A CAHNERS PUBLICATION

DECEMBER 10, 1987

EDN®

SPECIAL ISSUE—Part 1
Product Showcase No 26

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

Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

There was nothing to it really.

Instead of making one CMOS PLD (like some competitors we could name), Monolithic Memories makes many.

So many, in fact, that our CMOS PLDs offer you more speed, power and architecture options than you can get from any of our competitors.

Take our ZPAL™ family, for example. It's a zero standby power (less than $100\mu A$) version of our popular PAL® C20R8 Series. And it comes in both 35ns and 45ns versions.

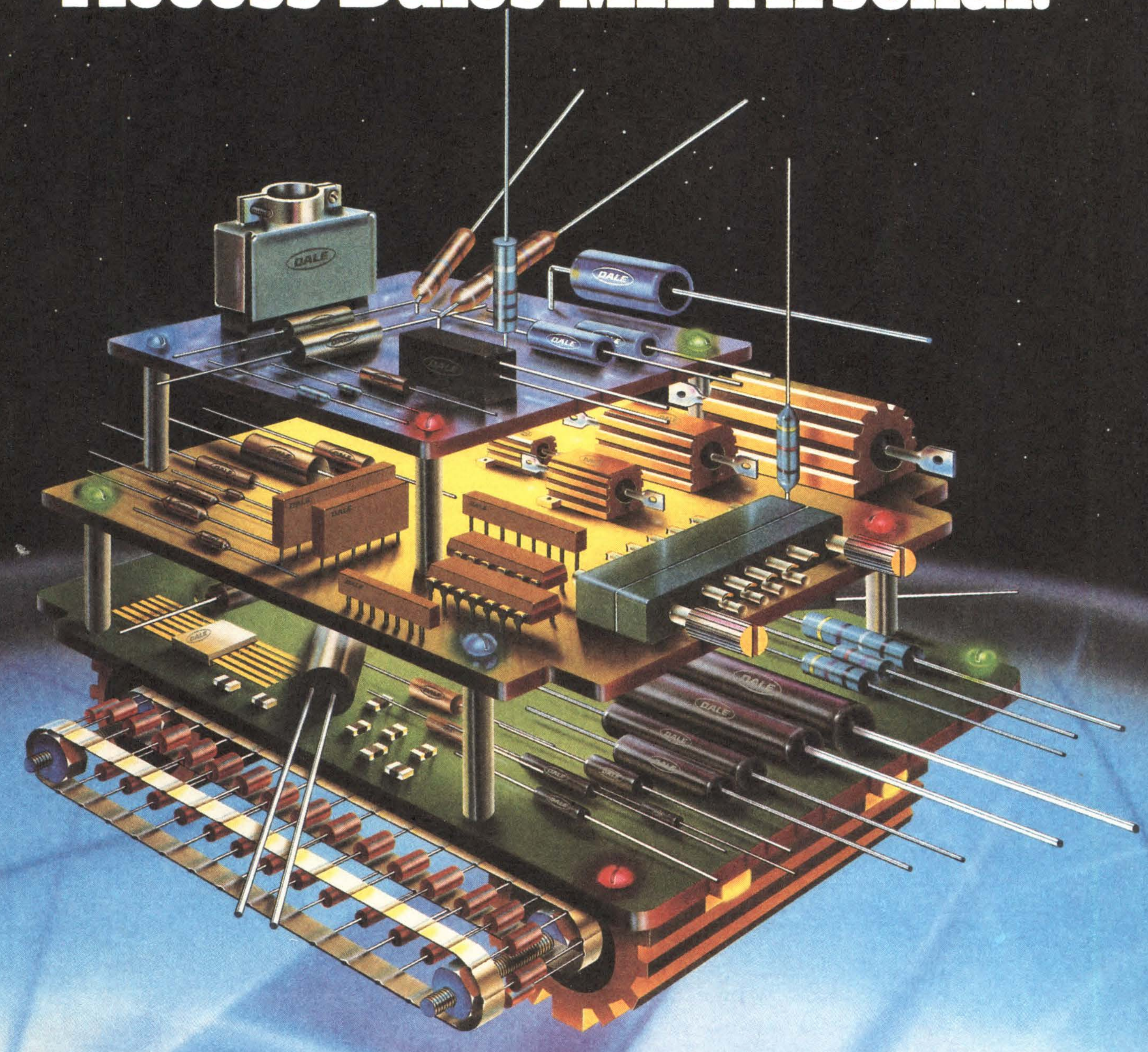
Or for universal applications, our PAL C22V10 combines a wide-open architecture with 25ns or 35ns speed. Yet it consumes a mere 90mA.

Better yet, our new quarter-power CMOS PAL C16R8 Series devices consume but 45mA. While their 25ns speed approaches the best of bipolar.

And should you need gate array density, but prefer PLD convenience, try our CMOS Logic Cell™ Arrays (LCA).

How we improved CMOS PLDs.

Access Dale's MIL Arsenal.



Be prepared to save time and add efficiency when buying or specifying MIL components. Check the list at right then call Dale®. We have carefully assembled the industry's broadest stock of MIL resistors including networks...chips...wirewound and metal film. And, we can also supply RF chokes and connectors to popular MIL requirements. This complete arsenal is stockpiled at strategic factory and distributor locations — giving you a reliable source of supply that will assure operation with low inventories. For complete information contact your Dale representative, your distributor, or call the factory.

RESISTOR NETWORKS
Phone 915-592-3253
MIL-R-83401
- RZ010, RZ020, RZ030
- RZ040, RZ050, RZ060
- RZ070, RZ080, RZ090

THICK FILM CHIPS
Phone 402-371-0080
MIL-R-55342/2,/3,/4,/5,/6
- RM0505, RM1005, RM1505
- RM2208, RM0705

METAL FILM RESISTORS
Phone 402-371-0080
MIL-R-122
MIL-R-10509
- RN50, RN55, RN60
- RN65, RN70

MIL-R-22684
- RL07, RL20

MIL-R-39017
- RLR05, RLR07, RLR20

MIL-R-55182
- RNR55, RNR60, RNR65
- RNC50, RNC55, RNC60
- RNC65, RNC70

WIREWOUND RESISTORS
Phone 402-564-3131
MIL-R-26
- RW67, RW68, RW69
- RW70, RW74, RW78, RW79
- RW80, RW81

MIL-R-18546
- RE60, RE65, RE70
- RE75, RE77, RE80

MIL-R-39007
- RWR71, RWR74, RWR78
- RWR80, RWR81, RWR82
- RWR84, RWR89

MIL-R-39009
- RER40, RER45, RER50
- RER55, RER60, RER65
- RER70, RER75

INDUCTORS
Phone 605-665-9301
MIL-C-15305
- MS75087, MS75088, MS75089
- MS75083, MS75084, MS75085
- MS14046, MS18130, MS90538

CONNECTORS
Phone 605-665-9301
MIL-C-28748/7,/8

Dale makes your basics better. DALE®

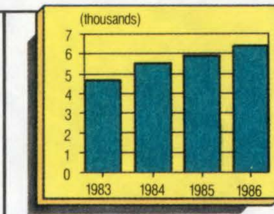
CIRCLE NO 1

Standards Update

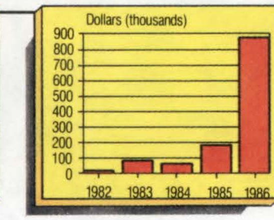
Uncle Sam Cracks Down on Computer Interference

Last Fall's COMDEX show in Las Vegas had a new kind of visitor. Federal marshals were there to seize equipment the FCC had tagged as non-compliant and to serve notice that arrests may follow. The computers were found to be in violation of Part 15 of the FCC rules, which bans sales of most electronic hardware unless tested for compliance.

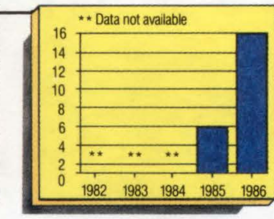
The event did not surprise most computer executives, some of whom paid their share of more than $800,000 in fines issued by the FCC last year. Said one disgruntled manager, "These guys walk around here like Matt Dillon."



The rising level of complaints to the FCC...



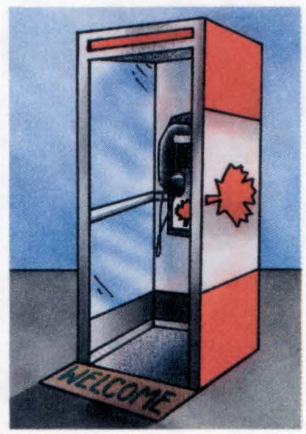
...caused it to issue more fines...



...and refer 15 cases for criminal prosecution.

The need to comply has spawned a whole new kind of test business, companies specially skilled in designing and testing for compliance. One of these, the Boxborough, MA-based laboratory of Dash, Straus & Goodhue, combines testing, design and even legal services under one roof, permitting manufacturers to go to COMDEX with their minds on sales, not sanctions. The company even offers a "Guaranteed Rate/Guaranteed Date" plan under which equipment is tested, modified for compliance, and retested per FCC standards for a fixed price guaranteed in advance. The laboratory has been accredited by the National Bureau of Standards for telecommunications and emissions testing, and can be reached at 617-263-2662.

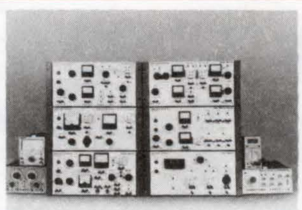
Canada Lays Out the Welcome Mat for Telecom Firms

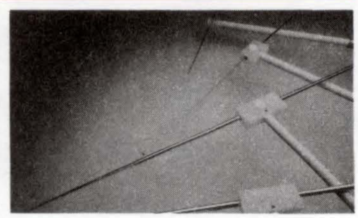


The Canadian government has swung its doors wide open for US telecom manufacturers. The open door policy is a welcome change for US manufacturers who have found most foreign markets closed to their goods. Canada's free trade telecom policy has allowed savvy manufacturers to increase their sales by up to 20%. But to sell north of the border, firms still need to follow a few simple steps. Most importantly, the equipment has to be registered under Canadian Standard CS-03, roughly equivalent to the FCC's interconnect regulations in Part 68. The government of Canada has already approved a number of firms in the United States to do the required telecom testing and submissions. One such firm, Dash, Straus & Goodhue of Boxborough, MA (617-263-2662), has seen a sharp rise in requests for Canadian approvals, especially among the industry's most successful firms. "There seems to be a correlation between economic success and willingness to enter foreign markets," says firm founder Glen Dash.

Elsewhere in the world, telecom markets are opening. Dash, Straus & Goodhue is currently performing submissions for telecom equipment in both the United Kingdom and Japan. New efforts within the Common Market (EC Directive 86/361/EEC) may make one unified approval scheme throughout Western Europe a reality within two to three years.

Fed's Own Instruments Help Manufacturers Comply





What kind of tools can best convince an agency that equipment complies? Why, their own, of course. Now the FCC's own designs are available through a company called Compliance Design. Key to emissions compliance is the use of the **Roberts Antenna**,® developed for the FCC in the 1950's. Willmar Roberts, its inventor, is a former Assistant Chief Engineer of the FCC Laboratory in Laurel, MD.

The antennas are renowned for their near-lossless characteristics. Compliance Design, the exclusive vendor of the Roberts brand, also offers a complete laboratory assembly package. The firm will supply antennas, masts, turntables, site design; and will even perform the crucial "site attenuation" tests the FCC requires. The Boxborough, MA-firm can be reached at 617-264-4668.

For telecom manufacturers, Compliance Design also supplies a **Part 68 Workstation**™ containing everything that's needed to comply with FCC, CS-03 (Canada) and EIA standards. The Workstation makes setting up Part 68 laboratories practical for just about everyone.

Safety Violation Sends a CEO to Jail

On February 13, Kenneth Oden, prosecutor for Travis County, TX, won a landmark case that sent shivers down corporate backbones nationwide. For the first time, company executives were sentenced to jail terms for negligence that cost a worker his life. The case highlighted a nationwide trend in which prosecutors are holding executives criminally liable for the death of a customer or employee.

For makers of EDP, medical and telecom equipment, safety on the job generally means getting their products UL® listed. Listing is a recognition that the product meets UL's standards for fire, shock, energy and mechanical hazards; listing is a legal requirement of certain municipalities. In those places, a death caused by a non-compliant product could give rise to the same charge of gross negligence which caused Travis County executives to be sentenced to jail.

Overseas, marks such as Canada's CSA and West Germany's GS are required, and foreign courts have been even less tolerant of corporate negligence than have our own. With the profusion of worldwide standards, obtaining those marks has proven to be quite a chore. Fortunately, certain key test labs have set up liaison services which permit worldwide product approvals at one location. Dash, Straus & Goodhue is one such lab and is regularly visited by agents of UL, CSA and West German TüV. Required marks for fourteen countries can be initiated from DS&G's location. Since the Travis County case, according to execs, its business has been brisk. Dash, Straus & Goodhue, Inc. can be reached at 617-263-2662.

UL® CSA® GS®

rugged plug-in amplifiers

0.5 to 1000MHz from $13.95 (5 to 24 qty)

Tough enough to meet full MIL-specs, capable of operating over a wide -55° to +100°C temperature range, in a rugged package... that's Mini-Circuits' new MAN-amplifier series. The MAN-amplifier's tiny package (only 0.4 by 0.8 by 0.25 in.) requires about the same pc board area as a TO-8 and can take tougher punishment with leads that won't break off. Models are unconditionally stable and available covering frequency ranges 0.5 to 500MHz and 0.5 to 1000MHz, and NF as low as 2.8dB.

Prices start at only $13.95, ***including*** screening, thermal shock -55°C to +100°C, fine and gross leak, and burn-in for 96 hours at 100°C under normal operating voltage and current.

Internally the MAN amplifiers consist of two stages, including coupling capacitors. A designer's delight, with all components self-contained. Just connect to a dc supply voltage and get up to 28dB gain with +9dBm output.

The new MAN-amplifier series...
another Mini-Circuits' price/performance breakthrough.

MODEL	FREQ. RANGE (MHz) f_L to f_u	GAIN dB min	flatness††	MAX. OUT/PWR† dBm	NF dB (typ)	DC PWR 12V, mA	PRICE $ ea. (5-24)
MAN-1	0.5-500	28	1.0	8	4.5	60	13.95
MAN-2	0.5-1000	19	1.5	7	6.0	85	15.95
MAN-1LN	0.5-500	28	1.0	8	2.8	60	15.95
◇MAN-1HLN	10-500	10	0.8	15	3.7	70	15.95

††Midband $10f_L$ to $f_{u/2}$, ± 0.5dB †1dB Gain Compression ◇Case Height 0.3 In.
Max input power (no damage) +15dBm; VSWR in/out 1.8:1 max.

finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

CIRCLE NO 189

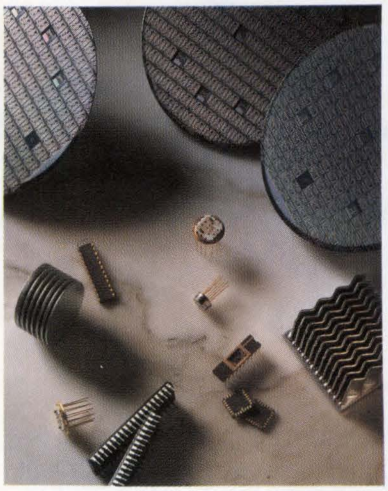
C118 REV. B

Volume 32, Number 25

EDN

December 10, 1987

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



On the cover: *Part 1 of EDN's Product Showcase No 26 contains a multifarious selection of products: devices such as EG&G Wakefield Engineering's heat sinks for pin-grid-array packages, and a slew of semiconductor products such as the ones Analog Devices manufactures. This issue's staff-written coverage includes an article on fans and blowers, which complements the section on hardware and interconnect devices (pg 96). The Showcase also deals with software in general, and debuggers in particular (pg 152); power sources such as dc/dc converters (pg 194); and integrated circuits for cache-memory systems (pg 244). (Conceptual photography by Dana Sigall; art direction by Kathleen Ruhl)*

DESIGN FEATURES

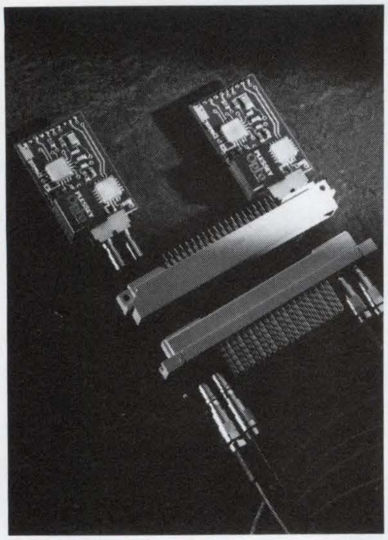
Continued on page 7

EDN® (ISSN 0012-7515) is published 38 times a year (biweekly with 1 additional issue a month) by Cahners Publishing Co, a Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158. William M Platt, President; Terrence M McDermott, Executive Vice President; Jerry D Neth, Vice President of Publishing Operations; J J Walsh, Financial Vice President/Magazine Division; Thomas J Dellamaria, Vice President Production & Manufacturing; Frank Sibley, Group Vice President. Copyright 1987 by Reed Publishing USA, a division of Reed Holdings Inc; Saul Goldweitz, Chairman; Ronald G Segel, President and Chief Executive Officer, Robert L Krakoff, Executive Vice President. Circulation records are maintained at Cahners Publishing Co, 44 Cook Street, Denver, CO 80206. Phone (303) 388-4511. Second class postage paid at Denver, CO and additional mailing offices. POSTMASTER: Send address corrections to EDN® at the Denver address.

BPA ABP


YOUR
BEST PROTECTION:
C&K® SWITCHLOCKS
From simple electrical lockout to high security mechanical lockout with electrical control, C&K Components offers the most complete line of Switchlocks.
Whether you want to control computer access, point-of-sale terminals, test instruments, medical equipment, process control systems, security and/or alarm systems, C&K Components can provide the right combination of value added features at the right cost to meet your specifications.
• Standard and instrument grade switching up to four poles • Power ratings from low-level up to 12 amps • From three to seven tumbler mechanisms including MEDECO high security locks • UL/CSA Listed • Shorting or nonshorting contacts • Special harnesses, finishes, latches and cosmetic designs • Front or back panel mounting • Anti-static options • 30-, 45-, or 90-degree indexing • Modular assembly
For the best protection, specify C&K Switchlocks. Send us your specs and we'll send you a free engineering sample. Call or write for our FREE literature.
1-800-334-7729
C&K COMPONENTS, INC. 1957–1987 30th ANNIVERSARY
C&K®
C&K Components, Inc.
2035 Highway 70 East
Clayton, NC 27520-0687
The Primary Source Worldwide®...

Continued from page 5



In the first part of December's showcase, you can read about hardware and interconnect devices, beginning on pg 115; software, beginning on pg 169; power sources, beginning on pg 205; and integrated circuits (shown above), beginning on pg 263.

PRODUCT UPDATE

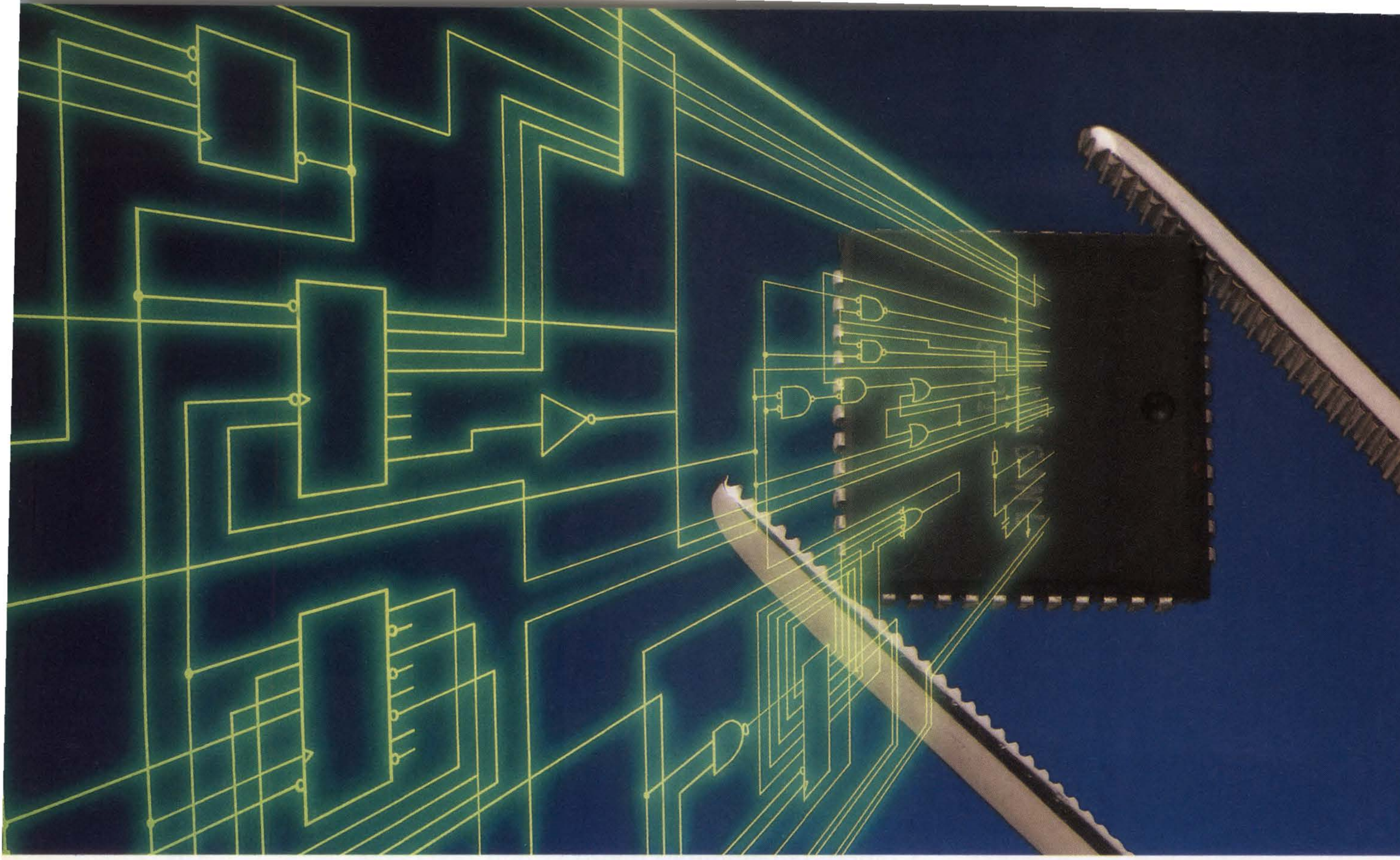
PRODUCT REVIEWS

DESIGN IDEAS

LITERATURE

Continued on page 9

Advertising and editorial offices: 275 Washington St, Newton, MA 02158. Phone (617) 964-3030. Subscription offices: 44 Cook Street, Denver, CO 80206. Phone (303) 388-4511. EDN® is circulated without charge to those qualified. Subscription to others: US, $95/year, $6/copy; Canada and Mexico, $110/year, $8/copy; Europe Air Mail, $135/year, $10/copy; all other nations surface mail, $135/year, $10/copy; all other nations Air Mail, $200/year. Special issue prices may vary. Send requests for qualification forms and/or change of address to subscription office.



THE FIRST PROGRAMMER WITH A SINGLE SITE FOR EVERY DEVICE.

NEW UNISITE 40 HANDLES LEADING-EDGE DEVICES WITH SPEED AND EASE.
Now you can program and test the latest programmable devices and packages, fast and accurately — all in a single site. The first true universal pin drivers support any device of a given package type in the same site. The UniSite™ 40's single DIP socket handles any device up to 40 pins, including PLDs, PROMs, IFLs, FPLAs, EPROMs, EEPROMs, and microcontrollers. The same site accommodates the most popular PLCCs and SO packages. A 16-bit processor, coupled with custom ICs and high-speed RAM, set new speed records for programming and testing.

TIMELY ACCESS TO TOMORROW'S DEVICES. With universal pin driver electronics hardware, device-specific instructions can be loaded from one

3½" micro-diskette. When new devices are introduced, you simply load a new master diskette, and the UniSite 40 is quickly updated.

MENUS MAKE PROGRAMMING EASY. Use your cursor to select any function. Menus prompt you step-by-step and HELP messages assist you throughout operation. A built-in listing of devices speeds part selection. The UniSite 40 can even save your most frequently used parameters for instant recall.

SHORTCUTS SPEED SETUP. More frequent users can bypass menus and zoom directly to specific operations by selecting key commands. Special software commands, like the ones in our QuickCopy™ mode, are also available to streamline your programmer operation.

DESIGN FREEDOM FOR TOMORROW. Call today and get the design freedom only the UniSite 40 can provide.

1-800-247-5700
Dept. 805

Data I/O Corporation 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. (206) 881-6444/Telex 15-2167
FutureNet 9310 Topanga Canyon Boulevard, Chatsworth, CA 91311-5728 (818) 700-0691/Telex 910-494-2681
Data I/O Canada 6725 Airport Road, Suite 302, Mississauga, Ontario L4V 1V2 (416) 678-0761/Telex 06968133
Data I/O Europe World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands (20) 622866/Telex 16616 DATIO NL
Data I/O Japan Sumitomoseimei Higashishinbashi Bldg., 8F, 2-1-7, Higashi-Shinbashi, Minato-ku, Tokyo 105, Japan (03) 432-6991/Telex 2522685 DATAIO J

DATA I/O

CIRCLE NO 190

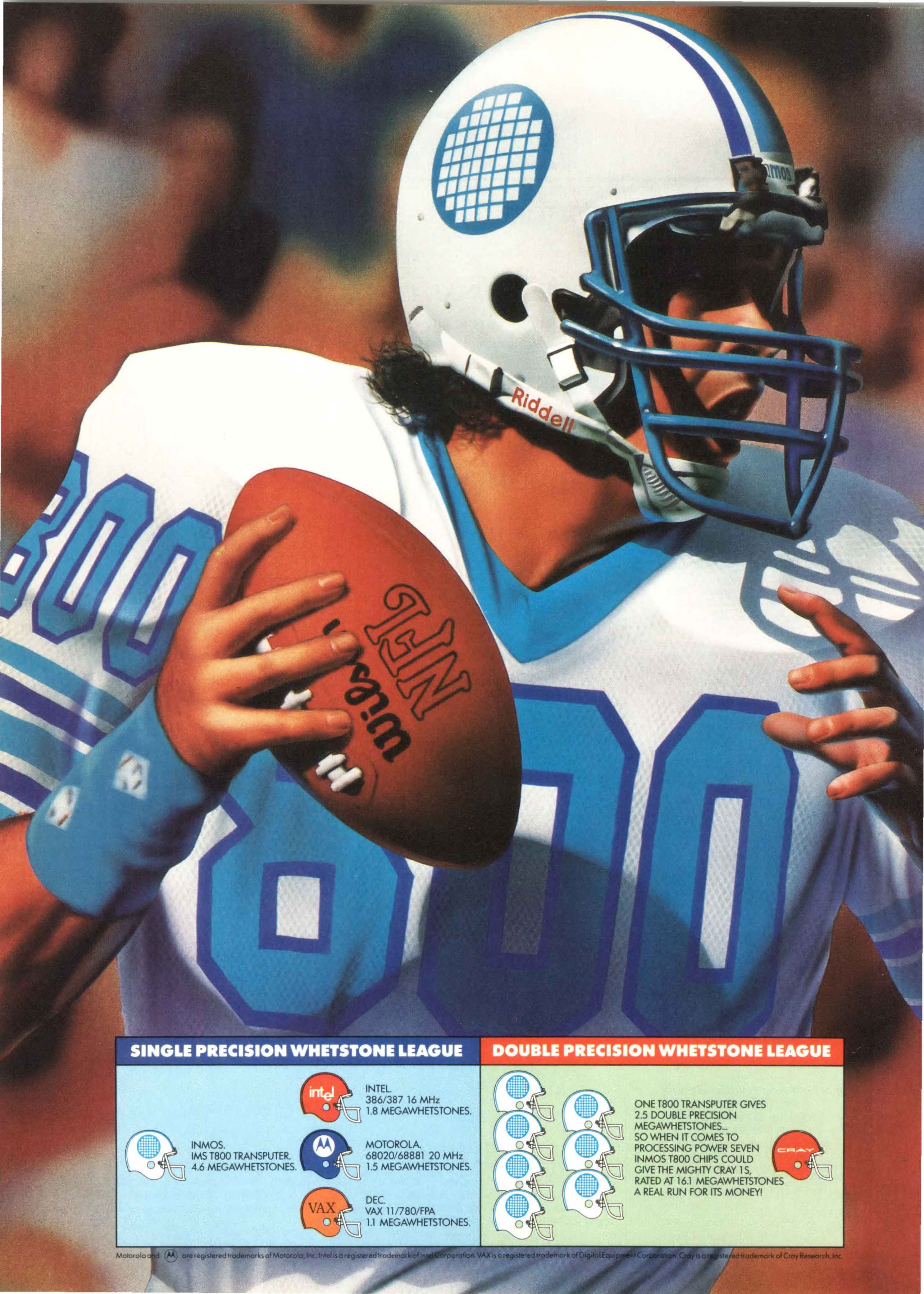
Continued from page 7

DEPARTMENTS

A product-oriented design aid

To save you time in your efforts to keep current, EDN's editors have surveyed the new-product offerings from thousands of companies, screening and selecting only the most significant of those offerings introduced in the last six months. We present our findings—the best of the best—in a format devised to make your product selection as easy as possible. You can keep this Product Showcase as a reference until the next one that covers these four key product areas appears in July.

Cahners Publishing Company □ A Division of Reed Publishing USA □ Specialized Business and Consumer Magazines for Building & Construction □ Interior Design □ Electronics & Computers □ Foodservice & Lodging □ Manufacturing □ Book Publishing & Libraries □ Medical & Health Care □ Child Care/Development



Riddell
NFL
800
SINGLE PRECISION WHETSTONE LEAGUE
INTEL.
386/387 16 MHz
1.8 MEGAWHETSTONES.
INMOS.
IMS T800 TRANSPUTER.
4.6 MEGAWHETSTONES.
MOTOROLA.
68020/68881 20 MHz
1.5 MEGAWHETSTONES.
DEC.
VAX 11/780/FPA
1.1 MEGAWHETSTONES.
DOUBLE PRECISION WHETSTONE LEAGUE
ONE T800 TRANSPUTER GIVES
2.5 DOUBLE PRECISION
MEGAWHETSTONES...
SO WHEN IT COMES TO
PROCESSING POWER SEVEN
INMOS T800 CHIPS COULD
GIVE THE MIGHTY CRAY 1S,
RATED AT 16.1 MEGAWHETSTONES
A REAL RUN FOR ITS MONEY!
CRAY
Motorola and (M) are registered trademarks of Motorola, Inc. Intel is a registered trademark of Intel Corporation. VAX is a registered trademark of Digital Equipment Corporation. Cray is a registered trademark of Cray Research, Inc.

