; Phone: (201) 393-6060TWX: 710-990-5071 Boston & Eastern Canada: Ric Wasley Sales Support: Barbara Leone 60 Hickory Drive, Waltham, MA 02154 Phone: (617) 890-0891FAX: (617) 890-6131 North Califonia/Colorado:Chuck Signor (408) 441-0550 Chicago/Midwest: Lisa Zurick Sales Assistant: Dawn Heili 180 N. Stetson Ave., Suite 2525 Chicago, IL 60601; (312) 861-0880 FAX: (312) 861-0874 North California/Utah/N.Mexico/Arizona: James Theriault (408) 441-0550 Los Angeles/Orange County/San Diego: Ian Hill Sales Asst: Patti Kelly 16255 Ventura Blvd., Suite 200 Encino, CA 91436; (818) 990-9000 FAX: (818) 905-1206 San Jose: Jeff Hoopes, Chuck Signor, James Theriault Sales Support: Karyn Walthart 2025 Gateway Pl., Suite 354 San Jase, CA 95110; 08) 441-0550 FAX: (408) 441-6052 or (408) 441-7336 Pacific N.W. & Western Canada: Jeff Hoopes (408) 441-0550 Texas/Southeast: Bill Yarboroug 1557 Bracher St. Houston, TX 77055 Phone: 713-984-7625. FAX: 713-984-7576 Direct Connection Ads & Direct Action Cards: Kim Stonger (201) 393-6080 Sarena Araiza (408) 441-0550 General Manager, European Operations: John Allen 36 The Green, South Bar Banbury. Oxford OX 16 9AE, U.K. Phone: 44 (0)-1-295-271003 FAX: 44 (0)-1-295-272801 Netherlands, Belgium: Peter Sanders, S.I.P.A.S. Rechestraat 58 1483 Be De Ryp, Holland Phone: 011-31-299-671303 Fax: 011-31-299 671500

France: Fabio Lancellotti Defense & Communication 10 Rue St. Jean 75017 Paris France Phone: 33-142940244, FAX: 33-143872729 Spain/Portugal: Miguel Esteban Publicidad Internacional Pza. Descubridor Diego de Ordas, 1 Escalera, 2 Planta 2D 28003 Madrid, Spain Phone: 91/4416266 FAX: 91/4416549 Scandinavia: Paul Barrett I.M.P. Hartswood, Hallmark House 25 Downham Road, Ramsden Heath, Billiricay, Essex, CM 11 1PV, UK. Phone:44(0)-1-268-711560, Fax:44(0)-1-268-711567 Germany, Austria, Switzerland: Friedrich Anacke InterMedia Partners GmbH Deutscher Ring 40 42327 Wuppertal, Germany Phone: 49 202 711 091 Fax: 49 202 712 431 Hong Kong: Kenson Tse IDG International Marketing Services Suite 25F, One Capital Place, 18 Luard Rood, Wanchai, Hong Kong Tel: 852-2527-9338. Fax: 852-2529-9956 Israel:Igal Elan, Elan Marketing Group 22 Daphna St., Tel Aviv, Israrl Phone:972-3-6952967 FAX: 972-3-268020 Toll Free in Israel only: 177-022-1331 Japan: Hirokazu Morito, Japan Advertising Communication Three Star Building 3-10-3-Kanda Jimbocho Chivada-Ku, Tokyo 101, Japan Phone: 3 3261 4591, FAX:3 3261 6126 Korea: Young Sang Jo, Business Communications Inc K.P.O. Box 1916, Midopa Building 146 Danaiu-Dong, Chongo-Ku, Seoul, Koreo ne: 011-82-2-739-7840 FAX: 011-82-2-732-3662 Pho Taiwan: Charles Liu, President, o-way Communications, Co., Ltd. 12F/1, No.99, Sec.2 Tun-Hwa South Road, Taipei, Taiwar Phone: 011-886-2-707-5828;FAX: 011-886-2-707-5825 United Kingdom: John Maycock John Maycock Associates **Reclands, Tapton House Road**

