A PREVIEW OF BUSCON/91 WEST

SWITCHING SUPPLY HAS LINEAR CHARACTERISTICS

FOR ENGINEERS AND ENGINEERING MANAGERS — WORLDWIDE

ELECTRONIC DESIGN

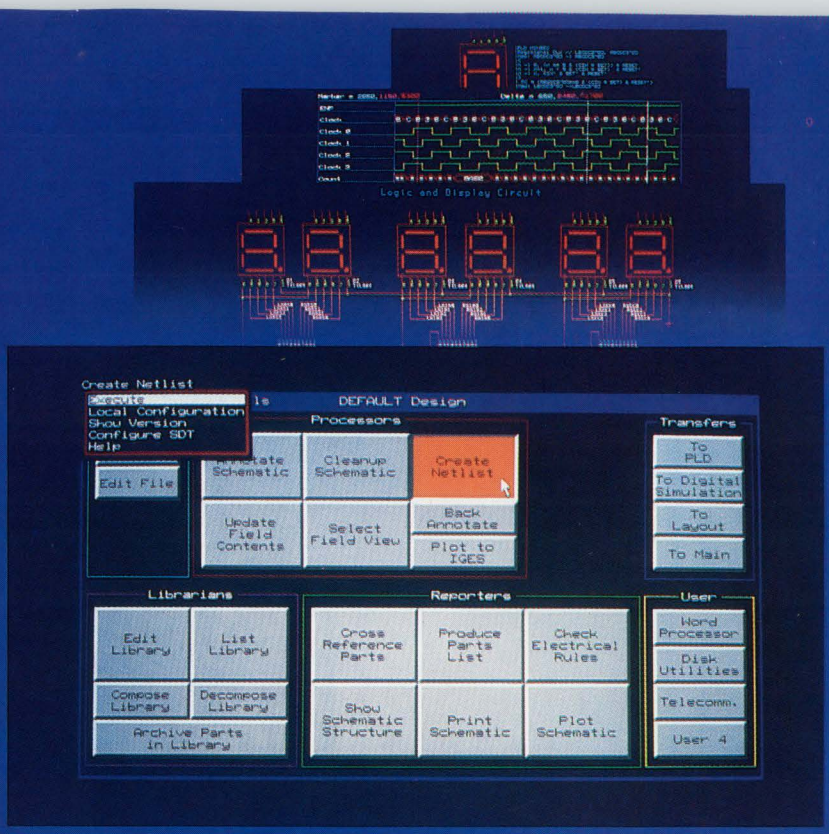
A PENTON PUBLICATION U.S. $5.00

JANUARY 31, 1991

NONVOLATILE MEMORY IC STORES ANALOG SIGNALS

- PIPS: POWER, INTERCONNECTS, PASSIVES, SWITCHES/RELAYS

OrCAD presents Release IV



The limits are gone

OrCAD has introduced the greatest product upgrade in its history. Memory limits, design restrictions, even boundaries between products are all disappearing.

For years, OrCAD's competitors have been playing a game of catch-up. With the introduction of Release IV, the race is over. No one will match our price/performance ratio on these features:

- Schematic Parts Library has been increased to over 20,000 unique library parts
- Digital Simulation process has been speeded up by an order of magnitude
- Printed Circuit Board Layout package offers autoplacement and autorouting at no extra charge
- Expanded memory capabilities

Best of all, OrCAD introduces ESP

ESP is a graphical environment designed specifically for the electronic designer. Software tools appropriate for different stages in the design process are now linked together to form a seamless flow of information. This easy-to-use framework relieves the designer of time consuming tasks and the inconvenience of moving from one tool set to another. You can now spend more time productively designing.

For more information . . .

You need to know more about Release IV and all of the benefits OrCAD has to offer. Call the telephone number below and we'll send you a free demonstration disk.

OrCAD®

More designs from more designers

For more information, call (503) 690-9881

or write to OrCAD Sales Department, 3175 N.W. Aloclek Drive, Hillsboro, Oregon, 97124

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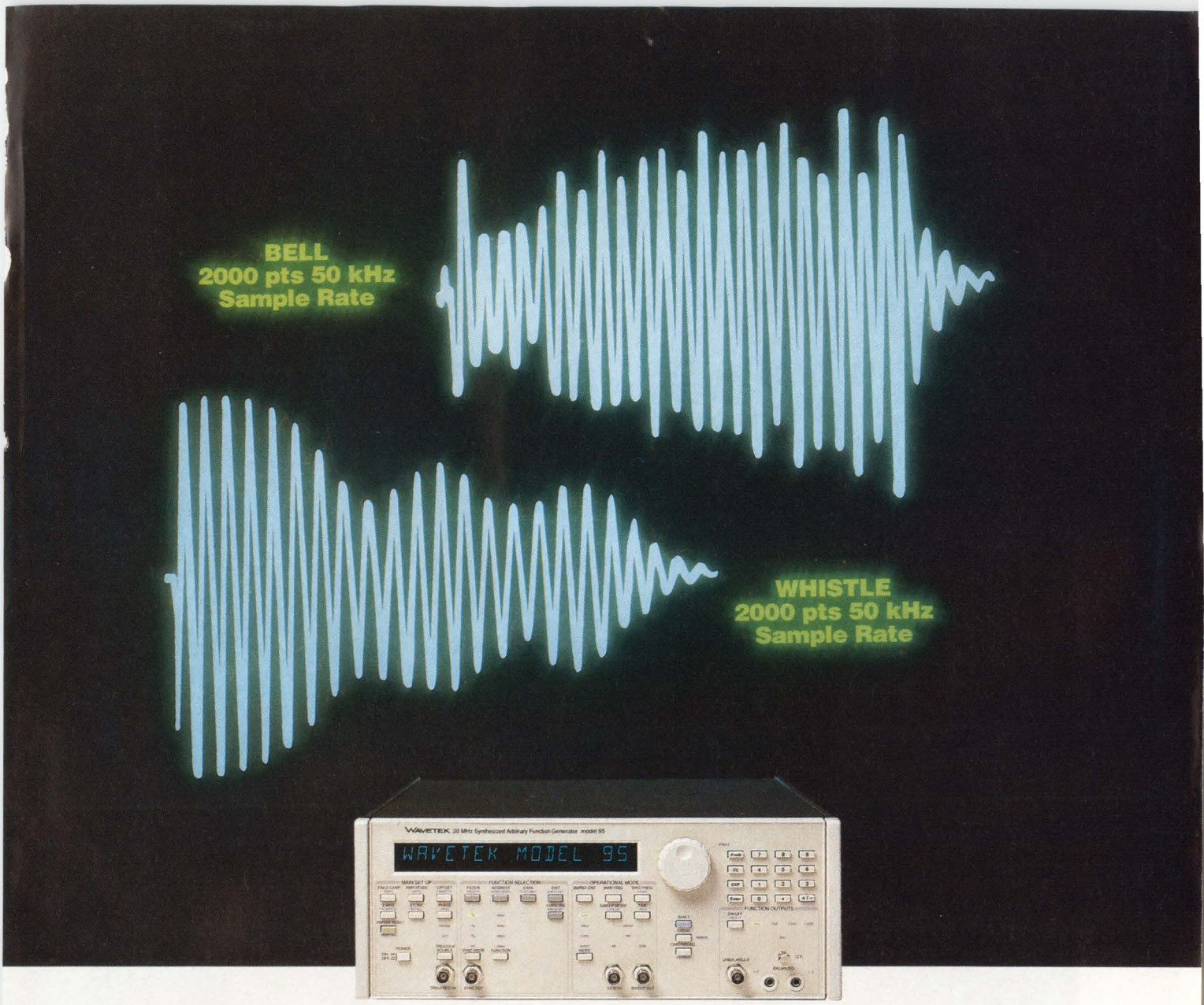


Our new function generator has all the bells and whistles.

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

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

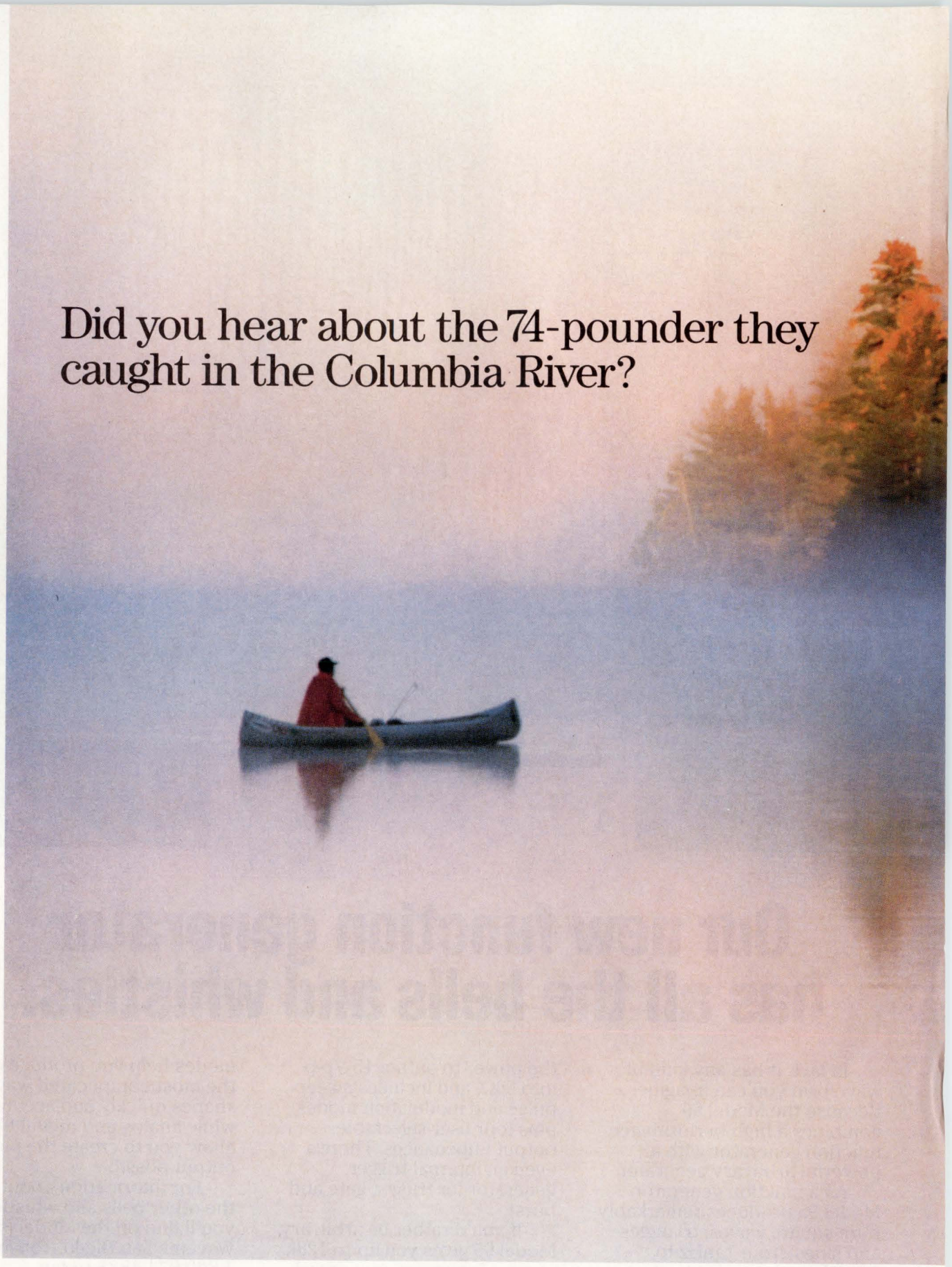
If you'd rather be arbitrary, Model 95 gives you up to 128k of waveform memory to work with, and a sample rate of 20 MHz. Four different editing modes help you produce even the most complicated wave shapes quickly and accurately, while analog and digital filters allow you to create the purest output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

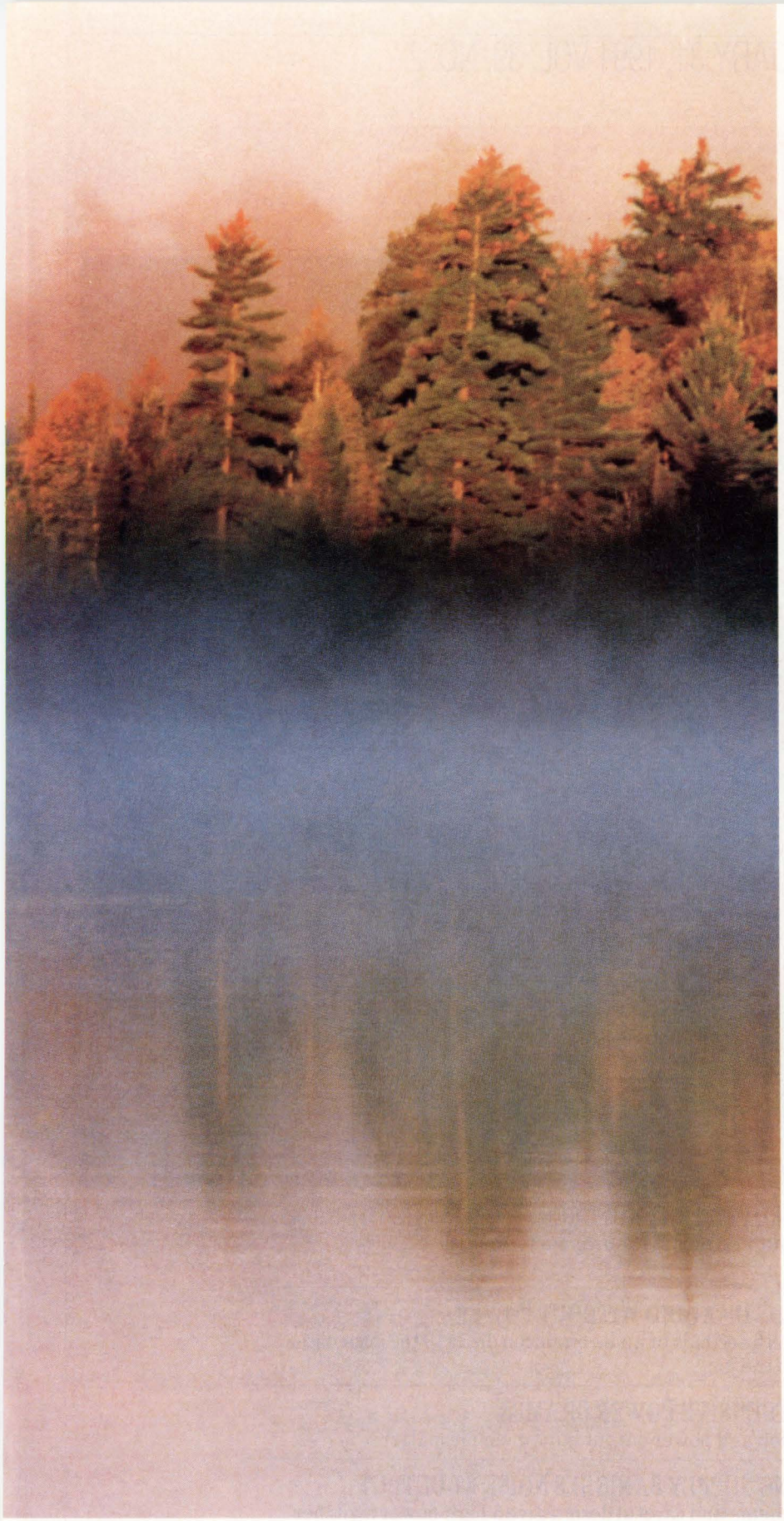
For information about all the other bells and whistles you'll find on the Model 95, call Wavetek San Diego, Toll Free at **1-800-874-4835** today.

Circle 130 for Literature

Circle 131 for Demo

WAVETEK®





It worked without a snag.

This is a story about the one that got away. And then came back as reliably as ever.

In 1987, bandits stole four HP signal generators from a truck in Spokane, Washington. Luckily, police managed to recover three of them. But the last one disappeared without a trace.

Six months later, a man fishing the Columbia River hauled in a heavy metal box. Well, within a few days, we had the missing signal generator back. There was mud in every nook and cranny.

But rather than clean this catch, one of our Service Engineers decided to plug it in. To his surprise, the instrument emitted a signal. Even more remarkable, it met specifications.

Stories like this underscore why HP rates highest for reliability among engineering managers. We're still not satisfied. In fact, in 1979 we started a Total Quality Control program to increase quality ten-fold in 10 years. We'll reach that goal this year.

It just goes to show you that when design and manufacturing productivity are at stake, there is no reliable substitute for HP. And that sometimes the best fish stories are actually true.

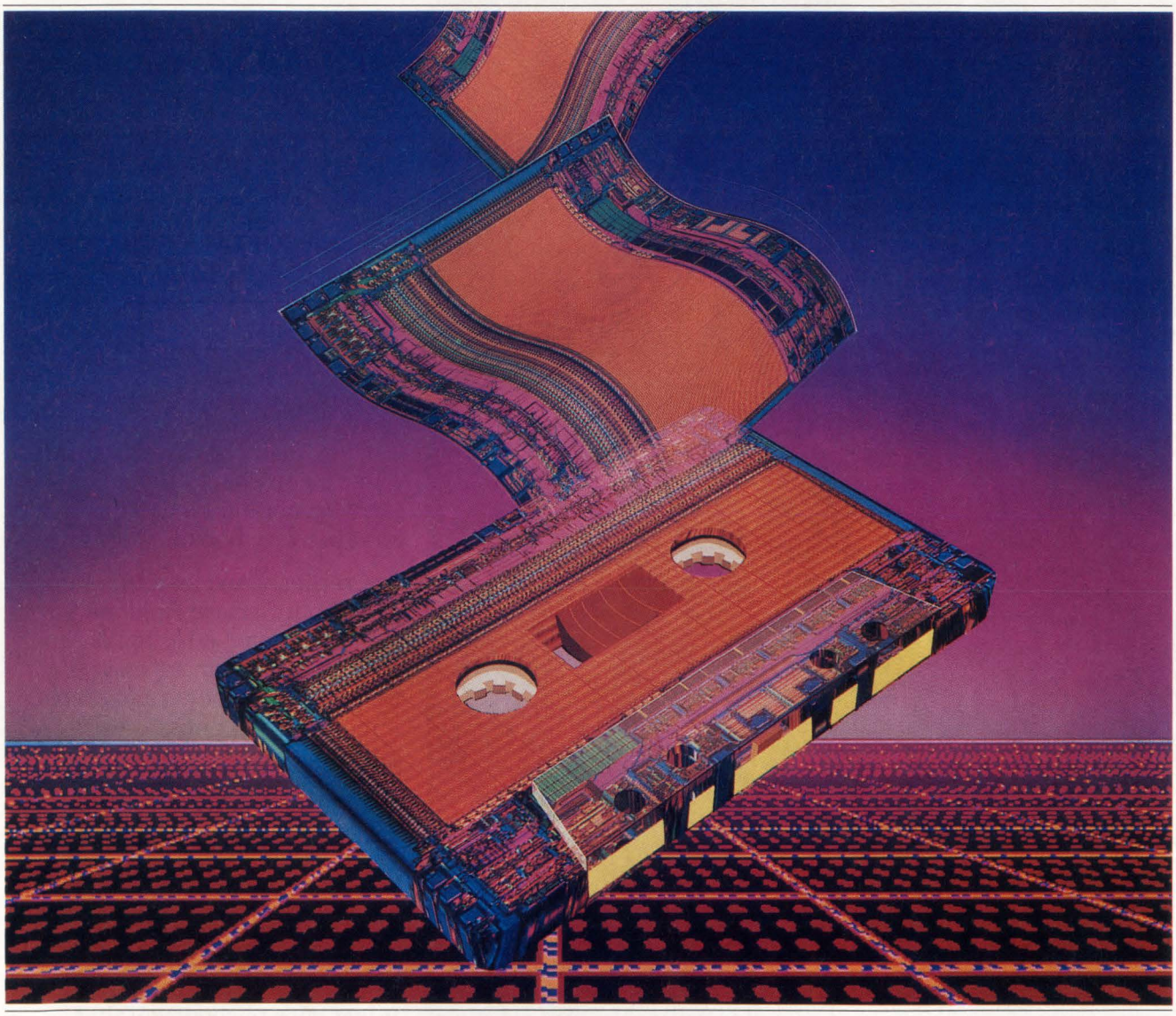
There is a better way.

HEWLETT PACKARD

CIRCLE 184

JANUARY 31, 1991 VOL. 39, NO. 2

ELECTRONIC DESIGN



COMING NEXT ISSUE
- Special Report: Highlights of the International Solid State Circuits Conference—advances in VLSI digital, analog, and communications ICs
- Techniques for characterizing digital control loops
- First details on a 100-MIPS embedded controller chip
- A new breed of low-cost, high-speed op amps
- Plus regular features:

Pease Porridge
Ideas for Design
Technology Advances
Quick Look

Certificate of Merit
Winner, 1988
Jesse H. Neal Editorial
Achievement Awards

Cover: Jook Leung

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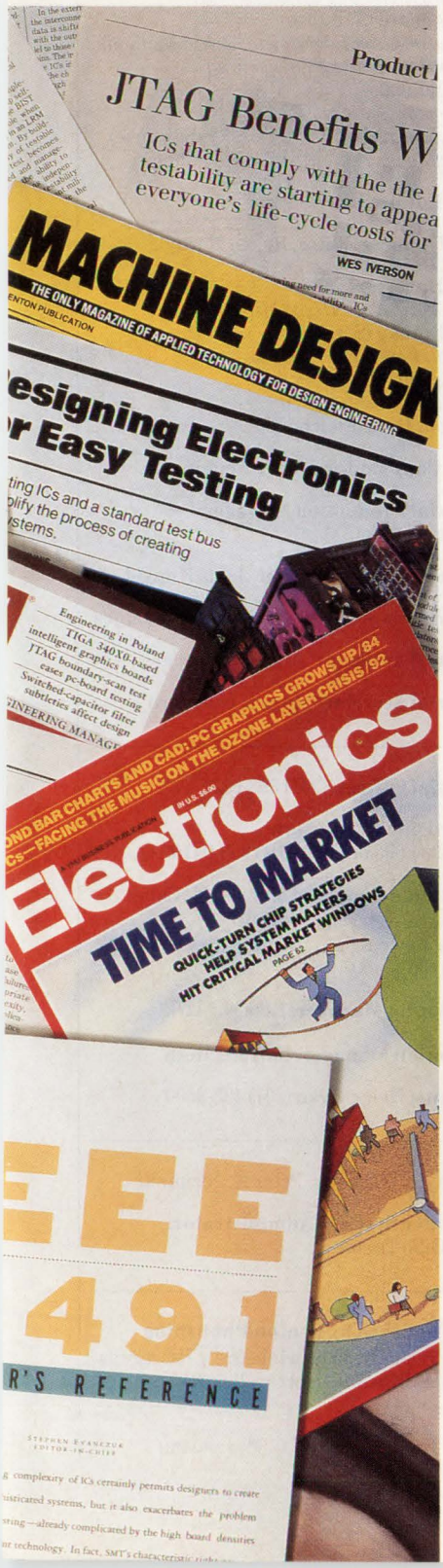
IN THE ERA OF MegaChip™ TECHNOLOGIES

A lot has been said about company is doing a lot about

testability, but only one it. Texas Instruments.



You've seen the headlines and read the stories. Design-for-test (DFT) is a challenge but one that's now easier to live with. The reason: Texas Instruments is the first to develop products for implementing the JTAG/IEEE 1149.1 testability standard quickly and effectively.

To market faster at lower cost

By implementing testability into your system from the outset, you can create one that uses high-performance circuits and is readily manufacturable, one that is lower in total cost and on the market faster. You can expect:

- Test integration — from silicon to system — that reduces debug and test time
- Reduced test software development time — generating test vectors is greatly simplified
- Reduced capital investment in test equipment
- Increased system fault coverage and reliability

SCOPE, our broad-based solution

To simplify and speed your design task, TI has developed its SCOPE™ (System Controllability/Observability Partitioning Environment) family. It is a coordinated, broad-choice set of commercial and military products compatible with the IEEE 1149.1 standard.

Included are bus-interface devices, standard cells, gate arrays, and digital signal processors, as well as our ASSET™ (Advanced Support System for Emulation and Test) diagnostics software.

On the way are diary memories, a series of IEEE 1149.1 stand-alone controllers, and microprocessors with boundary-scan and built-in self-test features.

We are in for the long haul

As a member of the Joint Test Action Group (JTAG), we contributed to the formulation of the IEEE 1149.1 standard and wholeheartedly support it. We are committed to growing our SCOPE family of products so that designing to the IEEE 1149.1 standard will be like second nature.

Your future competitiveness depends upon an engineering methodology where design teams bear the burden of testability, manufacturability, and reliability. The demands of concurrent engineering will be met in part by the extended capabilities accessed via the IEEE standard — from embedded system information that allows realtime availability of data throughout the design cycle to emulation and realtime system analyses capabilities built right into the silicon.

Get our floppy free, and learn more

Call 1-800-336-5236, ext. 3909, and we'll send you our unique floppy disk presentation. Just pop it into any MS-DOS™-compatible PC to find out more about DFT and TI's SCOPE testability family. What's more, the disk features a formula that allows you to calculate the cost-effectiveness of implementing testability in your system.

You will continue to read headlines about DFT. We intend to make many of them.

TEXAS INSTRUMENTS

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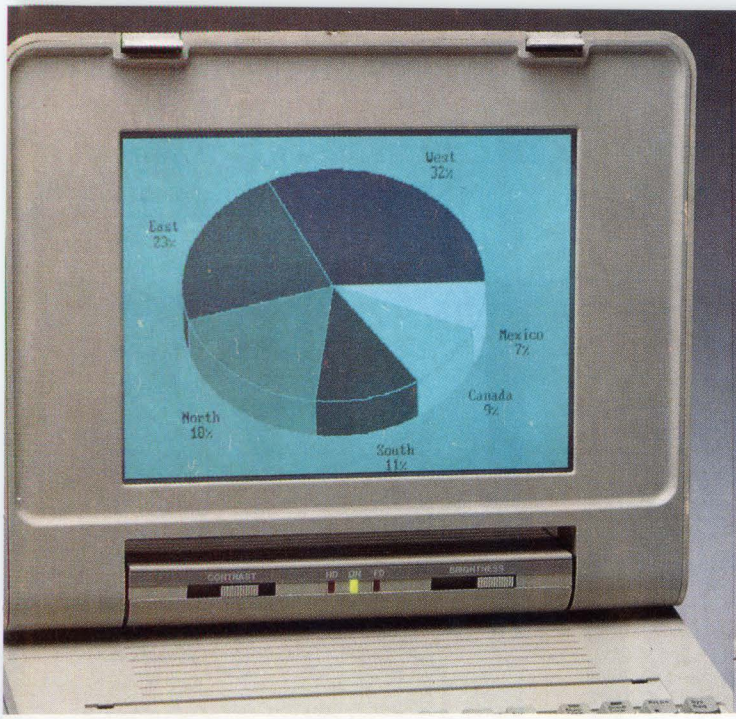
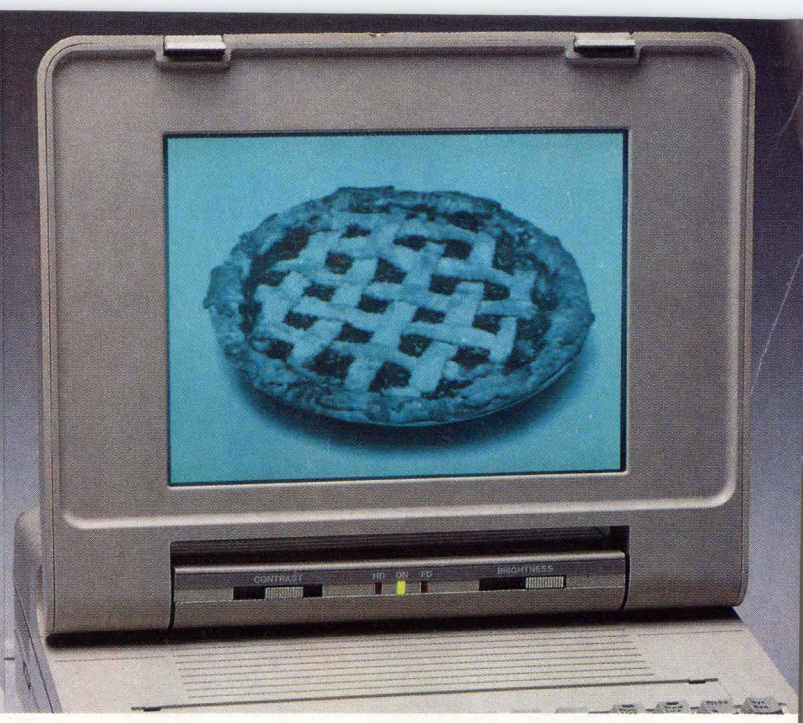


Cirrus Logic monochrome LCD controllers have given laptop leaders tastier looking graphics displays.



Even realistic scanned images aren't just pie in the sky with our enhanced VGA color mapping.

How Our LCD Chips Can Give You A Bigger Slice Of The Pie.

How do purchasers tell which laptop they want? They look. They look for better display quality. Brighter graphics. Clear, well-modeled images. And a battery-operated display that won't fade out on them.

Laptops that display these features sell better. So it's easy to see why Cirrus Logic is the leading supplier of LCD VGA display controller chips in the laptop and notebook market.

Our monochrome solutions give you displays that *PC Magazine* called "the stars of our VGA color-mapping tests"* with up to 64 shades of gray. Our LCD controller chips also include special power-saving features to maximize battery life.

For life-like 3-dimensional imaging, Cirrus Logic color LCD controllers offer the same technology leadership for your high-end color products. With direct support for the latest active-matrix LCD panels. Our controller chips do more than support your panel's color capabilities — they enhance it with full VGA color support and a fuller color palette. To give you color so good it competes with CRT quality.

Cirrus Logic LCD controllers are fully compatible with the popular PC video standards and will work with LCD, plasma, or electroluminescence displays.

Best of all, Cirrus Logic helps you increase speed and simplify your design job. We supply software and hardware design notes and full design support. A higher level of integration gives you the smallest form factor available. So you see the results you want quickly and easily.

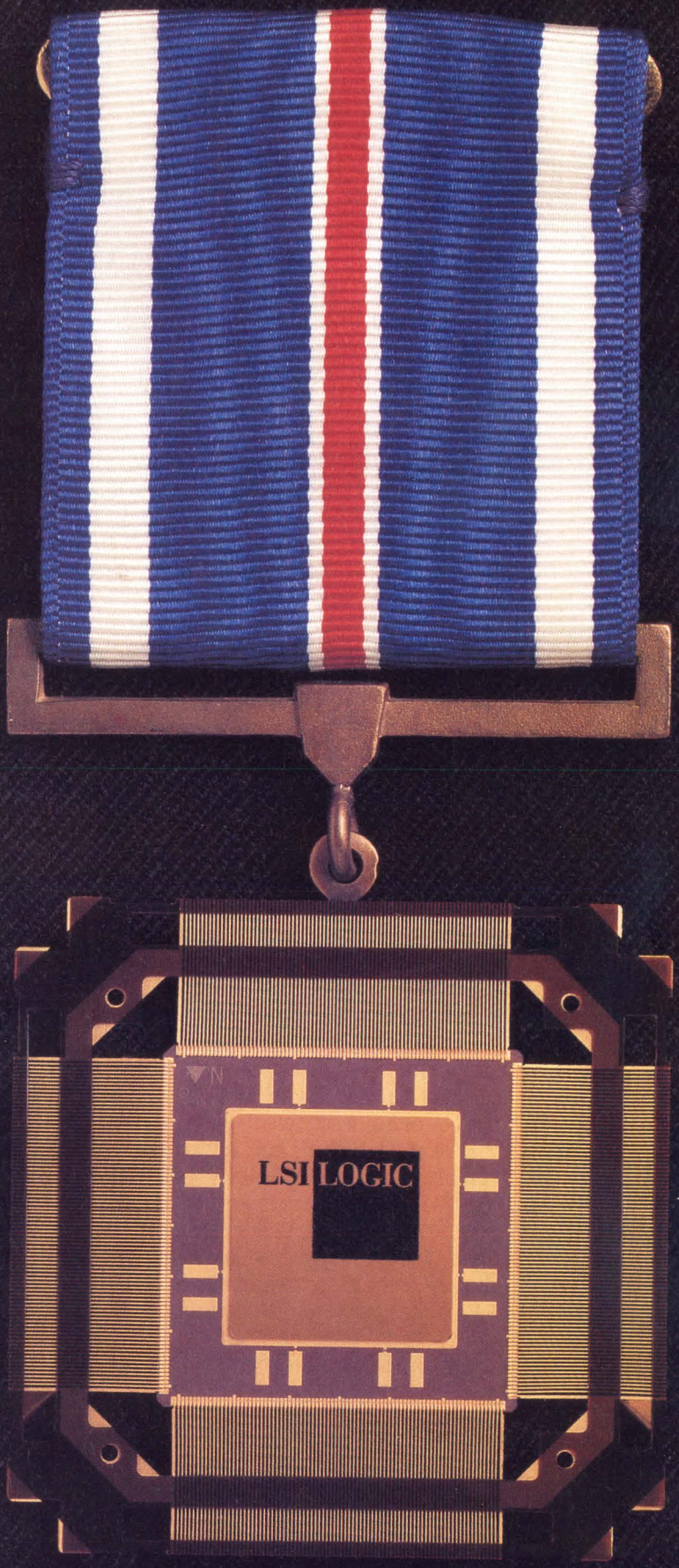
Get the picture. Get more information on LCD controllers.
Call 1-800-952-6300. Ask for dept. LL33.

Who wants a flat panel display that looks flat?

Show your true colors with Cirrus Logic controller chips. They actually add colors to your display capabilities for more realistic shading.

CIRRUS LOGIC

C L O S I N G T H E G A P


LSI LOGIC

WE'RE STILL ON ACTIVE DUTY.

While many companies have deserted the military ASIC business, our commitment hasn't changed.

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Our commitment continues as we ready the Silicon 1076, a VHDL system development environment capable of taking you from the highest levels of abstraction right through to actual silicon. Our military arsenal already consists of design software which ensures a first-time hit rate, dedicated manufacturing, radiation hardened processes and package development. Whether your program need is for one design or 30, we've got the capability to hit your milestone targets.

Next time you're looking for a technology upgrade, or need fast time-to-market, enlist the world's leader in military ASICs and RISC microprocessors. LSI Logic.

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We'll be there. Because we're always on active duty.

LSI LOGIC®

ACROSS THE BOARD

CIRCLE 107

THE CAE SOLUTION

In a recent issue of the London-based newsweekly The Economist, the editors point out Japan's strength in technical workers, its "army of engineers." The numbers spell this out: Japan has 5000 engineers per 1-million population vs. the U.S.'s 3500 and western Germany's 2500, with no other country coming close. This strength, says The Economist, is one reason Japanese companies can develop new products in a third to half the time spent by their western counterparts—at a tenth of the cost. How can others compete against that?

It's clear this situation will not change in the U.S. any time soon. Secondary-school science education is in a dismal state, and technical universities are recruiting foreign students to fill out engineering classrooms, both undergraduate and graduate. And, as repeatedly pointed out by the engineers themselves, employers often misuse the engineering talent they already have, relegating engineers to non-creative, rote jobs. The handwriting on the lab wall heralds that the U.S. electronics industry, the largest employer in the country, will have a tough time competing in the ever-more-global electronics marketplace.

U.S. engineers not only must work harder, but also work smarter. One hope is that computer-aided engineering, in which the U.S. still leads the world, will enable the proportionately fewer engineers to improve their design leverage to offset other countries' advantages of sheer numbers. Is there any alternative? Assigning routine tasks to the computer and leaving the innovator with more time to create can stick a pin in this ballooning problem.

All members of the electronics industry must increase their investments in capital equipment to become more competitive. There is a strong ongoing debate regarding government support of the semiconductor industry, with cogent arguments on both sides. But the far greater part of the electronics industry, the equipment builders, are perhaps in more need. Investments in CAE hardware and software—intellectual capital equipment—could have lasting payoffs for the industry as a whole.

Stephen E. Scrupski
Editor-in-Chief

SURFACE MOUNT MIXERS

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The opportunity for automated, low-cost assembly is a key benefit of surface-mount technology, but is often wiped out by the high price of surface-mount components. Now, Mini-Circuits offers a new series of mixers to meet the pricing demands of SMT...only $3.30 in 1,000 quantity ($3.95 ea. in quantity of 10)...at a cost even lower than most conventionally-packaged mixers.

The SCM-1 spans 1 to 500MHz and the SCM-2 covers 10 to 1,000MHz. Housed in a rugged, non-hermetic 0.4 by 0.8 by 0.3 in. high (maximum dimensions) plastic/ceramic package. Spacing between connections is 0.2 in. The mixer is offered with leads (SCM-L) or without leads (SCM-NL) to meet a wide range of pc board mounting configurations.

Each SCM is built to meet severe environmental stresses including mechanical shock/vibration as well as temperature shock. The operating and temperature storage range is -55°C to +100°C. Each SCM, designed and built to meet today's demanding reliability requirements, carries Mini-Circuits' exclusive 0.1% AQL guarantee of no rejects on every order shipped (up to 1,000 pieces).

When you think SMT for low-cost production, think of Mini-Circuits' low-cost SCM mixers.

SPECIFICATIONS (typical)	SCM-1L SCM-1NL (L=with leads)	SCM-2L SCM-2NL (NL=no leads)
FREQ. RANGE (MHz)		
LO,RF	1-500	10-1000
IF	DC-500	DC-500
CONVERSION LOSS (dB)		
Midband	6.3 dB	6.5 dB
Total Range	7.5 dB	8.0 dB
ISOLATION (dB)	(L-R)(L-I)	(L-R)(L-I)
Low-Band	60 45	45 35
Mid-Band	45 40	35 30
High-Band	40 35	25 20
PRICE	$3.30 (1000 qty) $4.25 (1-9)	$4.15 (1000 qty) $5.45 (1-9)

Units are shipped in anti-static plastic "tubes" or "sticks" for automatic insertion.

*NOTE: L & NL suffix for ordering only
Not marked on units.

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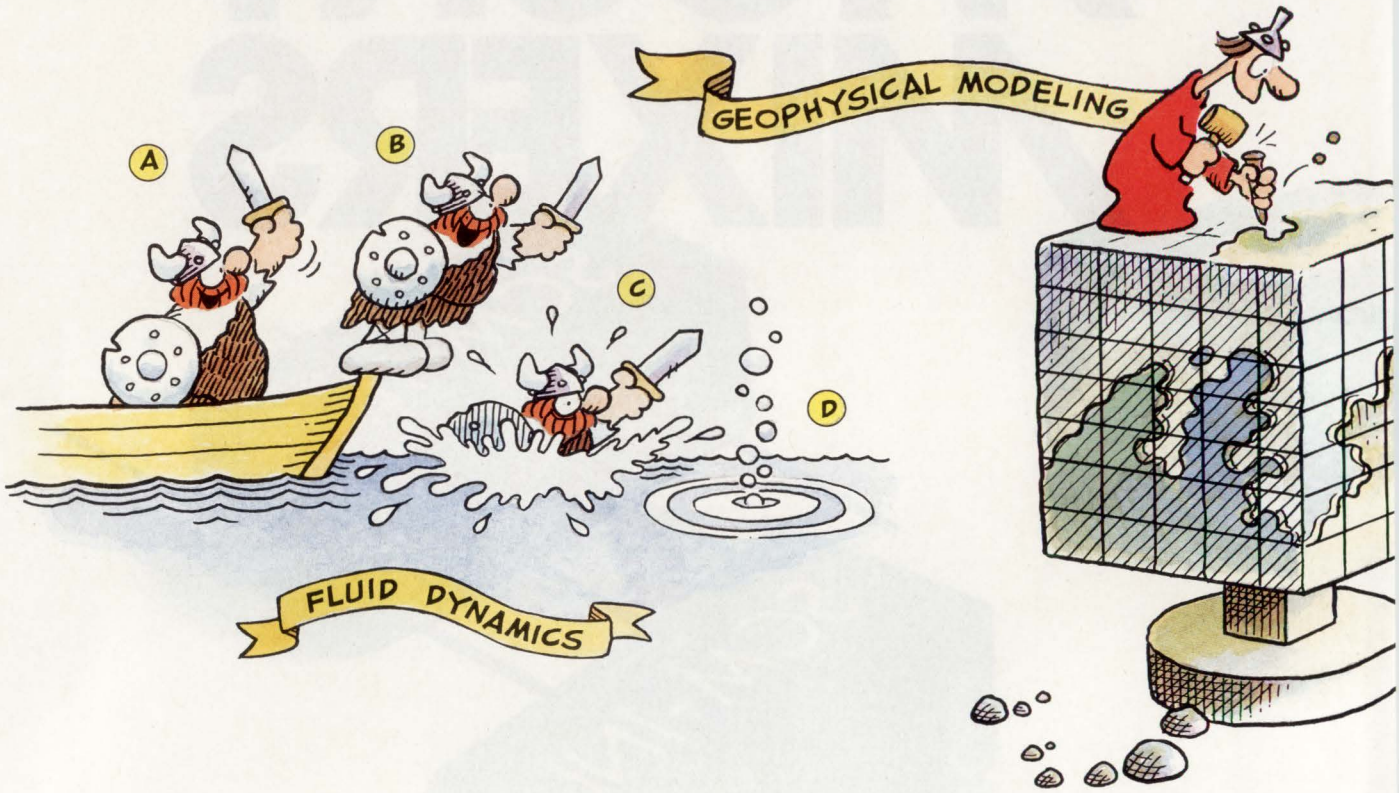
CIRCLE 90

C 115 REV E

The IBM RISC System/ The power you've been seeking



It's a never-ending quest for power seekers. You're always looking for ways to run your favorite applications faster. Well, search no more. The RISC System/6000™ family of POWERstations and POWERservers gives you power that soars as high as 23 MFLOPS and 56 MIPS.

	MFLOPS	MIPS	SPECmark™
POWERstation 320	7.4	29.5	22.4
DECstation 5000-200	3.7	24.2	18.5

When it comes to porting, your ship has come in. Of course, all the speed in the world wouldn't mean much without the applications you need. So the RISC System/6000 family already has more than 2,000 of the most popular technical and commercial applications up, running and running fast. And if you think you know a good thing when you see it, so do software vendors. That's why you'll also be seeing more and more applications coming on board the RISC System/6000 platform all the time. And if you like to build your own solutions, there's a full arsenal of enablers and relational data bases from leading vendors, as well as CASE tools and a host of popular programming languages.

A smorgasbord of solutions. Applications already announced include the IBM engineering design packages CADAM™, CAEDS™, CBDS™,

MFLOPS are the results of the double-precision, all FORTRAN Linpack test 100x100 array suite. The Dhrystone Version 1.1 test results are used to compute RISC System/6000 Integer MIPS value where 1,757 Dhrystones/second is 1 MIPS (Vax 11/780). SPECmark is a geometric mean of ten benchmark tests. All performance data are based on published benchmark information.

6000 family.
for all your applications.

CATIA™ and AES. Also available are a broad spectrum of solutions from vendors like Valid Logic, MacNeal Schwendler, Swanson Analysis, SAS Institute, SPSS, Wavefront, Alias, Polygen, Cadence, Fluid Dynamics International, Western Atlas, ECL Petro and creare.X. Scientific and technical applications are available in areas like physics, structural analysis, chemistry, securities trading, mathematics, earth resources, operations research, visualization, graphics, technical publishing and more. There's also accounting software like FourGen and support for leading UNIX®-based office automation packages. And there are key industry applications for businesses in medical groups, retail stores, newspapers, pharmacies and many more.

Command enormous processing clout.
The RISC System/6000 family is built to boost the performance of the software power seekers use most. It's got the best floating point processor in the business for numerically intensive applications, plus a new superscalar processor and incredible 3D graphics capabilities. To find out more, call your IBM marketing representative or IBM Business Partner. For literature, call 1 800 IBM-6676, ext. 990.

For the Power Seeker.

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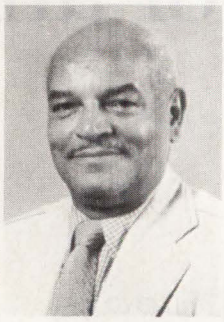
IBM®

CONCURRENT DESIGN: THEN AND NOW



MILT LEONARD
SENIOR EDITOR

The announcement of Interop Inc.'s first Achievement Award, presented to Motorola Inc., Phoenix, Ariz., for its peer-to-peer network, gave me cause to reflect on my previous career in the engineering world. At the dawn of the microprocessor era, I was a project engineer with a small company that designed and manufactured specialized instruments for spectrographic analysis. These products embodied an interesting mix of engineering disciplines. The instruments were designed to determine the composition of materials for the steel, oil, medical, and other industries. Most designs were customized for specific industry requirements.

We prototyped our instruments with lenses and prisms from Edmund Scientific, op-amp modules from Philbrick, electrical-power devices from local supply houses, and precision mechanical fixtures from local machine shops. Our data base for these multidiscipline designs was highly paper-intensive, making it very difficult to track and retrieve design data quickly. And applying concurrent design techniques was totally out of the question. Consequently, the design of an instrument progressed painfully from stage to stage, often dragging out to a year or more. Eventually, more sophisticated and complex instrumentation demanded by advancing spectroscopic techniques caught up with and outdistanced our ability to produce designs efficiently. The company went under.

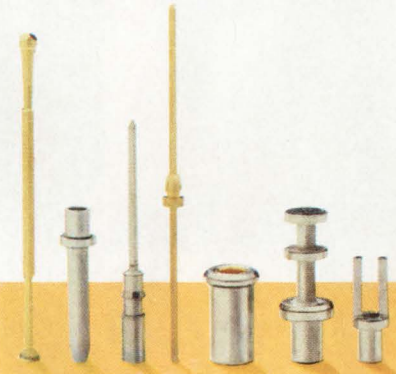
If controlling the flow of information became the downfall of our little company, consider the challenge faced by operations with globally dispersed engineering, manufacturing, assembly, and marketing facilities. Project management insists on daily updates of text files and graphics data for immediate access by anyone who needs it, regardless of geographical location. This is particularly crucial for shortening time to market by proceeding concurrently with the various aspects of the design. To solve the problem, more and more manufacturers are turning to networking technology so that projects can be managed from a central group. Nowhere is this application better illustrated than in Motorola's network.

Interop, the organization that runs the annual INTEROP Conference in San Jose, Calif., imparted the award to Motorola in recognition of its network. The network ties together the design and manufacturing facilities of 12 of the company's domestic plants and 8 of Motorola's plants deployed in Europe and Asia. In all, the network spans 17 time zones and has 13,000 nodes. The systems installed on the network include mainframe computers, minicomputers, workstations, file servers, and desktop computers from over a dozen different vendors.

Motorola's prior network consisted of many group-owned asynchronous and X.25 lines that linked together loosely coupled groups of local-area networks (LANs) with very low connectivity. Using store-and-forward techniques, transferal of a typical design database for an integrated circuit, which can range from 500 kbytes to 10 Mbytes, took up to several days. The updated network now links the distributed LANs through T1 communications land lines, optical-fiber links, and by satellite transmission. With database transfer time cut to a matter of minutes, a typical circuit design cycle can be reduced by as much as 40%. Equipped with such tools, an engineer in Munich can check the interface specifications of other parts of a chip being designed in Austin, Texas.

Motorola's system is acknowledged as a hallmark of global internetworking design. But I can't help wonder what might have been if our little company had been equipped with just a fraction of this networking capability those many years ago.

NOBODY TURNS OUT THE VOLUME LIKE MILL-MAX



Bar none, Mill-Max is America's leading source for interconnect components. Here's a brief medley of our top selling hits:

- PCB pins
- Pin receptacles
- I.C. socket pins
- Solder terminals
- Wrapost receptacles and terminals
- Custom products

MILL-MAX®

CIRCLE 146

Need interconnect components in record time? Mill-Max is your ticket. By producing over 70 million machined parts per week, we top the U.S. charts for our wide variety of items from stock.

But what makes Mill-Max "the King" is the superior quality we attain by manufacturing under one roof. And instrumental to the reliability of all our sockets is the "multi-finger" inner contact made famous by Mill-Max.

Sure, we've become very popular, but we never turn down a small gig: our prototypes and custom products are big hits.

Looking for a connector supplier in tune with your needs? Then write or call Mill-Max at (**516**) **922-6000** and we'll drum up a Mill-Max or Preci-Dip catalog.

Blow my mind with your free catalogs.
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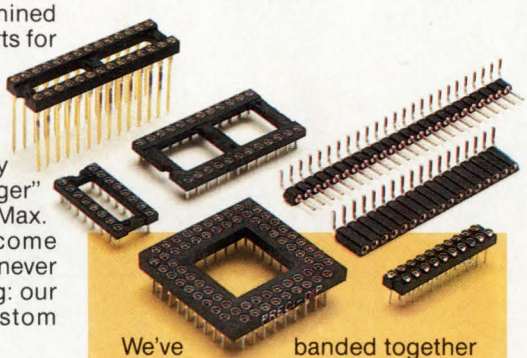
TAKING THE LEAD



We've banded together a complete line of Preci-DIP IC sockets and connectors that are real crowd pleasers.

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- Sockets for automatic insertion or surface mount
- PCB connectors
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dc to 3GHz from $11.45

lowpass, highpass, bandpass, narrowband IF

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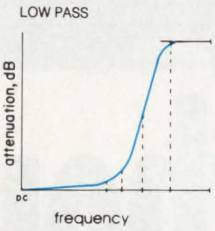
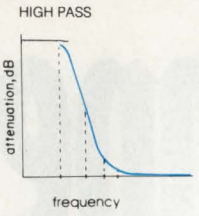
- 5-section, 30dB/octave rolloff • VSWR less than 1.7 (typ) • meets MIL-STD-202 tests
- rugged hermetically-sealed pin models • BNC, Type N; SMA available
- surface-mount • over 100 off-the-shelf models • immediate delivery



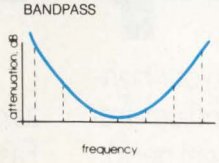
low pass dc to 1200MHz

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



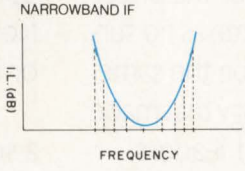
high pass dc to 2500MHz

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



bandpass 20 to 70MHz

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



narrowband IF

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

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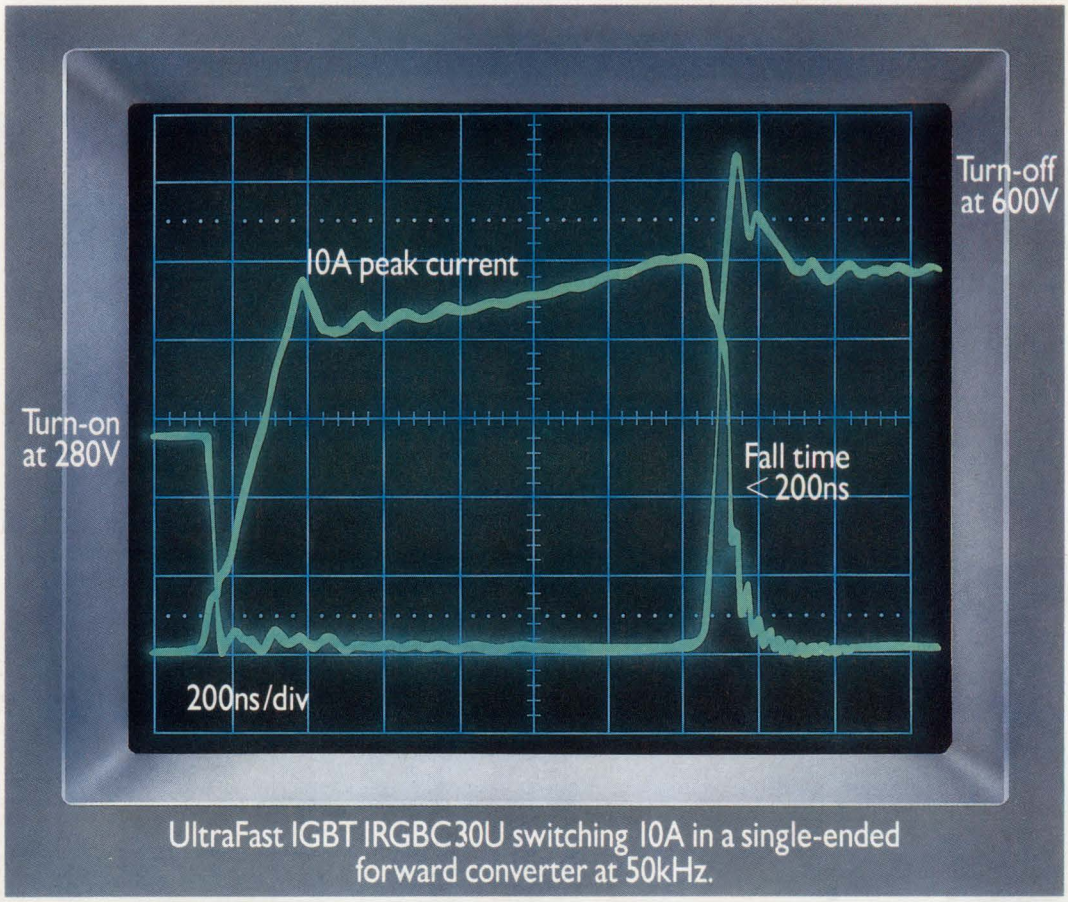
CIRCLE 89



UltraFast IGBT IRGBC30U switching 10A in a single-ended forward converter at 50kHz.

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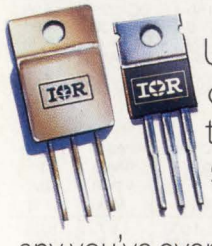

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CIRCLE 195

CAPACITIVE SENSING TRIMS MACHINING COST

By sensing electric fields before and after a machining tool passes over a surface, a high-resolution capacitive imaging sensor (HIRCIS) promises to lower the finishing cost. Developed at Sandia National Laboratories, Albuquerque, N.M., the sensor works by measuring changes in capacitance between two conductive surfaces. When a third surface (the workpiece) enters the electric field set up by the two conductive surfaces, it alters the capacitance. Then the alteration is sensed. Additional processing of this sensed data enables the system to delineate surfaces, edges, and other features. Raised discontinuities (burrs), beveled edges (chamfers), or other surface variations cause capacitance changes. These changes are picked up by the sensors and processed by a computer to identify the features for machine control and graphical display. By placing multiple sensors on a substrate, a complete two-dimensional picture of the surface can be created with one mechanical scan. Once the surface profile is generated, a machine tool, rather than a human operator, can perform the finishing automatically. And, because HIRCIS employs non-contact sensing, it isn't prone to erroneous signals or excessive wear due to machine-induced vibration. It's also less sensitive to misalignment errors. Contact Jim Novak, (505) 844-4227. *DB*

PC-BASED SOFTWARE CONTROLS CROSSTALK

A PC-based CAE program called KG Line Design helps designers avoid crosstalk on multiwire, high-bit-rate lines. The program calculates the transmission-line matrices and the impedance-matching network elements from the geometry of a multiwire line. It determines crosstalk due to mismatch for any termination network, as well as the crosstalk that develops as a pulse propagates along the line. In addition, the program calculates the gains for an unscrambler-decoder to undo the crosstalk, if that's the best solution. KG Line Design can analyze lines containing up to 45 wires. An on-line help function serves as a complete user's manual. KG Line Design runs on PCs, and is available now for $475. A demo version costs $5. Call Kenneth Granzow at (719) 528-6784. *LM*

80486-BASED MOTHERBOARD RUNS AT 50 MHz

By combining a cooling technology and the UM82C480 chip set on a motherboard with a 33-MHz 80486 processor, you get the IceJet-486 board with a processor that runs at 50 MHz and has a benchmark of 35.6 MIPS. The board, from Velox Systems, Santa Clara, Calif., derives its speed from the company's patented Peltier-effect chip cooling, called IceCap, which cools the processor down to 0°C. The UMC chip set supplies stable operation at 50 MHz by using 1.0-μm CMOS and a "one-times" system clock. Most other chip sets use a two-times clock, where the clock-signal generator is twice the speed of the system clock. This means that a 50-MHz processor would require a 100-MHz rather than a 50-MHz clock. The IceJet-486 is built on a baby AT board (8.5 by 13 in.) with seven ISA expansion slots. It carries up to 16 Mbytes of RAM and supports a Weitek 4167 coprocessor that's also cooled to 0°C. Prices for the board start at $3400 in OEM quantities. *RN* **CIRCLE 514**

ANALOG ARRAY FILLS MILITARY NEEDS

A dielectrically isolated (DI) analog tile array is now available from Harris Semiconductor, Melbourne, Fla. The HTA2000 bipolar array adheres to space class-S and military class-B requirements, which include overlapping metallization at contact windows and double bond/probe pads. DI isolation eliminates substrate parasitics between transistors. Moreover, DI, thin-film resistors, and high-gain narrow-base transistors result in high-radiation tolerance. The HTA2000 has ten tiles of 60 transistors each, plus capacitor and NiCr resistor trim areas to provide good integration. Also, p-channel FETs and buried Zener diodes are included. Up to ten 12- to 70-MHz op-amp equivalents can be on one tile array. Engineers can design the array using the Harris Fastrack design system. NRE costs start at $40,000. Call (800) 442-7747, ext. 1086. *LM*

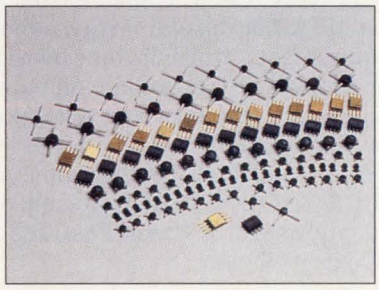
3D MULTICHIP MODULES COME DOWN IN COST

Heat dissipation is generally the limiting factor in high-density packaging techniques, such as 3D multichip modules. But thanks to a joint development effort between Quadrant Technology Inc. and Electrochem Corp., both from Hayward, Calif., viable manufacturing techniques and materials are now available. These advances offer much-improved heat dissipation and an order-of-magnitude cost reduction compared with existing thin-film methods. The firms have developed a 3D module incorporating internal thermal layers that dissipate high heat levels. Electrochem's Electroflex material is used as a thin-film interconnection medium with lines under 2 mils. The company's Thermostrate substrate material is bonded in multiple layers using a proprietary technique that results in very low production costs. Call John Woodman at (415) 785-9873. *DM*

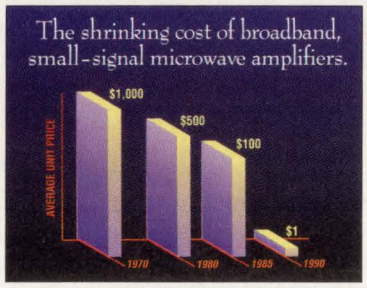
Why the cost of harnessing lofty technology is much less predatory these days.

Ancient falconers were the first to see the potential of harnessing high-flying technology. By the 1970's, microwave wizards had performed technical feats far beyond what ancient man could imagine. Yet, the most sweeping breakthroughs are emerging now, at Avantek.

Avantek is bringing the lofty cost of microwave technology down to earth, with a new generation of low-cost microwave components. In a word, our technology is going *plastic*—for high volume applications. Now, a wide range of high-performance MMICs and devices Avantek set the standards for are available in plastic and surface mount packages. This advanced microwave technology is also integrated into a variety of cost-effective components.



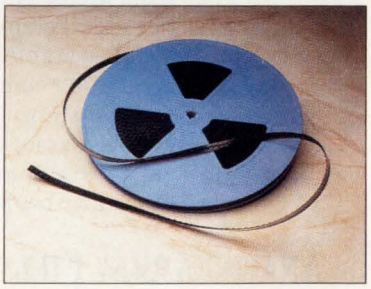
Avantek's broadband microwave amplifiers sell for as little as $1.00 each.



Avantek produces thousands of off-the-shelf products for the cellular telephone, sat com, fiber optics, data com, navigation, and telecom markets. We continue to break price/performance barriers with innovative products—silicon & GaAs semiconductors, LNAs, high power amplifiers, upconverters, downconverters, laser drivers and multiplexer/demultiplexers—for many high volume applications.

We also help customers hold down manufacturing costs in other ways. We offer the microwave industry's most extensive service and distribution network with twenty major stocking locations worldwide. So we can keep pace with the most demanding JIT programs. Or swiftly supply critical components for a single prototype. Or deliver a wide range of off-the-shelf components, often within 24 hours.

Making microwave history is part of Avantek's 25-year tradition. Today, we have an unsurpassed capability for RF and microwave products. As the world's leading manufacturer of commercial power amplifiers, GaAs & silicon transistors and MMICs for the cellular telephone, VSAT an DBS markets, we know how to meet demanding standards of cost, delivery and quality. Tomorrow this capability will enable us to meet the needs of new markets such as GPS and high frequency automotive electronics.



Avantek supplies microwave components in 7" and 13" tape and reel packaging for high-volume pick and place manufacturing.

For more information about how Avantek's new technologies can help your business thrive in the most predatory marketplace, call:

1-800-AVANTEK.

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Putting microwave technology to work for you.