MORE MULTIPROCESSOR MUSCLE. MORE RAW PERFORMANCE.

When you're out in the trenches fighting it out with ordinary microprocessors, running out of muscle is all too easy. That's why you should look to the new T800 Transputer from INMOS.

The T800 is the fastest 32-bit, single chip, floating-point microprocessor available today. A quick glance at its statistics will show why nothing else is in its league...

32-bit enhanced RISC processor...64-bit on-chip IEEE floating-point processor...4K Bytes on-chip 50ns static RAM...Four 20 MBits/sec interprocessor communication links...Eight independent DMA engines. All on a single chip capable of sustained 1.5 MFLOPS...and 4.6M Whetstones!

And, if that's not enough raw power, the T800's links allow multiprocessor systems to be constructed quickly and easily – giving you 6 MFLOPS with four T800's...30 MFLOPS with 20...150 MFLOPS with 100...In fact, there's no limit to the number of Transputers you can use!

Programming Transputers couldn't be easier, with compilers for C, Fortran and Pascal, and the world's first concurrent programming language OCCAM.

Want to turbocharge your current system? No problem. Our exclusive Link Adaptor IC's allow Transputers to be connected to other microprocessors or peripherals.

Other team members include the pin compatible T414 Transputer, offering lower cost, 10 MIP performance and 0.75M Whetstones. Lined-up to provide all the I/O processing you need, the T212 16-bit Transputer is the ideal high performance controller and the M212 Disk Processor combines disk controller hardware and a Transputer on a single chip, supporting both Winchester and floppy disks. And the C004 Link Switch makes the design of software reconfigurable multiprocessor systems as easy as kicking an extra point.

Whatever field you're in – from real-time distributed systems to high-performance graphics, from fault-tolerant systems to robotics, Transputer technology can give you scalable performance at a cost you can afford.

Transputers are manufactured using an advanced 1.5 micron CMOS process which keeps the power consumption under one watt. So your system stays cool while under fire.

Transputers to MIL-STD 883C will be available in the first half of 1988.

If this all sounds like your kind of game, put the ball in play by contacting your local INMOS sales office today. And get ready to score.

DESCRIPTION			PERFORMANCE		AVAILABILITY		PACKAGE
Part No.	Word Length	Clock MHz	Integer Drystones	Floating Point Whetstones	Commercial	Military	
IMS T800-20	32-Bit	20	9500	4.6 Million	Now	Q2 88	84 PGA
IMS T414-20	32-Bit	20	9500	0.75 Million	Now	Q2 88	84 PGA
IMS T212-17	16-Bit	17	8000	–	Now	Q2 88	68 PGA
IMS T212-20	16-Bit	20	9500	–	Now	Q2 88	68 PGA
IMS M212-17	16-Bit	17	8000	–	Now	–	68 PGA
NETWORK SUPPORT PRODUCTS					AVAILABILITY		PACKAGE
Part No.	Description		Communication Speed		Commercial	Military	
IMS C004	Software configurable 32 way link switch		10 + 20 MBits/sec		Now	Q2 88	84 PGA
IMS C011	Link to system bus		10 + 20 MBits/sec		Now	–	24 Pin DIP
IMS C012	Link to system bus		10 + 20 MBits/Sec		Now	Q2 88	24 Pin DIP

THE TRANSPUTER TEAM

inmos®

INMOS, Colorado Springs, Colorado 80935. Tel. (303) 630-4000.

Orange County – 714-957-6018
Santa Clara – 408-727-7771
Denver – 303-252-4100
Minneapolis – 612-932-7121
Dallas – 214-490-9522
Boston – 617-366-4020
Baltimore – 301-995-6952
Atlanta – 404-242-7444

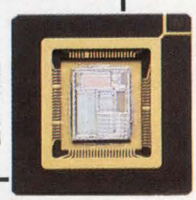
☐ Send me information on the Transputer Team. ☐ Send me the Transputer White Pages, a listing of third-party manufacturers' transputer-based products and services.
☐ Please have a Field Applications Engineer call. ☐ Please have a salesman call.

Name ________ Title ________

Company ________ Address ________

________ Zip ________ Tel ________

EDN112687

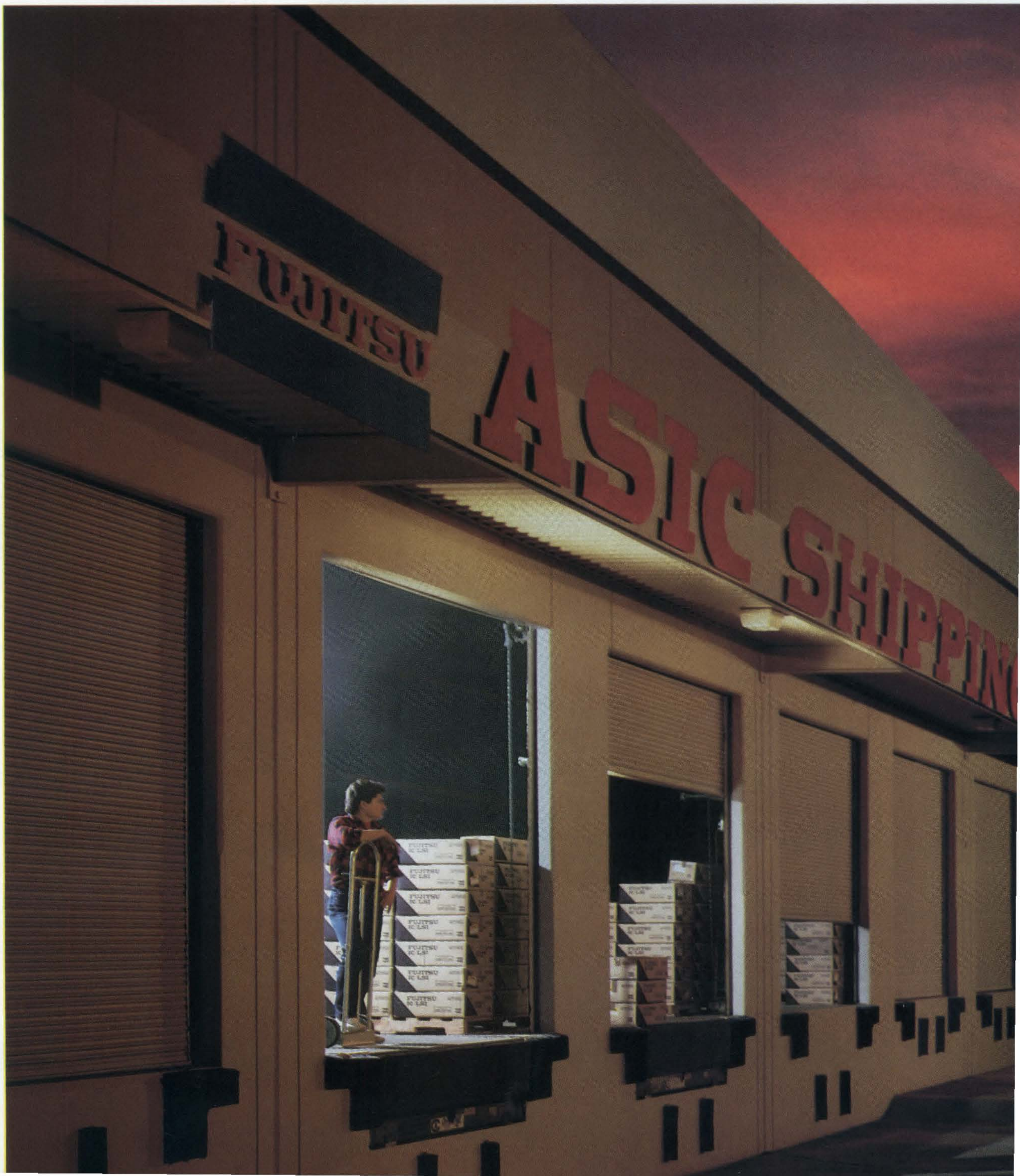


CIRCLE NO 186

THE POINT OF NO RETURN.

When you put a Fujitsu ASIC to work, you can rest assured it will work the way it should. And keep on doing its job for a very long time to come. In fact, when you look at our performance record over the years, you'll be hard pressed to find any field failures at all.

This is no empty promise. Product reliability has been a way of life for us for more than 15 years.



NOW

More power for less than the cost of a TO-126 bipolar

50-Volt HEXDIPs™

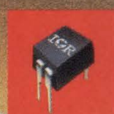
When it comes to motor drive control or high-side switching of grounded loads, our new N- and P-Channel 50V HEXDIP power MOSFETs deliver more at less cost than do equivalent bipolar devices. Here are some reasons why.

Unlike traditional die-mounting, HEXDIP chips are mounted on a dual-drain copper tab, resulting in power dissipation of up to 1 Watt – more than any FET in its class.

Designed for automatic insertion, our 4-pin HEXDIP packages are end-stackable on 100 mil centers. This cuts assembly time. And there's no wasted board space in high density packing applications.

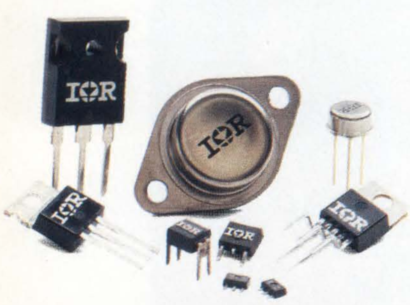
Four new HEXDIP 50V Series are available in N- and P-Channel types for today's state-of-the-art designs in automotive electronics, power supplies, and motor drive control circuits.

Rds(on) ranges from a low of 0.10 Ohms, with current ratings up to 2.4 amps depending on die size. For complete data, call (213) 607-8842. Today.



ACTUAL SIZE

HEXFET® TECHNOLOGY...
HEXDIPs are produced through our exclusive HEXFET process, resulting in guaranteed quality and reliability.



Most HEXFETs now in stock for immediate delivery!

Number 1 in power MOSFETs

International IOR Rectifier

WORLD HEADQUARTERS: 233 KANSAS ST., EL SEGUNDO, CA 90245. U.S.A. (213) 772-2000. TWX 910-348-6291, TELEX 472-0403
EUROPEAN HEADQUARTERS: HURST GREEN, OXTED, SURREY RH8 9BB. ENGLAND TELEPHONE (088 33) 3215/4231. TELEX 95219

Power MOSFETs • CMOS Power ICs • Commercial/Custom Power Packages • Schottkys
Rectifiers • Thyristors (SCRs) • Diode Bridges • Molded Circuits • Assemblies

CIRCLE NO 185

Only one company has the technology, the resources, and the vision to top the 68020.


MC68030

Introducing the 68030.

The next generation.

In 1984, we introduced the 68020. Now, three years later, it has the largest installed and broadest application base of any 32-bit MPU on the market. Having set that standard in the first place, we feel qualified to raise it. Which is why the only microprocessor that really surpasses the 68020 is our second generation 68030.

Meet the *Oh thirty!*

The '030 is twice the microprocessor its predecessor is. It's the first to sport an instruction cache, data cache and MMU on-chip. Combined with a Harvard-style parallel bus architecture that allows simultaneous, multiple fetches of instructions and data, processor throughput is pushed to unmatched levels.

What can you do with all that performance? Anything you like—from low-cost personal workstations to super-computers—and the 68030 will help you to do it less expensively.

With its burst fill mode for the dual caches, you'll be able to squeeze SRAM performance from low-cost DRAMs. It gives you graphics capability without the need for a graphics co-processor. And there's true object-code compatibility between the '030 and the '020. All this adds up to economies you can count on.

An architecture you can build on. And count on.

Application software that runs on any 68000 family MPU runs on the 68030. There's also a full array of development tools, and a new 68882 floating point co-processor, with up to 4x the performance of its predecessor. All of which gives your product plans an enormous amount of continuity. And that's not going to change. Since the 68030 supports both MS-DOS™ and UNIX® V.3, you can have your pick of over $12 billion worth of applications— and the broadest possible market.

With Motorola, you can see forever.

Our plans for the rest of the 68000 family extend well into the future, offering continuing compatibility and leading-edge performance. So you can go with Motorola, not just for what our microprocessors can do now, but what you'll be able to do with them later on.

For more information about the new 68030, call us toll-free at 800-521-6274 or write, Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, AZ 85036.

We're on your design-in team.

MOTOROLA

To: Motorola Semiconductor Products, Inc. 345EDN121087
P.O. Box 20912, Phoenix, AZ 85036

Please send more information on the *Oh thirty!*

Name ______

Title ______

Company ______

Address ______

City ______ State ______ Zip ______

Call me (______) ______

Now scan and record temperatures from freezing to scorching.

The new Fluke 52 goes to great extremes to outperform any other handheld thermometer.

With extra features, like our exclusive SCAN mode. Touch the button, and your Fluke 52 sequentially scans the readouts of two temperature inputs, and their difference.

Hit the RECORD button, walk away, and record the minimum and maximum from any one of these three channels for up to 1,200 hours. For troubleshooting intermittent problems, overnight monitoring, inlet/outlet servicing, and comparing trend information, it can't be beat.

If you don't need the scanning and recording features, you may prefer the single-point Fluke 51. Like the 52, it's easy to use, offers unsurpassed accuracy with resolution to 1/10th of a degree, and can use any K or J type thermocouple probe to fit your application.

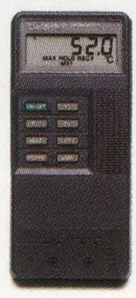
Even the warranty goes to great extremes: three years on parts and service — the longest in the industry. And prices start as low as $119.

But you don't have to go to extremes to get one.

Just contact your local supplier now for immediate delivery.

Or for more information, call toll-free **1-800-227-3800, Ext. 229.**

FROM THE WORLD LEADER IN HANDHELD TEST INSTRUMENTS.



Fluke 51 Single Input **Fluke 52** Dual Input

Measurement range: K-type: −200°C to +1370°C (−328°F to +2498°F) J-type: −200°C to +760°C (−328°F to +1400°F)
Accuracy: K-type is ±(0.1% of reading +0.7°C or 1.3°F) J-type is ±(0.1% of reading +0.8°C or 1.4°F)
°C or °F Selectable
Hold Mode
Scan, Differential, and Min/Max Recording Modes (52 only)
Standard mini-connector input
1200 hour 9V battery life
3-year warranty
General-purpose K-type bead probe included (two with 52).

FLUKE®

IN THE U.S. AND NON-EUROPEAN COUNTRIES: John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206, Sales: (206) 356-5400, Other: (206) 347-6100.
EUROPEAN HEADQUARTERS: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven, The Netherlands, (040) 458045, TLX: 51846.

NEWS BREAKS

EDITED BY JOANNE CLAY

THE LONG-AWAITED MC68030 FINALLY ARRIVES

The MC68030 32-bit μP from Motorola (Phoenix, AZ, (512) 440-2839) is now available. The 68030, which is fully compatible with the 68000 family, has on-chip data and instruction caches, a parallel (Harvard-style) architecture, and an on-chip memory-management unit. The vendor claims the 68030 achieves twice the performance of the 32-bit MC68020. The 68030 is currently available in 16- and 20-MHz versions priced at $400 and $550, respectively. The MC68882 math coprocessor (its 16- and 20-MHz versions cost $245 and $375, respectively) offers two to four times the performance of the MC68881, with which it is pin and software compatible.—David Shear

INSTRUMENT MONITORS FREQUENCY AND TIME-INTERVAL VARIATIONS

For more than a generation, engineers have been able to buy digital counters that sit on a benchtop and monitor time intervals, frequency, and phase. Some of these instruments provide outputs that can drive recording devices to indicate how the measured quantities vary over minutes, hours, or days. Now, Hewlett-Packard (Santa Clara, CA) is introducing the HP 5371A frequency and time analyzer, which, though it measures frequency and time, is quite unlike conventional counters. For example, it measures frequencies as high as 500 MHz, using sampling intervals as short as 100 nsec, with no dead time between measurements.

The analyzer performs a variety of firmware-based calculations on data it acquires, and it incorporates a CRT, which can display such information as histograms and plots of measured values vs time. HP expects the $21,500 analyzer to find application in development and testing of frequency-agile and digital communications systems, radar, electronic warfare systems, data-storage peripherals, and electromechanical devices.—Dan Strassberg

VME BUS INTERFACE CARD LINKS TO 96 RS-232C DEVICES

Using 1M-bps serial links to communicate with as many as six SYS336M16 Deltalink servers, the $1800 MVME336K Deltalink hub card from Motorola Inc's Microcomputer Div (Tempe, AZ, (800) 441-2345 ext 230) connects 96 full-duplex, RS-232C devices to a VME Bus-based system. Each $1800 server provides 16 RS-232C ports, and links to the hub card by means of as much as 800 ft of unshielded, twisted-pair cable (including telephone cord.) The Deltalink protocol encapsulates RS-232C transmissions in HDLC packets that provide both transport and error checking. Motorola currently incorporates drivers for this product in release 3 of its System V/68 operating system; the company will provide source code for driver routines to customers who wish to use the hardware with other operating systems.—Steven H Leibson

MODEM GIVES STD-BUS SYSTEMS PROGRAMMABLE COMMUNICATION

Supporting the full Hayes AT command set for modem control, the MCM-Modem from WinSystems (Arlington, TX) is the first STD-bus card that can provide systems with programmable, full-duplex 1200/300-bps Bell 212A/102 and CCITT V.22 and V.21 communications. The onboard Data Access Arrangement connects an STD-bus system directly to dial-up telephone lines. The modem card also offers self-test, autoanswer, autodial, and call-monitoring functions. An auxiliary RJ-11 jack lets you plug in a separate telephone handset. You can program this $395 modem to communicate at speeds ranging from 50 to 1200 bps.—J D Mosley

NEWS BREAKS

REAL-TIME OPERATING SYSTEM FOR RISC μP

Ready Systems (Palo Alto, CA, (415) 326-2950) has signed a contract with Advanced Micro Devices (Sunnyvale, CA) to port Ready's VRTX32 to AMD's forthcoming Am29000. VRTX32 is a multitasking executive designed for real-time embedded computer applications. It will work on the Am29000 without modification, so you should be able to move your high-level-language code from other processors to the Am29000 without revising the code. The Am29000 is a 32-bit μP based on a reduced-instruction-set computer (RISC) architecture and targeted at embedded applications. VRTX32 for the Am29000 will be available in May 1988 and will cost $9000.—David Shear

WORKSTATION TRANSFORMS 300,000 VECTORS/SEC

The HP 9000 Series 330CHX and 350CHX workstations transform as many as 250,000 and 300,000 vectors/sec, respectively. The workstations, from Hewlett-Packard (Fort Collins, CO), can achieve this level of performance because they each include an HP 98556A graphics accelerator. The accelerator is also available separately for $6000; you can use it with the vendor's 330CH and 350CH workstations. The 330CHX costs $22,250; the 350CHX sells for $38,550.—Jim Wiegand

SYSTEM AUTOMATES PLACEMENT, ROUTING, AND POSTPROCESSING

Combining hardware and software tools that automate the entire pc-board-design task, the PCB design system from Intergraph (Huntsville, AL, (205) 772-2000) helps you develop your concept from package placement through photoplotting. It costs $120,000. The design system includes a Micro II data-processing unit with tape drive, two InterPro 32C workstations, and software for pc-board design, automatic packaging and placement, automatic routing, and photoplotting.—J D Mosley

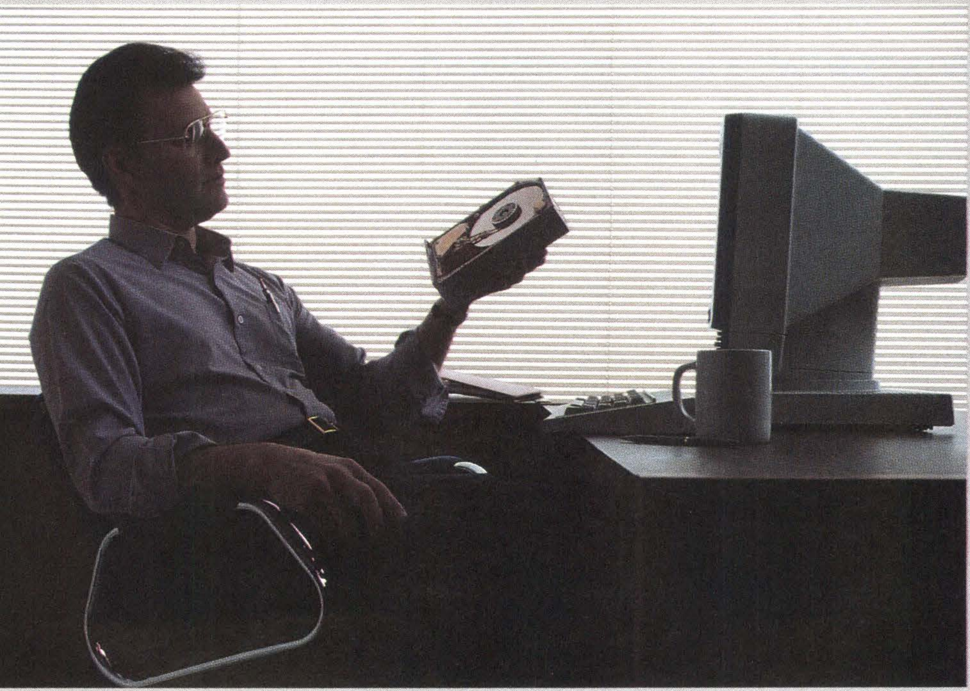
PLOTTERS SPEC 32-IPS PEN SPEED; OFFER SCANNING OPTION

For $4695, you can buy a DMP-61 single-pen plotter with an axial pen speed that reaches 32 ips and a maximum axial acceleration of 4g for A- through D-size drawings. For E-size drawings, the $6495 DMP-62 provides a maximum pen speed of 24 ips with a 2g acceleration. Both of these 68000-μP-based plotters from Houston Instruments (Austin, TX, (512) 835-0900) accept options such as the $750 MP-60 pen changer, the $2995 Scan-Cad optical scanner, a $995 1M-byte-buffer board with a replot feature for drawing multiple originals, and a $495 Kanji character-set board.—J D Mosley

CAD/CAE/CAM VENDOR CLIMBS ABOARD STANDARD PLATFORM

Cadnetix Corp (Boulder, CO, (303) 444-8075) has ported its CAD and CAE software packages to Sun Microsystems' (Mountain View, CA) workstations and become an OEM for those systems. The vendor calls these new workstation/software packages the Concept 3 family. The company offers the CDX-9600, a $15,900 CAE workstation based on the Sun 3/60, and the CDX-56000, a $89,900 CAD system that's also based on a Sun 3 workstation. The CAD system incorporates a graphics processor developed by the vendor that performs 400,000 vector clips and transformations per second. The Concept 3 family also includes a CAM workstation, the CDX-61000, for $88,900. Because the vendor's proprietary offerings incorporate Sun's LAN communications protocols, all of the vendor's existing products (which the company continues to offer), including its route engines, are compatible with the Concept 3 family.—Steven H Leibson

Imagine what you could do with a little quick cache.



A quick cache like DisCache,™ the unique drive-resident caching feature available on Quantum Q200 Series™ of half-high 5¼″ intelligent disk drives.

A Quantum 53 or 80-megabyte (formatted) drive with its integrated SCSI controller and DisCache can help your system perform faster and smarter. Depending upon the application, DisCache can actually cut disk transaction times in half by reducing seek and rotational latency delays.

DisCache acts as a high-speed memory between the disk and the host system. DisCache anticipates sequential host requests by looking beyond the current data request and storing adjacent data in cache memory. When the host requests this data, it is accessed in microseconds from the 60 KB of high-speed memory instead of in milliseconds from the disk.

Since typically 50% or more of all disk requests are sequential, DisCache can make your systems substantially faster. And that can help your systems sell faster.

DisCache is as flexible as it is fast, with programmable options to tailor caching parameters to suit your system.

DisCache is an option on both our Q250 and Q280 drives. Each drive features Quantum's innovative design and exceptional reliability.

Call or write for more information about DisCache and the Q200 Series of half-high 5¼″ intelligent disk drives.

We'll show you what a little quick cache can do for your business.

Quantum Corporation, 1804 McCarthy Blvd., Milpitas, CA 95035 (408) 432-1100. TWX 910-338-2203. Eastern Regional Sales: Salem, NH (603) 893-2672. Western Regional Sales: Santa Clara, CA (408) 980-8555. European Sales: Frankfurt, West Germany 069-666-6167. Quantum products are distributed in the United States and Canada by Arrow Electronics and Marshall Industries.

Quantum

First In Intelligent Disk Drives

CHANNELLESS GATE ARRAYS SUIT A VARIETY OF ASIC REQUIREMENTS

Combining the resources and technologies of its merged parent companies (SGS and Thomson Semiconductors), Innovative Silicon Technology (Agrate Brianza, Italy, TLX 330131) has introduced 1.5- and 1.2-μm, single-level-poly, double-level-metal gate-array families based on the sea-of-gates principle. The ISB8000 family comprises four 1.5-μm arrays having gate counts of between 3500 and 21,000. They suit random logic designs, and have output drivers with 24-mA capability.

Suitable for use in high-pin-count designs, the 1.5-μm ISB9000 family comprises 10 gate arrays with gate counts of between 288 and 21,000. The 1.2-μm ISB12000 family comprises 10 gate arrays with gate counts of between 8000 and 128,000. The ISB12000 arrays have a typical layout efficiency of 40% for random logic, but they easily accommodate large blocks of RAM and ROM. The 2-input NAND-gate propagation delays for the ISB8000, ISB9000, and ISB12000 arrays are 0.7 nsec, <0.7 nsec, and 0.6 nsec, respectively. The vendor expects to offer the larger ISB8000 gate arrays for between $0.18 to $0.19 (10,000) per gate for devices packaged in plastic leaded chip carriers.

—Peter Harold

IC-DESIGN SOFTWARE ENVIRONMENT ADAPTS TO CHANGING TOOL SETS

The Spirit IC-design software environment from Integrated Circuit Design (Enschede, The Netherlands, TLX 72280) provides you with a stable user interface through which you can access a variety of proprietary or commercial IC-design software tools. If you add to or change the set of design tools, the user interface remains the same, eliminating the need to learn a new user interface for each tool. In addition to the user interface, the tool set is surrounded by a design manager, a design database, and a foundry interface that allows you to meet the requirements of different silicon foundries. System-management software allows the system administrator to create and change information about users, projects, foundries, libraries, and process parameters. Priced at approximately gld 175,000 (including a tool set), Spirit is intended for use by teams that create full-custom IC designs. It is available for use on the Apollo Domain 3000 workstation, HP 9000 Series 300 and Series 500 computers, and the PCS Cadmus computer.—Peter Harold

16-BIT PARITY GENERATOR/CHECKER OPERATES AT 30 MHz

You can generate parity for 16-bit data with a single device by using the CMOS-compatible PC74HC7080 or TTL-compatible PC74HCT7080 parity generator/checker from Philips' Components Div (Eindhoven, The Netherlands, TLX 51573; in the US, Signetics Corp, Sunnyvale, CA, (408) 991-2000). For 16-bit data, the device operates at speeds as high as 30 MHz. Two cascaded devices generate parity for 32-bit systems at speeds as high as 20 MHz. You can select even or odd parity generation on an active-high or active-low output. At 20 MHz, both versions dissipate 17 mW typ. They operate over −40 to +125°C and come in 20-pin DIPs or small-outline surface-mount packages. Approximately gld 5.25 (100).—Peter Harold

ADAPTER CONVERTS 68-PIN PGA TO PLCC

If you're developing a design that will incorporate a device in a 68-lead plastic leaded chip carrier (PLCC), but you can only obtain the device in pin-grid arrays (PGAs), the 308-1846-XX Series adapter from Methode Electronics Inc (Chicago, IL, (312) 867-9600) can solve your problem. The top of the adapter accepts a 68-pin PGA; PLCC leads protrude from the bottom. The adapter is available in 10×10 and 11×11 grid patterns and costs $265 in production quantities.—Steven H Leibson

Alphanumeric Display Systems

W424 4040 4X40	W424 105D 1X5D	W424 105B 1X5B	Feature	W424 1058	W424 1053	W424 1051
●	●		Polling Capability/Real Time Clock			
●	●	●	Enclosed in Metal Housing			
●	●	●	NEMA 12 or 4X Stainless Steel Bezel			
●	●	●	115/230 Volt Power Supply Included			
			12 Volt Power Supply Required	●	●	●
●			Four Line x 24 Character Readout			
	●	●	Single Line Readout (24 Characters)	●	●	●
			64 Canned Messages in EPROM	●		
●	●		256 Canned Messages in CMOS RAM			
●	●	●	½″ Characters Utilizing Gas Plasma Technology	●	●	●
●	●		RS232/RS422 and 20mA Outputs			
			Full and Half Duplex Communication		●	
●	●	●	Accepts RS422 Serial ASCII Input			
●	●	●	Accepts RS232 & 20mA Serial ASCII Input		●	●
●	●		PC Software Available for Message Programming			
●	●	●	Accepts Parallel ASCII Input (TTL Logic Levels)		●	●
●	●		Recall Message with +5 to +30VDC Logic			

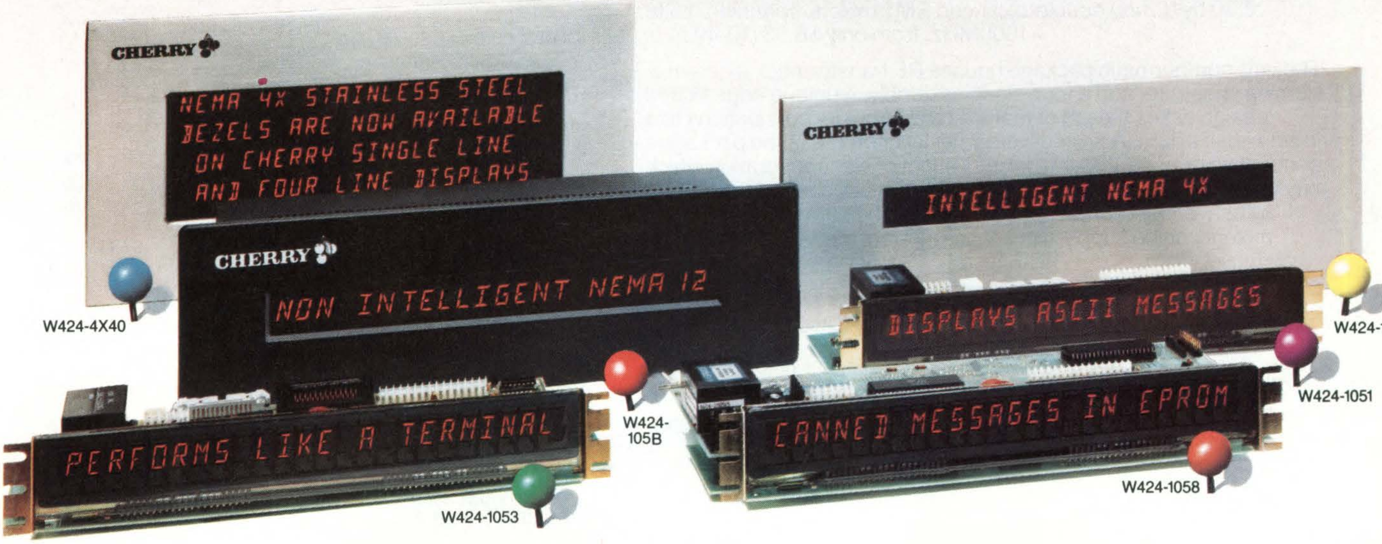
Get our detailed message: Send for specs.