Sheffield, England S 10 58Y Phone: 44 1142 667 050, FAX: 44 1142 660 540

INDEX OF ADVERTISERS

Advertiser	RS #	Page	Advertiser	RS #	Page
	400	146	NATIONAL SEMICONDUCTOR	-	45
ALLEGRO MICROSYSTEMS	122	64GG* 64H*	NATIONAL SEMICONDUCTOR	-	47 49
ALLIED ELECTRONICS	95	21	NEC ELECTRONICS	139	79*
ALIEKA CORPORATION	123	Cov2	NEC ELECTRONICS	138	64W*
AMD		2-3	NEEDHAM'S ELECTRONICS	140	04L-N 10
AMERICAN ADVANTECH	296	144	NOHAU CORPORATION	314	145
AMERICAN MICROSYSTEMS	323	71	NUMBER ONE STSTEMS	407	14/
AMERICAN MICROSYSTEMS	307-273	144-14	OMRON	256	141
ANLOT CUKPUKATION APEM	94 250	8 141	OMRON ELECTRONICS	143	23* 147
APEX	316	145	ORBIT SEMICONDUCTOR	144	93
APPLIED MICROSYSTEMS INC ARIES ELECTRONICS	253]4]-]44 107	ORCAD	277	142-1
AROMAT CORP/PCSD	100	64Z-AA*	OTTO CONTROLS	313-320	145
ASTEC AMERICA		140	Poc CNC	412	146
AUDIO PRECISION	261	93	PADS SUFTWAKE INC PENSTOCK	298	144 6411*
BENCHMARQ	152	51	PENTEK	176	74
BLILEY ELECTRIC BLIRR-BROWN	97 80	88 55	PHAR LAP SOFTWARE PICO FLECTRONICS	-	140
C & K COMPONENTS, INC.	272	142	POTTER & BRUMFIELD	140	64Q*
CAD-MIGOS CAPILAND COMPUTING	266	142	POWER ONE	148	113
CELESTICA	125	39	POWER TRENDS PREAMBLE INSTRUMENTS	260	141
CENTURION INTERNATIONAL	102	75	PRECISION INTERCONNECT	269	142
S DAT PRUTUS, INC. CLASSIFIED	401 240	148	PRECISION INTERCONNECT PREM MAGNETICS	175	104
CONEC CORPORATION	103	64J*	PROTEL TECHNOLOGY	276	142
LYBERNETIC MICROSYSTEMS	174	18	PROTO EXPRESS	285	143
DALE ELECTRONICS INC.	-	64N*	QUALITY TECHNOLOGIES	410	146
DALLAS SEMICONDUCTOR	104	66	RALTRON ELECTRONICS	151	121
DIGI KEY	287	143 9*	ROLTN OPTICS COMPANY ROSS TECHNOLOGY	286	142-1
-SWITCH	301	144	SAGEBRUSH SYSTEMS	295	144
CLIPTEK	265	142	SAMSUNG SEMICONDUCTOR	274	142
iespac	187	33	SAMSUNG SEMICUNDUCTOR	311	04K-S
FILWAY TECHNICAL LAMP	106	88	SAMTEC USA	127	108-1
IEWLETT PACKARD EMD	108	22 59	SANDISK Sandisk	158	112
IEWLETT-PACKARD	267	142	SIEMENS	159	53*
IEWLETT-PACKARD IYUNDAI	109		SIEMENS ELECTROMACHANICAL	271	142
CP ACQUIRE, INC	251	141	SIGNATEC	413	145
LLINOIS CAPACITOR	268	142	SIGNUM SYSTEMS	290	143
NNOVATIVE INTEGRATION	402	143	SILICUN STSTEMS	168	57 30
NNOVATIVE SOFTWARE	312	145	SPECIALIZED PRODUCTS	304	144
NTERFACE TECHNOLOGY	404	14/	STANFORD TELECOM	257	141
NTERNATIONAL RECTIFIER	111	35	SYNERGY	161	81
NTERNEC CORPORATION	318	145	SYNERGY	160	83
TT POMONA ELECTRONICS	306	144	SYNOPSYS		87
K MICROSYSTEMS	405	147	TANNER RESEARCH	291	143
EPCO	305	144	TECHRON	262	143
EYSTONE ELECTRONICS	252	141	TEKTRONIX	-	73*
EYSTONE ELECTRONICS	118	121	TELEDYNE KELAYS	164	89 148
ILA SYSTEMS	406	147	TEMIC	-	11
TOWA RIKA COMPANY ATTICE SEMICONDUCTOR	120	10	TEXAS INSTRUMENTS	189	111*
ECROY	264	141	TEXAS INSTRUMENTS		64F*
INEAR TECHNOLOGY	254	141	TEXAS INSTRUMENTS	-	64G*
INCAR ICCHNULUUT	183	14-15	TEXAS INSTRUMENTS	-	641° 648°
ASTER BOND	416-288	143-148	TEXAS INSTRUMENTS	188	64(C*
ATKA MHS AYIM	121	13	TEXAS INSTRUMENTS	173	16-17
AXIM	178-179	103	TOROTEL	325 258	145
EMORY PROTECTION	324	145	TOSHIBA AMERICA	-	640*
ICROMINT	1/2 280	124	IUSHIBA AMERICA IINITRODE INTEGRATED	145	64Y* 27
ICRON TECHNOLOGY	293	143	VALPEY FISHER	309	144
ICRON TECHNOLOGY	259	141	VERISYS	411	146
ICROTEK INTERNATIONAL	293	143	WHITE MICROFLECTRONICS	166	69 115
IDTEX	255	141	XICOR	275	142
INI-CIRCUITS INI-CIRCUITS	297	144	Z-WORLD ENGINEERING	310	144
INI-CIRCUITS	132-133	4	2-WUKLU ENGINEEKING	415	146
INI-CIRCUITS	128-129	Cov3			
INI-CIRCUITS	156-157	126			
ODEL TECHNOLOGY	299	142-144			
URATA ELECTRONICS	105	65	Domestic*		
ATIONAL INSTRUMENTS	135	041° 96	International **		
ATIONAL INSTRUMENTS	315	145	international **		