CIRCLE 154

TRANSLATOR ACCELERATES VERILOG SIMULATIONS

IC designs that are described and simulated in the Verilog hardware description language can now be converted automatically for high-speed simulation on an Ikos hardware-assisted simulator. The Verilog-Language-to-Ikos Translator (VLIT) software from Ikos Systems Inc., Sunnyvale, Calif., reads Verilog net lists and translates them into Ikos-compatible files. The Ikos simulators can operate on 1.2 million gates at speeds up to 75 million events/s. VLIT processes all structural constructs and notes behavioral constructs with diagnostic messages. The translator operates as a hierarchical net-list compiler, and generates a timing file with delay information for each primitive within top-level Verilog modules. VLIT runs on HP-Apollo and Sun workstations. It's available now for a $5000 license fee per node. Call (408) 245-1900. *LM*

QUICK TURNAROUND FOR MODULE SUBSTRATES

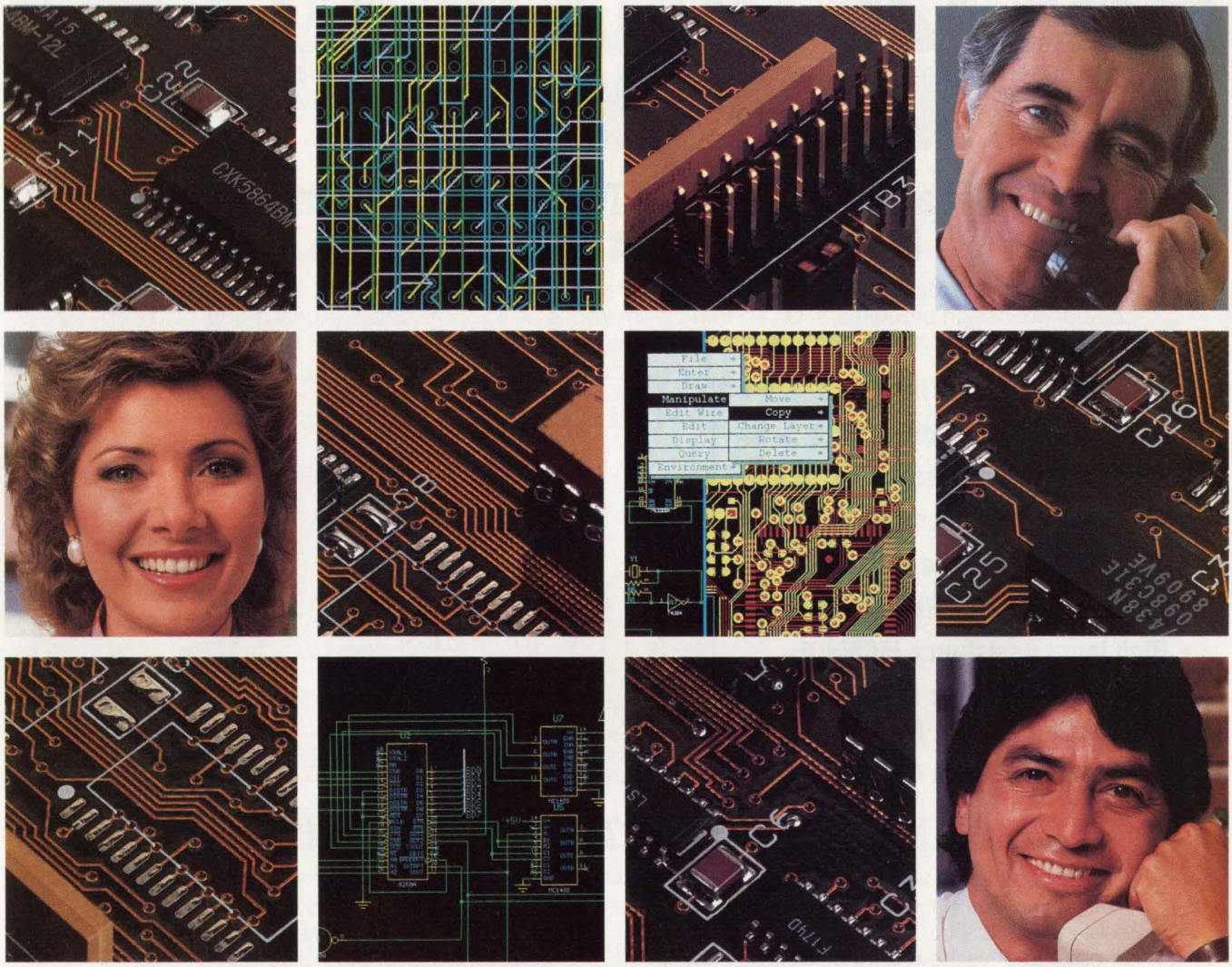
Lower product-cycle times for assemblies containing multichip modules could result from a successful demonstration of a quick-turnaround program for module substrates. The Microelectronics and Computer Technology Corp. (MCC), Austin, Texas, can now mass-produce substrates and "personalize" them later for specific applications. The quick-turnaround interconnect technology (QTAI) program begins with blank substrates that have the basic power and ground layers along with the X-Y signal layers. Then, the top layers are custom-made to user requirements. Two of the consortium's shareholders, Harris Corp., Melbourne, Fla., and Eastman Kodak Co., Rochester, N.Y., have already benefited from their collaboration in the technology's development. For Kodak's vehicle, a 2-Mbyte nonvolatile-memory card, substrate personalization was completed within seven working days from receipt of the photomasks. Harris used the technology in a crossbar switch that incorporates both tape-automated bonding and wire bonding. The switch's 16 VLSI chips each have 103 inputs and outputs. According to MCC, the flexible approach sacrifices little in performance compared with full-custom approaches and is viable at clock speeds well above 100 MHz. Contact MCC at (512) 343-0978. *DM*

FIRST BiCMOS PLDs CUT PROPAGATION DELAYS

Although the popular 22V10 architecture has been implemented in either bipolar or CMOS processes, designers have yet to attain a version that mixes the best of both. That will soon change when the first biCMOS versions of a 22V10 will be sampled by Cypress Semiconductor Corp., San Jose, Calif. The chips will deliver a worst-case propagation delay of just 7.5 ns, which is as fast as the GaAs version offered by another company. They will be usable in systems that operate with clock rates of 40 MHz. To achieve the short delay, designers at the company's Aspen Semiconductor subsidiary implemented the speed-critical paths in ECL circuits and used bipolar technology to implement the level-conversion circuits. Outside the speed-critical path, the control logic employs CMOS circuits to minimize total chip power consumption to about 850 mW. One-time-programmable metal fuses are employed by the logic to minimize the propagation delays in the programmable logic paths. Another advantage of biCMOS is the ability to program the signal edge rates to reduce ground bounce to just 1.1 V by matching output time-constants to packages and loads. Cypress offers a 22V10 and a superset version, the 22VP10. The superset permits bidirectional I/O signals on the registered outputs. Contact Don Tuite, (408) 943-2653. *DB*

MICRO-CHANNEL CHIP SET PUTS LOGIC INTO 4 ICs

Although i486 PC motherboard chip sets are becoming common, relatively few companies opt to implement a chip set to build systems compatible with the IBM PS/2 series computers that employ the Micro Channel Architecture (MCA) bus. By the pairing of the system-design expertise of Minneapolis, Minn.-based Micral, an independent affiliate of Goupe Bull, and the manufacturing strength of Toshiba America Electronic Components Inc., Irvine, Calif., designers now have a high-performance 4-chip motherboard implementation of the IBM MCA. The chip set employs Micral's short-line interface kernel. It's a system architecture that sets up the CPU and expanded external cache as a subsystem. As higher speed CPUs are introduced, just the CPU portion of the system need be upgraded for higher speed. The chip set consists of a bus master DMA controller (TC85M911), an address and data buffer (TC85M921), a memory and bus controller (TC85M931), and a peripheral support chip (TC85M951). A 32-bit system can be built with the four chips plus a second address and data-buffer chip to form a five-chip "motherboard"—just add the BIOS, cache, and desired peripheral functions. Contact Amar Dhillon, (714) 455-2000. *DB*



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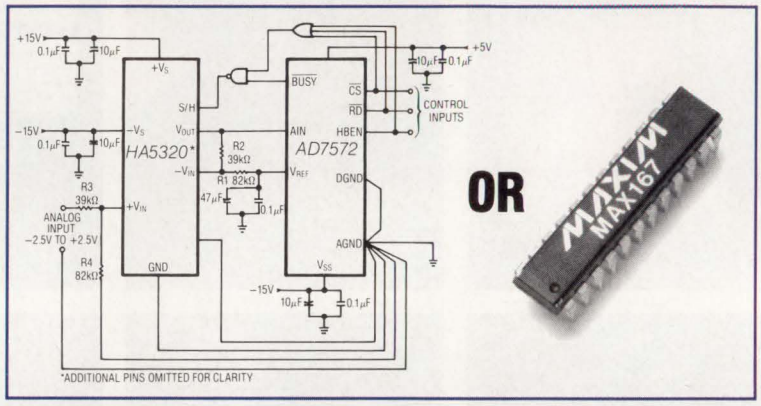

MAX167 replaces a sample/hold and an AD7572KN05 with better performance at a lower price (see table below).

MAX167 Replaces AD7572 and Sample/Hold

Pin compatible with the AD7572, Maxim's MAX163 Family can plug into existing sockets and eliminate an external sample/hold and a high performance amplifier. Unlike other A/Ds with low-resistance inputs, the high input resistance (500MΩ) of Maxim's converters allow the use of a lower cost amplifier to drive the A/D input. Compare the MAX167 specs to an AD7572KN05 used with an external sample/hold and see how well Maxim's performance looks — at a lower cost.

Specifications (S/H used with ADC†)	MAX167	LF398A†	AD585†	HA-5320†	SHC803†
Hold Step + Offset (LSB max)	6	16	10	8	19
Full Power Bandwidth (MHz typ)	6	0.3	0.6	2	0.6
Acquisition Time (μs max)	1	6	3	1.5	0.35
Aperture Delay/Jitter (ns/ps typ)	25/50	150/?	35/500	25/300	15/50
Power Dissipation (mW typ)	104	270	375	465	835
Price Range**	**$20**	**$27**	**$35**	**$35**	**$140**

† S/Hs assumed to be used with AD7572KN05.
* Price 1,000-up, FOB USA.
** Based on 100-up, FOB USA prices.

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CIRCLE 129

2.5-GBIT/S OPTICAL LINK SPANS 150 MILES OVER SPANISH MAINLAND

A 150-mile 2.5-Gbit/s fiber-optic link that runs from Valencia to Cuenca, Spain, increases the transmission rate about four times that of the fastest system in use. With a capacity of either 30,720 64-kbit/s voice channels or 16 140-Mbit/s TV channels, it's the highest-capacity communications line installed to date. The new link, which is the first part of a larger network, employs synchronous-digital-hierarchy (SDH) technology. It was installed by Philips Kommunikations Industrie AG (PKI) of Nuremberg, Germany, an affiliate of Holland's Philips International NV.

The SDH standard is based on the U. S. Sonet (synchronous optical network) standard. SDH gets around the limitations resulting from different national and applications-specific standards as does ISDN, the integrated services digital network. ISDN overcomes the drawbacks arising from multiple protocols, etc.

SDH allows any or all of the three main systems recommended by the CCITT (the International Consultative Committee for Telegraphy and Telephony) to operate within one system. The three systems are the North American and Japanese systems that are based on 24, 1.544-Mbit/s channels, and the 30-channel 2.048-Mbit/s European system. The SDH system uses distributed-feedback (DFB) Philips lasers that provide narrow bandwidths at a spectrum of 1550 nm, yielding excellent results *(see the photo)*.

SDH can work with plesiochronous networks (networks in which each signal source has its own clock), enabling present systems to further develop. Its big advantage is that flexible networks can be realized. Transmission capacity can be switched according to need. There's also the possibility that individual digital-signal channels, such as a 2-Mbit/s channel, can be added or dropped from an SDH multiplexed signal of higher order. The SDH signal thus needn't be demultiplexed.

SDH was agreed upon as a global standard optical-transmission system by the CCITT in February 1988, and was recommended for worldwide introduction in November of that year. Competing against American, Japanese, and other European firms for the Spanish network, PKI is the first to develop and install a 2.5-Gbit/s SDH system.

PKI turned over the link and its seven repeaters to Spain's national telephone operating company, Telefonica de Espana, late November last year for field tests under actual operating conditions in the public phone network. The Nuremberg firm will extend the link beyond Cuenca to Madrid by mid-1991.

The Valencia-to-Madrid leg will then be the first section of the 2.5-Gbit/s network that will eventually connect Valencia, Madrid, and Barcelona in a triangular form. Construction of this network is part of Spain's preparations for the 1992 Summer Olympics in Barcelona. Intended to improve the country's communications infrastructure, the network is to help spread the Games' results more efficiently around the country and beyond.

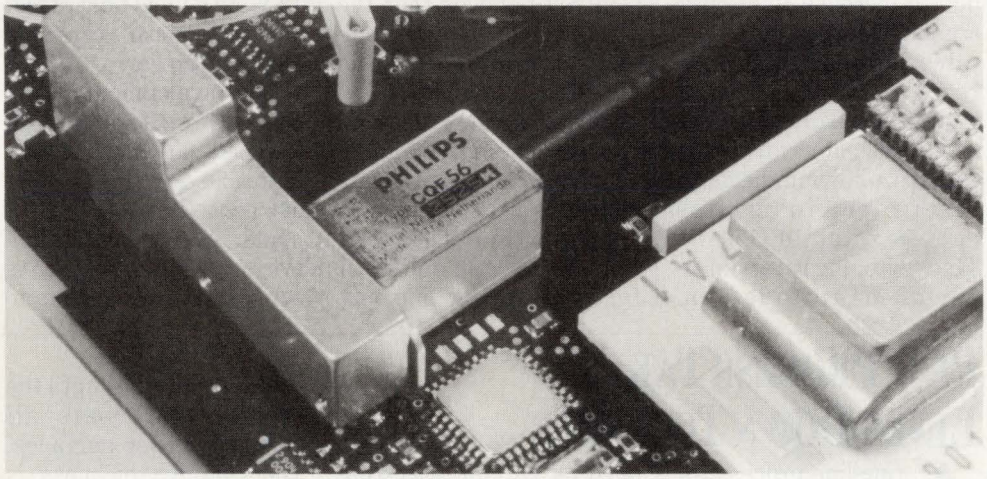
PKI's leading edge in gigabit-transmission systems—in the wavelength range of 1300 to 1550 nm—relies heavily on the close cooperation between system development and laser research. The Philips business unit Cable Transmission and Network Access (CTN) in Nuremberg has the broad-based know-how to develop a whole range of SDH products, while the company's parent in Eindhoven, the Netherlands, has expertise in advanced types of lasers.

The main transmission channel for the Philips system is driven by up to 16 synchronous transport modules. The basic element is the STM-1 signal with a bit rate of 155.520 Mbits/s. All higher-order transmission signals are multiples of the STM-1. Multiplexing to a 2.5-Gbit/s line signal using pointers is performed according to CCITT recommendations.

It's possible to access SDH overhead channels for bit-error monitoring and maintenance purposes. The equipment includes processor-controlled monitoring and checking facilities for system state analysis.

Inserting or dropping channels without changing the main data stream makes SDH ring networks possible in the future, says Rainer Wiechers, product manager for synchronous transmission systems at PKI. "A worldwide SDH standard means that SDH technology can be used with all networks existing around the world. Compatibility with all present transmission standards is ensured."

JOHN GOSCH



OPTICAL POLYMER ASSURES IMPROVED INTERFEROMETER

A Mach Zehnder interferometer, developed with an optical polymer, promises to reduce the cost of integrated optics devices and increase their performance. Designed by the PA Consulting Group Ltd., Royston, Hertfordshire, United Kingdom, which is under contract to the Dutch chemicals group AKZO nv that developed the polymer, the device is one of the first of its type.

The interferometer controls and modulates a lightwave output from a communications laser diode to increase fiber-optic transmission system data rates beyond what's currently possible. A 10-GHz modulation bandwidth was achieved in laboratory prototypes, allowing the interferometer to switch lightwaves at 10 Gbits/s. This switching rate is an order-of-magnitude improvement over commercially available interferometers that are generally fabricated from lithium niobate ($LiNbO_3$).

Moreover, the low-cost polymer used in the fiber-optic device could bring its price down to between $100 and $900, compared with $2000 to $9000 for $LiNbO_3$ devices, according to its designers. The ultimate goal is for prices in the tens of dollars, like those of passive optical components (e.g. splitters and couplers), states project leader Dr. Robin Godfrey of the PA Consulting Group. Godfrey believes that the device could reach commercial production within two to three years.

Polymer films used in the interferometer are about 1-μm thick. Its dimensions are several times smaller than those of $LiNbO_3$ devices, suiting it for integration within optical receiver-transmitter "light-to-logic" modules. And because the fabrication process of the polymer device is very simple, it will be easy to integrate multiple-channel devices into one package.

The device is made with photolithographic techniques similar to those used in semiconductor IC manufacturing. Chip size for the device is about 1 cm by a few μm. When packaged, its dimensions are about 1 cm by 1 cm. The interferometer is designed to be compatible with "silicon-voltage" levels of 5 to 12 V. As a pure field-effect device, it doesn't consume electrical power.

The development is part of a larger effort of using low-cost polymer materials to mass-produce nonlinear optoelectronic components. According to Godfrey, such components could start a new "photonics" industry that could replace electronics in the long term. He says that photonics developments are being stimulated by the need for ever-increasing speed in information transfer, storage, processing, and display.

"The development of new polymeric integrated optics devices represents a major breakthrough on the road towards broadband optical communications," Godfrey says. The materials provide low dielectric constants and thus very large bandwidths, as well as large nonlinear optical coefficients and good compatibility with low-voltage microelectronic circuits, he claims.

For more information, contact the PA Consulting Group, Cambridge Laboratory, Melbourn Royston Herts, SG8 6DP. Telephone +44 (0)763 261222.

PETER FLETCHER

PCB PROCESS TAKES LINES DOWN TO 3 MILS

A fine-line process for fabricating the inner layers of printed-circuit boards will result in volume production of boards with 3-mil line widths by the end of 1991. With a liquid-photoimageable-resist process as the key element, Praegitzer Industries, Dallas, Oreg., is now seeing significant yield increases at 5 mils and expects to be at 3 mils by this summer. The developments are aimed at satisfying the burgeoning need for much higher board densities for surface-mounted assemblies.

The Primecoat photoimageable resist was developed by DuPont Electronics, Wilmington, Del. It's applied by electrodeposition in a process called electrophoresis.

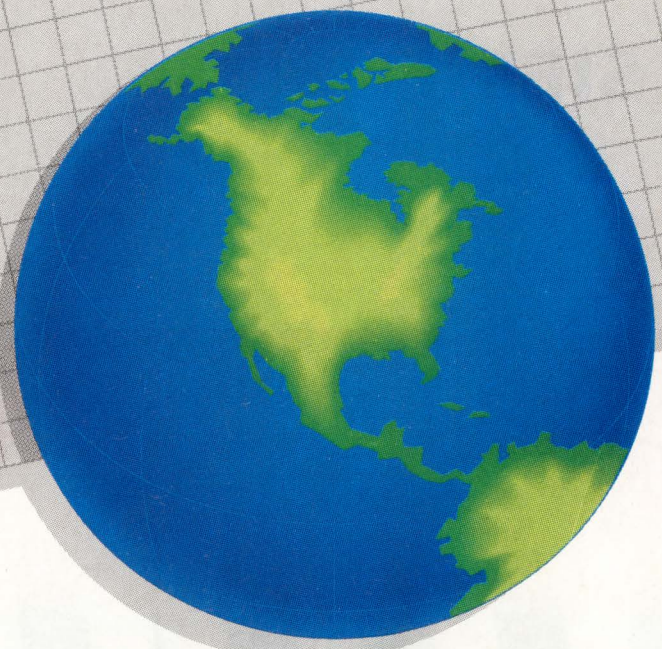
In that process, a copper board is uniformly coated by individually depositing resist molecules in an electrically charged bath. First, the copper substrate is placed in an electrolytic bath with oppositely charged electrodes on either side. Charged resin micelles are added to the bath and current is applied. This draws the molecules to the board, where they chemically react with the copper and form an insoluble resin. The deposition process continues until the resist layer coats all charged-copper surfaces. The coating thickness is from 0.25 to 1 mil, with 0.6 mils being ideal. Deposition is self-limiting and stops at a given thickness.

The liquid-resist process overcomes the high degree of difficulty that lies in the use of existing dry-film technology on the inner layer of boards. Dry resist has a process limitation at line and space widths below 5 mils. It requires an anchor on the panel, several mils wide to tent reliably. Liquids applied in the traditional manner exhibit inconsistencies in coating uniformity on laminate surfaces. Although the dry-film chemistry is essentially the same, the yields become cost prohibitive below 5 mils.

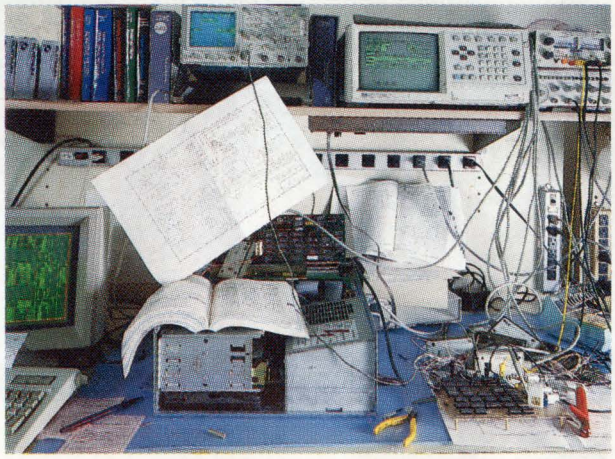
Aside from the electrodeposition step, Praegitzer's process uses conventional pc-board equipment. But the electrodeposition method gives them the advantages of increased resolution, adhesion, and reproducibility. According to Praegitzer, the electrodeposition process will give them a technological advantage over Japanese competitors, for whom electrodeposition of pc-board traces has been a priority for several years. Those competitors, he claims, are achieving yield rates over 80% at 5-mil lines and spaces.

DAVID MALINIAK

Burr-Brown's World of DSP SOLUTIONS



There Are Two Ways to Do DSP!



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- Unclear path from prototype to production
- Steep learning curve for software and hardware
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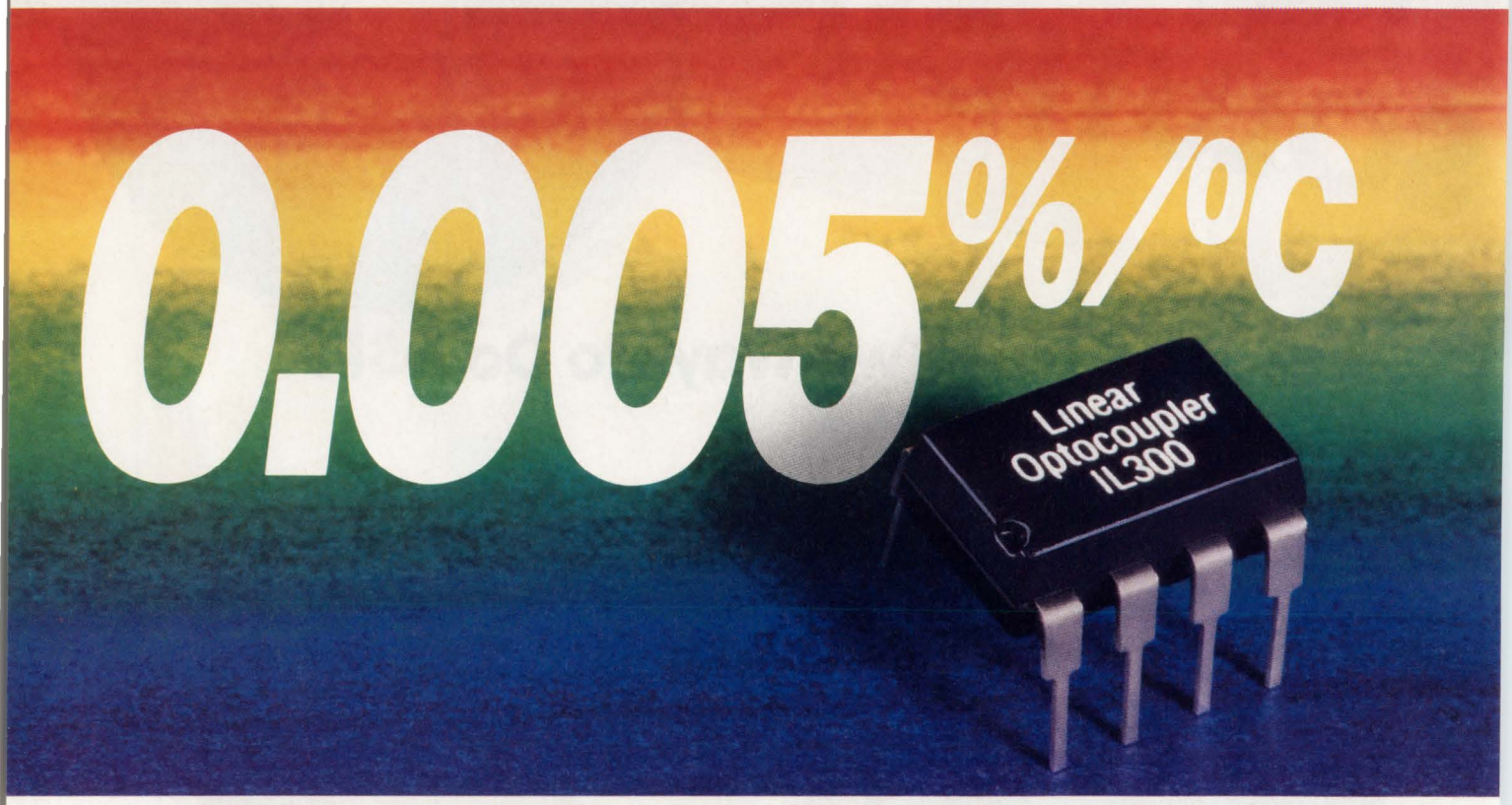

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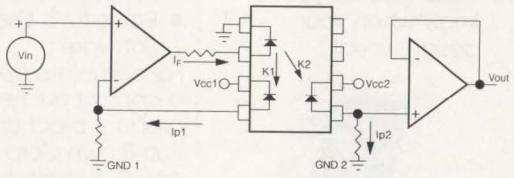

The IL300's stable operational characteristics are achieved by controlling the AlGaAs IRLED output flux with an optical feedback circuit. The servo PIN photodiode captures a percentage of the flux and generates a signal that can be used to control the LED drive current. This compensates for the LED's inherent non-linear, time, and temperature characteristics.

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BUSCON/91-WEST PROVES THAT FUTUREBUS+ IS STILL THE STAR

AS THE FUTUREBUS+ ROLLOUT HITS ITS FIRST ANNIVERSARY, PRODUCTS ARE NOW APPEARING.

RICHARD NASS

When the curtains are drawn open for this year's Buscon/91-West show, Futurebus+ will take center stage. It's been one full year since the architecture's rollout, and products are just starting to emerge. While the show's technical sessions cover all of the bus architectures, including VMEbus, Multibus II, PC platforms, and embedded systems, the balance still swings toward Futurebus+.

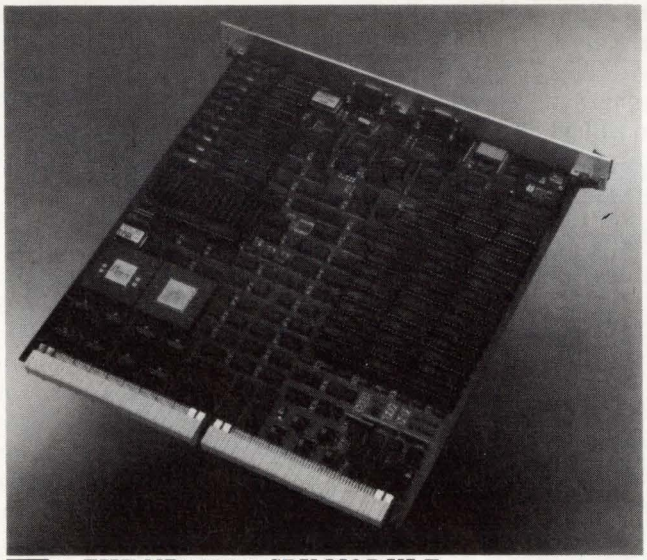
One full day of Buscon's technical sessions is devoted to Futurebus+, while the major other architectures merit half days. Day One kicks off with an introduction to Futurebus+ by Ray Alderman, Director of VITA (VMEbus International Trade Association). Futurebus+'s history and major features will be discussed. That's followed by the bus' technical details and its specifications.

A second Futurebus+ session offers an overview of the Futurebus+ Profiles. The number of profiles changes because a few are currently in the idea stage. Profile A is a 64-bit general-computing specification that uses a hard metric form factor. It's intended for board-level products. Profile B is a Futurebus+ I/O definition. Here, none of the high-performance mechanisms, including caches, packet modes, and message passing, are permitted. This profile also eliminates multiprocessing.

Profile F, for "fast," mandates all of the mechanisms not allowed in Profile B. This is because the bus has a minimum bandwidth of 500 Mbytes/s. In an earlier stage is Profile T, for "telecommunications." The standards group working on this profile has yet to define many of the necessary specifications. Profile D, for "desktop," fits an EISA form factor and uses an EISA connector. Desktop systems don't fit into a Profile A, B, or F chassis. The remaining profiles are M for "military" and C for "cable." The latter specification involves cache-coherent flat-cable networks.

Boards from different profiles may be able to operate in the same system, but performance may be hindered. This means that the boards are intermatable and interoperable, but not necessarily interworkable.

One of the first working system boards to follow the Futurebus+ specification is the NR3000-1 CPU module based on the MIPS R3000 microprocessor *(Fig. 1)*. The board, from Nanotek Inc., Idaho Falls, Idaho, is compatible with Profile A. The



1. THE NR3000-1 CPU MODULE is one of the first built to the Futurebus+ specification. The Profile A board from Nanotek is constructed with the MIPS R3000 processor and a 3010 coprocessor.

NR3000-1 is intended for use in systems ranging from diskless single-board computers to multiprocessor Unix-based systems. Both cache-coherent shared-memory and message-passing multiprocessor systems are supported. It includes a two-level cache hierarchy consisting of a 128-kbyte primary cache and a 1-Mbyte secondary cache, enabling efficient use of processor and bus resources. The board will be in production by the end of the first quarter at a price of $9900.

At Buscon/90-East in October, Philips Components-Signetics, Sunnyvale, Calif., and Texas Instruments, Dallas, announced a joint development and alternate-source agreement for several products. Each company agreed to second-source a broad range of transceivers, controllers, and data-path circuits. Signetics plans to introduce the FB2000 chip set's transceivers in the early part of this year with the LSI chips coming soon after.

The Signetics chip set includes pins to accommodate a future JTAG upgrade. JTAG's core features support external tests that drive the chips' outputs and sample tests to observe the inputs coming into a chip at any given time.

Another chipset, this one being introduced at the show, comes from National Semiconductor Corp., Santa Clara, Calif. *(see "Futurebus+ Builds Momentum with New Chip Set," p. 115).* National's five-chip set is already being sampled and will be in production in March.

Texas Instruments and Force Computers Inc., Campbell, Calif., will jointly develop an IC that will implement Futurebus+'s parallel protocol functions. The part offers parallel protocol control (PPC) of the Futurebus+ interface, as well as transaction support for cache-coherent multiprocessing shared-memory systems.

The PPC chip will also have support for processor and intelligent I/O transactions across the Futurebus+ backplane in high-performance shared-memory systems. The ability to implement this cache-coherency technology enhances the processing power of each bus segment in multiple-bus systems.

VMEbus Gets Its Day

Day Two's technical session is split between VMEbus and Multibus II. On tap is a review of the VMEbus architecture. Details will be provided by various VMEbus board manufacturers, including Force Computers, Heurikon, Ironics, Motorola, and Radstone, on ways to enhance VMEbus performance through daughterboard buses, multiprocessing configurations, and implementing mezzanine buses and modules. Bus and memory requirements, power considerations, and I/O connections will all be explored.

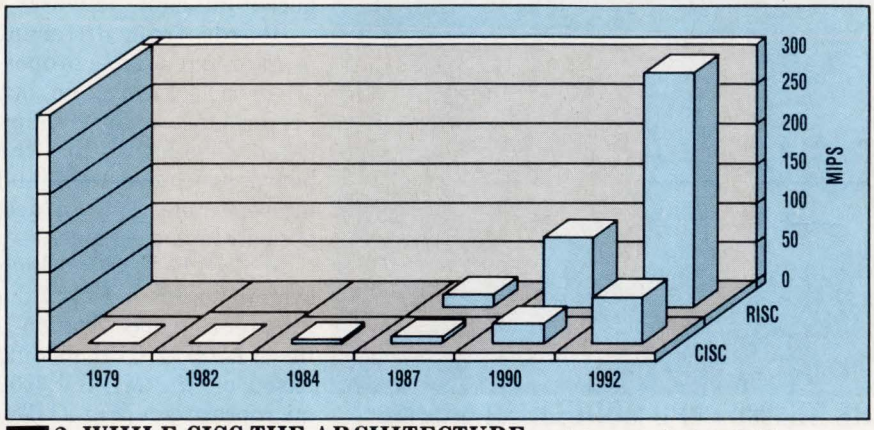
A VMEbus issue to be debated involves the performance benefits of advanced RISC and CISC processors. Current silicon trends suggest that a merger of the two processor types may be the best alternative. But history reveals that RISC, while still a relatively young technology, outperforms CISC in terms of MIPS, and may continue to do so in the future *(Fig. 2)*. In the session entitled "Microprocessor implementations: RISC and CISC," Fred Rehhausser of Force Computers tracks the histories of the two processor types and offers insight into their futures.

A host of VMEbus products are being released at the show. Xylogics Inc., Burlington, Mass., will show off its IPI-2 controller, the SV6892. The disk controller supports the 24-Mbyte/s transfer rates of Seagate Technology's recently announced Sabre Parallel Transfer Disk. It also supports IPI-2 drives from other manufacturers.

General Micro Systems Inc., Montclair, Calif., will release its VO5sx dual-ported memory board. The board is configured with 64 Mbytes of DRAM, ported to the VMEbus with VME64 and to a 32-bit expansion bus for direct CPU access. The board uses two-way interleaved static-column DRAM and supports synchronous-termination read and write cycles from the CPU. Hence, it acts as a block-mode slave that allows sub-zero wait-state accesses over the local bus.

The CMC-1150 series, from CMC, Santa Barbara, Calif., is a second generation of FDDI adapters for various VMEbus systems. The adapters are available as single- or dual-attach stations built to a 6U form factor. Performance is improved over the first generation due to an enhanced RAM buffer and data-path controller. The board runs at 25 MHz thanks to its AMD 29000 RISC processor. A second improvement is the addition of 512 kbytes of content-addressable memory.

The Multibus II seminar also begins with a brief overview of the bus standard. The sessions move into the software issues beginning with the initialization process. This process contains four phases: reset, board initialization, system initialization, and bootstrap loading. The specifics of each phase are discussed at



2. WHILE CISC THE ARCHITECTURE won't become obsolete, RISC presently outperforms the older technology in terms of MIPS. This graph shows that the trend won't change soon.

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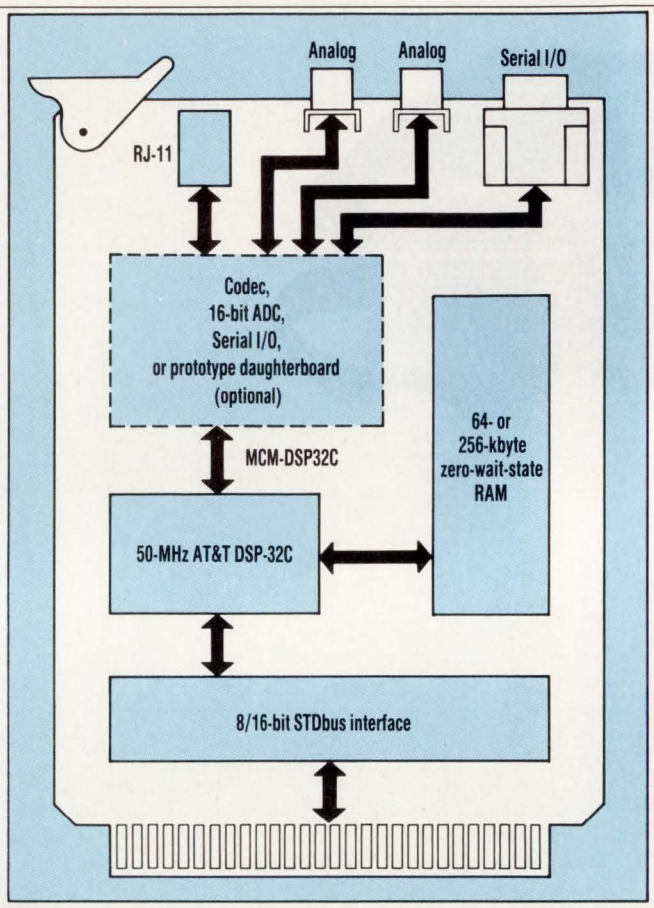
length. The next phase of platform software analyzes the transport issue. It details what it is, why it's needed, and how it works. Hardware issues, such as bus expansion and bridging to other buses, are tackled later in the day.

Multibus II product offerings at the show include a 25-MHz, 80486-based networking board from Concurrent Technologies Inc., Champaign, Ill. The CC 486/258 supplies eight high-performance asynchronous/synchronous serial channels, each with modem control and optional full-duplex DMA support.

Users can create custom interfaces without the delay or cost of a new pc board by using the Multibus II programmable-logic interface from General Standards Co., Huntsville, Ala. The MB2-PGA56T offers 56 TTL interface transceivers and six Xilinx programmable gate arrays. The board can be programmed to operate as a bus link, digital I/O with handshake, or other device. An optional EPROM configures the board as a DMA interface between Multibus II and other architectures.

The remaining two days of the technical conference cover PC-bus platforms, embedded systems, military applications, and emerging architectures, such as Sun's Sbus and DEC's TurboChannel. The PC-platform sessions cover software and hardware, as well as STDbus. There's a discussion based on STD 32, the 32-bit standard that offers all of the features found on 386- and 486-based PCs.

A session on operating systems is presented by James Ready of Ready Systems Corp., Sunnyvale, Calif. This seminar explores the issues surrounding the choice of the appropriate software environment for a particular PC-based application. It discusses application requirements as well as various aspects of DOS.



3. THE 50-MHZ AT&T DSP PROCESSOR is the heart of WinSystems' MCM-DSP32C STDbus board. Users can customize the board by connecting a 16-bit daughterboard.

An industrial family of multiprocessing products is used for real-time applications. The family, from Paracom Inc., West Chicago, Ill., includes the TPM-ADC, an analog-to-digital-converter board that offers up to 16 single-ended channels referenced to ground, or up to eight differential channels. The data-acquisition function includes internal and external trigger and handshake capabilities as well as autoranging. A sample rate of 200 kHz/s at 12 bits/sample can be achieved. This enables the board to scan all lines equally or focus on a specific area of activity. Both Paracom products are busless modules that can be integrated into PC/XT/AT systems.

STD Teams With DSP

An STDbus-based DSP board, the MCM-DSP32C, hails from WinSystems Inc., Arlington, Texas. The board is built around AT&T's DSP-32C floating-point processor. The board executes independently of an STDbus host CPU. A data-transfer rate of up 3.5 Mbytes/s between the board and the host is achieved through programmed I/O that doesn't interfere with the MCM-DSP32C's operation. The board also contains a daughterboard adapter for customization *(Fig. 3)*.

At the military end, Matrix Corp., Raleigh, N.C., released two VMEbus products: a digital I/O board and a memory board. The former, MR-DIO, comes with either 48 or 96 lines of data and 16 interrupt sources. The data lines, handled on two or four 24-bit ports, can be accessed from the front panel through right-angle latching 50-pin headers. Each input has a minimum of 0.4 V of hysteresis to ensure accurate readings. The memory board, MR-RAM, contains up to 4 Mbytes of battery-backed RAM. The double-height board is addressable as a 24- or 32-bit address slave and supports 8-, 16-, or 32-bit data transfers. The memory is organized in two banks, with each bank having its own battery and power monitor. Data retention is 10 years.

Along the lines of emerging standards, Rapid Systems Inc., Seattle, Wash., will unveil its PCXI EISA industrial PC. The system combines PCXI modularity with EISA's 32-bit capability. PCXI is completely backward-compatible with all PC instrumentation, data-acquisition, and control cards. The PCXI modules offer an excellent hardware environment to enhance EISA performance as the emi/rfi-shielded modules solve noise and emission problems.□

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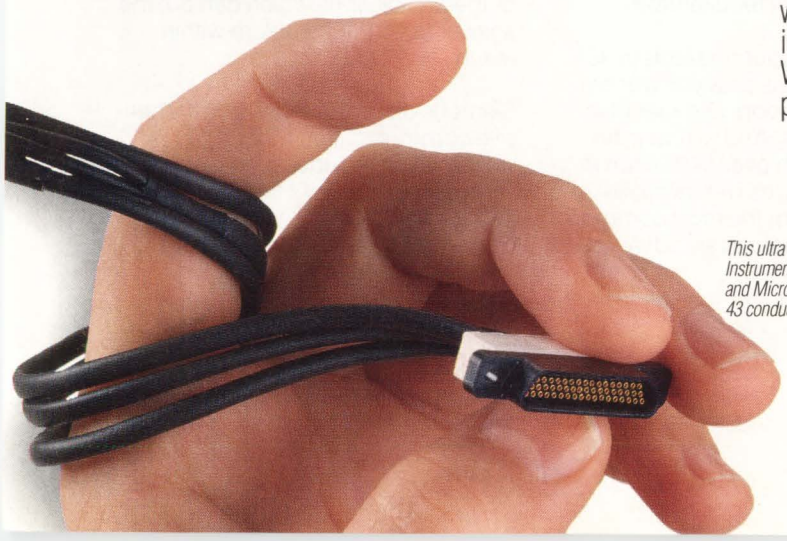

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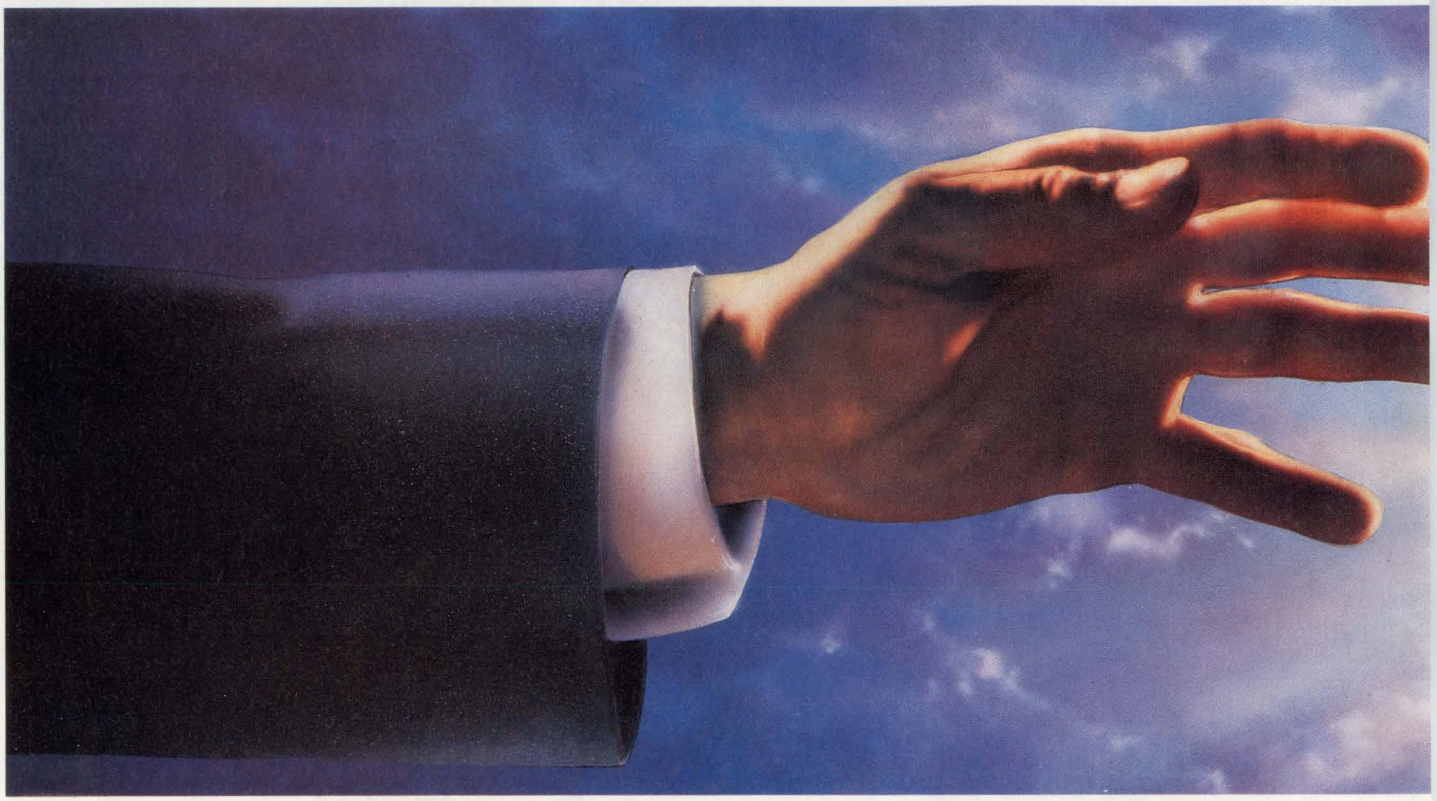

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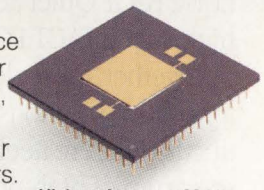

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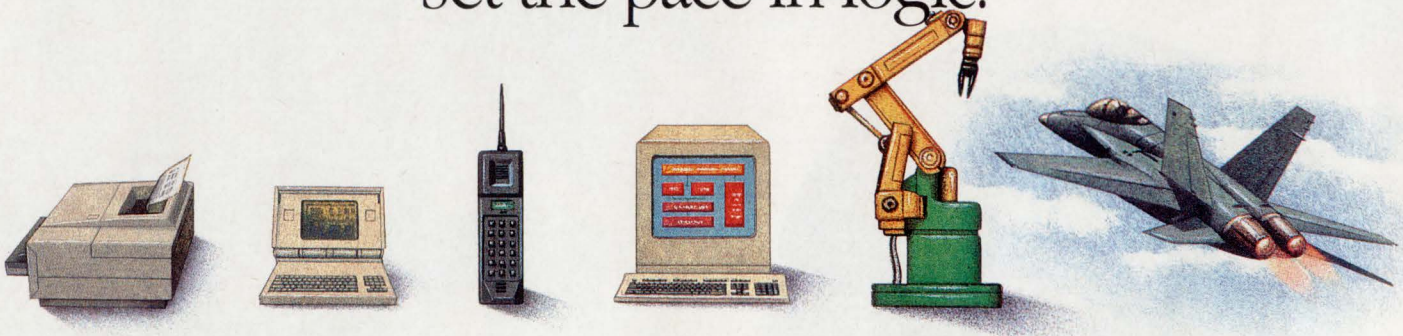

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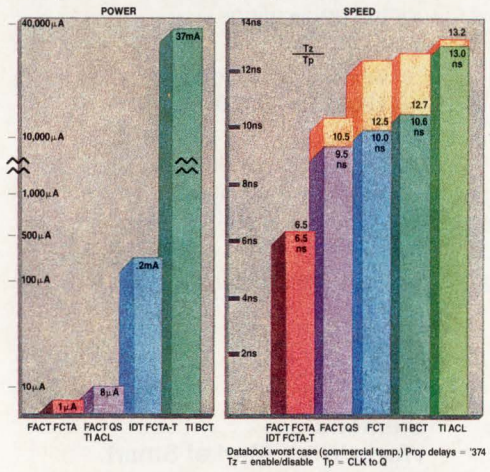

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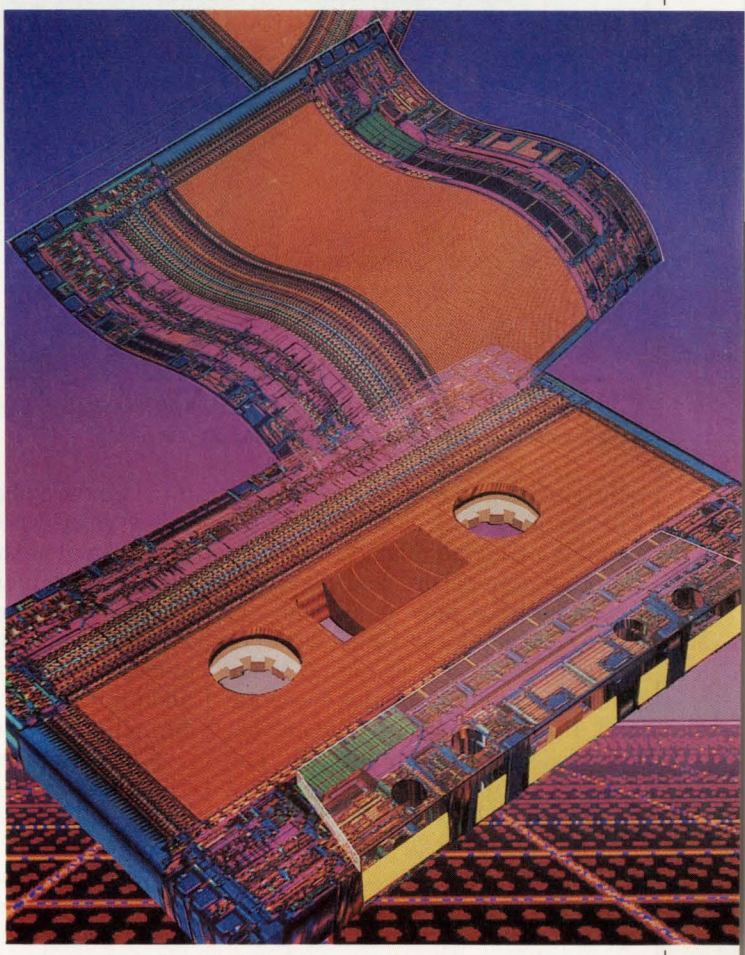
*From a 1990 study conducted by Washington Labs Inc., a subsidiary of Viollette Engineering Corporation.

ANALOG EEPROMS STORE 16 SECONDS OF AUDIO ON SILICON DIE 1/10 THE AREA DIGITAL EEPROMS NEED TO DO THE JOB.

IC HOLDS 16 SECONDS OF AUDIO WITHOUT POWER

FRANK GOODENOUGH



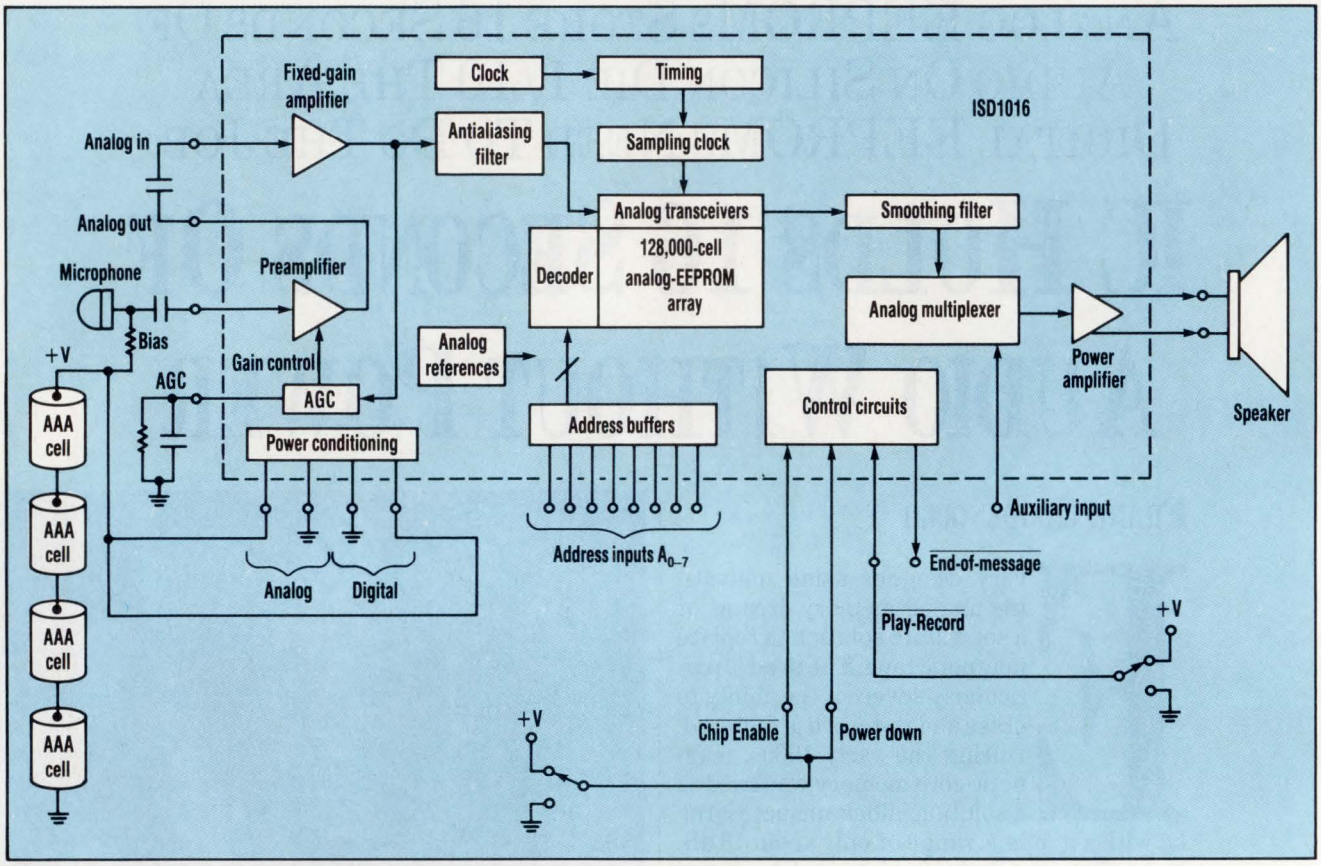
Every designer using nonvolatile analog memory dreams of a solid-state solution to replace magnetic tape. The need is particularly severe if the ability to erase and re-record is required. During the early 1960s, magnetic-core memory was tried as a solution, albeit unsuccessfully, with a dynamic range of only about 18 dB. Now, Trevor Blyth, Sakhawat Khan, and Richard Simko at startup Information Storage Devices (ISD) successfully extended EEPROM technology to the task with a technique they call direct analog storage (DAS).

With DAS, they can achieve a signal-to-noise ratio of 40 dB, a 3-dB bandwidth of 3400 Hz, and a total harmonic distortion of 2% at 1 kHz. All of this performance is achieved while the input signal is sampled according to the Nyquist theorem, not quantized or digitized *(for a look at how it works, see "Analog EEPROMS," p. 41)*. The DAS technique will affect many areas in the future *(to see where it's headed, see "Analog Memory Futures," p. 44)*.

The ISD1016 is the first of a large family of ICs and multi-IC modules from ISD *(see the figure)*. It stores 16 seconds of better-than-telecom-quality audio. After a signal is stored, the IC can be powered-down or removed from the circuit forever without losing the recorded signal. By putting it back in the circuit and powering up, you can play it back as often as you want or record a new signal, before or after erasing previous ones. If desired, multiple messages/signals can be recorded and accessed at will. The chip is complete: If it's connected to 5 V, a microphone, a speaker, and a few other parts, you have a record-playback system.

A point might be raised as to whether or not such performance can be achieved using EEPROMs together with an ADC and a DAC. It would take 1 Mbit of digital memory to store the same 16 seconds of data. As a result, a far larger and more expensive chip would be required than the 44,100 mils^2 of silicon the ISD1016 uses, which is about the size of today's 64-kbit EEPROMs. Such an EEPROM

NONVOLATILE ANALOG MEMORY CHIP



BY CONNECTING A MICROPHONE, loudspeaker, AAA cells, and passive parts to this one-chip ISD1016, you can create 16-second, nonvolatile, audio recordings and play them back.

solution ranges in cost from under $10 per chip to over $100 each, depending on sound quality, volatility, the ability to record and playback, and, of course, how many chips are needed. That doesn't include other system costs, such as signal conditioning, sampling, analog-to-digital and digital-to-analog conversion, and analog and digital I/O. By comparison, the ISD1016 costs $20 each in 1000-unit lots.

Infinite Uses

By now you've thought of a dozen applications for this chip or its technology. Say you're a surgeon watching a Celtics-Lakers basketball game in a $100 seat. The score is 101 to 101 and it's about a minute to the buzzer. Your pager beeps. Rather than head for a phone and miss the end of the game, you put the pager to your ear, hit a button, and get a 16-second message. A few additional voice applications include the out-going message on a standard phone recorder (within a few years, the incoming message as well) and next-generation cellular phones. Annunciators represent another area of use. Examples include talking appliances/vending machines, prompts/alarms in vehicles and aircraft, toys, theater/event information, and hotel wake-up calls.

While such voice-band applications quickly become obvious, nonvoice applications for direct analog storage are the realm of the truly creative individual. ISD divides nonvoice use into three broad categories based on input-vs.-output considerations: data capture (recording a single event), data acquisition (continuous sampling of an analog signal or signals), and the generation of analog signals.

Signal-generation applications, in most cases playback-only, are subtle. They include arbitrary-waveform generators, programmable-voltage references, and tone generators. The chip could be the heart of a built-in, or battery-powered, portable calibrator for an EKG recorder and/or other medical instruments.

Inside And Out

An application, such as a voice-message system, best illustrates both the ISD1016's operation and its features *(see the figure, again)*. As noted earlier, all that's needed to handle both record and playback for working hardware (in addition to the chip) are a few external parts: a microphone, speaker, switches, resistors, and capacitors. The IC itself performs preamplification, filtering, automatic gain control (agc), power amplification, control logic, and the analog storage.

Amplification is performed in two stages: with an input preamplifier and with a fixed-gain amplifier, each connected by a second external capacitor. This architecture allows system-design flexibility, particularly

NONVOLATILE ANALOG MEMORY CHIP

for non-voice applications, and adds a pole for low-frequency cutoff response.

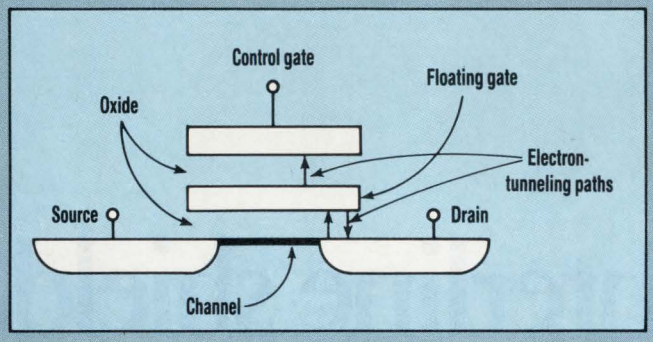
The preamplifier's gain is adjusted automatically to maintain an optimum non-clipped signal level at the filter input. The preamplifier's 20-dB gain-compression range compensates for variations in microphone characteristics and speech volume. It maintains signal integrity without clipping, or other major forms of distortion, while increasing dynamic range by 20 dB.

As stated previously, because this chip represents a true sampled-data system, an antialiasing filter follows the amplifiers to ensure that the Nyquist response is served. The filter essentially reduces the input signals that are above one-half the sampling rate to insignificance. The ISD1016 samples at 8 kHz and its filter's cutoff frequency is 3.4 kHz. The filter has 5 poles and rolls off at 40 dB/octave at that frequency. Such specifications essentially ensure that telecommunications requirements are met, even though the audio from the ISD1016 sounds better than telephone-line audio—even while using a typical handset as a microphone.

The signal is passed from the filter to the analog transceivers to write into the analog storage array, which can be viewed as 128,000 sample-and-hold amplifiers. Sequential samples are taken, under the direction of the sample clock, at 8 kHz, and level-shifted to produce the high voltages needed for the nonvolatile writing procedure. At the same time, com-

ANALOG EEPROMS

Information Storage Devices employs the analog storage property of the nonvolatile floating-gate EEPROM cell. Up to now, digital information was stored in these cells one bit at a time. If the floating gate is strongly programmed to a positive charge, the floating-gate transistor's channel is made strongly conductive. This state corresponds to a binary digital value, say, a logic 1.

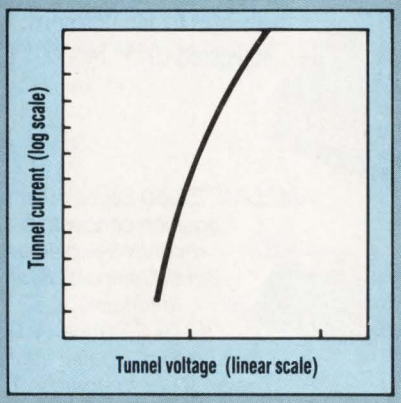


If the cell is erased, the floating gate is rendered strongly negative. Thus the EEPROM cell is rendered nonconductive, corresponding to the complementary binary value, a logic 0. By programming or erasing cells in an array, a digital memory is created. ISD takes advantage of the intermediate conductivity values between strongly conductive and nonconductive states to create a nonvolatile analog memory.

An EEPROM cell is a MOS transistor that stores electrical charge on an electrically isolated, conductive, capacitor plate—or "floating gate." The floating gate is located above the transistor channel *(Fig. 1)*. The charge on the floating gate creates an electric field that modifies the conductivity of the channel of the MOS transistor.

The charge on the gate, composed of electrons, is increased or decreased by a current-conduction mechanism called Fowler-Nordheim tunneling. The tunneling current is conducted through insulating gate-oxides, which are excellent insulators under typical, low-voltage bias levels. When high voltage is applied, the oxides conduct sufficiently via the electron tunneling to charge or discharge the floating gate. Tunnel current is a very sharp exponential function of the bias voltage across the oxide *(Fig. 2)*.

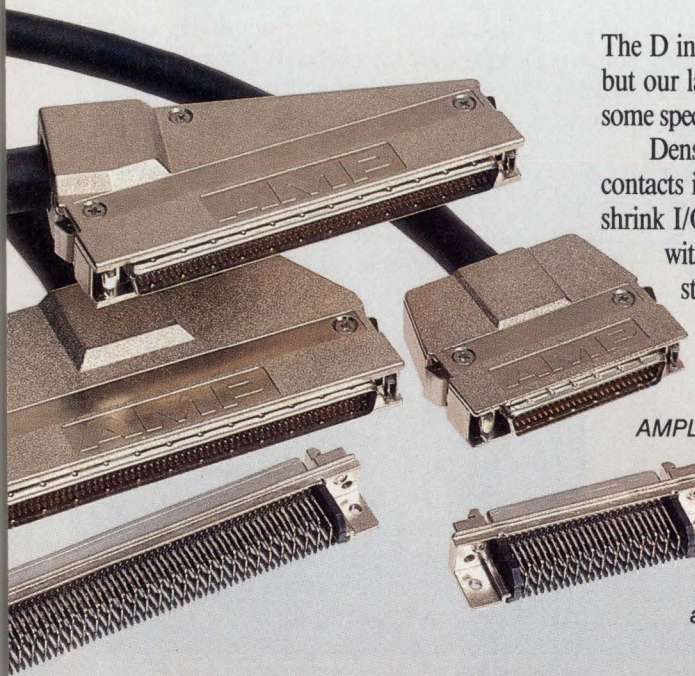
The polarity and location of the bias voltages applied to the transistor control the charging and discharging of the gate. The potential on the floating gate, and the potentials across the oxides, are manipulated by electrostatic capacitive coupling through the overlaying control gate and by various capacitances to the other transistor terminals.



When the bias values are reduced to low values, the oxides again behave like excellent insulators. The amount of charge on the floating gate can be retained for many years—even at high temperatures—in the low-bias condition. The voltage on the floating gate can now be "read" without disturbing the charge, and therefore not disturbing the stored voltage. The sensed, or measured, value of the cell's conductivity corresponds to the value of the analog level stored.

In digital memories, the high erase-and-programming voltages are applied in a binary fashion to cause large amounts of tunneling current to write a one or a zero. However, in the analog memory, the erase and programming voltages are applied in a more controlled fashion. The floating-gate charge levels are intelligently written to the proper analog values. The technology takes care of cell-to-cell variations due to processing, temperature, bias differences, and cell aging.

.050 centerline shielded I/O.



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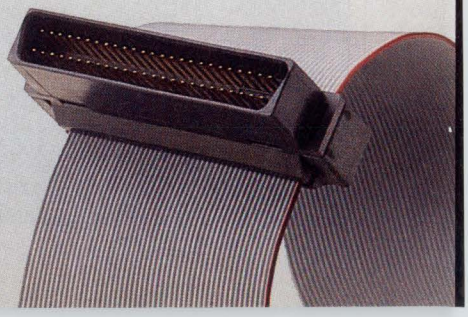
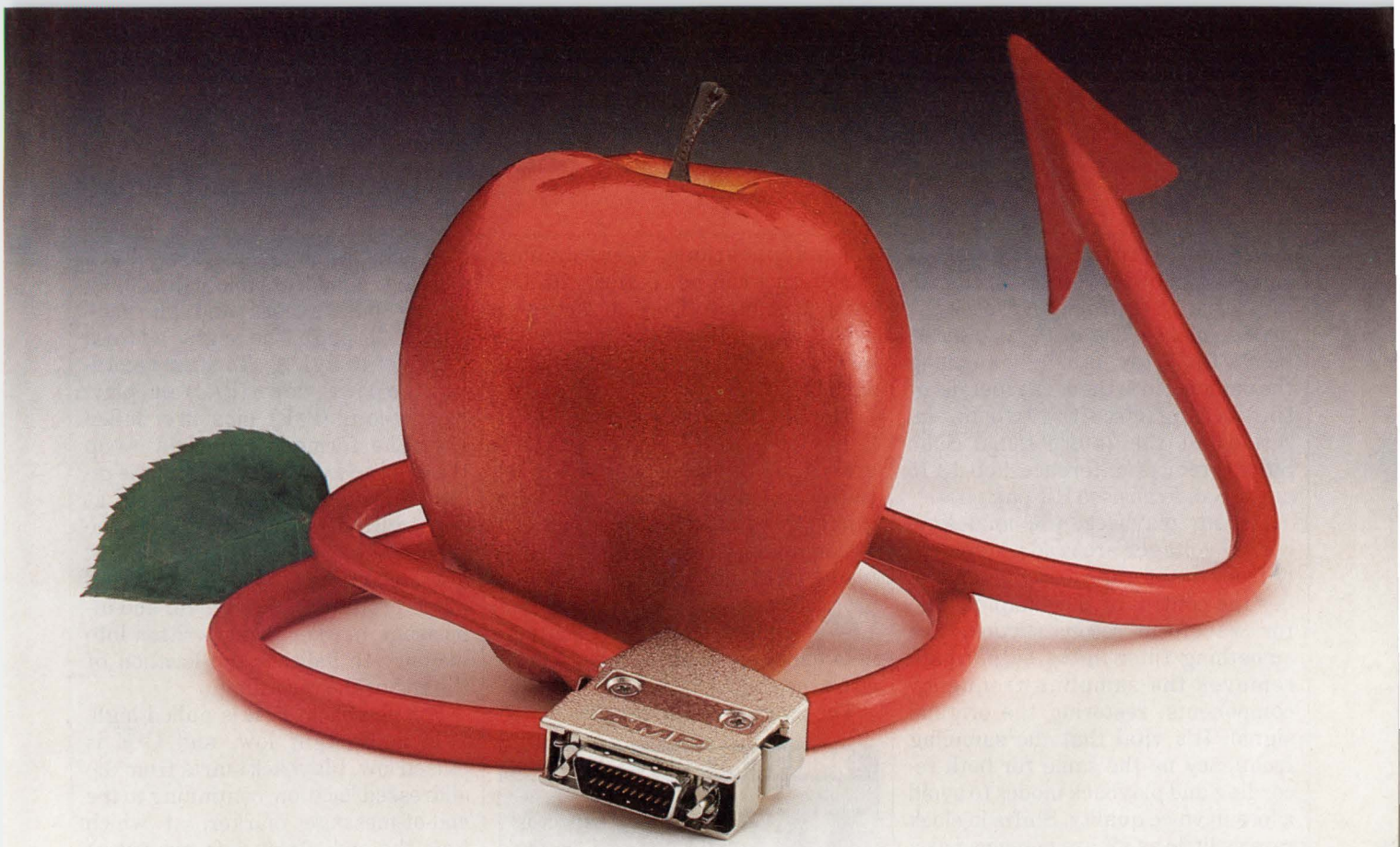
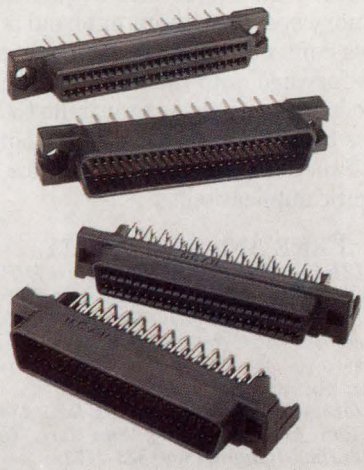




Very tempting.