CHERRY®

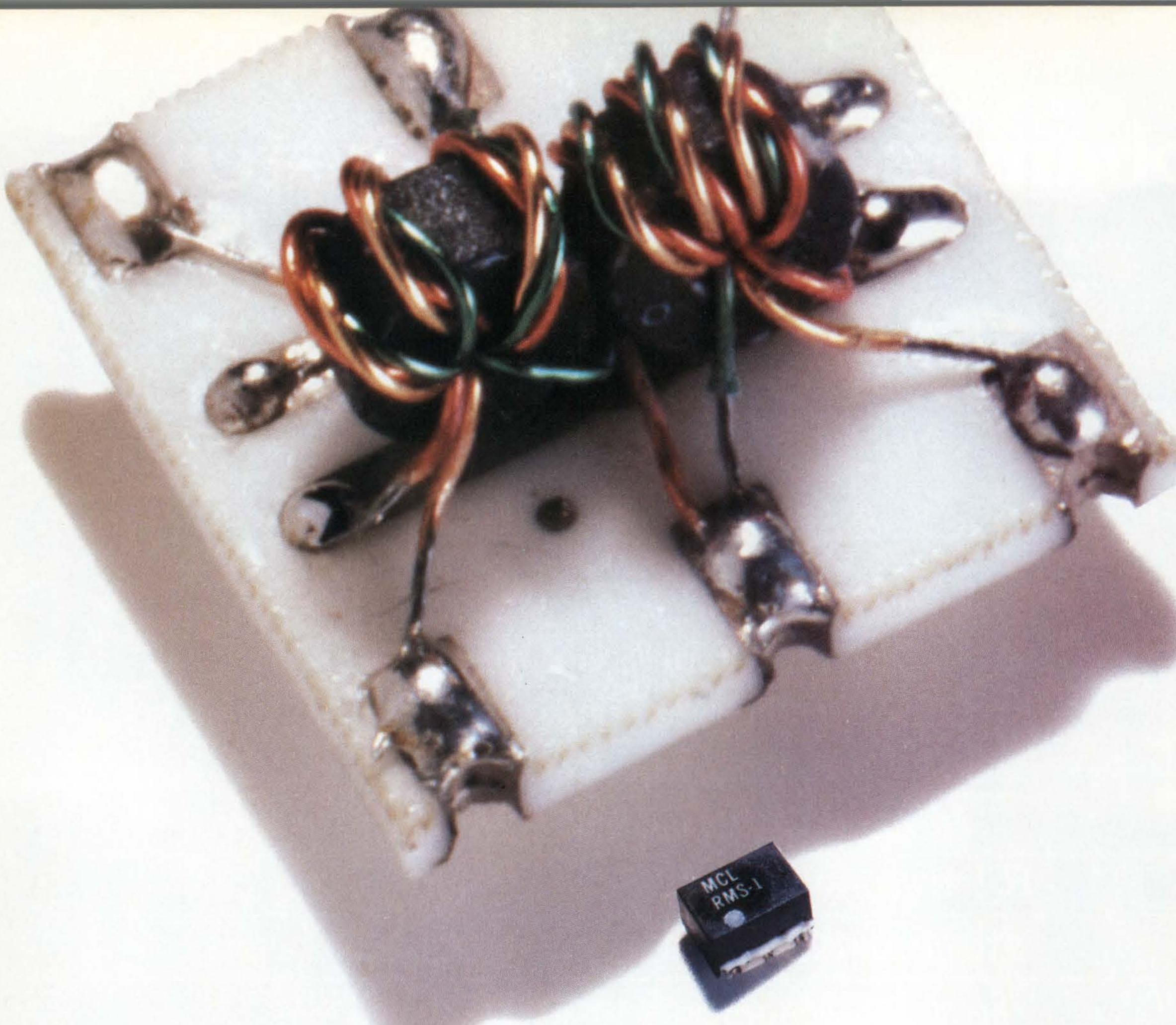
CHERRY ELECTRICAL PRODUCTS

3600 Sunset Avenue, Waukegan, IL 60087 • (312) 360-3500

Switches • Automotive Devices • Electronic Components • Displays • Printed Circuit Boards • ICs • Keyboards



CIRCLE NO 181



the world's smallest surface mount mixers from $6^{95}

Tight packing density, lowered assembly costs, and improved reliability make surface-mount technology (SMT) highly attractive to systems and product manufacturers. If your design is ready for SMT, specify Mini Circuits' new RMS series, the world's smallest (0.25 by 0.30 by 0.2 in.) double-balanced SMT mixers, spanning 0.5 to 1000MHz, from only $6.95 (10-49 qty).

The tiny, non-hermetic package houses RF transformers, a ceramic-alumina substrate, and a four-diode assembly. A unique edge-plated design eases the job of making reliable solder connections to a printed-circuit board. A protective-barrier layer on top of the package's conductive layer retards the harmful effect of electromigration which may occur during soldering. The RMS can be attached to a pc-board by conventional manual soldering or with automatic equipment; mixers can be supplied in a tape-and-reel format for automated pick-and-place machines.

When you think SMT, think small, low-cost... think Mini-Circuits RMS series.

SPECIFICATIONS	**RMS-1**		**RMS-2**	
FREQUENCY RANGE, MHz				
LO, RF	0.5 — 500		5 — 1000	
IF	DC — 500		DC — 500	
CONVERSION LOSS, dB, Typ.				
Mid-band ($10f_l$ — $f_{u/2}$)	5.5		6.5	
Total range (f_l — f_u)	6.2		7.0	
ISOLATION, dB, Typ.	L-R	L-I	L-R	L-I
Low-band (f_l — $10f_l$)	55	50	55	50
Mid-band ($10f_l$ — $f_{u/2}$)	33	30	35	30
Upper-band ($f_{u/2}$ — f_u)	27	24	25	20
PRICE (10-49)	**$6.95**		**$7.95**	

f_l = lowest frequency in range

f_u = highest frequency in range

finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

F110 REV. ORIG.

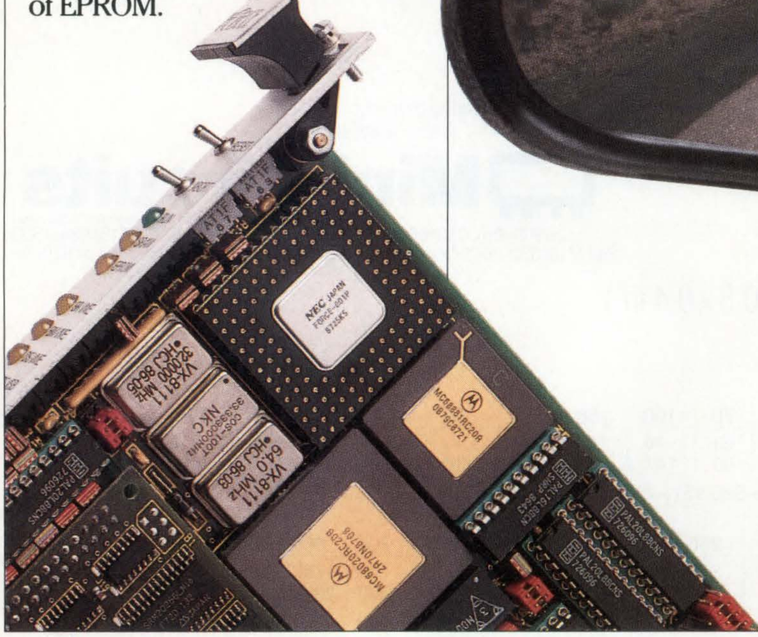
CIRCLE NO 180

VME/PLUS™ gives view of your

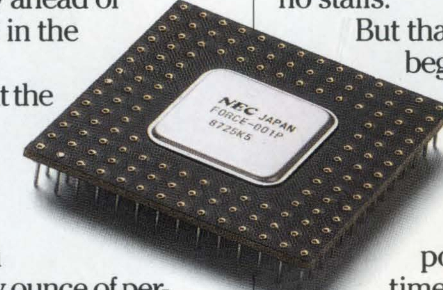
*H*old on to your seat. You're about to discover an entirely new level of VME performance. And life in the fast lane will never be the same.

Meet VME/PLUS. Our new family of VMEbus products with a host of sophisticated features that will give your project the kind of performance you've only dreamed about.

VME/PLUS starts with a 68020 running at 25MHz without wait states. Complemented by 1MB of local memory. There's also a new VSB interface on P2. Which lets you add lots of local memory and I/O without increasing bus overhead. You also get two serial ports and up to 4MB of EPROM.



The result is system throughput that's way ahead of anything else in the VME world.



Think about the possibilities for real-time applications. For the first time, you can squeeze every ounce of performance from every processor. With no wasted overhead. And no stalls.

But that's only the beginning. Take a look at the newest member of the VME/PLUS family, CPU 29. It comes with a powerful new real-time, multitasking monitor called VMEPROM.™

you a different competition.

It's resident in EPROM, so there's no license required. And no extra charge.

CPU-29 also incorporates a remarkable new gate array that packs the functionality of many complex ICs into a single, 135-pin device.

CPU-29 CHARACTERISTICS	
PROCESSOR	68020/12.5 TO 25 MHz
CO-PROCESSOR	68882/12.5 TO 25 MHz
ZERO-WAIT-STATE SRAM	1MB
VMEPROM™	REAL-TIME, MULTITASKING MONITOR
EPROM	UP TO 4MB @ 1 WAIT STATE
SERIAL I/O	2 RS-232 CHANNELS
SECONDARY BUS SUPPORT	VSB

What this new technology means for you is unprecedented levels of speed and system throughput, exceptional reliability and – here's the best part – lower total system cost.

And if that's not enough, we also offer a full set of off-the-shelf peripheral boards and software. All VMEbus compatible. And guaranteed to cut the wait states out of your design cycle.

So if you're looking for the best way to stay ahead of your competition and your deadline, take a close look at VME/PLUS. You'll get the best performance for simulation systems, real-time graphics, factory automation and many other tough applications.

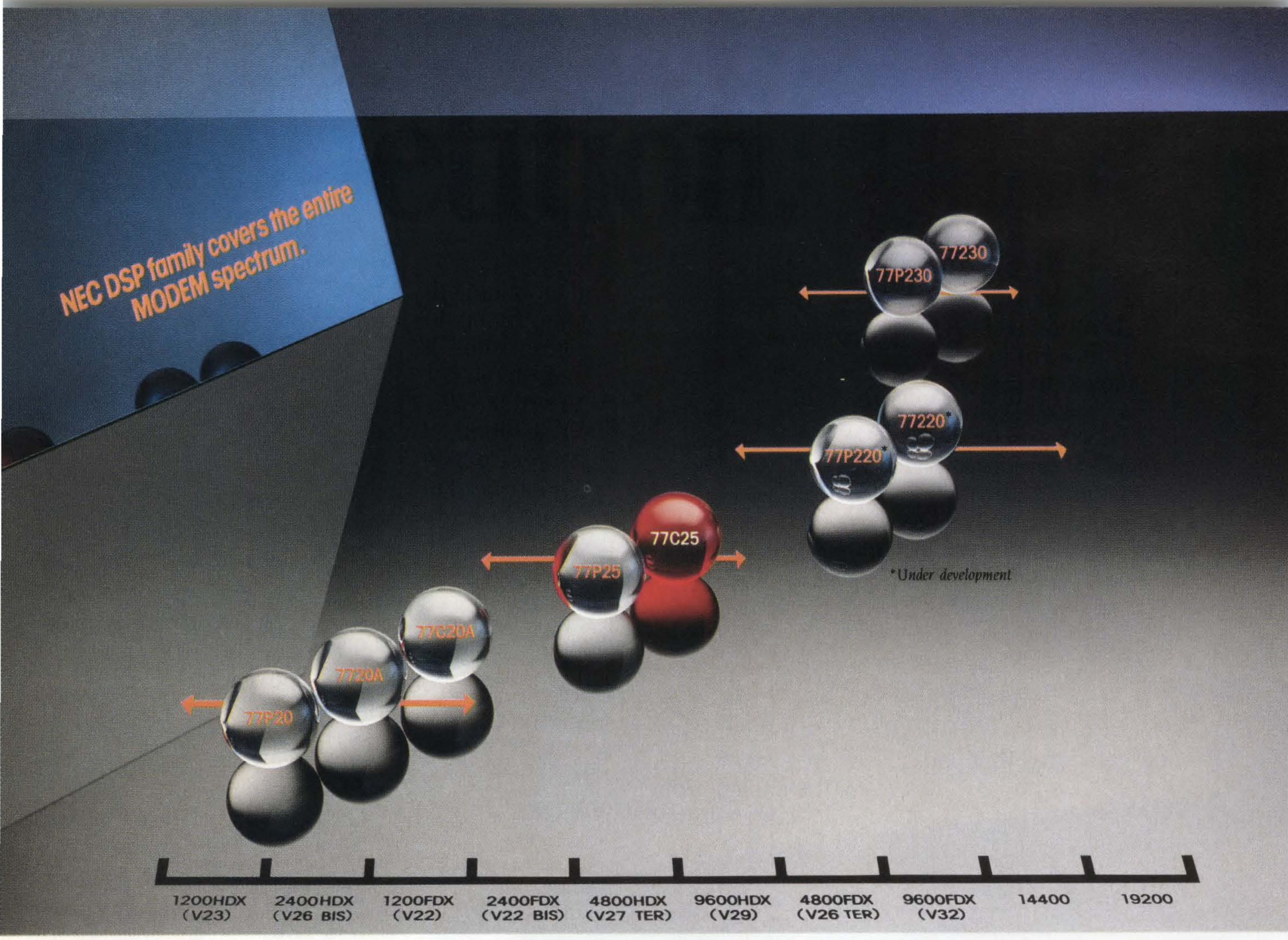
Give us a call today for our new 500-page, 1988 data book. You'll get such a great view of VME performance, you'll never look back.

1(800)BEST VME.
In California,
1(800)237-8862.

FORCE COMPUTERS®

FORCE COMPUTERS, INC.
727 University Ave., Los Gatos, CA 95030
Telephone (408) 354-3410
Telex 172465 Telefax (408) 395-7718

FORCE COMPUTERS, GmbH
Daimlerstrasse 9 D-8012 Ottobrunn
Telefon (089) 60091-0 Telex 524190 forc-d
Telefax (089) 6 097793



Calling all modems NEC introduces an enhanced 16-bit DSP

Whatever your modem design calls for, NEC's DSP family has the answer. We've been covering your 16-bit needs since 1980 with our pioneering μPD7720. For 32-bit applications, we offer the μPD77230. And now we're bridging the gap with our enhanced 16-bit CMOS μPD77C25.

The enhanced 77C25 gives you twice the performance of the 77C20A. Twice the speed—122ns. More than twice the memory capacity—2K × 24 instruction ROM, 1K × 16 data ROM, and 256 × 16 data RAM. Yet the same power consumption—0.2W max.

You can replace two 77C20As with one 77C25—with little modification in peripheral circuits. Available in 28-pin DIP or 44-pin PLCC. The 77C25 is both pin- and software-compatible at the source level with the 77C20A. Development tools are available off the shelf and the EPROM-version 77P25 is coming soon.

For a complete answer to your modem needs, call NEC. We've got you covered from 1,200 to 19,200bps and everywhere in between.

For further information, please contact:

■ USA	Tel:1-800-632-3531. In California: 1-800-632-3532. TWX: 910-379-6985.
■ Europe	W. Germany Tel:0211-650302. Telex:8589960 NE D.
	The Netherlands Tel:040-445-845. Telex:51923 NEC B NL.
	Sweden Tel:08-732-8200. Telex:13839 NECSCAN S.
	France Tel:1-3946-9617. Telex:699499 NEC EF.
	Italy Tel:02-6709108. Telex:315355 NECEIT I.
	UK Tel:0908-691133. Telex:826791 NECUK G.
■ Asia	Hong Kong Tel:3-755-9008. Telex:54561 HKNEC HX.
	Taiwan Tel:02-522-4192. Telex:22372 HKNEC TP.
	Singapore Tel:4819881. Telex:39726 NECES RS.
■ Oceania	Australia Tel:03-267-6355. Telex:AA38343 NECBCD.

C&C
Computers and Communications

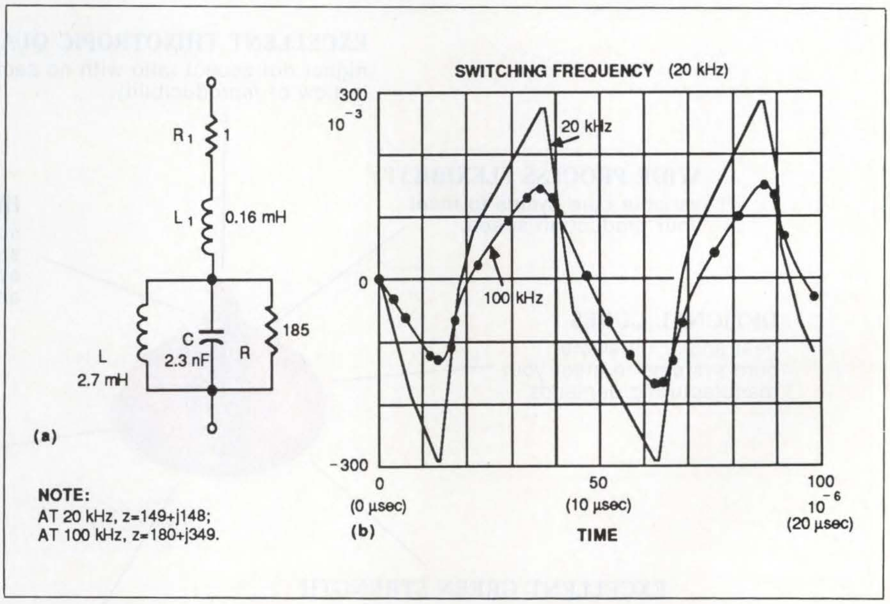
NEC

Motor's inductance is unlikely to decrease

In his article, "Proper design trade-offs translate to a precise position-control system" (EDN, August 6, pg 167), Yoram Hirsch writes (on pg 173) that the winding inductance of the motor used in his tests "actually decreases with increasing frequency." He continues: "As unlikely as this might seem, measurement results indicate that, even though the winding inductance is about 3 mH at 1 kHz, it is only 0.8 mH at 100 kHz." Yet, the thing that he describes is, in my opinion, easily explained.

The simple equivalent circuit of a motor's winding, whose impedance appears simply as an inductor and a resistor in series, is not usable at high chopping frequencies. Here the distributed winding capacitance, eddy-current losses, and other factors come into play, and you account for them by adding a few more components to the old model.

The accompanying figure shows one attempt at such a model (**a**). It consists of two inductors, two resistors, and one capacitor. Its complex impedance, calculated at 20 kHz and 100 kHz, is seen to be inductive. Yet the imaginary parts are at a ratio of 2.3:1 instead of 5:1. If you measured the equivalent series inductance on a bridge, you would read 3.3 mH at 1 kHz, 1.2 mH at 20 kHz, and 0.6



Anatomy of a dot.

EXCELLENT THIXOTROPIC QUALITIES
higher dot aspect ratio with no sacrifice in flow or reproducibility.

WIDE PROCESS FLEXIBILITY
variable cure cycles to meet your production speed.

HIGH STRENGTH
superior chip shear strength after cure ensures reliability and reduces rework.

OPTIONAL CURES
heat and/or ultraviolet cure systems to meet your manufacturing demands.

VOID FREE
smooth, uniform, void free dots that won't trap process chemicals.

EXCELLENT GREEN STRENGTH
assures component retention with no skewing prior to cure.

CONVENIENT PACKAGING
syringes, cartridges and jars for pneumatic dispensing, pin transfer or screen printing.

We pack a lot of features and versatility into a little dot. Plus a lot of know-how. We were the first to pioneer and develop surface mount adhesives (SMA™). As the world's leading manufacturer supplying the largest companies, we have the products, application knowledge and technology to meet your dot demands.

No matter what industry you're in, our high-contrast, fluorescent SMA's are ready for your pneumatic dispensing, pin transfer or screen printing operations. And we're ready to provide the dot you want.

Find out more. Call or write us on your letterhead for a free sample. Just give us your basic application specs and we'll send you a special **Dot Decision Kit**. It's packed with information and a free sample of material.

Call or write:
Emerson & Cuming, Inc.
Dot Decision Kit
77 Dragon Court
Woburn, MA 01888
617-935-7574

Send for information and a free sample.

EMERSON & CUMING
GRACE Polymer & Electronic Materials

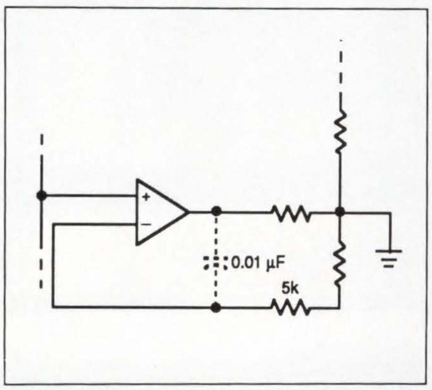
mH at 100 kHz. Furthermore, the current waveforms shown in the accompanying figure (Spice simulation at ±40V square wave) **(b)** are strikingly similar to the oscilloscope photos in **Fig** 8 of the article (pg 172).

As a consequence, it is unlikely that the motor's inductance decreases with increasing frequency. But if in fact it happens, then let us have some explanation of the mechanism causing such a strange effect.

Claudio de Sa e Silva
Unitrode Integrated Circuits Corp
Merrimack, NH

Misplaced resistor

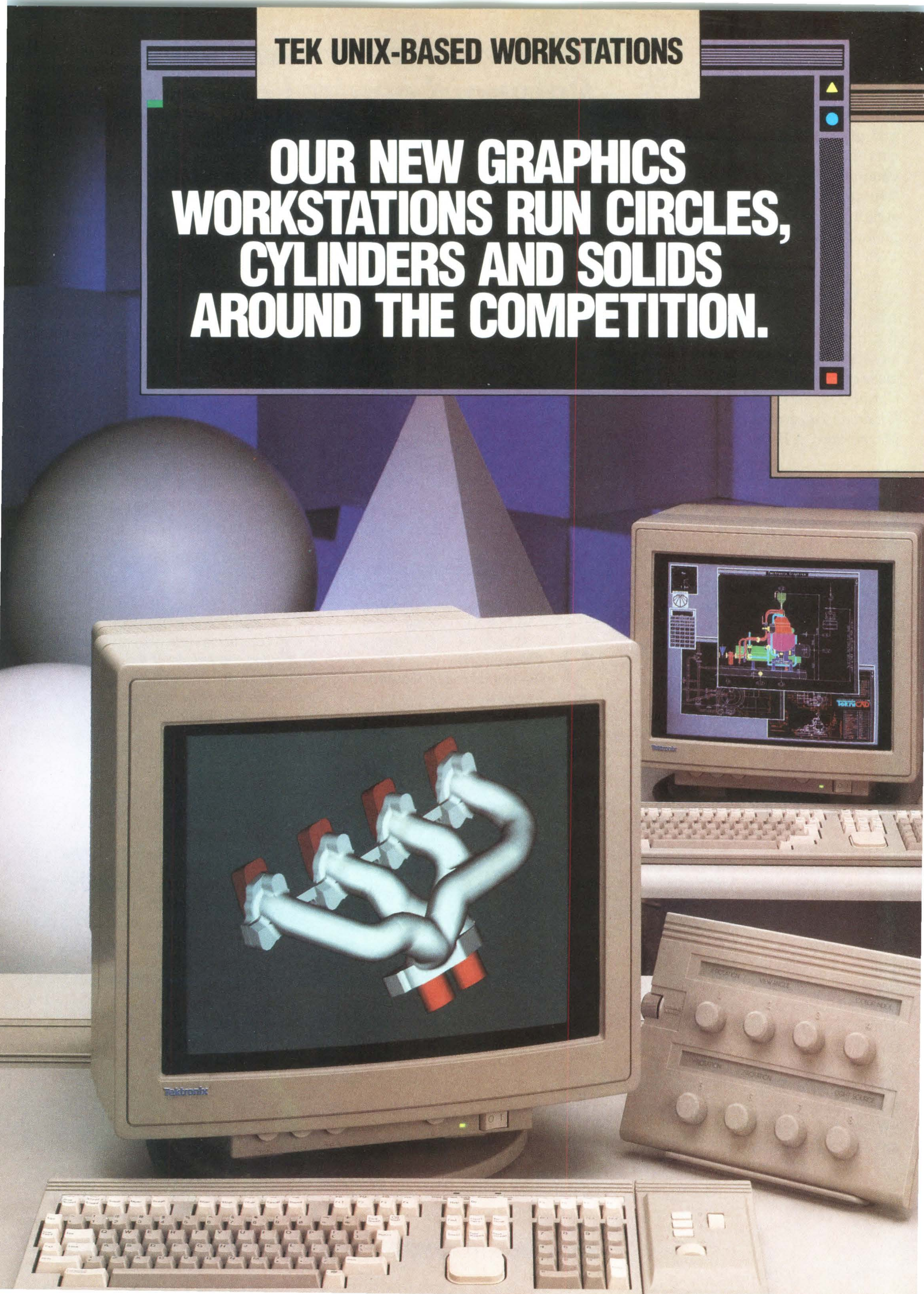
Please note a correction to the Design Idea "Low-power circuit splits supply voltage" (EDN, October 1, pg 198). The 5-kΩ resistor belongs after the 0.01-µF capacitor, as shown below, and not in series with the op amp's inverting input as in the original figure.



Correction

The News Breaks section of the September 17 issue (EDN, pg 21) listed an incorrect phone number for James Electronics, a Chicago, IL, maker of 4W adapters. The correct number is (800) 438-1400; in IL, (312) 463-6500. Please also note that the company offers a line of sixteen 4W adapters (not 16 and 4W adapters as the article states.)

CIRCLE NO 3


TEK UNIX-BASED WORKSTATIONS
OUR NEW GRAPHICS WORKSTATIONS RUN CIRCLES, CYLINDERS AND SOLIDS AROUND THE COMPETITION.
Tektronix

Led by dual 32-bit engines dividing computing and graphics processing tasks, Tek's new 4300 Series Workstations set the pace in graphics-intensive productivity. Now you can count on Tek's 68020-based graphics processor, parallel pipelined architecture, and five custom gate arrays to put your graphics throughput on the fastest track.

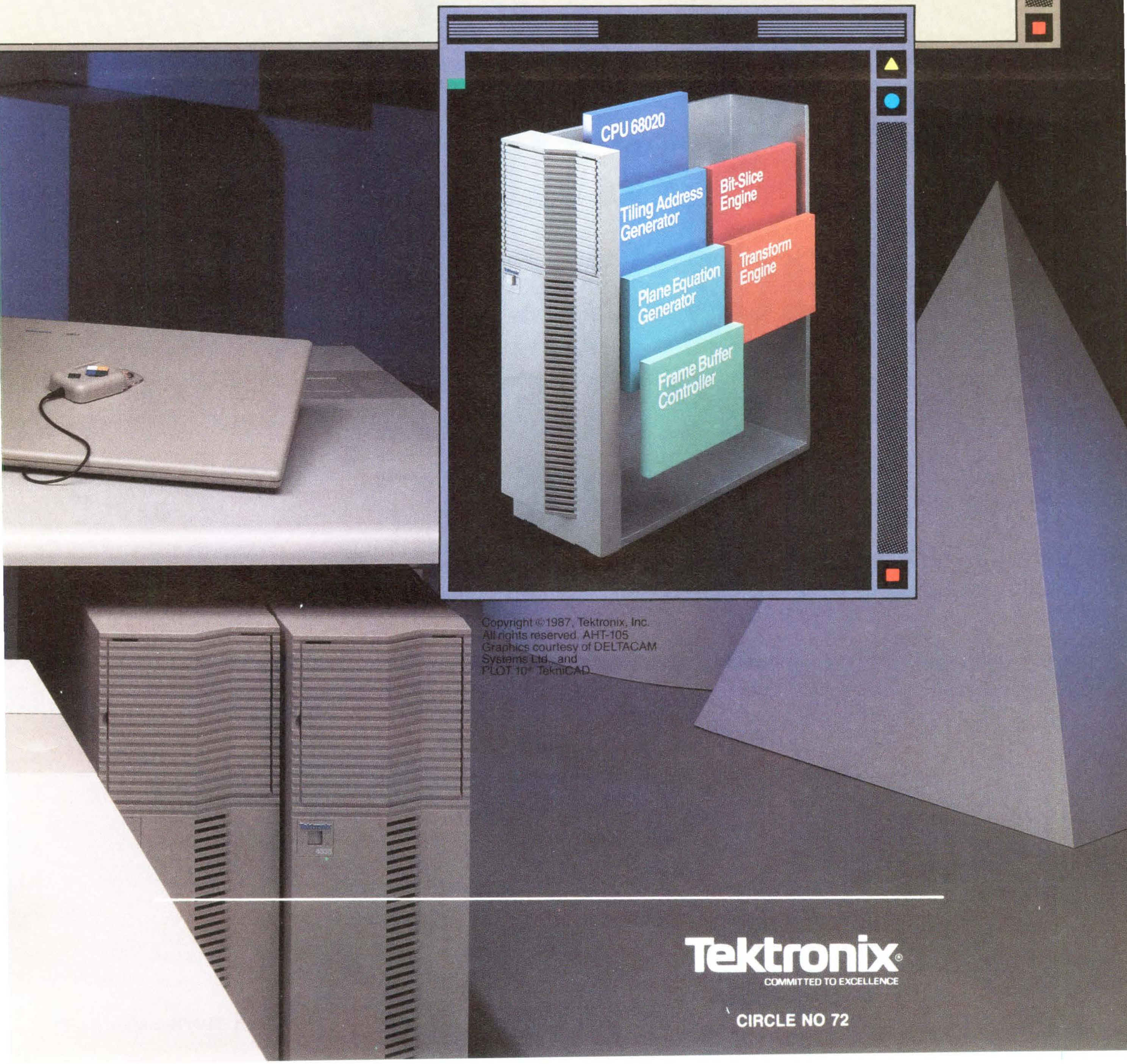
Match these workstations against the rest of the field: with speeds like 450,000 2D vectors, 340,000 3D vectors, and 20,000 Gouraud shaded polygons per second—plus Tek's high resolution displays, superior user interface and unsurpassed quality—the 4300 Series outdistances them all.