43

2.5KHz-8GHz AMPLIFIERS (3 Piece Set)

10MH2-4-2GHZ

\$1095 (Set of 3 1-9 qty.) +20dBm Power Output, 20dB Gain

			Power Output,	DC	Power		ind v.
	Freq.	Gain	dBm @ 1dB	Volt	Current	Conn.	Price (\$)
Model :	(MHz)	(dB)	Compression	V	mA	Type	(1-9 qty.)
ZHL-6A	.0025-500	21	+23	+24	350	BNC	199
ZHL-1042J	10-4200	25	+20	+15	330	SMA	495
ZRON-8G	2000-8000	20	+20	+15	310	SMA	495

Set of 3 Amplifiers # KZHL-318: \$1095 (1-9 qty.)

2.5KHZ-500MHZ

2-8GHZ

Expand laboratory capabilities and put a full spectrum of power at your fingertips with Mini-Circuits 2.5KHz to 8GHz medium power amplifier set. Each ultra-wideband set contains three individual heat sinked FF amplifiers with at least +20dBm output and overlapping frequency response range capabilities; 2.5KHz to 500MHz, 10MHz to 4.2GHz and 2GHz to 8GHz. Applications for these amplifiers include increasing the signal levels to power meters, spectrum analyzers, frequency counters and network analyzers as well as boosting signal generator outputs.

ZHI

You can buy these amplifiers individually at Mini-Circuits already low prices, or own the full spectrum set for the money saving price of only \$1095 (1-9 qty.) ! To order from stock with a guarantee to ship within one week, call Mini-Circuits today !

Mini-Circuits...we're redefining what VALUE is all about!





P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661 INTERNET http://www.minicircuits.com For detailed specs on all Mini-Circuits products refer to • 740- pg. HANDBOOK • NTERNET • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.

DREAM TEAM

ANDIERA. FLEX 10K

THE DESIGNER'S DREAM TEAM WITH UP TO 100,000 GATES.

10.020

ISABLE GALES

7,000-31,030

The FLEX 10K Dream Team of programmable logic devices is a championship roster from Altera. With densities from 10,000 to 100,000 gates and up to 15 times greater memory efficiency than FPGAs, FLEX 10K can take on even the most aggressive gate arrays.

2 000

USANIE

30,000

ERF13K40

41.00

TYPICAL GATES TYPICAL GATES TYPICAL GATES TYPICAL GATES TYPICAL GATES TYPICAL GATES TYPICAL GATES

EPF10K50

50,000

USABLE GATES USABLE GATES USABLE GATES USABLE GATES USABLE GATES

EP#10170

70.020

36.000-116.000 46.000-118.000 62.000-151.0

FLEX 10K offers all the benefits of programmability and features such as memory, incircuit reconfigurability, and built-in JTAG support. And, Altera's easy-to-use MAX+PLUS II development tools interface with all major CAE tools, giving you a team that will easily score against mid- to high-density gate arrays.

AN EMBEDDED ARRAY GAME PLAN.

The unique FLEX 10K architecture adds an embedded array to a logic array, so you can have up to 24K bits of RAM in a single chip, and megafunctions*such as microprocessors, microcontrollers, DSP and PCI functions, and others.

THE ALTERA ADVANTAGE.

You need every advantage to compete in this league. Value, competitive pricing, high-performance technology, and comprehensive technical support — that's The Altera Advantage.

It's time to put the Dream Team to work for you. Call Altera today for your free FLEX 10K information kit. 800-9-ALTERA (800-925-8372), Dept. A165. Or, find us at http://www.altera.com on the world-wide web.



EPFIOK100

100.000

*Developed through AMPP (Altera Megafunction Partners Program) Note: Individual family members available over the next 12 months. © Copyright 1996 Altera Corporation. Altera, FLEX, and MAX+PLUS are registered trademarks, and FLEX 10K, MAX+PLUS II, and specific device designations are trademarks of Altera Corporation. All rights reserved.