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AMP Interconnecting ideas

CIRCLE 156

pensation is provided for problems caused by Fowler-Nordheim tunneling. *(see "Analog EEPROMS," again, p. 41).* The clock also increments the array decoders, mapping the samples into the array (details of the writing circuitry will be described at the International Solid State Circuits Conference, Feb. 13-15 at the San Fransisco Hilton).

During playback, the analog-recorded voltages are read sequentially from the storage array, again under the control of the sample clock, for waveform reconstruction. The smoothing filter in the output path removes the sampling-frequency components, restoring the original signal. It's vital that the sampling frequency be the same for both recording and playback modes to avoid a loss in voice quality. Shifts in clock rate as little as 2% are perceived as a change in the "mood" of the speaker—for example, more excited or tired. The on-chip oscillator (which needs no external components) is constant within 1% over changes in supply voltage and temperature. Consequently, even though conditions may vary greatly between record and playback modes, reproduction quality isn't affected.

The smoothing filter's output connects to the output power amplifier through an analog multiplexer. The power amplifier can directly drive a 16-Ω speaker with 50 mW of rms power (100 mW pk).

Digging Deeper

Not only can the ISD1016 be used by itself, but several ISD1016s can be cascaded to increase recording time to several minutes. The limit is mostly set by the number of 28-pin DIPs that are connected. In fact, by late spring, ISD will be offering multichip modules with record times of 32 and 64 seconds in the same 28-pin DIP footprint.

The address pins can preset a start address at the beginning of a record or a playback. With a processor-controlled system, this addressability makes it possible to link sounds together. Short utterances, or words, can be used to construct longer, more complicated messages. In non-voice applications, very complex waveforms can be created with the same technique. Once a particular arbitrary waveform (lasting say 500 ms) is "designed" and recorded, it can be played back repeatedly.

The ISD1016 typically needs about 20 mA from one 4.5- to 9-V rail. Three grades are available, depending on required power-supply voltage range: 4.5 to 5.5 V (standard), 4 to 4.4 V (communications), and 6 to 9 V (extended). The high voltage required to program the array and the internal 1.5-V "analog ground" (which permits handling ac signals) is generated on the chip.

The storage array consists of 160 segments, each 100-ms long. Each segment is addressable individually during both record and playback modes through the eight address pins A_0 through A_7. To start recording, the power-down (P/D) and playback-record (P/$\overline{R}$) pins are pulled low. The former action powers-up the chip, and the latter selects the record function. Recording starts at the addressed segment when the Chip Enable (C/$\overline{E}$) pin is brought low. Recording stops when the C/$\overline{E}$ pin is brought high, with an end-of-message marker being written into memory to indicate the location of the end of the recording.

For playback, P/$\overline{R}$ is pulled high, P/D is brought low, and C/$\overline{E}$ is pulsed low. Playback starts from the addressed location, continuing to the end-of-message marker, at which time the end-of-message pin pulses low and playback stops. If the end-of-message pin is continuously held low, playback continues over the marker to the next segment.

The eight address pins can address up to 256 segments. But because only 160 segments are used, space is available for other purposes. In the ISD1016, this space reconfigures the control functions for different modes.

For example, the chip can be set up to record messages into sequential memory spaces without external address control. It can also be made to fast-forward onto the next message or to loop on a message until the C/$\overline{E}$ pin is brought high. That is, the control functions can be optimized for a specific application.□

Price And Availabilty

The ISD1016 comes in 28-pin plastic DIPs, SOICs, and PLCCs. In quantities of 1000, plastic DIP versions go for $20 each. Initial devices are rated for commercial-temperature-range operation. Small quantities are in stock.

Information Storage Devices Inc., 2841 Junction Ave., Suite 204, San Jose, CA 95134; Jim Oliphant, (800) 825-4473.

CIRCLE 512

Analog Memory Futures

What can you expect in the near and in the not-so-near future from this truly new technology? To start, a family of devices will arrive before mid-year based on combinations of alternative sampling rates, and multiple-chip modules. However, all devices will be in the same 28-pin package. The sampling rate will be raised to 10 kHz for higher quality, at the expense of lower IC storage time of 12 seconds. In other models, the sampling rate will be cut to 6.4 kHz, raising storage time to 20 seconds. In addition, each of these ICs will be packaged in "modules" holding 2 and 4 die to produce storage times ranging from 24 seconds (10-kHz sampling with 2 die) to 80 seconds (6.4-kHz sampling with 4 die). One additional 6.4-kHz IC will run off voltages down to 4.0 V.

Before the year is out, ISD expects present technology (128,000 cells per chip) to increase the IC's signal-to-noise ratio (SNR) to 48 dB (8 bits), and sampling rates to reach 100 kHz. In two years, one-million-cell devices offering 60-dB (10-bit) SNR while sampling at 1 MHz should be seen. Looking further ahead, 4-million-cell devices sampling at 10 MHz are expected. The SNR is anyone's guess.

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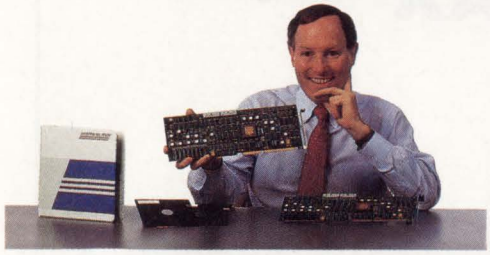

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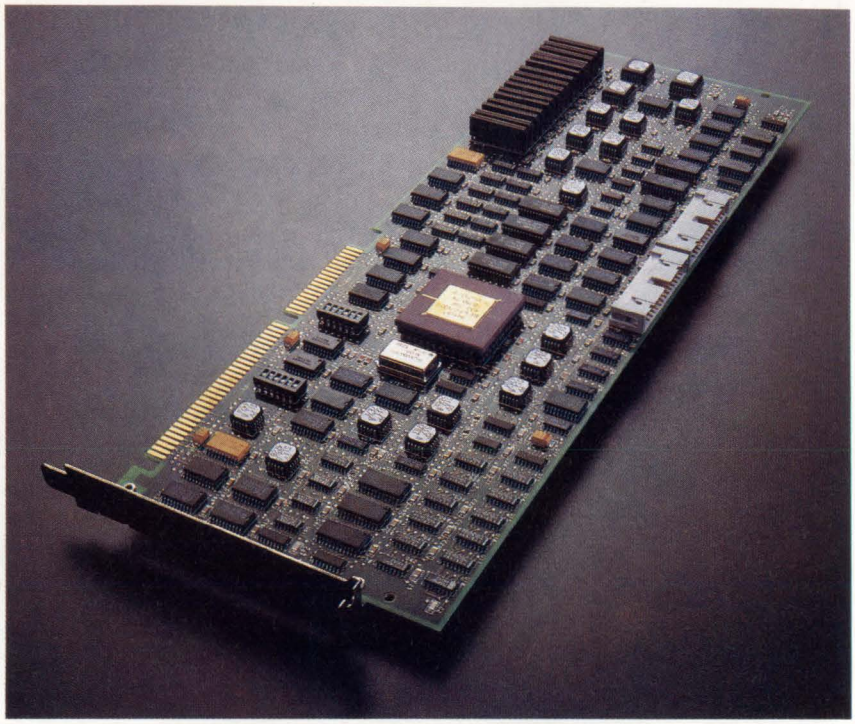

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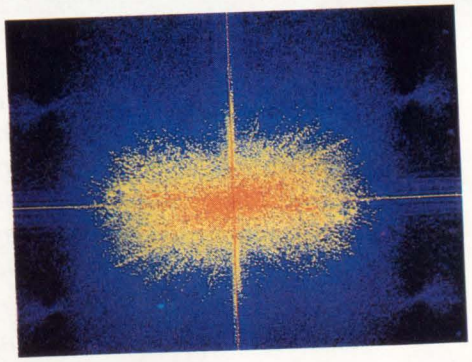

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IT'S NOT A SIMPLE MATTER TO OPTIMIZE BOTH PROTECTION AND POWER OUTPUT.

PROTECT THOSE EXPENSIVE POWER OP AMPS

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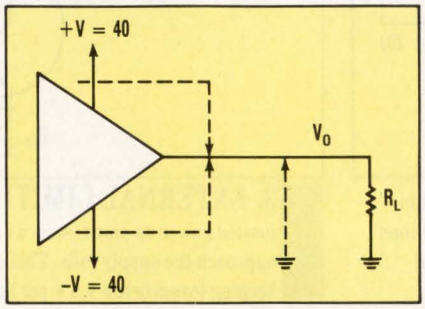
Hybrid, power op amps can reliably deliver large power outputs as long as proper protection is carefully considered. Unlike their discrete brethren, in which individual components can be replaced relatively easily, proper protection represents a key factor in making these devices cost effective. A failure of just one component—within an amplifier in its hermetically sealed metal can—necessitates a new amplifier.

The challenge to the designer, then, is optimizing both protection and power output. Because amplifier limits are described by safe-operating-area (SOA) graphs, to which the protection circuits must be designed to adhere, the task isn't as simple as it seems. Depending on the expected fault conditions, much of the amplifier's apparent current or voltage capacity must often be sacrificed. In addition, the protection circuitry usually shouldn't interfere with the passage of normal signals in any way.

Limiting output current is the most complex area to consider when designing amplifier protection. Either protection must be traded off against performance or a lengthy design involving more complex protection methods must be used. While current-limiting considerations are the most important aspect of power-amplifier protection, the amplifiers can also be overstressed by power supplies, the load itself, and even by input signals.

All power op amps are equipped with current limiting. In some, it is fixed internally to a single value. Others may have externally programmable current limiting. To fully protect an amplifier, it must be kept within SOA limits. The first task is to determine what constitutes the worst-case expected load fault *(Fig. 1)*. For instance, must the amplifier tolerate shorts to either supply rail, or will tolerance of shorts to ground be adequate? The designer then refers to the SOA curves to determine where to set current limits *(Fig. 2)*. The PA04 with its MOSFET output stage can handle more current at high voltage. Unlike the bi-



1. WHEN USING POWER op amps, designers must define whether worst-case load faults include shorts (dashed lines) to ground or to either rail. Extremely reactive loads or motor reversals can be equivalent to shorts to either supply rail.

PROTECTING POWER OP AMPS

polar output PA12, it has no secondary breakdown.

With resistive loads, the worst-case fault condition is likely to be a short circuit to ground. In a split-supply application, the voltage stress is then simply equal to one of the supply voltages, or half the total rail-to-rail voltage.

With a resistive load to ground in a single-supply application, ground is the negative supply rail. In this case, the voltage stress is equal to the total supply voltage rail-to-rail. The voltage stress also equals the total rail-to-rail voltage in split-supply applications with load faults to either supply rail—or when driving inductive loads.

Once the fault condition is defined, it's up to the designer to ensure that the current is limited to a value, coincident with the voltage stress, that's safe for the amplifier. What is safe depends on several other factors. In general, the dc SOA limit at 25°C should be some minimum value for amplifier protection. Realistically, however, such a limit can't be sustained indefinitely due to the amplifier's temperature rise.

By knowing the highest temperature the amplifier's case will reach, due to both ambient temperature and dissipation, a completely reliable current limit can be selected along the dc SOA lines—generally at temperatures of 70°, 85°, and 125°C when available. While these lines don't appear in figure 2, most amplifier SOA curves do supply them.

Using the bipolar output PA12 as an example, refer again to the SOA curves in figure 2 for the bipolar output PA12. Point 1 will be a safe current limit for shorts to ground. Point 2 will be safe for shorts to either rail or for reactive loads.

LIMITED SAFETY

Amplifiers with a fixed internal current limit are safe under a very limited set of conditions. In many applications, these amplifiers will not be safe even for short circuits to ground. However, external current limiting can be applied to any internally limited amplifier to meet SOA requirements under load faults *(Fig. 3)*.

In this circuit, a biasing current is supplied to Q_2's base at all times by R_1. The value of R_1 is determined by the minimum beta of Q_2, and the minimum supply voltage:

$$R_1 = (V_s - V_{beq2}) / (I_{lim}/\beta Q_2)$$

where the $V_{beq2} \approx = 1.2$ V.

The current limit is activated when the drop across R_{CL} is enough to turn on Q_1, so the current limit is equal to:

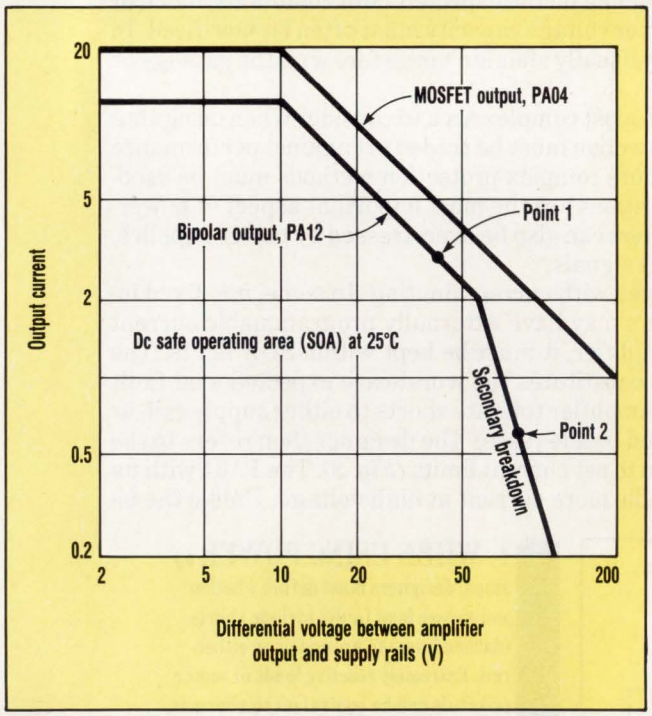
$$I_{lim} = V_{beq1}/R_{CL}$$

where $V_{beq1} \approx 0.7$ V.

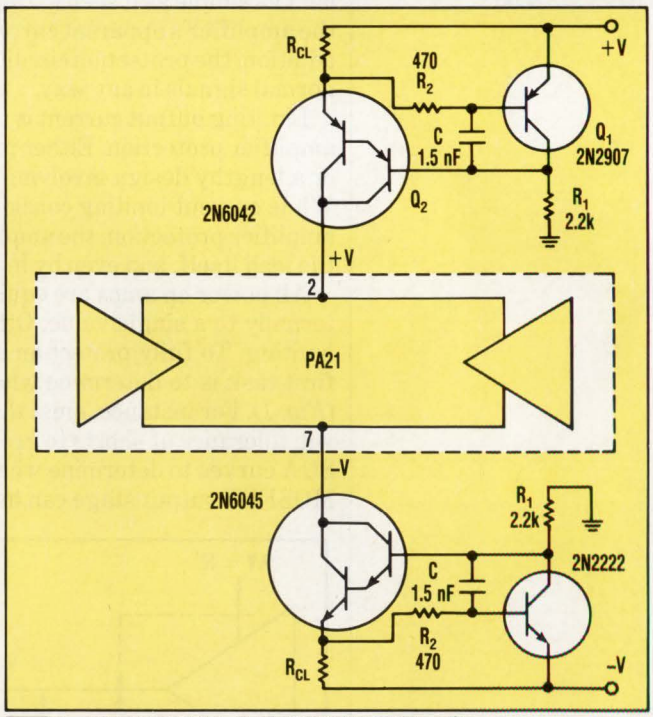
R_2 and capacitor C keep the current-limit circuit from oscillating.

Two of these current limiters are used, one between each supply rail and the op amp's power-supply pins. A single-supply bridge circuit however, where one is confident that load faults will occur only between amplifier outputs and not to ground, can be protected with one current limiter in the positive supply line of each amplifier.

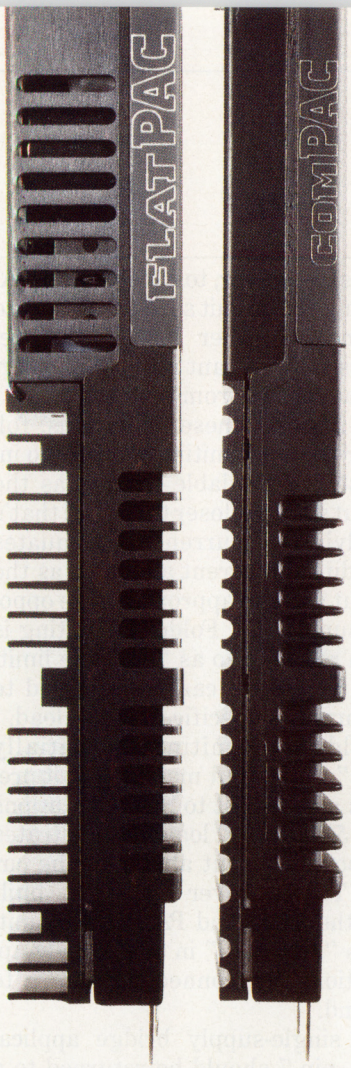
Amplifiers with externally programmable current limiting are easi-



2. POWER-OP-AMP OUTPUTS must be kept within their safe-operating-area (SOA) limits. Defining fault condiditons and their associated voltage stress determines maximum load current.



3. EXTERNAL LIMITING HELPS protect internally limited power op amps (such as the PA21) as output swings approach the supply rails. This clamp circuit works to 5 A while keeping losses below 1.5 V per limiter.



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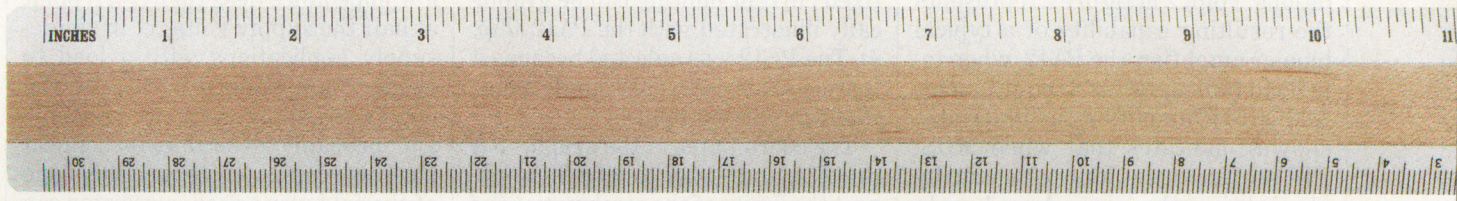

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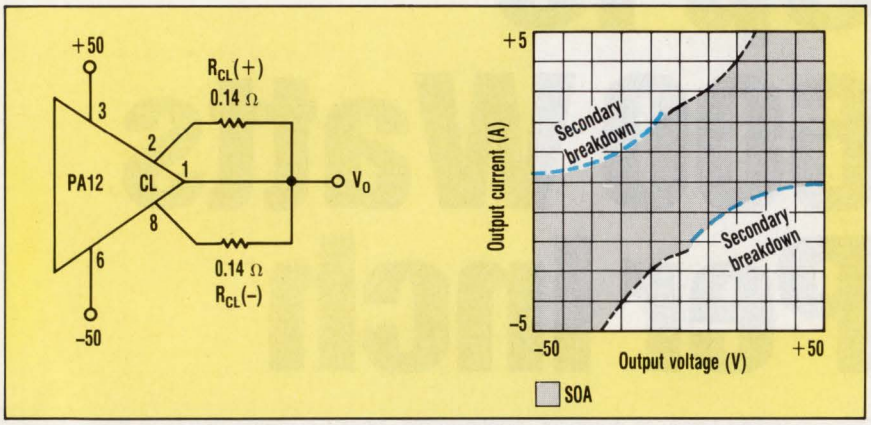


4. A PA12 WITH A 5-A CURRENT LIMIT isn't safe for output shorts to ground. Here, safe-operating-area curves are drawn on a "map" of attainable output voltages and currents.

er to keep within their SOA. Though they're simpler, all simple current-limit methods make great sacrifices in amplifier current-handling capability in the interest of reliability. It's not unusual for a seemingly robust 10-A amplifier to be reduced to a 600-mA weakling in order to remain within the SOA under load-fault conditions. Point 2 in figure 2 represents the resulting capability of a typical bipolar amplifier, the PA12, when total load fault safety is a requirement. A MOSFET amplifier, the PA04 (also shown), indicates that while MOSFETs offer some improvement, by eliminating the secondary breakdown region, even simple power limits greatly reduce safe attainable currents.

FOLDBACK LIMITING

Unfortunately, amplifier manufacturers believe that designers will be attracted by the simplicity and reduced component count offered by amplifiers with programmable current limiting which use one external resistor. What actually is needed, however, is multislope foldback (or foldover) limiting.

As will be pointed out later, this technique requires not only a two-resistor current limit—but also free access to the bases of the current-limit transistors inside the op amp. That is the only way to get the flexibility needed to optimize both protection and power output.

Perhaps this obsession with reducing component count is the same trap that reliability people fall into: The higher the component count, the lower the reliability. This fallacy results in many power-op-amp failures because about a dollar's worth of extra diodes to protect an unrepairable, $50 amplifier aren't included. The effect of foldover limiting compared to fixed current limiting can be graphically illustrated with the PA12 *(Fig. 4)*. The PA12 was selected because it features an internal, single-slope, foldover current limit.

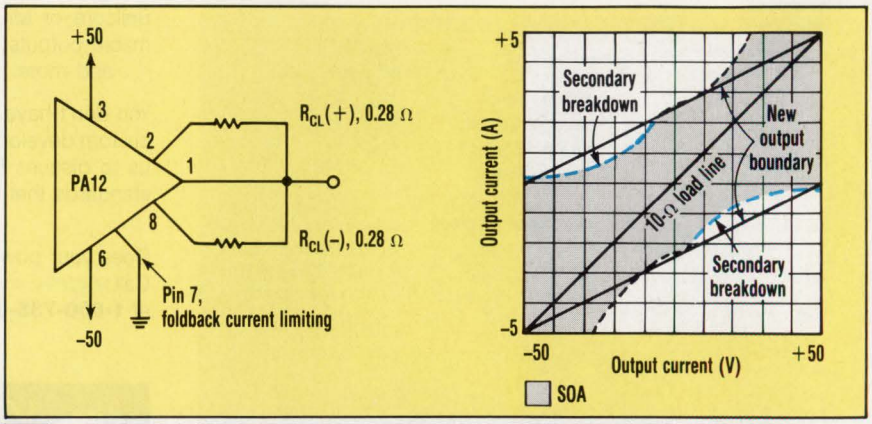
The coordinates of the graph, –5 A to +5 A and –50 V to +50 V, represent the limits of the combinations of output voltage and current attainable from a PA12 using a fixed current limit. The lines represent the SOA limits of the PA12. There are significant opportunities (operating points), however, to exceed the SOA. Making the circuit safe for a short to ground, or other load faults, requires a significant reduction in current available (from the supply).

To improve these limitations, foldover current limiting is added to increase the available current as the output swings closer to the rail that's supplying the current. This equates to reducing current available as the output voltage approaches the opposite supply rail. Foldover limiting is often referred to as "load-line limiting" because it can be designed to conform to a specific resistive load.

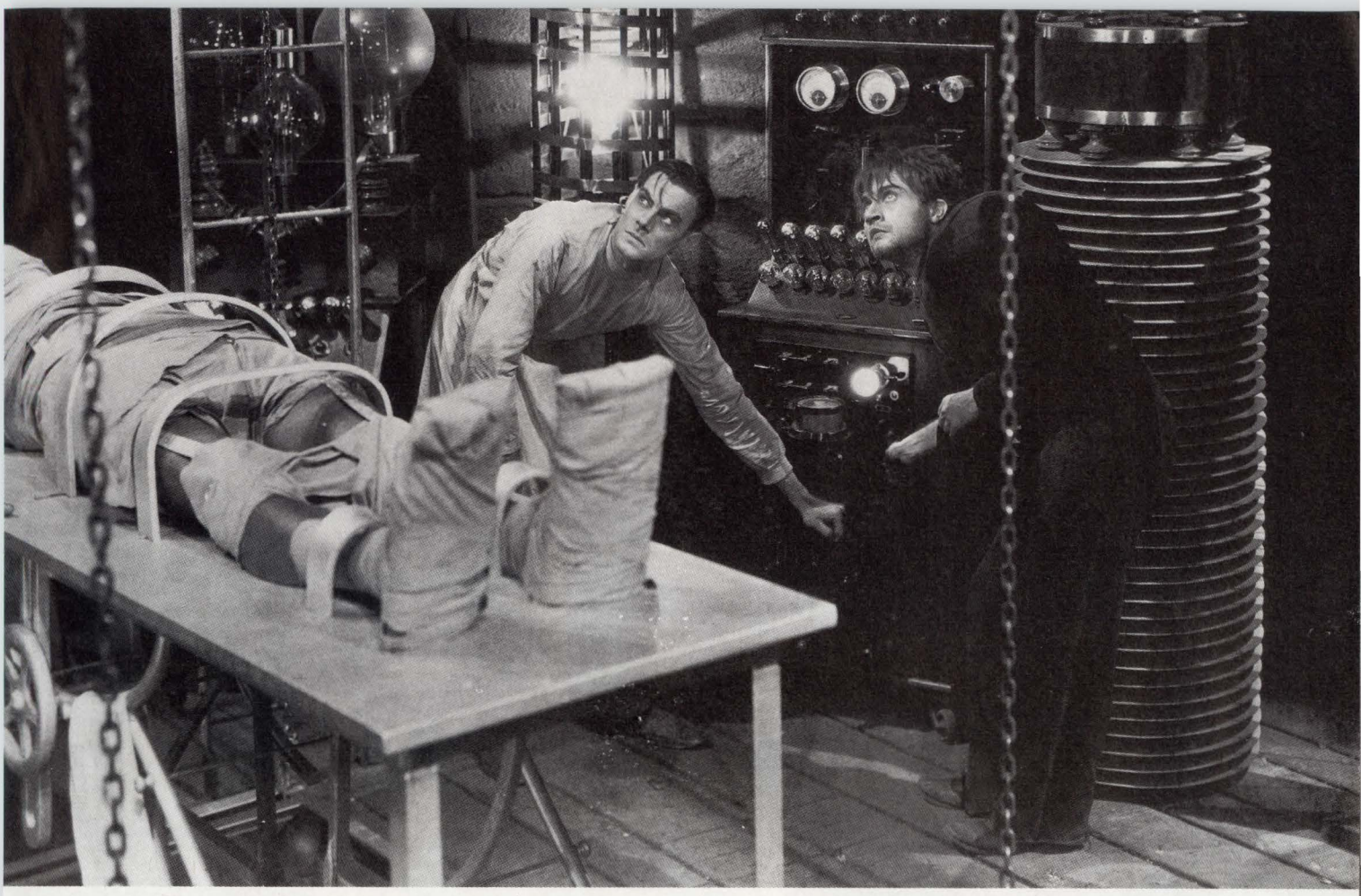
Foldover limiting essentially "tilts" the output map so that it presents a better fit to SOA limitations *(Fig. 5)*. The 10-Ω load line illustrates the power output ability of the circuit. This foldover limiting is built into the PA12 and PA10. This limiting is "activated" in split-supply applications by connecting pin 7 to ground.

In single-supply bridge applications, pin 7 should be returned to a low impedance (less than 2 kΩ) point at half the supply voltage. In single-supply applications with a load to ground (equivalent to a load to the negative supply rail), it's feasible and probably desirable to connect pin 7 to ground. To reduce the slope of the foldover action, a resistor can be inserted in series with pin 7.

Two techniques can implement foldback current limiting: the subtractive and the additive *(Fig. 6a and Fig. 6b, respectively)*. However, the



5. FOLDBACK CURRENT LIMITING, WHICH IS BUILT INTO the PA12 power op amp, makes the device safe for shorts, but still lets it deliver 5 A to a load along a 10-Ω load line.



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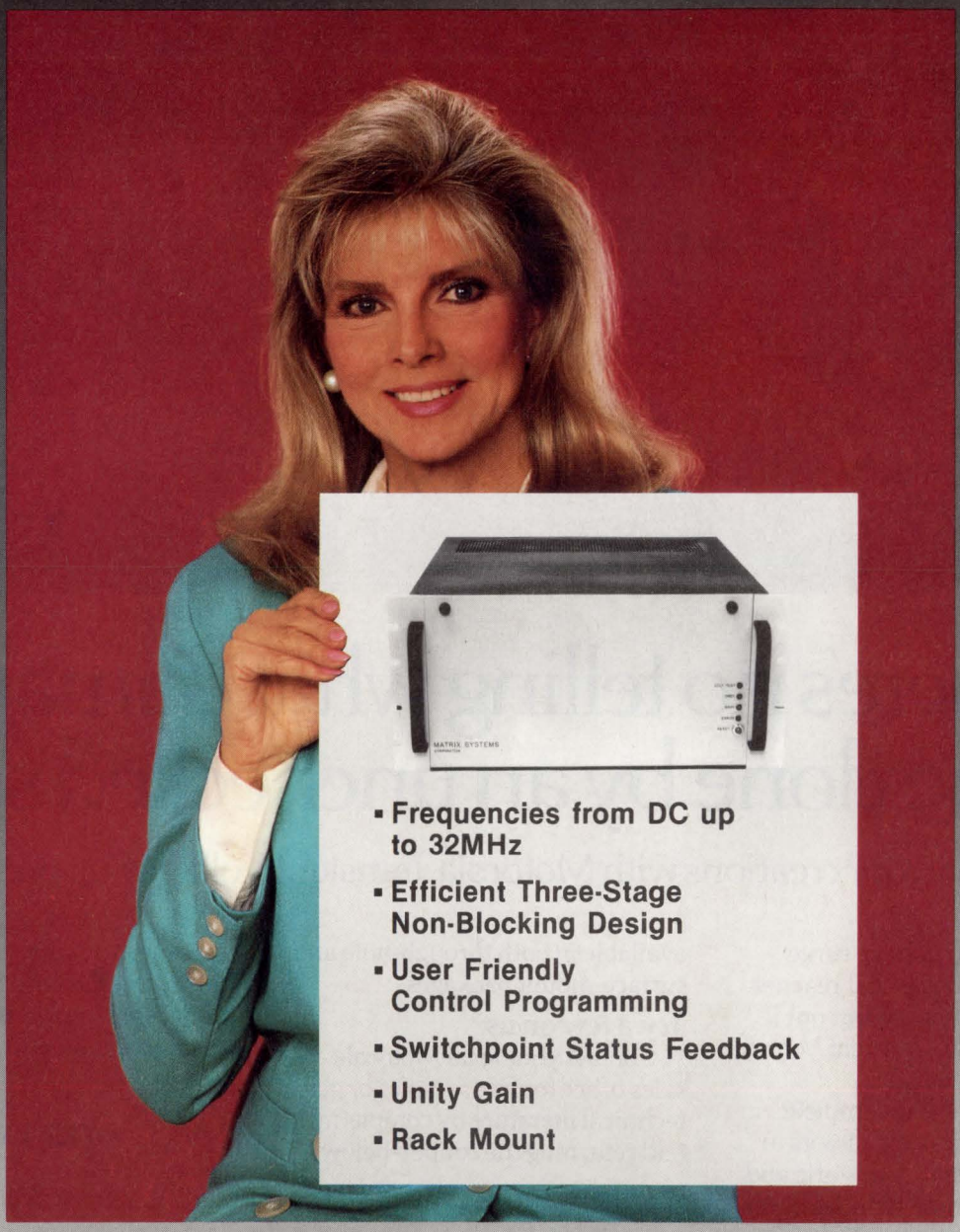

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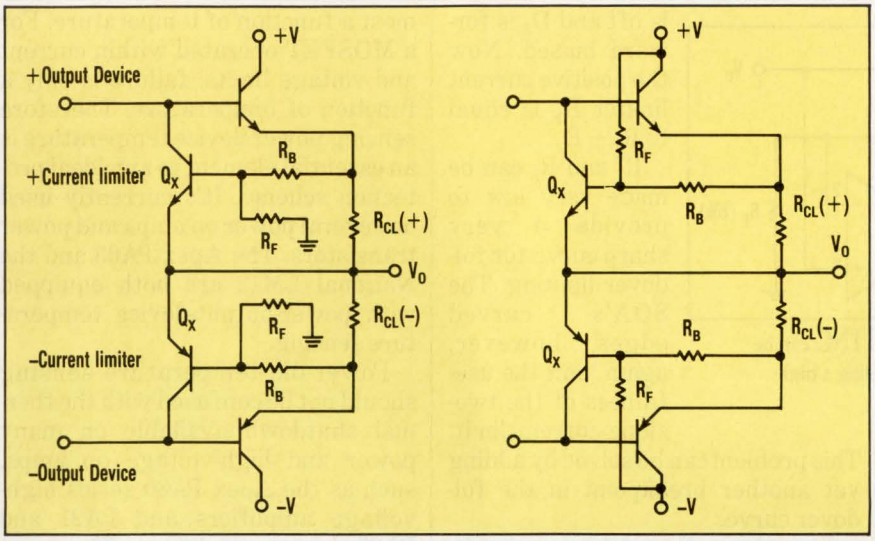


6. FOLDBACK SUBTRACTIVE current limiting is used inside the PA10 and PA12 power op amps (a). Additive limiting isn't adaptable to any current power op amps (b).

additive approach doesn't adapt to currently available power op amps.

The subtractive circuit obtains its foldback characteristic from the slight voltage divider effect of R_B and R_F. As the output swings toward a supply rail, the divider effectively reduces the V_{be} drive available to the current-limit transistor Q_x from the current limit resistor R_{CL}.

As the output swings away from a rail, the divider adds drive to the base of Q_x. The technique increases the available current when the output is close to a supply rail, and reduces it when the output is away from a supply rail.

While the PA10 and PA12 are the only amplifiers currently available with foldover limiting built-in, the four-wire limiting on a PA04 lends itself to implementing foldover current limiting with two external resistors and a capacitor *(Fig. 7)*. The capacitor prevents oscillation during current limit. The base resistor R_B is set to the same value as the base resistor in the previous example using the PA10 and PA12. The same equations apply with adjustments made for the value of R_F.

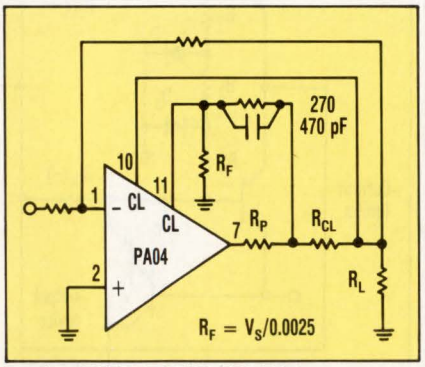
An additional op amp adapts virtually any amplifier hosting an externally settable current limit to foldover limiting *(Fig. 8)*. The high-voltage small signal IC on the right (such as a Harris HA-2645 or a National LM343), modifies the base-emitter voltage of the current-limit transistors, inside the power device, by driving their emitters through pins 2 and 8. The resistors R_B and R_F serve identical functions, and have identical values with their equivalents in the PA10 and PA12. No resistance should ever be located between the op-amp output and current-limit emitters. They would soften the current-limit transistors' clamping action on the power-device base drive. Initially, C_1 and C_2 should be at least 100 pF, and then increased to the minimum value necessary to overcome any oscillations that occur during current limit.

There's a maximum benefit which can be realized by using the single-slope foldover limiting built into the PA12, or the add-on universal foldover limiting. By referring back to the foldover-limiting output map, it can be seen that the current available at full output swing is twice that at zero-volts out *(Fig. 6, again)*. Moreover, the current available when the output voltage is at the rail opposite the one supplying current is nearly 0.

This 2-to-1 relationship between maximum available current and the current for zero-volts out—is the maximum attainable with this basic method of foldover limiting. Setting R_F to too low a value will activate the opposite-side current limit before full output voltage swing has occurred, clamping any drive that would otherwise be available to swing the output voltage in the opposite direction. This then leads to a nondestructive latch-up in output voltage, which can only be recovered from by removing power.

R_F must be kept small enough so that, for example, when the output is at full positive swing, there's less than 0.7 volts across the negative current-limit transistor base-emitter junction. This base-emitter drop is the voltage that appears across R_B (inside the power op amps). The lower limit of R_F is determined by:

$$R_F = V_s/(0.7/R_B)$$



7. THE FOUR-WIRE current limiting technique used by the PA04 power op amp easily adapts to external foldback current limiting.

REACTIVE LOADS

Reactive loads require special consideration with foldover limiting. A reactive load in the circuit of figure 6 would have an elliptically shaped load line that may be difficult to contain within the SOA and the output characteristic map.

If it extends outside the limiting curve, current limiting and distortion will occur. Reducing reactance or raising current limits are the only solution. In addition, foldover current limiting with a reactive load will produce a sharp flyback pulse that mandates using external, ultra-fast-recovery flyback diodes.

It's this limitation of foldover limiting that could make the designer wish that not only were two current

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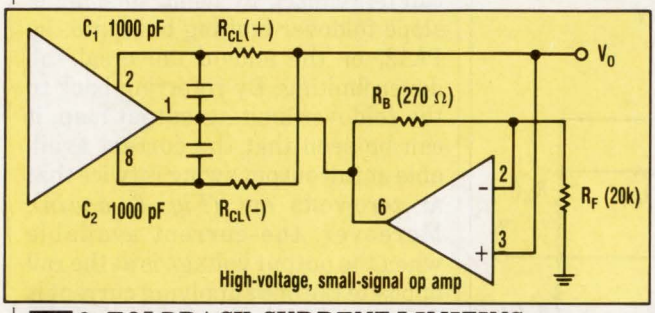


8. FOLDBACK CURRENT LIMITING can be adapted to virtually any power op amp by adding a high-voltage, small-signal op amp externally.

limit resistors used, but that both current-limit device bases were brought out separately—and independently—of any other connections.

The foldover limiting techniques described so far have a single slope. But referring back to the output map of figure 6 and looking at the SOA lines, it indicates that a steeper slope of foldover limiting is acceptable in the regions where output voltage and current have the same polarity. In fact, the SOA regions are nonlinear on the output map, suggesting a multislope foldover can offer an even better fit.

Multislope foldover can only be implemented if the current-limit transistor bases are separated both from each other and from the output transistors. No currently available power op amp lends itself to this arrangement. However, the technique can be used if you're building power boosters for available amplifiers—or are building your own power op amps from scratch.

The most basic multislope technique is a two-slope method offering a steeper foldover characteristic as the output passes through zero *(Fig. 9)*. R_B serves the same function as in typical current limiting. Depending on output polarity, diodes D_1 and D_2 provide different values for the resistance R_F. Looking at the positive limiter for instance, when the output voltage swings positive, D_1 is forward biased, and the value of R_F is equivalent to R_1. During this interval, D_2 is reversed biased and R_F for the negative limiter is equal to $R_2 + R_3$. If the output swings negative, D_1 is off and D_2 is forward biased. Now the positive current limiter R_F is equal to $R_1 + R_2$.

R_1 and R_3 can be made very low to provide a very sharp curve for foldover limiting. The SOA's curved edges, however, again limit the usefulness of the two-slope current limit. This problem can be solved by adding yet another breakpoint in the foldover curve.

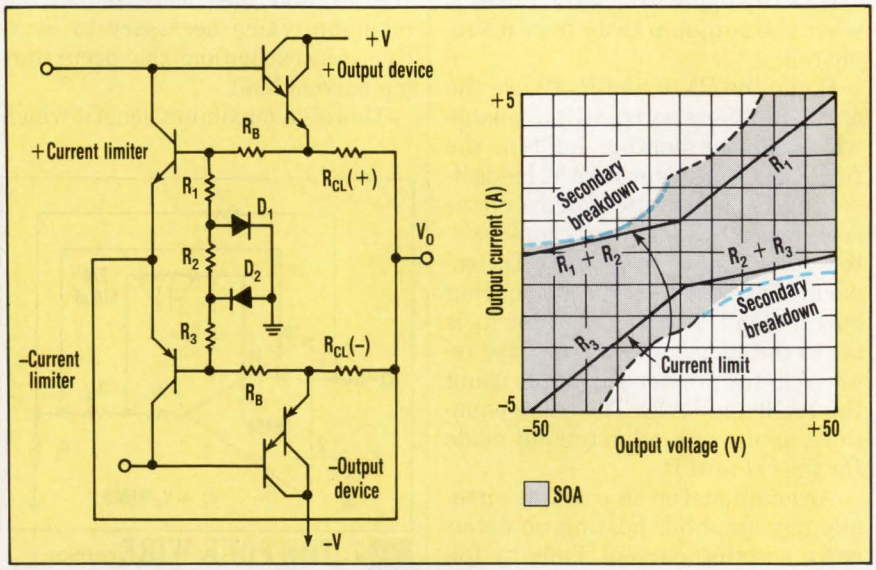
In a three-slope foldover circuit, the first break occurs around 0 V out with the activation of either D_1 or D_2, depending on output signal polarity *(Fig. 10)*. At a higher output voltage, either Zener diode DZ_1 or DZ_2 turn on to further reduce the effective value of R_F. This three-slope foldover offers the best fit yet to the amplifier SOA. A totally independent circuit is used on both halves of the multislope limiting to avoid any possible interaction that could latch-up the amplifier.

HEAT'S THE ENEMY

The destruction of an amplifier's power transistors is first and foremost a function of temperature. For a MOSFET operated within current and voltage limits, failure is only a function of temperature. Therefore sensing power device temperature is an essential element to any ideal protection scheme. It's currently used on several power op amps and power transistors. The Apex PA03 and the National LM12 are both equipped with power-output-device temperature sensing.

Power-die temperature sensing should not be confused with the thermal shutdown available on many power and high-voltage op amps, such as the Apex PA80 series high-voltage amplifiers and PA21 and PA07 power amplifiers. The most common form of thermal shutdown is a slow-action case temperature-sensing system that protects amplifiers from excessive temperatures. However, it doesn't provide load-fault protection.

The Apex PA03 is an example of a hybrid realization of power-die temperature sensing. It's accomplished by mounting a small-signal temperature-sense transistor directly on top of the power die. This intimate thermal sensing acts rapidly enough so that when the op amp is operated within proper voltage limitations, it's fully protected from load faults. This output-transistor temperature



9. WITH TWO-SLOPE, FOLDBACK current limiting, the diodes let R_1 and R_3 set the current limits at low currents. Their combination with the resistance of R_2 sets the current limit at high currents.

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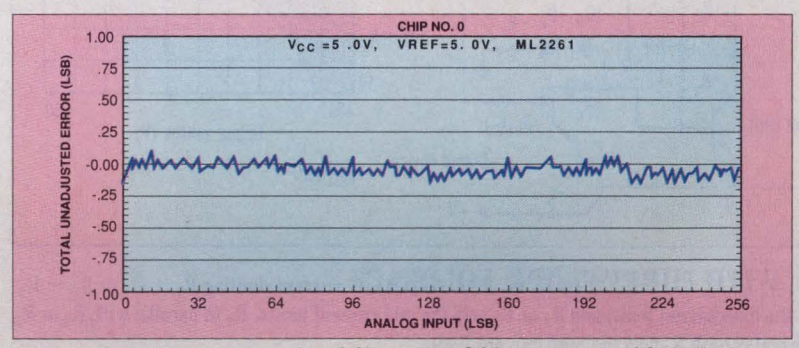

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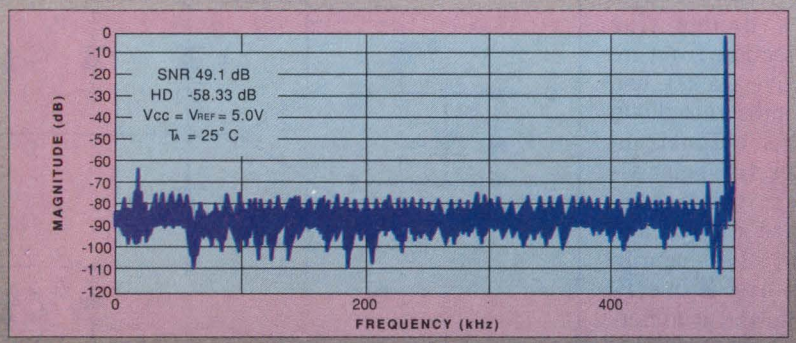

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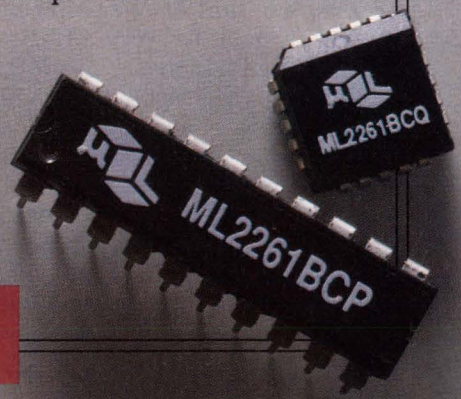

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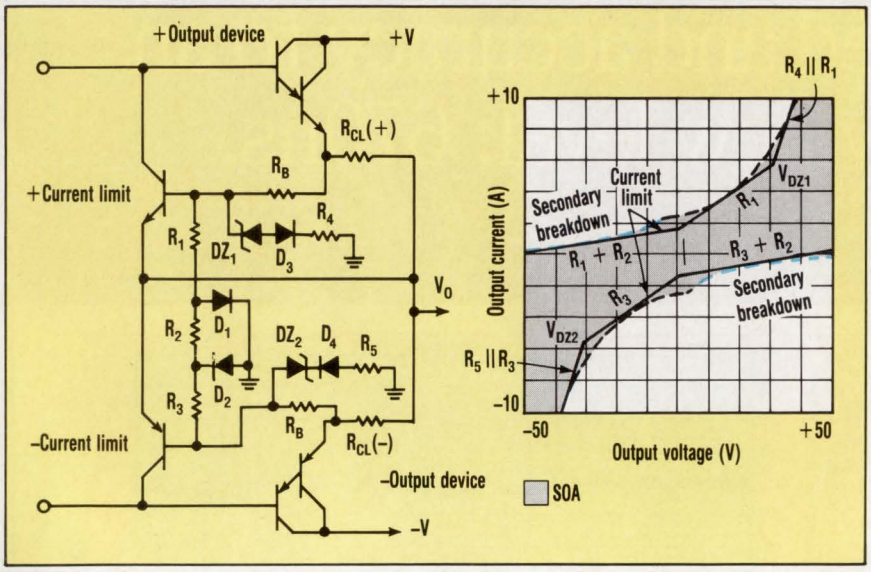


10. WITH THREE-SLOPE, FOLDBACK current limiting $R_1 + R_2$ or $R_2 + R_3$ set the low-current limit, and R_1 or R_3 sets the mid current limits. R_1 in parallel with R_4 or R_5 in parallel with R_3 sets the high current limits.

sensing is coupled with a package-temperature sensor that thermally shuts the whole PA03 down in the event of sustained excessive package temperatures.

Though thermal sensing is the most sophisticated form of protection, it does have its peculiarities. It *is not* a "clean" form of limiting, and can result in odd-looking waveforms when it becomes activated. Due to secondary breakdown, thermal limiting becomes less effective as higher voltages are used with the currently available bipolar power output stages. Secondary breakdown creates isolated "hot spots" on a die that can escape sensing by the thermal protection. This causes thermal runaway, destroying the power device.

Yet to be seen is a power op amp combining MOSFET outputs with thermal sensing. Without secondary breakdown limitations, thermal sensing should be very effective with MOSFETs. In theory, as a MOSFET develops a hot spot, the local on-resistance rises, shifting the load into the lower resistance remainder of the MOSFET.

In the process, the thermal load is spread. Moreover, tests of prototypes of the 90-V (rail-to-rail), 20-A PA77 (the first power op amp with MOSFET outputs and thermal protection), indicates that the theory holds. The device stands up under continuous shorts to ground while trying to put out maximum voltage (it will be out early in 1991). Final proof will have to wait until the Apex PA77 becomes available.

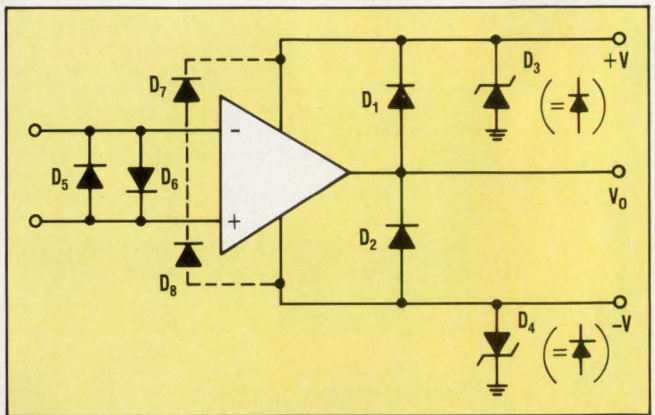
Operating a power op amp within an SOA doesn't eradicate all of the possibilities of destroying it. For example, any time current is interrupted in inductive or even partly inductive loads, a flyback kick will be generated. This kick will reach whatever voltage level is necessary to maintain current flow—and will apply it to the amplifier's output.

Most amplifiers with built-in flyback diodes (for protection from inductive kicks) use the substrate diode of their output transistor. In bipolar devices, these substrate diodes are slow, their continued use is inefficient, and it generates heat. Consider also that certain loads, such as brush-type DC motors, have a continuous interruption of current flow due to commutation. This produces a continuous train of kickback pulses that, averaged over time, can cause power-device failure.

The need for external flyback diodes was discussed in connection with inductive loads and foldover current limiting. Anytime inductive loading is expected, external flyback diodes are an inexpensive reliability enhancement. Ideally, these diodes should be ultra-fast-recovery types, but fast recovery or standard recovery is often better than none at all.

Power-supply transients are another source of amplifier overstress. In fact, adding flyback diodes merely couples flyback pulses into power supply lines—it's usually assumed that the power supply has the storage capacity to absorb them. If the only energy storage on the power supply is a large electrolytic filter capacitor, its high series inductance won't absorb extremely fast transients. A regulated power supply isn't a guarantee of safety either. Most regulated supplies are excellent current sources and lousy current sinks.

Ultimately, the only protection from power supply transients is Zener-diode transient suppressors. No other type of transient protection is fast enough. The Zeners must be rated below the amplifier maximum rating, but greater than the expected maximum supply voltage. Unregulated supplies where this transient protection is mandatory often neces-



11. DIODES AND ZENER diodes protect power op amps from inductive kick-back spikes, power-supply transients, and high input-common-mode transients.

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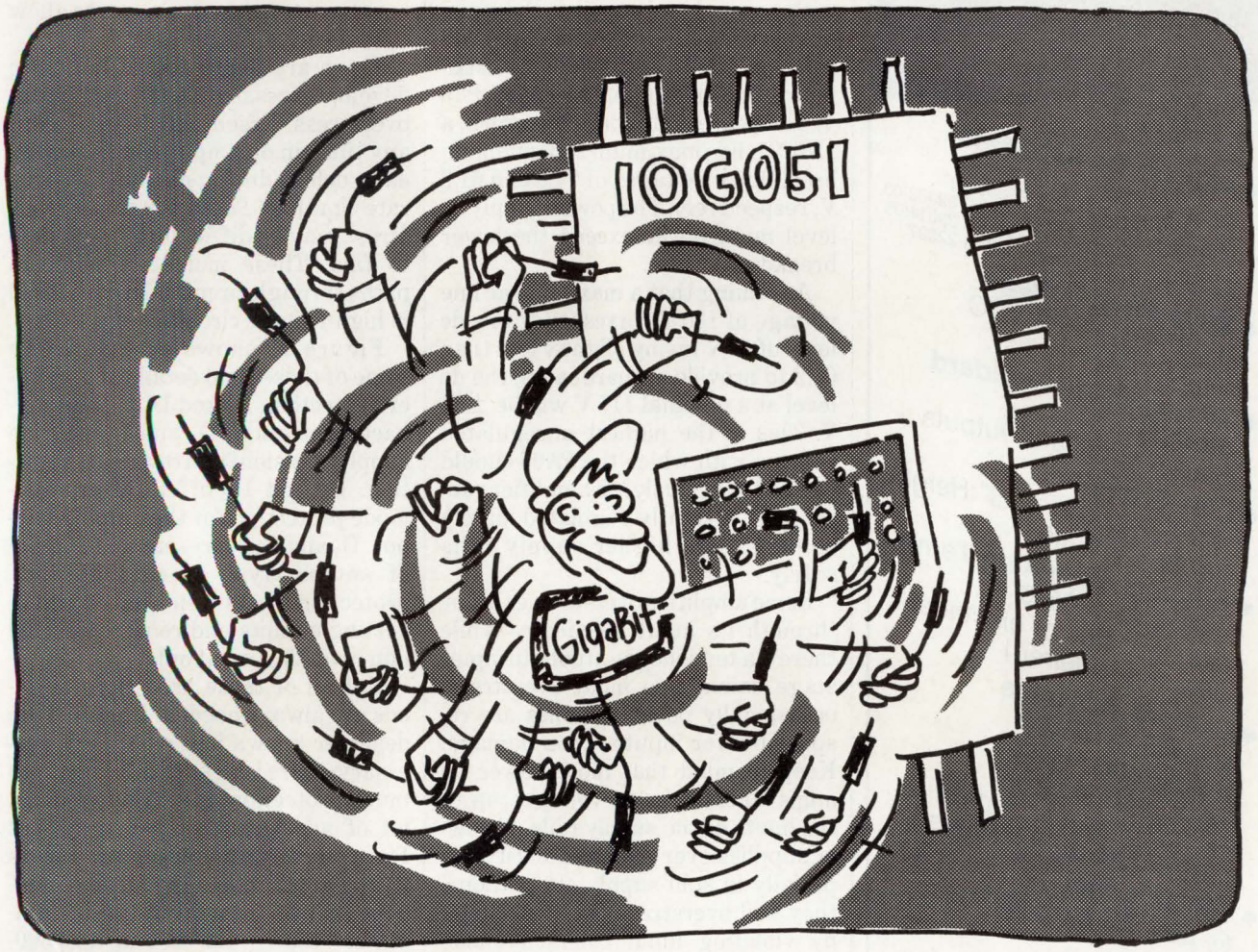
2.6 Gbit/s 16x16 Crosspoint Switch IC



Not even a 16-hand operator can switch this fast! GigaBit's new 10G051 16x16 Crosspoint Switch IC can switch signals at 2.6 Gbit/s rate in less than 2 ns. With its wide bandwidth, the 10G051 handles SONET OC3 to OC48 as well as HIPPI/Fiber Channel signals at full speed.

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CIRCLE 103

PROTECTING POWER OP AMPS

sitates great sacrifices in operating voltages when tolerance stack-up is considered *(Fig. 11)*. Transient absorbing Zeners (called Transorbs by General Semiconductor, Tempe, Ariz.) D_3 and D_4 are shown operating with a PA03 amplifier.

Using this circuit as an example, with unregulated supplies, the maximum permissible supply voltage will be calculated. The PA03 has a maximum allowable supply rating of ±75 V. The nearest standard Transorb, a 1N6291, has maximum and minimum breakdown voltages of 74.8 and 61.2 V, respectively. The power-supply dc level must never exceed the lower breakdown value.

Assuming that a maximum ac line voltage of 130 V corresponds to a dc level of 60 V (using slightly less than 61.2 to provide a guardband), the dc level at a nominal 117 V will be ±54 V. This is the highest unregulated voltage with which the PA03 should be used. Obviously, an amplifier running off a tightly regulated supply could handle higher supply rails safely.

Some amplifier overstresses occur through its input terminals. While there's a tendency to attribute input-stage damage to input overstress, occasionally power supplies are responsible for input-section damage. Keep in mind that most power op amps tolerate input voltages up to the limits of the supply rails. If power supplies ever reverse polarity, especially in split-supply applications, they will overstress the input stage by violating input common- mode limits. Outputs are generally protected from supply reversals by their built-in flyback diodes.

The chance of supply reversal furthers the argument for using Zener diodes to protect the supply lines. If the supply reverses, the Zeners act as forward biased diodes to clamp the reverse polarity excursion—if unidirectional Zener diodes are used.

The need to keep an amplifier's inputs within the supply rails generally falls under the heading of common-mode protection of amplifier inputs. This is in contrast to differential-mode protection considerations. Differential-mode input protection is easily implemented with the diode clamps shown between amplifier inputs. With FET input amplifiers (when the low bias current of the FET is important to the application), these may need to be low leakage diodes. Alternatively, if high slew rates are important, multiple diodes may have to be used in series to allow for overdrive.

There are many opportunities to develop excessive differential-input overstress. Essentially, it can occur any time an op amp becomes nonlinear, such as during clipping or slew-rate limiting. Paths for input overstress may be difficult or impossible to find. These include breakdown paths through circuit board material in high-voltage circuits.

Figure 11 shows schematically some of these final details of amplifier protection. D_1 and D_2 provide flyback protection. D_3 and D_4 provide supply transient and reversal protection. D_5 and D_6 offer differential-mode protection for the amplifier input. D_7 and D_8 represent an example of another type of common-mode protection most often used on noninverting circuits and required on the non-inverting input only.

Not all of these protection methods are always needed. But until the designer knows just what isn't necessary, there isn't such a thing as too much protection. It may seem like a lot of additional componentry just for protection. But only a few dollars worth of additional diodes and components are invested to protect amplifiers that could cost up to $300-$500. Don't fall into the mental trap of taking it for granted that reduced component counts and reliability always go together.

Jerry Steele, a senior applications engineer with Apex Microtechnology, has 15 years of experience in electronic engineering, application engineering, and seminar presentations.

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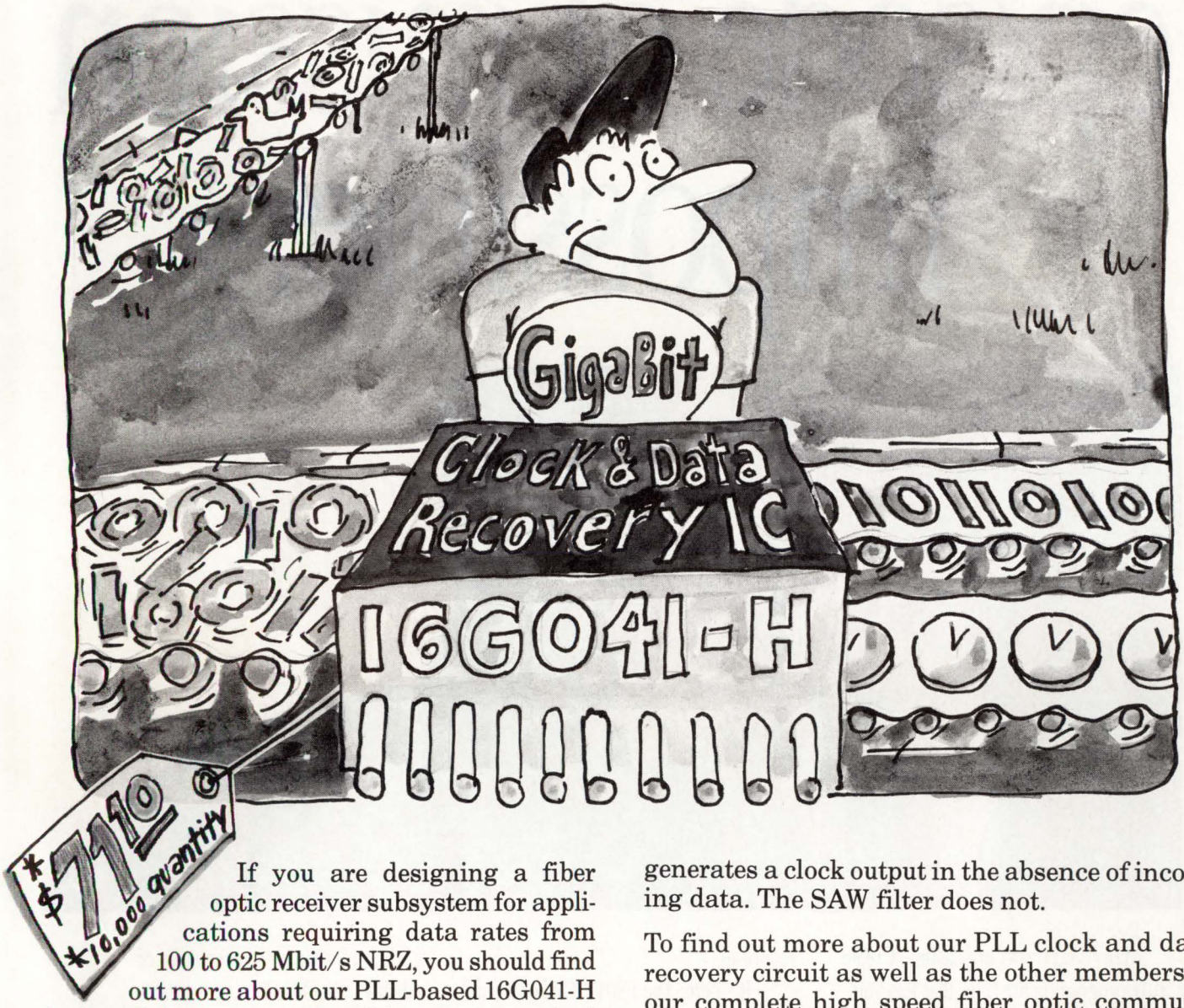

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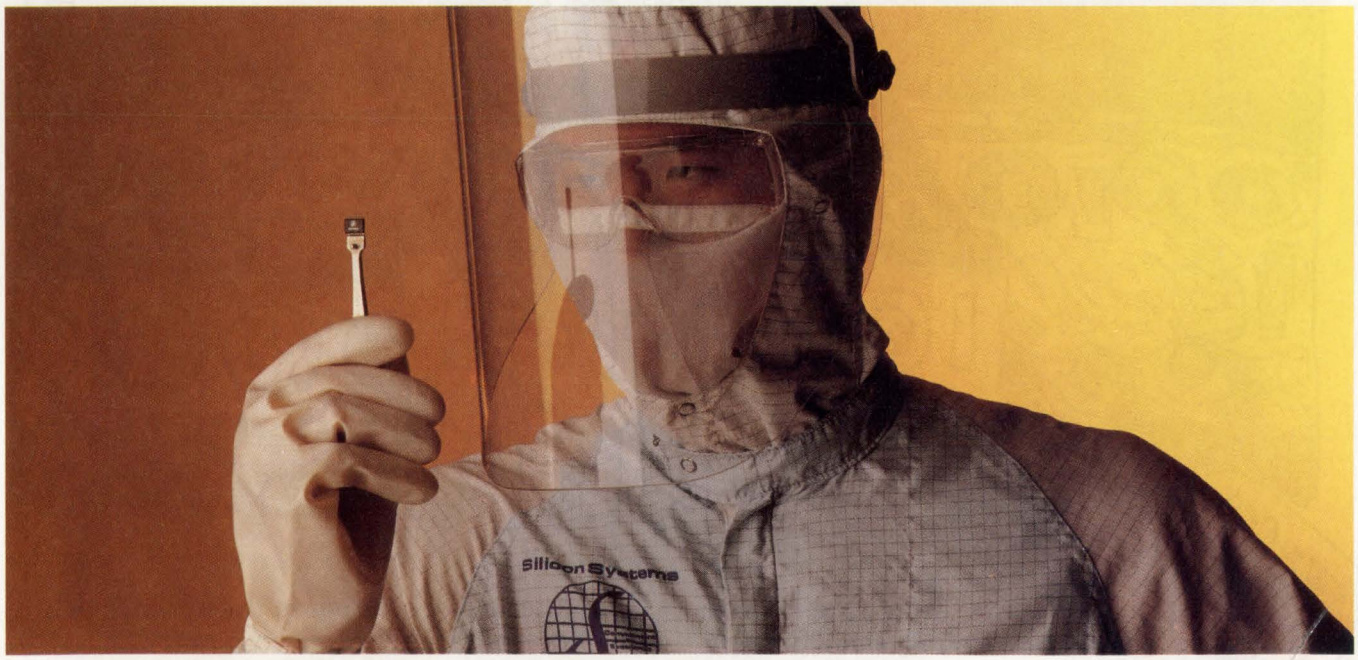
CIRCLE 166

The F80 Programmable Filter

Another exciting episode of mission impossible.



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CIRCLE 521

DRIVE 100-MA CABLE LOADS

JIM WILLIAMS
Linear Technology Corp., 1630 McCarthy Blvd.,
Milpitas, CA 95035; (408) 954-8400.

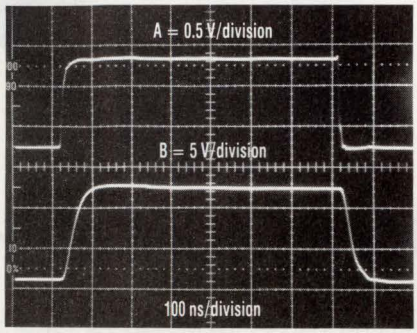
Capacitance or cable loads with currents of 100 mA can be driven by an amplifier circuit that has over 20 MHz of small-signal bandwidth. The circuit's input capacitance is below 1.5 pF, bias current is about 100 pA, and the output is fully protected. These features make this amplifier suitable for use as an automatic-test-equipment (ATE) pin amplifier, a video analog-to-digital converter input buffer, or a cable driver. The circuit also permits wideband probing when oscilloscope probing isn't tolerable. The overall amplifier consists of a low-input capacitance FET, two LT1010 buffers, and a gain stage—Q_3 and Q_4 *(Fig. 1)*.