The 4300 Series protects your software investment, too, because it's compatible with more than 300,000 PLOT 10® packages already written for Tek terminals.

Finally, 14 different standalone workstation and high-performance terminal products let you shape and reshape each configuration to fit your evolving needs.

For more information on the graphics workstations that run circles, cylinders and solids around the competition, contact your local Tektronix representative.

Or call 1-800-225-5434.
In Oregon, 1-235-7202.



Graphics courtesy of DELTACAM Systems Ltd., and PLOT 10® TekniCAD

Tektronix®
COMMITTED TO EXCELLENCE

CIRCLE NO 72

Motorola announces one of the smallest advances in the history of VME.

CIRCLE NO 71

Motorola puts awesome multiprocessing performance on two new single-board computers.

As computer applications get more complex, OEMs are turning more to multiprocessing designs. To handle things like CAD/CAM, robotics, signal processing, simulation and large-scale data acquisition, a single processor simply can't keep up.

Adding several CPUs to a system off-loads the main processor, but what happens to the system bus? It frequently reaches saturation, slowing down the entire system.

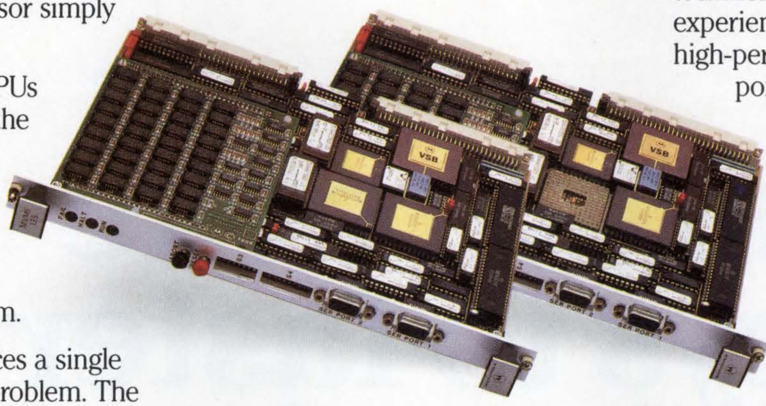
Motorola introduces a single chip solution to this problem. The **V**ME **S**ubsystem **B**us, a fast, 32-bit secondary bus, has been implemented on a gate array at Motorola.

The end of the multiprocessor traffic jams.

The VSB sub-bus removes traffic from the VMEbus, increasing total system throughput. And by saving space on the VSB—and other components—Motorola has been able to pack an impressive array of multiprocessor functions onto two standard VME boards: the MVME135 and MVME136. These highly integrated microcomputers include *all* the functions usually required for high-performance multiprocessing. In addition to the VSB, they feature the MC68020 with floating-point coprocessor, both running at either 16.67 or 20.0MHz.

For virtual memory environments, a demand-paged memory management unit can also be added. Plus 1 Megabyte of shared local dynamic RAM is included—with optional parity—designed to operate with zero wait states.

Included in the 135/136 modules



are many special hardware features that facilitate multiprocessing. Things like MP control and status registers. An expanded interrupt-handling mechanism. And master/slave control bit settings.

Hardware alone is hardly enough.

Complete multiprocessing hardware on a single board saves you design time and system space. But to get your application up and running on a tight schedule, it takes software and support tools too. Like those available from Motorola.

If you're building a multi-user/multi-tasking system, you can use our version of AT&T's UNIX® System V Release 3, with Remote File Sharing. For real-time tasks, there's our full-featured VERSAdos™ operating system, as well as debugging firmware with on-board diagnostics. Then too, you have access to third-party software such as OS-9,™ MTOS,™ PDOS,™ pSOS,™ RTUX,™ and VRTX.®

Add to that Motorola's in-depth technical support. We have more experience in building reliable, high-performance VME system components than any other vendor. Plus a specialized systems and support staff available at over 100 field offices worldwide.

To see how good multiprocessors can come in small packages, call us toll-free today: **1-800-556-1234 Ext. 230** (in California, 1-800-441-2345 Ext. 230). Or write; Motorola Microcomputer Division, 2900 South Diablo Way, Tempe, AZ 85282.

MVME135/136 Highlights

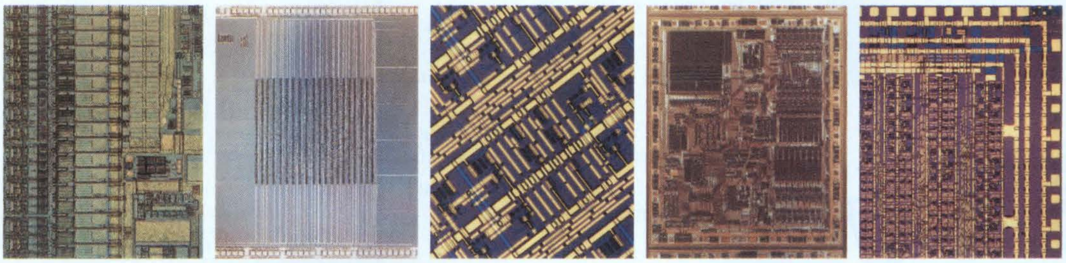
Model	Description
MVME135	VMEbus 32-bit SBC; 16.67-MHz MC68020 CPU; MC68881 FPU; 1Mb on-board DRAM; up to 512 Kb EPROM; two RS-232-C serial ports; two 16-bit timers; master/slave interface; MP control and status registers; system controller
MVME135-1	Same as MVME135, but with 20-MHz MC68020 CPU
MVME136	Same as MVME135, but with MC68851 PMMU

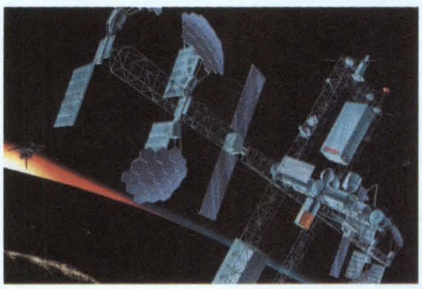
OS-9 is a trademark of Microware Systems Corporation. MTOS is a trademark of Industrial Programming Inc. PDOS is a trademark of Eyring Research Institute, Inc. pSOS is a trademark of Software Components Group. RTUX is a trademark of Emerge Systems. VRTX is a registered trademark of READY SYSTEMS. VERSAdos is a registered trademark of Motorola, Inc. UNIX is a registered trademark of AT&T.

MOTOROLA *Microcomputer Division*

Approaching our technology from your point of view.

CIRCLE NO 71





One workstation, one company, for all your military/space designs.

Remember when semicustom IC designing was impractical because your technology options were too limited, your CAD tools too new and turnaround too slow?

Times have changed! Now Harris makes designing military/space ASICs — in the broadest range of technologies — easier than ever. Because you use the same workstation and design tools for all.

Libraries of solutions: Our GaAs DIGI-II library offers nearly 50 fully characterized cells that are ECL, TTL, CMOS or GaAs compatible. Or...in silicon our advanced HSC 2.0-micron rad-hard CMOS library provides cells and macros you can intermix. Resident libraries also exist for CMOS and bipolar, analog, and digital plus analog/digital mixed technologies.

Hardware and software: Our open-system software CAE/CAD toolset fully integrates with Harris/Masscomp workstations, and meshes easily with other UNIX-based platforms. Daisy and Mentor support is also available.

On to manufacturing: You handle the front-end; leave the back-end to Harris. We carry your ASIC design through to mask, then manufacturing — with the screenings you want and most popular packages: metal flat-pack, side-brazed DIP, chip carriers, and more.

Guaranteed survivors: Now you can create ASICs that tap the high speed of GaAs, or the low power of CMOS, and are guaranteed to survive military and space environments. And you can do it faster.

For more on military/space silicon and GaAs ASICs, call for our Rad-Hard/Hi-Rel Data Book. In U.S. phone 1-800-4-HARRIS, or in Canada: 1-800-344-2444; for GaAs ask for Ext. 1525, for CMOS ask for Ext. 1925.

IN MILITARY ASICs, THE NAME IS

HARRIS

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS

CIRCLE NO 70

CALENDAR

Microcomputer Graphics Conference, New York, NY. Expoconsul International, 3 Independence Way, Princeton, NJ 08540. (609) 987-9400. December 16 to 18.

Third Annual Technical Symposium on Optoelectronics and Laser Applications in Science and Engineering, Los Angeles, CA. SPIE, Box 10, Bellingham, WA 98227. (206) 676-3290. January 10.

ATE and Instrumentation Conference West, Anaheim, CA. MG Expositions Group, 1050 Commonwealth Ave, Boston, MA 02215. (800) 223-7126. January 12 to 14.

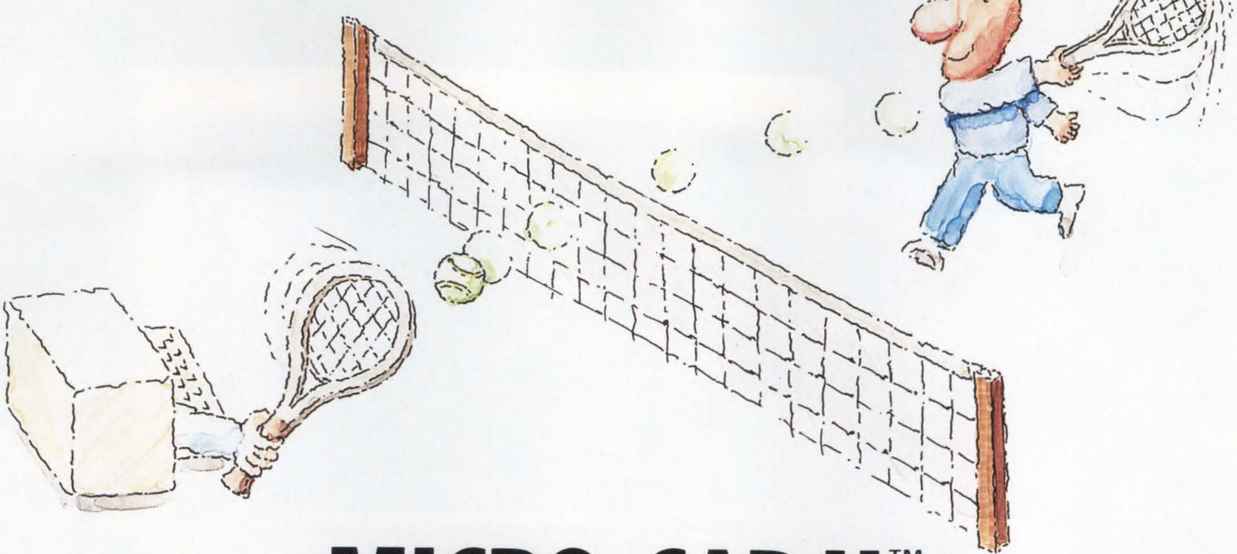
Third Annual Battery Conference on Applications and Advances, Long Beach, CA. Cecile Duong, Department of Electrical Engineering, California State University at Long Beach, 1250 Bellflower Blvd, Long Beach, CA 90840. (213) 498-4605. January 12 to 14.

Annual IEEE Design Automation Workshop, Apache Junction, AZ. Walling Cyre, Control Data, HQM 173, Box 1249, Minneapolis, MN 55440. (612) 853-2692. January 13 to 15.

Conference on Optical Fiber Communication (OFC '88), New Orleans, LA. Optical Society of America, 1816 Jefferson Pl NW, Washington, DC 20036. (202) 223-0926. January 25 to 27.

Annual Reliability and Maintainability Symposium, Los Angeles, CA. V R Monshaw, RCA, Astro Electronics, Box 800, MS 55, Princeton, NJ 08540. (609) 426-2182. January 26 to 28.

Modern Electronic Packaging (seminar), Orlando, FL. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. February 9 to 11.

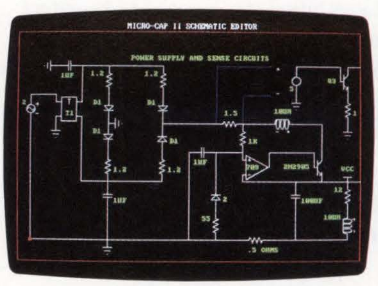


MICRO-CAP II.™

The CAE tool with fully interactive analog simulation for your PC.

Spectrum Software's MICRO-CAP II® is fast, powerful, and feature rich. This fully interactive, advanced electronic circuit analysis program helps engineers speed through analog problems right at their own PCs.

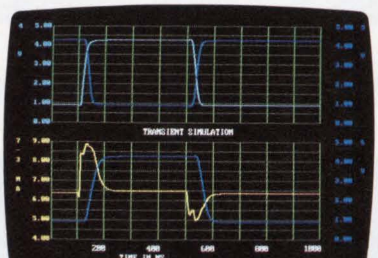
MICRO-CAP II, which is based on our original MICRO-CAP software, is a field-proven, second-generation program. But it's dramatically improved.



Schematic Editor

MICRO-CAP II has faster analysis routines. Better resolution and color. Larger libraries. All add up to a powerful, cost-effective CAE tool for your PC.

The program has a sophisticated integrated schematic editor with a pan capability. Just sketch and analyze. You can step



Transient Analysis

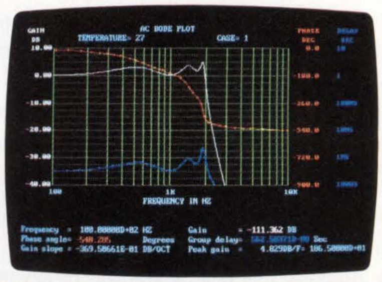
component values, and run worst-case scenarios—all interactively. And a 500-type* library of standard parts is at your fingertips for added flexiblity.

MICRO-CAP II is available for IBM® PCs and Macintosh.™ The IBM version is CGA, EGA, and Hercules® compatible and costs only $895 complete. An evaluation version is available for $100. Call or write today for our free brochure and demo disk. We'd like to tell you more about analog solutions in the fast lane.

- Integrated schematic editor
- Fast analysis routines
- High-resolution graphic output
- Standard parts library of 500* types

*IBM versions only.

- Transient, AC, DC, and FFT routines
- Op-amp and switch models
- Spec-sheet-to model converter*
- Printer and plotter* hard copy



AC Analysis

spectrum

1021 S. Wolfe Road, Dept. E
Sunnyvale, CA 94087
(408) 738-4387

MICRO-CAP II is a registered trademark of Spectrum Software.

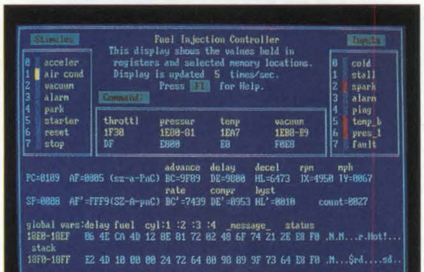
Macintosh is a trademark of McIntosh Laboratory, Inc. and is being used with express permission of its owner.

Hercules is a registered trademark of Hercules Computer Technology

IBM is a registered trademark of International Business Machines, Inc.

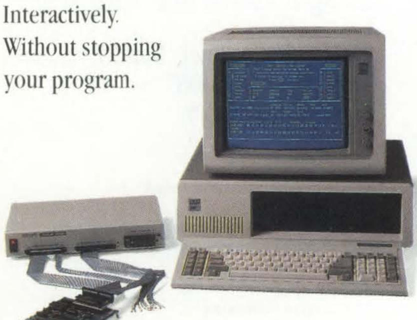
WATCH WHAT YOU'RE DOING.

Introducing UniLab 8620 analyzer-emulator with InSight.



■ There's nothing like InSight.™ A feature of the new 8620 that lets you actually **watch** your program go through its paces. So you can debug faster. And speed up microprocessor development. For demanding applications like the automotive controller shown.

■ An exciting industry first, InSight blends analyzer/emulator techniques to give you continuous, real time monitoring of key processor functions. See changing register contents, I/O lines, ports, user-defined memory windows. With your own labels. And all at once. Interactively. Without stopping your program.



■ InSight is made possible by the 8620's advanced bus state analyzer, its 2730-bus-cycle trace buffer, and a new high-speed parallel interface that eliminates RS-232 bottlenecks.

■ The fast interface also speeds data throughput. From your hard drive, you can load a 64K program into emulation memory in five seconds.

■ On top of that, you get a new, crystal-controlled 1 μsec clock for super precise event timing.

■ Computer integrated instruments from Orion prove debugging needn't be costly or tedious. For more than 150 processors. Like all our analyzer-emulators, the 8620 debugs by symptom. Via advanced truth table triggering. Always included is enough breakpointing and single stepping (now faster than ever) to assure optimum efficiency. We even provide a stimulus generator and built-in EPROM programmer to help finish the job.

■ Get serious about price/performance. Save big on design, test, and support costs. UniLab 8620 analyzer-emulator.

■ Look into it.

Toll free: 800/245-8500. In CA: 415/361-8883.

ORION INSTRUMENTS

Computer Integrated Instrumentation
702 Marshall Street, Redwood City, CA 94063
Telex: 530942

*InSight is a trademark of Orion Instruments, Inc.

CALENDAR

Unix Technical Conference, Dallas, TX. Usenix Conference Office, Box 385, Sunset Beach, CA 90742. (213) 592-1381. February 9 to 12.

Compcon Spring (33rd IEEE Computer Society International Conference), San Francisco, CA. Hasan AlKhatib, Dept of EECS, Santa Clara University, Santa Clara, CA 95053. (408) 927-1818. February 29 to March 4.

Modern Electronic Packaging (seminar), Torrance, CA. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. March 16 to 18.

American Power Conference, Chicago, IL. Robert Porter, Chicago Institute of Technology, Chicago, IL 60618. (312) 567-3202. April 18 to 20.

IEEE Instrumentation/Measurement Technology Conference (IMtc/88), San Diego, CA. Bob Myers, IMtc, 1700 Westwood Blvd, Los Angeles, CA 90024. (213) 475-4571. April 19 to 22.

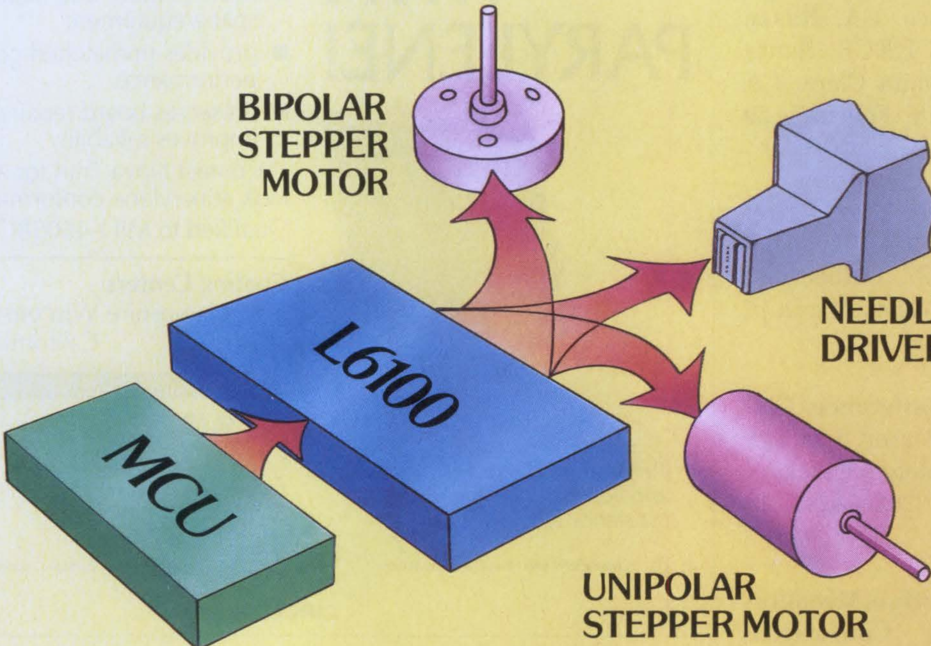
Modern Electronic Packaging (seminar), Washington, DC. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. April 21 to 23.

Pittsburgh Conference on Modeling and Simulation, Pittsburgh, PA. William Vogt or Marlin Mickle, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15261. May 5 to 6.

EMC Expo, Washington, DC. Karen Smith, EMC Expo, Box D, Gainesville, VA 22065. (703) 347-0030. May 10 to 12.

IEEE Custom Integrated Circuits Conference, Rochester, NY. Roberta Kaspar, 20 Ledgewood Dr, Rochester, NY 14615. (716) 865-7164. May 16 to 19.

WHO CAN PUT POWER MOSFETS



SGS-THOMSON Microelectronics--The Brighter Power--of course. The L6100 and L6102 are implemented in our unique Multipower-BCD™ technology, which allows complete isolation of the output MOSFETs. With prices starting at less than $2 in 10K quantities, the 100V, 5A/8A devices open up a whole spectrum of design possibilities.

The L6100/2 is a more economical, more reliable and more compact alternative to using four discrete MOSFETs.

Compared to darlingtons, the L6100/2 offers much lower dissipation, no secondary breakdown and an intrinsic free wheeling diode in each transistor.

The L6100, now in full production, is available in an 18 lead DIP package with a special leadframe that conducts heat to the PCB copper. The L6102—soon to be in full production—comes in SGS-THOMSON's own industry standard 15 pin Multiwatt® package.

Regardless of whether you're driving unipolar DC motors, stepper motors, needle solenoids or many other types of loads—the fast switching, easily paralleled L6100/2 delivers the economy and reliability to turn design possibilities into realities.

V_{DS} Max	100V min
I_D (Powerdip)	1.5A cont., 5A peak
(Multiwatt)	2.0A cont., 8A peak
$R_{DS(ON)}$	1.2 Ohms max
Packages	Powerdip (18 pin) L6100 Multiwatt (15 pin) L6102

SGS-THOMSON Microelectronics
1000 E. Bell Road, Phoenix, Arizona 85022

SGS and Thomson anticipate a merger of their U.S. subsidiaries in the near future. The name of the new company will be SGS-THOMSON Microelectronics, Inc.

FOUR ISOLATED IN A SINGLE CHIP?

SGS-THOMSON's exclusive Multipower-BCD™ technology—that's integrated Bipolar, CMOS, DMOS—has a lot more to offer. What other smart power IC technology isolates the DMOS output power transistors to let you connect as many as you need on a chip anyway you like? None.

That's just one example of how smart our power really is. And the L6100 is just one of many SGS-THOMSON smart power products.

Why not get the full story on SGS-THOMSON Multipower-BCD™ technology plus full data on the L6100. Call 602/867-6259 now. After all, the brighter your smart power source, the brighter your design's future.

SGS-THOMSON
MICROELECTRONICS

CIRCLE NO 67

IN MEMORIES.

We are the leader in 1Mb DRAMs. In 256K static RAMs, CMOS EPROMs and 1Mb ROMs. Yet, people still think of us only as the world leader in CMOS and NMOS static RAMs.

We are the world leader in CMOS and NMOS static RAMs, in 16K, 64K and 256K byte wide memory products. We make the fastest 2K x 8 at 35 ns and also a 4K x 4 static RAM at 35 ns. We pioneered the 8K x 8 CMOS static RAM and are now offering a 64K x 1 (55 ns) and 32K x 8 CMOS static RAM.

But we make more than static RAMs. As you can see from the chart, we have a complete line of DRAMs, CMOS, and NMOS ROMs, EPROMs, and one time programmables. And they are all in volume production today.

Tradition of being first.

We were also the first to introduce the 1 Mb DRAM and we're now the market leader. We were one of the first suppliers of the 256K CMOS static RAM. We were a leader with the 256K ROM and within a year of introduction, we shipped more than all other suppliers combined. And we are matching that with our 1 Mb CMOS mask ROM.

So you can see that we have the capability to supply the memory products you want—when you want them.

That's memory power; that's Toshiba.

TOSHIBA MEMORY PRODUCT SUMMARY

PART NO.	ORG.	PROCESS	SAMPLES	PROD.	SPEED SORTS AVAILABLE (ns)				PACKAGE OPTIONS
DYNAMIC RAMS									
TMM41256AP/AT/AZ	256KX1	NMOS	YES	YES	100	120	150		P,T, Z
TMM41257AP/AT/AZ	256KX1	NMOS	YES	YES	100	120	150		P,T, Z
TMM41464AP/AT/AZ	64KX4	NMOS	YES	YES	100	120	150		P,T, Z
TC511000P/J/Z	1MbX1	CMOS	YES	YES	85	100	120		P, J, Z
TC511001P/J/Z	1MbX1	CMOS	YES	YES	85	100	120		P, J, Z
TC511002P/J/Z	1MbX1	CMOS	YES	YES	85	100	120		P, J, Z
TC514256P/J/Z	256KX4	CMOS	YES	YES	100	120			P, J, Z
TC514258P/J/Z	256KX4	CMOS	YES	YES	100	120			P, J, Z
THM81000S	1MbX8	CMOS	YES	YES	100	120			S
STATIC RAMS									
TMM2016AP	2KX8	NMOS	NO	YES	90	100	120	150	P
TMM2016BP	2KX8	NMOS	YES	YES	90	100	120	150	P
TMM2015AP	2KX8	NMOS	NO	YES	90	100	120	150	P 300 MIL
TMM2015BP	2KX8	NMOS	YES	YES	90	100	120	150	P 300 MIL
TMM2064P	8KX8	NMOS	YES	YES	70	100	120	150	P
TMM2064AP	8KX8	NMOS	YES	YES	70	100	120		P
TMM2063P	8KX8	NMOS	YES	YES		100	120	150	P 300 MIL
TMM2063AP	8KX8	NMOS	YES	YES	70	100	120		P 300 MIL
TC5516AP	2KX8	CMOS	YES	YES	200	250			PFY
TC5517/18CP	2KX8	CMOS	YES	YES	150	200			PFY
TC5565P	8KX8	*CMOS	YES	YES	120	150			PFY
TC5565AP	8KX8	*CMOS	YES	YES	100	120	150		PFY
TC5563AP	8KX8	*CMOS	YES	YES	100	120			P 300 MIL
TC5564P	8KX8	CMOS	YES	YES	150	200			PFY
TC5564AP	8KX8	CMOS	YES	YES	120	150			PFY
TC55257P	32KX8	*CMOS	YES	YES	85	100	120	150	P
TC55257AP	32KX8	*CMOS	YES	YES	85	100	120	150	PF
HIGH SPEED STATIC RAMS									
TMM2018D	2KX8	NMOS	YES	YES	35	45	55		D
TMM2018AD	2KX8	NMOS	YES	YES	25	35	45		D
TMM2068D	4KX4	NMOS	YES	YES	35	45	55		D
TMM2068AD	4KX4	NMOS	YES	YES	25	35	45		D
TMM2078D	4KX4	NMOS	YES	YES	35	45	55		D
TMM2078AD	4KX4	NMOS	YES	YES	25	35	45		D
TMM2088P	8KX8	NMOS	YES	YES	35	35	45		P
TMM2089V	8KX9	NMOS	YES	YES	35	45			C 300 MIL
TC55416P	16KX4	*CMOS	YES	YES	35	45			D
TC55417P	16KX4	*CMOS	YES	YES	35	45			D
TC5561P	64KX1	*CMOS	YES	YES	70				P
TC5562P	64KX1	*CMOS	YES	YES	45	55			PY
TC51832P	32KX8	PSEUDO	YES	YES	120	150			P
EPROMS									
TMM2764AD~	8KX8	NMOS	YES	YES	150	200			D
TMM2764ADI~	8KX8	NMOS	YES	YES	150	200			D
TMM27128AD~	16KX8	NMOS	YES	YES	150	200			D
TMM27128ADI~	16KX8	NMOS	YES	YES	150	200			D
TMM27256AD~	32KX8	NMOS	YES	YES	150	200			D
TMM27256ADI~	32KX8	NMOS	YES	YES	150	200			D
TC57256D	32KX8	CMOS	YES	YES		200	250		D
TC57256AD	32KX8	CMOS	YES	YES	150	200			D
TMM27512D	64KX8	NMOS	YES	YES		200	250		D
TMM27512DI~	64KX8	NMOS	YES	YES		200	250		D
TC571000D	128KX8	CMOS	YES	YES		200	250		D
TC571001D	128KX8	CMOS	YES	YES		200	250		D
TC571024D	64KX16	CMOS	YES	YES		200	250		D
ONE TIME PROGRAMMABLES									
TMM2464AP	8KX8	NMOS	YES	YES	200				PF
TMM24128AP	16KX8	NMOS	YES	YES	200				PF
TMM24256AP	32KX8	NMOS	YES	YES	200				PF
TC54256AP	32KX8	CMOS	YES	YES	200				PF
TMM24512P	64KX8	NMOS	YES	YES	250				PF
MASK ROMS									
TMM23256P	32KX8	NMOS	YES	YES	150				P28
TC53257P	32KX8	CMOS	YES	YES	200				FP28
TC53512P	64KX8	CMOS	YES	YES	200				P28
TC531000P	128KX8	CMOS	YES	YES	200				P28
TC532000P	256KX8	CMOS	YES	YES	200				P32

P = PLASTIC C = CERAMIC F = FLAT PACK D = CERDIP Y = DIE T = PLCC J = SOJ
Z = ZIP *CMOS = 4 TRANSISTOR CELL LOW POWER ~ = ± 10% Vcc AVAILABLE S = SOCKET MODULE

TOSHIBA. THE POWER IN MEMORIES.