A_3 acts as a dc restoration loop. The 33-Ω resistors sense A_1's operating current, biasing Q_3 and Q_4. These devices furnish complementary voltage gain to A_2, which supplies the circuit's output. Feedback is from A_2's output to A_1's output, which is a low impedance point. The "current-mode" feedback permits fixed bandwidth over a wide range of closed-loop gains. This contrasts with typical feedback schemes where bandwidth degrades as closed-loop gain increases.

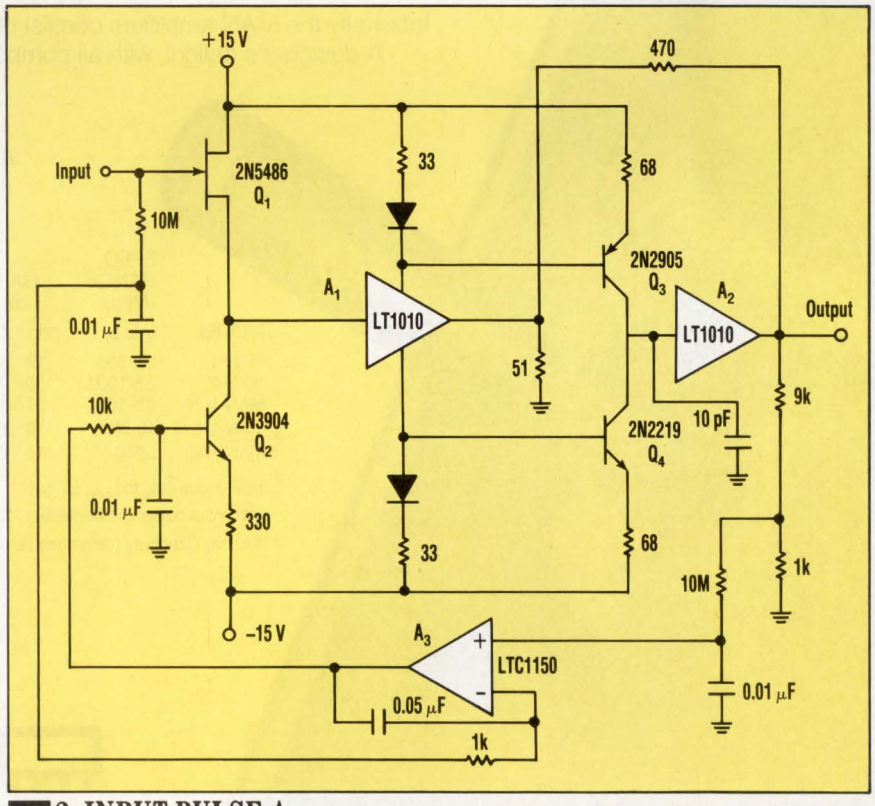
A_3's stabilizing loop compensates for large offsets in the signal path, which are dominated by a mismatch in transistors Q_3 and Q_4. A_3 measures the dc difference between the amplifier's input and its output and biases the signal path to correct for offset. Correction is implemented by controlling Q_1's channel current through Q_2. The channel current sets Q_1's V_{GS}, enabling A_3 to control overall circuit offset. The 9- to 1-kΩ divider that feeds A_3 is selected to equal the gain ratio of the circuit, in this case 10.

The feedback scheme makes A_1's output look like the amplifier's negative input, with closed-loop gain set by the ratio of the 470- and 51-Ω resistors. The outstanding feature of this connection is that the bandwidth becomes relatively independent of closed-loop gain over a reasonable range. For this circuit, small-signal bandwidth exceeds 20 MHz over gains of 1 to 20. The loop is quite stable, and the 10-pF value at A_2's input supplies good damping over a wide range of gains.

Large signal performance can be seen at a gain of 10 when driving 10 ft. of cable *(Fig. 2)*. The response displayed at the output is quick and clean and has no slew residue or poor dynamics.□



1. WITH 20 MHZ of small signal bandwidth, this circuit can drive 100-mA capacitance or cable loads. The circuit's feedback, from A_2's output to A_1's output, permits a fixed bandwidth over a wide range of closed-loop gains.



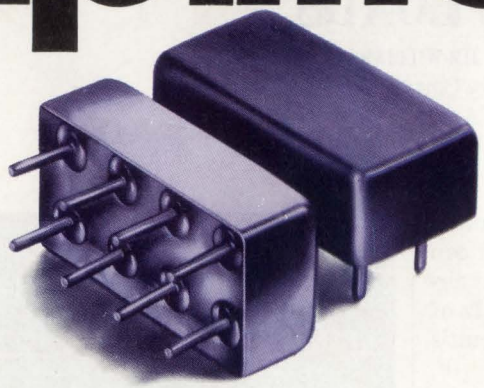
2. INPUT PULSE A produces output pulse B. These signals are for an amplifier gain of 10, driving 10 ft. of cable.

IFD WINNER

IFD Winner for September 27

David Johnson, 10198 W. Berry Dr., Littleton, CO 80127; (303) 973-8408. His idea: *"Convert Waveform Period To Voltage."*

rugged plug-in amplifiers



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*MAN-1AD	5.500	16	0.5	6	7.2	85	24.95

††Midband 10f_L to $f_{u/2}$, ±0.5dB †1dB Gain Compression ◇Case Height 0.3 In.
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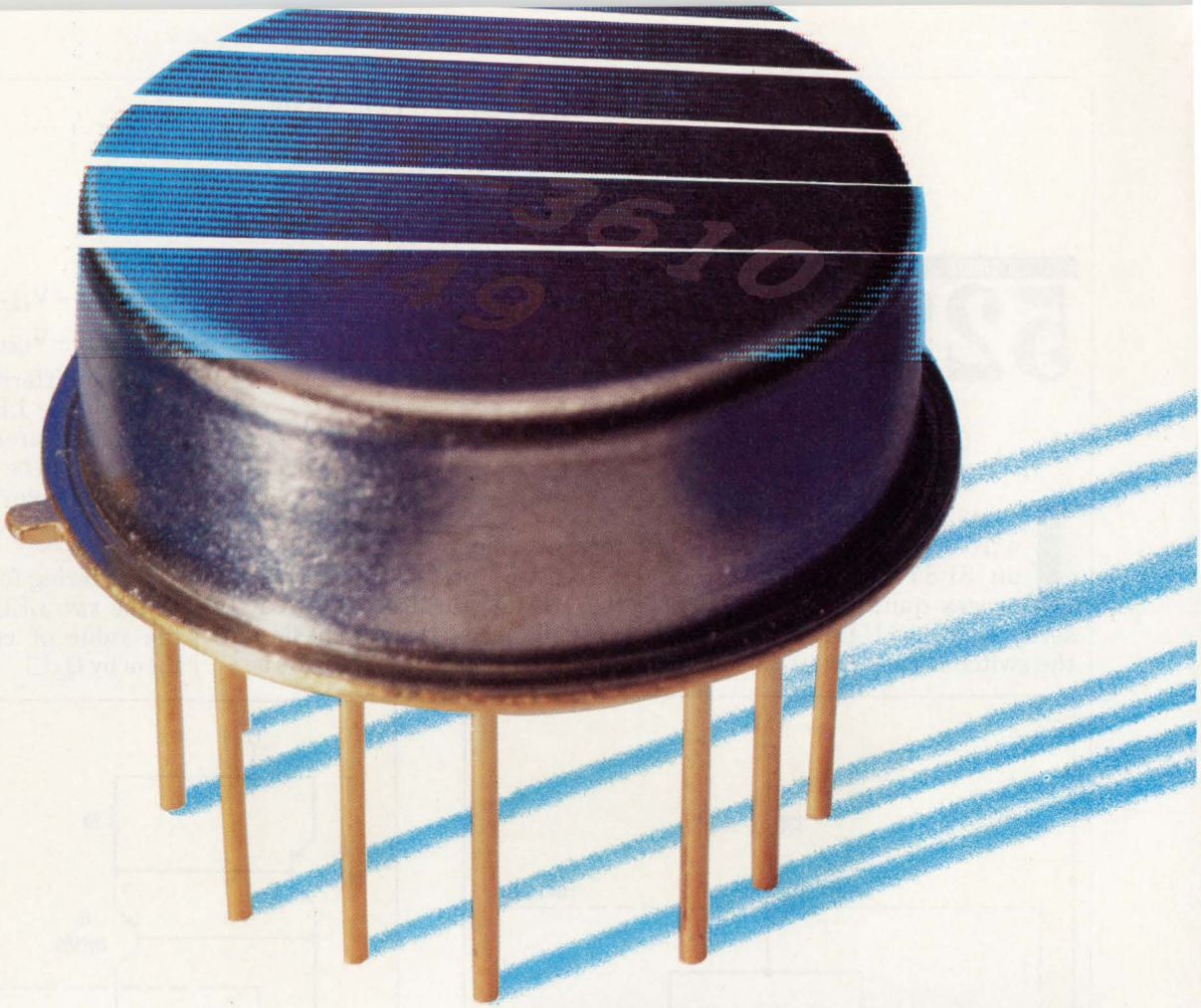
CIRCLE 92

C118 REV. E



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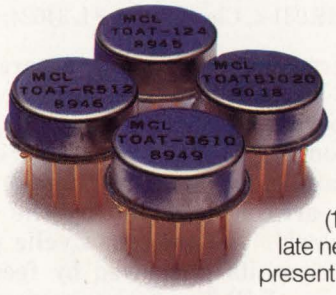
0.5	**0.12**	**1.0**	**0.2**	**3.0**	**0.3**	**5.0**	**0.3**
1.0	**0.2**	**2.0**	**0.2**	**6.0**	**0.3**	**10.0**	**0.3**
1.5	0.32	3.0	0.4	9.0	0.6	15.0	0.6
2.0	**0.2**	**4.0**	**0.3**	**10.0**	**0.3**	**20.0**	**0.4**
2.5	0.32	5.0	0.5	13.0	0.6	25.0	0.7
3.0	0.4	6.0	0.5	16.0	0.6	30.0	0.7
3.5	0.52	7.0	0.7	19.0	0.9	35.0	1.0

bold faced values are individual elements in the units



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CIRCLE 522

RELAY SELECTS BETWEEN TWO LEDS

JOHN DUNN
Centroid Inc., 3 Aerial Way, Syosset, NY 11791; (516) 822-4770.

If two LEDs must be switched on a front-panel display using only an SPST relay, this circuit proves quite useful. LED1, in series with the 1N4148 diode, is lit if the switch is open *(Fig 1)*. When the switch closes, LED2 lights. LED2's forward voltage drop is too low for current to flow through LED1 and the 1N4148, turning off LED1. In this alignment, the current (in mA) passing through the two LEDs is:

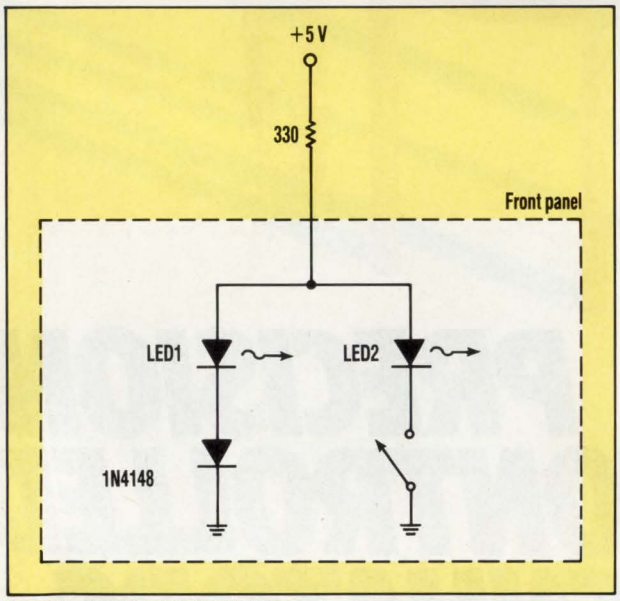
$I_{LED1} = (5 - V_{LED} - V_{diode})/330 = 8.79.$

$I_{LED2} = (5 - V_{LED})/330 = 10.6.$

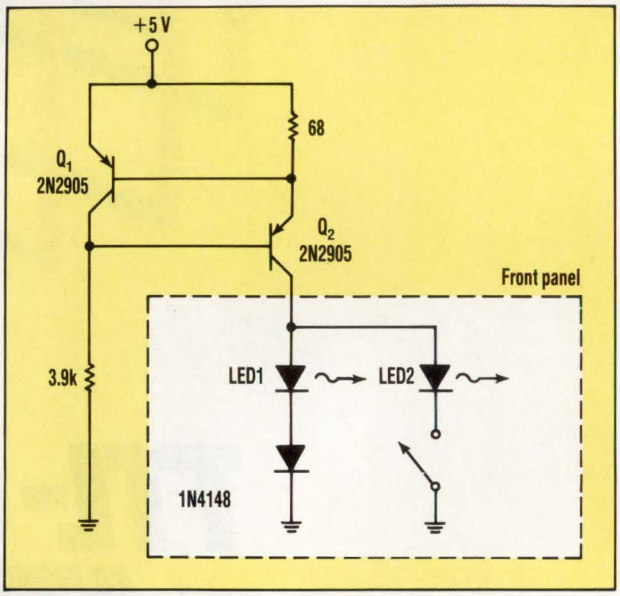
If the differing currents flowing through the LEDs cause an objectionable difference in brightness, the currents can be equalized by using a current source *(Fig. 2)*. Now,

$I_{LED1} = I_{LED2} = V_{BE}/68 = 8.82.$

The differing forward voltage drops of the two LED paths won't affect the value of current injected into them by Q_2.□



1. THIS CIRCUIT switches between two LEDs on a front-panel display using only an SPST relay. LED1 is lit when the switch is open. When it closes, LED2 goes on and LED1 turns off.



2. TO KEEP EQUAL BRIGHTNESS for both LEDs, a current source can be inserted. This equalizes the amount of current flowing through the two LEDs.

CIRCLE 523

BUILD SIMPLE 32-BIT PATTERN GENERATOR

MICHAEL A. WYATT
SSO Honeywell Inc., MS 931-4, Clearwater, FL 34624; (813) 539-5653.

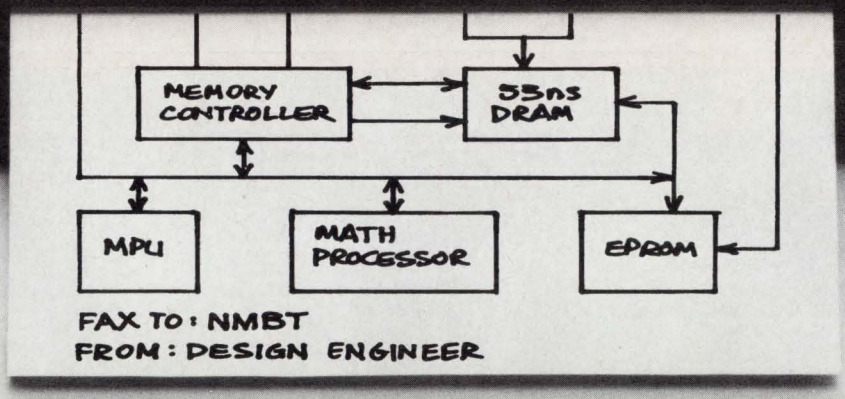
A simple 32-bit pattern generator with four 8-bit shift registers can operate at high speeds. The four registers comprising the 32-bit parallel-to-serial converter—U_2 to U_5—are connected in series *(see the figure)*.

Each shift register receives its eight parallel inputs from DIP switches S_1 through S_4, which set the 32-bit pattern to be shifted out serially after the parallel load (SH/$\overline{LD}$) goes low. A parallel load is initiated by pressing the Load pushbutton, which causes U_{1B} and SH/$\overline{LD}$ to go low. The 0.1-μF capacitor connected to U_{1B}'s input eliminates chatter caused by the Load pushbutton switch. Cyclic pattern output is achieved by feeding the last shift register's output (U_5) back to the first register's serial input. As a result, data is continuously cycled through the four shift registers. Each data bit is shifted on the falling edge of the clock input.

Data Output is taken from the serial input of the first shift register (U_2) and buffered by the parallel combination of U_{1D}, U_{1E}, and U_{1F}. The three 140-Ω resistors and the parallel gates form a high-speed 50-Ω driver for Data Output. Data phase can be inverted with switch S_5.

This design comes in handy when used with digital communications, and it can operate beyond 10 Mbits. Higher-speed operation could be achieved by replacing the 74HC165 and 74HC14 chips with a faster logic family. If different data-pattern lengths are desired, adding (or removing) additional shift registers is all that's required.□

53ns FREE*



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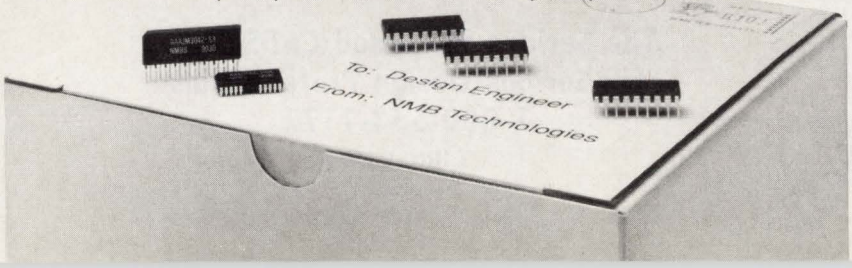

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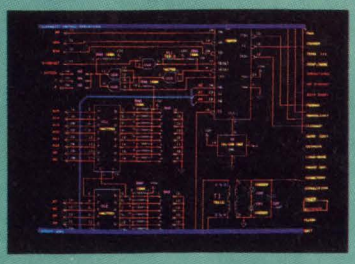
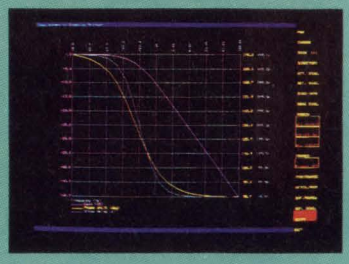
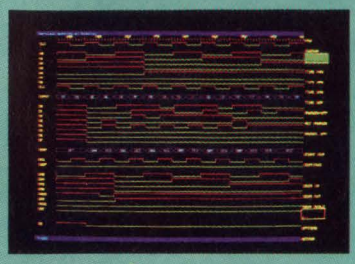


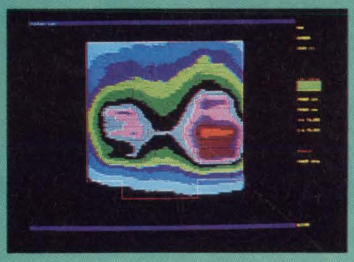
Schematic Capture



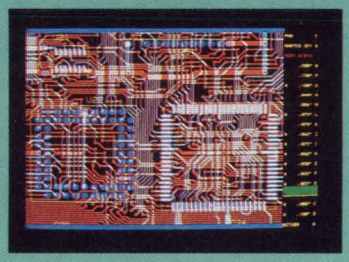
Analog Simulation



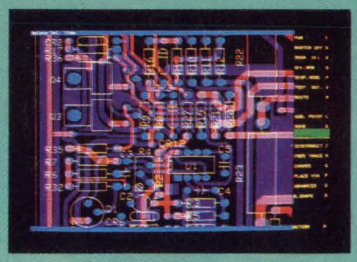
Logic Simulation



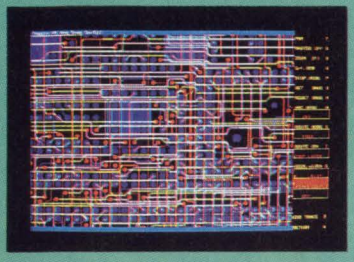
Thermal Analysis



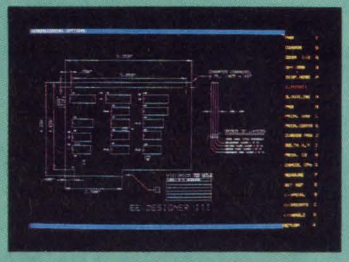
PCB Layout



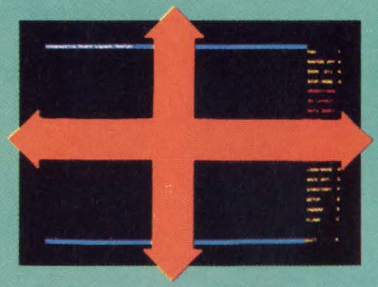
Analog Design



Autorouting



Fabrication Drawings



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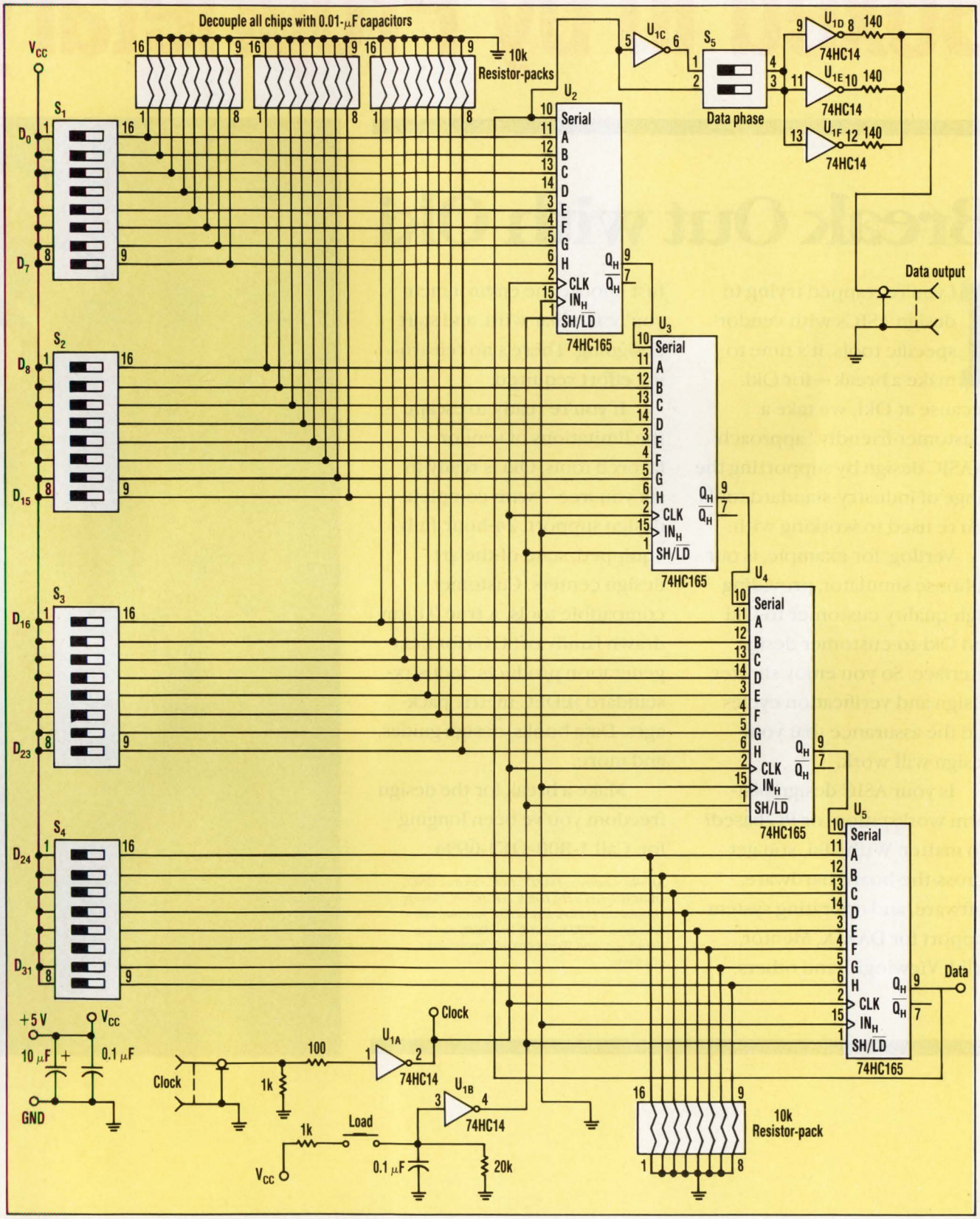

THIS 32-BIT PATTERN GENERATOR uses four DIP switches at its input. Each switch sends eight parallel signals to the four shift registers. A parallel load of the registers is initiated by pressing the Load pushbutton. By feeding U_5's output back to U_2's serial input, a cyclic pattern is achieved.

Boxed In by Proprietary

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If you're trapped trying to design ASICs with vendor-specific tools, it's time to make a break—for Oki. Because at Oki, we take a "customer-friendly" approach to ASIC design by supporting the range of industry-standard tools you're used to working with.

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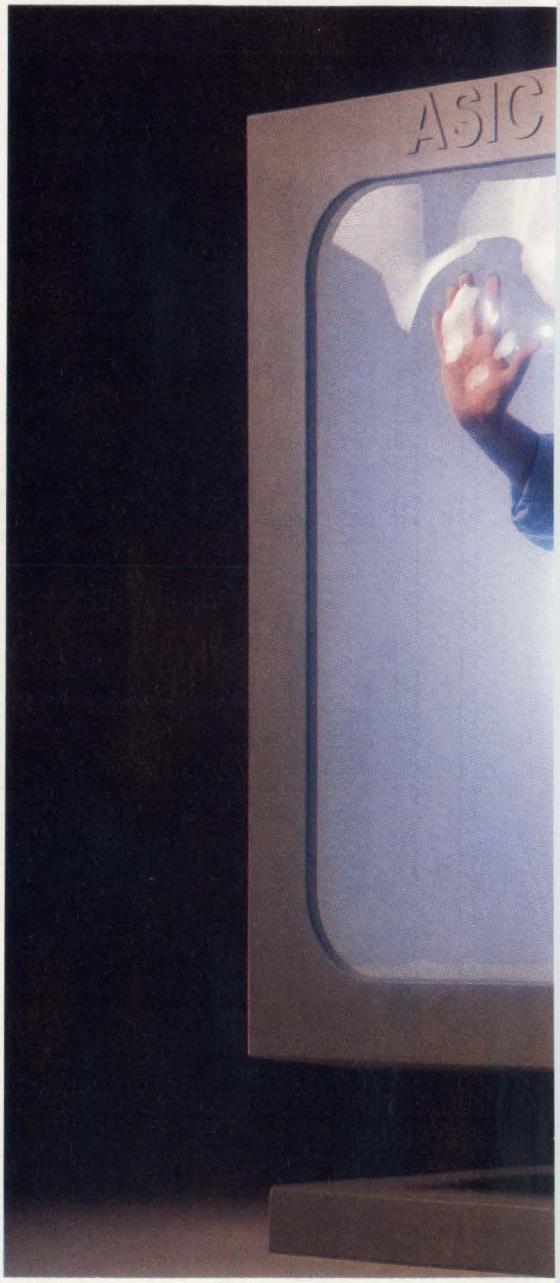

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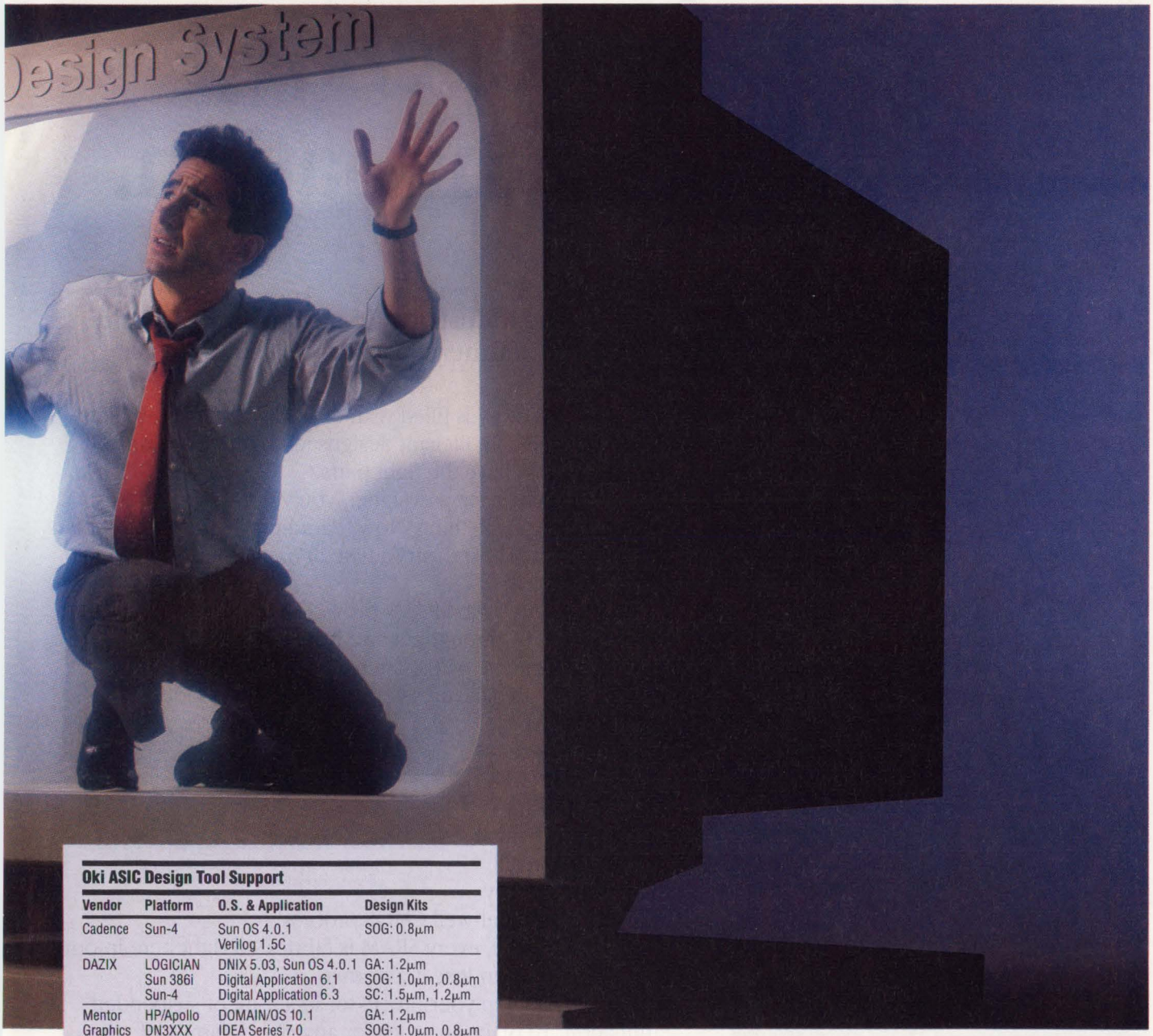
ASIC Tools?



Oki ASIC Design Tool Support

Vendor	Platform	O.S. & Application	Design Kits
Cadence	Sun-4	Sun OS 4.0.1 Verilog 1.5C	SOG: 0.8μm
DAZIX	LOGICIAN Sun 386i Sun-4	DNIX 5.03, Sun OS 4.0.1 Digital Application 6.1 Digital Application 6.3	GA: 1.2μm SOG: 1.0μm, 0.8μm SC: 1.5μm, 1.2μm
Mentor Graphics	HP/Apollo DN3XXX DN4XXX	DOMAIN/OS 10.1 IDEA Series 7.0	GA: 1.2μm SOG: 1.0μm, 0.8μm SC:1.5μm, 1.2μm
Synopsys	Sun-4	Sun OS 4.03 *Interface to Mentor, Valid, Viewlogic	SOG: 1.0μm, 0.8μm
Valid	Sun-4 Sun-3	Sun OS 4.0.1 GED, ValidSIM, RapidSIM	GA: 1.2μm SOG: 1.0μm, 0.8μm SC: 1.5μm, 1.2μm
	DEC Station 3100	ULTRIX ValidSIM GED	GA: 1.2μm SOG: 1.0μm, 0.8μm SC: 1.5μm, 1.2μm
Viewlogic	Sun-4	Sun OS 4.0.3 Workview 4.0	GA: 1.2μm SOG: 1.0μm, 0.8μm SC: 1.2μm
	PC386	DOS 3.3 Workview 4.0	GA: 1.2μm SOG: 1.0μm, 0.8μm SC: 1.2μm

OKI Semiconductor

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Sunnyvale, CA 94086-2909

CIRCLE 85

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The industry's first 20 ns Military and Commercial 1 Megabit SRAMs.

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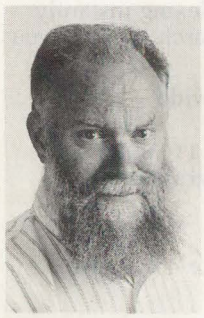
CIRCLE 116

WHAT'S ALL THIS RZAMBLE STUFF, ANYHOW?

Sometimes I go on hikes with my sons and my wife. Sometimes I go on hikes without them; sometimes they go on hikes without me. Here in Northern California, just in the San Francisco Bay area, there are many dozens of parks, and many hundreds of miles of trails in these parks.

Sometimes my wife leads a hike for the local chapter of the Sierra Club. Sometimes my son Benjamin (age 25, he has a full Red Cross certificate and I don't, so I am not eligible to lead hikes) leads the same hike. I have been on some of their hikes. What they amount to is a Ramble. Or, as I mistyped the other day, a Rzamble, which is a word that sounds pretty good to me.



BOB PEASE OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

The main point is, that when you go on a hike with my wife, you will probably have a pleasant ramble. If you go on the same hike led by my son, you will have a pleasant ramble, but it will be a *different* ramble. If you join me on these hikes through the world of analog ideas, that will be a *different* Rzamble, and I hope you find it enjoyable. I read several daily columns in the San Francisco Chronicle—columns by Herb Caen, who has been writing daily columns more than 50 years. I don't know how he can do that! I also read columns by Jonathan Carroll, who is a little bit *meshugineh* (a little crazy) and quite amusing. Art Hoppe is another. I have big thick envelopes full of columns by Stanton Delaplane and Charles McCabe who wrote for the Chronicle for many years, but they died a few years ago. I must say, I have always been impressed with people who can assemble a few hundred words, *everyday* (or, every weekday). This column I'm writing is every 14th day, and I must admit, that ratio of 14:1 or 10:1 is a *huge* difference. I maintain an awesome respect for people who can put out a column every day.

When I took on this project, I knew immediately that if I had to *meet* a deadline, I would be in deep trouble. So, I would have to write a whole bunch of columns, and get *way* ahead of the game. Fortunately, I have had a little help from my friends, and I think I'm ahead of schedule—thanks to Frank Good enough, ELECTRONIC DESIGN's editor in Boston. I have been encouraged and am making good progress at keeping ahead. I'm sure if I start to fall behind, Frank will chew on my ankles and get me straightened out.

How can I crank out all these words? Well, it helps to have a decent word-processing machine to write on. Why am I typing this on an IBM-compatible Personal Computer (made by Compaq)? Well, I own an old Coleco ADAM word-processor at home and it works perfectly adequately for writing memos and letters. But, it's not set up to transmit text encoded in ASCII, neither by modem nor by floppy, to Frank Goodenough in Boston or to the editors back in New Jersey. So I have this IBM-compatible machine, with processing by PC-Write-Lite* from Quicksoft, which works pretty well.

And while I'm a great fan of analog computers, I must say they're not terribly successful at saving and storing and transmitting text. I once set up a pair of voltage-to-frequency converters to put the X-Y coordinates of some letters and words onto a stereo cassette recorder. It did work. I was able to store the words. But the resolution was marginal, the throughput rate was awful, and the amount of tape to store 100 words would be absurd.

And when we played it back, using a brace of frequency-to-voltage converters and a pen-plotter, the words and letters were shaky due to the jitter and wobble and wow of the time-base of even the best (analog) audio tape recorder. So, I'm not going to even try to use an analog-computer word processor—even though it's not absolutely impossible. I'll use one of these new-fangled digital word-processors (which is not yet as user-friendly as my old ADAM) and plunk down my words. It works, and I don't gripe much about things that work.

What I really want is a word processor like that new Super Food Processor: You can feed in a 2×4, and the processor will grind it up into sawdust. Then you can put the sawdust into its hopper, and it will extrude them out into a rigid 2×4.

I just want to be able to do that with *words*, too!!

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

ADDRESS:
Mail Stop C2500A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

*PC-Write-Lite, available for $79 from Quicksoft Inc., 219 First Ave. N #224, Seattle, WA 98109—a very reasonable price, and a plausible, darned-nearly user-friendly piece of software. I recommend.

p.s. —Herb Caen just announced in June that—after 52 years in the game,—he's going to cut back from 6 columns to 5 columns per week. That's still a huge number of words per week. But, no more "Sunday columns" from Herb Caen.

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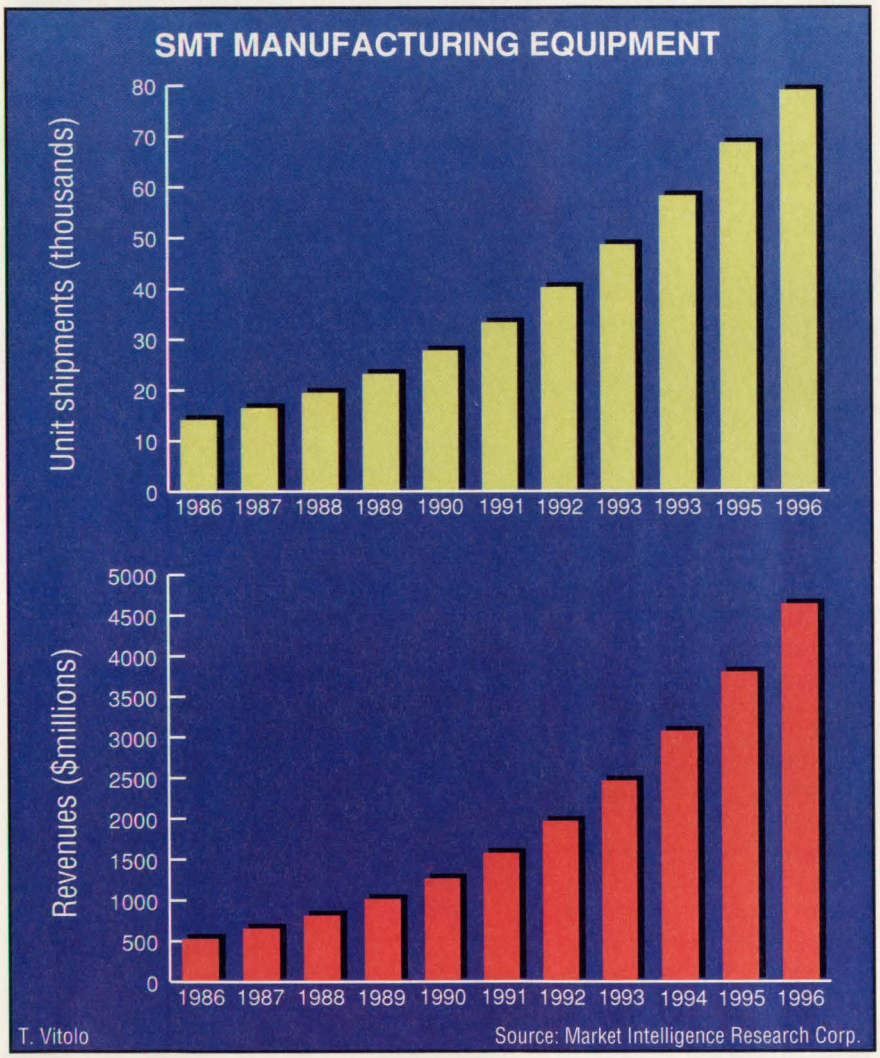
IHS-905NTB-1290

CIRCLE 181

ELECTRONIC DESIGN

QUICK LOOK

EDITED BY SHERRIE VAN TYLE



MARKET FACTS

The market for surface-mounted technology manufacturing equipment is growing at more than 24% a year. Last year, 27,800 units of SMT manufacturing equipment were shipped. This equipment was worth $1.3 billion, according to the Market Intelligence Research Corp. (MIRC). Most of the equipment revenue comes from placement equipment, which accounted for about 45% of world revenue in 1989. The Mountain View, Calif., market researcher predicts that the total market will grow to $4.6 billion by 1996.

The largest user of SMT manufacturing equipment is the computer industry, which, along with the consumer electronics segment, accounted for about half of equipment sales in 1989. Fastest growing are the telecommunication and aerospace sectors. SMT boards meet requirements for high-performance, I/O intensive jobs in these areas. SMT boards also meet the tough thermal and reliability demands for these applications.

Look for big changes in inspection equipment, where manual inspection is being replaced by powerful but costly automatic optical systems.

As in other areas of electronics, users are demanding standards that do not limit them to proprietary products from one vendor. Establishing SMT standards also would help U. S. companies develop products that are internationally competitive.

OFFERS YOU CAN'T REFUSE

A free newsletter offers tips on working with Spice. *Intusoft Newsletter* discusses the modeling of pulse-width modulators, with diagrams and program listings. Contact Intusoft, P. O. Box 6607, San Pedro, CA 90734-6607; (213) 833-0710; fax (213) 833-9658.

Data-acquisition tasks are falling to PCs these days. To cope with such issues as connection of thermocouples and various types of hardware, Dianachart Inc. offers a free 66-page booklet, "How to Measure with your PC." along with a demo disk. Also covered: thermistors, strain gages, and pressure transducers. Systems are described for portable measurement, rack mounting, high speed, and data-acquisition workstations. Contact the company at 101 Round Hill Dr., Rockaway, NJ 07866; (201) 625-2299.

As numeric coprocessors become more popular so grows the need for arithmetic standards for consistency and accuracy. Cyrix Corp., Richardson, Tex., is offering a free test suite to check coprocessors for conformance to the IEEE standard for 80-bit arithmetic (IEEE 754-1990).

The test, developed at the University of California at Berkeley, evaluates performance in all data formats supported by 386-based PCs. For a free disk, contact the company at 1850 N. Greenville, Suite 184, Richardson, TX 75081; (800) 327-6284.

QUICKLOOK

HOT PC PRODUCTS

Windows have been out of reach for PC users working with 640k, XT machines—Windows 3 works best on 386 machines with 2 Mbytes of RAM [Quick Look, Nov. 8, 1990, p. 119]. Now users of lower end machines can have their graphical user interface and keep their hardware too. With a street price of about $150, GeoWorks Ensemble offers a multitasking environment and seven integrated applications. Ensemble runs with 512k RAM, a hard disk, mouse, and graphics—Hercules, CGA, EGA, VGA, or MCGA. It complies with the OSF/Motif GUI.

The environment's operating system supports object-oriented programming, multitasking, WYSIWYG printing, and virtual memory management. Ensemble includes a word processor with outline fonts and page-layout capabilities, an object-oriented drawing program, file manager, address book, and phone dialer.

For more information contact the company at 2150 Shattuck Ave., Berkeley, CA 94704; (415) 644-0883; fax (415) 644-0928.

Now there's a way to save designs hatched on blackboards without recopying them by hand. From Quartet Manufacturing Co., the Ovonics Electronic Copyboard combines proprietary sensors with an erasable white board.

Its porcelain, enamel-on-steel surface suits it for plants or other industrial environments. An electronic scanner feeds digital signals into a printer that can produce multiple copies of the material written on or attached to the board's surface. Prices start at about $3100.

For more information, contact the company at 5700 Old Orchard Rd., Skokie, IL 60077; (708) 965-0600.

Ricoh Corp. says it has come up with the world's smallest fax machine. So the PF-1 portable fax takes its place among other achievements recorded in *The Guinness Book of World Records* for 1991. The portable fax has dimensions of 11 by 7 by 2 in. and weighs 5.5 pounds.

For better accuracy with a cellular phone, the fax has built-in error correction. It works from a car's cigarette lighter, a rechargeable battery pack, or a wall outlet; list price is $1,695. Contact the company at 5 Dedrick Pl., West Caldwell, NJ 07006; (201) 882-2000; fax (201) 882-2506.

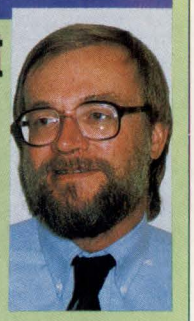
DID YOU KNOW?

... that the investment climate for high-tech start-ups is cooling off. Venture capital investments in high-tech companies dropped to $249 million in the third quarter of last year. That's a 14% decline compared with the $290 million worth of venture-capital investments that were made in the third quarter of 1989.

Technologic Computer Letter

KMET'S KORNER

...Perspectives on Time-to-Market

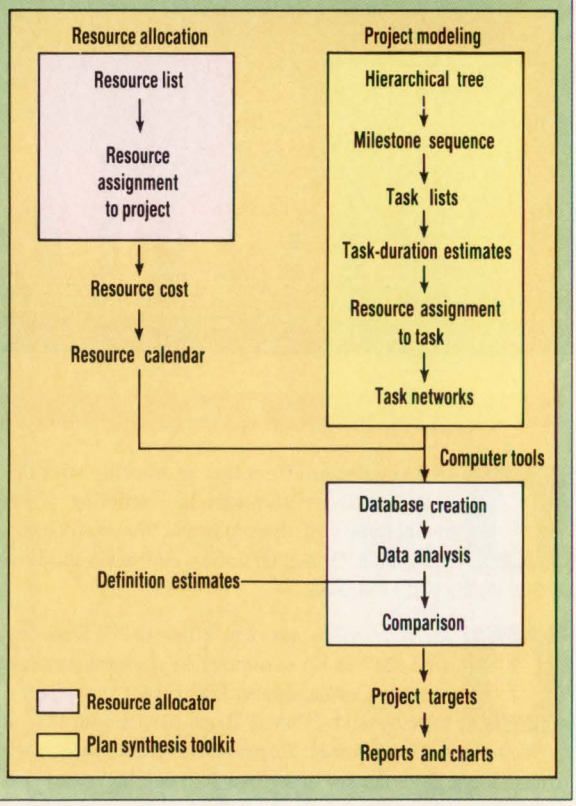


BY RON KMETOVICZ
President, Time to Market Associates Inc.
Cupertino, Calif.; (408) 446-4458

Organizations that don't plan adequately may find themselves in a new-product development situation like the one described in the Jan. 10 column (beginning development without a planning phase). To improve time to market, these companies must change the way they operate. The good news is that most of the techniques and tools needed to make the transition are readily available and can be obtained for relatively low cost.

You need not equip your entire product development team with the latest project management software to produce quality results. Following the process described below produces excellent results quickly and at minimal cost.

The modeling portion of the process works like this: Members of the product development team are sought out for input on their part of the project where they provide information on aspects of the project's hierarchical decomposition, milestone sequence, task list, task-duration estimates, suggested task resource assignments, and task networks. Information must be collected horizontally and vertically throughout the organization—the final network model should be the collection and summation of individual plans with appropriate intragroup and cross-functional linkages built into the model. People can model their work activities using simple manual tools while developing and refining their estimation and network modeling skills. I've found that a calendar, paper, a pen or pencil, and Post-its make an excellent tool kit. Once complete, the results produced by individuals and functional teams are entered onto a computer for integration and analysis.



Hierarchical production of the model builds confidence in the results. And it gives managers and supervisors the opportunity to interact with team members in creating the model's structure and information content.

QUICKLOOK

TIPS ON INVESTING

The new tax legislation recently signed into law by President Bush could affect engineers' investment portfolios as well as their wallets. That legislation eliminated the 33% marginal tax bracket and replaced it with a new 31% federal tax bracket.

Engineers could end up paying taxes at an effective rate even higher than 31%. Certain provisions phase out personal exemptions and reduce itemized deductions for higher income taxpayers. As a result, some engineers in the 33% bracket may not see any tax cut at all. High-income engineers formerly in the 28% bracket may find themselves in the 31% "plus" bracket.

If you are one of the many engineers who face a tax increase next year, municipal bonds should be more attractive to you than ever before. Since almost all municipal bonds are exempt from federal taxation, the prospect of higher federal taxes makes them more practical. As tax rates rise, tax-exempt income becomes more attractive. Similarly, to remain competitive, the yield needed on a taxable investment would have to rise to provide the same after-tax return as a municipal bond.

Consider, for example, an engineer in the new 31% marginal federal income tax bracket. He or she will have to earn 10.14% from a taxable bond to get the same return after taxes as from a tax-free municipal bond yielding 7%.

A municipal bond is simply a promissory note issued by a municipality, state, or local government. The government issues bonds to borrow money for any number of reasons: a new road, a school, sewer line, or courthouse. The promissory note states how long the local government has to repay the loan, the amount to repay and the interest rate for use of the funds.

Besides the increase in federal tax rates, many states have increased their tax rates or may be forced to do so in the future. Generally, municipal bonds issued by the holder's own state are exempt from state and local taxes. Therefore, if you face a high tax rate, consider municipals issued in your home state.

In addition, engineers who do not need the income can choose municipal zero coupon bonds for funding a future investment goal such as a child's education or retirement. The interest income from tax-free municipal zero coupon bonds grows tax-free, allowing a small investment today to benefit from the powerful compounding effect of interest being earned on interest until the bonds mature. Since tax planning is an important consideration in making investment decisions, the engineer should discuss this particular situation with a professional tax adviser. However, the recent tax increase does make municipal bonds more appealing to many taxpayers. If interest rates fall during 1991 this may be the time to lock in high tax-free yields.

If you'd like a free copy of *Municipal Bonds—Now More Than Ever*, a Shearson Lehman Brothers publication, call or write to me at the address below.

Henry Wiesel is financial consultant with Shearson Lehman Brothers, 1040 Broad St., Shrewsbury, NJ 07702; (800) 631-2221 (U. S.) or (800) 221-0073 (N. J.) He is also a qualified pension coordinator. Wiesel invites questions and comments, which should be addressed to him c/o the news editor.

From Integrated Circuit Engineering Corp. comes a chart showing the top 10 merchant semiconductor suppliers in 1990. The Scottsdale, Ariz., company also displays sales figures for four companies close to ranking among the top 10. Intel Corp. has the highest growth rate—20%—which helped propel it from eighth place in 1989 to fifth place in 1990. Intel's growth spurt stems from its sole-sourcing of the 80386 microprocessor, ICE says.

1990 WORLDWIDE TOP TEN MERCHANT SEMICONDUCTOR SUPPLIERS

RANK 1990	RANK 1989	COMPANY	1990 IC SALES ($M)	1990 DISCRETE SALES ($M)	1990 TOTAL SEMI SALES ($M)	1990/1989 PERCENT CHANGE	1990 PERCENT MARKETSHARE
1	1	NEC	4,145	650	4,795	0	8.44
2	2	TOSHIBA	3,570	1,050	4,620	–3	8.13
3	3	HITACHI	3,205	470	3,675	–2	6.47
4	4	MOTOROLA	2,750	840	3,590	8	6.32
5	8	INTEL	2,915	0	2,915	20	5.13
6	7	FUJITSU	2,765	20	2,785	–5	4.90
7	5	TI	2,715	40	2,755	–1	4.85
8	6	MITSUBISHI	2,035	310	2,345	–4	4.13
9	9	MATSUSHITA	1,285	510	1,795	4	3.16
10	10	PHILIPS*	1,175	525	1,700	4	2.99
TOTAL			26,560	4,415	30,975	1	54.50
PERCENT OF WORLDWIDE TOTAL			56%	47%	54%	—	—
CLOSE							
11	11	NATIONAL	1,611	75	1,686	6	2.97
12	14	SGS-THOMSON**	1,175	305	1,480	15	2.60
13	12	SAMSUNG	1,335	65	1,400	8	2.46
14	15	SIEMENS	1,000	390	1,390	17	2.45

* Including Signetics
** Including Inmos

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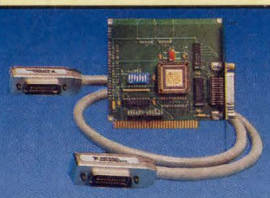
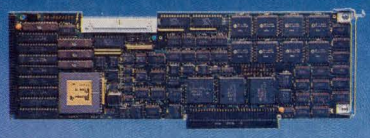
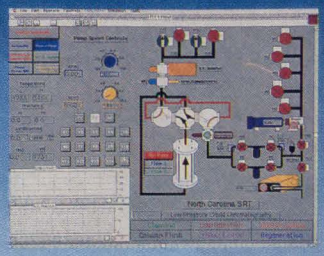
Front Panel Graphical User Interface
Hardcopy Output



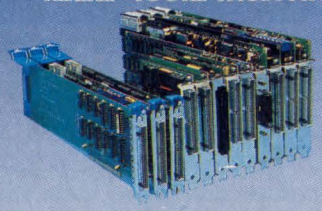
IEEE-488.2 Interfaces



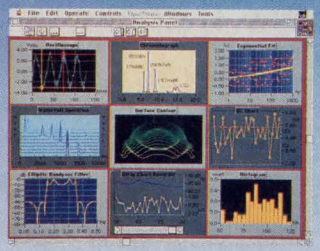
DSP Hardware



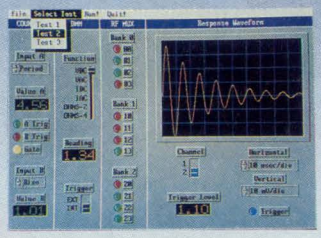
LabVIEW 2
Graphical User Interface



Plug-in Data Acquisition



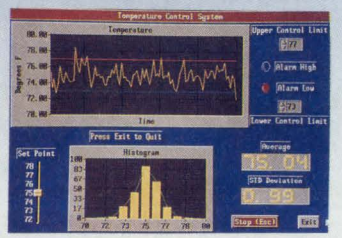
Macintosh Analysis Software



LabWindows 2.0
Graphical User Interface

VXI
Controllers

Software
for RS-232
Instruments



DOS-Based Analysis Software

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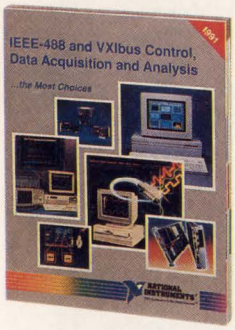

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CIRCLE 117

A SPECIAL EDITORIAL FEATURE

PIPS

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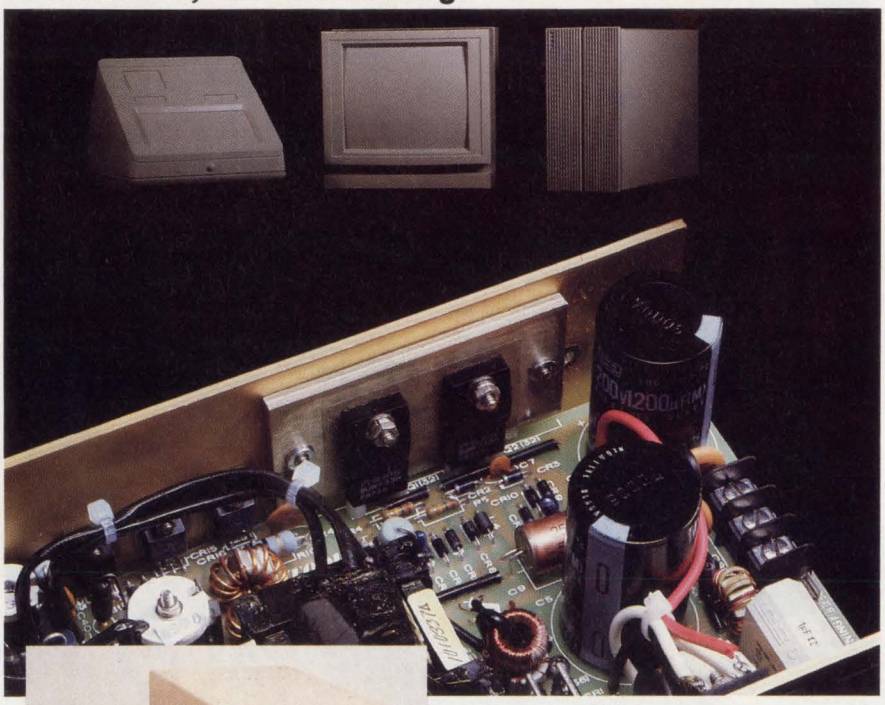

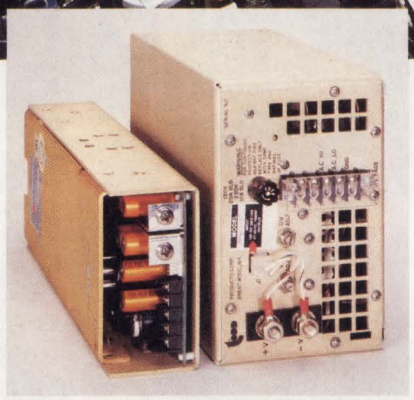

Designed for high-end computer products, TODD's MAX-750 combines a compact size, 13.5" x 5" x 2.6" compared to the typical 5" x 8" x 11" shoebox switcher (see photo insert), and very competitive pricing. OEM product designers can reduce product size with a MAX-750 or build in power supply redundancy, replacing one "shoebox" switcher with two MAX-750's in the same space.

The small package size, high power density of 4 watts/in., high peak current for motor starting, and cooling options, make the MAX-750 the power supply of choice for VMEbus systems, workstations, file servers and mini-computer systems. The switcher provides 120 amps of +5 volts for logic and memory, and features up to three auxiliary outputs providing high efficiency, tightly regulated 12 volts or −5.2 volts at up to 20 amps. Designed for world wide use, the series offers AC power fail, AC autoline select, and meets International Safety standards and Class A RFI requirements of FCC and VDE 0871.

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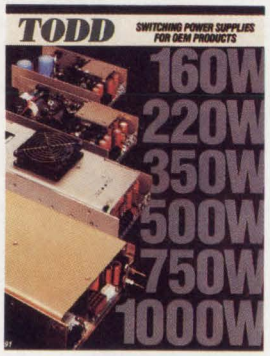
New Products Featured In 1991 TODD Catalog



TODD has just released its 1991 switching power supply catalog of over 100 standard switching power supplies ranging from 150 to 1000 watts, including several new products. Available in single and multiple outputs, ac to dc and dc to dc, these switchers meet a broad range of requirements for telecom, computers, industrial controls and medical electronics applications.

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A User's Guide To Applying Power-Conversion Modules

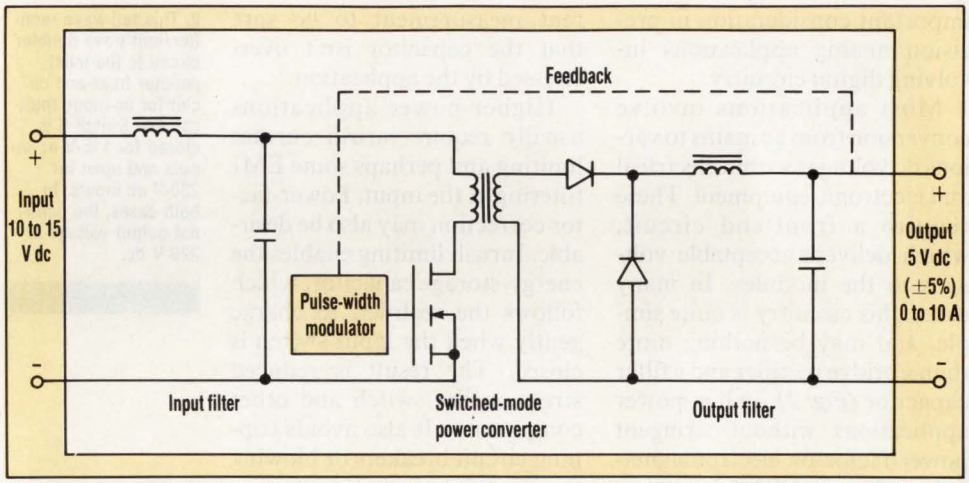
Today's High-Density Modules Call For Some Attention To Design Detail.

BY CHARLES E. MULLETT
Mullett Associates Inc., 5301 Beethoven St., Los Angeles, CA 90066; (213) 306-4075

The effects of present-day power-conversion modules on the electrical- and electronic-product manufacturing industries have been significant and positive. Small, efficient dc-dc converters not only make products more compact, but also drastically reduce the nonrecurring cost and time-to-production elements of system manufacturing.

Product and system manufacturers now have a new way to build a power supply for their products. They can design their own system-power supplies with dc-dc converters and get into production months earlier and for tens of thousands of dollars less than required for a typical custom design.

High-density dc-dc converters are typically less than 0.5 in. tall and have a footprint of about 2.5 by 4.5 in. In this size range, typical power-handling capability is 100 or 200 W, which implies power densities as high as 35 W per cubic inch. Conversion efficiencies are typically above 80%, which is a requirement for reasonable heat management. They are, however, dc-input devices. They can be used within ac-to-dc power supplies, but doing so requires adding at least a rectifier or filter at the input. This reduces the power density, of course, but the overall result still is very good. Higher power (above 200 W) can be achieved by connecting the modules in master-slave configurations or by adding current-sharing circuitry to the design.



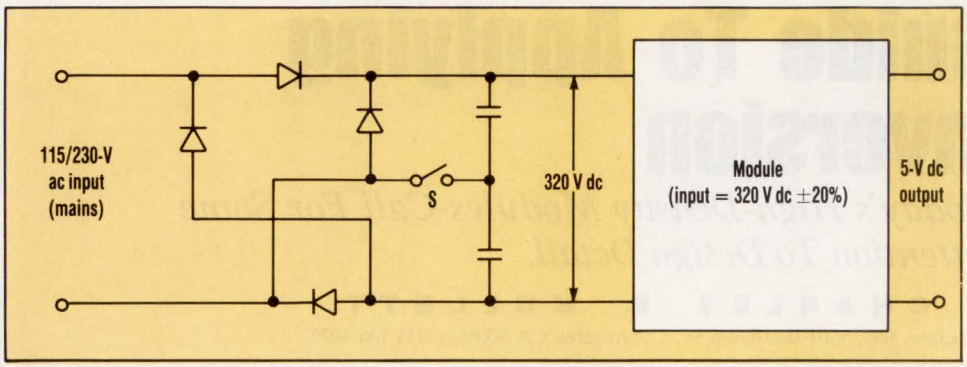
1. The circuitry within the compact power modules consists of a high-frequency dc-dc converter of either the pulse-width-modulated (as shown) or resonant types.

A representative module schematic looks like one of a typical dc-dc converter—which it is *(Fig. 1)*. However, it operates at high frequency (usually over 200 kHz) and is packaged with state-of-the-art techniques to minimize size and optimize thermal performance. The simplest application is a single-output dc-to-dc power supply. In this case, the design task may be nothing more than prescribing a mounting and connection scheme for the module. Most modules will operate without heat sinks at a small fraction of their maximum power limit. To get the most out of these modules, however, a well-designed heat sink is mandatory.

Most OEM power-supply requirements are for multiple outputs. Although most modules are single- or double-output types, they come in many shapes and power levels, which makes them well-suited for multiple-output applications. For example, a triple-output power supply with outputs of 5 V at 10 A, +15 V at 5 A, and −15 V at 10 A would be difficult to find in an off-the-shelf switching power supply. That's because the +15-V output currents are usually small compared to the 5-V current. With modules, one can mix and match the units to fit the requirements of the application and not waste space and cost on capability that's not needed.

An advantage of this approach is that the output capability of the +15-V outputs is independent of the load on the 5-V output. In most triple-output switching power supplies, this isn't the case: The 5-V output must have a minimum load to allow a heavy load on the other outputs.

A further advantage is that the noise and regulation performance of the +15-V outputs can be vastly different from that of the 5-V output if necessary. In addition, there's inherently more isolation (less crosstalk) between the 5-V output and the other outputs. This can be an



2. This full-wave rectifier/half-wave doubler circuit is the most popular front-end circuit for ac-input applications. Switch S is closed for 115-V ac inputs and open for 230-V ac inputs. In both cases, the nominal output voltage is 320 V dc.

important consideration in precision analog applications involving digital circuitry.

Most applications involve conversion from ac mains to various dc voltages within electrical and electronic equipment. These require a front-end circuit, which delivers acceptable voltages to the modules. In many cases, this circuitry is quite simple, and may be nothing more than a bridge rectifier and a filter capacitor *(Fig. 2)*. In low-power applications without stringent power-factor or electromagnetic-interference (EMI) requirements, this may be all that's needed. The design task, then, is in choosing the rectifier and capacitor carefully.

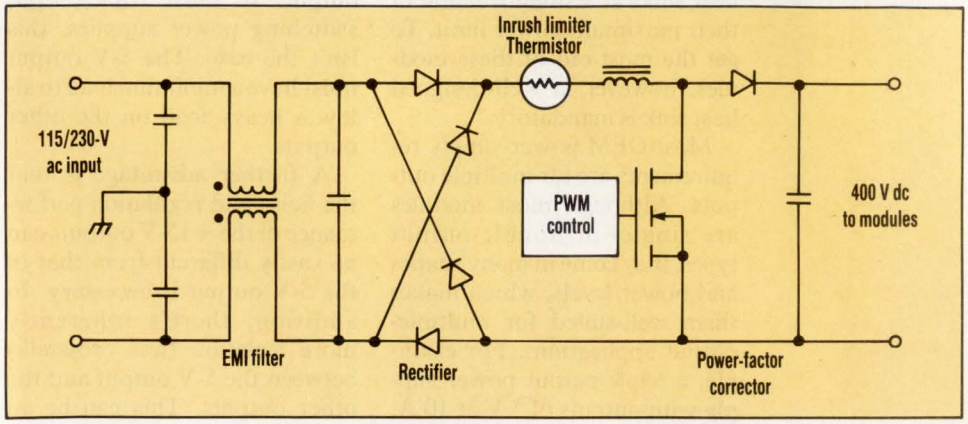
The modules usually have a specified ripple-attenuation characteristic, wherein a given amplitude of ripple at the input will produce a specified amount of ripple at the output. The right input capacitor ensures that the output ripple is acceptable. The capacitor's ripple-current rating must also be checked against predicted or actual ripple-current measurement to be sure that the capacitor isn't overstressed by the application.

Higher-power applications usually require inrush current limiting and perhaps some EMI filtering at the input. Power-factor correction may also be desirable. Inrush limiting enables the energy-storage capacitor, which follows the rectifier, to charge gently when the input switch is closed. The result is reduced stress on the switch and other components. It also avoids tripping circuit breakers or blowing the input fuse.

The primary purpose of the EMI filter is to reduce the amount of high-frequency noise coupled from the switching converter to the mains. Without this filtering, the power converter may cause interference with radios, television sets, and other EMI-sensitive electronic appliances.

Power-factor correction allows more useful power to be drawn from the mains by shaping the input current to match the sinusoidal shape and phase of the input voltage. The power-factor-correction circuit usually supplies wide-range input as a fringe benefit, which permits the unit to operate on mains voltages from 90 to 260 V ac without setting a switch or jumper for the appropriate voltage range *(Fig. 3)*.

3. The input circuit for higher power includes an inrush limiter, EMI filter, and power-factor-correction circuitry. Typical output is 400 V dc.



Systems requiring over several hundred watts are often candidates for distributed power conversion. This is particularly true when the power is mostly at low voltage (implying high current) and the load is spread out over a rack chassis or one or more cabinets.

With distributed power conversion, the power can be conveyed to the loads at higher voltage (and lower current) and then regulated by individual converter modules at the load locations. As a result, each load site receives clean, well-regulated power. Moreover, power distribution at lower current makes the job much easier and less critical.

The most common approach to distributed power conversion with input from the ac mains begins with a simple rectifier and filter to produce a dc bus that feeds the modules. The rectifier is a four-diode bridge, configured as a half-wave doubler for 115-V ac inputs and as a full-wave bridge for 230-V ac inputs *(Fig. 2, again)*. The distribution bus is the natural voltage that appears after the rectifier, which, in both cases, is 320 V dc. This scheme has the advantage of simplicity—only a rectifier is required at the input. Furthermore, the current is relatively low. The disadvantage is that the voltage is dangerously high and may require special insulation for safety's sake.

By adding a step-down converter or ac-to-dc power supply at the input, the bus voltage can be made compatible with a back-up battery *(Fig. 4)*. Here, the battery is charged while the mains voltage is present, and then is switched to the bus when

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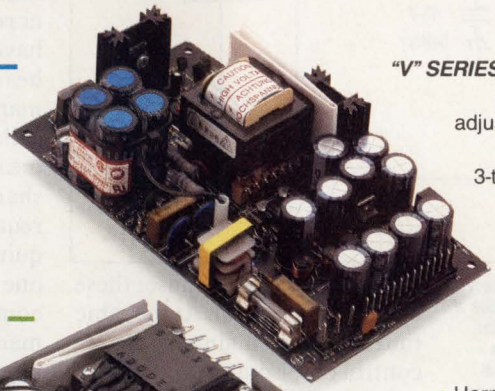

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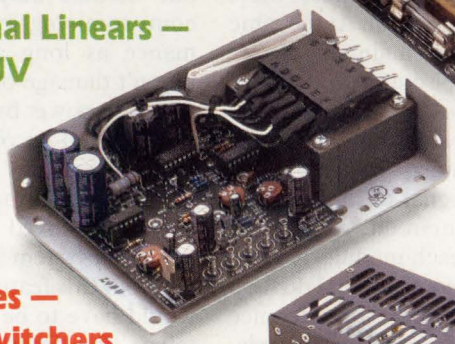

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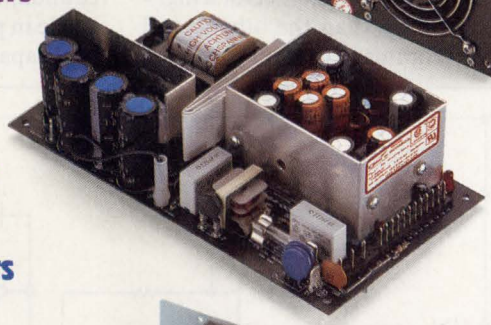

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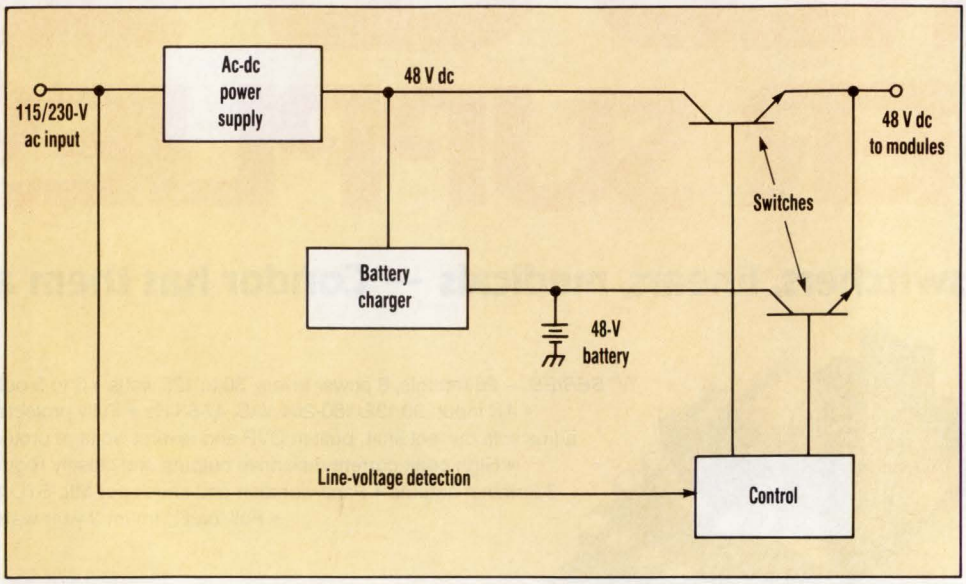


line failure is detected. The switch connecting the battery to the load can be opened before the battery discharges to an unacceptably low level. The switch also allows the charging voltage to rise above the bus voltage to ensure full charge. This type of uninterruptible power supply, known as a dc UPS, is simpler than an ac UPS, which provides an uninterruptible ac input to the system. The dc-UPS technique is very useful in instruments, computers, communication equipment, and so forth.

4. An internal battery-backup scheme uses a step-down converter at the input with a battery charger and control circuitry to engage the battery when the line input fails.

In some cases, the required power exceeds the maximum power available in one module, and yet the demand is concentrated at one location rather than distributed over a chassis or rack. Such applications can be satisfied by adding booster modules, which are connected in parallel with the master module. Other connections between the modules pass synchronization and regulation signals from the master to the slaves. Boosting can also be provided by paralleling two or more identical modules.

Current sharing, however, isn't automatic in most cases. Either the modules must have this feature built in (most don't), or it must be added outside the modules. Current-sharing circuitry must monitor the current from each module and cause these currents to be equal. At the same time, it must maintain proper control of the output voltage.

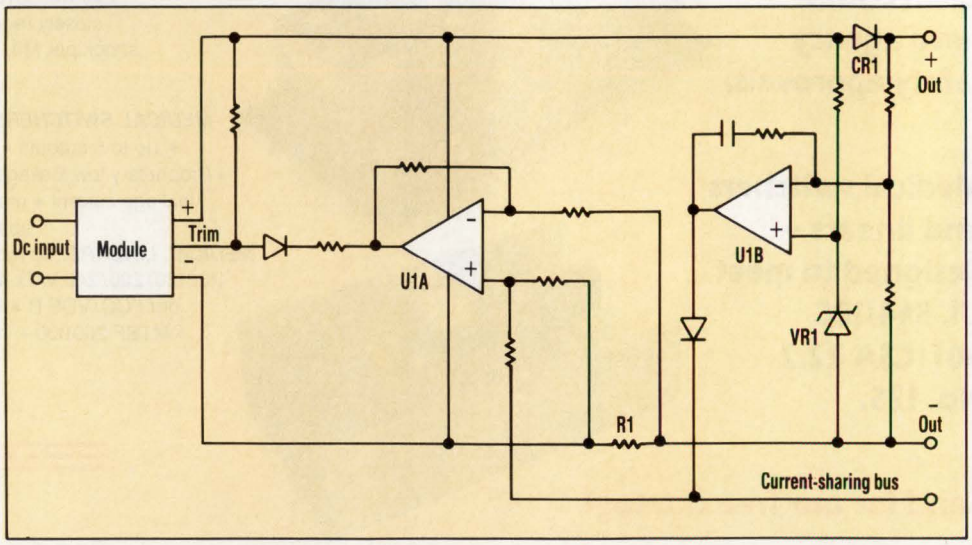
In one possible current-sharing scheme, each module's output is "trimmed" by applying an adjusting signal to the trim pin *(Fig. 5)*. The circuit, which is appended to each module, is comprised of a conventional dual op amp (U1), a precision reference (VR1), a current-sensing resistor (R1), and an optional isolation diode (CR1). Typically, a group of these circuits is placed in parallel. Among them, one will have its reference and voltage-sensing circuit set for a higher voltage than the others, and will command the voltage on the current-sharing bus. This, in turn, equalizes the current in each module by demanding that the same voltage appear across all of the sensing resistors. Consequently, the currents will match within the tolerance of the resistors.

There's growing interest in systems that tolerate internal failures and continue to function normally. Such systems must have a power system at their heart that performs in the same manner. The usual approach is called n+1 redundancy, which means there are n+1 modules sharing the load (n is the number required to satisfy the load requirement). In such a scheme, one module may fail without compromising system performance as long as the failure doesn't damage or overload the common power bus.

A natural accompaniment of n+1 redundancy is "hot swapping," which means modules can be removed and replaced while the system is powered up. Without this feature, the system would have to be shut down to repair the fault. That would compromise the spirit of the fault-tolerant feature.

Although hot swapping is conceptually simple and would seem to be inherent in an n+1 redundant system, it's not so simple in practice. One reason is that capacitors appear at the

5. This current-sharing circuit converts a common dc-dc converter module to one which will share current equally with others. The voltage at the current-sharing bus commands the output current, which is sensed by R1.



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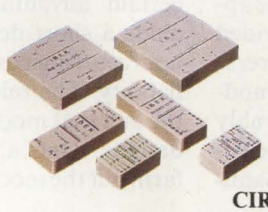

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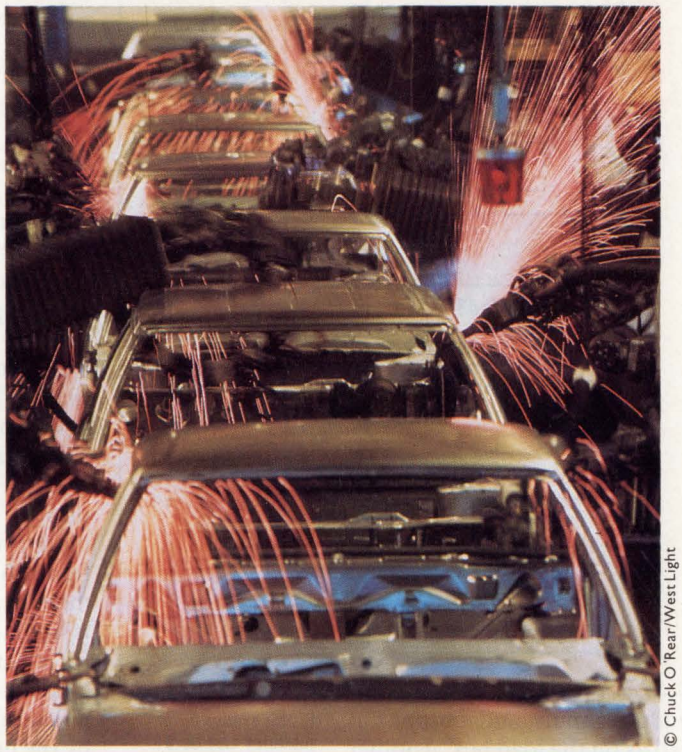

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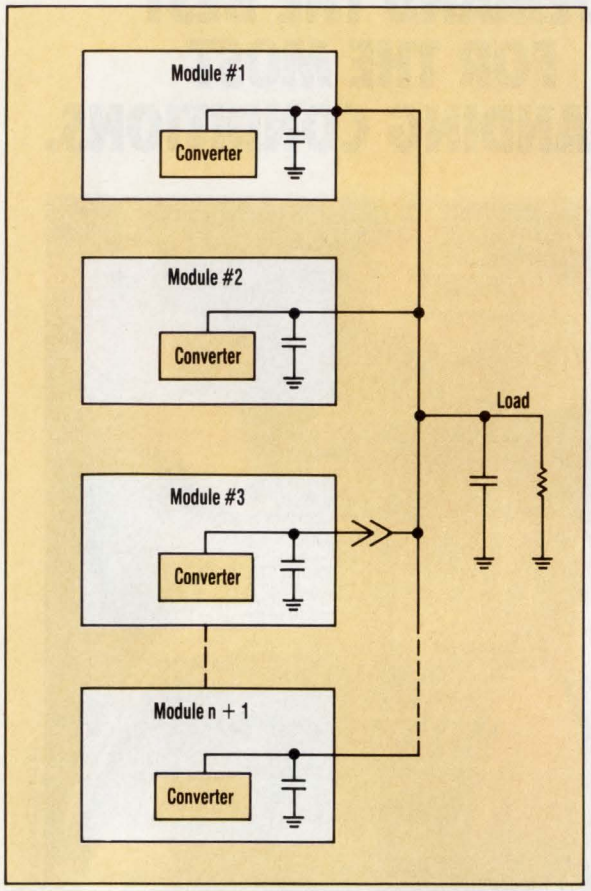


6. Hot-swapping of modules can be a problem if one module's capacitance isn't small compared to the total capacitance. As the module is inserted, it may cause a transient on the load bus.

module inputs and outputs as well as on the load bus. Another is that the control loops must gracefully survive the transient that occurs when the replacement module is installed.

The problem can be illustrated simply *(Fig. 6)*. Before module number 3 is installed, its output capacitor is discharged. All other capacitors on the bus are charged to the bus voltage. When the capacitor of module 3 contacts the bus, a huge transient current flows into it and a voltage transient occurs on the bus. If the modules are few and the module capacitance is comparable to the load capacitance, this transient can be large enough to upset all of the logic circuits served by the bus.

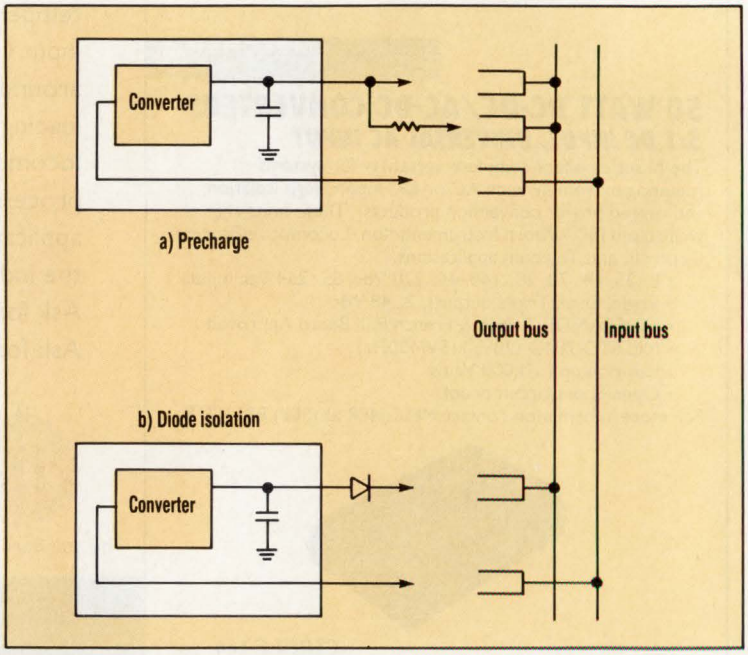
Obviously, this is a serious problem, but there are two possible solutions. One is to precharge the output capacitor of module 3 as it is inserted *(Fig. 7a)*. The other is to place a diode in series with each module output *(Fig. 7b)*. The latter approach has the disadvantage of power loss in the diode (with its attendant heat dissipation) and the advantage of isolating any faults at the failed module's output.

For example, if the output capacitor in a module fails as a short circuit, the diode prevents it from pulling down the power bus and interfering with system operation. After the module is inserted, the converter circuit turns on and the output rises smoothly according to its soft-start circuitry, perhaps as a 100-ms ramp up to the output-bus voltage. If the ramp rises slowly compared to the loop-response time of the other modules, the new module will not upset the bus voltage.

Heat generated by the modules is typically removed by mounting them to a cold plate or finned heat sink that's cooled by moving air. The design problem is similar to choosing a heat sink for a semiconductor. Excellent guidelines are supplied in the application information provided by the heat-sink manufacturers.

The economy of power modules has improved considerably because of higher power densities and new automated manufacturing techniques. Putting more power capability into a small package reduces the overhead costs per watt. For example, housing cost for today's 200-W modules is comparable to that of a 10- or 20-W module in the past. Packing and shipping costs follow the same example. Because the circuit complexity of a 200-W module compares to that of the smaller modules, assembly costs are much less on a per-watt basis. The result is that new-generation modules significantly reduce cost in terms of dollars per watt. Present pricing for production quantities is in the area of $0.50 per watt, compared to $1 to $2 and more per watt in the past.

The new modules, then, are more economical than earlier generations. But how do they stack up with other alternatives? This depends on several considerations, some that are intangible or at least difficult to measure. Designing and building the power supply with modules has certain advantages. These include a short design cycle, low nonrecurring costs, and high reliability. The reliability owes to the fact that modules are mature designs. One alternative is to farm out the modular design and



7. Two solutions to the load transient problem are shown here: In one, a two-stage connector connects a charging circuit to the output bus (a). In the second, using an isolation diode eliminates the need for the charging network, but the diode may require an additional heat sink (b).

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A Look Back At A Company Built On Looking Ahead.

The first Philips carbon-filament lamp still burns symbolically today, inspiring us in the fundamental research that leads to better products.

What a century! It started in 1891 with a young Dutch engineer deciding to produce incandescent lamps. Gerard Philips couldn't have dreamed that his tiny factory staffed with 10 would grow into a giant—the 22nd largest industrial corporation in the world.

He believed in the power of research. In 1908, he created a chemistry laboratory to help solve production issues with all types of lamps. Then six years later, he helped establish the Philips Physics Laboratory, which still today provides a broad range of research.

When suppliers proved unreliable during World War I, Philips opened its own plants to produce glass, hydrogen gas and cardboard. While others responded to the Depression by cutting back on research, Philips moved ahead with breakthroughs in gas-discharge lamps, X-ray equipment, gramophones, car radios, telecommunications equipment, welding rods and electric shavers.

Even vast destruction during World War II couldn't stop the momentum. Factories were rebuilt and production again reached pre-war levels by 1946.

After the war, science and technology made great advancements. Philips R&D laboratories contributed significantly with the invention of new magnetic materials that were used on a large scale. The knowledge obtained from this research formed the basis of later work on transistors, integrated circuits and charged coupled devices.

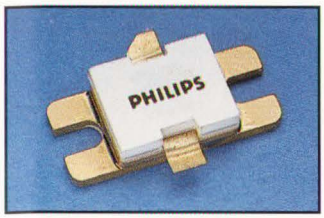
In recent years, Philips' work on lasers and microelectronics has achieved great advances in processing, storage and transmission of images, sound and data. Among the developments are the compact disc, LaserVision optical disc and new optical telecommunications systems.

Today in North America, Philips Components Discrete Products Division supplies the marketplace with thousands of quality electronic products. Passive components such as resistors, capacitors and trimmers. Discrete semiconductors including power, surface mount, MOSFET and small signal devices. Ferrite cores, beads, chokes, recording heads and other specialty products. And professional components such as camera tubes, photomultipliers and image intensifiers.

Our century-long spirit of innovation continues. Use the attached reply card to learn more about our products.

On front: Gerard Philips testing carbon filaments for lamps in 1890.

Microwave Transistor Offers Highest Output Power.



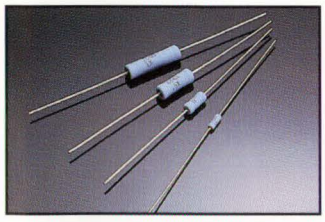
Philips' new PXB16050U microwave CW transistor provides the highest available output yet. Ideal for use in satellite links in INMARSAT and similar systems, the new transistor features input and output prematching circuits that simplify external circuit design and more evenly distribute power over its total active area. The result: no hot spots.

With its NPN silicon planar epitaxial design, the PXB16050U is geared for peak performance in common-base Class C narrow band amplifiers. Use it for voice and data communications on ships, aircraft and ground-based systems.

It provides 50W continuous wave power at 1.6GHz while operating from a 28V supply. Typical power gain is 9.5dB. Collector efficiency is as high as 52% with a low thermal resistance of 1.5K/W.

Gold metallization helps assure stability and extend device life, while use of diffused emitter ballasting resistors improve ruggedness and ensure excellent current sharing. Spec sheets available; delivery is 10 weeks ARO.

PPR5000 Film Resistors: Uncommon Stability, Power Handling.



Now you can specify a precision power film resistor with the stability and power handling ability you thought only wirewounds offered.

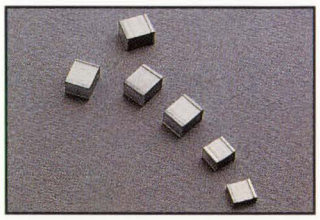
Replace your precision wirewound resistors with the new PPR5000 Series film resistors from Philips.

These resistors achieve the typically low inductance and reliability of metal film resistors and the power handling and stability of wirewounds—while maintaining comparably smaller size

In power handling, the new series ranges from 1, 2, 3 and 5 watts at 25 °C with temperature coefficients to ±20 PPM. Tolerance levels are ±.05% to ±1% and maximum voltage ranges from 160 V at 1 watt to 500 V at 5 watts.

Ask for the PPR5000 resistors in bulk or on tape and reel. Delivery is 6 to 14 weeks.

Surface Mount Film Capacitors Keep Cost And Size Small.



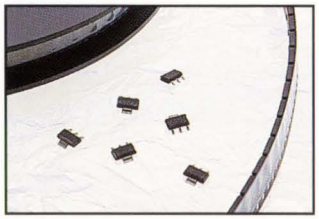
Thinking of ways to do away with encapsulation and shrink dimensions even more? Philips' new surface mount metallized film capacitors are what you need.

Made of high-temperature resistance dielectric polyphenylene sulphide (PPS) film in stacked construction, they're among the smallest capacitors on the market today. Three case sizes are available.

These new film capacitors feature solder-coated copper end-terminals to improve their solderability. They're ideal for all soldering processes—including wave soldering. Among other features: stability with temperature, voltage and frequency, high insulation resistance, low tan ESL/ESR, an open-circuit failure mode and high reliability.

Rated voltage is 25V DC with capacitance tolerances of ±5 and ±10%. Capacitors are available in blister tape on reel or in bulk.

First Schottky Rectifier In SOT-223 SMD® Package.



Philips has introduced the world's first Schottky power rectifiers in an industry-standard SOT-223 surface mount package.

PBYR235CT, PBYR240CT and **PBYR245CT** feature a center-tapped pair of Schottky diodes. Each is capable of delivering an average output current of 1A and is perfectly matched through single monolithic substrate fabrication.

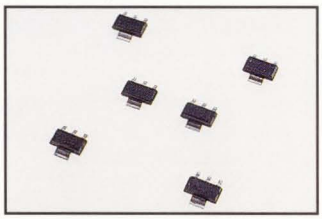
To assure highly efficient operation, the new rectifiers' forward voltage drop is less than 0.45V at a current of 1A. Leakage current at the diodes' maximum continuous reverse voltage is less than 100 μA.

Key features of the Schottky series include small size—just 6.5 x 3.5 x 1.8mm—a 2A current rating and surface mount capability.

The series offers reverse voltage ratings of 35, 40 and 45 volts that make it especially suited for low-voltage switch mode power supply applications such as 5V/2A units.

They're available on standard 12mm tape for SMD pick and place equipment. Samples and data sheets available. Production quantities delivered from 6 to 8 weeks ARO.

SOT-223 SMD® Package: Another Design First.



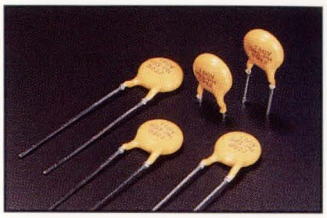
Few things have advanced medium-power surface mount design flexibility as much as Philips' introduction of its SOT-223 package.

A one-watt discrete semiconductor package when mounted on FR4 PCB, the SOT-223 allows you to achieve higher power dissipations and maximize board space without relying on conventional through-hole components. The new package dissipates 1 to 2 watts, and board mounting is possible with either reflow or wave soldering.

The SOT-223 is designed with flexibility of application in mind. The package can accommodate bipolar transistors, small signal MOSFETs, Schottky diodes, rectifier diodes, power MOSFETs, wide band/RF transistors, triacs and thyristors.

The surface mount package is especially suited to all applications where circuit board space is severely limited and power dissipations approaching 1W are required.

Flanged Varistors Improve Solderability.



An exclusive flanged design is key to the improved solderability of a new series of Philips zinc oxide disc varistors.

The new design also makes component insertion easier.

Available in 5mm and 7mm diameters, the new flanged varistors further expand Philips' line of straight-lead and kinked-lead devices.

By defining the mounting height of the varistor, the flanged lead minimizes stress on the component from automatic insertion equipment. The flange also improves solderability by allowing flux to escape through the PCB holes during soldering.

The new varistors offer maximum AC voltage ratings from 14V to 460V; maximum DC voltages from 18V to 615V. With maximum nonrepetitive transient current ratings from 100A to 1200A, and transient response times of less than 20 nsec.

Use them to suppress voltage transients in telecommunications, data processing, consumer and automotive electronics applications. They're available in bulk or tape and reel. Delivery 6-12 weeks.

Plumbicon® Camera Tube Geared To Medical, Industrial Use.

DETACH HERE

Medical X-ray imaging, military and industrial vision systems will get a boost from the new very high resolution Plumbicon camera tube.

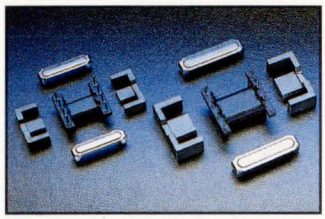
High spatial resolution, improved contrast resolution and enhanced S/N are among the advantages of Philips' Type 88XQ tube.

Electrostatic deflection reduces both the tube's length and overall "in-coil" diameters, making it an ideal fit for compact cameras. Its conical shape helps reduce operation scanning voltage. And because of the electrostatic deflection, corner and center resolution are better than that offered by magnetic deflection tubes.

The 88XQ is especially suited for medical imaging. It offers the highest modulation depth of all lead oxide tubes, resolving more than 2500 TV lines in the center and more than 1600 in the corner. Short response time is another advantage. And the camera tube's lag is tunable, a major design benefit for such dynamic applications as cardiac study.

Other 88XQ features: a low output capacitance (LOC) window, and a diode gun capable of handling 4 μA of peak signal with minimal loss of resolution and deterioration of lag characteristics.

Flat E-Cores Reduce Height In Transformers.



Making use of low-loss 3F3 material, Philips is introducing a series of flat E-cores designed to cut the height of transformers in DC/DC power modules.

The EFD (Economic Flat Design) cores come in four types:

- 15/8/5 for board areas 15 x 15mm and 500kHz operation
- 20/10/7 for board areas 20 x 20mm and 300kHz operation
- 25/13/9 for board areas 25 x 25mm and 100kHz operation
- 30/15/9 for board areas 30 x 30mm and 100kHz operation

All the new flat cores can be operated at up to 1MHz and can be used in transformers with power throughput densities as high as 20W/cm. That's possible because of the cores' high-frequency ferrite materials and computer-aided design.

EFD cores come with matching bobbins and clips suitable for automated production lines. Sample cores—with bobbins and clips—are now available from Philips.

SMD® Tantalum Chips Offer Extended Capacitance.

Philips is introducing a new line of conformally coated tantalum chip capacitors for use in high-reliability and medical applications.

The 49EC Series capacitors offer high capacitance density with low ESR values at 100 kHz and low DC leakage current. They're designed for operation from −55 °C to +85 °C with rated DC voltage applied. AT 67% of rated voltage, the temperature range can be extended to +125 °C.

The new capacitors, though non-military, are pad-compatible and interchangeable with established MIL-C-55365/4 CWR06 conformally coated and CWR09 molded tantalum chips.

Depending on the voltage rating, 49EC chips offer two to three times the capacitance values of CWR06 and CWR09 products in the same case size. Rated DC voltages of 4, 6, 10, 15, 20, 25 and 35 volts are available in each of eight case sizes. These sizes are identical to those of CWR06 devices. Gold-plated or hot solder-dipped terminals are available. Standard capacitance tolerances include ±20%, ±10% and ±5%. Delivery is 12 to 14 weeks ARO.

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build the supply in-house. Nonrecurring costs may be lower in this instance if the outside resource is more experienced with the technology.

Yet another option is to design and build the power supply with discrete components. This option depends heavily on in-house design and production, and has potentially the longest design cycle. In its favor as a strategy, though, is that it can be less costly for volume production. A third alternative is to purchase a semicustom power supply from a vendor. In this case, users are totally dependent on vendor ability, which can be an excellent, trouble-free situation with the right vendor. It probably involves an intermediate time-to-production delay. One drawback is that in most cases, the customer doesn't own the design.

Thanks to lower assembly costs, today's power modules significantly cut costs in terms of dollars per watt.

The bottom line is that each case must be evaluated in its own context. For example, it's likely that the module approach has the shortest design cycle. If the power supply is the critical-path item in a very time-sensitive new product, this advantage may overshadow all other considerations. In another case, with time less critical and considerable in-house power-supply design and manufacturing resources, the design-from-scratch approach may be best. Finally, it may make sense to use a "hybrid" approach that mixes the aforementioned alternatives. Sometimes, the optimum power system will include standard and custom power supplies, modules, and a portion of in-house designed circuitry. Choosing properly among these alternatives will result in the maximum overall benefit.

In conclusion, the new power-conversion modules expand the range of choices in power system design. They can reduce the risk of new designs and shorten the design cycle. Multiple vendors offer security in future production, and continue to invest in product improvement to the ultimate benefit of the OEM customers.

Charles E. Mullett, president of Mullett Associates Inc., Los Angeles, holds BSEE and MSEE degrees from the Univ. of Illinois and is a registered professional engineer in California.

HOW VALUABLE?

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MODERATELY	CIRCLE 542
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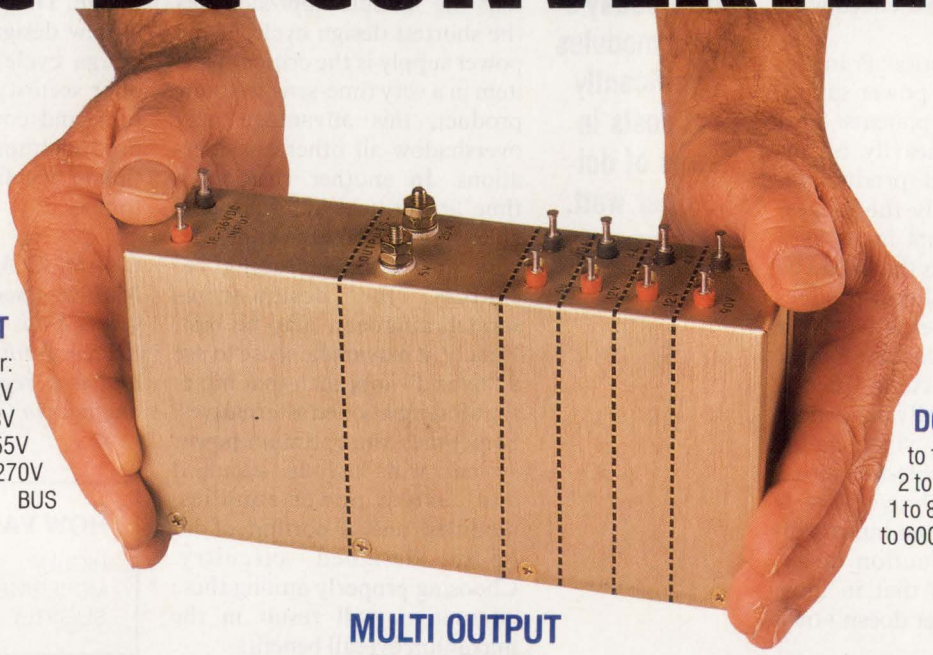

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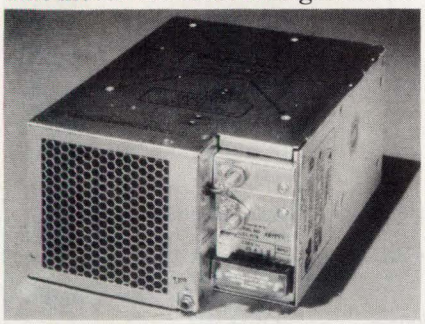
Built-in >0.99 power-factor correction and 1500 W of output power are features of the Model PM2541A switching supply. The single-output unit meets the most stringent international safety and EMI standards, including IEC 555-2. That standard places limits on line-current harmonic content for supplies rated higher than 300 W. Because it effectively eliminates third-harmonic currents, the switcher is well-suited for installations where neutral wire current exceeds recommended values due to waveform distortion caused by typical off-line units. Pricing starts at $1350 in single quantities. Delivery is from stock.



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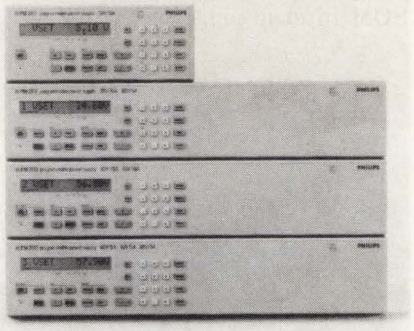

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(continued on p. 84)

KEY

Power Supplies

Output

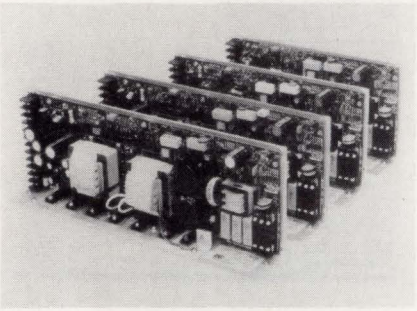
(50S)	To 50 V
(51S)	51 to 500 V
(500S)	Over 500 V
(10S)	To 10 W
(11S)	11 to 200 W
(200S)	Over 200 W

Types

(LA)	Laboratory
(RM)	Rack mounting
(OF)	Open-frame OEM
(CV)	Constant voltage/current
(PR)	Precision ac output
(RP)	Remote programming
(MD)	Military designs

▼ BIPOLAR 50-KHZ SWITCHERS MEET SAFETY SPECS

The latest international requirements for safety isolation and EMI/RFI specifications are met by the SQM International Series of 50-kHz

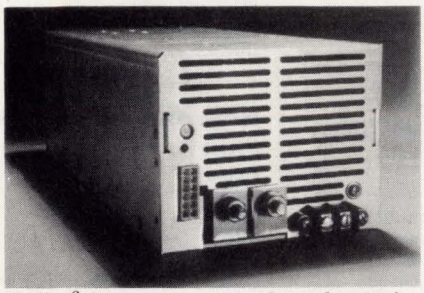


open-frame switchers. The series includes models with outputs from 150 to 350 W of continuous output power. All units feature higher peak-power ratings to accommodate initial power-up loads for peripherals such as disk and tape drives. Pricing ranges from $266 to $358 in single quantities. Delivery is from stock to two weeks for small lots.

Switching Systems International
500 Porter Way
Placentia, CA 92670
(714) 996-0909
▶ CIRCLE 730

▼ AUTORANGING SWITCHERS DELIVER 5 W/IN.^{3}

A worldwide input range, modular adjustable auxiliaries, an optional dc input, and current sharing are featured in the R Series switching power supplies. The 1000-W units use 100-kHz MOSFETs to deliver up to 5



W/in.^{3} in a compact 5-by-4-by-10-in. package. Autoranging circuitry enables the supplies to operate worldwide without need for a switch or jumper for setting the input. Call for pricing and delivery.

Unipower Corp.
2981 Gateway Dr.
Pompano Beach, FL 33069
(305) 974-2442
▶ CIRCLE 731

POWER-SUPPLY MANUFACTURERS

Deltron Inc.
290 Wissahickon Ave.
North Wales, PA 19454
(215) 699-9261
(50S) (11S) (200S) (RM) (OF)
CIRCLE 329

EG&G Power Systems
1330 E. Cypress St.
Covina, CA 92635
(818) 967-9521
(50S) (51S) (11S) (200S) (MD)
CIRCLE 330

EMCO High Voltage Co.
11126 Ridge Rd.
Sutter Creek, CA 95685
(209) 223-3626
(50S) (51S) (500S) (10S) (11S) (LA) (RM) (OF) (CV) (RP) (MD)
CIRCLE 331

EPSCO Inc.
1020 W. Fullerton Ave., Suite D
Addison, IL 60101
(708) 543-0410
(50S) (51S) (LA) (RM)
CIRCLE 332

Electroid Co.
45 Fadem Rd.
Springfield, NJ 07081
(201) 467-8100
(51S) (11S) (CV)
CIRCLE 333

Electronic Measurements Inc.
405 Essex Rd.
Neptune, NJ 07753
(201) 922-9300
(50S) (51S) (500S) (200S) (LA) (RM) (OF) (CV) (RP)
CIRCLE 334

Elenco Electronics Inc.
150 W. Carpenter St.
Wheeling, IL 60090
(708) 541-3800
(50S) (LA) (CV)
CIRCLE 335

Elpac Power Systems
3131 S. Standard Ave.
Santa Ana, CA 92714
(714) 979-4440
(50S) (10S) (11S) (OF)
CIRCLE 336

Entran Devices Inc.
10 Washington Ave.
Fairfield, NJ 07004
(201) 227-1002
(50S) (LA) (RM) (CV)
CIRCLE 337

Ericsson Components Inc. Power Products
403 International Pkwy. #500
Richardson, TX 75081
(214) 997-6561
(50S) (10S) (11S) (200S) (RM) (OF) (CV)
CIRCLE 338

Fiskars Electronics Corp.
P.O. Box 1490, Newton Rd.
Littleton, MA 01460
(508) 486-9551
(51S) (200S) (LA) (RM) (CV) (PR) (MD)
CIRCLE 339

Gamma High Voltage Research
1096 N. U.S. Hwy. #1
Ormond Beach, FL 32174
(904) 677-7070
(51S) (500S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (RP) (MD)
CIRCLE 340

Georator Corp.
9617 Center St.
Manassas, VA 22110
(800) 523-9938
(200S) (OF) (PR) (MD)
CIRCLE 341

Glassman High Voltage
P.O. Box 551, Route 22
Whitehouse Station, NJ 08889
(908) 534-9007
(500S) (11S) (LA) (RM) (CV) (RP)
CIRCLE 342

HC Power Inc.
17032 Armstrong Ave.
Irvine, CA 92705
(714) 261-2200
(50S) (200S) (RM) (CV)
CIRCLE 343

Hewlett-Packard Co. Power Supplies
19310 Pruneridge Ave.
Cupertino, CA 95014
(800) 752-0900
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (CV) (RP)
CIRCLE 344

IMC Magnetics Corp. Florida Div.
14025 N.W. 60th Ave.
Miami Lakes, FL 33014
(305) 822-2558
(51S) (500S) (RM) (OF) (CV)
CIRCLE 345

Integrated Power Designs
9C Princess Rd.
Lawrenceville, NJ 08648
(609) 896-2122
(50S) (11S) (200S) (OF) (CV)
CIRCLE 346

International Power DC
373 Dawson Dr.
Camarillo, CA 93012
(805) 987-7900
(11S) (OF)
CIRCLE 347

International Power Sources
200 Butterfield Dr.
Ashland, MA 01721
(508) 881-7434
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (OF)
CIRCLE 348

Intronics Inc.
150 Dan Rd.
Canton, MA 02021
(617) 828-4992
(LA) (RM) (OF) (CV)
CIRCLE 349

Jerome Industries
730 Division St.
Elizabeth, NJ 07201
(201) 353-5700
(50S) (10S) (11S) (CV)
CIRCLE 350

John Fluke Mfg. Co. Philips T & M Group
P.O. Box 9090
Everett, WA 98206
(206) 356-6157
(50S) (51S) (11S) (LA) (RM) (CV) (RP)
CIRCLE 351

Joule Power Inc.
Summer Rd.
Boxborough, MA 01719
(508) 263-9712
(50S) (11S) (200S) (OF) (RP)
CIRCLE 352

Kaiser Systems Inc.
126 Sohier Rd.
Beverly, MA 01915
(508) 922-9300
(500S) (200S) (LA) (RM) (CV) (RP)
CIRCLE 353

Keltec Florida
P.O. Box 2917
Fort Walton Beach, FL 32549
(904) 244-0043
(50S) (51S) (500S) (10S) (11S) (200S) (MD)
CIRCLE 354

Kepco Inc.
131-38 Sanford Ave.
Flushing, NY 11352
(718) 461-7000
(50S) (51S) (500S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (PR) (RP)
CIRCLE 355

LZR Electronics Inc.
8051 Cessna Ave.
Gaithersburg, MD 20879
(301) 921-9440
(50S) (51S) (10S) (11S) (LA) (OF) (CV) (PR)
CIRCLE 356

(continued on p. 87)

KEY

Power Supplies

Output

(50S)	To 50 V
(51S)	51 to 500 V
(500S)	Over 500 V
(10S)	To 10 W
(11S)	11 to 200 W
(200S)	Over 200 W

Types

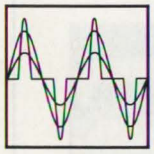
(LA)	Laboratory
(RM)	Rack mounting
(OF)	Open-frame OEM
(CV)	Constant voltage/current
(PR)	Precision ac output
(RP)	Remote programming
(MD)	Military designs

Should you use power factor correction in your 400W–2,500W power supplies?

Phone for this free report.

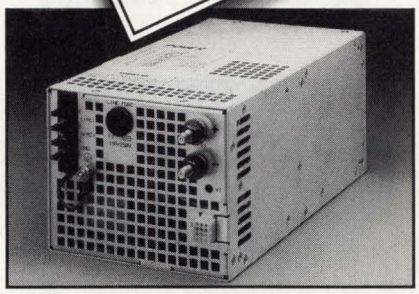
Now it's easy for you to evaluate the benefits of power factor correction. Phone to reserve your copy of this exclusive report and discover:

- ✔ The systems most prone to low power factor, with a graphical example of how the problem occurs.
- ✔ How to quickly determine whether power factor correction is appropriate for your applications.
- ✔ How to get 30% more power out of any standard wall socket—and meet UL's spec requiring that equipment plugged into a 15A outlet draw no more than 12A.
- ✔ The most cost-effective way to eliminate potential safety hazards from harmonic distortion.



With power factor correction, the input current is virtually sinusoidal.

- ✔ An update on the IEC 555.2 harmonic distortion spec.
- ✔ The critical advantages of an active over a passive power factor correction scheme.
- ✔ Special benefits of power factor correction for companies that operate sensitive equipment on an A/C line.
- ✔ Tips on selecting converter topology to ensure maximum efficiency and reliability in a power factor corrected supply.
- ✔ How to use the same supply anywhere in the world without modification.
- ✔ How to use power factor correction as a marketing tool for your products.



Power Components makes 250W–2,500W switching power supplies with and without power factor correction.

Specialists in power factor correction.

We're Power Components, makers of high performance switching power supplies in the 250W–2,500W range—and a leader in power factor correction. We were among the first to produce a 1,000W power supply with .998 power factor.

Power factor corrected supplies from Power Components meet UL, CSA, VDE and FCC standards, and IEC 555.2 harmonic requirements.

MTBF exceeds 200,000 hours.*

Power Components' power factor corrected supplies have a MTBF of more than 200,000 hours (using Mil-217E standards).

A statistical process control system with 20 measurement points ensures consistent quality. Our QA system follows Mil-I-45208 and ESD standards.

For exceptional reliability, a half-bridge power converter is used to reduce the transformer's operating temperature and minimize thermal stress.

Power supplies are inspected and tested repeatedly. Each supply is burned-in at 50°C at full load while being cycled "on" and "off." You get a printout of final test results with each supply.

Get power factor corrected supplies for about the same price as many standard supplies.

Power Components uses a modular, conservative design approach. You don't pay extra for features you don't need.

And since manufacturing takes place in our low-cost facility in Mexicali, Mexico, a major savings is passed on to you.

The result? Power factor corrected supplies from Power Components—with exactly the features you need—cost about the same as many standard supplies from other makers.

For your free report or more information, phone:

1·800·828·7289

Extension 100

*Single output supply. (All other Power Components' supplies contain a minimum MTBF of 160,000 hours.)

The Power Factor Correction Specialists

POWER COMPONENTS

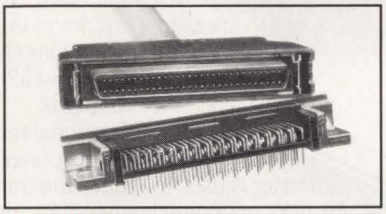
Subsidiary of Vanguard Electronics Co., Inc.

15th Anniversary

1480 West 178th Street, Gardena, CA 90248 213·323·8120 (fax) 213·329·8427

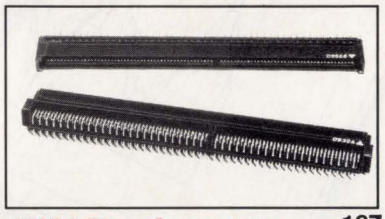
CIRCLE 136

You need 'em. We got 'em. Let's talk connectors.



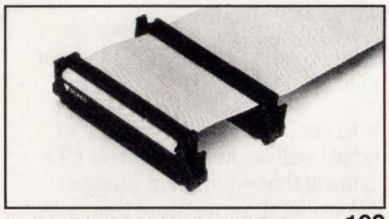
.050" I/O Connectors 177

- 20-100 position
- EMI/RFI shielding
- Discrete wire IDC



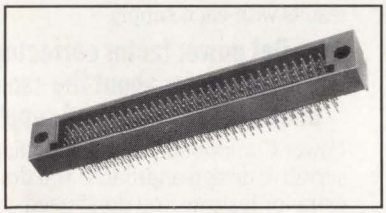
.050" 2-Piece Connectors 187

- 20-200 position
- Horizontal, vertical or parallel mating



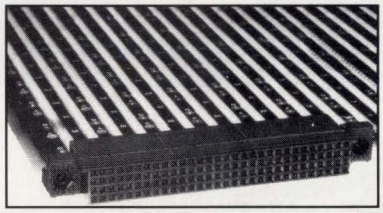
Daisy Chainable .050" IDC 188

- 20-100 positions
- Utilize .025" cable
- Integrated latch/ejection mechanism



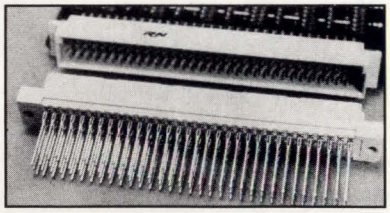
High Density Connectors 189

- Male & female options
- Extended ground contacts for "hot board replacement"
- 3 & 4 rows up to 488 positions



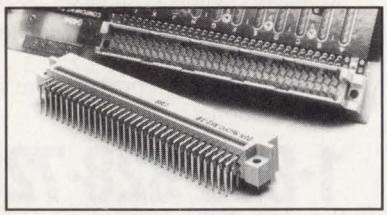
Industry Standard 190

- Low 2 oz/pin insertion force
- Dual beam BeCu contact provides .100" wipe
- Rigid solder tails ease board assembly



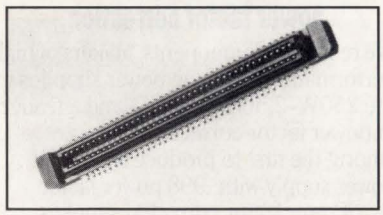
Expanded DIN Sizes 191

- 48, 64, 96, 100, 120 & 150 positions
- Pressfit and solder options
- "Better than Gold" ROBEX® plating



High Temp IR Compatible DIN 192

- Extended ground contacts for "hot board replacement"
- Integral retention clips ease board assembly
- .028" rounded solder tail allows additional traces between pins



.050" Board Stacking 193

- Low profile 7-12 mm
- High temp and SMT options
- 20-120 position

The Call is on Us.

800-338-8152

Robinson Nugent

P.O. Box 1208 • New Albany, IN 47150-1208 • 800/338-8152 • FAX 812/945-0804
6 Rue St. Georges, CH 2800 Delémont • (41) 66-22-9822 • FAX (41) 66-22-9813

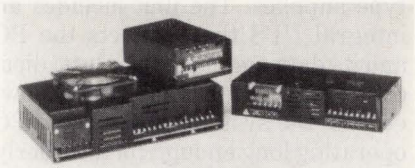
▼ SINGLE-OUTPUT LINEAR DELIVERS 48 V AT 8 A

The model IF48-8 power supply is a single-output linear unit that operates from 115 or 230 V ac at 47 to 440 Hz. The unit's output is 48 V dc at 8 A. Remote sense is provided. Other output variations are available up to 60 V dc at 4 A. In single quantities, pricing is $229.42. Delivery is from stock to eight weeks depending on quantity ordered.

International Power DC Power Supplies Inc.
355 N. Lantana, Suite 710
Camarillo, CA 93010
(805) 987-7900
▶ **CIRCLE 732**

▼ 48 MULTI-OUTPUT SUPPLIES RANGE FROM 50 TO 1500 W

Forty-eight multiple-output supplies offer a range of output power from 500 to 1500 W. The supplies come in three series. The SMLC Series has 20 models with up to four outputs in power ranges from 50 to 100 W. Prices start at $110. The HSS Series



has 25 models with up to five outputs and power outputs from 100 to 180 W. Pricing begins at $155. The SMM/SMS Series has four models with up to five outputs and power ranging from 300 to 1500 W. Prices start at $385. All prices are for lots of 100. Delivery is from stock.

Lambda Electronics Inc.
515 Broad Hollow Rd.
Melville, NY 11747
(516) 694-4200
▶ **CIRCLE 733**

▼ LINEAR SUPPLIES HELP CRACK EUROPEAN MARKET

A line of external linear power supplies is designed to help U.S. companies quickly penetrate the European market without the delays caused by regulatory-agency approvals. The CMI Series of supplies includes five TUV-approved models that accept inputs from 200 to 250 V ac. Input connections are made by means of a VDE-approved IEC connector. Two models are single-output types and three are triple-output supplies. Wattage runs from 7.5 to 14 W. Prices depend on wattage and range from $25 to $35 each in lots of 100. Delivery is from stock to eight weeks.

Elpac Power Systems
3131 South Standard Ave.
Santa Ana, CA 92705
(714) 979-4440
▶ **CIRCLE 734**

POWER-SUPPLY MANUFACTURERS

Lambda Electronics Inc.
515 Broad Hollow Rd.
Melville, NY 11747-3700
(516) 694-4200
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (RP) (MD)
CIRCLE 357

MIL Electronics Inc.
106 Perimeter Rd.
Nashua, NH 03063
(603) 882-3200
(50S) (51S) (10S) (11S) (CV)
CIRCLE 358

Melcher Inc.
200 Butterfield Dr.
Ashland, MA 01721
(508) 881-4715
(11S) (RM) (RP) (MD)
CIRCLE 359

Micropac Industries Inc.
905 E. Walnut St.
Garland, TX 75040
(214) 272-3571
(50S) (51S) (10S) (11S) (CV) (MD)
CIRCLE 360

Modular Devices Inc.
4115 Spencer St.
Torrance, CA 90503
(213) 542-8561
(50S) (200S) (RM) (OF) (CV)
CIRCLE 361

Modupower Inc.
374 Turquoise St.
Milpitas, CA 95035
(408) 263-6115
(50S) (10S) (CV)
CIRCLE 362

Multi Products International
250 Lackawanna Ave.
West Paterson, NJ 07424
(201) 890-1344
(50S) (51S) (10S) (11S) (LA) (CV)
CIRCLE 363

NH Research Inc.
16601 Hale Ave.
Irvine, CA 92714
(714) 474-3900
(50S) (51S) (200S) (RM) (CV) (PR) (RP) (MD)
CIRCLE 364

OECO Corp.
4607 S.E. International Way
Milwaukie, OR 97222
(503) 659-7932
(50S) (51S) (500S) (200S) (OF) (CV) (PR) (RP) (MD)
CIRCLE 365

Onan Power/Electronics
9713 Valley View Rd.
Minneapolis, MN 55344
(612) 943-4642
(50S) (51S) (10S) (11S) (200S) (OF)
CIRCLE 366

PC Power & Cooling Inc.
31510 Mountain Way
Bonsall, CA 92003
(619) 723-9513
(50S)
CIRCLE 367

PDS Technologies
875 Bridgeport Ave.
Shelton, CT 06484
(203) 925-0123
(50S) (11S) (200S) (LA) (RM) (OF) (CV) (MD)
CIRCLE 368

Panasonic Industrial Co. Power Supplies Div.
1600 McCandless Dr.
Milpitas, CA 95035
(408) 946-7200
(50S) (51S) (11S) (200S) (OF) (CV)
CIRCLE 369

Phoenix Contact Inc.
P.O. Box 4100
Harrisburg, PA 17111
(717) 944-1300
(50S) (10S) (11S) (CV)
CIRCLE 370

Pioneer Magnetics Inc.
1745 Berkeley St.
Santa Monica, CA 90404
(800) 233-1745
(200S) (LA) (RM) (OF) (PR)
CIRCLE 371

Polytron Devices Inc.
P.O. Box 398
Paterson, NJ 07544
(201) 345-5885
(50S) (LA) (RM) (CV) (MD)
CIRCLE 372

Power Conversion Products
42 East St., P.O. Box 380
Crystal Lake, IL 60014
(815) 459-9100
(50S) (51S) (11S) (200S) (RM) (CV)
CIRCLE 373

Power General Unitrode Corp.
152 Will Dr., P.O. Box 189
Canton, MA 02021
(617) 828-6216
(50S) (11S) (OF)
CIRCLE 374

Power Switch Corp.
50 Graphic Pl.
Moonachie, NJ 07074
(201) 641-4544
(50S) (200S) (OF)
CIRCLE 375

Power Systems Inc.
45 Griffin Rd. South
Bloomfield, CT 06002
(203) 726-1300
(50S) (51S) (500S) (10S) (11S) (200S) (OF) (CV)
CIRCLE 376

Power Ten Inc.
486 Mercury Dr.
Sunnyvale, CA 94086
(408) 738-5959
(500S) (200S) (LA) (RM) (CV) (RP)
CIRCLE 377

Power-One Inc.
740 Calle Plano
Camarillo, CA 93010-6090
(818) 889-5084
(50S) (51S) (10S) (11S) (200S) (OF) (CV)
CIRCLE 378

Powercube Corp.
18810 N. Glenville #102
Richardson, TX 75081
(214) 480-9281
(50S) (51S) (10S) (11S) (200S) (MD)
CIRCLE 379

Preferred Electronics Inc.
Main Line Dr., P.O. Box 248
Westfield, MA 01086
(413) 568-2301
(50S) (500S) (10S) (OF) (CV) (MD)
CIRCLE 380

Qualidyne Systems Inc.
3055 Del Sol Blvd.
San Diego, CA 92154
(619) 575-1100
(50S) (11S) (200S) (RM) (OF) (CV) (RP)
CIRCLE 381

RO Associates Inc.
246 Caspian Dr.
Sunnyvale, CA 94089
(408) 744-1450
(50S) (11S) (200S) (LA) (RM) (OF) (CV) (MD)
CIRCLE 382

Rantec Microwave & Electronics
1173 Los Olivos Ave.
Los Osos, CA 93402
(805) 528-5858
(500S) (10S) (11S) (OF) (CV) (MD)
CIRCLE 383

Rantec Microwave & Electronics
9401 Oso Ave.
Chatsworth, CA 91311
(818) 885-8223
(50S) (51S) (500S) (11S) (200S) (OF) (CV) (MD)
CIRCLE 384

(continued on p. 88)

KEY

Power Supplies

Output

(50S)	To 50 V
(51S)	51 to 500 V
(500S)	Over 500 V
(10S)	To 10 W
(11S)	11 to 200 W
(200S)	Over 200 W

Types

(LA)	Laboratory
(RM)	Rack mounting
(OF)	Open-frame OEM
(CV)	Constant voltage/current
(PR)	Precision ac output
(RP)	Remote programming
(MD)	Military designs

POWER-SUPPLY MANUFACTURERS

▼ TRIPLE-OUTPUT SWITCHER POWERS HARD DISKS

Systems including high-capacity hard-disk drives can be powered by the model NFS75 75-W triple-output switcher. The unit delivers 110 W to start drives as well as an unusually high 6-A peak (+12 V) output rating. A universal input enables the supply to operate from any line voltage worldwide without setting switches or jumpers. Pricing is $103 in lots or 100. Delivery is from stock.

Computer Products Inc.
3797 Spinnaker Ct.
Fremont, CA 94538
(415) 657-6700
▶ CIRCLE 735

▼ PC SUPPLY/UPS DROPS REPLACES OLDER TYPES

The model 2210 supply is a drop-in replacement for existing AT 80386-type supplies. The unit includes an integral UPS that protects the PC and its data against power loss, dips, or surges. In the event of a total power loss, the system can keep the PC operating long enough for an orderly shutdown. Retail pricing is $495 in single quantities. Delivery is from stock.

PC Power & Cooling
31510 Mountain Way
Bonsall, CA 92003
(619) 723-9513
▶ CIRCLE 736

▼ UNIVERSAL-INPUT SUPPLY OFFERS FOUR OUTPUTS

As many as four outputs are offered in a compact 7-by-4.25-by-1.25-in. package in the SRW-115 Series power supplies. The forward topology of the 115-W unit accepts any input voltage from 85 to 264 V ac without user intervention. A low 50 mV pk-pk of noise is found on all outputs. Other features include 1% regulation for the main output and 20-ms holdup time. Call for pricing and delivery.

Integrated Power Designs Inc.
9C Princess Rd.
Lawrenceville, NJ 08648
(609) 896-2122
▶ CIRCLE 737

POWER-SUPPLY MANUFACTURERS

Reich Associates Inc.
Rte. 4, Box 4620
Lakehills, TX 78063
(512) 751-3220
(50S) (51S) (500S) (10S) (11S) (200S) (OF) (CV) (MD)
CIRCLE 385

Reliance Comm/Tec Lorain Products
1122 F St.
Lorain, OH 44052
(216) 288-1122
(50S) (200S) (RM) (OF)
CIRCLE 386

Resonant Power Technology Inc.
3350 Scott Blvd., Bldg. 42/01
Santa Clara, CA 95051
(408) 982-0200
(51S) (OF) (PR) (RP) (MD)
CIRCLE 387

Ritz Electronics Ltd.
196 Queens St. N.
New Dundee, Ontario, Canada NOB 2EO
(519) 696-2616
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (PR) (MD)
CIRCLE 388

Semiconductor Circuits Inc.
49 Range Rd.
Windham, NH 03087
(603) 893-2330
(50S) (11S) (RM)
CIRCLE 389

Shindengen America Inc.
5999 New Wilke Rd., #406
Rolling Meadows, IL 60008
(708) 593-8585
(50S) (10S) (11S) (200S) (OF) (CV)
CIRCLE 390

Shogyo International Corp.
287 Northern Blvd.
Great Neck, NY 11021-4799
(516) 466-0911
(50S) (10S) (11S) (RM) (CV) (PR)
CIRCLE 391

Sierra West Power System
2615 Missouri Ave., Bldg. 5
Las Cruces, NM 88001
(505) 522-8828
(50S) (51S) (500S) (10S) (11S) (200S) (RM) (OF) (CV) (RP) (MD)
CIRCLE 392

Sola Electric
1717 Busse Rd.
Elk Grove Village, IL 60007
(708) 439-2800
(50S) (11S) (200S) (RM) (OF)
CIRCLE 393

Solidstate Controls Inc.
875 Dearborn Dr.
Columbus, OH 43085
(614) 846-7500
(200S) (PR)
CIRCLE 394

Sorensen Company
5555 N. Elston Ave.
Chicago, IL 60630
(312) 775-0843
(50S) (51S) (500S) (11S) (200S) (LA) (RM) (OF) (CV) (RP) (MD)
CIRCLE 395

Speco/Emco Electronics
1172 Rt. 109
Lindenhurst, NY 11757
(516) 957-8700
(50S) (LA)
CIRCLE 396

Superior Electric Co.
383 Middle St.
Bristol, CT 06010
(203) 582-9561
(51S)
CIRCLE 397

Switching Systems International
500 Porter Way
Placentia, CA 92670
(714) 996-0909
(50S) (11S) (200S) (OF) (CV)
CIRCLE 398

Tamura Corp. of America
1150 Dominguez St.
Carson, CA 90746-3518
(213) 638-1790
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (OF) (CV)
CIRCLE 399

Technology Dynamics Inc.
100 School St.
Bergenfield, NJ 07621
(201) 385-0500
(50S) (51S) (500S) (10S) (11S) (200S) (LA) (RM) (OF) (RP) (MD)
CIRCLE 400

Todd Products Corp.
50 Emjay Blvd.
Brentwood, NY 11717
(516) 231-3366
(50S) (51S) (10S) (11S) (200S) (RM) (OF) (RP)
CIRCLE 401

Toko America Inc.
1250 Feehanville Dr.
Mount Prospect, IL 60056
(708) 297-0070
(50S) (10S) (11S) (RM) (OF) (CV) (PR)
CIRCLE 402

Total Power International
418 Bridge St.
Lowell, MA 01850
(508) 453-7272
(50S) (RM) (OF) (RP)
CIRCLE 403

Transistor Devices Inc.
274 S. Salem St.
Randolph, NJ 07869
(201) 361-6622
(50S) (51S) (500S) (11S) (200S) (LA) (RM) (OF) (CV) (PR) (RP) (MD)
CIRCLE 404

U.S. Elco Inc.
2930 Scott Blvd.
Santa Clara, CA 95054
(408) 980-5144
(50S) (10S) (11S) (200S) (OF)
CIRCLE 405

Unipower Corp.
2981 Gateway Dr.
Pompano Beach, FL 33069
(305) 974-2442
(50S) (200S) (RM) (CV)
CIRCLE 406

Universal Voltronics
27 Radio Circle Dr.
Mt. Kisco, NY 10549
(914) 241-1300
(50S) (200S) (LA) (RM) (OF) (CV) (RP) (MD)
CIRCLE 408

VSR Corp.
4609 S. 33rd Pl.
Phoenix, AZ 85040
(602) 243-6200
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (CV) (PR) (RP)
CIRCLE 409

Vicor Corp.
23 Frontage Rd.
Andover, MA 01810
(508) 470-2900
(50S) (11S) (200S) (OF) (CV) (RP) (MD)
CIRCLE 410

Viking Industrial Products
729 Farm Rd.
Marlboro, MA 01752
(508) 481-4600
(50S) (51S) (11S) (200S) (OF) (CV) (PR)
CIRCLE 411

Viteq Corp.
10000 Aerospace Rd.
Lanham, MD 20706
(301) 731-0400
(51S) (200S) (PR)
CIRCLE 412

Voltex Co. Inc.
3460 Great Neck Rd.
N. Amityville, NY 11701
(516) 842-2772
(50S) (51S) (500S) (10S) (11S) (200S) (RM) (OF) (CV) (RP)
CIRCLE 413

Walker Scientific Inc.
Rockdale St.
Worcester, MA 01606
(508) 852-3674
(50S) (51S) (500S) (200S) (LA) (CV)
CIRCLE 414

Wall Industries Inc.
5 Watson Brook Rd.
Exeter, NH 03833
(603) 778-2300
(50S) (10S) (11S) (CV) (PR)
CIRCLE 415

Wells-Gardner Electronics
2701 N. Kildare
Chicago, IL 60639
(312) 252-8220
(50S) (51S) (OF) (CV)
CIRCLE 416

Westcor Corp.
485-100 Alberto Way
Los Gatos, CA 95032
(408) 395-7050
(50S) (10S) (11S) (200S) (LA) (RM) (MD)
CIRCLE 417

Zenith Electronics Corp.
1000 Milwaukee Ave.
Glenview, IL 60025
(708) 391-8510
(50S) (11S) (200S) (OF)
CIRCLE 418

KEY

Power Supplies

Output

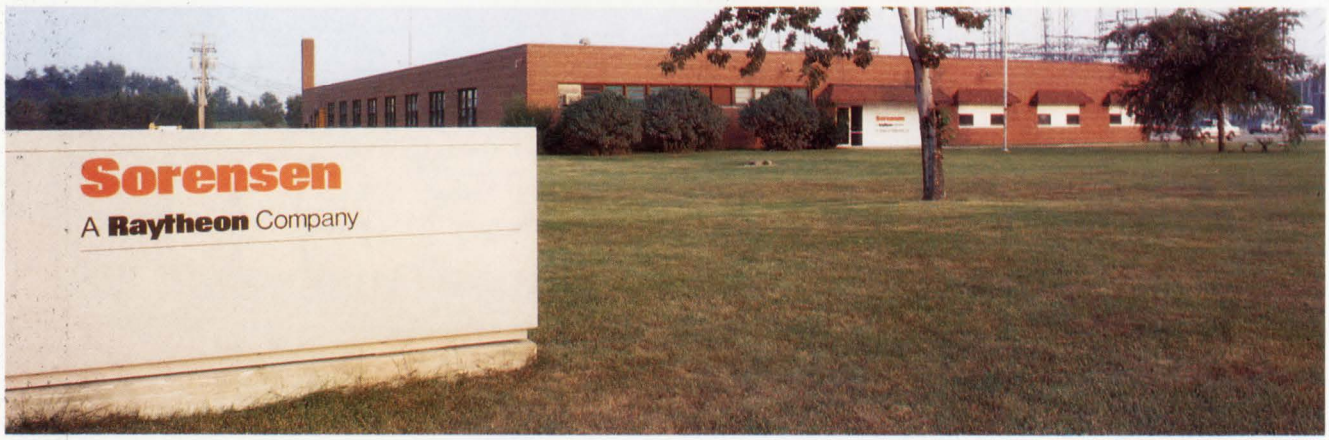
(50S)	To 50 V
(51S)	51 to 500 V
(500S)	Over 500 V
(10S)	To 10 W
(11S)	11 to 200 W
(200S)	Over 200 W

Types

(LA)	Laboratory
(RM)	Rack mounting
(OF)	Open-frame OEM
(CV)	Constant voltage/current
(PR)	Precision ac output
(RP)	Remote programming
(MD)	Military designs

Sorensen

The People, The Products, The Service
For The OEM Market



World Class Customer Satisfaction: From A World Class Company.