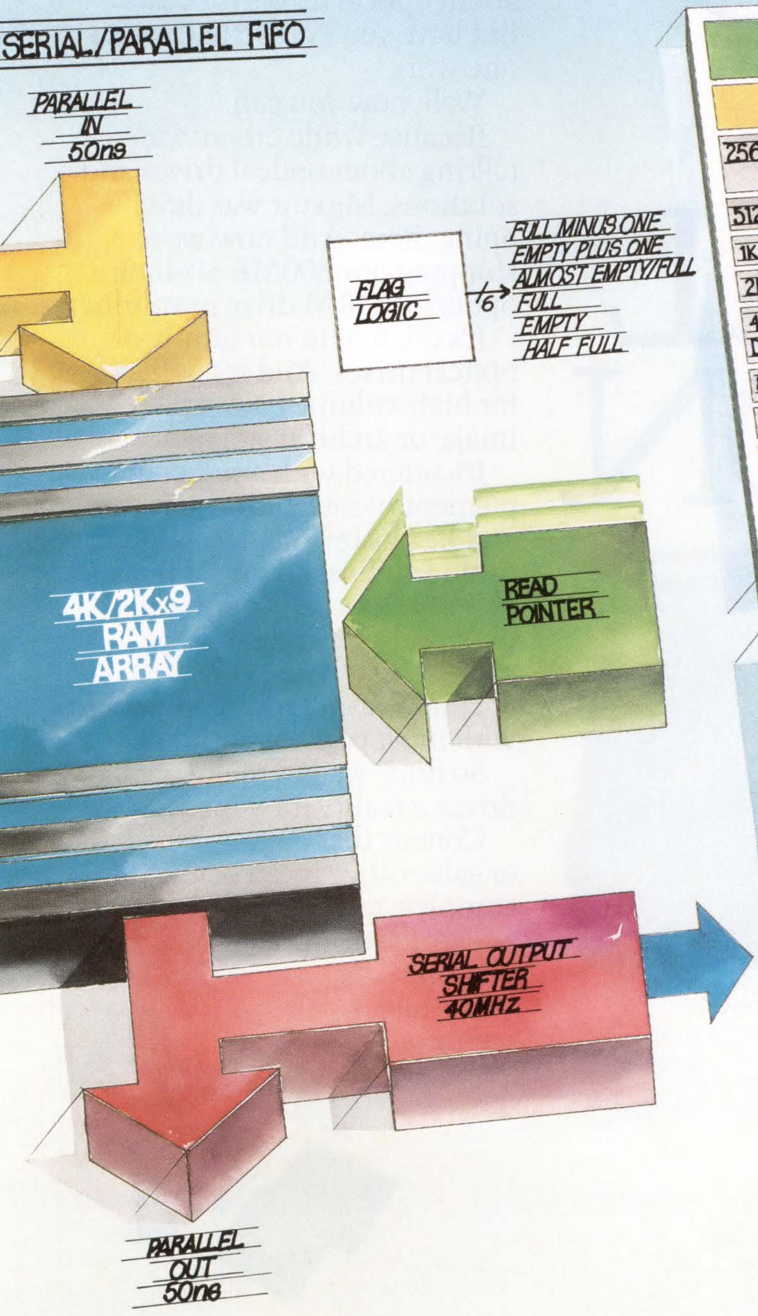
TOSHIBA AMERICA, INC.

MINNESOTA, Electric Component Sales, (612) 933-2594; **MISSISSIPPI, Montgomery Marketing, Inc., (205) 830-0498; MISSOURI,** D.L.E. Electronics, (316) 744-1229; **MONTANA,** Components West, (206) 885-5880; **NEVADA,** Elrepco, Inc., (415) 962-0660; **NEBRASKA,** D.L.E. Electronics, (316) 744-1229; **NEW ENGLAND,** Datcom, Inc., (617) 891-4600; **NEW HAMPSHIRE,** Datcom, Inc., (617) 891-4600; **NEW JERSEY,** Nexus-Technology, (201) 947-0151; **NEW MEXICO,** Summit Sales, (602) 998-4850; **NEW YORK,** Nexus Technology, (201) 947-0151; Pi-tronics, (315) 455-7346; **NORTH CAROLINA/SOUTH CAROLINA,** Montgomery Marketing, Inc., (919) 467-6319; **NORTH DAKOTA/SOUTH DAKOTA,** Electric Component Sales, (612) 933-2594; **OHIO,** Steffen & Associates, (216) 461-8333; (419) 884-2313, (513) 293-3145; **OKLAHOMA,** MIL-REP Associates, (214) 644-6731; **OREGON,** Components West, (503) 684-1671; **PENNSYLVANIA,** Nexus Technology, (215) 675-9600, Steffen & Associates, (412) 276-7366; **RHODE ISLAND,** Datcom, Inc., (617) 891-4600; **TENNESSEE,** Montgomery Marketing, Inc., (205) 830-0498; **TEXAS,** MIL-REP Associates, (512) 346-6331, (713) 444-2557, (214) 644-6731; **UTAH,** Straube Associates Mountain States, Inc., (801) 263-2640; **VERMONT,** Datcom, Inc., (617) 891-4600; **WEST VIRGINIA,** Steffen & Associates, (419) 884-2313; **WASHINGTON,** Components West, (206) 885-5880, (509) 922-2412; **WISCONSIN,** Carlson Electronics, (414) 476-2790, Electric Component Sales, (612) 933-2594; **WYOMING,** Straube Associates Mountain States, Inc., (303) 426-0890; **CANADA, BRITISH COLUMBIA,** Components West, (206) 885-5880; **ONTARIO,** Electro Source, Inc., (416) 675-4490, (613) 726-1452.

CIRCLE NO 66

tion of fast FIFOs.

□ the fastest big FIFOs □ the fastest small CMOS FIFOs □ the only parallel/serial FIFOs.



WORLD'S DENSEST FAST FIFO'S

PART TYPE	IDT		
256x9	7200	Coming 4Q87	Half full flag. Full read retransmit capability and zero fall-through time
512x9	7201△	35ns	
1Kx9	7202△	35ns	
2Kx9	7203	50ns	
4Kx9 World's Densest fast FIFO	7204	50ns	
8Kx9 Module	7M205	55ns	
16Kx9 Module	7M206	55ns	
2Kx9 Serial/Parallel	72103	50ns	New flags: Almost empty/full Empty plus one Full minus one
4Kx9 Serial/Parallel	72104	50ns	

WORLD'S FASTEST SMALL FIFO'S

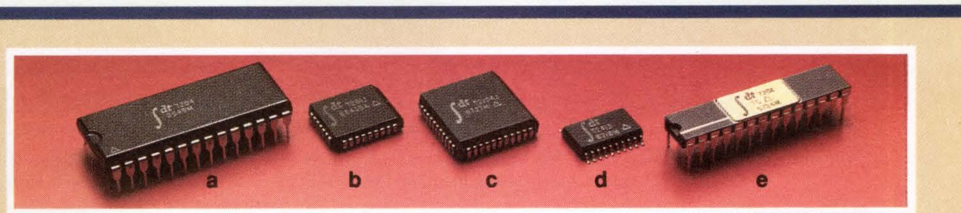
	IDT PART NO.	IDT CMOS	MMI BIPOLAR	Cypress CMOS
64x4 MMI67401 Compatible	72401*	35MHz**	16.7MHz	15MHz
64x5 MMI67402 Compatible	72402*	35MHz**	16.7MHz	15MHz
64x4 CY7C403 Compatible	72403*	35MHz**		25MHz
64x5 CY7C404 Compatible	72404*	35MHz**		25MHz
64x5 MMI67413 Compatible	72413*	35MHz**	35MHz	

△Now available in 300 mil space saving THIN SIDEBRAZE for IDT7201/02

* These IDT parts available in compact gull-wing SOIC, Hermetic DIP, LCC and plastic DIP packages

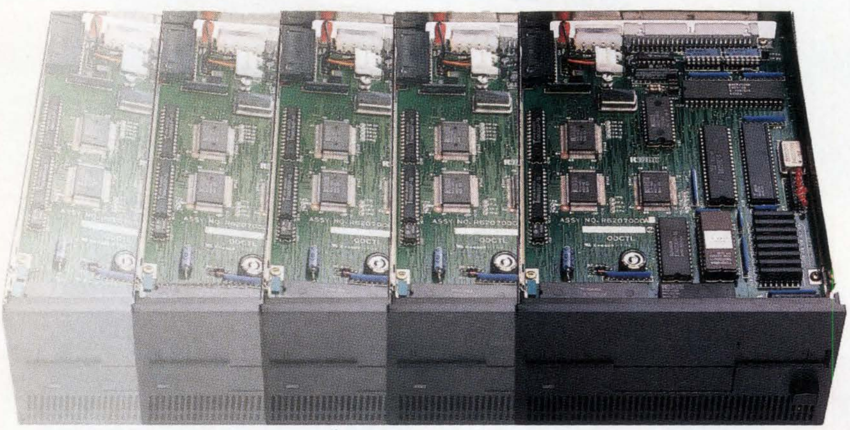
**45 MHz devices available 4Q87

Standard DIP packages:
(a) 28-pin, 600 mil wide plastic DIP
Surface mount packages:
(b) 32-pin PLCC (c) 44-pin PLCC (d) 20-pin SOIC
Space saving packages:
(e) 28-pin, 300-mil wide Sidebraze THINDIP



CIRCLE NO 65

HOW TO END THE OPTICAL ILLUSION.



People have been talking about optical drives for years. But have you ever actually seen one work?

Well, now you can.

Because while others were talking about optical drives and solutions, Maxtor was developing them. And now we're shipping our 800MB 5¼-inch optical WORM drive in volume.

It's the first in our family of optical drives. And it's perfect for high-volume back-up, image or archival storage.

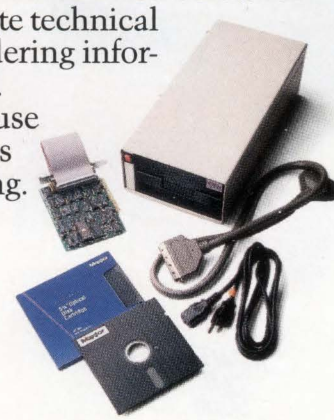
It's offered with a full complement of integration software and hardware, including media, cable and host adapter. Or it's available as a fully-configured plug-and-play mass storage subsystem.

Either way, it's fully compatible with most popular computers.

So don't wait to make optical drives a reality for your system.

Contact the Maxtor distributor or sales office listed below for complete technical and ordering information.

Because seeing is believing.



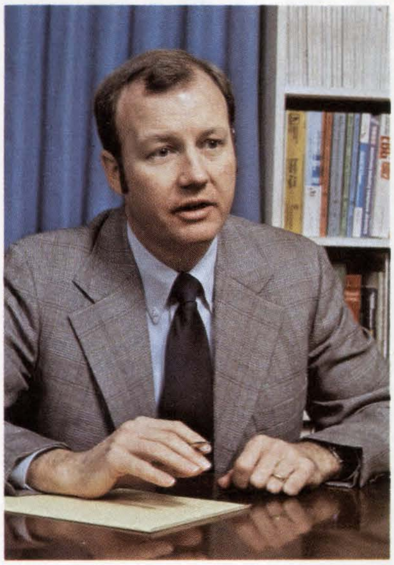
Maxtor

Sales offices: Atlanta (404) 455-4226, Austin (512) 345-2742, Boston (617) 872-8556, New Jersey (201) 747-7337, Orange County (714) 472-2344, San Jose (408) 435-7884, Woking, England (44)/4862-29814, Tokyo, Japan 81-3-431-8940.

Distributed by Anthem Electronics, (714) 768-4444, (408) 295-4200, (617) 657-5170, Future Electronics, (514) 694-7710, Pioneer Standard Electronics, Inc., (216) 587-3600, (301) 921-0660, Quality Components, Inc., (214) 733-4300, Storex Corporation, (617) 769-3400, Storage Dimensions, Inc., (408) 395-2688.

EDITORIAL

The service-economy myth



The economists and consultants who see a service-based economy as the salvation for the US haven't faced reality. It's obvious they haven't taken a car in for servicing, stood in line at a bank, or tried to have an electrician make a house call. There are many reasons why an economy based mainly on services is headed for rough times. Here are several:

Most service jobs offer low pay, little chance for advancement, and few benefits. In fact, some service businesses hire only part-time workers just to avoid paying for benefits that would be available to full-time employees. In short, many service jobs are a dead end. Few customer-service representatives or muffler-replacement workers have the chance to become store managers—and they know it. So, with few benefits and little chance for advancement, service jobs attract just the people who shouldn't be in those positions.

Besides offering few monetary and professional rewards, many companies offer service employees little training, scant motivation, and no sense of mission or importance. Most managers view service people as disposable resources. If these "throwaway" employees don't work out, there are usually others who want the jobs.

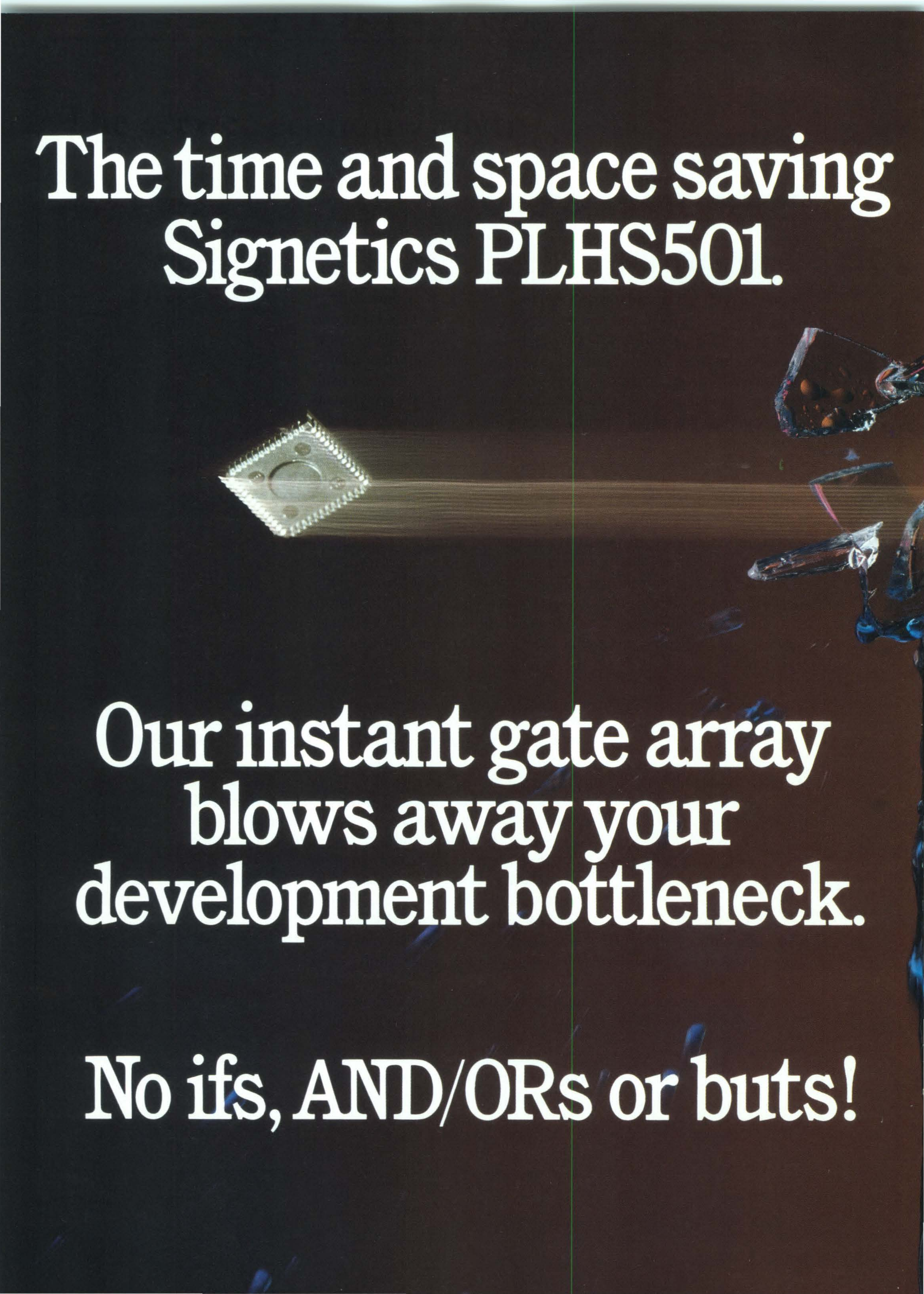
There are notable exceptions. A chain of lumber and hardware outlets in the greater Boston area provides employee benefits that include pension and profit-sharing plans. Employees are loyal, have low absenteeism, and know the products the company sells. Service people are abundant, helpful, and cheerful, even on Saturday morning.

Unlike a manufacturing endeavor, a small service business is easy to start, so some people view such businesses as an easy way to make money. Unfortunately, those businesses often leave behind distressed customers and much ill will. For example, if after six months the accounting software you got as a bargain from a consultant goes haywire, it may be impossible to locate the programmer or the consultant, despite a contract and guarantees. Because many service businesses require little investment, it's difficult to hold the owners financially responsible for their work—or the lack of it. There's little gain in tracking down and suing someone who has limited resources.

Certainly, businesses that manufacture products can have problems, too. However, the potential for poor quality seems higher in service industries. Before we treat service businesses as an economic panacea, let's examine how we're treating service people, how they treat customers, and how we can hold small service businesses accountable to customers.

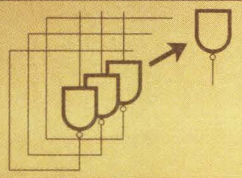
Jon Titus

Jon Titus
Editor


The time and space saving Signetics PLHS501.
Our instant gate array blows away your development bottleneck.
No ifs, AND/ORs or buts!

An "instant gate array" with no "gate-a-risk." The high-speed (t_{PD} = 22ns) Signetics PLHS501 Programmable Random Logic unit blows away your gate array development time. And with it your NRE, inventory problems and quality concerns. It's programmable or reprogrammable within hours—not weeks. And delivered on schedule, fully tested.

No interconnect restrictions. The unique single NAND array architecture of the PLHS501 eliminates the design constraints of AND/OR gates by delivering more utilization of on-chip resources. There are no interconnect restrictions because any NAND gate connects with any other NAND gate.



Third generation single NAND array architecture with NAND foldback paths. The direct internal foldback supports multiple levels of logic without wasting I/O resources or suffering routing channel congestion.

Single-chip space saver. The PLHS501 provides 1300 effective gates—a complete solution on a single 52-pin PLCC package.

Powerful software support. All Signetics Programmable Macro Logic devices, including the PLHS501, are supported by our powerful AMAZE software that makes complex designs easy by simplifying logic entry, simulation and device programming.

Break your bottleneck. When you want your gate array development time blown away in an instant—call Signetics. (800) 227-1817, ext. 978D. Or mail the coupon below for the PLHS501 Development Kit, including a **free sample.** We have only one standard—zero defects. And one goal—customer satisfaction.

One standard. 0 defects.

Signetics

a subsidiary of U.S. Philips Corporation

EDN 121087

☐ Please send me the PLHS501 Development Kit
☐ Please send me the Signetics Programmable Logic Data Manual
☐ Please have a salesperson call me

My application is ____________

Name ____________

Title ____________

Company ____________ Phone (____) ____________

Address ____________

City ____________ State ______ Zip ______

Send coupon to: Signetics Corporation, 811 E. Arques Ave., P.O. Box 3409, Sunnyvale, CA 94088-3409 Attn: Publication Services, M/S 27


sun
3/60

ated today's ign tools. Now, we're rrow's. Concept 3.

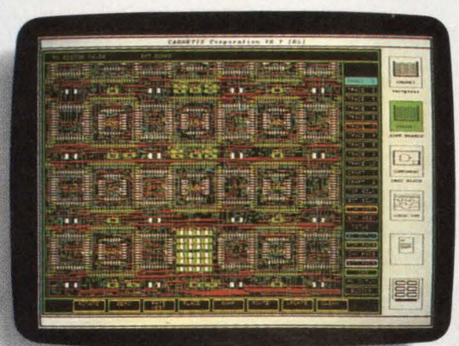
Cadnetix has been looking into the future. Two years of research, development and strategic planning have culminated in a significant breakthrough in electronic design. Concept 3 is a standard platform from Sun Microsystems® and a whole lot more. It's a new world of system design capability.

Emerging technologies demand a new set of design solutions. Advances in ASICs, high-frequency components and fine-line design are creating new challenges in engineering, design and manufacturing. A new level of CAE/CAD/CAM sophistication is required to get the job done, and stay competitive. Companies must have even tighter integration between engineering, design and manufacturing, plus open access to all the equipment that's needed to produce a product quickly.

That's why we developed Concept 3, the convergence of advanced design tools and open systems, and more. We've redesigned our tools from the database up, to meet your design future. Concept 3 is Flexible Field™ routing and high-frequency design. It's a global data structure designed to handle off-grid components. It's RISC-based simulation acceleration, extraordinary ease-of-use and a seamless data path from schematic to manufactured product.

Concept 3 is also Cadnetix and Sun. Front-to-back system design on an industry-standard workstation. It's a perfect fit. Both companies have established reputations for delivering advanced technology. Both are committed to open systems and networking. And both base their products on industry standards such as UNIX,® Ethernet and NFS.™

Now you get ease-of-use, state-of-the-art design, and a UNIX workstation that runs all Sun third-party software. We take full advantage of an open environment, so that Sun Workstations can share the network with Cadnetix systems and DOS PCs. It's the best balance of cost and performance available. Moreover, every workstation has access to the advanced capabilities of multiprocessor, RISC Engines for accelerated simulation, physical modeling or accelerated 100% routing.



The Cadnetix CAE Sun Workstation is a complete desktop solution, with tools for schematic creation, analog and digital simulation and ASIC design. The CAD/CAM Sun Workstation includes Cadnetix' industry-famous tools for PCB layout, routing, tooling, assembly and test. Cadnetix front-to-back CAE, CAD and CAM eliminate netlists, data conversions and design to manufacturing hold-ups. It's a level of integration unmatched in the industry.

Take a look at Cadnetix Concept 3. Because it isn't enough to solve today's system design problems. You have to be ready for tomorrow's.

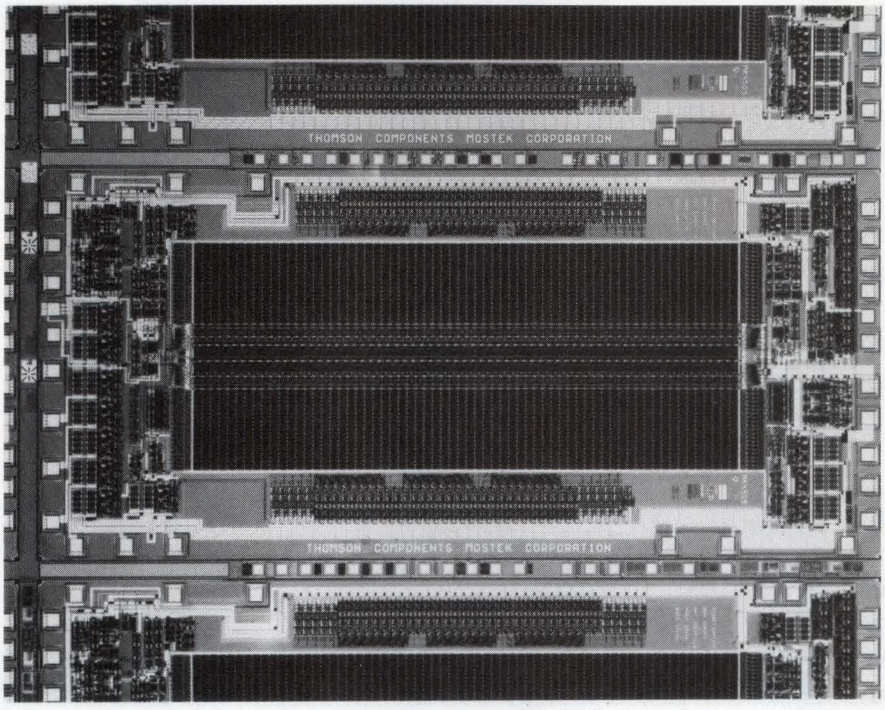
CADNETIX

Because tomorrow's design problems demand solutions today.

Boulder, CO (303) 444-8075

CIRCLE NO 63

CMOS FIFO memory has 15-nsec access time and two free-running clock inputs



This edge-triggered, latched, expandable, and cascadable FIFO buffer, the MK4505 from Thomson-Mostek, offers a 15-nsec access time.

You can now purchase a clocked 1k×5-bit FIFO memory with a 40-MHz cycle rate and a 15-nsec access time. The MK4505 has two independent, asynchronous, free-running clock inputs. These inputs provide automatic read- and write-protection logic for the device by creating an input stage that's similar to a rising-edge-triggered, D-type flip-flop. The clocked interface eliminates any need for external registers, buffers, or pulse-shaping circuits.

In addition, several status flags warn you when the buffer is full, empty, half-full, almost full, or almost empty. The almost-full and almost-empty flags warn you when only eight bytes remain before the device is completely full or empty. The device also provides Data Ready and Output Valid status flags. The MK4505 latches all the status flags, and it won't change states until it's triggered.

You can order the MK4505 in either master (MK4505M) or slave (MK4505S) versions. You can't read the master when it's empty or write to it when it's full. However, you can force the slave to read and write continuously regardless of the FIFO buffer's status, so you can take advantage of the slave's edge-triggered 3-state output. Further, the MK4505M provides you with all the control necessary for width and depth expansion. You'll need an MK4505M for each 1k bit of depth you add to your FIFO array, and you'll require an MK4505S for each additional 5 bits of width. The practical expansion limit, however, is 40 bits: Beyond that point, you'll encounter drive-capability problems.

Because the MK4505 contains dual-port RAM, the device isn't susceptible to the ripple-through delay times that plague shift-register FIFO buffers. The device's separate read- and write-enable inputs let you enable or disable read and write operations on command in the presence of a continuous periodic clock. Internal read and write address pointers automatically provide the RAM with correct addresses, but data moves only on the rising edge of the clock pulses. If a clock is turned off, the MK4505 latches the previous cycle, regardless of any further input changes. Besides allowing simultaneous read and write activity, the FIFO memory's asynchronous design lets you stop either the read or the write clock without disrupting the other port's activity.

You can use the MK4505 as a digital delay by using one free-running clock and one control clock that has a programmable counter for determining the duration of the delay. The delay can last from two to 1022 cycles. Because of its pipelined architecture, the MK4505 is suitable for use in high-speed data links, fiber-optic circuits, and digitized video/graphics applications.

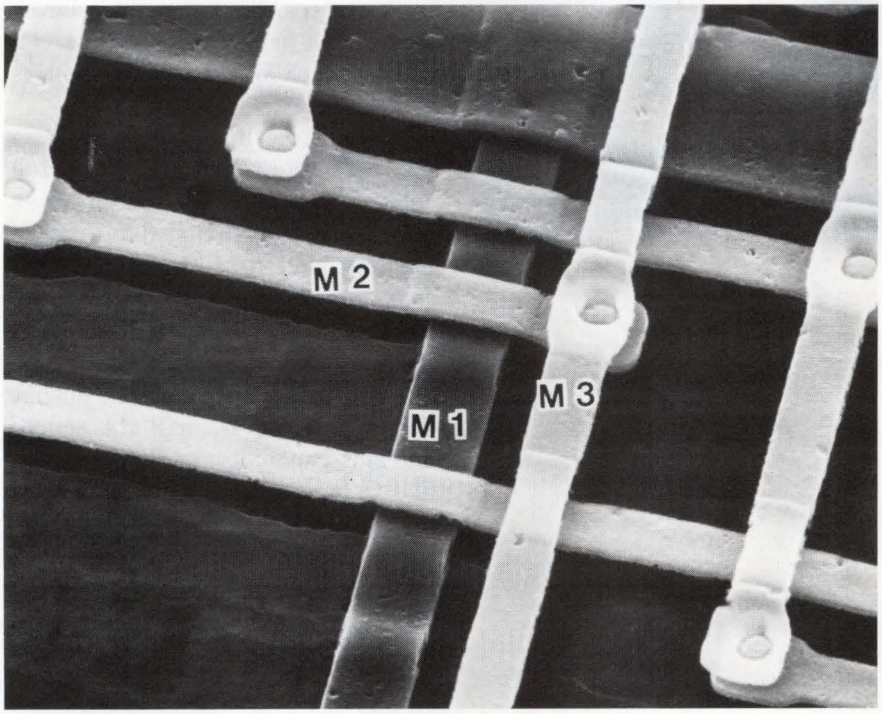
You can order the MK4505-25, a version with a 25-nsec cycle time and a 15-nsec access time, for $48.43 (100). A slower version, the MK4505-50, specs a 50-nsec cycle time and a 25-nsec access time; it sells for $33.67 (100). Both parts come in 300-mil DIPs with TTL-compatible inputs and outputs.

—J D Mosley

Thomson Components-Mostek Corp, 1310 Electronics Dr, Carrollton, TX 75006. Phone (214) 466-6000. TLX 730643.

Circle No 729

High-density ASIC family achieves 100k-cell arrays



Three layers of metal carrying signals and power *(labeled M1, M2, and M3) allow the Max HDC100 family of macrocell arrays to use about 75% of the available transistors on arrays with as many as 104,832 8-transistor cells.*

By using 1-μm drawn gate lengths, 1.2-μm design rules, and three metal layers to route signals and power, the vendor has developed the Max HDC100 family of ASICs, which are CMOS macrocell arrays that encompass as many as 100,000 cells. The largest chip in the family measures only 483 mils per side. In addition, the ASICs feature internal gate speeds of 400 psec (with a fanout of 2) and offer as many as 512 configurable I/O cells.

You can use the vendor's $7500 Modular Design System software and $500 HDC library to develop designs for the Max family on a Mentor Graphics workstation. The library contains several hundred macrocell designs, including designs from the company's existing BiMOS and CMOS ASIC libraries, as well as ALUs, UARTs, timers, and several designs equivalent to AMD's 2900 family of bit-slice parts.

You execute the first design phase by developing the schematic and performing functional and timing simulations on the workstation. The vendor then uses the resulting design files to place and route an HDC100 ASIC of suitable size on its DEC VAX 8800. This process takes about two days. Sample parts arrive 12 to 14 weeks after you approve the final chip layout.

Initially, the company plans to offer three members of the Max family: the HDC016, HDC031, and HDC100, which have 16,416, 31,290, and 104,832 cells, respectively. It estimates that nonrecurring engineering (NRE) charges for these arrays will be $35,000 to $250,000. Eventually, the vendor plans to offer 10 devices having 5670 to

104,832 cells. Part costs range from about $37 for the 16k-cell array in a plastic quad flat pack to approximately $624 for a 100k-cell array in a multilayer, ceramic pin-grid array. Because it uses all three metal layers for both signal and power traces, the company believes that it can achieve an average cell utilization of 75% on the channelless array.

These three initial offerings also incorporate 136, 180, and 300 I/O cells, respectively, for devices placed in packages that require wire bonding, and 204, 280, and 512 I/O cells, respectively, for devices put in TAB (tape-automated bonding) packages. You can configure each I/O cell to be an input; an output driver with 2-, 4-, or 8-mA source and sink capability; or a bidirectional I/O pin. Although 512 I/O cells may seem like a very large number, the company points out that these cells have additional applications. You can gang as many as six cells to create a 48-mA (source and sink) I/O driver, and you can use an I/O cell as an internal buffer for heavily loaded signals such as a clock line.

The Max arrays feature an 8-transistor primary cell. You can construct gates or bits of ROM and RAM with each cell. A bit of RAM requires six transistors; a bit of ROM requires only a single transistor. The memory achieves a 10-nsec access time for blocks having less than 1k bits and a 30-nsec access time for blocks with as many as 32k bits. You can merge bits of RAM and ROM in a primary cell; one cell can be used to build a RAM bit and two bits of ROM or as many as eight ROM bits. This interleaving scheme also allows memory-address decoders and drivers to perform double duty by simultaneously driving both RAM and ROM arrays.

—Steven H Leibson

Motorola Inc, Box 52073, Phoenix, AZ 85072. Phone (602) 821-4426.

Circle No 727

WE TAUGHT THE WORLD TO DRIVE WITH OUR FULL-SIZE MODELS.

Internal 19,200-bps modem speeds PC communications

Permitting a range of communication speeds from 300 to 19,200 bps on a single IBM PC-compatible plug-in expansion card, the PC-Race 24/96 internal PC modem provides error correction, autodial, auto-answer, and full-duplex operation. The modem is compatible with the Hayes AT command set as well as with the manufacturer's extended communication commands.

The PC-Race 24/96 costs $995. If you need only CCITT V.22 compatibility for 300-, 1200-, and 2400-bps communication, you can purchase the PC-Race 24 for $595. If you want faster speeds and don't need V.22 compatibility, you can buy the $795 PC-Race 96, which gives you 9600-bps communication and a 19,200-bps BMX file-transfer mode.

Because of the modem's modular design, you can begin with the PC-Race 24 card and upgrade to a PC-Race 24/96 by plugging in a daughter card. Similarly, if you begin with the PC-Race 96 and decide later to add V.22 compatibility, you can plug in a daughter card to do just that.

Each version includes built-in error correction, which reduces data-transmission overhead between your PC and host computers by eliminating any need for special error-protection protocols. For PC-to-PC and PC-to-host communication over standard phone lines, you can use popular MS-DOS communication software such as Crosstalk, Carbon Copy, and Mirror.

The PC-Race 96 uses full-duplex asymmetrical frequency division to divide the voice telephone band into a high-speed, wideband CPU-to-screen channel and a slow-speed, narrowband keyboard-to-CPU operator input channel. It achieves 9600-bps operation over dial-up lines. If

The modular construction of the PC-Race modem card *from Data Race lets you upgrade your PC's file-transfer speed from 2400 bps to 19,200 bps by plugging a daughter board into the vendor's basic, PC-compatible expansion card.*

the receiving modem is another Data Race high-speed modem, the company's proprietary data-compression algorithm lets the two computers communicate at file-transfer rates reaching 19,200 bps, with error protection and EIA or X-On/X-Off flow control. This modem also accepts half-duplex, block-mode file transfers.

An internal speaker with external volume control lets you monitor the progress of your data transfer. The board interfaces with your IBM PC or compatible computer via a COM1 or COM2 bus assignment; COM3 and COM4 bus assignments are available by special order.

—J D Mosley

Data Race Inc, 12758 Cimarron Path, Suite 108, San Antonio, TX 78249. Phone (512) 692-3909.

Circle No 730

ASIC verification tester has 100-MHz clock and data rates

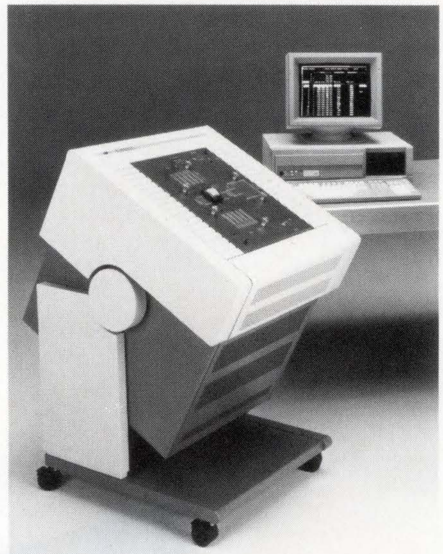
The Logic Master XL100 allows you to perform verification testing of devices at 100-MHz clock and data rates. Testing devices at these speeds requires more than just fast clock rates, however. You need to be able to place timing edges accurately in order to test timing margins. The XL100 can place timing edges with 100-psec resolution; the manufacturer claims that a calibration routine keeps the channel-to-channel skew levels within ±1 nsec.

It's also important for ASIC verification testers to provide a flexible environment for developing test programs. You need to be able to make test-program modifications quickly without being constrained by the test system's hardware. The XL100 uses a shared-resource architecture that gives you four drive-high voltage levels (−0.8 to +5.5V), four drive-low levels (−2 to +3.5V), and four compare levels (−2 to +5V). The XL100 also provides 12 timing sets that support two edges each. The resources are not constrained by channel; in other words, any or all of the channels can select a particular time set, drive level, and so on.

The modular design of the XL100 supports as many as 224 I/O channels or any combination of input and output channels to a maximum of 448. Each channel has 16k bits of drive-pattern memory and 16k bits of response memory. An optional dc parametric measurement system is available.

To help you develop test programs, the vendor provides software that converts the functional and timing data from your ASIC simulation into pattern-generation and expected-response data for the XL100. When you're ready to begin production of your ASICs, you can use the vendor's software to convert the test vectors you've generated into a format that's compatible with production testers.

The XL100 uses 6000-gate ECL arrays to perform timing generation and formatting. The channel drivers and receivers of the XL100 are implemented with linear arrays. A typical system with 128 I/O pins costs about $250,000. Delivery is 12 weeks.—***Doug Conner***



Providing as many as 224 I/O channels, *the Logic Master XL100 ASIC verification tester —from Mentor Graphics' recently acquired Integrated Measurement Systems Div—can operate at 100-MHz clock and data rates.*

Mentor Graphics Corp, Integrated Measurement Systems Div, 9525 SW Gemini Dr, Beaverton, OR 97005. Phone (503) 626-7117.

Circle No 728

NOW YOU CAN DRIVE OUR SUBCOMPACTS.

Seagate's family of 3½″ hard disc drives.

As computers grow smaller, the demand for high-quality drives grows larger. But if you're looking for 3½″ drives for your small computer systems, you don't have a lot to choose from.

Except at Seagate.

We offer six 3½″ drives with 21, 32 and 48 MB formatted capacities. You also have a choice of interfaces: SCSI or ST412 with RLL or MFM encoding. All with 28 msec access time.

Our 3½″ drives use Seagate's field-proven, proprietary stepper motors to achieve fast access times normally found only with more expensive voice coil actuators.

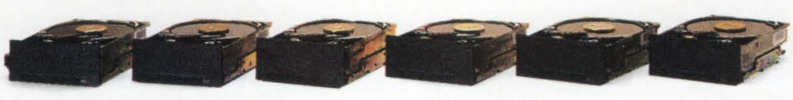
Seagate's 3½″ drives are not only fast —they're power savers, using as little as 8 watts.

And for added data integrity, the drives feature autopark with a balanced positioner.

All of Seagate's 3½″ drives are built with the precision and quality that have made us the world's leading independent manufacturer of 5¼″ full-height and half-height hard disc drives.

Only Seagate has the worldwide, high-volume manufacturing efficiency to meet the growing demand for 3½″ drives.

Once you evaluate Seagate's subcompacts, you'll be ready to go for a little drive. Call us today. 800-468-DISC.



Seagate

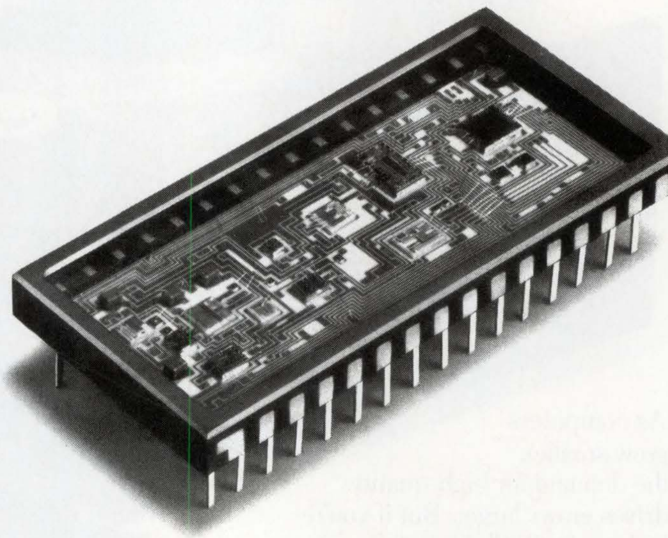
The first name in disc drives.

CIRCLE NO 61

MILITARY 16-BIT A/D's FIRST IN THEIR CLASS

MIL-STD-1772 CERTIFIED

MN5295/MN5290 & MN6290



High Speed:
- MN5295: 17μsec Max. Conversion Time
- MN5290: 40μsec Max. Conversion Time
- MN6290: 20kHz Min. Sampling Rate

Small 32-Pin Double-Wide DIP
14-Bit "No Missing Codes"
−55°C to +125°C Operation
MIL-STD-883 Screening

In the two speed classes of 16-bit A/D's that have emerged, only *one* supplier designs its devices to meet all of your military and aerospace requirements: Micro Networks.

In the high-speed (15-20μsec) class, our MN5295/96 are the fastest (17μsec), smallest (by 31%), and *only* devices to offer −55°C to +125°C operation and MIL-STD-883 screening.

In the general-purpose (40-50μsec) class, our MN5290/91 offer these same advantages; while our MN6290/91 add an internal T/H, plus FFT testing for improved performance, ease of specification, and significant space savings.

And most critical to your designs, these are the *only* devices that operate over the extended military temperature range with full military screening.

MN5295/MN5296

The newest in our expanding line of high-performance, military, 16-bit A/D's are at the top of their class.

Fastest Conversion Time:
17μsec Max. (16 Bits)
Smallest Package by 31%:
Double vs. Triple DIP
Widest Temperature Range:
−55°C to +125°C
Only Devices Available with 883 Screening

In the top speed class, our MN5295/96 excel, providing outstanding 16-bit performance in a DIP package that is fully 31% smaller than any competitor's. No other supplier can meet your requirements for high-speed, high-resolution, military A/D's. When your design demands the best, demand Micro Networks MN5295/96.

MN5290/MN5291

They're the best in their speed class of workhorse 16-bit A/D's. Specify them for all your applications that don't require the added performance of our MN5295/96.

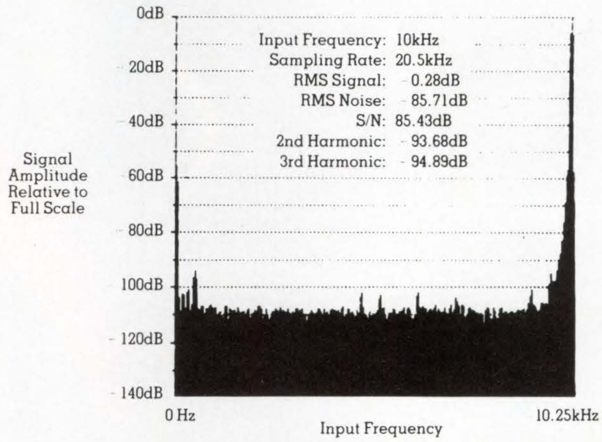
Fastest Conversion Time in Their Class:
40μsec Max.
Smallest Package by 31%:
Double vs. Triple DIP
Widest Temperature Range:
−55°C to +125°C
Only Devices Available with 883 Screening

Like our MN5295/96, our MN5290/91 A/D's are ideal for any design where you need *true* 14 or 13-bit performance over an extended temperature range. These devices were the first 16-bit military A/D's. Since their introduction, their broad acceptance and proven performance have made them industry standards.

MN6290/MN6291

In a class by themselves, these FFT-tested sampling A/D's are ideal for traditional data acquisition and DSP applications.

Single Package Sampling A/D
High Resolution/Sampling Rate:
16 Bits @ 20kHz
Signal-to-Noise Ratio: 84dB
Harmonics: −88dB
Temperature Range: −55°C to +125°C
Available with MIL-STD-883 Screening



These devices eliminate the hassle of evaluating T/H specs that are difficult to understand and often don't relate.

For more detailed information, send for our comprehensive data sheets. For rapid response, call Russ Mullet at Ext. 208.

Micro Networks
324 Clark Street
Worcester, Massachusetts 01606
(617) 852-5400

**Micro Networks
Advancing Data Conversion
Technology**

Micro Networks
A DIVISION OF **UNITRODE** CORPORATION

Regional Sales Offices: Worcester, MA (617) 852-5400; Dallas, TX (214) 991-8566; Santa Ana, CA (714) 261-5044.

CIRCLE NO 58

Your next destination:

The ACL Computer Age.

The future belongs to computers and peripherals built with RCA Advanced CMOS Logic (ACL).

The pressure is on to make your systems smaller, faster, cheaper.

Some of your competitors are doing just that by incorporating ACL into their new designs. If you want to stay on the fast track, you can't afford not to consider ACL for your new designs.

The computer of the future.

Imagine a computer with power dissipation so low you could eliminate all cooling systems. Or design a sealed system to prevent dust problems.

And get dramatically improved reliability, thanks to the far lower heat generated. As well as far smaller system size.

You'd also be able to use it in a far wider operating temperature range (-55°C to +125°C). Even in high-noise environments.

FAST* speed, CMOS benefits.

Advanced CMOS Logic gives you high speed (less than 3ns propagation delay with our AC00 NAND gate) and 24 mA output drive current.

But unlike FAST, it gives you a whole new world of design opportunity for computers, peripherals, telecommunications and other speed-intensive applications.

ACL dissipates less than 1/8 Watt while switching, compared to 1/2 Watt for a FAST IC (octal transceiver operating at 5 MHz). And quiescent power savings are even more dramatic: ACL idles at a small fraction of the power of a FAST IC.

In addition, ACL offers balanced propagation delay, superior input characteristics, improved output source current, low ground bounce and a wider operating supply voltage range.

Latch-up and ESD protection, too.

Latch-up concern is virtually eliminated, because ACL uses a thin epitaxial layer which effectively shorts the parasitic PNP transistor responsible for SCR latch-up.

And a dual diode input/output circuit provides ESD protection in excess of 2KV.

A broad and growing product line.

Our line already includes over 100 of the most popular types (SSI, MSI and LSI). More are coming soon. And many are available in High-Rel versions.

All this at FAST prices.

Our ACL line is priced comparably to FAST. So you get better performance at no extra cost. Why wait, when your competition is very likely designing its first generation of ACL products right now?

Get into the passing lane, with RCA ACL from the CMOS leader: GE Solid State. Free test evaluation kits are available for qualified users. Kits must be requested on your company letterhead. Write: GE Solid State, Box 2900, Somerville, NJ 08876.

For more information, call toll-free 800-443-7364, extension 24. Or contact your local GE Solid State sales office or distributor.

*FAST is a trademark of Fairchild Semiconductor Corp.

In Europe, call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm (08) 793-9500.

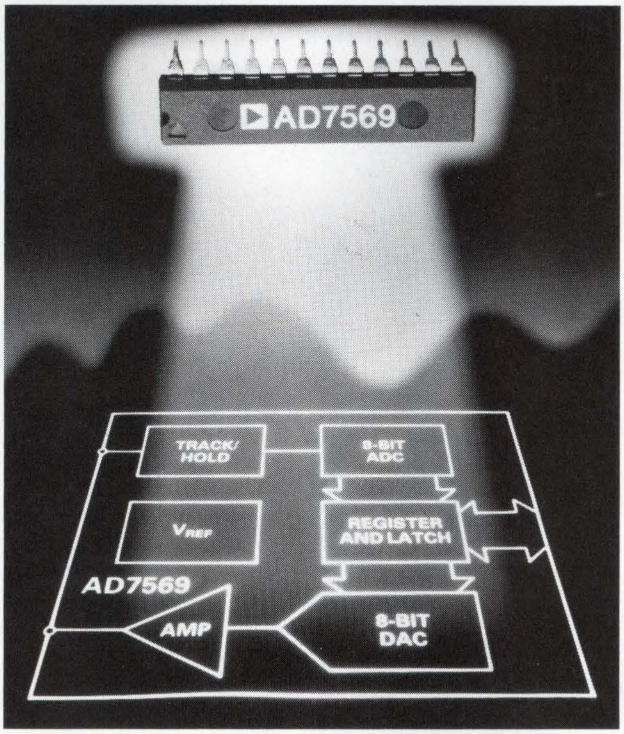
GE Solid State

GE/RCA/Intersil Semiconductors

These three leading brands are now one leading-edge company. Together, we have the resources—and the commitment—to help you conquer new worlds.

READERS' CHOICE

Of all the new products covered in EDN's **October 1, 1987,** issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **October 1, 1987,** issue.



◄ ANALOG I/O PORT

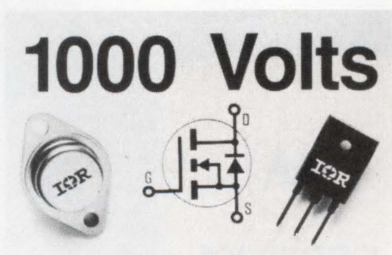
The AD7569 combines an 8-bit A/D converter, an 8-bit D/A converter, a track/hold amplifier, a buffer amplifier, and a 1.25V bandgap reference on a monolithic chip that includes both CMOS and bipolar transistors (pg 212).
Analog Devices Inc.
Circle No 601

PROJECT PLANNER

Project:Vision Level 2 is an enhanced version of the vendor's project-planning software package, which runs on IBM PCs and compatible computers (pg 232).
Inmax Corp.
Circle No 605

▲ HANDHELD SCOPE

The Scout SC01 is a handheld, multipurpose instrument that functions as a digital oscilloscope, a frequency counter, and a dual-channel DMM (pg 226).
Dolch American Instruments Inc.
Circle No 604

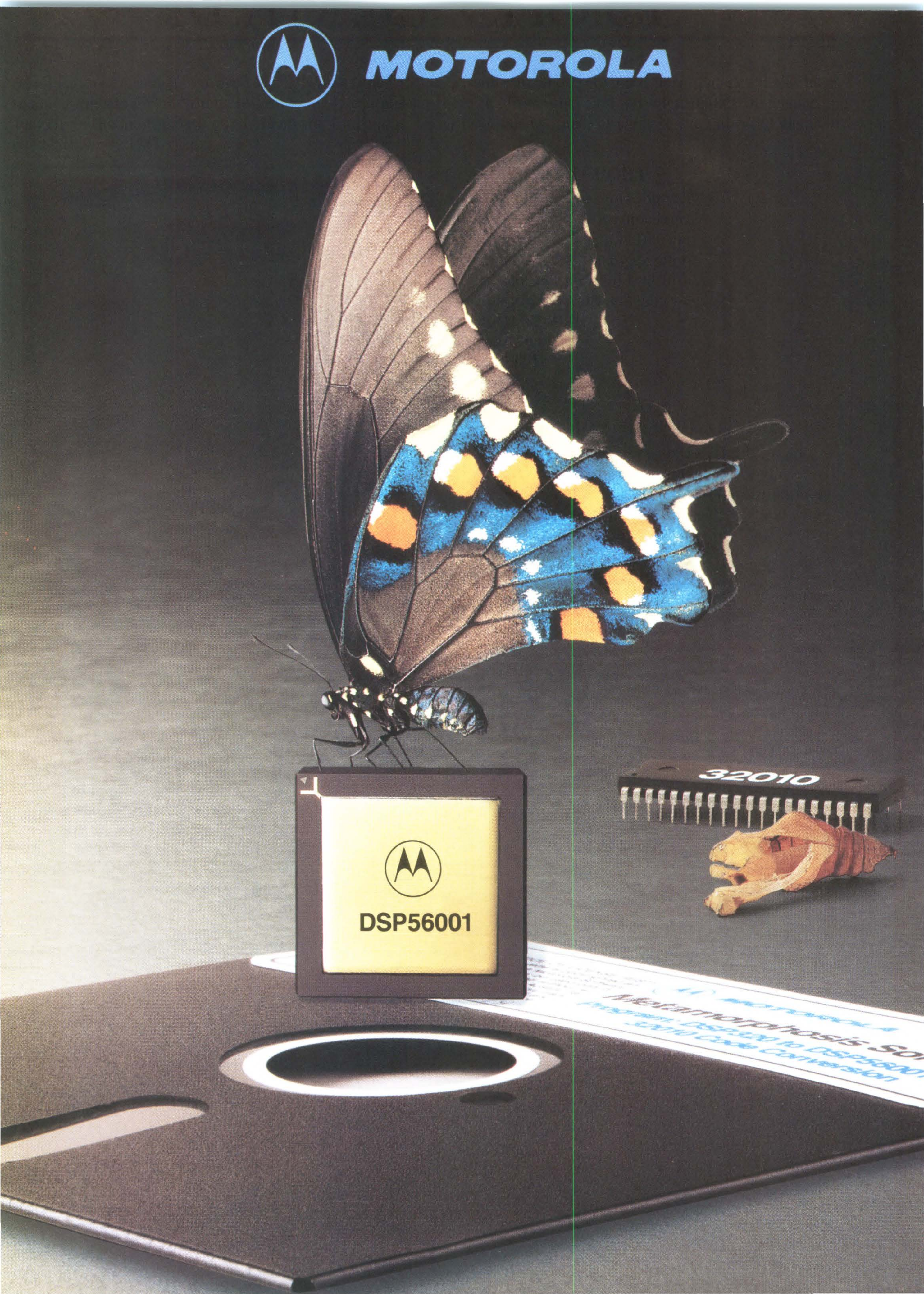


◄ POWER MOSFETs

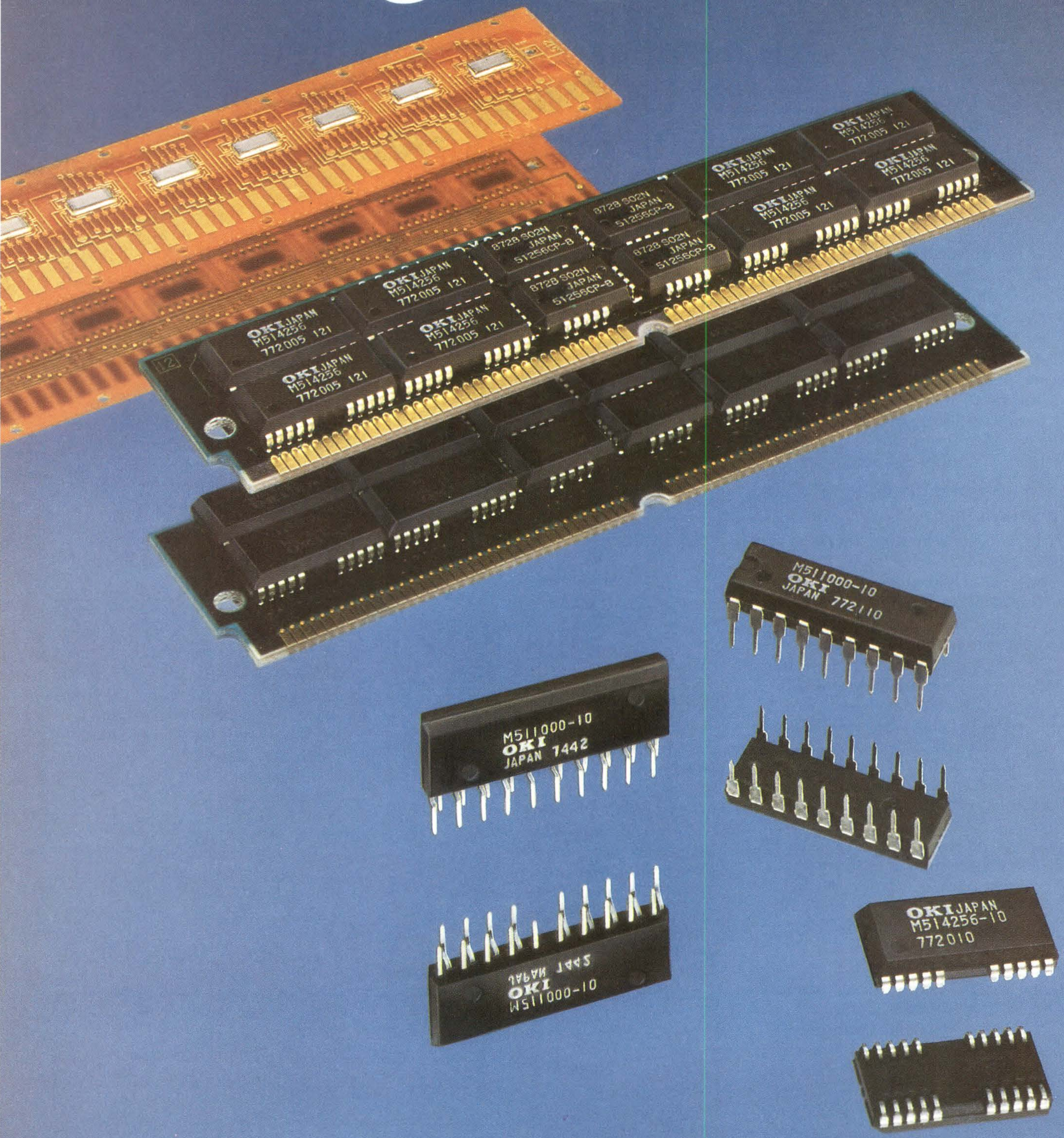
Designed for high-voltage applications, these power MOSFETs are available in TO-3 and TO-3P packages and have continuous-current ratings to 8.1A (pg 206).
International Rectifier.
Circle No 603

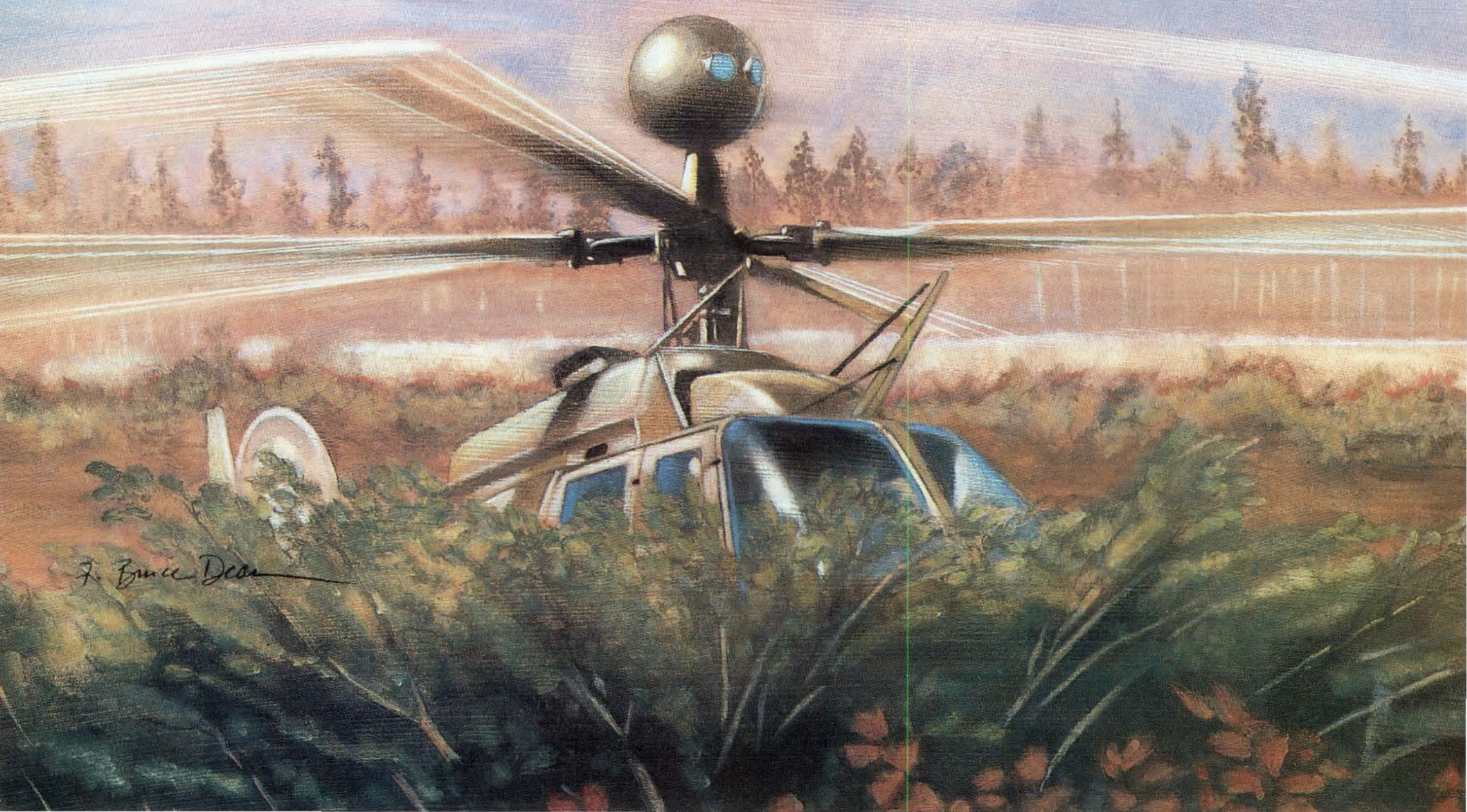
GRAPHICS ADAPTER

The VGA Extra is a plug-in board for the IBM PS/2 Model 30 as well as the IBM PC, PC/XT, and PC/AT. The adapter is compatible with all the modes of IBM's Video Graphics Array (VGA) standard (pg 216).
STB Systems Inc.
Circle No 602


MOTOROLA
DSP56001
32010
Code Conversion

Mega DRAMs.
Mega options.