Consider yourself a world class customer!

In an increasingly global economy, high quality standards are vital to staying in the market. Companies everywhere are putting new strategies into action for improving their manufacturing processes.

For almost half a century, Sorensen has consistently established new benchmarks for innovation and quality performance in power supply manufacturing. Today, with facilities in both the U.S.A. and Scotland, we are competing among the best as a World Class Manufacturer. But that is not enough for us because when all is said and done, it is not enough to be able to eliminate defects, reduce inventory, shorten cycle times and provide the incremental improvements that make-up a World Class Manufacturer, unless, of course, it benefits you, the customer.

At Sorensen, every customer is a world class customer. In all our efforts, no matter how big or small, we are committed to delivering the benefits to you. From listening to your application needs, to designing the right reliable product, to on-time deliveries and, of course, the right pricing. All Sorensen people have their eyes on the prize: your ultimate satisfaction.

Meeting The Highest Possible Standards ... YOURS!

When every customer counts,

every aspect of the total process from product design through pricing is of the utmost importance. For Sorensen, that means we work in fully integrated product teams comprised of the various functions necessary to build a complete product. The goals of each team are two-fold and closely related. The operational goal is to sustain the habit of quality improvement while the target is perfection. The team pursues the target. From conception, to procurement, to production, to shipping ... it's a total team effort focused on your satisfaction!

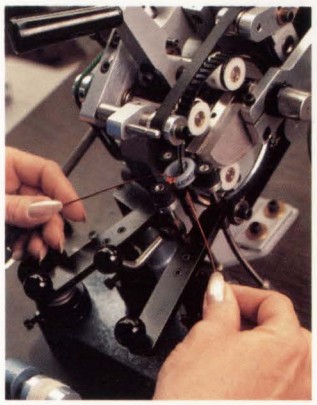
We are committed to producing your power supply products that meet your needs, and to continuously improving our process for your satisfaction. At Sorensen, we believe that world class customer satisfaction is a lifestyle that we all share equally, from conference rooms to loading dock. And that belief makes all the difference in the world when it comes to the quality you receive.

The principles of World Class Manufacturing are available to any company. The energy and drive to push further and give the customer world class attention to every detail ... that comes from people who make up the company. That is the difference Sorensen makes.

It begins with Sorensen **Total Quality Management**, which is a guideline that involves everyone in a totally integrated effort to improving performance at every level.

World Class Performance . . .

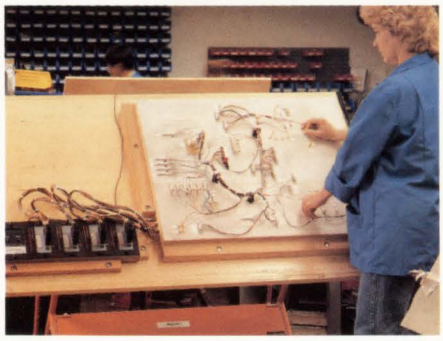
What is the measure of World Class Manufacturing?



The use of **Statistical Process Control** methods of data collection and analysis is used throughout operations as well as the rest of the organization. This provides a common language by which to communicate information so that every process can continually improve.

Automatic Testing Equipment for state-of-the-art processing to assure exacting levels of perfor mance for product applications.

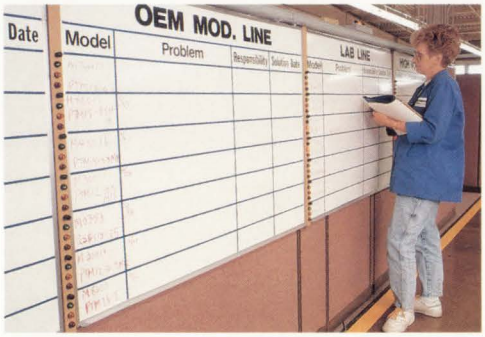
Just In Time production makes us flexible enough to respond to your needs even on the shortest notice.



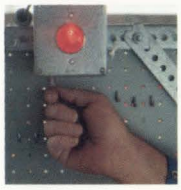
And a dedication to **Continuous Improvement** to challenge ourselves at even the smallest milestones to meet ever-increasing standards for quality and responsiveness to your needs.

These are the components of a World Class Manufacturer. A company working not just to be good, but to be one of the best.

We can sum it up in two words: the customer. The customer is our measure for continuing world class quality. Meeting your every expectation, then exceeding it. It's not just better manufacturing, it's better design, better response to your needs, better turnaround time — and doing it all better the next time.



STATUS BOARDS
Team Status Boards allow everyone to be aware of any problems, assigns responsibility for corrective action and date by which problem is to be rectified.



SIGNAL LIGHTS
Unique signal light system notifies all team members as to the status of a given product run. Should a problem arise, a team member has only to turn on their light and all members respond to help solve the problem.

ENGINEERING
Using today's latest technology in CAD/CAM and simultaneous engineering techniques, our teams are constantly developing new and better product designs.

TEAM MEETING
Weekly team meetings provide a forum for the exchange of ideas and suggestions. This not only promotes pride in workmanship, but also encourages constant improvement in every process.

ASSEMBLY LINE W/ATE STATION
Components are assembled on a pull basis and tested using computerized state-of-the-art Automated Test and Burn-in Equipment to assure 100% defect free finished product.

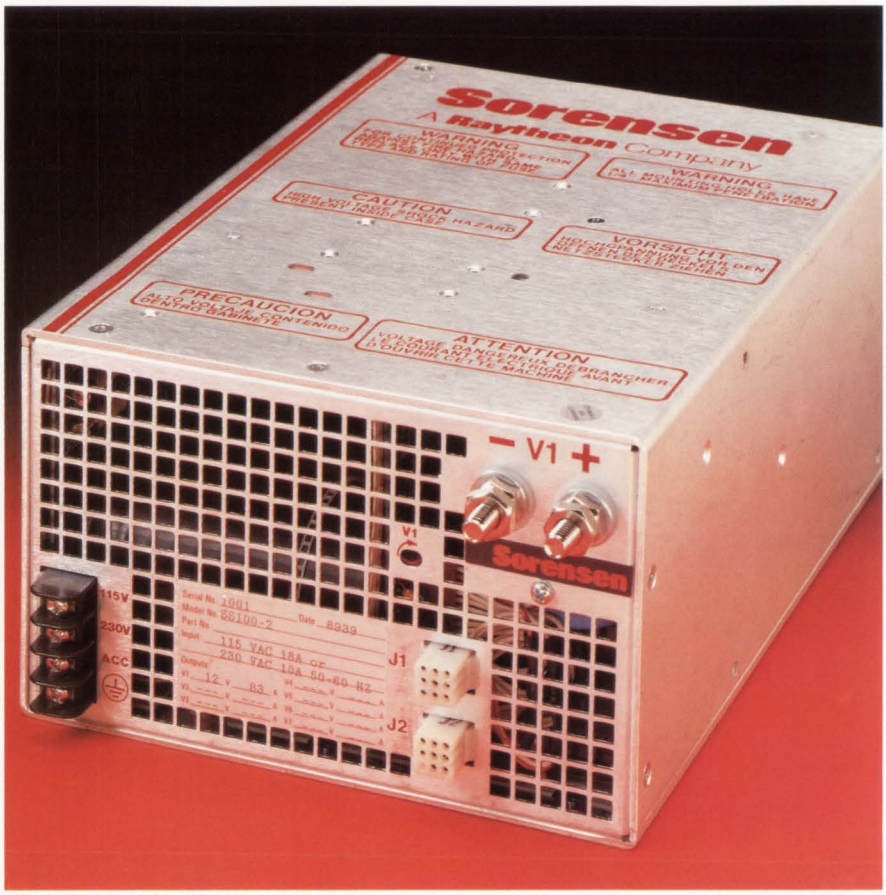
S Series
Multi-Output Switching Power Supplies

Leon Blackwell, Design Engineer

"To me, Sorensen quality means robust designs and thorough testing to provide the reliable products that the market is demanding."

Jeff Corn, Development Technician

"Sorensen quality?...it's something we all believe in. It means no compromises, it must be done right or not at all."



S Series switching power supplies offer thousands of models with 1 to 5 outputs and power levels of 500, 750, 1000, 1250, 1500 & 2000W. High power and reliability in high packaging density are achieved through power MOSFET design resulting in high switching speeds, low noise and ease of filtering. S Series supplies have fast load response (even at low input voltages), absolute current sharing and 2-stage limiting.

- Thousands of models with 500W, 750W, 1000W, 1250W, 1500W, & 2000W power levels
- One through 5 outputs: 2V, 5V, 12V, 15V, 18V, 24V, 28V, 36V & 48V
- Dual inputs (selectable) 90-130 Vac or 180-260 (Vac 500W to 1250W); 180-264 Vac (1500W & 2kW). Optional inputs available
- Dc inputs (–42 to –56 Vdc) on 500W, 750W & 1000W models
- Switching speeds up to 144 kHz
- No minimum output loading required
- Designed to meet UL 1950, CSA Electrical Bulletin CSA C22.2 #220, IEC 950, IEC 308 & VDE 0806 (selected models)
- Remote sense protection standard on outputs V1, V2 & V3
- Current sharing, reverse polarity protection, power fail warning & thermal shutdown
- Current monitoring & +5V logic voltage
- OVP standard on V1, V2, V3 & V4 outputs
- Low noise bandgap reference voltage
- High packaging density: up to 5 outputs in standard 5″ × 8″ case profile
- Options: DC input power (selected models); 208/230 Vac, 3∅ input power; FCC class A line filter; reverse air flow; and current sharing on V1 and V2 outputs
- 5-year warranty

SPECIFICATIONS

INPUT

Input Voltage: Standard dual range 90-130 Vac or 180-260 Vac single phase (500W to 1250W), 180-264 Vac single phase (1500W & 2kW). 180-264 Vac, 3 phase option available.

Frequency Range: 47-440 Hz, single phase

Fusing: All units are internally fused.

Inrush Current: Limited to 40A rms max. for 20 ms.

Line Regulation: 0.2% over full input range.

Transient Protection: Meets IEEE 472 Guide for surge withstand capability.

OUTPUT

Voltage Adjustment Range: ±10% (Except V5 which tracks V2).

Load Regulation: 0.2% no load to full load (except V5 is 5%).

Cross-Regulation: 0.1% max. except V5 is ±5%.

Overvoltage Protection: Standard on V1, V2, V3, V4 and not available on V5. If any output exceeds nominal voltage by 20-30%, OVP circuit activates and turns off all outputs. Ac input or remote On/Off must be recycled to restart supply.

Hold-Up Time: In regulation of 30 ms (min.) after loss of nom. power.

Overshoot/Undershoot: None during turn-on or turn-off.

Turn-On Delay: All outputs in regulation in <500 ms.

Transient Response: Recovery to 1% regulation within 100 μs (25% step load change).

Polarity: All outputs floating; reference determined by user.

Reverse Polarity Protection: V1 & V2 outputs protected to I_{max}; other outputs protect to 6A.

Reference Voltage: 5.1V ± 1% @ 0.1 mA low noise bandgap voltage is available at J1-3.

Minimum Loads: None required on any output.

Current Sharing: Terminals are provided for V1 and V2 outputs; when terminals are connected to same terminals (and share lines) at same voltage on another supply, paralleled outputs share current within 1%.

Thermal Shutdown: Supply shuts down when temperatures are exceeded; restarts automatically upon cool-down.

GENERAL

Temperature Coefficient: Output change <0.02%/°C after 30 minute warmup.

Efficiency: 70% min. for multi-outputs; 75% min. for single output (outputs 5V or greater).

Safety Standards: Meets UL 1950, CSA C22.2 #220, IEC 950, IEC 308 & VDE 0806 (selected models).

Ripple & Noise: (PARD): Differential mode, 1% max. or 50 mV whichever is greater. Measurements made at output terminals with 20MHz scope.

Remote Sense: Outputs V1, V2, V3 compensate for 500 mV of load cable loss. With lines open, output is sensed through internal resistors. Reversing sense lines causes no damage.

Current Monitor: Calibrated voltage proportional to V1 current is provided; 1V ± 5% for full load.

Remote Margin: ±3% to ±10% for V1. (see Installation Instructions.)

Logic Voltage: +5V (up to 50 mA current) is available when ac is applied. Voltage is reference to logic common, V1.

Power Fail: Internal resistor to +5V for pull-up is provided for external connection.

Remote Enable: Internal resistor to +5V for pull-up is provided for external connection.

Power Fail Warning: Logic signal is supplied through an optical coupler and may be referenced as desired. Signal is provided at least 5 ms before loss of any output voltage, but is not activated for at least 20 ms after loss of nominal ac power.

Ambient Operating Temperature & Humidity Range: Full power to 50°C (122°F), derate to 60% @ 70°C (158°F).

Storage Temperature & Humidity Range: -55 to +85°C (-67 to +185°F), 90% RH max.

Cooling: Brushless 24 Vdc fan for efficient operation at low input voltages. Reverse air movement optional.

OPTIONS

Option D: Dc input (-42 to -56 Vdc) on 500W, 750W & 1000W models

Option F: FCC Class A line filter

Option H: Current Share, V1 output

Option I: Current Share, V2 output

Option R: Reverse air flow on fan

Option T: 3 phase ac power input

S SERIES SPECIFICATIONS

SINGLE OUTPUT					
	500W	750W	1000W	1500W	2000W
V1	2V, 120A	2V, 175A	2V 230A	2V, 340A	2V, 400A
	5V, 100A	5V, 150A	5V, 200A	5V, 300A	5V, 400A
	12V, 42A	12V, 63A	12V, 83A	12V, 125A	12V, 167A
	15V, 34A	15V, 50A	15V, 67A	15V, 100A	15V, 134A
	18V, 28A	18V, 42A	18V, 56A	18V, 83A	18V, 111A
	24V, 21A	24V, 31A	24V, 42A	24V, 63A	24V, 84A
	28V, 18A	28V, 27A	28V, 36A	28V, 54A	28V, 72A
	36V, 14A	36V, 21A	36V, 28A	36V, 42A	36V, 56A
	48V, 11A	48V, 16A	48V, 21A	48V, 31A	48V, 42A

DUAL OUTPUTS*					
	500W	750W	1000W	1250W	1500W
V1	5V, 80A	5V, 110A	5V, 150A	5V, 200A	5V, 230A
V2	2V, 10A	2V, 15A	2V, 50A	2V, 50A	2V, 50A
	5V, 10A	5V, 15A	5V, 50A	5V, 50A	5V, 50A
	12V, 10A	12V, 15A	12V, 33A	12V, 35A	12V, 35A
	15V, 8A	15V, 10A	15V, 27A	15V, 28A	15V, 28A
	24V, 6A	24V, 10A	24V, 17A	24V, 18A	24V, 18A

*Total output power is limited to power rating shown.

TRIPLE OUTPUTS*					
	500W	750W	1000W	1250W	1500W
V1	5V, 80A	5V, 110A	5V, 150A	5V, 200A	5V, 230A
V2	2V, 10A	2V, 15A	2V, 20A	2V, 50A	2V, 50A
	5V, 10A	5V, 15A	5V, 20A	5V, 50A	5V, 50A
	12V, 10A	12V, 15A	12V, 15A	12V, 35A	12V, 35A
	15V, 8A	15V, 10A	15V, 15A	15V, 28A	15V, 28A
	24V, 6A	24V, 10A	24V, 10A	24V, 18A	21V, 18A
V3	2V, 5A	2V, 5A	2V, 10A	2V, 10A	2V, 10A
	5V, 5A	5V, 5A	5V, 10A	5V, 10A	5V, 10A
	12V, 5A	12V, 5A	12V, 10A	12V, 10A	12V, 10A
	15V, 5A	15V, 5A	15V, 8A	15V, 8A	15V, 8A
	24V, 3A	24V, 3A	24V, 5A	24V, 5A	24V, 5A

QUAD OUTPUTS*					
	500W	750W	1000W	1250W	1500W
V1	5V, 80A	5V, 110A	5V, 150A	5V, 200A	5V, 230A
V2	2V, 10A	2V, 10A	2V, 20A	2V, 50A	2V, 50A
	5V, 10A	5V, 10A	5V, 20A	5V, 50A	5V, 50A
	12V, 10A	12V, 10A	12V, 15A	12V, 35A	12V, 35A
	15V, 8A	15V, 8A	15V, 15A	15V, 28A	15V, 28A
	24V, 6A	24V, 6A	24V, 12A	24V, 18A	24V, 18A
V3	2V, 5A	2V, 5A	2V, 10A	2V, 10A	2V, 10A
	5V, 5A	5V, 5A	5V, 10A	5V, 10A	5V, 10A
	12V, 5A	12V, 5A	12V, 10A	12V, 10A	12V, 10A
	15V, 5A	15V, 5A	15V, 8A	15V, 8A	15V, 8A
	24V, 3A	24V, 3A	24V, 5A	24V, 5A	24V, 5A
V4	2V, 3A	2V, 3A	2V, 5A	2V, 5A	2V, 5A
	5V, 3A	5V, 3A	5V, 5A	5V, 5A	5V, 5A
	12V, 3A	12V, 3A	12V, 5A	12V, 5A	12V, 5A
	15V, 2A	15V, 2A	15V, 3A	15V, 3A	15V, 3A
	24V, 2A	24V, 2A	24V, 3A	24V, 3A	24V, 3A

PENTA OUTPUTS*					
	500W	750W	1000W	1250W	1500W
V1	5V, 80A	5V, 110A	5V, 150A	5V, 200A	5V, 230A
V2	2V, 10A	2V, 10A	2V, 20A	2V, 50A	2V, 50A
	5V, 10A	5V, 10A	5V, 20A	5V, 50A	5V, 50A
	12V, 10A	12V, 10A	12V, 15A	12V, 35A	12V, 35A
	15V, 8A	15V, 8A	15V, 15A	15V, 28A	15V, 28A
	24V, 6A	24V, 6A	24V, 12A	24V, 18A	24V, 18A
V3	2V, 5A	2V, 5A	2V, 10A	2V, 10A	2V, 10A
	5V, 5A	5V, 5A	5V, 10A	5V, 10A	5V, 10A
	12V, 5A	12V, 5A	12V, 10A	12V, 10A	12V, 10A
	15V, 5A	15V, 5A	15V, 8A	15V, 8A	15V, 8A
	24V, 3A	24V, 3A	24V, 5A	24V, 5A	24V, 5A
V4	2V, 3A	2V, 3A	2V, 5A	2V, 5A	2V, 5A
	5V, 3A	5V, 3A	5V, 5A	5V, 5A	5V, 5A
	12V, 3A	12V, 3A	12V, 5A	12V, 5A	12V, 5A
	15V, 2A	15V, 2A	15V, 3A	15V, 3A	15V, 3A
	24V, 2A	24V, 2A	24V, 3A	24V, 3A	24V, 3A
V5	†PK 12V, 5A/8A 24V, 5A/8A	†PK 12V, 7A/10A 24V, 7A/10A	†PK 12V, 8A/12A 24V, 8A/12A	**	**

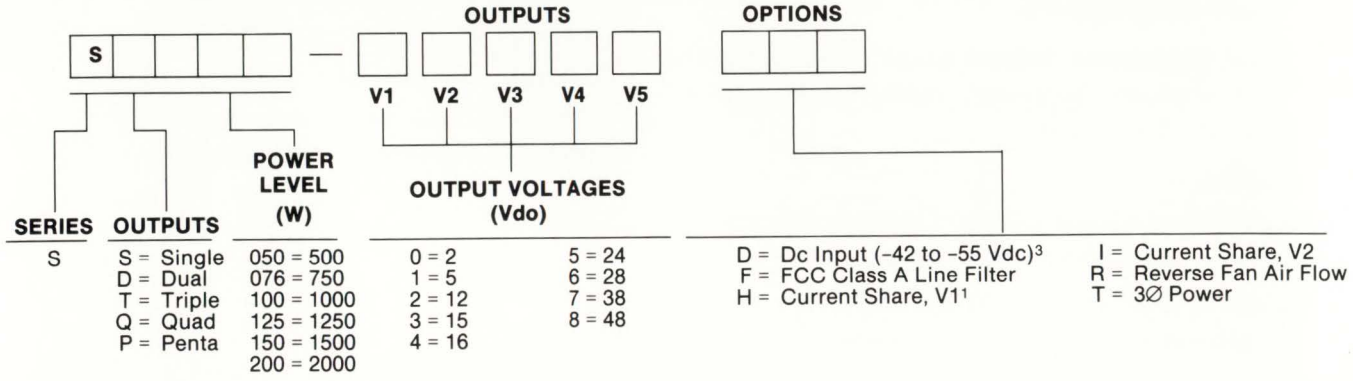
*Total output power is limited to power rating shown.

†Peak output for 30 seconds.

**Contact Sorensen

NOTE: V5 output not available if line filter is specified.

Part Number System

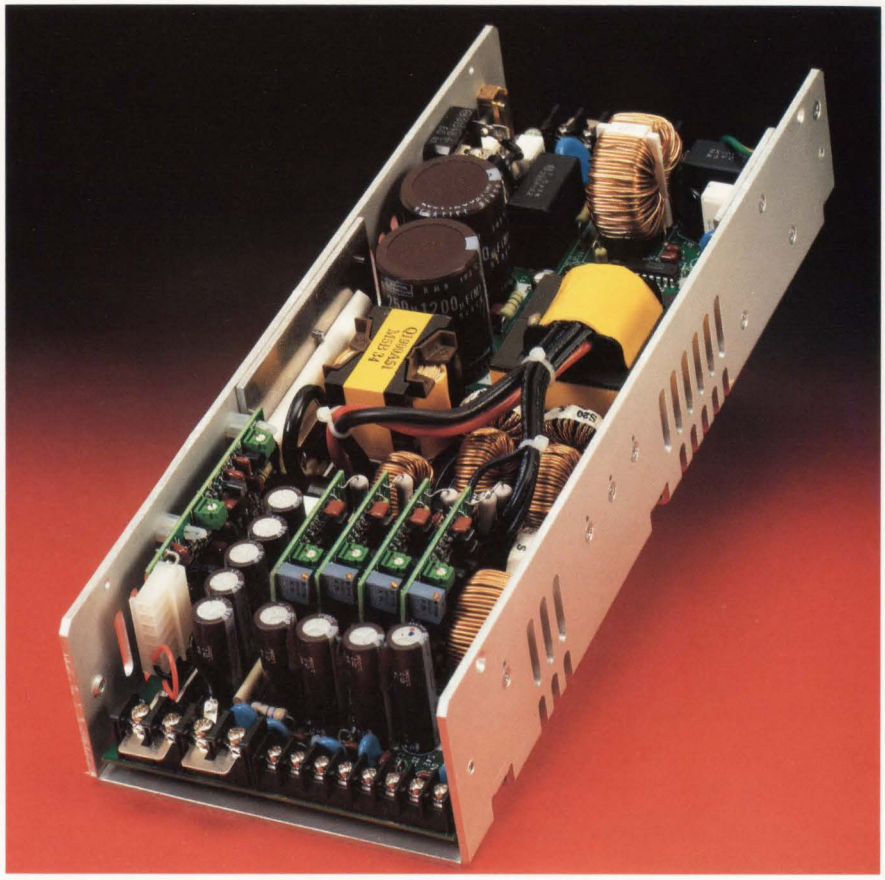


KSA 400 Series

5 Output 400W Switching Power Supply

Geri Williams, Product Assembly

"Sorensen quality to me means taking the time and effort to make sure that every unit we assemble will perform the way it was designed to, and that means meeting or exceeding the customers expectations."



The KSA400 switching power supply incorporates features for stable, heavy duty operation, including parallel MOSFETs in a forward converter technology and conservatively rated electrolytic capacitors. Five outputs are available: main output V1, and outputs V2 through V5 (which are adjustable over a wide range). KSA 400 is designed for demanding service in computer and data processing equipment, as well as others needing multiple, adjustable outputs. KSA 400 is built to meet UL, CSA, and TUV requirements, and provides EMI protection to FCC and VDE 0871, level 1.

- 5 Voltage ranges: Main output V1, 5V; outputs V2, V3 & V4, 5-15V; output V5, 12-24V
- 300W output (convection); 400W output (forced air cooling)
- 115/230 Vac selectable inputs, 47-63 Hz, single phase
- Overvoltage protection standard (V1 output)
- Overload protection standard (all outputs)
- Remote sense standard (V1 output)
- Power fail standard
- Remote inhibit standard
- UL, CSA, VDE recognized*
- 2-year warranty

*Pending

Voltage/Current Ratings:

Output No. 1:	5V nom/40A max. (convection). 5V nom/50A max. (forced air).
Output No. 2:	Adjustable 5-15V nom/ 0-6A max.
Output No. 3:	Adjustable 5-15V nom/ 0-6A max.
Output No. 4:	Adjustable 5-15V nom/ 0-6A max.
Output No. 5:	Adjustable 12-24V nom/ 0-6A max.

Size: 2.5″ H × 5.0″ W × 12.992″ D.

KEC ProductGroup

KE 600 Series

600W, 150 kHz Single-Output Switching Power Supplies

Julie Gerdes, Assembly Supervisor

"Sorensen quality; I think it's the little things that are done each day, by the team, to continually improve our ability to produce a better product."

The advanced packaging of the KE600 Series 600 Watt power supply is due to state of the art 150 kHz switching technology, which allows for high component density, low profile and light weight. This unit is designed with the end user in mind, providing maximum flexibility in the areas of Remote On/Off, N + 1 redundancy capabilities, selectable ac inputs, remote output monitoring, selectable remote sense or PALS (Programmable Automatic Load Sensing) for fixed load line applications. PALS eliminates the need for external sense line harnessing.

- Compact size, 150 kHz switching speed, 2.3W/in.^{3}
- 110 or 220 Vac input (selectable), single phase
- EMI filtered to FCC 20780 class A
- Meets UL, CSA & VDE (TUV) 0871, class A safety standards
- Remote On/Off (TTL-H = on, L = off) or contact relay shutdown (open = on, short = off)
- Remote output monitoring
- Voltage Adjustment ±10%
- Selectable remote sense or Programmable Automatic Load Sensing (PALS)
- Automatic thermal shutdown
- Parallel operation, up to 4 units
- Fault tolerant (N + 1) redundancy.
- DC fan cooled. Fan OK circuit turns off output if fan fails to operate.
- DC OK status LED
- 2 year warranty

Model	Adjustment Range Vdc		Current Adc	Regulation		PARD mV	Efficiency %
	Min.	Max.		Line %	Load %		
KE600-2	1.8	2.2	0-120	±0.2%	±0.2%	65	70
KE600-5	4.5	5.5	0-120	±0.2%	±0.2%	35	70
KE600-12	10.8	13.2	0-50	±0.2%	±0.2%	40	80
KE600-15	13.5	16.5	0-40	±0.2%	±0.2%	55	80
KE600-24	21.6	26.4	0-25	±0.2%	±0.2%	55	80
KE600-28	25.2	30.8	0-22	±0.2%	±0.2%	80	82
KE600-48	43.2	25.8	0-13	±0.2%	±0.2%	35	83

SIZE: 3.78″ H × 7.87″ W × 9.44″ D

KEC ProductGroup

KVB Series

Compact Single-Output Switching Power Supplies

Mark LeJeune, Mechanical Engineering

"Sorensen quality means developing a durable product that best satisfies the requirements of all the members of that product's team, and especially the customer."

Compact, light weight, low cost KVB Series has a single 5V, 12V, 15V, or 24V output with choice of 10W, 15W, or 25W output power level. All units are UL recognized and CSA listed. EMI conforms to FCC Class B requirements.

- 10W, 15W, 25W outputs
- Output voltages: 5V, 12V, 15V, 24V; ±10%
- Ac or dc input: 85-132 Vac, 47-440 Hz, single phase or 110-170 Vdc
- Overvoltage & overcurrent protection standard
- UL recognized and CSA listed
- EMI protection conforms to FCC Class B
- 2-year warranty

SIZES:

1.063″ H × 2.913″ W × 3.819″ D.
Models: KVB010-05, KVB010-12, KVB010-15 KVB010-24.

1.378″ H × 3.583″ W × 4.726″ D.
Models: KVB015-05, KVB 015-12, KVB015-15 KVB015-24.

1.378″ H × 3.583″ W × 5.433″ D.
Models: KVB025-05, KVB025-12, KVB025-15 KVB025-24.

Model	Adjustment Range Vdc Min	Max.	Current Adc (max.)	Regulation Line/Load (mV)	PARD mV (max)	Efficiency % (typ.)
KVB010-05	4.5	5.5	2	20/40	30	65
KVB010-12	10.8	13.2	0.8	48/100	60	65
KVB010-15	13.5	16.5	0.7	60/120	30	65
KVB010-24	21.6	26.4	0.4	96/150	70	65
KVB015-05	4.5	5.5	3	20/40	25	65
KVB015-12	10.8	13.2	1.3	48/100	60	65
KVB015-15	13.5	16.5	1	60/120	30	65
KVB015-24	21.6	26.4	0.6	96/150	70	65
KVB025-05	4.5	5.5	5	20/40	20	65
KVB025-12	10.8	13.2	2.1	48/100	60	65
KVB025-15	13.5	16.5	1.7	60/120	85	65
KVB025-24	21.6	26.4	1	96/150	30	65

KEC ProductGroup

KVL Series
Compact 3 Output Switching Power Supplies

Donna Herrin, Purchasing Department

"Sorensen quality means implementing such plans as our Vendor Certification program that ensures quality material and timely delivery to the production line."

New KVL Series offers both low cost and small package size. Three outputs are available with combinations of +5V, ±12V & ±15V at 15, 25, or 40W power levels. Overload and overvoltage protection are standard, and all models conform to UL and CSA safety requirements. All outputs can be used at full ratings simultaneously. 2 year warranty.

- 15W, 25W & 40W outputs
- Output voltages: +5V, ±12V & ±15V (in combinations)
- AC or dc input: 85-132 Vac, 48-440 Hz. single phase or 100-170 Vdc.
- Overvoltage protection standard on +5V output
- Overcurrent and inrush current protection standard
- Separate ground return on +5V output
- Outputs 2 & 3 are post-regulated (on selected models)
- Class B Line filter and mounting brackets are standard
- UL recognized & conforms to CSA safety requirements
- Options: covers
- Sizes:
  1.378″ H × 3.347″ W × 3.858″ D (KVL15);
  1.575″ H × 3.347″ W × 5.118″ D
  (KVL25, KVL40)

Model[1]	Output No. 1		Output No. 2		Output No. 3		Post Reg. Outputs 2&3
	V (nom.)/ I (max.)	Usable Current (A)	V (nom.)/ I (max.)	Usable Current (A)	V (nom.)/ I (max.)	Usable Current (A)	
KVL 15-01T	+5/2	0.4 -2	+12/0.3	0 -0.3	-12/0.3	0-0.3	Std.
KVL 15-02T	+5/2	0.4 -2	+15/0.3	0 -0.3	-15/0.3	0-0.3	Std.
KVL 25-01	+5/2.5	0.45-2.5	+12/1	0.3- 1	-12/0.3	0-0.3	No
KVL 25-01T	+5/2.5	0.45-2.5	+12/0.5	0.3-0.5	-12/0.3	0-0.3	Std.
KVL 25-02	+5/2.5	0.45-2.5	+15/1	0.3- 1	-15/0.3	0-0.3	No
KVL 25-02T	+5/2.5	0.45-2.5	+15/0.5	0 -0.5	-15/0.3	0-0.3	Std.
KVL 40-01	+5/3	0.45-2.5	+12/2	0.3- 2	-12/0.3	0-0.3	No
KVL 40-01T	+5/3	0.45-2.5	+12/1	0 - 1	-12/0.3	0-0.3	Std.
KVL 40-02	+5/3	0.45-2.5	+15/2	0.3- 2	-15/0.3	0-0.3	No
KVL 40-02T	+5/3	0.45-2.5	+15/1	0 - 1	-15/0.3	0-0.3	Std.

NOTE: 1. Suffix T-post regulators on 2nd & 3rd outputs.

KEC ProductGroup

KRE Series
Single Output Switching Power Supplies

Sandi Ventimiglia, Quality Engineering

"Sorensen quality means satisfying all the needs of every customer and ensuring that our products meet or beat the highest standards."

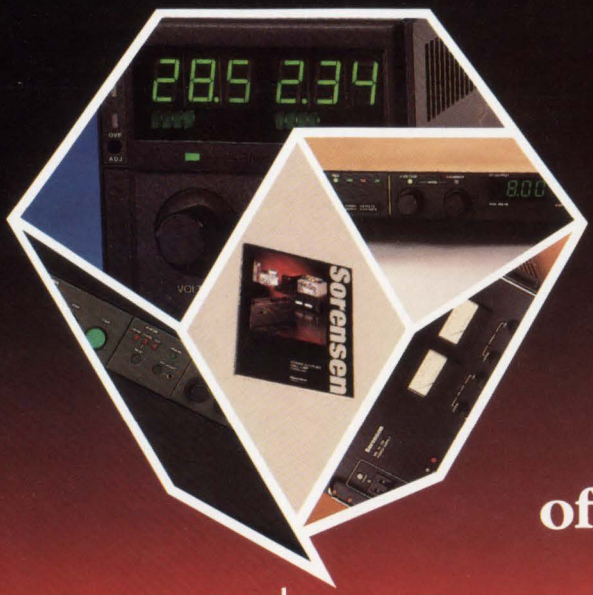
150 kHz switching technology affords compact size, low cost and high wattage/in.^{3} Output voltages are 5V, 12V, 15V, 24V at 50W, 100W and 150W levels. Standard features include: OVP and overcurrent protection, inrush current limiting, remote sense and dual input power. Covers are optional. UL recognized and meets CSA requirements.

- 12 models with 50W, 100W & 150 W power levels
- 5V, 12V, 15V & 24V output for each power lead
- Compact size, proven 150 kHz switching
- Ac or dc input (85-132 Vac or 110-170 Vdc). 47-440 Hz, single phase (ac only)
- UL recognized. Meets CSA safety. Conforms to FCC class B and VCCI-2 for EMI
- Inrush current limiting
- Overvoltage protection
- Remote sense
- 2-year warranty

Model	Adjustment Range Vdc Min.	Max.	Current Adc (max.)	Regulation Line/Load (mV)[1]	PARD mV	Efficiency %	Size (in.)
KRE 050-05	4.5	5.5	10	10/20	45	77	1.42 H × 3.8 W × 5.62 D
KRE 050-12	10.8	13.2	4.2	24/48	35	81	
KRE 050-15	13.5	16.5	3.4	30/60	35	81	
KRE 050-24	21.6	26.4	2.1	48/96	35	82	
KRE 100-05	4.5	5.5	20	10/20	35	79	1.97 H × 3.82 W × 7.52 D
KRE 100-12	10.8	13.2	8.5	24/48	25	83	
KRE 100-15	13.5	16.5	7	30/60	25	83	
KRE 100-24	21.6	26.4	4.5	48/96	45	84	
KRE 150-05	4.5	5.5	30	10/20	35	80	2.56 H × 3.82 W × 7.92 D
KRE 150-12	10.8	13.2	13	24/48	40	83	
KRE 150-15	13.5	16.5	10	30/60	25	84	
KRE 150-24	21.6	26.4	6.5	48/96	25	85	

1. ±2%/ ±4%.

KEC ProductGroup



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Port Glasgow, Scotland UK PA14 6 PD
Tel: 44 0475 45231
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tion. Efficiencies of up to 81% are offered in power ranges from 1.5 to 25 W. The series includes 62 models with inputs from 4.5 to 72 V dc. Outputs of 5, 12, 15, and 24 V are offered in all package sizes. All specs are guaranteed over the operating range of –20 to +71°C. Pricing starts at $30 for single quantities and delivery is from stock.

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(516) 694-4200
▶ CIRCLE 738

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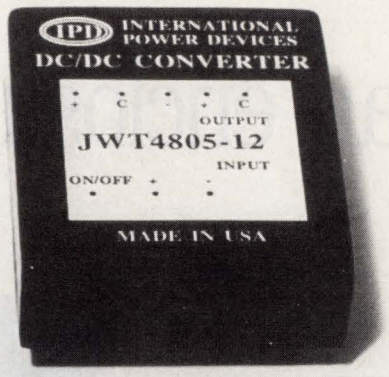

telecommunication and transportation industries. Samples are available now. Call for pricing and availability.

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CIRCLE 419

AT&T Power Supplies
3000 Skyline Dr.
Mesquite, TX 75149
(214) 288-2428
(50C) (10C) (11C) (200C) (DC) (MO)
CIRCLE 420

Abacus Electronics
P.O. Box 534
South River, NJ 08882-0534
(201) 238-4631
(DC) (AC)
CIRCLE 421

Abbott Electronics Inc.
2727 S. La Cienega Blvd.
Los Angeles, CA 90034
(213) 202-8820
(50C) (51C) (DC) (AC) (MO) (MI)
CIRCLE 422

Acme Electric Corp.
20 Water St.
Cuba, NY 14727
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Acopian Inc.
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CIRCLE 424

Apex Microtechnology Corp.
5980 N. Shannon Rd.
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(800) 421-1865
(50C) (11C) (DC)
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(200C)
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Clary Corp. Precision Instruments Div.
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High Bridge, NJ 08829
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CIRCLE 437

Computer Products Tecnetics
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Boulder, CO 80030
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CIRCLE 438

Computer Products Inc. Power Conversion
3785 Spinnaker Ct.
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Conversion Devices Inc.
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Brockton, MA 02401
(508) 559-0880
(50C) (DC) (MO)
CIRCLE 440

Current Technology Power Supplies Div.
1400 S. Sherman
Richardson, TX 75081
(214) 238-5300
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CIRCLE 441

Custom Power Systems
33 Comac Loop
Ronkonkoma, NY 11779
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CIRCLE 442

Cyberpak Co. Custom Design
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(800) 328-3938
(11C) (200C)
CIRCLE 443

Datel Inc.
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Mansfield, MA 02048
(508) 339-3000
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CIRCLE 444

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Covina, CA 92635
(818) 967-9521
(50C) (11C) (200C) (DC) (AC) (MI)
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EMCO High Voltage Co.
11126 Ridge Rd.
Sutter Creek, CA 95685
(209) 223-3626
(50C) (51C) (500C) (10C) (11C) (DC) (MO) (IC) (MI)
CIRCLE 447

(continued on p. 91)

KEY

Power Converters

Output

(50C)	To 50 V
(51C)	51 to 500 V
(500C)	Over 500 V
(10C)	To 10 W
(11C)	11 to 200 W
(200C)	Over 200 W

Types

(DC)	Dc to dc
(AC)	Dc to ac
(MO)	Modular
(IC)	IC DIP
(MI)	Military designs

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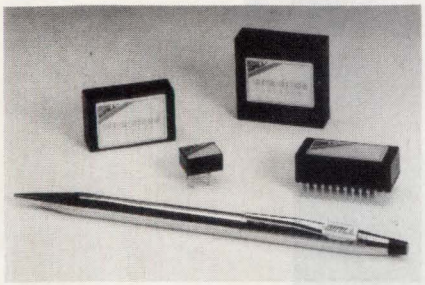
Local-area-network applications are the target for the LAN Series of ultra-miniature dc-dc converters. The units, which measure 0.5 by 0.4 by



0.28 in., are single-output devices offering short-circuit protection, regulated and unregulated outputs, and isolation voltage to 2500 V dc. Input voltages of 5 and 12 V dc provide up to 2 W of power in 5-, 9-, 12-, and 15-V dc output configurations. Call for pricing and delivery.

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take up less than 2.4 in. of board area and are just 0.4 in. tall. Thanks to their 600-kHz switching frequency, their power density is 35 W/in.^{3}, which permits smaller components to generate more power. In lots of 100, pricing starts at $362. Small quantities are available for delivery from stock.

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(51C) (500C) (DC)
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Redmond, WA 98073-9705
(206) 882-3100
(50C) (10C) (11C) (DC) (MI)
CIRCLE 461

Intronics Inc.
150 Dan Rd.
Canton, MA 02021
(617) 828-4992
(50C) (DC) (MO) (IC)
CIRCLE 462

Jerome Industries
730 Division St.
Elizabeth, NJ 07201
(201) 353-5700
(50C)
CIRCLE 463

Keltec Florida
P.O. Box 2917
Ft. Walton Beach, FL 32549
(904) 244-0043
(50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MO)
CIRCLE 464

Kepco Inc.
131-38 Sanford Ave.
Flushing, NY 11352
(718) 461-7000
(50C) (51C) (10C) (11C) (200C) (DC) (MO)
CIRCLE 465

LZR Electronics Inc.
8051 Cessna Ave.
Gaithersburg, MD 20879
(301) 921-9440
(50C) (51C) (10C) (11C) (DC) (AC) (MO)
CIRCLE 466

Lambda Electronics Inc.
515 Broad Hollow Rd.
Melville, NY 11747-3700
(516) 694-4200
(50C) (51C) (10C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 467

Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035-7487
(408) 432-1900
(50C) (DC) (IC) (MI)
CIRCLE 468

MIL Electronics Inc.
106 Perimeter Rd.
Nashua, NH 03063
(603) 882-3200
(500C) (10C) (11C) (DC) (MO) (MI)
CIRCLE 469

Marathon Power Technologies
P.O. Box 8233
Waco, TX 76714-8233
(817) 776-0650
(51C) (DC) (AC)
CIRCLE 470

Melcher Inc.
200 Butterfield Dr.
Ashland, MA 01721
(508) 881-4715
(50C) (10C) (11C) (DC) (MO) (IC) (MI)
CIRCLE 471

Micropac Industries Inc.
905 E. Walnut St.
Garland, TX 75040
(214) 272-3571
(50C) (51C) (10C) (11C) (DC) (MO) (MI)
CIRCLE 472

Modular Devices Inc.
4115 Spencer St.
Torrance, CA 90503
(213) 542-8561
(50C) (200C) (DC) (MO)
CIRCLE 473

Modupower Inc.
374 Turquoise St.
Milpitas, CA 95035
(408) 263-6115
(50C) (10C) (11C) (DC) (IC)
CIRCLE 474

Multi Products International
250 Lackawanna Ave.
West Paterson, NJ 07424
(201) 890-1344
(50C) (51C) (10C) (11C) (DC) (AC) (MO)
CIRCLE 475

NH Research Inc.
16601 Hale Ave.
Irvine, CA 92714
(714) 474-3900
(50C) (51C) (200C) (MO) (MI)
CIRCLE 476

National Semiconductor
2900 Semiconductor Dr.
M/S 16-300
Santa Clara, CA 95052
(408) 721-2641
(50C) (10C) (11C) (DC) (IC) (MI)
CIRCLE 477

(continued on p. 93)

KEY

Power Converters

Output

(50C)	To 50 V
(51C)	51 to 500 V
(500C)	Over 500 V
(10C)	To 10 W
(11C)	11 to 200 W
(200C)	Over 200 W

Types

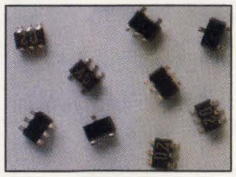
(DC)	Dc to dc
(AC)	Dc to ac
(MO)	Modular
(IC)	IC DIP
(MI)	Military designs

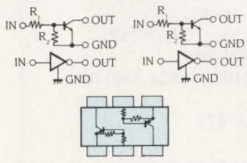
Real help.

When you're looking for solutions that work *today,* call us. We have products that'll give you some real help.

ROHM makes a great line of components—monolithic and hybrid ICs, LEDs, displays, LCDs, discretes, passives, printheads and more. In fact, we're among the world's top 25 semiconductor companies.

Dual Digital Transistors



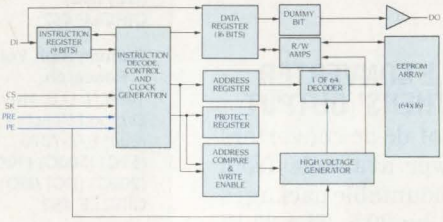


Take our digital transistor series. These combine up to four resistors and two transistors in a SOT-36—a neat little package we developed so we could put more stuff into the same space as the good old SOT-23. And save you a lot of real estate on the circuit board.

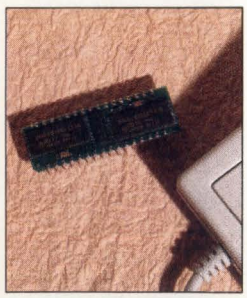
You can get V_{ce} ratings from 11 to 120 volts, and current ranges from 30 to 100 mA. Whichever configuration you choose, they're all the same size, which sure helps simplify your layout. And their surface-mount packaging makes them popular with the manufacturing folks, too.

SRAMs

If you're looking for a way to cram 2 Mbits of static RAM into a 1 Mbit space, take a look at our BPS81288P.



It's a standard 32-pin DIP module loaded with eight TAB-type CMOS memory ICs, plus chip select logic and on-board capacitors. IC memory is organized as 32,768 X 8-bit words.



TAB fabrication makes this SRAM low—in profile and in problems. CMOS logic makes the device low in power requirements, too. Typical operating power for each of the eight memory ICs is 40 mW (f=1 MHz), with standby at only 10 mW.

Access time is 100 nsec, with chip select times running 150 nsec maximum. No clock or refresh is required, and all I/Os are TTL-compatible.

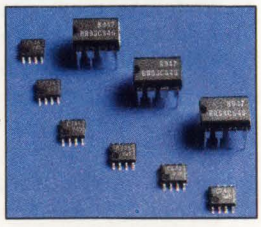
E²PROMs

Maybe you need a PROM with low power consumption and high reprogrammability. If so, take a look at our new CMOS 1024-bit EEPROM, the best alternative to traditional NMOS we know of.

In addition to all the standard features you'd expect, the BR93CS46 operates at a low 2.7 volts, drawing only 20 μA with minimum read voltage of 2 V. And you can even run it at a full 1 MHz.

The BR93CS46 gives you external read/write memory in sixty-four 16-bit registers, and interfaces with standard microprocessors like Intel's 8048/49/51/96, National's COP4XX, Motorola's 6801/05, TI's TMS1000, and Zilog's Z8. Seven 9-bit instructions control everything.

Next time you're trying to figure out a solution that works today—or tonight—FAX us an S.O.S. Thank-you.



Then turn off the light and go home. Your family will thank you, too.

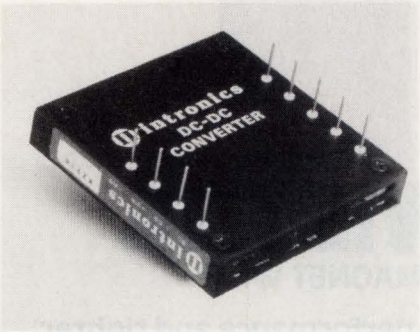
ROHM

ROHM Corporation, ROHM Electronics Division ■ 8 Whatney ■ Irvine, CA 92718 ■ (714) 855-2131 ■ FAX (714) 855-1669

CIRCLE 114

▼ CONVERTERS SPORT ONE OR THREE OUTPUTS

The telecommunication, instrumentation, and computer industries will find use for the KZ200 Series of single- and triple-output dc-dc converters. The single-output devices have outputs of 5, 12, or 15 V dc. The triple

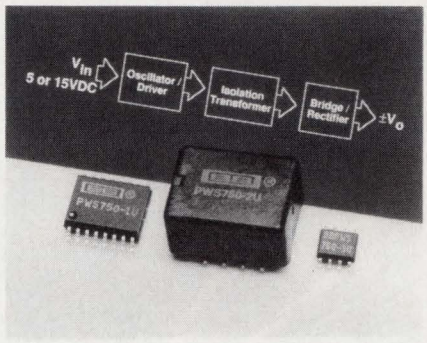


unit offers outputs of 5 and ±12 V dc or 5 and ±15 V dc. Input ranges of 20 to 60 V dc and 36 to 72 V dc are available. There are 10 models in the series. Line and load regulation is ±1% on main outputs and ±5% on others from 20% to 100% load. In lots of one to nine, the single- and triple-output models cost $92 and $110 each, respectively. Delivery is in four weeks after receipt of order.

Intronics Inc.
150 Dan Rd.
Canton, MA 02021
(617) 828-4992
▶ CIRCLE 742

▼ COMPONENT SYSTEM BUILDS ISOLATED CONVERTERS

The PWS750 component system makes it easy to design and build isolated dc-dc converters for various applications. The basic system consists of oscillator-driver, isolation transformer, and diode-bridge building blocks in very small surface-mounted packages. The components can be assembled into single- or multiple-



channel configurations with 15-V dc outputs and 750-V rms isolation from input to output and channel to channel. In lots of 100, each set of building blocks goes for under $9. Delivery for small quantities is from stock to four weeks.

Burr-Brown Corp.
P.O. Box 11400
Tucson, AZ 85734
(800) 548-6132
▶ CIRCLE 743

POWER-CONVERTER MANUFACTURERS

OECO Corp.
4607 S.E. International Way
Milwaukie, OR 97222
(503) 659-7932
(50C) (51C) (500C) (11C) (200C) (DC) (MI)
CIRCLE 478

Onan Power/Electronics
9713 Valley View Rd.
Minneapolis, MN 55344
(612) 943-4642
(50C) (51C) (10C) (11C) (200C) (DC) (AC)
CIRCLE 479

PDS Technologies
875 Bridgeport Ave.
Shelton, CT 06484
(203) 925-0123
(50C) (11C) (200C) (DC) (MI)
CIRCLE 480

Panasonic Industrial Co. Power Supplies Div.
1600 McCandless Dr.
Milpitas, CA 95035
(408) 946-7200
(50C) (11C) (MO)
CIRCLE 481

Phoenix Contact Inc.
P.O. Box 4100
Harrisburg, PA 17111
(717) 944-1300
(50C) (10C) (11C) (DC) (AC) (MO)
CIRCLE 482

Pico Electronics Inc.
453 N. MacQuesten Pkwy.
Mt. Vernon, NY 10552
(914) 699-5514
(50C) (51C) (500C) (10C) (11C)
CIRCLE 483

Pioneer Magnetics Inc.
1745 Berkeley St.
Santa Monica, CA 90404
(800) 233-1745
(200C) (DC) (AC)
CIRCLE 484

Polytron Devices Inc.
P.O. Box 398
Paterson, NJ 07544
(201) 345-5885
(50C) (DC) (MO) (IC) (MI)
CIRCLE 485

Power Conversion Products
42 East St., P.O. Box 380
Crystal Lake, IL 60014
(815) 459-9100
(50C) (200C) (DC) (AC) (MO)
CIRCLE 486

Power General Unitrode Corp.
152 Will Dr., P.O. Box 189
Canton, MA 02021
(617) 828-6216
(50C) (51C) (11C) (DC) (AC)
CIRCLE 487

Power Systems Inc.
45 Griffin Rd. South
Bloomfield, CT 06002
(203) 726-1300
(50C) (51C) (11C) (200C) (DC) (AC)
CIRCLE 488

Power Trends Inc.
1101 N. Raddant Rd.
Batavia, IL 60510
(708) 406-0900
(50C) (10C) (11C) (DC)
CIRCLE 489

Powercube Corp.
18810 N. Glenville #102
Richardson, TX 75081
(214) 480-9281
(50C) (51C) (10C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 490

Preferred Electronics Inc.
Main Line Dr., P.O. Box 248
Westfield, MA 01086
(413) 568-2301
(50C) (11C) (200C) (DC) (MO)
CIRCLE 491

Qualidyne Systems Inc.
3055 Del Sol Blvd.
San Diego, CA 92154
(619) 575-1100
(50C) (11C) (200C) (DC) (MO)
CIRCLE 492

RO Associates Inc.
246 Caspian Dr.
Sunnyvale, CA 94089
(408) 744-1450
(50C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 493

Rantec Microwave & Electronics
9401 Oso Ave.
Chatsworth, CA 91311
(818) 885-8223
(50C) (51C) (500C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 494

Reich Associates Inc.
Rte. 4, Box 4620
Lakehills, TX 78063
(512) 751-3220
(50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MO) (MI)
CIRCLE 495

Reliance Comm/Tec Lorain Products
1122 F St.
Lorain, OH 44052
(216) 288-1122
(51C) (200C) (DC)
CIRCLE 496

Resonant Power Technology Inc.
3350 Scott Blvd., Bldg. 42/01
Santa Clara, CA 95051
(408) 982-0200
(50C) (DC)
CIRCLE 497

Ritz Electronics Ltd.
196 Queens St. N.
New Dundee, Ontario, Canada
NOB 2EO
(519) 696-2616
(50C) (DC) (AC)
CIRCLE 498

SGS-THOMSON Microelectronics
1000 E. Bell Rd.
Phoenix, AZ 85022
(602) 867-6289
(50C) (10C) (11C) (DC) (MO) (IC)
CIRCLE 499

Semiconductor Circuits Inc.
49 Range Rd.
Windham, NH 03087
(603) 893-2330
(50C) (11C) (DC) (MO) (IC)
CIRCLE 500

Shindengen America Inc.
5999 New Wilke Rd., #406
Rolling Meadows, IL 60008
(708) 593-8585
(50C) (10C) (11C) (DC) (MO)
CIRCLE 501

Shogyo International Corp.
287 Northern Blvd.
Great Neck, NY 11021-4799
(516) 466-0911
(50C) (10C) (11C) (DC) (AC) (MO)
CIRCLE 502

Sierra West Power System
2615 Missouri Ave., Bldg. 5
Las Cruces, NM 88001
(505) 522-8828
(50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MO) (MI)
CIRCLE 503

Solidstate Controls Inc.
875 Dearborn Dr.
Columbus, OH 43085
(614) 846-7500
(51C) (200C) (AC)
CIRCLE 504

Switching Systems International
500 Porter Way
Placentia, CA 92670
(714) 996-0909
(50C) (11C) (DC)
CIRCLE 505

(continued on p. 95)

KEY

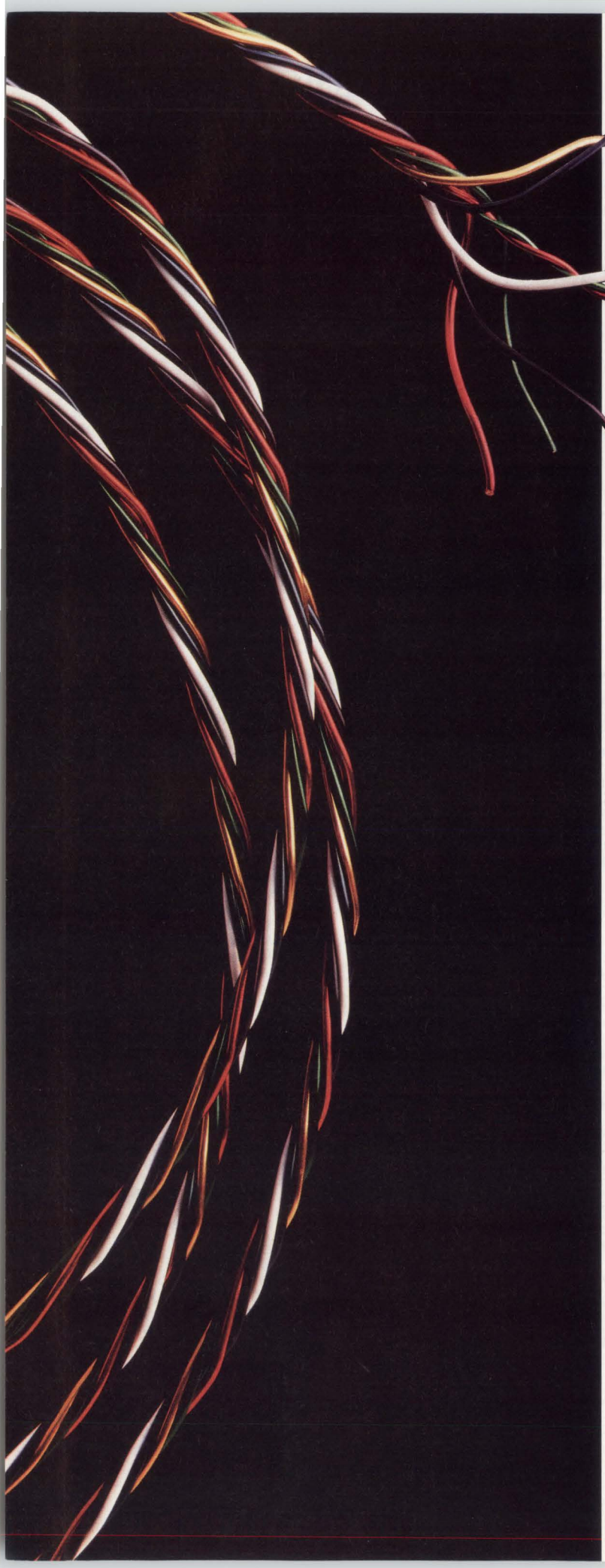
Power Converters

Output

(50C)	To 50 V
(51C)	51 to 500 V
(500C)	Over 500 V
(10C)	To 10 W
(11C)	11 to 200 W
(200C)	Over 200 W

Types

(DC)	Dc to dc
(AC)	Dc to ac
(MO)	Modular
(IC)	IC DIP
(MI)	Military designs



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For superior performance and tighter control over twisted wire construction.

Developed for use in the production of custom toroid, ferrite or recording head coils, specialty audio and R.F. transformers, TWISTITE offers a number of distinct advantages.

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MWS
Wire Industries

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818 991-8553 FAX 818 706-0911

CIRCLE 135

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POWER-CONVERTER MANUFACTURERS

Tamura Corp. of America
1150 Dominguez St.
Carson, CA 90746-3518
(213) 638-1790
(50C) (51C) (10C) (11C) (DC) (AC) (MO) (IC)
CIRCLE 506

Technology Dynamics Inc.
100 School St.
Bergenfield, NJ 07621
(201) 385-0500
(50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MO)
CIRCLE 507

Teledyne Components
1300 Terra Bella Ave.
Mountain View, CA 94039-7267
(415) 968-9241
(50C) (DC) (MO) (IC) (MI)
CIRCLE 508

Todd Products Corp.
50 Emjay Blvd.
Brentwood, NY 11717
(516) 231-3366
(50C) (51C) (10C) (11C) (200C) (DC) (MO)
CIRCLE 571

Toko America Inc.
1250 Feehanville Dr.
Mount Prospect, IL 60056
(708) 297-0070
(50C) (10C) (11C) (DC)
CIRCLE 572

Total Power International
418 Bridge St.
Lowell, MA 01850
(508) 453-7272
(50C) (10C) (11C) (DC) (AC) (MO) (IC)
CIRCLE 573

Transistor Devices Inc.
274 S. Salem St.
Randolph, NJ 07869
(201) 361-6622
(50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MO) (MI)
CIRCLE 574

U.S. Elco Inc.
2930 Scott Blvd.
Santa Clara, CA 95054
(408) 980-5144
(50C) (10C) (DC)
CIRCLE 575

Unipower Corp.
2981 Gateway Dr.
Pompano Beach, FL 33069
(305) 974-2442
(50C) (51C) (200C) (DC)
CIRCLE 576

Universal Voltronics
27 Radio Circle Dr.
Mt. Kisco, NY 10549
(914) 241-1300
(500C) (200C) (DC) (MI)
CIRCLE 577

VSR Corp.
4609 S. 33rd Pl.
Phoenix, AZ 85040
(602) 243-6200
(50C) (51C) (10C) (11C) (200C) (DC) (AC)
CIRCLE 578

Vicor Corp.
23 Frontage Rd.
Andover, MA 01810
(508) 470-2900
(50C) (10C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 579

Viking Industrial Products
729 Farm Rd.
Marlboro, MA 01752
(508) 481-4600
(50C) (51C) (10C) (11C) (200C) (DC) (AC)
CIRCLE 580

Voltex Co. Inc.
3460 Great Neck Rd.
N. Amityville, NY 11701
(516) 842-2772
(50C) (51C) (500C) (10C) (11C) (200C) (DC) (MO)
CIRCLE 581

Wall Industries Inc.
5 Watson Brook Rd.
Exeter, NH 03833
(603) 778-2300
(50C) (51C) (500C) (10C) (11C) (DC) (MO) (IC)
CIRCLE 582

Wells-Gardner Electronics
2701 N. Kildare
Chicago, IL 60639
(312) 252-8220
(50C) (51C)
CIRCLE 583

Westcor Corp.
485-100 Alberto Way
Los Gatos, CA 95032
(408) 395-7050
(50C) (10C) (11C) (DC) (MO) (MI)
CIRCLE 584

Zenith Electronics Corp.
1000 Milwaukee Ave.
Glenview, IL 60025
(708) 391-8510
(50C) (11C) (DC)
CIRCLE 585

KEY

Power Converters

Output

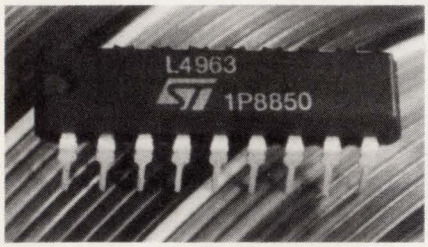
(50C)	To 50 V
(51C)	51 to 500 V
(500C)	Over 500 V
(10C)	To 10 W
(11C)	11 to 200 W
(200C)	Over 200 W

Types

(DC)	Dc to dc
(AC)	Dc to ac
(MO)	Modular
(IC)	IC DIP
(MI)	Military designs

▼ HIGH-CURRENT REGULATOR SUITS LOW-COST JOBS

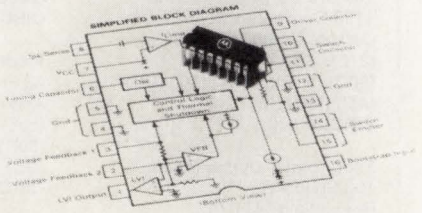
The L4963 high-current switching regulator IC is a step-down converter that operates in discontinuous mode. The device, which is optimized for low-cost applications, can deliver up to 1.5 A with an input voltage up to 46 V. The output voltage is variable from 5.1 to 40 V. Packaging is an 18-lead DIP with a 12+3+3 lead frame. The IC operates without a heat sink and needs just a few square centimeters of pc-board copper on the ground plane to dissipate heat. Discontinuous-mode operation permits the use of an inductor of just 40 μH, which keeps circuit costs low. Various protection and supervision functions are included. Pricing is $2.50 in lots of 1000. Small quantities are delivered from stock.



SGS-Thomson Microelectronics
1000 E. Bell Rd.
Phoenix, AZ 85022
(602) 867-6100
▶ CIRCLE 744

▼ 3-A SWITCHING REGULATOR EASES DC-DC DESIGNS

An on-chip output switch capable of controlling currents of more than 3 A is featured in the MC34163 switching-regulator IC. The device contains the primary functions needed for dc-dc converters and is designed to implement step-up, step-down, and voltage-inverting applications with a minimum of external components. The IC operates from a 2.5-to-40-V input and includes a 2% reference. Standby current is just 6 mA. The device costs $1.14 for the commercial version and $1.34 for the industrial type in lots of 10,000. Delivery is from stock.



Motorola Inc.
Bipolar Analog IC Div.
2100 E. Elliot Rd.
Tempe, AZ 85284
(602) 897-3615
▶ CIRCLE 745

POWER-REGULATOR MANUFACTURERS

A E S Corp.
P.O. Box 209
Peabody, MA 01960
(508) 535-7310
(50R) (11R) (10R) (LI) (SW) (MU)
CIRCLE 586

Abbott Electronics Inc.
2727 S. La Cienega Blvd.
Los Angeles, CA 90034
(213) 202-8820
(50R) (LI) (SW) (MU) (ML)
CIRCLE 587

Acme Electric Corp.
20 Water St.
Cuba, NY 14727
(716) 968-2400
(50R) (51R) (11R) (200R) (LI) (SW) (ML)
CIRCLE 588

Ault Inc.
7300 Boone Ave. N.
Minneapolis, MN 55428
(612) 493-1900
(LI) (SW)
CIRCLE 589

Bikor Corp.
1504 W. 228th St
Torrance, CA 90501
(213) 539-6320
(50R) (11R) (200R) (SW) (MU)
CIRCLE 590

Boeing Electronics Co. Electronic Systems Div.
P.O. Box 3999, M/S 9F-UF
Seattle, WA 98124-2499
(206) 657-7474
(50R) (SW) (MU) (ML)
CIRCLE 591

CEAG Electric Corp.
1324 Motor Pkwy.
Hauppauge, NY 11788
(516) 582-4422
(50R) (51R) (200R) (SW) (MU) (ML)
CIRCLE 592

Cherry Semiconductor Corp.
2000 S. County Trail
Warwick, RI 02818
(401) 885-3600
(50R) (10R) (LI) (SW) (ID)
CIRCLE 593

Computer Power Inc.
124 W. Main St.
High Bridge, NJ 08829
(908) 638-8000
(200R) (SW)
CIRCLE 594

Computer Products Inc. Power Conversion
3785 Spinnaker Ct.
Fremont, CA 94538
(415) 657-6700
(50R) (SW)
CIRCLE 595

Controlled Power Co.
1955 Stephenson Hwy.
Troy, MI 48083
(313) 528-3700
(50R) (51R) (500R) (10R) (11R) (SW)
CIRCLE 596

Current Technology Power Supplies Div.
1400 S. Sherman
Richardson, TX 75081
(214) 238-5300
(50R) (51R) (11R) (200R) (SW) (MU)
CIRCLE 597

Custom Power Systems
33 Comac Loop
Ronkonkoma, NY 11779
(516) 467-5328
(50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 598

Cyberpak Co. Custom Design
251 S. Frontage Rd. #23
Burr Ridge, IL 60521
(800) 328-3938
(11R) (200R) (SW)
CIRCLE 599

EG&G Power Systems
1330 E. Cypress St.
Covina, CA 92635
(818) 967-9521
(LI) (SW) (ML)
CIRCLE 600

EMCO High Voltage Co.
11126 Ridge Rd.
Sutter Creek, CA 95685
(209) 223-3626
(50R) (51R) (500R) (10R) (11R) (LI) (SW) (MU) (ID) (ML)
CIRCLE 601

Endicott Research Group Inc.
P.O. Box 267
Endicott, NY 13760
(607) 754-9187
(50R) (LI) (SW)
CIRCLE 602

Gamma High Voltage Research
1096 N. U.S. Hwy. #1
Ormond Beach, FL 32174
(904) 677-7070
(51R) (500R) (10R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 603

HC Power Inc.
17032 Armstrong Ave.
Irvine, CA 92705
(714) 261-2200
(50R) (200R) (SW)
CIRCLE 604

Hitachi America Ltd. Semiconductor & IC Div.
2000 Sierra Point Pkwy.
Brisbane, CA 94005-1819
(415) 589-8300
(SW)
CIRCLE 605

Integrated Power Designs Inc.
9C Princess Rd.
Lawrenceville, NJ 08648
(609) 896-2122
(50R) (10R) (11R) (SW)
CIRCLE 606

International Power DC
373 Dawson Dr.
Camarillo, CA 93012
(805) 987-7900
(LI)
CIRCLE 607

International Power Sources
200 Butterfield Dr.
Ashland, MA 01721
(508) 881-7434
(SW)
CIRCLE 608

Intronics Inc.
150 Dan Rd.
Canton, MA 02021
(617) 828-4992
(SW)
CIRCLE 609

Jerome Industries
730 Division St.
Elizabeth, NJ 07201
(201) 353-5700
(50R) (LI) (SW)
CIRCLE 610

John Fluke Mfg. Co. Philips T & M Group
P.O. Box 9090
Everett, WA 98206
(206) 356-6157
(SW)
CIRCLE 611

Keltec Florida
P.O. Box 2917
Fort Walton Beach, FL 32549
(904) 244-0043
(50R) (51R) (500R) (10R) (11R) (200R) (SW) (ML)
CIRCLE 612

Kepco Inc.
131-38 Sanford Ave.
Flushing, NY 11352
(718) 461-7000
(50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW) (MU)
CIRCLE 613

Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035-7487
(408) 432-1900
(50R) (51R) (10R) (11R) (LI) (SW) (ID) (ML)
CIRCLE 614

(continued on p. 97)

KEY

Power Regulators

Output

(50R)	To 50 V
(51R)	51 to 500 V
(500R)	Over 500 V
(10R)	To 10 W
(11R)	11 to 200 W
(200R)	Over 200 W

Types

(LI)	Linear
(SW)	Switching
(MU)	Modular
(ID)	IC DIP
(ML)	Military designs

POWER-REGULATOR MANUFACTURERS

M.S. Kennedy Corp.
8170 Thompson Rd.
Clay, NY 13041
(315) 699-9201
(50R) (51R) (10R) (11R) (LI) (ML)
CIRCLE 615

MIL Electronics Inc.
106 Perimeter Rd.
Nashua, NH 03063
(603) 882-3200
(50R) (51R) (500R) (10R) (11R) (SW) (ML)
CIRCLE 616

Melcher Inc.
200 Butterfield Dr.
Ashland, MA 01721
(508) 881-4715
(50R) (10R) (11R) (200R) (SW) (MU) (IC) (ML)
CIRCLE 617

Micrel Semiconductor
560 Oakmead Pkwy.
Sunnyvale, CA 94086
(408) 245-2500
(ID)
CIRCLE 618

Micro Linear Corp.
2092 Concourse Dr.
San Jose, CA 95131
(408) 433-5200
(SW)
CIRCLE 619

Micropac Industries Inc.
905 E. Walnut St.
Garland, TX 75040
(214) 272-3571
(50R) (10R) (11R) (LI) (MU) (ML)
CIRCLE 620

Modular Devices Inc.
4115 Spencer St.
Torrance, CA 90503
(213) 542-8561
(SW) (MU)
CIRCLE 621

Modupower Inc.
374 Turquoise St.
Milpitas, CA 95035
(408) 263-6115
(50R) (10R) (11R) (SW) (ID)
CIRCLE 622

Multi Products International
250 Lackawanna Ave.
West Paterson, NJ 07424
(201) 890-1344
(50R) (10R) (11R) (LI) (SW) (MU)
CIRCLE 623

NH Research Inc.
16601 Hale Ave.
Irvine, CA 92714
(714) 474-3900
(SW) (MU)
CIRCLE 624

National Semiconductor
2900 Semiconductor Dr.
M/S 16-300
Santa Clara, CA 95052
(408) 721-2641
(50R) (10R) (11R) (LI) (SW) (MU) (ID) (ML)
CIRCLE 625

Omnirel Corp.
205 Crawford St.
Leominster, MA 01453
(508) 534-5776
(50R) (10R) (11R) (LI) (SW) (ML)
CIRCLE 626

Onan Power/Electronics
9713 Valley View Rd.
Minneapolis, MN 55344
(612) 943-4642
(50R) (51R) (10R) (11R) (200R) (LI) (SW)
CIRCLE 627

PDS Technologies
875 Bridgeport Ave.
Shelton, CT 06484
(203) 925-0123
(50R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 628

Panasonic Industrial Co.
Power Supplies Div.
1600 McCandless Dr.
Milpitas, CA 95035
(408) 946-7200
(50R) (11R) (SW) (MU)
CIRCLE 629

Phoenix Contact Inc.
P.O. Box 4100
Harrisburg, PA 17111
(717) 944-1300
(50R) (10R) (11R) (LI) (MU)
CIRCLE 630

Pico Electronics Inc.
453 N. MacQuesten Pkwy.
Mt. Vernon, NY 10552
(914) 699-5514
(50R) (10R) (11R) (LI) (SW)
CIRCLE 631

Polytron Devices Inc.
P.O. Box 398
Paterson, NJ 07544
(201) 345-5885
(50R) (LI) (SW) (MU) (ML)
CIRCLE 632

Power Conversion Products
42 East St., P.O. Box 380
Crystal Lake, IL 60014
(815) 459-9100
(LI) (SW)
CIRCLE 633

Power General
Unitrode Corp.
152 Will Dr., P.O. Box 189
Canton, MA 02021
(617) 828-6216
(SW) (MU)
CIRCLE 634

Power Systems Inc.
45 Griffin Rd. South
Bloomfield, CT 06002
(203) 726-1300
(50R) (51R) (500R) (10R) (11R) (200R) (SW)
CIRCLE 635

Power Trends Inc.
1101 N. Raddant Rd.
Batavia, IL 60510
(708) 406-0900
(50R) (10R) (11R) (SW)
CIRCLE 636

Power-One Inc.
740 Calle Plano
Camarillo, CA 93010-6090
(818) 889-5084
(50R) (51R) (10R) (11R) (200R) (LI) (SW) (MU)
CIRCLE 637

Powercube Corp.
18810 N. Glenville #102
Richardson, TX 75081
(214) 480-9281
(50R) (51R) (10R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 638

Preferred Electronics Inc.
Main Line Dr., P.O. Box 248
Westfield, MA 01086
(413) 568-2301
(50R) (51R) (11R) (200R) (LI) (SW)
CIRCLE 639

Qualidyne Systems Inc.
3055 Del Sol Blvd.
San Diego, CA 92154
(619) 575-1100
(50R) (11R) (200R) (LI) (SW) (MU)
CIRCLE 640

RO Associates Inc.
246 Caspian Dr.
Sunnyvale, CA 94089
(408) 744-1450
(50R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 641

Rantec Microwave
& Electronics
9401 Oso Ave.
Chatsworth, CA 91311
(818) 885-8223
(50R) (51R) (500R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 642

Reich Associates Inc.
Rte. 4, Box 4620
Lakehills, TX 78063
(512) 751-3220
(LI) (SW)
CIRCLE 643

Reliance Comm/Tec
Lorain Products
1122 F St.
Lorain, OH 44052
(216) 288-1122
(50R) (200R) (SW) (MU)
CIRCLE 644

(continued on p. 98)

KEY

Power Regulators

Output

(50R)	To 50 V
(51R)	51 to 500 V
(500R)	Over 500 V
(10R)	To 10 W
(11R)	11 to 200 W
(200R)	Over 200 W

Types

(LI)	Linear
(SW)	Switching
(MU)	Modular
(ID)	IC DIP
(ML)	Military designs

POWER-REGULATOR MANUFACTURERS

Resonant Power Technology Inc.
3350 Scott Blvd., Bldg. 42/01
Santa Clara, CA 95051
(408) 982-0200
(SW) (MU) (ML)
CIRCLE 645

Ritz Electronics Ltd.
196 Queens St. N.
New Dundee, Ontario,
Canada NOB 2EO
(519) 696-2616
(50R) (51R) (10R) (11R) (200R) (LI) (ML)
CIRCLE 646

SGS-THOMSON Microelectronics
1000 E. Bell Rd.
Phoenix, AZ 85022
(602) 867-6289
(50R) (200R) (SW) (ID)
CIRCLE 647

Samsung Semiconductor
3725 N. First St.
San Jose, CA 95131-1708
(408) 954-7264
(50R) (LI) (SW)
CIRCLE 648

Shogyo International Corp.
287 Northern Blvd.
Great Neck, NY 11021-4799
(516) 466-0911
(50R) (10R) (LI) (MU)
CIRCLE 649

Sierra West Power Systems
2615 Missouri Ave., Bldg. 5
Las Cruces, NM 88001
(505) 522-8828
(50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 650

Silicon General Inc. Semiconductor
11861 Western Ave.
Garden Grove, CA 92641
(714) 898-8121
(50R) (10R) (LI) (SW) (MU) (ID) (ML)
CIRCLE 651

Sola Electric A Unit of General Signal
1717 Busse Rd.
Elk Grove Village, IL 60007
(708) 439-2800
(51R) (11R) (200R) (LI) (SW)
CIRCLE 652

Solidstate Controls Inc.
875 Dearborn Dr.
Columbus, OH 43085
(614) 846-7500
(200R) (LI)
CIRCLE 653

Sorensen Co.
5555 N. Elston Ave.
Chicago, IL 60630
(312) 775-0843
(500R) (LI)
CIRCLE 654

Switching Systems International
500 Porter Way
Placentia, CA 92670
(714) 996-0909
(50R) (11R) (200R) (SW)
CIRCLE 655

Tamura Corp. of America
1150 Dominguez St.
Carson, CA 90746-3518
(213) 638-1790
(50R) (51R) (10R) (11R) (LI) (SW)
CIRCLE 656

Technology Dynamics Inc.
100 School St.
Bergenfield, NJ 07621
(201) 385-0500
(LI) (SW)
CIRCLE 657

Teledyne Components
1300 Terra Bella Ave.
Mountain View, CA 94039-7267
(415) 968-9241
(10R) (LI) (SW) (MU) (ID) (ML)
CIRCLE 658

Texas Instruments Semiconductor Div.
P.O. Box 809066
Dallas, TX 75380-9066
(800) 232-3200
(50R) (10R) (LI) (SW) (IC)
CIRCLE 659

Todd Products Corp.
50 Emjay Blvd.
Brentwood, NY 11717
(516) 231-3366
(50R) (51R) (10R) (11R) (200R) (SW) (MU)
CIRCLE 660

Total Power International
418 Bridge St.
Lowell, MA 01850
(508) 453-7272
(50R) (LI) (SW) (MU) (ID)
CIRCLE 661

Transistor Devices Inc.
274 S. Salem St.
Randolph, NJ 07869
(201) 361-6622
(50R) (LI) (SW) (ML)
CIRCLE 662

Universal Voltronics
27 Radio Circle Dr.
Mt. Kisco, NY 10549
(914) 241-1300
(500R) (200R) (LI) (SW) (ML)
CIRCLE 663

VSR Corp.
4609 S. 33rd Pl.
Phoenix, AZ 85040
(602) 243-6200
(50R) (51R) (10R) (11R) (200R) (LI)
CIRCLE 664

Vicor Corp.
23 Frontage Rd.
Andover, MA 01810
(508) 470-2900
(50R) (10R) (11R) (200R) (LI) (SW) (MU) (ML)
CIRCLE 665

Viking Industrial Products
729 Farm Rd.
Marlboro, MA 01752
(508) 481-4600
(50R) (51R) (11R) (200R) (LI) (SW)
CIRCLE 666

Voltex Co. Inc.
3460 Great Neck Rd.
N. Amityville, NY 11701
(516) 842-2772
(50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW)
CIRCLE 667

Wells-Gardner Electronics
2701 N. Kildare
Chicago, IL 60639
(312) 252-8220
(50R) (51R) (SW)
CIRCLE 668

KEY

Power Regulators

Output

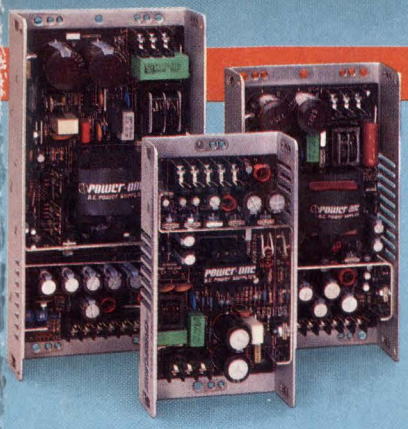
(50R)	To 50 V
(51R)	51 to 500 V
(500R)	Over 500 V
(10R)	To 10 W
(11R)	11 to 200 W
(200R)	Over 200 W

Types

(LI)	Linear
(SW)	Switching
(MU)	Modular
(ID)	IC DIP
(ML)	Military designs

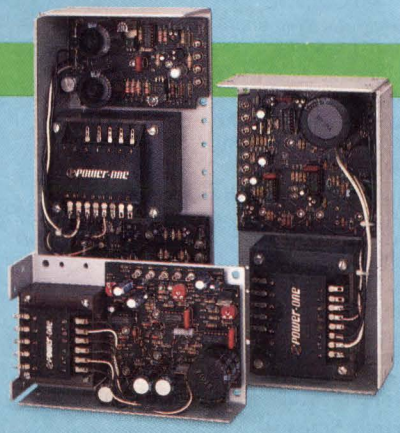
POWER-ONE D.C. POWER SUPPLIES

Not Only The Best...The Best Selection, Too



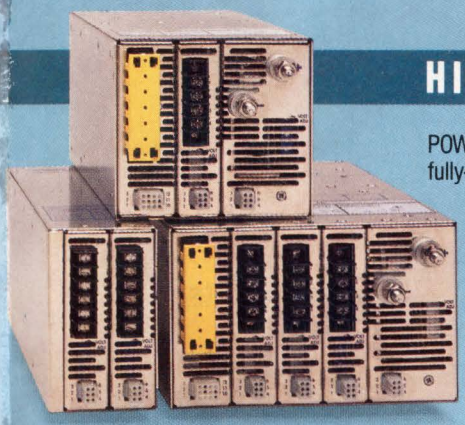
SWITCHERS

POWER-ONE'S International Switcher Series incorporates the latest state-of-the-art switching technology while providing POWER-ONE's traditional high quality at low prices. With certification to the world's toughest safety agency requirements, the series is especially suited for products sold not only domestically, but internationally as well. **• 85 models. . .40 watts to 400 watts • Efficient. . .reliable. . .economical • VDE construction • Up to 5 fully regulated outputs • Full international safety and EMI approvals**



LINEARS

POWER-ONE'S International Linear Series is the world's undisputed leader in versatile, cost-effective linear power supply products. A long-time favorite of designers and engineers worldwide, the series is the most widely purchased power supply line through distribution in the industry. The most popular voltage and current combinations are available in a wide variety of off-the-shelf standard models. **• Popular industry standard packages • 77 models. . . 6 watts to 280 watts • ±0.05% regulation • Up to 4 fully regulated outputs • Worldwide safety approvals**



HIGH POWER

POWER-ONE'S International High Power Series is the industry's only true fully-modular high power product line. Specify a power system that meets your exact requirements from a wide selection of single, dual and triple output plug-in power modules. Virtually any combination of output voltage and current rating can be delivered from stock. **• 500 watts to 1500 watts • Fully modular construction • Up to 15 fully regulated outputs • UPS battery backup option • Parallelable outputs with current sharing**

TOLL-FREE LITERATURE HOT-LINE: (800) 678-9445

POWER-ONE offers one of the largest selections of switcher, linear, and high power standard models in the world. So, whatever your D.C. power supply requirement calls for, make POWER-ONE your first choice and be sure you're getting the best—not only in quality, but selection and value as well. Call today for our new 1990 catalogs.

"Innovators in Power Supply Technology"

POWER-ONE D.C. POWER SUPPLIES

POWER-ONE, INC.
740 Calle Plano • Camarillo, CA 93012-8583
Phone: (805) 987-8741 • (805) 987-3891
TWX: 910-336-1297 • FAX: (805) 388-0476

CIRCLE 133

Coilcraft Designer's Kits

First they save you time. Then they save you money.

These kits make it easier than ever to pick the right coils, chokes and other magnetics for your project.

Why waste hours calling around for samples or trying to wind them yourself. Coilcraft's low-cost kits put dozens of values right at your fingertips!

You not only save time on engineering. You also save money when you go into production because we stock just about all the parts in our kits at low off-the-shelf prices.

Call in today, and you can have your kit tomorrow!

To order, phone **800/322-COIL**.

"Unicoil" 7/10 mm Tuneable Inductors
.0435 µH - 1.5 µH
49 shielded, 49 unshielded (2 of each)
Kit M102 $60

"Slot Ten" 10 mm Tuneable Inductors
0.7 µH - 1143 µH
18 shielded, 18 unshielded (3 of each)
Kit M100 $60

Surface Mount Inductors
4 nH - 33 µH
48 values (10 of each)
Kit C100 $125

Axial Lead Chokes
0.1 µH - 1000 µH
25 values (5 of each)
Kit F101 $50

Horizontal Mount Inductors
Tuneable and fixed
Inductance: 31.5 - 720nH
33 Values (6 of each)
Kit M104 $60

Common Mode Data Line Filters
Attenuation bandwidth: 15 dBm,1.5-30 mHz
DC current capacity: 100 mA
2, 3, 4 and 8 line styles (4 of each)
Kit D101 $65

Common Mode Line Chokes
Current: .25 - 9 amps RMS
Inductance: 508 µH - 10.5 mH
8 styles (2 of each)
Kit P202 $100

Current Sensors
Sensing range: 0.5-35 amps
Freq. resp.: 1 - 100 kHz, 50 - 400 Hz
Transformer and sensor-only versions
8 styles (15 total pieces)
Kit P203 $50

Base/Gate Driver Transformers
Inductance: 1.5 mH Min.
Frequency: 10 - 250 kHz
2 single, 2 double section (2 of each)
Kit P204 $50

Mag Amp Toroids
Current: 1, 5 amps
Volt-time product: 42 - 372 V-µsec
6 styles (2 of each)
Kit P206 $100

Power Filter Chokes
Current: 3, 5, 10 amps
Inductance: 5 - 300 µH
18 styles (48 total pieces)
Kit P205 $75

Axial Lead Power Chokes
Current: .03-4.3 amps
Inductance: 3.9 µH - 100 mH
60 styles (2 of each)
Kit P209 $150

Coilcraft

eem/electronic engineers master See our catalog in Vol. A, Section 1800

1102 Silver Lake Rd., Cary IL 60013 800/322-COIL Fax 708/639-1469

CIRCLE 143

▼ LITHIUM-CELL PAIRS BACK UP MEMORIES

Two-cell encapsulated lithium-battery sets are designed for backup of computer memory. The 2ER6K batteries offer a capacity of 1900 mAh and are available in a 6.8-V format with a resistor and diode and a 7.2-V format with diode only. The pairs can be customized with various lead-wire-connector configurations as well as different values of resistors and diodes. The operational-temperature range is from +55 to 85°C.

Maxell Corp. of America
22-08 Route 208
Fair Lawn, NJ 07410
(201) 794-5938
▶ CIRCLE 746

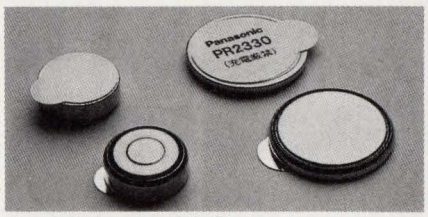
▼ NICKEL-METAL HYDRIDE CELL DOUBLES NICAD LIFE

With twice the run time of same-sized nickel-cadmium batteries, the first of a line of nickel-metal hydride cells can make portable products smaller and lighter. The Cs-sized cell offers 2300 mAh of capacity for applications in cellular phones and notebook computers. Limited production quantities of the cell are available. Shortly, limited quantities will be available of an AA-sized cell with 1100-mAh capacity and a 7/5Af-sized cell with 2300-mAh capacity.

Gates Energy Products Inc.
P.O. Box 861
Gainesville, FL 32602
(904) 462-3911
▶ CIRCLE 747

▼ ZINC-AIR BATTERIES GO BEYOND HEARING AIDS

The first zinc-air batteries not designed for hearing aids are the PR1662 and PR2330 models. The 1.4-V cells are intended for wrist-watch-type pagers, but are also suited for use in pocket-type hearing aids. The PR1662 button cell is rated at 1100 mAh and offers extremely high capacity for its size. The PR2330 coin cell is rated at 700 mAh. Activation is by removal of a tab. Applications for the coin cell include smart cards. Call for pricing and delivery.



Panasonic Industrial Co.
Battery Sales Group
Two Panasonic Way
Secaucus, NJ 07094
(201) 348-5266
▶ CIRCLE 748

BATTERY MANUFACTURERS

A E S Corp.
P.O. Box 209
Peabody, MA 01960
(508) 535-7310
(LC)
CIRCLE 669

AT&T Power Supplies
3000 Skyline Dr.
Mesquite, TX 75149
(214) 288-2428
(LC)
CIRCLE 670

Avex Portable Battery
1683 Winchester Rd.
Bensalem, PA 19020
(215) 638-1515
(AL) (LT) (NC)
CIRCLE 671

Battery Engineering Inc.
1636 Hyde Park Ave.
Hyde Park, MA 02136
(617) 361-7555
(LT)
CIRCLE 672

Battery Fabricators Inc.
P.O. Box 88716
Atlanta, GA 30338
(404) 449-4651
(AL) (CZ) (LC) (LT) (NC) (SO)
CIRCLE 673

Catalyst Research Corp.
3706 Crandall Ln.
Owings Mills, MD 21117
(301) 356-2400
(LT)
CIRCLE 674

Computer Power Inc.
124 W. Main St.
High Bridge, NJ 08829
(908) 638-8000
(LC)
CIRCLE 675

East Penn Mfg. Co. Inc.
Deka Road
Lyon Station, PA 19536
(215) 682-6361
(LC)
CIRCLE 676

Electrochem Industries
10000 Wehrle Dr.
Clarence, NY 14031
(716) 759-7313
(LT)
CIRCLE 677

Gates Energy Products Inc.
P.O. Box 861
Gainesville, FL 32602
(904) 462-3911
(LC) (NC)
CIRCLE 678

Hydrocap Corp.
975 N.W. 95th St.
Miami, FL 33150-2095
(305) 696-2504
(LC) (NC)
CIRCLE 679

Marathon Power Technologies
P.O. Box 8233
Waco, TX 76714-8233
(817) 776-0650
(NC)
CIRCLE 680

Maxell Corp. of America
22-08 Route 208
Fair Lawn, NJ 07410
(201) 794-5938
(AL) (CZ) (LC) (LT) (NC) (SO) (ZC)
CIRCLE 681

Panasonic Industrial Co. Battery Sales
Two Panasonic Way 7A-1
Secaucus, NJ 07094
(201) 348-5266
(AL) (CZ) (LC) (LT) (ME) (NC) (SO) (ZA) (ZC)
CIRCLE 682

Plainview Batteries Inc.
23 Newtown Rd.
Plainview, NY 11803
(516) 249-2873
(LC) (LT) (NC)
CIRCLE 683

Power Card Corp.
391 Totten Pond Rd.
Waltham, MA 02154
(617) 890-6789
(AL) (CZ) (LT)
CIRCLE 684

Power Conversion Products Inc.
P.O. Box 380
Crystal Lake, IL 60014
(815) 459-9100
(LC)
CIRCLE 685

Power-Sonic Corp.
3106 Spring St.
Redwood City, CA 94063
(415) 364-5001
(LC) (NC)
CIRCLE 686

Shogyo International Corp.
287 Northern Blvd.
Great Neck, NY 11021-4799
(516) 466-0911
(AL) (LT) (NC) (SO)
CIRCLE 687

TNR Technical Inc.
279 Douglas Ave., #1112
Altamonte Springs, FL 32701
(800) 346-0601
(AL) (CZ) (LC) (LT) (ME) (NC) (SO)
CIRCLE 688

Tadiran Electronic Industries Batteries Div.
40 Seaview Blvd.
Port Washington, NY 11050
(516) 621-4980
(AL) (LT) (SO)
CIRCLE 689

Tauber Electronics Inc.
4901 Morena Blvd. #314
San Diego, CA 92117
(619) 274-7242
(AL) (CZ) (LC) (LT) (ME) (NC) (SO) (ZA) (ZC)
CIRCLE 690

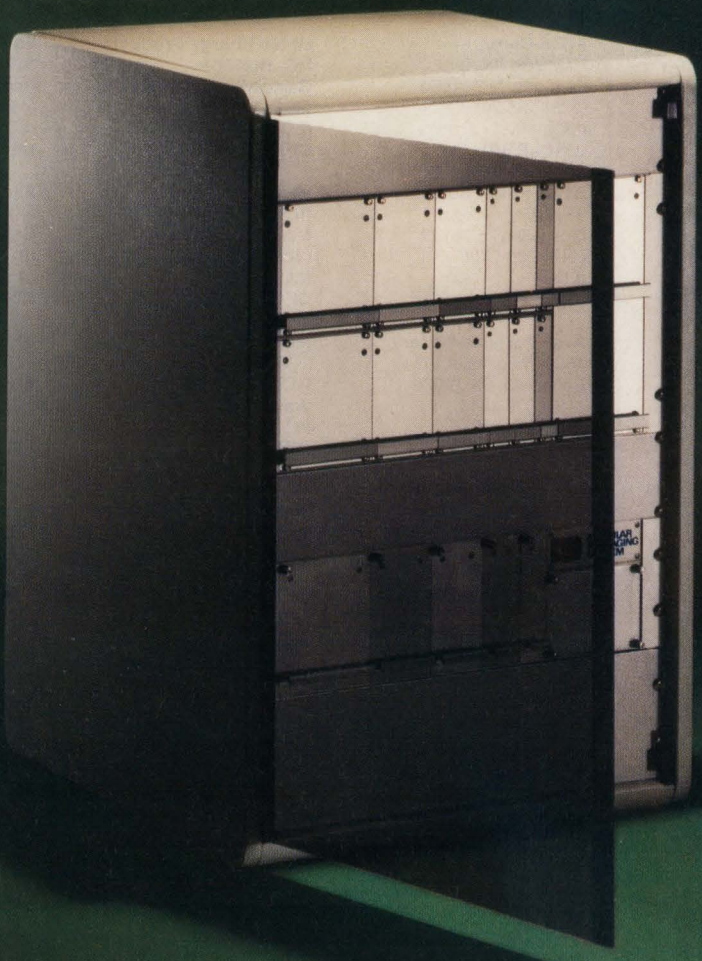
Yuasa Battery (America)
9728 Alburtis Ave.
Santa Fe Springs, CA 90670
(213) 949-4266
(LC) (NC)
CIRCLE 691

KEY

Batteries
(AL) Alkaline
(CZ) Carbon zinc
(LC) Lead acid
(LT) Lithium
(ME) Mercury
(NC) Nickel cadmium
(SO) Silver oxide
(ZA) Zinc air
(ZC) Zinc chloride

JAGUAR™

The ultimate enclosure with sleek, sophisticated styling, computer-aided, high-tech design and functionality and Bud's legendary built-in quality.



The new Jaguar Cabinet offers the contoured elegance of a modern classic in perfect harmony with advanced engineering and inspired technical innovation. Beneath the graceful curves of its removable top cover, you'll discover a rugged steel frame engineered to be incredibly strong and stable. The sophisticated, functional design provides a precise environment for today's, and tomorrow's, high-tech equipment.

Utilizing Bud's standard option packages and our engineer-assisted custom capabilities, we can create a unique Jaguar Cabinet to meet your specific technical requirements.

Bud East, Inc.
4605 East 355th Street
P.O. Box 431
Willoughby, Ohio 44094
(216) 946-3200
FAX: 216-951-4015

Bud Industries, Inc.

Bud West, Inc.
7733 West Olive Avenue
P.O. Box 1029
Peoria, Arizona 85345-0350
(602) 979-0300
FAX: 602-878-5371

BUD...Your Single Source Enclosure Company.

CIRCLE 99

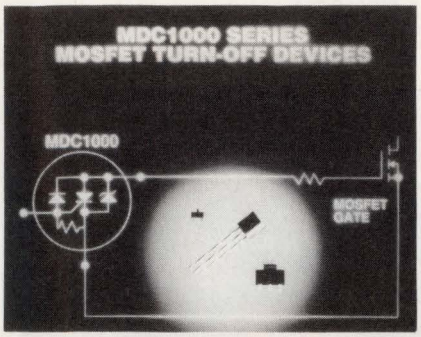
▼ STANDARD TRANSISTORS ARE PACKAGED IN ARRAY

Industry-standard 2N2222, 2N2907, 2N3467, and 2N3725 transistors are now available in an array containing dual, quad, or NPN/PNP complementary-pair configurations. The SGQ line of arrays (SGQ2222, 2907, 3467, and 3725) comes in ceramic DIP, flat pack, and leadless-chip-carrier packages and are fabricated in a MIL-S-19500 facility. Volume pricing for the quad-PNP and quad-NPN arrays is under $4. Delivery is in two weeks from receipt of order.

Silicon General Semiconductor
11861 Western Ave.
Garden Grove, CA 92641
(714) 898-8121
▶ CIRCLE 749

▼ MOSFET TURN-OFF DEVICE SIMPLIFIES CIRCUITS

An economical and space-saving method of turning off a power MOSFET which achieving a level of circuit improvement is available in the MDC1000 series of MOSFET turn-off devices. One MDC1000 device replaces a Zener diode, a signal diode, a resistor, and a PNP transistor, which frees pc-board space. The device quickly discharges the gate-source and gate-drain capacitances when the input signal is removed. It also provides protection of the gate-source in the event of an overvoltage condition on the control line. Pricing for lots of 100 and up is $0.40 in the TO-92 package, $0.35 in the SOT-23 package, and $0.70 in the SOT-223 package. Samples are available now and lead times are six to eight weeks for large quantities.



Motorola Inc.
5005 E. McDowell Rd.
Phoenix, AZ 85008
(602) 244-5504
▶ CIRCLE 750

POWER-SEMICONDUCTOR MANUFACTURERS

Abacus Electronics
P.O. Box 534
South River, NJ 08882-0534
(201) 238-4631
(BI) (MF) (TH) (PI) (PC)
CIRCLE 692

Advanced Power Technology
405 S.W. Columbia St.
Bend, OR 97702
(503) 382-8028
(MF)
CIRCLE 693

Apex Microtechnology Corp.
5980 N. Shannon Rd.
Tucson, AZ 85741
(800) 421-1865
(PI)
CIRCLE 694

Central Semiconductor Corp.
145 Adams Ave.
Hauppauge, NY 11788
(516) 435-1110
(BT) (TH)
CIRCLE 695

Cherry Semiconductor Corp.
2000 S. County Trail
Warwick, RI 02818
(401) 885-3600
(PC)
CIRCLE 696

Elantec Inc.
1996 Tarob Ct.
Milpitas, CA 95035
(408) 945-1323
(PI)
CIRCLE 697

Electronic Devices Inc.
21 Gray Oaks Ave.
Yonkers, NY 10710
(914) 965-4400
(REC)
CIRCLE 698

Gennum Corp.
P.O. Box 489, Station A
Burlington, Ontario
Canada, L7R 3Y3
(416) 632-2996
(PC)
CIRCLE 699

Germanium Power Devices Corp.
P.O. Box 3065, SVS
Andover, MA 01810-3065
(508) 475-5982
(REC)
CIRCLE 700

Hitachi America Ltd.
2000 Sierra Point Pkwy.
Brisbane, CA 94005-1819
(415) 589-8300
(BT) (MF) (PI) (PC)
CIRCLE 701

IXYS Corp.
2355 Zanker Rd.
San Jose, CA 95131-1109
(408) 435-1900
(MF) (TH) (PI) (PC)
CIRCLE 702

Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035-7487
(408) 432-1900
(PI)
CIRCLE 703

Marconi Circuit Technology
160 Smith St.
Farmingdale, NY 11735
(516) 393-8686
(BT) (TH) (PC)
CIRCLE 704

Micrel Semiconductor
560 Oakmead Pkwy.
Sunnyvale, CA 94086
(408) 245-2500
(PI) (PC)
CIRCLE 705

Micro Linear Corp.
2092 Concourse Dr.
San Jose, CA 95131
(408) 433-5200
(PC)
CIRCLE 706

Motorola Inc. Semiconductor Products Sector
500 E. McDowell Rd.
Phoenix, AZ 85008
(602) 244-5697
(BT) (MF) (TH) (PI) (PC)
CIRCLE 707

National Semiconductor
2900 Semiconductor Dr.
M/S 16-300
Santa Clara, CA 95052
(408) 721-2641
(BT) (MF) (PI) (PC)
CIRCLE 708

Omnirel Corp.
205 Crawford St.
Leominster, MA 01453
(508) 534-5776
(BT) (MF) (TH) (PI) (PC)
CIRCLE 709

Optek Tecnology Inc.
1215 W. Crosby Rd.
Carrolton, TX 75006
(214) 323-2447
(BT) (MF) (PI) (PC)
CIRCLE 710

Panasonic Industrial Co. Semiconductor Sales Div.
1600 McCandless Dr.
Milpitas, CA 95035
(408) 945-5675
(MF) (TH) (PC)
CIRCLE 711

Power Integrations Inc.
411 Clyde Ave.
Mountain View, CA 94043
(415) 960-3572
(PI)
CIRCLE 712

Power Tech Inc.
0-02 Fair Lawn Ave.
Fair Lawn, NJ 07410
(201) 791-5050
(BT) (TH)
CIRCLE 713

SGS-THOMSON Microelectronics
1000 E. Bell Rd.
Phoenix, AZ 85022
(602) 867-6289
(BT) (MF) (TH) (PI) (PC)
CIRCLE 714

Samsung Semiconductor
3725 N. First St.
San Jose, CA 95131-1708
(408) 954-7264
(BT) (MF) (PI) (PC)
CIRCLE 715

Semikron Inc.
P.O. Box 66
Hudson, NH 03051
(603) 883-8102
(BT) (MF) (TH)
CIRCLE 716

Shindengen America Inc.
5999 New Wilke Rd., #406
Rolling Meadows, IL 60008
(708) 593-8585
(BT) (MF) (PI) (PC)
CIRCLE 717

Siemens Components Inc. Integrated Circuit Div.
2191 Laurelwood Rd.
Santa Clara, CA 95054
(408) 980-4545
(MF)
CIRCLE 718

Silicon General Inc. Semiconductor
11861 Western Ave.
Garden Grove, CA 92641
(714) 898-8121
(BT) (PI) (PC)
CIRCLE 719

Silicon Transistor Corp.
Katrina Rd.
Chelmsford, MA 01824
(508) 256-3321
(MF)
CIRCLE 720

Siliconix Inc. Power Products
2201 Laurelwood Rd.
Santa Clara, CA 95056-9951
(800) 554-5565
(MF) (PI) (PC)
CIRCLE 721

Sprague Semiconductor
363 Plantation St.
Worcester, MA 01613
(508) 7995-1300
(BT) (PI) (PC)
CIRCLE 722

Supertex Inc.
1225 Bordeaux Dr.
Sunnyvale, CA 94088
(408) 744-0100
(MF) (PI) (PC)
CIRCLE 723

Teledyne Components
1300 Terra Bella Ave.
Mountain View, CA 94039
(415) 968-9241
(PI) (PC)
CIRCLE 724

Texas Instruments Semiconductor Div.
P.O. Box 809066
Dallas, TX 75380-9066
(800) 232-3200
(PI) (PC)
CIRCLE 725

Unitrode Integrated Circuits
7 Continental Blvd.
Merrimack, NH 03054-0399
(603) 424-2410
(PI) (PC)
CIRCLE 726

KEY

Power Semiconductors
(BT) Bipolar transistors
(MF) MOSFETs
(PC) Power-control ICs
(PI) Power ICs
(RE) Rectifiers
(TH) Thyristors

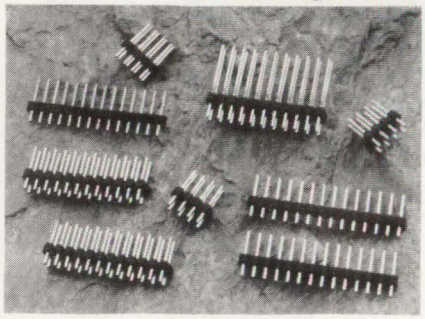
▼ SOCKET CONNECTOR BOASTS HIGH DENSITY

High-speed computer and communication equipment need high input/output signal density, and a high-contact-density socket connector fills the bill. The female connector has 0.100-by-0.100-in. contact spacing with four rows of contacts available from 100 up to 240 pins. The terminals feature a 0.250-in. and 0.550-in. pressfit Flexpress contact that requires no soldering. In lots of 100, the connector costs $0.20 per pin. Delivery is from stock to four weeks.

Robinson Nugent
800 E. Eighth St.
New Albany, IN 47150
(812) 945-0211
▶ **CIRCLE 761**

▼ 0.100-IN. STRAIGHT HEADERS WITHSTAND IR REFLOW

Reflow-solder processing can be used on the 9100-2 series of 0.100-in. straight headers from Methode Electronics Inc. An insulator-standoff design permits solder paste to be screened around through-board



holes and reflowed along with surface-mounted components. This eliminates dual solder processing for boards. The connectors can be supplied with up to 80 circuits. Single- or dual-row versions are available in various pin lengths and with standard platings. Call for pricing and delivery information.

Methode Electronics Inc.
Interconnect Products Div.
1700 Hicks Rd.
Rolling Meadows, IL 60008
(800) 323-6864
▶ **CIRCLE 762**

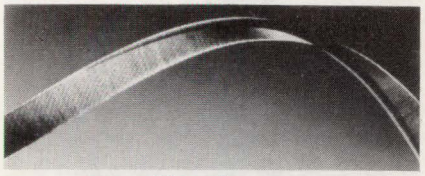
▼ LATCHED SIMM SOCKETS IMPROVE RETENTION

Increased retention of SIP modules and baby boards that are larger and heavier than earlier styles is provided by four SIMM socket options with metal latches. The stainless-steel latches are designed to take heavy abuse on the manufacturing floor and during application by non-technical end users. With an audible click, they signal users that the memory module is fully seated in the socket. The latch design also aids in module extraction. Latches are available in 0.100-in., single-row-vertical 30-circuit SIMM sockets and in 0.100-by-0.400-in. dual-row products. Pricing for the vertical, single-row, 72-circuit socket is $3.25 in quantities of 5000 to 9999. Delivery is in six weeks.

Molex Inc.
2222 Wellington Ct.
Lisle, IL 60532
(708) 969-4550
▶ **CIRCLE 763**

▼ CARBON-FIBER CONNECTORS LINK PLANAR SURFACES

Connections between two planar surfaces, such as flat-panel displays and their driver boards, can be made with AMP's conductive carbon-fiber



connectors. The devices are composed of alternating layers of nonwoven conductive carbon-fiber mats and insulating silicone rubber. They're said to be more economical than elastomer alternatives, to carry more current (up to 100 mA), to offer 10 times the conductivity, and to require less compression. Call for pricing and delivery.

AMP Inc.
P.O. Box 3608
Harrisburg, PA 17105-3608
(800) 522-6752

▶ **CIRCLE 768**

▼ HIGH-DENSITY SYSTEM MEETS SCSI II NEEDS

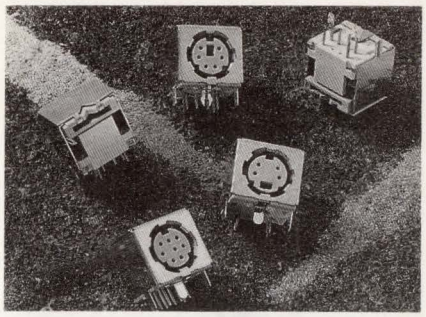
A highly reliable contact-termination process from ITT Cannon's Components Div. is embodied in the MD-50 connector. The device features 0.050-by-0.100-in centerlines and is fully compatible with SCSI II interface requirements. The connectors assure a reliable link by means of a proprietary contact-termination system. A brace on the contact terminator secures the contact in place during the termination process and eliminates the possibility of contact deformation. The unit costs $3.40 each in lots of 1000 for a size-50 cable plug and $3.90 each for the receptacle. Sizes range from 26 to 120 positions. Production quantities ship in the first quarter of 1991

ITT Cannon
Components Div.
1851 E. Deere Ave.
Santa Ana, CA 9270
(714) 757-8442

▶ **CIRCLE 769**

▼ MINI-DIN SOCKETS BOAST EMI SHIELDING

Get maximum EMI/RFI/ESD protection from a line of sockets for Cinch's circular mini-DIN interconnects. They come in six connector



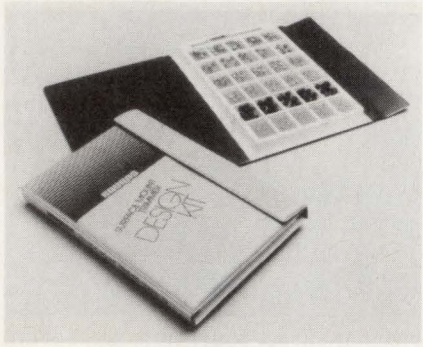
sizes of three, four, five, six, seven, and eight positions, and offer space saving of 69% vs. standard circular DIN sockets. A six-position unit costs $0.60 in 10,000s. Stock delivery.

Cinch Connector Div.
1500 Morse Ave.
Elk Grove Village, IL 60007
(708) 981-6000

▶ **CIRCLE 770**

▼ SMD TRIMMER KIT STAYS UP TO DATE

The surface-mount design kit from Bourns features over 200 SMT trimmers in popular sizes with many resistance values and pin styles. The

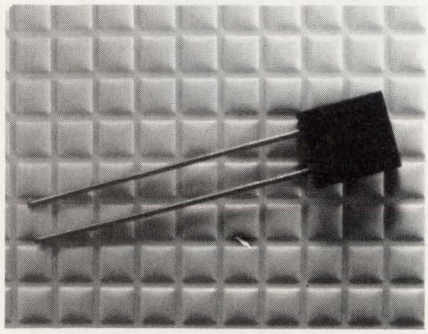


kit can be registered with an enrollment card for a Sample Update Program. As new products are released, kit owners will automatically receive free samples with data sheets, for an up-to-date source of product information and evaluation samples. Call for pricing and availability.

Bourns Inc.
1200 Columbia Ave.
Riverside, CA 92507
(714) 781-5071
▶ CIRCLE 751

▼ MIL RESISTOR LINE HAS BEEN EXPANDED

Qualification to MIL-R-122 standards has been extended to the value range of 4.99 Ω through 50 kΩ for Vishay's M122/1, M122/3, and



M122/10 QPL lines. In the past, qualification was down to 100-Ω values. The M122/1 and /10 lines are qualified for A, B, and C characteristics. The /3 line is qualified for E and F. Call for pricing and availability.

Vishay Resistive Systems
63 Lincoln Hwy.
Malvern, PA 19355
(215) 644-1300
▶ CIRCLE 752

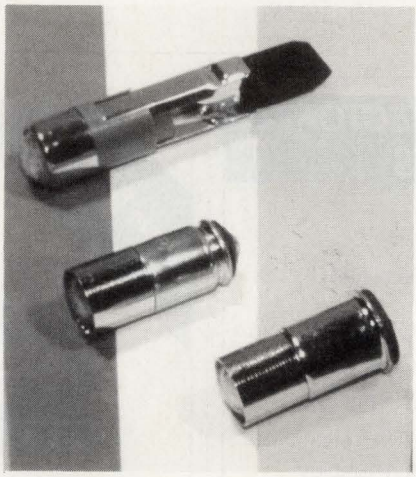
▼ SMT CHIP RESISTORS BOAST TIGHT TOLERANCES

Offered in five standard sizes including the 0805 and 1206 styles, the BCR series of thick-film chip resistors from Beckman industrial Corp. features tight dimensional tolerances. Power-rating options are 1/16, 1/10, 1/8, 1/4, and 1/2 W. Standard resistance values range from 10 Ω to 1 MΩ with tolerances of 1%, 2%, and 5%. Zero-ohm jumper chips are also available. The devices are packaged on paper tape in 5000-piece reels. Call for pricing and availability.

Beckman Industrial Corp.
4141 Palm St.
Fullerton, CA 92635
(714) 447-2345
▶ CIRCLE 753

▼ BRIGHT-WHITE LED REPLACES INCANDESCENTS

Intended as a replacement for incandescent lamps, a multi-chip white LED from Ledtronics Inc. is 100%

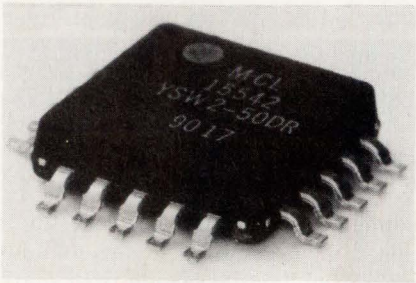


brighter than present amber-yellow LEDs. The WhiteLite can be used to light pushbuttons, pilot lights, backlights, and indicators. Light is generated in an amber-yellow color spectrim between 565 nm (green) and 635 nm (red) with illumination of 75 mcd, which is much higher than the 40 mcd of present pure amber-yellow (585-nm) LEDs. In lots of 1000, the WhiteLite LED costs from $2 to $3, depending on the base style and circuit requirements. Delivery is in from four to six weeks.

Ledtronics Inc.
4009 Pacific Coast Hwy.
Torrance, CA 90505
(213) 549-9995
▶ CIRCLE 754

▼ 5-GHZ SPDT SWITCH HAS BUILT-IN DRIVER

Operation at a 3-ns switching speed over a wide dc-to-5-GHz range is offered by the YSW-2-50DR single-

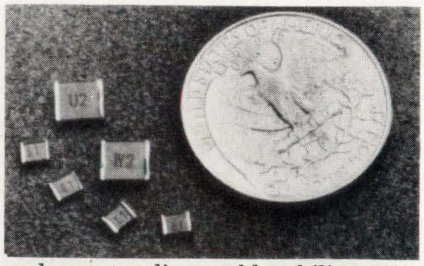


pole, double-throw switch with built-in driver. Packaged in a 0.327-in. plastic case, the GaAs switch-driver combination offers better than 40-dB isolation in the off state, less than 1-dB insertion loss in the on state, and a +1-dB compression point of +20 dBm. The TTL-controlled switch costs $19.95 in quantities of one to nine. Delivery is from stock.

Mini-Circuits
P.O. Box 350166
Brooklyn, NY 11235-0003
(718) 934-4500
▶ CIRCLE 755

▼ CHIP MICA CAPACITOR CAN TAKE OVERVOLTAGES

Featuring the stable electrical characteristics of natural mica, the SM series of chip mica capacitors possess excellent crack-free capability



and outstanding solderability. The devices can take twice their rated voltages for 1 to 5 seconds without damage, arcing, or breakdown. In addition, their minimum capacitance tolerance is ±0.25% or ±0.25 pF, whichever is greater. The capacitors are well suited for high-frequency surface-mounted applications. Prices start at $0.55 in 1000s. Delivery is stock to eight weeks.

Tecate Industries Inc.
P.O. Box 711509
Santee, CA 92072
(619) 448-0912
▶ CIRCLE 754

Your Make/Buy Decision Just Got A Lot Easier!

BURR-BROWN'S OEM MICROTERMINALS SATISFY ALL YOUR OPERATOR INTERFACE/ CONTROL PANEL NEEDS - INCLUDING PRICING THAT'S SO LOW YOU NO LONGER NEED TO EVEN CONSIDER BUILDING YOUR OWN!

Cost-Effective Solutions

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Industry's Widest Selection

Burr-Brown brings you fourteen models from which to choose . . . from the most basic device to multifunction microterminals to rugged, industrial units. Plus multiple customization options designed specifically with the OEM in mind. Whatever your requirements, we have models to fit your particular needs.

Burr-Brown OEM Microterminal allows operator to interface to a precision laser.

Years of Experience

For over a decade, Burr-Brown has been supplying quality, high-performance microterminals, worldwide. For applications such as control systems, instrumentation, communications, test & monitoring, machine setup, medical, and many, many more.

For a copy of our new brochure, or information about demonstration units, write Burr-Brown Corp., P.O. Box 11400, Tucson, AZ 85734. Or, call Toll-Free **1-800-548-6132.**

CIRCLE 120

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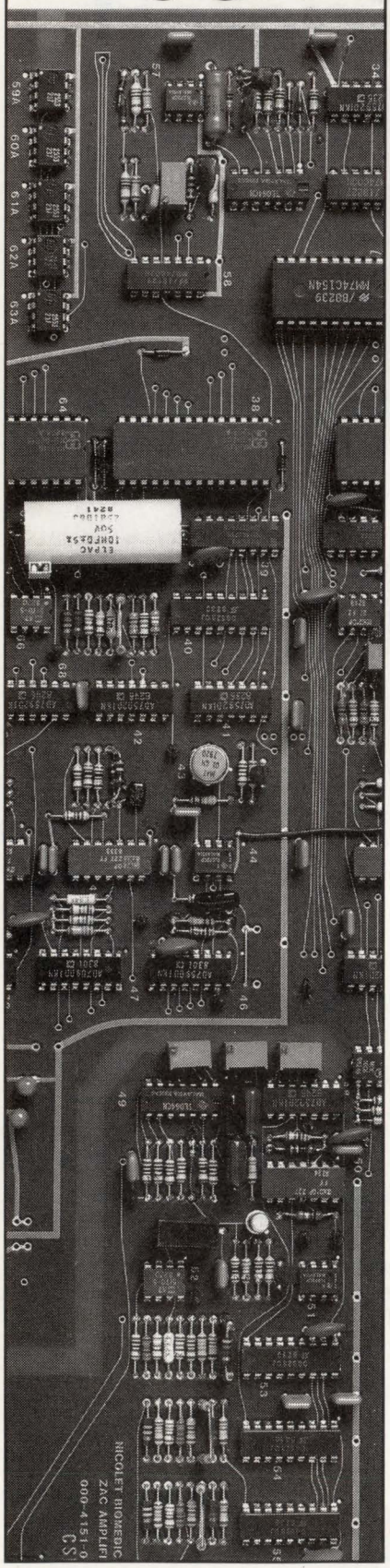
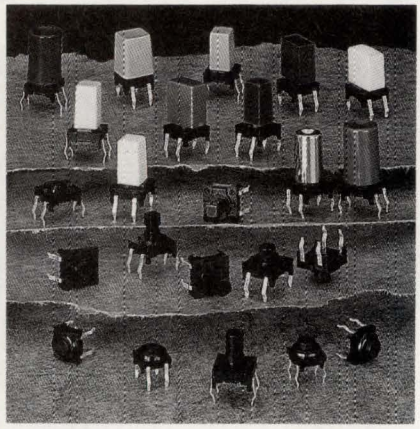
Bigger.



SWITCHES

▼ MICRO-KEY SWITCHES HANDLE LOGIC LEVELS

Two lines of micro-key switches are suited for analog and digital circuit functions for logic-level switching. The CDS710 (9-mm) and CDS720 (7-



mm) lines are TTL- and MOS-compatible switches that feature snap-dome construction with positive feedback and a pleasant audio response. Both also offer low profiles, excellent solderability, a lifespan up to 1 million operations, and compatibility with pick-and-place insertion. In lots of 10,000, the 710 series costs $0.219 each while the 720 series goes for $0.145. Small quantities are delivered from stock.

CRL Components Inc.
Highway 20 West
Fort Dodge, IA 50501-9006
(515) 573-1300.
▶ CIRCLE 764

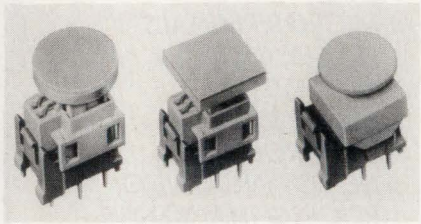
▼ ROTARY-CODED SWITCH IS FIRST SMD TYPE

The industry's first surface-mounted rotary-coded switch is the S-7000 series from Mepcopal Co. The 7-mm-square device is a sealed unit that comes in BCD or BCH codes. With the switch, operators with no knowledge of digital codes can make settings. It eliminates the complicated bit settings that piano-key-type DIP switches require. Features include gold-plated contacts and an O-ring seal that prevents solder-flux contamination during processing. In lots of 1000, the switch costs $2. Delivery time is from stock to eight weeks.

Mepcopal Co.
11468 Sorrento Valley Rd.
San Diego, CA 92121
(619) 453-0332
▶ CIRCLE 765

▼ MEMBRANE-SWITCH SYSTEM IS HIGHLY RELIABLE

Available in round and square pushbuttons, EAO Switch's membrane-switch system is for use under a customer-supplied embossed membrane assembly. The rugged illuminated or non-illuminated Series 96 pushbuttons are highly reliable and are suited for heavy-duty use. The switches

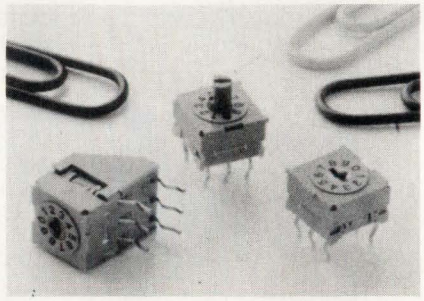


are sealed to IP67 specifications and feature distinct, constant tactile operation and single-pole, double-throw snap-acting gold contacts. Pricing starts at $4.35 list and delivery is from stock to four weeks.

EAO Switch Corp.
198 Pepe's Farm Rd.
Milford, CT 06460
(203) 877-4577
▶ CIRCLE 766

▼ BCD-CODED DIP SWITCHES HALVE SIZE OF OTHERS

The ultra-miniature dimensions of the ND series rotary DIP switches make them suitable for many appli-

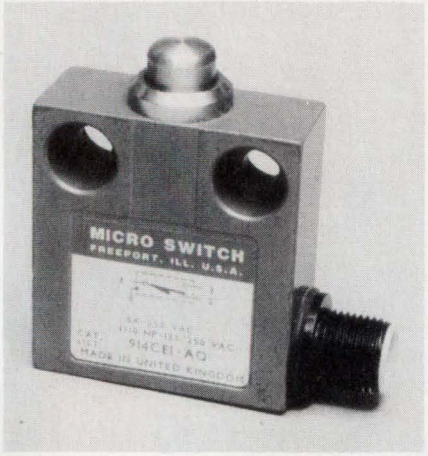


cations where space saving is essential. The binary-coded switches feature gold contacts and a precision detent design for crisp, positive action. The devices are completely washable and wave-solderable. All terminals (straight and right-angle) are crimped to ensure secure pc mounting. The switches are rated at 100 mA at 5 V dc. Call for pricing and delivery.

NKK Switches
7850 E. Gelding Dr.
Scottsdale, AZ 85260
(602) 991-0942
▶ CIRCLE 767

▼ CONNECTOR ADDED TO ENCLOSED SWITCH

Connector capability has been added to the 914CE series miniature enclosed switch. The plug-in, quick-connect termination offers an efficient way to install or quickly change switches. Versions are offered with bottom-exit or side-exit connectors. Mating quick-connect cables can also be provided. The switch's operating-temperature range is from 10 to 200°F. Applications include robotics, machine tools, material handling, and others. List price ranges from $61 to $86 and delivery is from stock.



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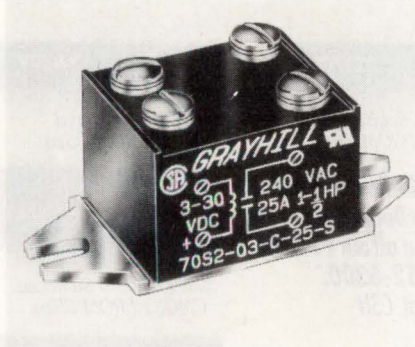
The style S solid-state relay requires a full cubic inch less volume than standard hockey-puck packages, yet is capable of switching 25-A loads.



Besides its high switching current, the relay offers a dielectric-strength voltage rating of 3750 V rms from input to output and a 3000-V/μs static dV/dT rating. The relay is UL-recognized and CSA-certified. In lots of 100, pricing is $17.10 each. Delivery is from stock.

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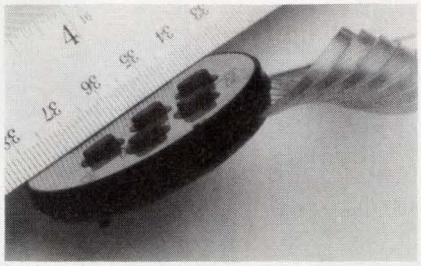

units incorporate a 2-in.-diameter dual-durometer rubber keypad, a pc board, liquid-crystal display, flexible printed circuit, polycarbonate overlay, and elastomeric connector. Production tooling costs about $18,000 and piece price is $5.72 in lots of 10,000. Tooling takes 10 weeks and production pieces start in six weeks.

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Either ac or dc coils can be installed in the RKS Series miniature relays. The devices switch loads up to 20 A at 277 V ac or 24 V dc on pc boards. The UL-recognized and CSA-certified relays meet VDE 8-mm coil-to-contact spacing specs. Input-to-output dielectric strength is 4000 V rms. From contact to contact, isolation is 1000 V rms. Available contact arrangements include 1 Form A, 1 Form B, and 1 Form C. Additionally, dc-coil models come in 2 Form A and 2 Form C types. A relay with 1 Form C contacts and a 24-V ac coil costs $2.88 in lots of 5000. Small quantities are delivered from stock.

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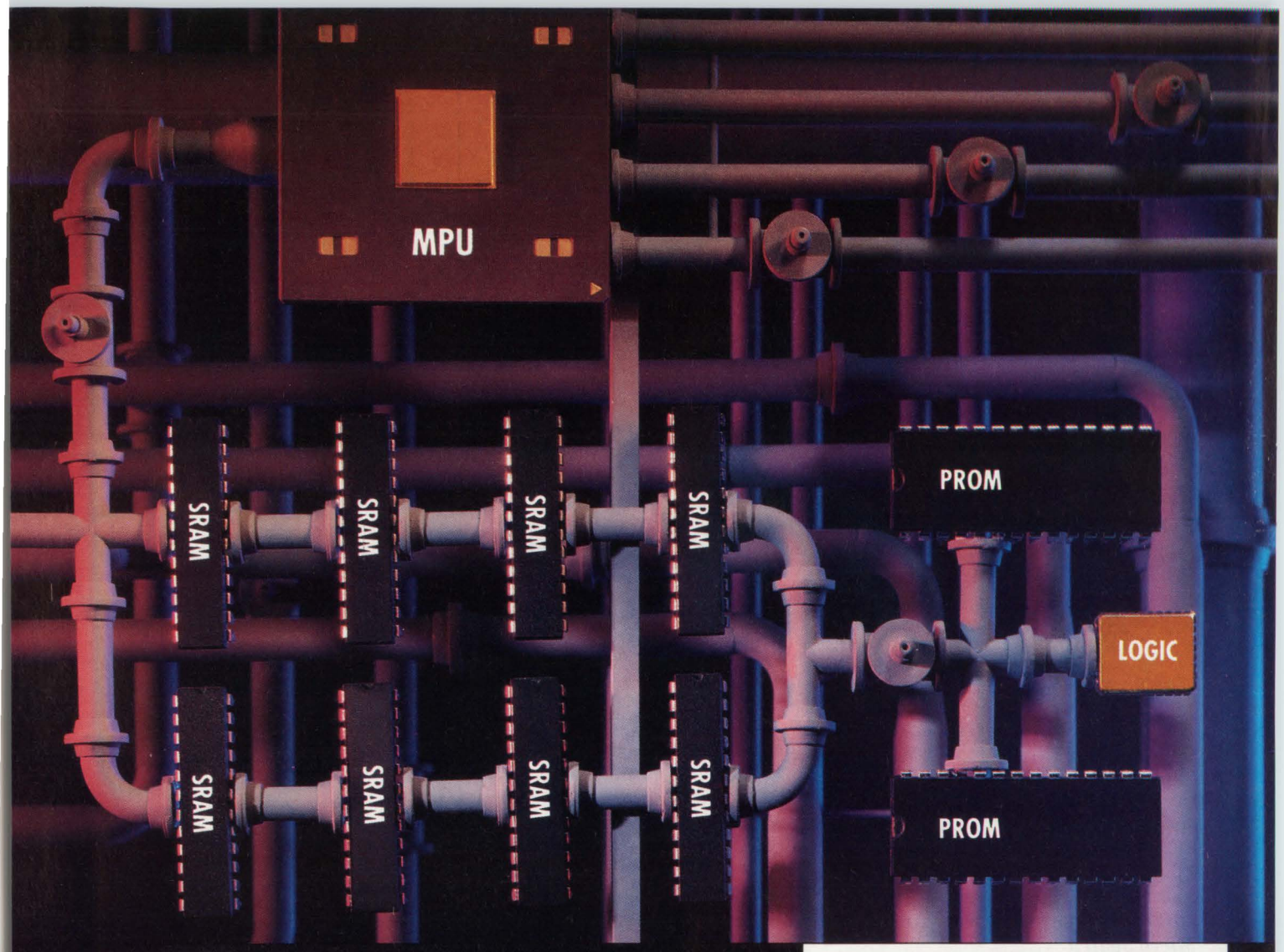

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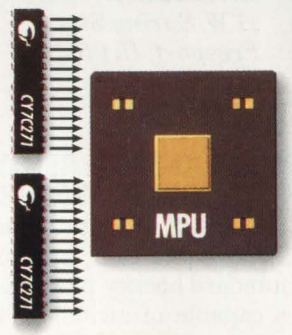

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2-kW Dc Switching Supply Banishes Noise At Output

An Elaborate Filtering Scheme And Careful Design Give A High-Power Switcher Distinctly Linear Characteristics.

David Maliniak

When seeking to enter the high-power supply market close to four years ago, the main complaint heard from potential customers of Hewlett-Packard's New Jersey Division concerned the switching supplies that were available to them. No matter how good the linear portion of their switching preregulated supplies were, common-mode switching noise still corrupted the supplies' outputs. In the course of its design work on the problem, Hewlett-Packard's engineers found that higher-order common-mode filtering could help mitigate the problem.