LEADTIME INDEX

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
TRANSFORMERS								
Toroidal	7	29	28	36	0	0	8.7	8.6
Pot-Core	8	25	25	34	8	0	10.0	9.7
Laminate (power)	5	37	32	26	0	0	7.7	9.2
CONNECTORS								
Military panel	0	29	29	28	14	0	11.2	9.9
Flat/Cable	13	50	25	12	0	0	5.4	5.0
Multi-pin circular	0	36	37	27	0	0	8.2	6.6
PC (2-piece)	17	42	25	16	0	0	5.8	5.8
RF/Coaxial	11	58	21	10	0	0	5.1	5.6
Socket	39	38	15	8	0	0	3.6	4.1
Terminal blocks	27	41	23	9	0	0	4.5	4.3
Edge card	11	39	33	17	0	0	6.4	7.0
D-Subminiature	29	38	24	9	0	0	4.5	6.4
Rack & panel	0	46	31	23	0	0	7.4	8.9
Power	21	21	29	29	0	0	7.4	5.7
PRINTED CIRCUIT BOARDS								
Single-sided	12	40	36	12	0	0	5.9	5.3
Double-sided	6	29	53	12	0	0	6.9	7.0
Multi-layer	5	20	60	15	0	0	7.7	9.3
Prototype	7	70	19	4	0	0	4.2	4.1
RESISTORS								
Carbon film	45	26	26	3	0	0	3.3	3.7
Carbon composition	35	17	39	9	0	0	5.0	3.3
Metal film	35	23	38	4	0	0	4.4	4.1
Metal oxide	33	17	44	6	0	0	4.9	6.0
Wirewound	21	29	38	12	0	0	5.8	7.2
Potentiometers	21	36	36	7	0	0	5.0	4.5
Networks	27	27	31	15	0	0	5.7	6.3
FUSES	42	29	21	8	0	0	3.8	4.2
SWITCHES								
Pushbutton	28	32	32	8	0	0	4.8	6.4
Rotary	11	53	26	10	0	0	5.3	6.2
Rocker	28	28	33	11	0	0	5.2	6.4
Thumbwheel	12	44	25	19	0	0	6.2	9.3
Snap action	19	43	29	9	0	0	5.0	7.0
Momentary	11	33	45	11	0	0	6.3	7.1
Dual in-line	0	57	29	14	0	0	6.2	6.9
WIRE AND CABLE								
Coaxial	36	40	16	8	0	0	3.7	4.3
Flat ribbon	44	30	17	9	0	0	3.7	5.1
Multiconductor	25	45	20	10	0	0	4.5	6.2
Hookup	41	29	26	4	0	0	3.5	2.8
Wire wrap	31	31	31	7	0	0	4.4	2.3
Power cords	25	42	21	12	0	0	4.9	6.0
POWER SUPPLIES								
Switcher	15	15	39	31	0	0	8.3	6.2
Linear	7	36	29	28	0	0	7.8	6.7
CIRCUIT BREAKERS	15	40	15	30	0	0	7.1	5.6
HEAT SINKS	29	37	17	17	0	0	5.0	4.8
RELAYS								
General purpose	23	32	32	13	0	0	5.6	4.4
PC board	23	27	23	27	0	0	6.9	7.7
Dry reed	12	38	25	25	0	0	7.0	8.0
Mercury	0	33	34	33	0	0	8.8	7.5
Solid state	7	21	36	36	0	0	9.0	7.5
DISCRETE SEMICONDUCTORS								
Diode	36	25	22	17	0	0	5.1	4.8
Zener	32	32	18	14	4	0	5.5	5.4
Thyristor	18	18	35	29	0	0	7.9	8.0
Small signal transistor	29	28	24	19	0	0	5.7	7.5
MOSFET	14	29	9	48	0	0	9.0	7.9
Power, bipolar	6	38	25	31	0	0	8.0	8.4
INTEGRATED CIRCUITS, DIGITAL								
Advanced CMOS	4	39	35	22	0	0	7.3	8.4
CMOS	14	39	25	22	0	0	6.5	6.4
TTL	20	40	20	20	0	0	5.9	6.0
LS	20	48	16	16	0	0	5.2	6.1
INTEGRATED CIRCUITS, LINEAR								
Communication/Circuit	0	40	27	33	0	0	8.5	8.2
OP amplifier	16	28	32	24	0	0	7.1	7.9
Voltage regulator	20	36	28	16	0	0	5.8	5.8
MEMORY CIRCUITS								
RAM 16k	15	54	31	0	0	0	4.1	7.7
RAM 64k	18	27	37	18	0	0	6.5	7.1
RAM 256k	27	13	40	20	0	0	6.7	8.7
RAM 1M-bit	0	21	29	43	0	7	11.8	10.0
ROM/PROM	0	39	39	22	0	0	7.7	7.1
EPROM 64k	20	20	45	15	0	0	6.5	7.7
EPROM 256k	16	16	47	21	0	0	7.5	8.8
EPROM 1M-bit	0	8	54	38	0	0	10.5	8.3
EEPROM 16k	8	23	38	31	0	0	8.5	8.5
EEPROM 64k	7	20	47	26	0	0	8.5	8.0
DISPLAYS								
Panel meters	14	38	29	19	0	0	6.4	9.9
Fluorescent	0	27	36	37	0	0	9.4	12.5
Incandescent	7	43	29	21	0	0	6.9	8.6
LED	21	38	29	12	0	0	5.4	7.5
Liquid crystal	0	25	50	25	0	0	8.6	9.7
MICROPROCESSOR ICs								
8-bit	12	29	42	17	0	0	6.8	6.8
16-bit	12	38	25	25	0	0	7.0	8.3
32-bit	12	19	19	50	0	0	9.8	12.5
FUNCTION PACKAGES								
Amplifier	8	23	46	23	0	0	8.0	9.4
Converter, analog to digital	12	19	44	25	0	0	7.9	9.3
Converter, digital to analog	7	21	50	22	0	0	8.0	8.6
LINE FILTERS	15	23	39	23	0	0	7.3	7.9
CAPACITORS								
Ceramic monolithic	25	32	25	18	0	0	5.7	4.8
Ceramic disc	33	15	37	15	0	0	5.7	4.7
Film	29	21	33	17	0	0	5.9	5.0
Aluminum electrolytic	26	26	19	26	3	0	7.1	5.5
Tantalum	19	32	26	20	3	0	6.9	5.6
INDUCTORS	15	40	25	20	0	0	6.3	6.3

Source: *Electronics Purchasing* magazine's survey of buyers

Now you can layout in the Sun.

You can also layout with Apollo.® And on the DEC.®*

With complete access to GDS II.™

Introducing the EDS III™ IC Design System.

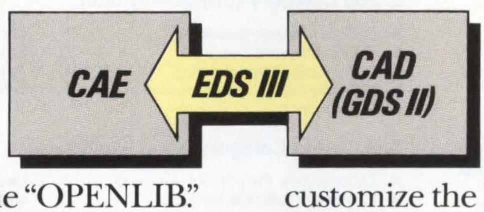
GE Calma's new Electronic Design System puts the automated IC design tools you need onto the industry's hottest platforms. Without sacrificing control or your investment in GDS II.

You see, we've linked the most popular engineering workstations to the GDS II library. So you can retrieve and work on any existing design.

Or create entirely new designs in such modern, easy-to-use environments as Sun,® Apollo and MicroVAX.™

Visit your GDS II library anytime.

EDS III provides a direct library-level interface to any GDS II design on the network.



Just give the "OPENLIB." command and the GDS II library you want will appear on your workstation. Without going through time-consuming STREAM™-level conversions.

Then make changes using the advanced EDS III features, including an upcoming high-level, GPL™-compatible user programming language.

You'll cut design time while making the most of your GDS II library and its powerful capacity for GaAs, hybrids and mixed analog/digital design.

And as upgrades for GDS II are released, EDS III will still be your standard platform access.

Route any block and cell automatically.

You can save more time by routing standard cells and blocks of all shapes and sizes automatically. And you have the same capability with standard cell placement and floor planning.

But even though the system is automated, you're still in charge. With control of die size, power and ground distribution, and placement.

And you can document your design as you go along.

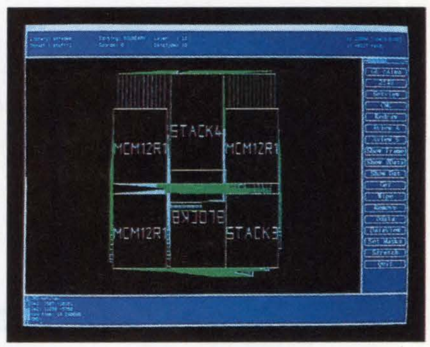
What's more, you can customize the EDS III interface to fit your needs. Whether you prefer the latest pull-down menus and windows in EDS III, the familiar GDS II menus or your own personal setup.

And because EDS III is open, you can take advantage of database access routines to integrate your own tools.

Now everyone shines.

With design tracking that automatically reflects any change throughout the system, EDS III keeps everyone on your design team informed.

And you in complete control. No matter how many revisions are made.



For more hot news, call our hot line.

So if you're interested in connecting your industry standard workstations with the industry standard CAD system, ask for our free brochure. Call us at 1-800-GE-CALMA, ext. 430.

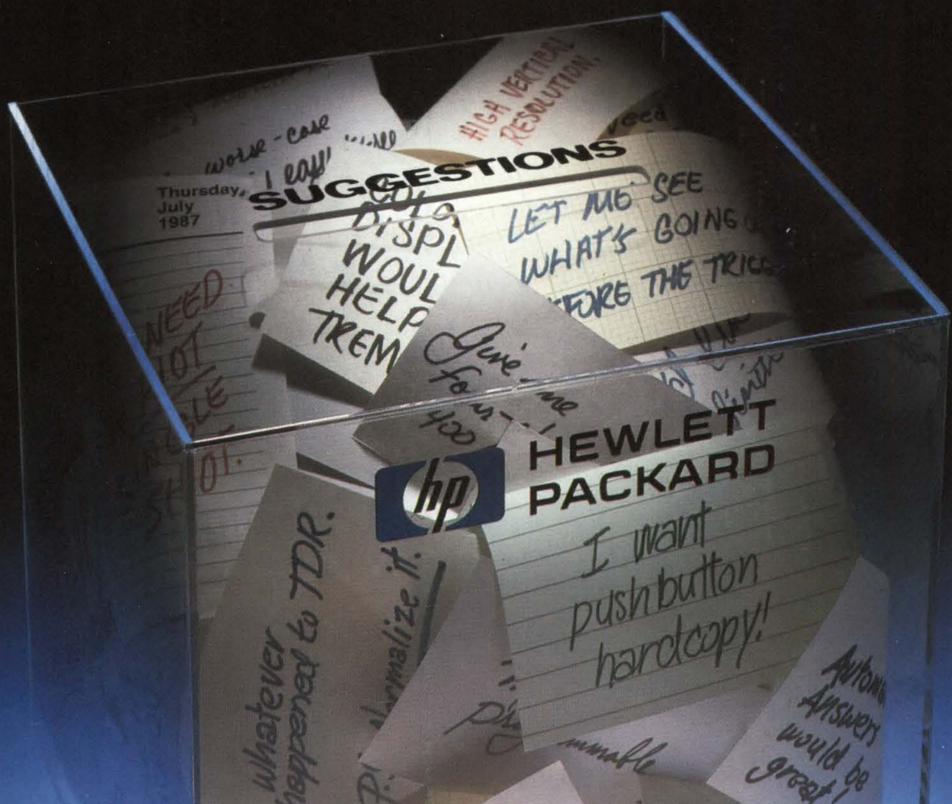
And start getting some Sun.

**Calma*

Apollo and MicroVAX platforms available early 1988.

Calma

You told us what you wanted in digitizing oscilloscopes,



and we took your advice...

...AGAIN.

Introducing HP's new high-perfo

You told us what would best meet your measurement needs.

So in '84 and '85 we brought you digitizing oscilloscopes with pioneering features like full programmability, 1 GHz repetitive bandwidth, color displays, automatic answers, single-shot pulse reconstruction, infinite persistence, and instant hardcopy output.

And now, we bring you the new HP 54111D/54112D/54120T series.

These high-performance digitizing oscilloscopes let you measure what you've never measured before, with superb accuracy and ease of use.

You'll find innovations such as 20 GHz bandwidth, 4-channel simultaneous 400 MSa/sec with 64k memory per channel, time domain reflectometry (TDR) with normalization, 10 psec time interval accuracy, and more.

HP 54111D: the hot single shot.

The HP 54111D offers two simultaneous channels operating at up to 1 Gigasample per second...allowing you to capture high-speed single-shot phenomena such as high-speed pulses, plasma discharge, high voltage arcing, high frequency bursts, laser pulses and high energy events.

You get the single-shot performance of analog storage oscilloscopes with all of the performance advantages of digitizing oscilloscopes.

The HP 54111D also offers a 500 MHz bandwidth, so it will perform admirably in a wide variety of repetitive as well as non-repetitive applications.

HP 54112D: 64,000 bytes times 4.

The HP 54112D offers you simultaneous 4-channel capture at 400 Megasamples per second with 64k of memory per channel. Just right for the long data streams found in serial data communication applications.

HP 54111D

- ☐ 1 Gigasample/sec digitizing rate
- ☐ 500 MHz repetitive bandwidth
- ☐ 250 MHz single-shot bandwidth
- ☐ 8k memory per channel
- ☐ 1 mV/div sensitivity

HP 54112D

- ☐ 400 Megasamples/sec digitizing rate
- ☐ 100 MHz repetitive or single-shot
- ☐ 4 simultaneous channels
- ☐ 64k memory per channel

rmance digitizing oscilloscopes.

Four simultaneous channels enhance critical timing measurements on multiple test points...single-shot. And the HP 54112D's four channels are always real-time correlated for every trigger occurrence.

In automated test, four channels with 64k memory per channel boost your throughput by capturing 256k of data simultaneously.

HP 54120T: excels in high-speed applications.

With its 20 GHz bandwidth and 10 psec accuracy, the HP 54120T lets you measure propagation delays of ICs or switching times of high-speed diodes. Characterize microwave switches. Verify signal path impedances in computer backplanes and test fixtures. And more.

You get high sensitivity, resolution, and accuracy for repeatable time-interval and voltage measurements, with stability and ease-of-use comparable to lower-performance oscilloscopes.

The HP 54120T offers four channels for logic gate characterization. Time and voltage histograms to help you quantify noise and jitter. Normalization to correct for imperfect connectors in reflection (TDR) and transmission measurements. Probing to 6 GHz. And the list goes on.

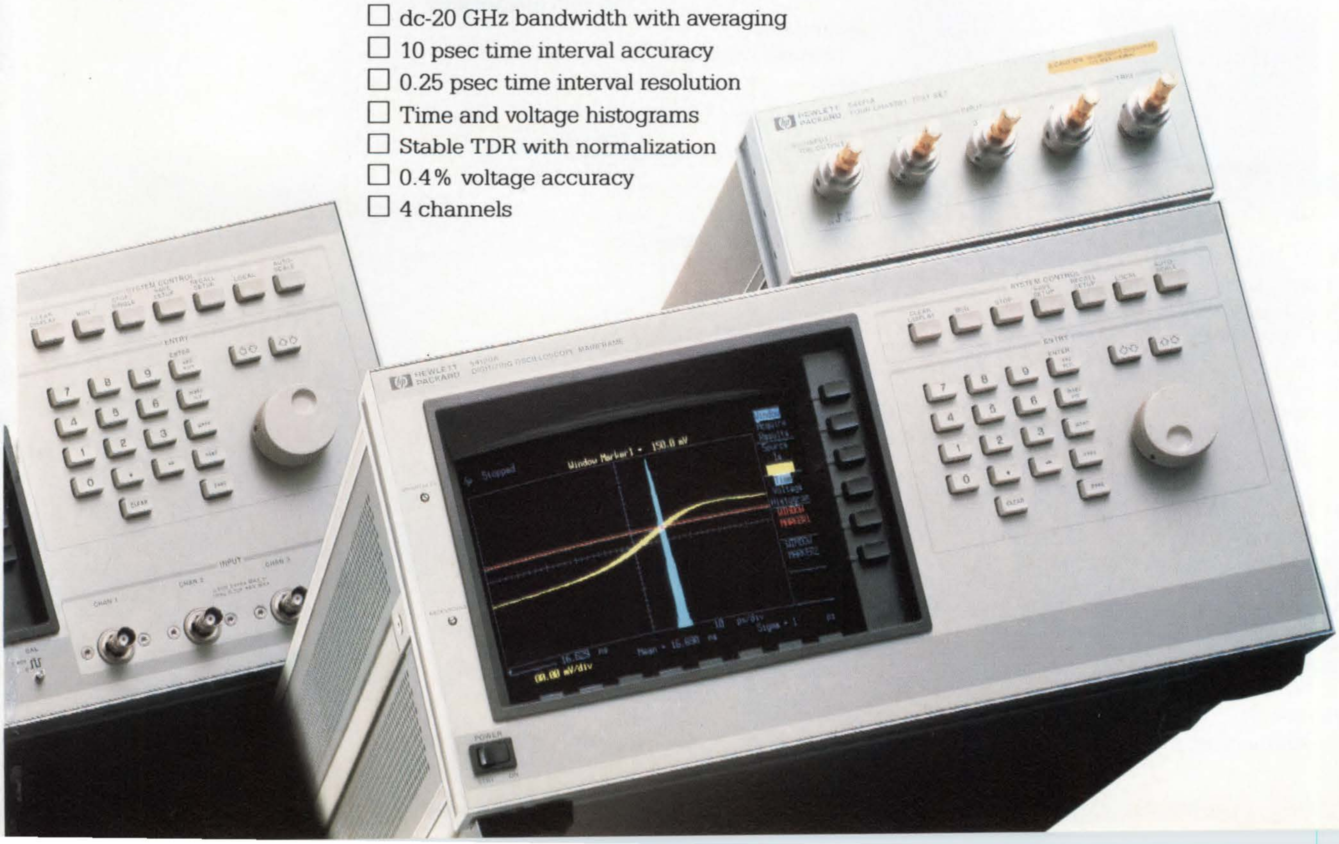
Contact HP today!

For more information on our new high-performance digitizing oscilloscopes, fill out and mail the postage-paid reply card today. Call us direct at **1-800-367-4772, Ext. 215L.** Or contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

HEWLETT PACKARD

HP 54120T

- ☐ dc-20 GHz bandwidth with averaging
- ☐ 10 psec time interval accuracy
- ☐ 0.25 psec time interval resolution
- ☐ Time and voltage histograms
- ☐ Stable TDR with normalization
- ☐ 0.4% voltage accuracy
- ☐ 4 channels

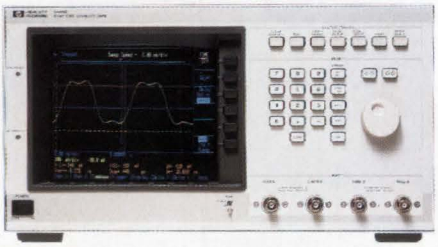


The specs you need, and the features you want.

In addition to their outstanding individual contributions, the new HP 54111D/54112D/54120T digitizing scopes offer you full programmability, automatic measurements, instant hardcopy output to printers and plotters, waveform storage, and multiple-color displays.

You also have HP's excellent reliability, documentation, and support to make you productive with your HP instrument quickly and ensure your satisfaction for years to come.

we never stop asking "What if..."



HP 54111D $23,900.00*

VERTICAL	
Rep. bandwidth	500 MHz
S.S. bandwidth	250 MHz
Inputs	2 chan & 2 trig
Resolution	8 bit to 25 MHz, 7 bit to 100 MHz, 6 bit to 250 MHz
Sensitivity	1 mV/div to 5 V/div
Coupling	ac, dc; 50 Ohm & 1 MOhm
HORIZONTAL:	
Digitizing rate (max)	1 GSa/sec
Resolution	10 psec
Pre-trigger viewing	YES
MEMORY:	
Acquisition/chan	8k
Waveform storage	2 pixel, 4 rep wfm, 4 ss wfm
Nonvolatile instrument setups	10

HP 54112D $22,900.00*

VERTICAL:	
Rep. bandwidth	100 MHz
S.S. bandwidth	100 MHz
Inputs	4 chan & 1 trig
Resolution	6 bit to 100 MHz
Sensitivity	5 mV/div to 5 V/div
Coupling	ac, dc; 50 Ohm & 1 MOhm
HORIZONTAL:	
Digitizing rate (max)	400 MSa/sec
Resolution	40 psec
Pre-trigger viewing	YES
MEMORY:	
Acquisition/chan	64k
Waveform storage	2 pixel, 4 rep wfm, 4 ss wfm
Nonvolatile instrument setups:	10

HP 54120T $27,850.00**

VERTICAL:	
Rep. bandwidth	20 GHz
S.S. bandwidth	NO
Risetime	17.5 psec
Accuracy	0.4%
Inputs	4 chan & 1 trig
Resolution	12 bits
Sensitivity	1 mV/div to 80 mV/div
Coupling	50 Ohm
HORIZONTAL:	
Accuracy	10 psec
Resolution	0.25 psec
Pre-trigger viewing	NO
Range	10 psec/div-1 s/div
MEMORY:	
Acquisition/chan	0.5k
Waveform storage	2 pixel (volatile), 4 rep wfm (nonvolatile)
Nonvolatile instrument setups:	10
TDR	
Pulse source	
Amplitude	0-200 mV
Risetime	35 psec
Flatness	1%
Normalization	YES
Waveform histograms	YES

*U.S. list price only.
Varies according to options selected.
**U.S. list price only.
Includes both the HP 54120A and HP 54121A.
Specifications subject to change without notice.

DESIGNED FOR HP-IB SYSTEMS

HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

HEWLETT PACKARD

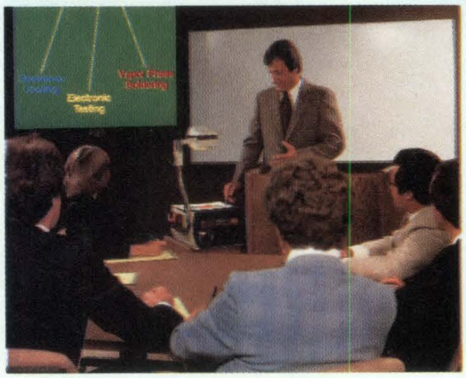
EI15701
5954-2661

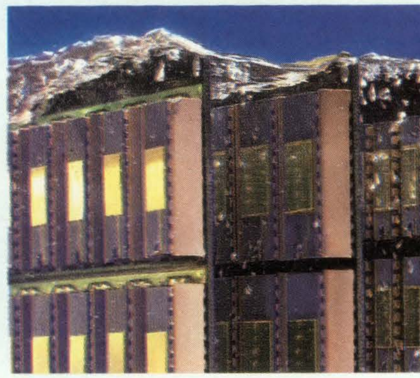

Discover
Fluoronics Resources

Fluorinert™ Liquids–products that power Fluoronics Resources

*Fluoronics Resources:

An exclusive 3M combination of innovative products backed by research and development, manufacturing expertise, technical data and service assistance built on more than 35 years' experience of pioneering in fluorochemistry.





3M has had a whole generation of experience in the development, manufacture and refinement of perfluorinated liquids. We first introduced these versatile liquids to electronics design, testing and production professionals in the fifties. Since then, Fluorinert Liquids have become the mainstays in electronic cooling, high reliability testing and vapor phase soldering.

Fluorinert Liquids, used as a direct contact heat transfer medium, offer a range of physical properties that make them particularly suitable for electronic uses. They are non-polar and exhibit no solvent action. They are colorless, low in toxicity, non-flammable and offer exceptionally high dielectric strength plus thermal and chemical stability. Most important, they have almost no chemical reactivity and they evaporate without leaving a residue on parts.

Buy the numbers

Our FC™ numbers — FC-40, FC-70, FC-77, etc. — are used to identify Fluorinert Liquids that offer certain physical characteristics to meet specific application needs. These FC numbers are solely 3M designations for various fluorochemical products.

Fluorinert Liquids are being used cost-effectively in cooling, high reliability testing and vapor phase soldering operations. When you are interested in applying these versatile liquids in your own production, 3M can provide an abundance of technical information and support.

Technical assistance: the main benefit of Fluoronics Resources

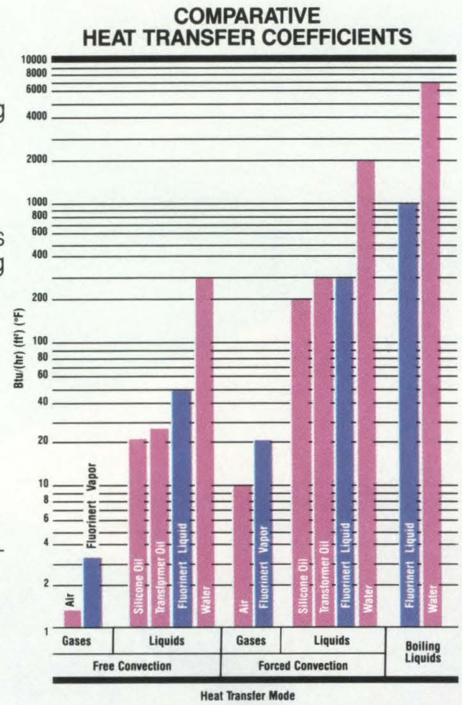
3M offers prompt assistance to help you solve many production and testing problems. We provide comprehensive technical recommendations for specific fluids. We consult with you on the proper application equipment and help you evaluate production methods and results. Our service bulletins bring you up to date on the most recent advances in vapor phase soldering and high reliability testing. Ask us about 3M's audiovisual materials and on-site application training seminars.

Discover Fluorinert™ Liquids' heat transfer capability

What are your needs? A precise degree of temperature control? Fast, uniform heat transfer? High dielectric strength? Fluorinert Liquids offer the broad range of physical characteristics required in most applications.

Fluorinert Liquids are an effective direct contact heat transfer medium whether used in a liquid or vapor state. Their unique properties enable you to use them in contact with sensitive components and substrates.

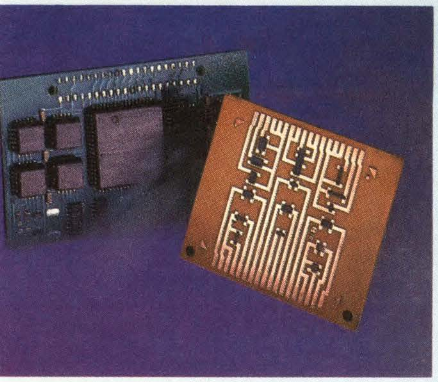
Major differences between the various products in the Fluorinert Liquids family can be seen in their boiling points. These can range from 56°C to 253°C. Should you need products with intermediate boiling temperatures, the 3M staff will work with you to fashion a product especially for your needs. It's an example of how 3M's Fluoronics Resources provide you with "customized" service to solve special problems.



Fluorinert™ Liquids achieve accurate high reliability testing

It's a small world you work in. Where time ticks in nanoseconds and dimension is measured in Angstrom units. And as circuitry becomes more complex, a greater demand is placed on testing capability — not only in speed, but in higher reliability and accuracy.

Fluorinert Liquids meet those requirements by providing a controlled temperature environment and a high degree of electrical protection. They offer maximum compatibility between



the heat transfer medium and the device under test. Fluorinert Liquids reduce testing costs by reducing testing time substantially. They do this by rapidly reaching test temperature and providing precise and uniform temperature control. You'll minimize the number of faulty units by detecting defects before they become rejects.

These liquids provide cost-effective tests such as gross leak, thermal shock, liquid burn-in, ceramic crack detection, electrical environmental, temperature calibration and failure analysis/short detection.

Fluorinert Liquids are specified in the MIL-STD's for thermal shock and gross leak testing.

THERMAL SHOCK TEST CONDITIONS

Military Standard 883-1011			Military Approved Fluorinert Liquids	
Test Condition	**Hot Test Step 1**	**Cold Test Step 2**	**Hot Test Step 1**	**Cold Test Step 2**
A	100°C	– 0°C	Water , FC-40	Water , FC-40, FC-77
B	125°C	– 55°C	FC-40, FC-70, FC-5311	FC-77
C	150°C	– 65°C	FC-40, FC-70, FC-5311	FC-77
D	200°C	– 65°C	FC-70, FC-5311	FC-77
E	150°C	– 195°C	FC-40, FC-70, FC-5311	Liq. N_2
F	200°C	– 195°C	FC-70, FC-5311	Liq. N_2

GROSS LEAK TEST CONDITIONS

Military Standards	Military Approved Fluorinert Liquids		
	Indicator Fluids	**Detector Fluids**	**Absorption Fluids**
MIL-STD 883-1014	FC-40, FC-43	FC-72, FC-84	Do not apply
MIL-STD 750-1071	FC-40, FC-43	FC-72, FC-84	FC-43, FC-75, FC-77
MIL-STD 202-112	FC-40, FC-43	FC-72, FC-84	Do not apply

Discover higher yields in vapor phase soldering

Fluorinert Liquids have been the industry's fluid of choice since the vapor phase reflow soldering (VPS) process was introduced in 1975. There are a number of good reasons for this universal acceptance. VPS with Fluorinert Liquids produces highly reliable solder joints. The system reduces reject rates, increases production, and lowers production costs. With Fluorinert Liquids, you can be assured that your products will never be exposed to a temperature higher than the selected liquid's boiling point. (See above)

You'll avoid those problems usually associated with other systems — shadowing, uneven heating, and overheating. The liquids are non-flammable. Their low surface tension helps them evaporate quickly from the work pieces without leaving a residue.