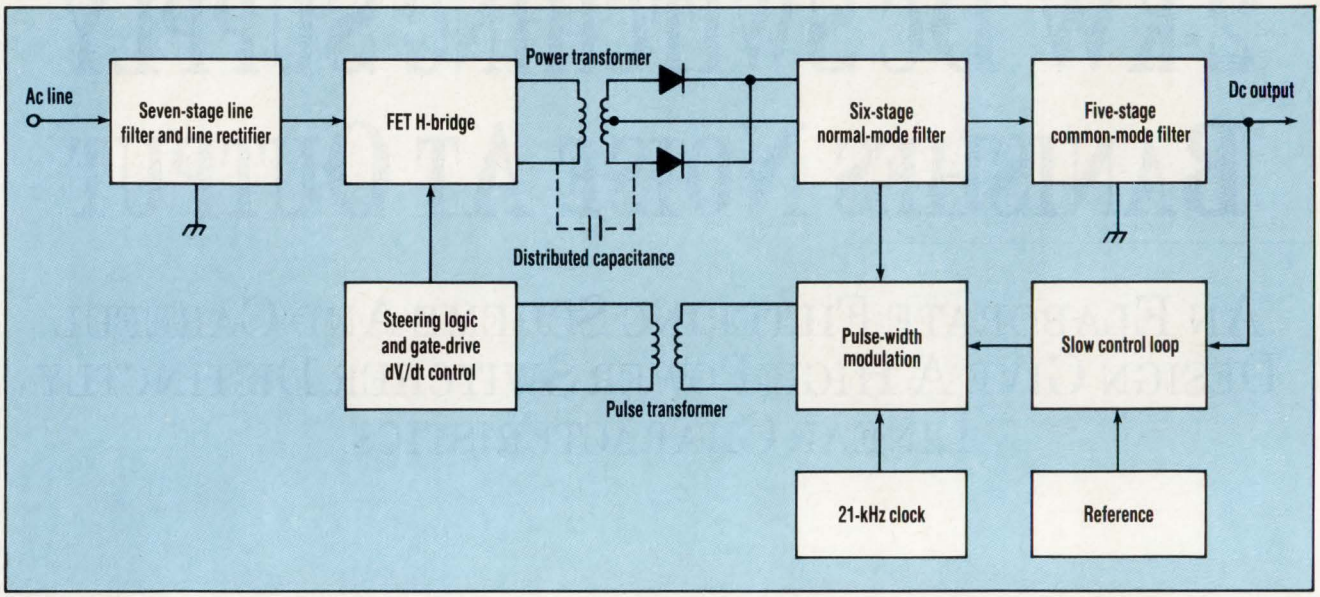
Now, the research into filtering has borne fruit in a pair of 2-kW system dc power supplies that take a switching supply to a level of performance that was previously attained only by pure or post-regulated linear supplies. But in reaching that performance level, Hewlett-Packard's HP 6671A and HP 6674A supplies offer the efficiency and compactness of a switching-based power mesh.

The pair of supplies are the vanguard of a planned five-supply series. Their outputs are rated at 0 to 8 V and 0 to 220 A for the HP 6671A, and at 0 to 60 V and 0 to 35 A for the HP 6674A. At 2 kW, the supplies are the company's highest-output supplies with a built-in GPIB interface.

Normal-mode noise, a key yardstick for determining a power supply's usefulness in an application, is about 50 mV pk-pk maximum for a switching supply. For a post-regulated linear supply, it's about 5 mV. The HP 6671A is specified at 7 mV pk-pk, bringing it as close as can be to pure-linear performance while still remaining a switcher.

Another measurement of power-supply worthiness is common-mode noise, which is the noise current present in both the plus and minus outputs of the supply, with earth ground completing the path. Common-mode noise is the source of "unexplained" noise that's often associated with switching power supplies. It can convert to substantial normal-mode noise at the device under test (DUT). The noise results from subtle differences in the output-distribution network's common-mode impedance. These differences are typically found in either the load-lead inductances or the capacitive coupling of the plus and minus DUT inputs to earth ground.

HIGH-POWER SYSTEM DC SUPPLIES



CONTROLLED-SLOPE SWITCHING and a complex filtering scheme contribute to the extremely low-noise performance of Hewlett-Packard's HP 6670A series system dc supplies. Normal- and common-mode noise are tightly controlled to near-linear levels.

When it comes to common-mode noise, which is best characterized as a current and not a voltage, the HP 6670A series supplies again find themselves bordering on linear territory. Switchers are typically in the 50-to-500-mA pk-pk range. Linear post-regulated supplies run from 500 μA to 5 mA pk-pk. The HP 6671A sits atop the linear range at 5 mA pk-pk.

Many power-supply vendors don't even specify common-mode noise performance for their supplies. That's because controlling it can be very costly. Linear supplies inherently have less of a problem with it because they don't have the high-frequency content found in most switchers. That's why linears have traditionally been preferred for noise - sensitive tasks. In the HP 6671A and 6674A supplies, Hewlett-Packard has mitigated the common-mode noise problem. As a result, either load lead can be connected to ground with very little difference in noise performance at the load.

The keys to the supplies' low-noise performance are in controlled-slope switching, careful layout, a six-pole normal-mode output filter, a five-pole common-mode-current filter, and an uncompromising design approach *(see the figure)*. The controlled-slope switching approach limits the voltage slew rates in the switching portion of the power mesh, which minimizes conduction of common-mode current through the power transformer. Controlled-slope switching does sacrifice some efficiency, but the resulting gains in noise abatement are well worth it. Efficiency is still 76% at full output.

The filtering scheme is even more remarkable when compared to the efforts of other supply vendors. Most incorporate either a two-stage or four-stage filter for normal-mode noise, and simple decoupling capacitors for common-mode noise. In addition, Hewlett-Packard took pains to make the ground points within the common-mode filter network into single-point grounds, which minimizes ground loops within the network. Those grounds are brought out to the back of the box, giving users access to the quietest ground on the unit. It makes for an ideal point to connect the shield of a remote-sense cable.

In designing the supply, careful attention was paid to its layout. The power path is in a direct line in a U-shape from the right rear (line input) to left rear (output) of the box. A pair of large heat sinks running from front to back bisect the box and form a channel through which cooling air is forced by a fan. The power FETs are electrically isolated as much as possible from the heat sinks, which decreases the heat sinks' dV/dt.

The 20-kHz switchers meet level B of the German VDE 0871/6.78 spec for radiated emissions. And for programmability, the HP 6670A series emulates the earlier HP 6650A and 6030A series.

After discovering that users still prefer the feel of knobs to control voltage and current, Hewlett-Packard incorporated them in the HP 6670A series. That gives users five ways to shape the power-output's makeup: knobs, the HP-IB bus, increment keys, analog programming, and keypad entry. The supply is calibrated from the front panel.□

PRICE AND AVAILABILTY

List prices for the HP 6671A and HP 6674A system dc power supplies are $4450 and $4300, respectively. Availability for both models is currently estimated at four weeks or less from receipt of order.

Hewlett-Packard Co., 19310 Pruneridge Ave., Cupertino, CA 95014; (800) 752-0900. CIRCLE 511

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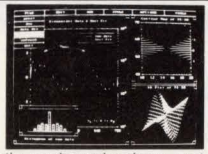

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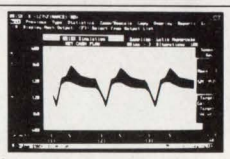

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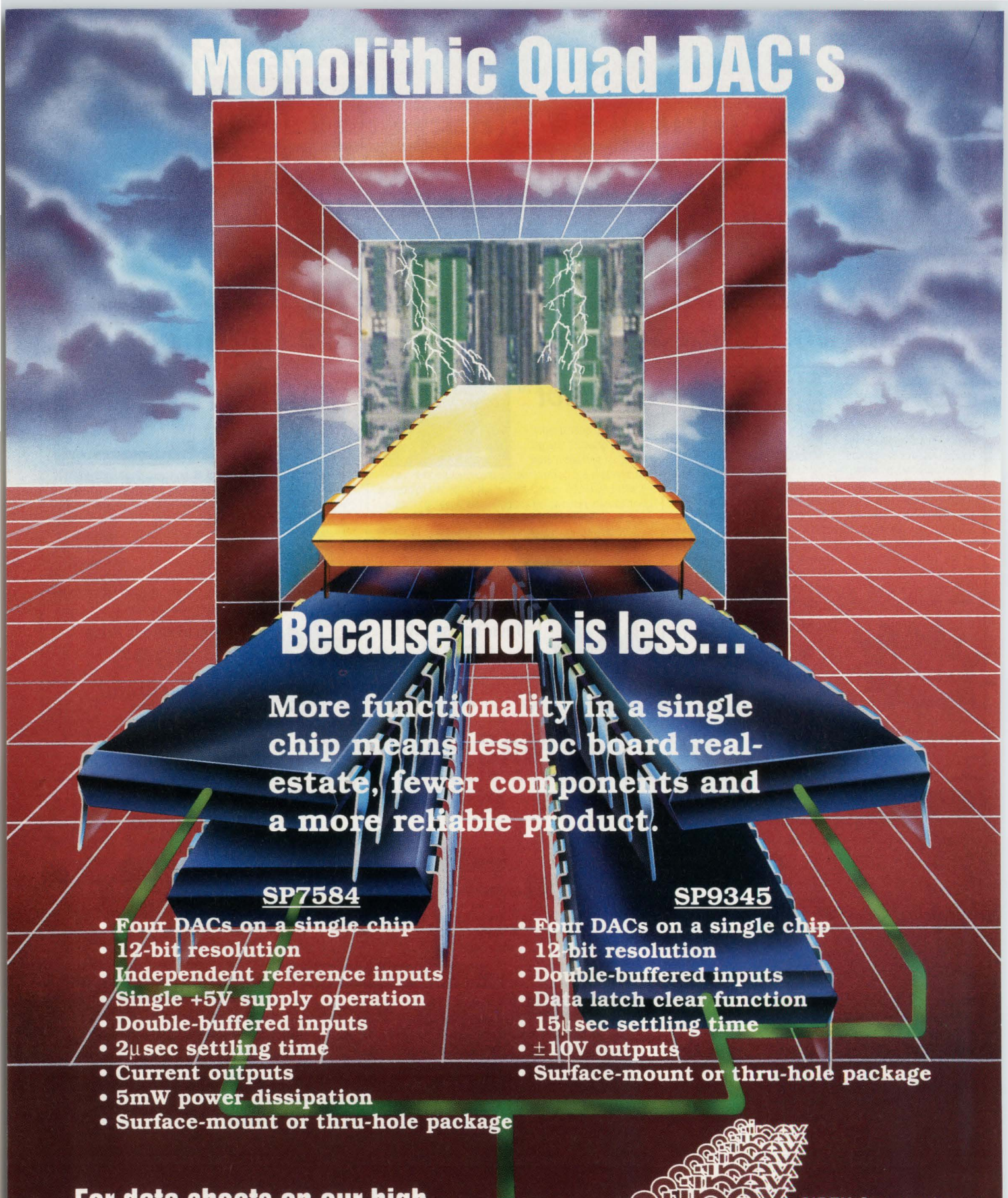

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CIRCLE 125

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FUTUREBUS+ BUILDS MOMENTUM WITH NEW CHIP SET

RICHARD NASS

Since its introduction a year ago, Futurebus+ has branded itself as the standard bus specification of the 1990s and beyond for high-performance systems. However, designers have had to contend with only sample quantities of a few Futurebus+ chips. Now the standard has been given a further boost with a new Futurebus+ chip set from National Semiconductor Corp., Santa Clara, Calif.

The chip set differs architecturally from another set introduced earlier by Philips-Signetics (ELECTRONIC DESIGN, *May 10, 1990, p. 63).* National integrated some extra functionality onto the chips, such as glitch filters and competition logic. Because of Futurebus+'s noise margins, tightly controlled thresholds are needed. QV_{CC} and Q_{ground} signals (Q denotes quiet) that tie into one central logic point on the chips were incorporated to maintain the thresholds. This controls the receiver thresholds so that the devices' internal ground bounce doesn't affect the receiver circuitry. Furthermore, all of the chips are housed in 44-pin packages, as opposed to the 52 pins on the Philips-Signetics parts.

Futurebus+ is a scalable, multiprocessor bus architecture that can handle data widths from 32 to 256 bits and address up to 64 bits. It includes a protocol bandwidth from 25 to 100 Mtransfers/s. At a data width of 256 bits, 100 Mtransfers/s produces a bus bandwidth of 3.2 Gbytes/s. VME, the previous standard for high-end systems, delivers a throughput of 30 Mbytes/s.

With National's chip-set introduction, the first Futurebus+ system (probably a cacheless system) should arrive around the middle of this year. Later, Futurebus+ systems will migrate to telecommunications, high-end workstations, servers, and graphics platforms.

The chip set consists of four BTL (backplane transceiver logic) transceivers and an arbitration controller. Specifically, they are the DS3883 and DS3886 9-bit data transceivers, the DS3884 handshake transceiver, the DS3885 arbitration transceiver, and the DS3875 Futurebus+ arbitration controller.

Now an IEEE standard, BTL was invented by National Semiconductor in 1985. It's currently used as a Futurebus+ technology, enabling a Futurebus+ system to pass data at very high transfer rates. BTL also solves the bus-driving problems created by the deficiencies in TTL drivers. TTL devices aren't suited to drive characteristically low-impedance buses due to a capacitive load in each system slot.

The chip set handles all of the transceiver functions for driving signals across the backplane *(see the figure).* There are four different transceivers because different transceivers, or different numbers of transceivers, are required for diverse applications. For instance, in one application, four transceivers are used in the data path for a 32-bit system; a 64-bit system would require eight transceivers. Moreover, two more transceivers are needed for the control logic. The

end result is six transceivers in a 32-bit system and ten in a 64-bit system.

The data transceiver comes in two versions. The DS3883 is a straight converter and driver from the TTL signals on the board to the BTL levels on the backplane. The DS3886 contains latches for additional system performance.

Determining if designers should use the DS3883 or the DS3886 depends on the data-path construction. Most applications require the DS3886's ability to latch the data at the transceiver level to get the highest performance. Less time-critical applications may not the need the complex latching in the data paths. However, a majority of designs go the DS3886 route.

The DS3884 handshake transceiver has a programmable glitch filter on board. The filter is required by the Futurebus+ specification, but it doesn't have to be incorporated into the chip set. By including filters in the devices, National eliminates one extra step for system designers. Also, by putting the filters into the chip set, there will be one less skew delay going through the output buffers and into the filter. This increases system reliability.

The filters are used for the handshake lines in the Futurebus+ protocols. Three lines are needed for each board in the system. When signals are wire-ORed in the backplane, a glitch will occasionally pop up due to current matching when a signal releases. Hence, a filter is needed to eliminate the glitches. The chip includes programmable filters for 5-, 10-, 15-, and 25-ns delays. The correct time is determined by the length of the backplane.

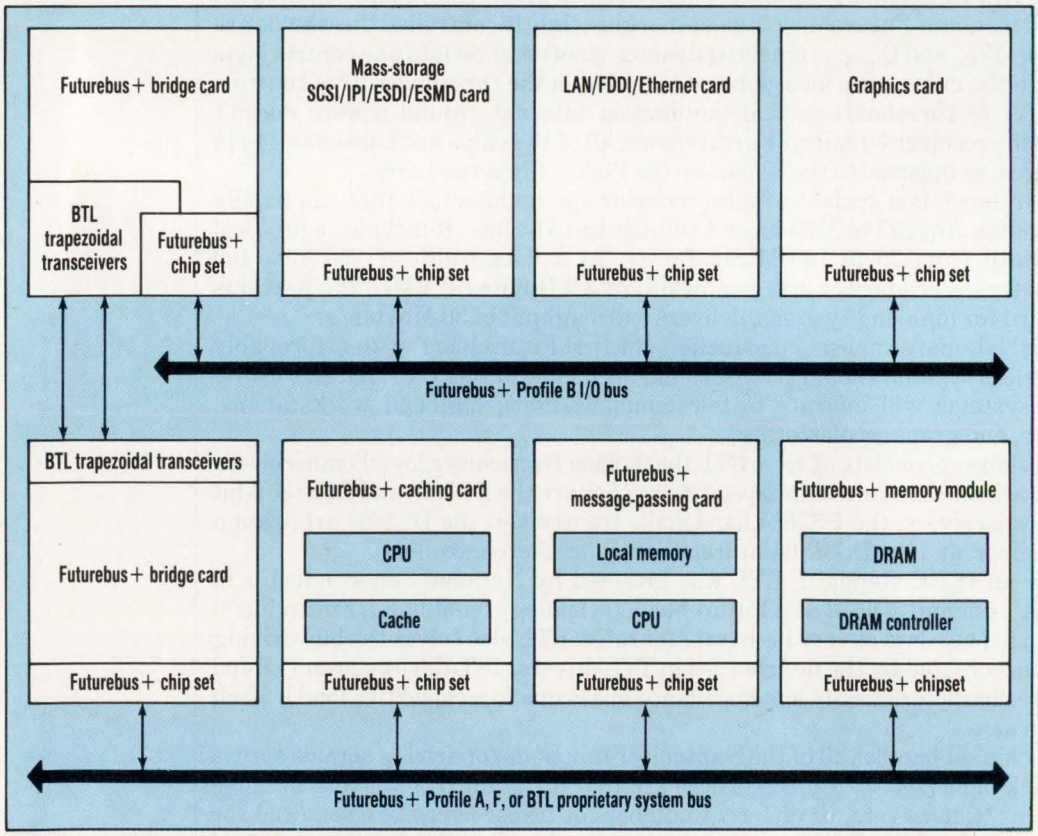
The DS3885 arbitration transceiver and the DS3875 arbitration controller form what National calls a complete arbitration solution. This combination of devices handles the distributed part of the arbitration as well as the message-passing protocols. The DS3885 contains the Futurebus+ arbitration logic. National decided to put the portion that needed a higher performance level—the competition logic—directly on the transceiver, rather than have a transceiver go straight to the controller. The remaining logic was put into the controller chip. Placing the competition logic on the chip reduces arbitration time by 30 to 50% for the distributed mode.

Competition is a continuous process, unlike the latch data transceiver, where one skew delay is eliminated from the input buffer to the output buffer when data is taken in. As a result, multiple magnitudes of the skew get added into the calculations, causing a considerable delay.

Some special features were added in the latter part of the design stage. An LI (live insertion) pin was included in the transceivers. This pin adds some special logic that the Futurebus+ committee included in the specification. The spec lets users insert boards into a running system without causing a glitch in any other boards in the backplane. Therefore, the system needn't be shut down to insert a board, because everything isn't powered on the board.

To eliminate the glitches, the Futurebus+ committee decided to add a V_{CC} pin to each end of the board. The pin goes directly to the transceiver devices. This LI pin reverse-biases some of the circuitry, making it look like the transceiver is on even though V_{CC} isn't applied. That reduces the capacitance in the unpowered state to about 2 pF, rather than 10 to 15 pF. The small 2-pF capacitance won't be detected on the backplane upon insertion.

Some special circuit-



EACH TRANSCEIVER FUNCTION for driving signals across the backplane is handled by the chip set. Here, in a dual-bus architecture, the chip set acts as an interface between the system cards and the I/O and proprietary system buses.

FUTUREBUS+ CHIP SET

ry also appears on the pinouts. BTL inherently has a 1-V signal swing. Consequently, tight receiver thresholds are required. National used separate circuitry with an alternate V_{CC} and ground to connect into the board's logic. As a result, there are no ill effects from ground bounce. This is especially important in noise-margin calculations, because there's very little margin when working with 1 V.

The chips also use a separate ground for each BTL output to reduce crosstalk and ground bounce on each driver. It's like having nine separate drivers as far as the grounds are concerned, rather than having one connected together.

One remaining part is a protocol or data-transfer controller. A generic controller can't get the performance that's required by Futurebus+. It has to be tailored to the specific architecture, depending on the processor and memory configuration and the type of local bus and I/O that's being employed. National hasn't released this part yet, and they probably won't until the Futurebus+ committee defines the protocols.

All of the chips except the DS3875 arbitration controller are housed in 44-pin quad flat packs and PLCC packages. The quad flat packs result in a 25 to 30% space savings. National strived to keep the designs as small as possible because it's important to have a chip in close proximity to the connector. The company will eventually include JTAG board-level testing on the chips. But that would require more pins, making for larger chips.

PRICE AND AVAILABILTY

All five devices are available in sample quantities and will be in production in March. In quantities of 1000, the DS3883 costs $6.50, the DS3884 and DS3885 are priced at $11.75, the DS3886 costs $7.75, and the DS3875 goes for $28.75.

National Semiconductor Corp., 2900 Semiconductor Dr., P.O. Box 58090, Santa Clara, CA 95052; (408) 721-5000. **CIRCLE 513**

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MODERATELY	566
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One chip can prevent microprocessor systems from crashing by maintaining the current state of the CPU in battery-backed-up memory. The Micro Softener replaces up to eight LSI and MSI chips. The chip can even initiate a call for help to a remote system in an emergency so that diagnostic software can be downloaded.

Versions of the DS53XX Softener—the DS5340, 5311, 5396 and 5303—will be available for the 8086-compatible high-integration NEC V40, the Motorola 68HC11, the Intel 80C196, and the Hitachi HD6301/6303. Embedded in the chip is power monitoring logic, watchdog timer, nonvolatile controller, address decoder, bootstrap ROM, parallel I/O ports, dual-ported register file, and interrupt controller.

The IC connects directly to the host microprocessor's address, data, and control lines. It also does decoding and control for off-chip lithium-backed-up CMOS SRAM that can retain data for at least 10 years. The chip converts as much SRAM as the host can address into nonvolatile battery-backed memory. Should power fail, the nonvolatile storage can be used to save as much data as possible from the host—register states, critical data in local memory, etc.

The CMOS battery-backed RAM can be dynamically partitioned so that areas can be set aside to specifically hold programs or data, for example. The built-in bootstrap loader initializes the storage area with application code downloaded from a remote system, such as PC, eliminating the need for a customized boot EPROM.

Early warning of a system failure is signaled to the system by the Softener so that the system's operational state can be saved in the few micro to milliseconds before power is lost.

When operating power returns to the system, the Softener automatically resets the processor. After reset, the processor continues its program as if no failure or fluctuation had occurred. Additional crash-proof operations are included for electrically noisy environments.

Depending on the particular version of the Micro Softener, up to four byte-wide parallel I/O ports are available to provide extended system or diagnostic I/O capabilities. Furthermore, all versions also have two ports that can be configured as an interface to the internal dual-port register file. Such a feature turns the two ports into a high-speed parallel interface to a host processor.

The dual-ported register file consists of eight input buffer registers, eight output buffer registers, a status register, and some interrupt control circuitry that handles inputs from the host processor and the Softener's internal controller.

The first version of the Micro Softener will tie into the V40 microprocessor and turn the CPU into an embedded control system. Because the V40 contains a superset of instructions that include all those of the Intel 8086 CPU, application software can be directly developed on a PC and easily moved to the end system.

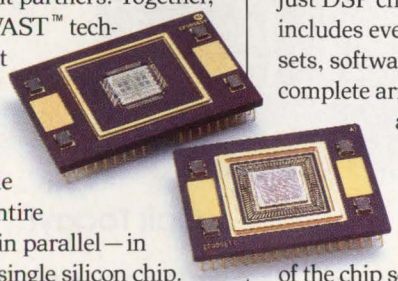
The 8-MHz V40 version of the DS5340 Softener chip comes in an 80-lead plastic quad-sided flat package and sells for $9.20 in 1000-unit lots. Samples are immediately available.

Dallas Semiconductor Corp., 4350 South Beltwood Parkway, Dallas, TX 75244-3292; Don Folkes, (214) 450-0400. CIRCLE 796

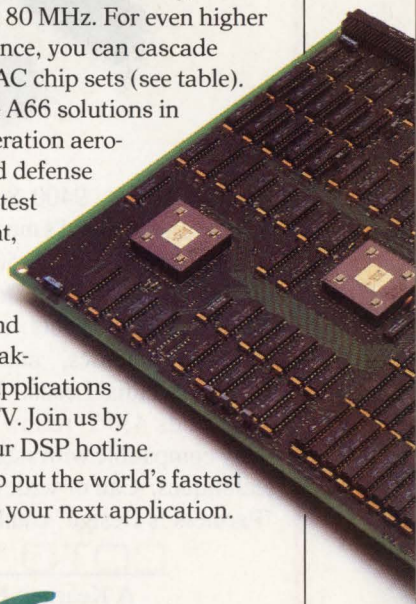
WHEN MANY THINGS COME TOGETHER, BREAKTHROUGHS HAPPEN.

NOW AVAILABLE! A REAL BREAKTHROUGH IN DSP: 400MOPS ARRAY PROCESSING CHIP SETS.

The world's fastest DSP product family is now together as a complete system solution from Array Microsystems. We started by gathering world leaders in digital signal processing to build a new company dedicated to supplying the next generation of DSP. Our products are a response to the needs of E-Systems, Tektronix, United Technologies, and our other industry development partners. Together, we pioneered VAST™ technology, the first architecture to perform a complete DSP algorithm while operating on entire arrays of data in parallel—in real time, on a single silicon chip. Not only does array processing make 400 million operations per second possible, its high-level instructions make programming nearly transparent. For example, eight simple instructions execute a complex 64K-point FFT. Array Microsystems delivers complete solutions, not just DSP chips. The A66 family includes everything you need: chip sets, software development tools, complete array processor boards, and custom memory ICs and modules. The Digital Array Signal Processor (DASP) is the heart of the chip set, and executes 16 high-level functions, including FFT butterflies, windowing, complex multiplies, and general-purpose functions. The Programmable Array Controller (PAC) manages the entire system, including address generation for DASP and memory, and I/O up to 80 MHz. For even higher performance, you can cascade DASP/PAC chip sets (see table). You'll see A66 solutions in next-generation aerospace and defense systems, test equipment, medical instruments, and other breakthrough applications like HDTV. Join us by calling our DSP hotline. We'll help put the world's fastest DSP into your next application.



SOLUTION	1K complex FFT	64K complex FFT	2K tap FIR
Array A66			
1 processor	131 μSec	13.1 mSec	2.3 MHz
Fully cascaded	26μSec (5)	1.6mSec (8)	25MHz (13)



array™ MICROSYSTEMS

CIRCLE 183

1420 Quail Lake Loop, Colorado Springs, Colorado 80906 • Call 719-540-7999, FAX 719-540-7950.

REDESIGNED CPUS RUN FASTER, CONSUME LESS

Targeting low-power and high-speed applications, NEC Electronics has reimplemented its V20 and V30 16-bit microprocessors to consume less power and run faster. The just-released V20H and 30H use static CMOS logic to trim power consumption to less than 8 mA/MHz—one of the lowest levels in the market for 16-bit processors. Furthermore, the static logic allows the clock to actually be stopped—without any data loss—to further reduce the power consumption.

An improved fabrication process lets designers increase the maximum clock speed to 16 MHz. This makes the H-grade CPUs some of the fastest 16-bit CPUs available today.

Both chips, like their predecessors, have instruction sets that are supersets of the Intel 8086. The V20H has an 8-bit interface similar to the 8088, while the V30H has a full 16-bit bus interface. Both processors operate from 5- or 3-V supplies. At 5-V power, the chips can operate at a maximum clock rate of 16 MHz and have a minimum instruction cycle time of 125 ns. At 3 V, the maximum operating frequency is reduced to 8 MHz, doubling the instruction execution time.

Samples of the chips are available in 40-pin DIPs, 52-lead quad-sided flat packages, and 44-lead plastic leaded chip carriers. Industrial and automotive temperature-range grades are available. Prices start at $6 each in 10,000-unit quantities. Delivery is from stock.

NEC Electronics Inc., 401 Ellis St., Mountain View, CA 94039; Farshad Zarghami, (415) 965-6117. CIRCLE 771

CONTROLLER TARGETS CONSUMER EQUIPMENT

Directed toward advanced consumer applications, an 80C51-based microcontroller includes an 8-bit a-d converter with a nonlinearity of ±1 LSB and a dual d-a converter circuit with pulse-width-modulated outputs to drive stepper motors. With these features, the PCB83C562 can control consumer equipment, including satellite television and satellite radio sets, videotape recorders, and high-end CD players.

The CMOS microcontroller also has 8 kbytes of mask-programmed ROM, 256 bytes of RAM, a full-duplex serial interface, and five I/O ports. These ports make the chip ideal for controlling general-purpose equipment, such as real-time instrumentation and industrial control gear.

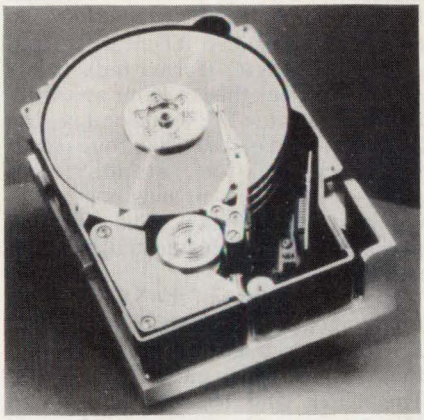
Besides incorporating all of the standard features of an 80C51 microcontroller, the PCB83C562 microcontroller has an extra 16-bit counter-timer circuit, a 16-bit watchdog timer circuit, and idle and power-down modes for low-power operation.

Samples are currently available for the PCB83C562 microcontroller, which will sell for around $10 each in quantities of 100.

Philips Components, P.O. Box 218, NL-5600 MD Eindhoven, The Netherlands; phone (0031) 40-724173. CIRCLE 772

SPEEDY 3-1/2-IN. DRIVE INCREASES RELIABILITY

By incorporating a dedicated servo mechanism, the reliability in the latest entry of Microscience's high-capacity 3-1/2-in. hard-disk-drive family has



been increased. The Model 7200 boasts an 18-ms average access time and a data-transfer rate of 12.5 Mbits/s. Also, the drive's integrated device electronics interface makes it simple to integrate into a system. The high capacity results from the 7200's four disk platters and seven thin-film data heads. The drive carries an MTBF rating of 60,000 power-on hours. It's priced at $1350. Evaluation units are now available.

Microscience International Corp., 90 Headquarters Dr., San Jose, CA 95134; (408) 433-9898. CIRCLE 773

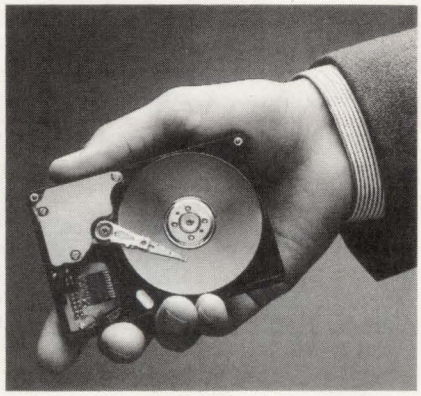
SEND VGA OUTPUT TO EIGHT MONITORS

Using the TwinSplit, QuadSplit, or OctoSplit VGA splitters, up to eight monitors can display VGA output simultaneously from any PC. Moreover, the monitors can be located up to 200 ft. from the computer. The splitters are fully compatible with all VGA, Super VGA, and 8514/A graphics cards. A front-panel switch supplies individual gain selection for each output to compensate for any extra-long cable lengths. High-performance equalized video circuits are combined with individual buffering of each output to help supply the high-quality output. TwinSplit, used to drive two monitors, is priced at $295. QuadSplit, for four monitors, sells for $495. OctoSplit, for eight monitors, costs $895. All come standard with a 6-ft. cable. The cable contains a standard high-density 15-pin connector. All are available now.

Communications Specialties Inc., 89A Cabot Ct., Hauppauge, NY 11788; (516) 273-1638. CIRCLE 774

WIDE RANGE OF DRIVES SUITS MOST SYSTEMS

Resulting from a burst of product activity, more than half-a-dozen disk drives, ranging in size from 2.5-in. units for notebook computers to 5.25-in. high-performance drives for minisupercomputers, fit almost any system need. In the 2.5-in. area are the ST9096A, 51A, and 25A, which pack 84, 42, and 21 Mbytes (formatted), respectively, and come with an embedded AT interface. The drives weigh in at 6.4 oz. and can withstand nonoperating shocks of up to 150 Gs. Access times are sub-20 ms and internal power management keeps the average power dissipation to less than 1 W.



In 3.5-in. drives, there are two new members—a low-profile ST3120A and the half-height ST1480. The 3120A includes an embedded AT-interface and stores 107 Mbytes (formatted). It has an average seek time of 18 ms and an internal data rate of 12 Mbits/s. Like the 2.5-in. drive, the 3120A has four power levels—active, idle, standby, and sleep—with the power consumed ranging from 5.1 to 0.6 W. The ST1480A packs 426 Mbytes (formatted) and consumes 8 to 13 W.

Bigger members of the 5.25-in. Wren family include the ST4767E and 4769E ESDI models, and the largest member, the ST41650, which packs 1.42 Gbytes. The 4767E and 69E both pack 766 Mbytes, and the 69E transfers 24 Mbits/s and has an average seek time of 11.9 ms. The 67E is slightly slower. The ST41650 has an average seek time of 15 ms and a data rate from 17 to 32 Mbits/s. A pair of drives in the 5.25-in. Elite family offer a dual-channel SCSI adapter. The ST41520N and 41600 also pack 1.352 Gbytes and have an average seek time of 11.5 ms.

***Seagate Technology Corp.**, 920 Disc Dr., Scotts Valley, CA 95066; Bob Maeser, (408) 438-6550.*

CIRCLE 775

■ *DAVE BURSKY*

DATA COMPRESSION PUSHES STORAGE CAPACITY TO 25 GBYTES

By adding data compression to its EXB-8500 8-mm cartridge tape subsystem, Exabyte Corp. has significantly increased the unit's transfer rate and storage capacity. The drive can store up to 25 Gbytes on one cartridge while transferring data at 2.5 Mbytes/s. In addition, the 5-1/4-in.-form-factor subsystem can search for data at speeds up to 187.5 Mbytes/s.

The data compression incorporated by Exabyte uses an IBM algorithm that's currently implemented in IBM's improved data-recording capability (IDRC). The compression method offers a unique data-integrity verification feature. After data is compressed, it's decompressed immediately and compared to the original data prior to being written on tape. This compression-integrity check ensures that the failure of any electronic component within the compression implementation won't compromise the integrity of the data written to tape.

In addition to increasing storage capacity, transfer rates, and search speeds, the data compression reduces backup time, data-cartridge requirements, and tape mounts. The compression option can be added to existing 8500 or 8200 drives. It will be available in 1991.

A second announcement made by Exabyte concerns their EXB-10 cartridge-handling subsystem. A new version, the 10i, will offer random as well as sequential access. This means that the cartridges (up to 10 in a system) can be accessed randomly or sequentially. The 10i will be shipping in the second quarter of 1991. Samples will be available in the first quarter.

***Exabyte Corp.**, 1685 38th St., Boulder, CO 80301; (303) 442-4333.*

CIRCLE 776

■ *RICHARD NASS*

GOODBYE WORKSTATION

HELLO PADS-PCB

It's time to say goodbye

to expensive engineering workstation based CAD systems. Why should management tie up $100,000.00 or more in a workstation when the same (and often better) performance is obtained with PADS-PCB, a PC based CAD system?

PADS-PCB is a high performance printed circuit board design software that offers a degree of functionality a designer could expect only from an expensive engineering workstation, including Logic Simulation, Circuit Analysis, and Thermal Analysis.

Powerful auto/interactive features are a part of what makes PADS-PCB the best selling CAD system on the market today!

- 1 mil database-32″x32″ board size-30 layers
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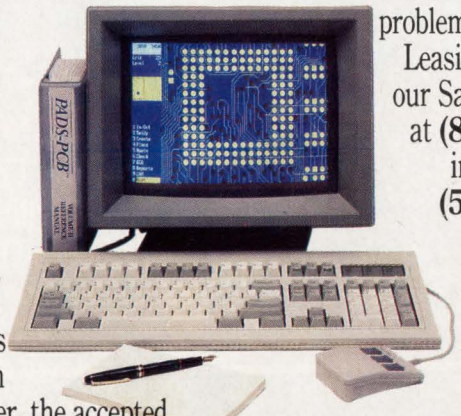

CAD Software asks you to try its Evaluation Package, at no charge, so you can judge for yourself how PADS-PCB can be the solution to your design problems. Ask about our Leasing Program. Call our Sales Hotline today at **(800) 255-7814;** in Massachusetts, **(508) 486-8929.**

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CAD Software, Inc.

CIRCLE 82

5-GBYTE DAT DRIVE FITS 3-1/2-IN. FORM FACTOR

Using WangDAT's Model 3600 digital-audio-tape (DAT) drive, users can store up to 5 Gbytes of data. The drive fits in a standard 3-1/2-in. form factor. The actual drive dimensions are 1.625 by 4 by 5.75 in.

The 3600 offers a high level of performance: It features a sustained transfer rate of 520 kbytes/s with burst rates of 4 Mbytes/s (asynchronous) and 5.3 Mbytes/s (synchronous).

The high storage capacity results from a combination of hardware-based data compression and long-length tapes. WangDAT uses the Stac 9703 coprocessor and a Stac variant of the LZ1 (Lempel-Ziv) compression algorithm. This approach prevents data expansion. If compression doesn't decrease data size, the compressed data is discarded and the original uncompressed data is stored.

The drive's ultra-slim mechanism employs a vertical-hub-engagement feature that assures consistent reliable cassette engagement and disengagement. Using this technique, the cassette is positioned straight into the drive in a one-step action. This eliminates the usual step of positioning the cassette down onto the reel spindles.

Designed using just one board with a reduced chip count, the drive's MTBF rises to 60,000 hours. The Model 3600 sells for $1400 in OEM quantities and is available now.

WangDAT Inc., *141 Kalmus Dr., K-3, Costa Mesa, CA 92626; (714) 241-9613.* **CIRCLE 779**

■ *RICHARD NASS*

MULTIFUNCTION OPTICAL DRIVE HOLDS 1 GBYTE

The RF-7010 multifunction optical disk drive combines the high capacity of optical-disk storage systems with the choice of write-once or erasable media. The 5-1/4-in. drive has a capacity of 1 Gbyte. It incorporates a positive filtered air pressure design that lengthens head life and improves performance. The drive's MTBF is rated at 20,000 hours. It also contains a push-button SCSI switch that simplifies daisy chaining. The maximum transfer rate is 4 Mbytes/s synchronous, or 1.5 Mbytes/s asynchronous. Average seek time is 90 ms. The drive can either be mounted internally or exist as an external unit. It's compatible with IBM PC/XT/AT, PS/2, and Macintosh computers. Its SCSI interface permits easy integration with most MS-DOS, Mac, OS/2, or LAN-based systems. Available now, it costs $3995.

Reflection Systems Inc., 99 W. Tasman Dr., San Jose, CA 95134; (408) 432-0943. **CIRCLE 780**

VIDEO CHIP INTEGRATES WINDOWING, SCALING, AND ZOOM FUNCTIONS

Designed for multimedia applications, the 82C9p001 PC Video IC from Chips and Technologies controls display-window size and positioning, and allows motion video to be merged with a mix of computer graphics still-video pictures. PC Video also supports scaling of both interlaced and noninterlaced inputs down to 1/64th of the original image size, in 1/64 increments. Video-input formats can be NTDS, PAL, SECAM, S-VHS, and RGB. Zooming ranges from 200% to 400% to 800%.

The chip accepts digitized and formatted video inputs from any standard video digitizer chip set. These signals pass through the PC Video into external video memory comprised of 256-kword-by-4-bit RAMs. By integrating AT and CMA bus interfaces, the host CPU can access video memory for capturing and displaying images stored on disk.

Windowing control is obtained through programmable position registers, color keying, or patterns written in external RAM. Digital color data for color keying comes from the feature connector on a VGA monitor.

At the PC Video's output, YUV signals are converted to analog RGB. The VGA and video data pass to a VGA monitor through an external multiplexer controlled by the PC Video. The chip supports video output rates up to 45 MHz, and 640-by-480, 800-by-600, and 1024-by-768 interlaced VGA and Super VGA modes. Packaged in a 160-pin plastic flat pack, the PC Video is now sampling and will be available in volume quantities in April 1991 for $40 each.

***Chips and Technologies, Inc.**, 3050 Zanker Rd., San Jose, CA 95134; (408) 434-0600.* **CIRCLE 781**

■ *MILT LEONARD*

10BASE-T TRANSCEIVER SAVES POWER

An Ethernet transceiver for 10Base-T twisted-pair LAN media draws an idle current of under 35 mA and a power-down current of less than 250 μA. Maximum current is 55 mA. Based on mixed-mode ASIC technology, NCR's 92C03 transceiver is a custom cell that includes 32-mA matched output-pad drivers and all key analog and digital functions for embedded and external media-attachment-unit applications. Other features include asynchronous operation and autopolarity. The analog circuits allow optional long-mode operation of up to 15.5 dB. The device also supports pre-10Base-T standard designs by making it possible to disable link-test and signal-quality error-test functions. Available in January, it comes in a 28-pin DIP or plastic leaded chip carrier. The DIP version costs $9.75 each in 1000s.

NCR Microelectronic Products Div., 2001 Danfield Ct., Fort Collins, CO 80525; (800) 334-5454. **CIRCLE 782**

CHIP SET BRINGS MULTIMEDIA TO DESKTOP

Consisting of the 82750PB pixel processor and the 82750DB display processor, Intel's i750 video processor integrates digital motion video, special effects, stills, audio, graphics, and text for presentation on PCs and workstations. The 25-MHz pixel processor links with video RAM to compress and store, or to retrieve and decompress data. Microcode instructions executed from an on-chip instruction RAM use leftover frame time to perform special effects, or to overlay fast graphics and text.

The 82750DB display processor retrieves bit-map image data from VRAM, performs post-processing operations such as 2D UV interpolation, translates it from YUV digital format to RGB analog format, and generates CRT synchronization and control signals. The 28-MHz processor delivers the pixel processor's output to a range of video displays, including VGA, NTSC, PAL, and SECAM.

Besides executing the JPEG (Joint Photography Experts Group) algorithm, full programmability enables the i750 family to run a variety of other algorithms for video and audio processing, and such special effects as scaling and zooming. In quantities of 1000, the 82750PB is $49 each in a 132-lead plastic quad flat pack, and the 82750DB in the same package is $56 each. A sample kit containing one of each device costs $500. Production quantities will be available in the first quarter of 1991, with an application design kit that has an evaluation board, run-time system software, software development tools, board design information, and a microcode developer's toolkit.

***Intel Corp.**, 3065 Bowers Ave., P.O. Box 58065, Santa Clara, CA 95051; 1-800-548-4725.* **CIRCLE 783**

■ *MILT LEONARD*

COMPANDER IC BOOSTS SIGNAL-TO-NOISE RATIO

The MC33110 compander chip from Motorola improves the signal-to-noise ratio in audio applications by reducing the transmitted dynamic range. The device has two variable-gain circuits that combine to compress an 80-dB dynamic range to 40 dB, and then re-expand it to 80 dB. Each circuit has a full-wave rectifier that provides average-value data to a variable-gain cell located in either the input stage or the feedback path. A temperature-stable bandgap reference provides precision voltages and currents. The compander runs on supply voltages from 2.1 V to 7.0 V, has an adjustable response time, and a preset unity-gain level of 100 mV rms. Five external capacitors and two resistors are required, all non-precision. The MC33110 compander chip comes in a 14-pin DIP or SO package and costs $0.80 in quantities of 10,000.

***Motorola Inc.**, P.O. Box 52073, Phoenix, AZ; (602) 897-3615.* **CIRCLE 784**

PLD TOOL OPTIMIZES DEVICE RESOURCES

Enhancements to Version 2.0 of PLDesigner expand the tool's ability to optimize a design. PLDesigner, a synthesis tool for programmable logic devices (PLDs), has new features that include automatic DeMorganization, automatic don't care capability, and increased device support. PLDesigner now generates the DeMorgan equivalent of all equations automatically, and for a given device, selects the equation that uses the fewest device resources for fitting. Automatic generation of don't care outputs can be enabled by the user for If-Then-Else, Case, or state machine designs. With this feature, unspecified output values are assumed to be don't cares. When the equations are reduced, the compiler will assign a 0 or 1 value to the output, depending on which value produces the optimal equation. Also, more devices have been added to the PLDesigner libraries, bringing their total to almost 3200. Shipping now, PLDesigner runs on Sun workstations and 80286- and 80386-based PCs. Pricing ranges from $1950 to $10,500, depending on platform and options.

Minc Inc., 6755 Earl Dr., Colorado Springs, CO 80918; (719) 590-1155. CIRCLE 785

DESIGN FPGAS FROM BEHAVIORAL ENTRY

The Plustran Behavioral Entry System (BES) is a field-programmable gate array (FPGA) toolset that lets designers bypass schematic capture and create chips with behavioral descriptions. Behavior can be entered with Abel, CUPL, Palasm, and other Boolean descriptions. Consequently, designers familiar with PLDs and PALs can have access to FPGA technology without changing their design tools or methodology. Plustran BES doesn't require that designers partition logic equations to fit a smaller series of PALs. In addition, existing design implementations using multiple PALs can be converted to an FPGA with Plustran. The tool processes these existing designs as an integrated set, automatically removing the artificial partitions. Plustran BES is available now in DOS or Sun Unix versions for $475.

Plus Logic Inc., 1255 Parkmoor Ave., San Jose, CA 95126; (408) 293-7587. CIRCLE 786

REVAMPED SHOVE ROUTER IS EASIER TO USE

A new user interface, better on-line help, and faster options setting with integrated configuration utilities have made Maxroute version 3.20 easier to use than previous autorouter versions. Maxroute is an interactive pc-board autorouter that uses shove technology to select the shortest and most efficient path for each trace by shoving existing traces out of the way whenever necessary. Also, version 3.20 places vias better and ensures proper entry to and from pads. New algorithms allow for automatic routing of surface-mounted components in the same way that it would be done manually. In addition, Maxroute's algorithms have been fine-tuned to reduce the number of vias. Maxroute version 3.20 runs on PCs, and is available now for $6500. Maintenance costs $750. A free demonstration disk or evaluation copy of Maxroute is available by calling the company.

Massteck Ltd., 95 Russell St., Littleton, MA 01460; (508) 486-0197. CIRCLE 787

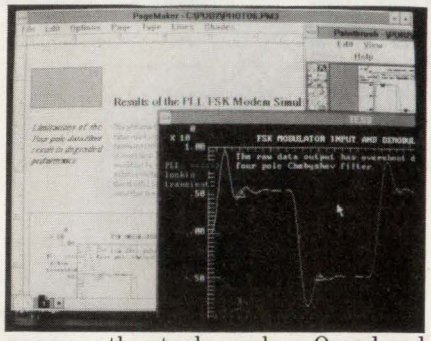
SPREADSHEET CREATES ANALOG MODELS

Analog-circuit designers can build custom Spice models with SpiceMod, a modeling spreadsheet that creates circuit models quickly and accurately based on data-sheet parameters. The program models all types of diodes, Zener diodes, bipolar-junction transistors, power transistors, Darlington transistors, and field-effect transistors. Built-in intelligence lets designers determine model parameters even if the appropriate data isn't available. SpiceMod understands both data-sheet parameters and Spice model parameters, and converts from one to the other. Designers can create entire model libraries, search for individual models, and update them as desired. Because all models made with SpiceMod are stored in ASCII files, designers can view and edit models with their favorite editor or word processor. The program contains complete on-line help with information on data-sheet parameter requirements, the Spice model, and the subcircuit parameters produced. Critical equations for device operation are also given. SpiceMod runs on PCs and costs $200. It is shipping now.

Intusoft, P.O. Box 6607, San Pedro, CA 90734-6607; (213) 833-0710. CIRCLE 788

24 FILTERS ADDED TO SYSTEM SIMULATOR

Version 1.1 of the Tess block-diagram simulator incorporates a long list of new features, including 24 new filters. With a filter-response calculator, users can compare simulated and ideal filters. Designers can specify nonlinearities with intercepts and compression points using the rf mixer and amplifier models. Also new to version 1.1 are high-quality graphics with interfaces to publishing software and plotting devices. The tool's memory management can handle large model libraries and



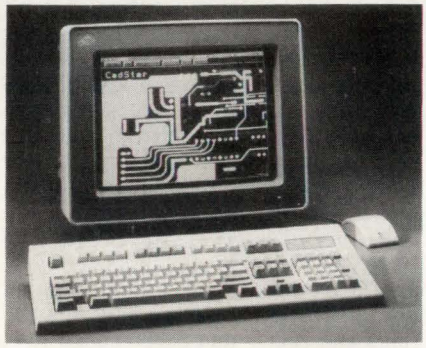
can run other tools, such as Orcad and P-CAD schematic software. The new release maintains compatibility with existing Tess simulations and user-created models, and the user interface is the same. Tess version 1.1, which runs on PCs, costs $695 and is shipping now. A demonstration disk is available by calling the company.

Tesoft, 205 Crossing Creek Ct., Roswell, GA 30076; (404) 751-9785.

CIRCLE 777

CAD TOOLSET GETS A NEW USER INTERFACE

The newest generation of Cadstar design tools are easier to use thanks to a Motif-like user interface. Cadstar's new interface no longer has several menu filters, improving click and move performance. The interface provides



consistency across all functional operations. Its features include Macintosh-like operation with a menu top bar. Cadstar helps users with surface-mounted technology and high-density board design, combining auto-rename-by-side for two-sided boards with surface-mounted parts. Analog design features include curved track, curved copper, teardrop pads, maximize copper, and copper cutout. These features support layout technologies for rf, microwave, and high-power applications. Cadstar, which is shipping now, costs $4850 and runs on PCs.

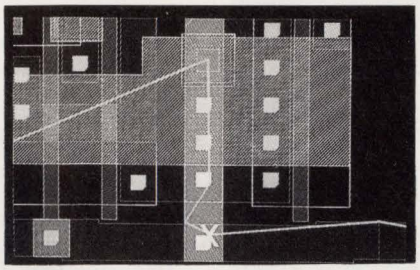
Racal-Redac, 1000 Wyckoff Ave., Mahwah, NJ 07430; (201) 848-8000. CIRCLE 778

FASTER VERIFICATION, PLACE AND ROUTE SPEEDS ASIC DESIGN

Improved verification and place-and-route tools available from Mentor Graphics Corp. can speed ASIC design. Explorer CheckMate is an IC physical-verification tool that was codeveloped with Texas Instruments. Across most designs, users can expect throughput improvements of 20 to 300%. Parade is an ASIC place-and-route tool that the company claims works up to 10 times faster than any other router today.

In addition to being fast, Explorer CheckMate also has high capacity. These two benefits are the result of network distributed processing, efficient database management, and efficient memory and disk-space use. Special algorithms minimize much of the repetitive data found in most hierarchical designs. CPU time is reduced by checking only one of many identical cells in a design. High capacity is achieved by compressing polygonal data and taking advantage of repetitive, hierarchical data.

The Parade tool can place and route gate arrays as well as complex-block and standard-cell designs in any combination of architectures. Moreover, Parade can handle any number of routing layers and over-the-cell routing. Its speed is obtained through network distributed processing, improved architecture and database efficiency, and a new placement technology called Spectral Derivatives. Spectral Derivatives provides better component placement of ASIC cells, which results in less work during placement improvement and 5 to 15% better gate utilization.



Both Explorer CheckMate and Parade are available now for $98,500 and $300,000, respectively. A parallel-processing option for the Parade software costs $45,000 per node.

Mentor Graphics Corp., *8500 S.W. Creekside Pl., Beaverton, OR 97005; (503) 626-7000.* **CIRCLE 789**

■ *LISA MALINIAK*

UPGRADED PC-BASED CAD SYSTEM PERFORMS AUTOMATIC T-ROUTING

The latest version of CAD Software's PC-based Pads-2000 pc-board design system now executes T-routing. Version 2.0 is the second release of the 32-bit CAD system, which features many functions of the workstation-based systems.

T-routing is the ability to route from any track within a net to any other pin, via, or track segment in the same net. Users can start from or tie into a track using a "T" without having to finish at a component pin. In addition, the T-routing feature automatically removes excess track where necessary.

A new graphics engine has been added to Pads-2000. The new engine facilitates the use of Number Nine, ELSA, and Metheus graphics, as well as many others. Also, Postscript and HP Laser Jet outputs are available.

Other features include micro, thru, and blind and buried vias. Users can rotate text and 2D designs, and can rotate components and component pads in 0.1° increments.

Pads-2000 Version 2.0 is shipping now for $6995. It runs on 80386- or 80486-based PCs. Pads-2000 Version 3.0 will be shipping in a few months. It will include all of the Version 2.0 features, plus automatic mitering of 90° angles and curved tracks.

CAD Software Inc., *119 Russell St. Suite # 6, Littleton, MA 01460; (508) 486-9521.* **CIRCLE 790**

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DATABASE SYSTEM GIVES USERS GRAPHICAL HELP

The second generation of an object-oriented database from Ontologic Inc.—Ontos Release 2.0, a graphical design tool—automatically generates C++ header files and database schema. In addition, interactive database inspection and maintenance are simplified with a graphical browser. Ontos is an object-oriented database management system targeted at network-based, data-intensive applications. Ontos supports full data distribution across local-area networks and has support for multiple inheritance. Ontos Release 2.0, which is shipping now, runs on Apollo, DEC, and Sun workstations. Four development licenses for Ontos cost $22,500, not including software support.

Ontologic Inc., Three Burlington Woods, Burlington, MA 01803; (617) 272-7110. CIRCLE 791

HP CASE TOOLS RUN ON SUN SPARCSTATION

HP's SoftBench, which now runs on Sun Sparcstation computers, is a tool-integration framework used for computer-aided software engineering (CASE). It offers a common interface and communication among tools used to analyze, design, debug, test, and maintain software products. This is the first offering for SoftBench outside the HP-Apollo environments. In addition, HP's Encapsulator tool is now available for Sparcstations. The software integrates third-party CASE tools into SoftBench. Both tools should be available in April, each for about $3000 per seat.

Hewlett-Packard Co., 19310 Pruneridge Ave., Cupertino, CA 95014; (800) 752-0900. CIRCLE 792

MAC COMMAND SHELL ADDS FEATURES OF DOS AND UNIX

By combining the convenience of a Macintosh with the flexibility of a DOS or Unix-style command-line interface, users get a simple-to-use interface for their Macintosh. Envyre, an interactive command shell for the Mac, offers the ability to rapidly manipulate files, manage directories, or view source code or hexadecimal listings of source code. The software supports any ASCII printer that connects to a Mac. Because of Envyre's command-line interface, users can easily switch between DOS, Unix, and Mac environments. It's available now for $99.95.

Appropriate Solutions Inc., 145 Grove St., P.O. Box 458, Peterborough, NH 03458; (603) 924-6079. CIRCLE 793

PLOT ENGINEERING DATA USING COMPLEX OPERATORS

Graph Version 3 retains many features of the previous editions of the plotting software, but also adds many new features. Designed for plotting scientific and engineering data, the tool permits data transformations with operators that include log, exponential, square root, add, subtract, reciprocal, integral, and derivative functions. Plots can have linear or log axes and data can be presented in histogram form. Some of the new features include extended-memory support, multiple Y-axis plotting, and importing of Lotus, dBase, and ASCII files. Graph Version 3 costs $149 or $69 to upgrade from an earlier version.

MicroMath Scientific Software, 2469 East Firt Union Blvd., Suite 200, P.O. Box 21550, Salt Lake City, UT 84121; (801) 943-0290. CIRCLE 794

SERIAL I/O CONTROLS, READS, OCTAL LOW-SIDE SWITCH IC

Driving up to eight separate 1-A, 30-V loads, the TPIC2801 from Texas Instruments consists of eight low-side switches, host-controlled through a bidirectional, serial I/O interface. Applications for the IC are numerous, and range from office machines and computer peripherals to medical instrumentation, vehicles, and industrial controls.

Typical loads for the device include lamps, relays, print-heads, small solenoids, and stepping motors. The IC's outputs can also be used to drive larger bipolar and power DMOS transistors.

The condition of each of the eight switches in the IC is set by an 8-bit word from a host computer via one of the two I/O lines. The second line, a clock, drives the serial-in, parallel-out shift register fed by the serial input word. The eight shift-register outputs set latches that, in turn, set the power switches on or off. A serial-out pin permits daisy chaining multiple 2801s or other compatible serial I/O ICs. Alternatively, switches can be paralleled to handle higher currents.

Each switch is monitored by a voltage-comparator circuit that checks its output voltage against an internal, out-of-saturation, voltage reference level. When the output voltage exceeds the 2-V reference (if the switch is closed), the switch is latched open. Current-limiting keeps the current in each output below 1.05 A, and a 90-kΩ pull-down resistor keeps switch outputs low when in the off state.

The eight npn-transistor switches in the TPIC2801 IC all have 35-V, collector-base, Zener-diode clamps, which eliminate the need for external snubber circuits when switching inductive loads. The Zener diodes turn the switch on, preventing avalanching and providing a 40-mJ unclamped inductive-energy rating.

If an overvoltage or overcurrent fault occurs, the chip identifies the recalcitrant output and notifies the host computer via the I/O port while the unaffected switches remain in operation. The host computer checks for an open-circuit output by turning it off. Another control byte is then clocked into the chip. If the diagnostic bit returning to the host computer is low, the output is open. The host computer detects a current overload by turning a switch on. A second control byte is sent and a logic-high returning check-bit indicates current overload.

The TPIC2801 low-side switch circuit is available in a 15-pin power SIP and is rated for operation at case temperatures ranging from −55 to 150°C. In quantities of 1000, the chip is priced at $3.20 each.

Texas Instruments Inc., *Semiconductor Group, (SC-9076), P.O. Box 809066, Dallas, TX 75380-9066; (800) 336-5236, ext. 700.*

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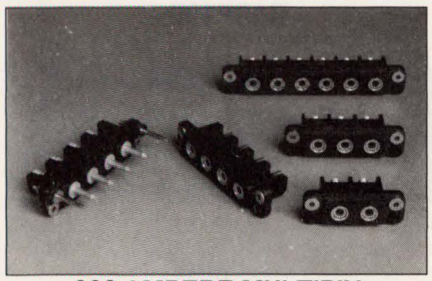

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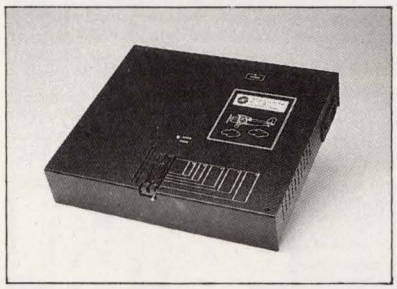

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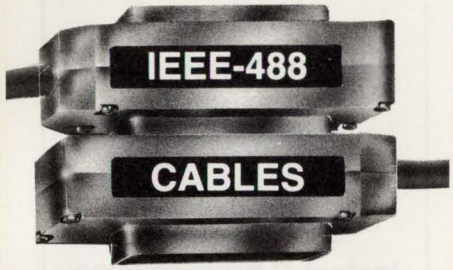

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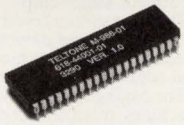

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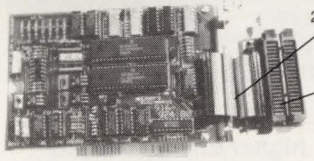

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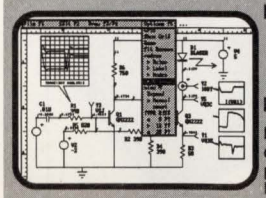

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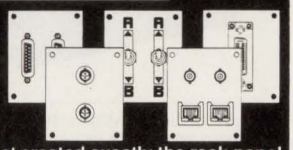

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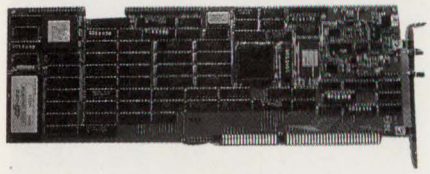

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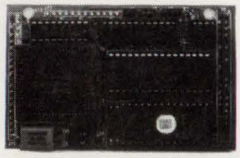

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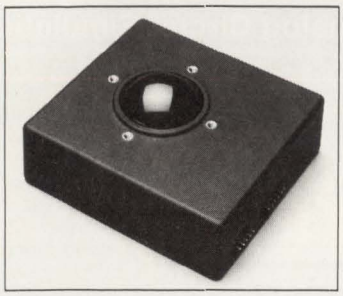

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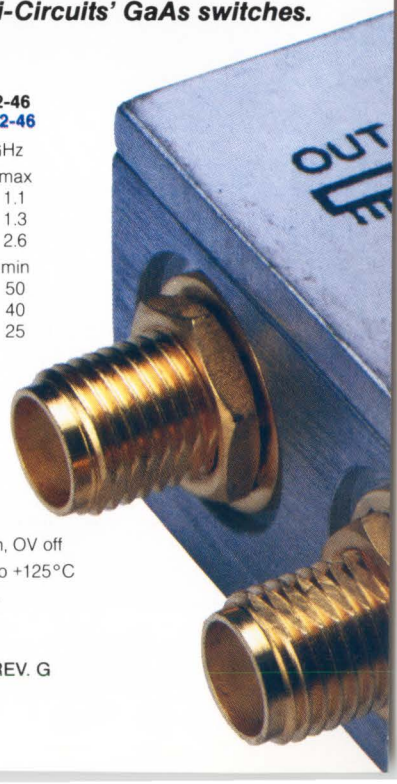
Pin Model / Connector Version	KSW-2-46 / ZFSW-2-46		KSWA-2-46 / ZFSWA-2-46	
FREQ. RANGE	dc-4.6 GHz		dc-4.6 GHz	
INSERT. LOSS (db)	typ	max	typ	max
dc-200MHz	0.9	1.1	0.8	1.1
200-1000MHz	1.0	1.3	0.9	1.3
1-4.6GHz	1.3	1.7	1.5	2.6
ISOLATION (dB)	typ	min	typ	min
dc-200MHz	60	50	60	50
200-1000MHz	45	40	50	40
1-4.6GHz	30	23	30	25
VSWR (typ) ON	1.3:1		1.3	
OFF	—		1.4	
SW. SPEED (nsec) rise or fall time	2(typ)		3(typ)	
MAX RF INPUT (bBm)				
up to 500MHz	+17		+17	
above 500MHz	+27		+27	
CONTROL VOLT.	-8V on, OV off		-8V on, OV off	
OPER/STOR TEMP.	-55° to +125°C		-55° to +125°C	
PRICE (10-24)	**$32.95**		**$48.95**	
	$69.95		**$79.95**	



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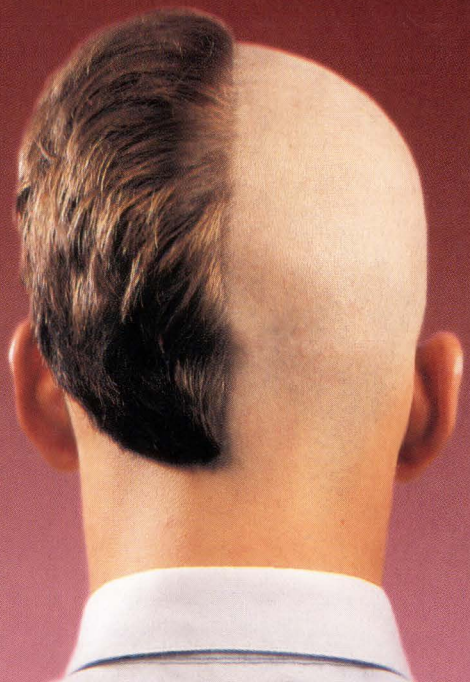
CIRCLE 91

Paying to get trimmed?



Linear's trimmed instrumentation amplifiers solve 7 problems and cost less.

The LT1101 is the first micropower single supply instrumentation amplifier. It operates from ±15 volts down to a single supply of 1.8V at only 75μA supply current. No external gain setting resistor or trims are required. The LT1101 offers fixed internal gains of 10 and 100 with a factory tested and guaranteed max gain error of 0.04%. Its gain nonlinearity is only 3ppm, and gain drift is only 1ppm/°C—all in a space saving, 8 pin mini-dip or 16 pin SOIC package ready to drop into your board.

The LT1102 is the fastest FET input instrumentation amp with a slew rate of 30V/μS and 6.5μS max settling time to 0.01%. It provides fixed internal gains of 10 and 100 with factory tested and guaranteed gain errors of 0.05% max. No external resistors or trims are necessary.

1. Zero drift and offset
2. Single supply
3. Micropower
4. Fast
5. 8 pin DIP
6. 0.05% max gain error
7. No external parts

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Gain nonlinearity is only 3ppm and input bias currents are only 40pA max. And the LT1102's 8 pin package is a real space saver.

LTC1100 is the first "zero drift, zero offset" instrumentation amp with only 10μV max input offset voltage and 0.1μV/°C max temperature drift—ideal for thermocouple amplification. It offers internal fixed gain of 100 in the 8 pin DIP (10 and 100 in the 16 pin SOIC package) with tested gain error of only 0.05% max. The LTC1100 operates on ±5 volts or a single supply down to 4.75V.

100 piece quantity pricing for the 8 pin plastic DIP versions starts at $4.95. For more data call **800-637-5545** or contact Linear Technology Corporation, 1630 McCarthy Blvd., Milpitas, CA 95035.

CIRCLE 110