VPS with Fluorinert Liquids is especially suited for boards with high mass or complex geometries. The liquid vapors completely surround the assembly and penetrate remote recesses to heat all surfaces evenly. The vapors are 15 to 20 times heavier than air so they can be contained easily within the work area. The system offers an oxygen-free, non-corrosive environment to minimize rejects from oxidation contamination.

Some typical applications using Fluorinert Liquids in VPS include surface mounted leaded or leadless components, through-hole leads and wire-wrap pins, lead frame attachment, reflow of electroplated solder or tin and miscellaneous metal joining.

VPS SELECTION GUIDE

Fluorinert Liquid	Boiling Point	Typical Solders
FC-43	174°C/345°F	70 Sn/18 Pb/12 In 100 In 58 Sn/42 In 58 Bi/42 Sn
FC-70, FC-5311 FC-5312	215°C/419°F	63 Sn/37 Pb 60 Sn/40 Pb 62 Sn/36 Pb/2 Ag
FC-71	253°C/487°F	100 Sn 95 Sn/5 Ag 60 Pb/40 Sn

Discover the unique cooling benefits of Fluorinert™ Liquids

As the package size decreases, your need for more efficient heat dissipation increases in proportion. 3M Fluorinert Liquids are very efficient as a direct contact heat transfer medium, with the added advantage of having the high dielectric characteristics needed to meet stringent demands of the diversified electronics industry. We offer 11 liquids with boiling points that range from 56°C to 253°C.

These stable liquids allow you to maximize power density and miniaturize your package. Yet they reduce failure rates and increase reliability.

Fluorinert Liquids are used in such demanding applications as:
- Radar transmitters • Power supplies
- High voltage transformers • Lasers
- Radar klystrons • Computer modules
- Computer memories • Fuel cells

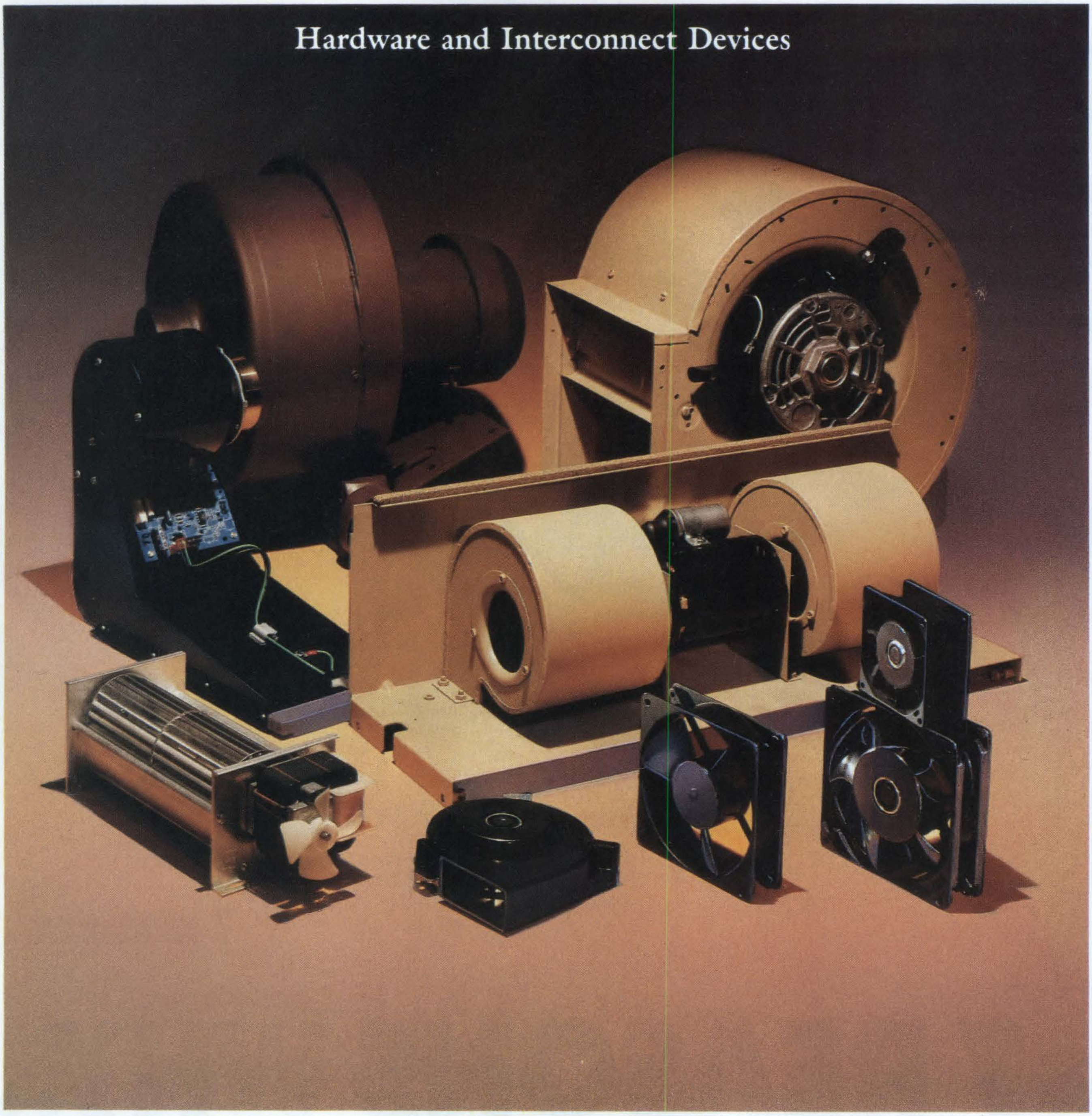
Typical properties of Fluorinert Liquids used in cooling are:

Fluorinert Liquid FC-77 (English Units)	Liquid		Vapor
	Room Temp. (77°F)	**Boiling Point (207°F)**	**Boiling Point 207°F @/ATM**
Density lb./ft^3	111	100	0.85
Thermal Conductivity Btu/(hr) (ft^2) (°F/ft)	0.037	0.033	0.008
Specific Heat Btu/(lb.) (°F)	0.25	0.28	0.23
Viscosity c.p.	1.42	0.46	0.02
Coefficient of Thermal Expansion ft^3/(ft^3) (°F)	0.0008	0.0009	0.0015

Discover heating/curing with Fluorinert™ Liquids

Because they maintain their vapor temperature with absolute precision, Fluorinert Liquids can be used in many heating and/or curing operations. They serve as heat transfer media in solder mask and polymer thick film applications and for polymer processing. The non-corrosive vapors will not support oxidation. Ideal where solvent flash-off is a problem.

Hardware and Interconnect Devices



Fans and blowers *(Torin Engineered Blowers)*

Shrinking board size has changed the rules for thermal design: A surface-mount assembly that occupies only 40% of the space of its through-hole counterpart can nevertheless dissipate as much power. Achieving adequate reliability requires that you understand and apply the new rules.

Cooling devices take the heat from SMDs

Dan Strassberg, *Associate Editor*

Small fan suited to spot cooling (Indek)

Surface mounting is about the hottest technology in electronic packaging today, and if you don't heed the advice of fan and heat sink vendors, you might find that claim to be literally true. They advise you to consider thermal management early in the design cycle. Otherwise, your customers might be the first to know about thermally induced reliability problems.

Surface-mount technology (SMT) is moving reliability concerns well beyond the purview of packaging engineers, power-supply designers, and designers of the traditionally temperature-sensitive low-level analog circuits. Fortunately, vendors are offering products ranging from CAD tools to heat sinks to help you develop and implement a strategy to limit semiconductor junction temperatures to a level that delivers the desired reliability.

Thermal design is now part of logic design

Thermal considerations pervade every aspect of SMT-based circuit design. For example, if you design high-speed SMT-based logic circuits, then your concerns encompass not only propagation delays and reflections in signal lines but thermal management as well. IC vendors normally don't offer their highest power devices in surface-mount packages (see **box,** "High-speed logic: toward even hotter technology"). But compared with their through-hole counterparts, the logic surface-mount devices (SMDs) that vendors do offer dissipate just as much power, mount closer together, and transfer a larger percentage of the heat they develop out of their packages through the leads. Close spacing between devices and widespread use of multilayer boards, whose inner layers exhibit fairly high thermal conductance, make it likely that the temperature of an SMD will affect—and be affected by—that of nearby devices more than would the temperature of a leaded through-hole device.

Among the army of products that stand ready to help you battle high temperatures is PCB Thermal, a CAD software package from Pacific Numerix, which allows you to impose thermal as well as electrical constraints when determining where to place components on a circuit board. PCB Thermal presents you with a graphic interface; it runs on many 32-bit CAE workstations and performs a finite-element thermal analysis. When configured for a Sun 3, it costs $15,000.

If your product is going to be manufactured in high volumes or will be quite complex, and if you feel that solving its thermal problems will take help from people who specialize in thermal management, you might

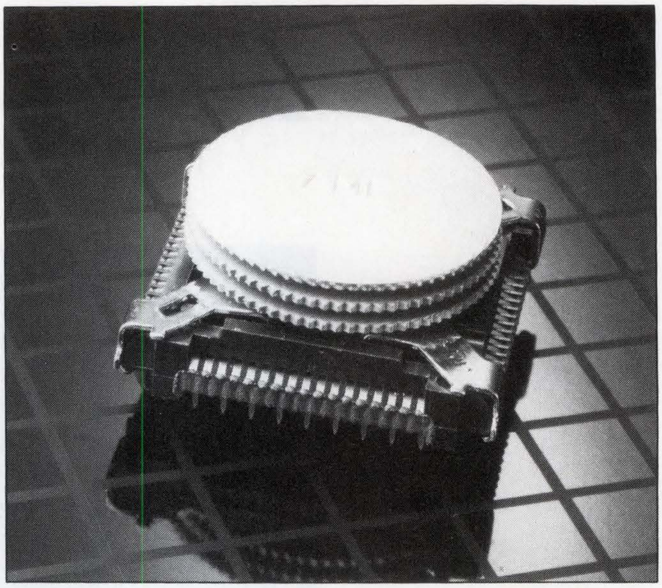
SMT is moving reliability concerns well beyond the purview of packaging engineers and power-supply designers.

consider EG&G Wakefield Engineering. Wakefield is probably best known as a supplier of heat sinks, but its product line includes other types of cooling devices as well. The company's applications engineers will work with you to develop a comprehensive thermal-management proposal if your application has the potential for requiring more than $25,000 worth of Wakefield products per year.

SMD heat sinks pose unusual design problems

You won't find a wide variety of heat sinks designed especially for SMDs. Those that do exist require you to mount the SMDs in leaded sockets that you solder into through holes, just as you would solder other conventional components. One reason for the scarcity of SMD heat sinks is the wide variety of SMD packages; no single package yet accounts for enough of the market to make it attractive for vendors to provide matching heat sinks. Furthermore, SMD packages make it difficult to attach heat sinks. Thermally conductive adhesives can be used, but applying them is a messy job, distasteful to supervisors of pc-board assembly groups. Worse yet, if you add the mass of a heat sink to an SMD, particularly one with J or gull-wing leads, you create a mechanically resonant system. During transit the device might vibrate severely enough to cause metal fatigue, which could weaken or fracture the leads or solder joints.

Attaching a heat sink to a component also increases the amount of heat you must deliver to it to solder it to a pc board. Prolonging the exposure of an SMD (or any other semiconductor device) to the high temperatures necessary to melt solder is likely to degrade its reliability. Therefore, if you attach heat sinks to SMDs, several IC vendors advise you to do it after the reflow-soldering operation. If you are using SMDs packaged in leadless ceramic chip carriers (LCCCs), heat sinks such as Thermalloy's 2313B ($1.27 (1000)) teamed with AMP's 55159-1 or -2 socket and cover ($5 (OEM qty)), or EG&G Wakefield's 830-20B ($0.31 (5000)) coupled with 3M-Textool's 268-5400-00-1102 socket ($12.13), allow you to wait until after soldering to mount not only the heat sinks but also the SMDs themselves. You place the IC in its socket, put the heat sink on top of it, and snap the two into place. You can use thermal compound to improve heat transfer from the IC to the heat sink. When used in air moving at 600 linear ft/minute, heat sinks of this type can reduce the junction-to-air thermal resistance (and hence the junction temperature rise above ambient) of an IC packaged in a 68-lead LCCC by approximately 60% compared with that of a similar device without a heat sink in still air.



Heat sink for an SMD, designed for use with an AMP socket *(Marketed by Thermalloy and AMP)*

Although the primary mechanism for heat transfer in solids is conduction (for instance, from a chip to its package, from the package to a pc board, and from one area of the board to another), air is not a particularly good conductor of heat, so the primary mechanism for heat transfer in air is convection—transfer of heat by air motion. With natural convection, temperature differences within your product will cause air to move and thus to transfer heat from the hotter parts to the cooler regions. If you use a fan or blower to increase the amount of air that passes by the heat sink, the heat-transfer mechanism is called forced convection. Temperatures reached by electronic components normally aren't high enough for the third heat-transfer mechanism—radiation—to play a significant role.

You can use some simple rules of thumb to help determine the point at which natural convection becomes inadequate: If your pc board dissipates $<0.5W/in^2$, natural convection will almost surely be adequate. From 0.5 to $1W/in^2$, natural convection might be adequate. From 1 to $2.5W/in^2$, conventional forced convection, where airflow parallels the plane of the boards, is likely to provide sufficient cooling. Above $2.5W/in^2$, you will probably have to resort to newer methods of forced convection, such as impingement cooling, in which you force air in a direction perpendicular to the plane of the board—directly at hot devices. At power densities greater than $5W/in^2$ you will probably have to abandon forced convection and resort to techniques like mounting hot components against a plate chilled with a cold liquid.

Many factors affect choice of cooling mode

Factors affecting the point at which you change from one cooling mode to another include your product's maximum specified operating ambient temperature and its internal configuration. Products that have generous spacing between boards (>1 in. center to center) are likely to operate reliably with natural convection at pc-board power densities that require the use of forced convection in more densely packed products.

If you determine that you need forced convection, you should not lightly approach the task of selecting the optimal air-moving device and the best scheme for moving air through your product. If you have to move air through the product from its surroundings, two of the problems you will face are noise and dust. Therefore, keep in mind that where cooling requirements are modest, you might not have to draw in air from outside the enclosure; you may be able to provide adequate cooling by stirring—using forced convection to move air from the warm interior of the product to the relatively cool inside surface of the enclosure. The enclosure is cooled, in turn, by the natural convection of the outside air.

Piezo Electric Products' LP Series air-moving de-

High-speed logic: toward even hotter technology

You won't find surface-mount versions of the logic devices that exhibit the highest dissipation. Many ECL gate arrays, for example, dissipate too much power for today's surface-mount packages, commercial-grade boards, and processes. LCCCs (leadless ceramic chip carriers) exhibit about the best heat-transfer properties of commonly used surface-mount packages. Their junction-to-case thermal resistance is approximately 30% lower than that of plastic leaded chip carriers (PLCCs) with the same number of leads. Because LCCCs have no leads at all, only solder holds them to the board (unless you place them in through-hole-mounted sockets, thereby surrendering the advantages of surface mounting). Because expansion coefficients of packages differ from those of most boards, increasing temperature causes stress to build up on the solder joints and make the connections between the package and the board unreliable.

On the other hand, with ICs in pin-grid-array (PGA) packages, if you don't use sockets, you solder the parts into through holes that have plenty of sidewall friction; because solder isn't all that holds the devices, retention is more reliable. Reliable retention is one reason that IC vendors prefer to package high-dissipation logic devices in PGAs rather than in LCCCs. Moreover, the vendors can get PGA packages with 300 pins; at present, the maximum pin count for LCCCs is 84.

One company, Texas Instruments (Attleboro, MA), has devised a solution to the problem of differing coefficients of expansion between boards and LCCCs. TI makes the clad metals now used in US coinage. Clad-metal technology makes it possible for TI to fabricate Invar-copper-Invar sheets that pc-board vendors can use as the embedded power and ground planes in multilayer boards. Because Invar has a much lower expansion coefficient than copper or glass-epoxy, by using the clad metal layers you can design boards whose expansion closely matches that of LCCC packages. TI will not design your printed-circuit boards for you, but it will assist you in selecting the clad-metal material that your board supplier can use to deliver the properties you want.

The Microwire process, developed by the PCK Technologies division of Kollmorgen Corp (Melville, NY), can take advantage of TI's clad metals as well as the extraordinary circuit densities possible with Microwire, a high-density version of Kollmorgen's older Multiwire process, to deliver boards that have controlled expansion and, because of their thinner insulating layers, heat conduction superior to that of boards with equivalent circuit density made either by multilayer or Multiwire processes.

One CAD software package allows you to impose thermal as well as electrical constraints when determining where to place components on a circuit board.

vices are well suited to stirring or spot cooling (cooling of a small number of hot devices in an otherwise cool unit). These 1.5×1.5-in. low-profile units attach to your pc board close to the device you want to cool. They use a piezoelectric, rather than electromagnetic, transducer to convert electrical energy to mechanical energy and are so quiet in operation that you can't hear them above the ambient room noise. They are only 0.16 in. thick, and you space them another 0.25 in. from the board. You power them with either 12 or 24V dc. The volume of air they move is modest—less than 2 cfm, but the air velocity is respectable—as much as 1000 linear ft/minute. Evaluation kits, which include a dc/ac inverter, cost \$250; production units cost from \$10 to \$25 (10,000).

Another device well suited to spot cooling is the FDC40-05H from Indek. Like the vast majority of fans, it's an electromagnetic device, but it measures only 1.5×1.5×0.79 in. You can mount it on a pc board and power it from 5V dc. It consumes 3W, its free-air delivery is 8 cfm, and its noise rating is 45 dBA. It costs \$16.65 (500).

If you know how much power your product dissipates, the formula

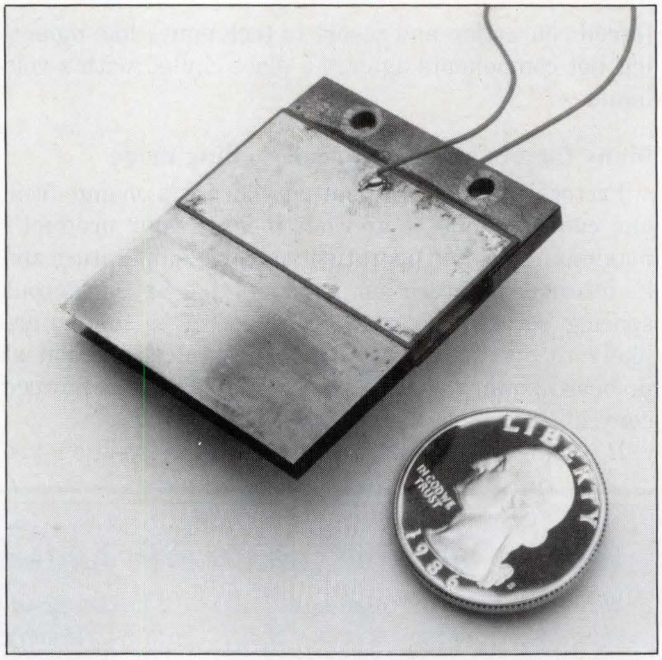
$$\text{AIRFLOW} = 1.756 \times P/\Delta T$$

(where airflow is measured in cfm, P is power in watts, and ΔT is temperature rise in degrees Celsius) tells you how much air you must move through it to limit the difference between incoming and outgoing air temperature to a specified rise.

For example, suppose that an IBM PC/AT work-alike computer has a power supply capable of delivering 220W. Further, suppose that the supply is 75% efficient, so that the power dissipated within the computer case is 1.33×220W, or 293.3W, if the supply is fully loaded. According to the airflow formula, to maintain the exit air temperature at 15°C above the entry air temperature (that is, 15°C above ambient room temperature), 34.3 cfm must move through the case.

At first, the required flow sounds quite reasonable; several vendors supply fans with free-air delivery of approximately 50 cfm in a 3.62×3.62×1-in. package. However, with a very small back pressure—approximately 0.07 in. of H_2O—such fans deliver less than the required 34.3 cfm, and they rotate at 3300 rpm, which makes them quite noisy for the computer's intended office environment.

When deciding about the overall scheme for directing air through a product, designers have traditionally considered two approaches—evacuation, where a fan pulls air through the product, and pressurization, where the fan pushes the air. Even though it adds the fan's own power dissipation to the heat load in the cabinet, pressurization is the more common of the two. A reason often given for selecting pressurization is that with a pressurized cabinet, dust doesn't enter through small openings; you can keep dust out by placing a filter over the opening directly in front of the fan.



Air mover incorporating a piezoelectric transducer *(Piezo Electric Products)*

Filters are a mixed blessing, however. Many designers believe that filters create at least as many problems as they solve. A filter clogged with dust severely restricts air flow, and users of electronic products are notorious for forgetting to clean or change filters. If you must use a filter, you should consider monitoring the temperature within your product so that you can warn the user, or shut power off, if the temperature becomes excessive.

When opting for cabinet pressurization, what many designers forget is that air moving at relatively low velocities picks up much less dust than does air moving rapidly. If the fan is not directly behind an air inlet, and air enters the product through many small, unfiltered openings, it will enter the enclosure slowly, thus minimizing dust buildup.

Because you can't easily control the path by which air enters a fan, you will usually find the highest air velocities, hence the greatest heat-transfer capabilities, directly in front of the air discharge. You might be able to combine these good heat-transfer properties with low dust buildup and freedom from filter maintenance by placing a fan in the middle of your product, as **Fig 1** shows, so that it draws air past the elements that dissipate little power and discharges directly over the hottest components.

Use pressure/volume curves to select fans

Fig 2 shows the pressure-vs-volume curve of a 4.69×4.69×1.5-in. fan—in this case, EBM Industries' 5-bladed W2G110-AO48-31, a 24V dc unit that consumes 6W. (In production quantities—1000 to 50,000 pieces—a number of vendors sell dc-powered, ball-bearing fans of this size for $11 to $17.) Overlaid on the pressure-vs-volume curve is the pressure-vs-volume curve of a product in which you might use the fan (for example, a cabinet filled with pc boards and power supplies).

Unfortunately, the only accurate way of establishing the pressure-vs-volume characteristic for *your* product is through airflow measurements on a mockup or an actual unit. Note that the volume of air that the fan can deliver is a function of the back pressure, and the back pressure is a function of the volume of air delivered. You can solve the simultaneous equations graphically—the operating point lies at the intersection of the two curves. Note also that the pressure-vs-volume curve of the cabinet is not linear; if you attempt to double the volume of air, the back pressure more than doubles. A nonlinear pressure-vs-volume curve is characteristic of turbulent flow. Although it's noisier than laminar flow, designers usually attempt to create turbulence because it aids in transferring heat from hot components to the moving air.

Choices you must make when selecting an air-moving device include whether to use a fan or a blower, whether to use ac or dc power to drive the air-moving device, whether to use an air mover with ball or sleeve bearings, and whether to control fan speed in response to changes in temperature of the components you are cooling.

Understand how blowers differ from fans

Fans deliver air along their axis of rotation; blowers usually deliver air in a direction perpendicular to their axis of rotation—either radially or tangentially. In general, for a given physical volume, a fan will deliver

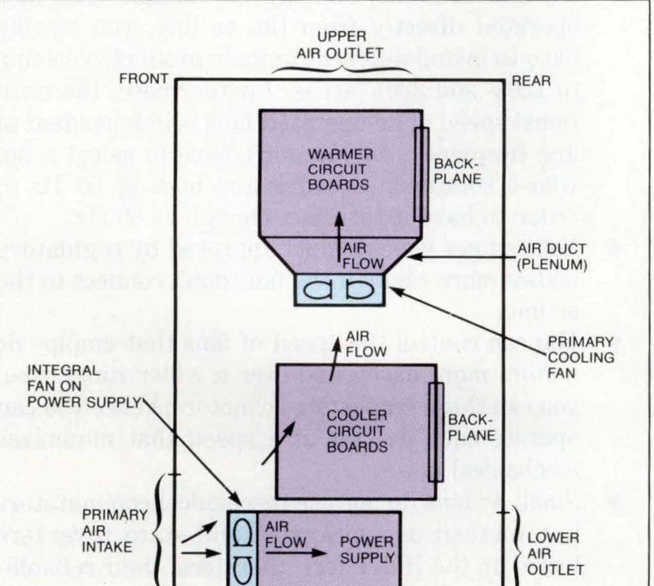


Fig 1—Unusual fan placement, *such as that depicted here, can make it possible to eliminate filters without inviting dust to build up within your product.*

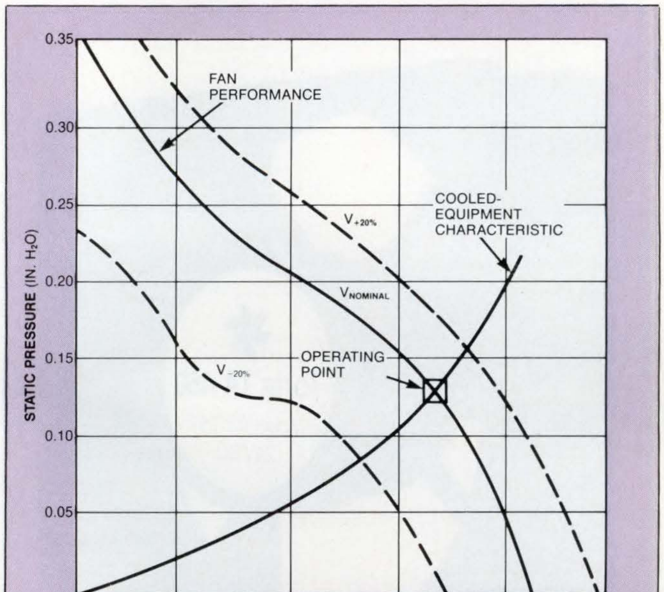


Fig 2—Use pressure-vs-volume curves *to get an idea of how much air a fan or blower will move. The operating point lies at the intersection of the fan's curve and that of the equipment you are cooling.*

No single SMD package yet accounts for enough market share to make it attractive for vendors to provide matching heat sinks.

more air at zero back pressure than a blower, but a squirrel-cage blower will deliver air at higher velocities and will do so even at back pressures that would completely cut off airflow from a fan.

Squirrel-cage blowers, such as Comair Rotron's Biscuit ($30.40), deliver air tangentially. At zero back pressure, the Biscuit delivers only 20% of the air *volume* of a fan with similar dimensions. However, because of the Biscuit's smaller discharge area, the exit *velocity* is more than twice as high, and the Biscuit can deliver air against back pressures nearly twice as high as those that would cut off airflow from a fan of comparable size. Their small exit area and high discharge velocity make small squirrel-cage blowers good choices for blowing air directly on very hot components.

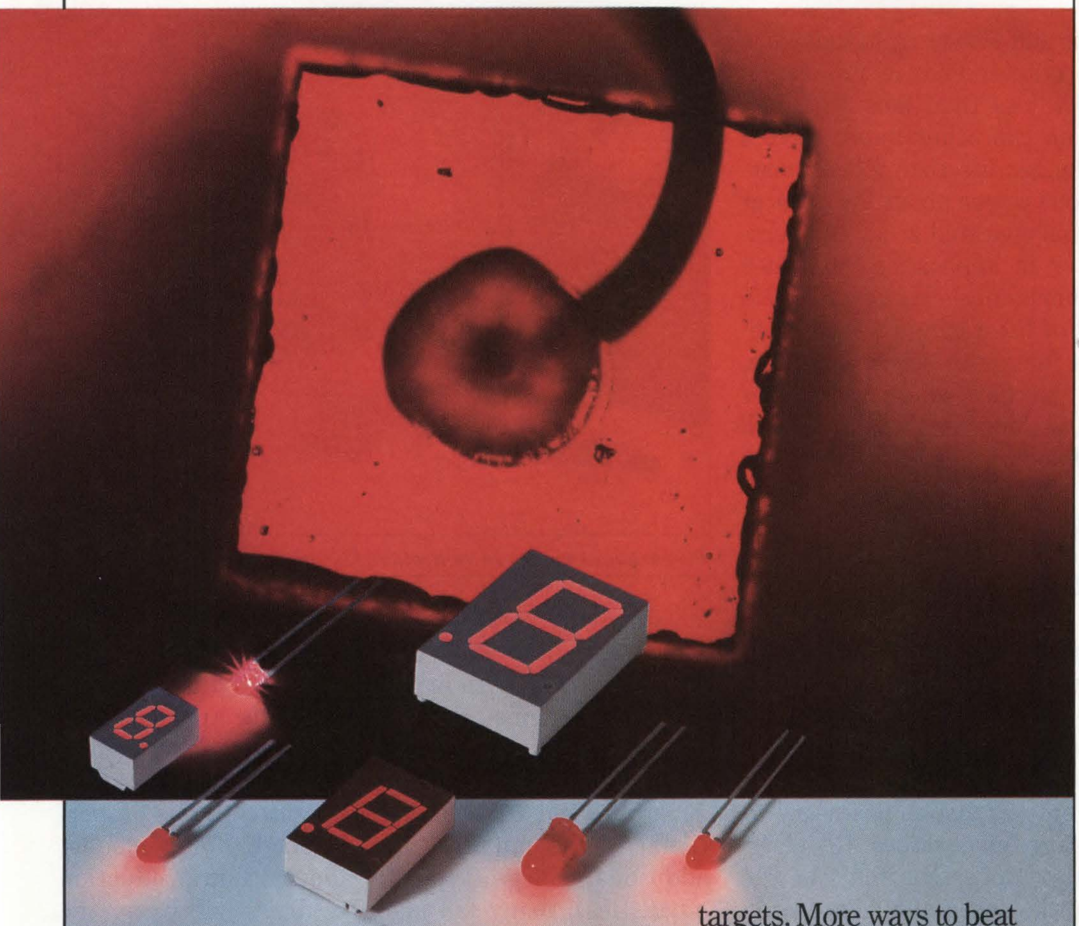
The percentage of small fans and blowers sold that use dc power is growing rapidly. All manufacturers now offer dc-powered—typically 12 or 24V—fans as well as ac-powered ones. Despite slightly higher cost for dc (approximately 20% for the air mover itself, not including costs you incur if you have to increase the capacity of your product's dc power supplies) and occasional concerns about controlling the inverter ripple current that some dc fans inject into the dc supplies, the trend exists for good reason:

Three-bladed fan *(Nidec-Torin)*

Squirrel-cage blower *(Comair Rotron)*

- With dc power, your company can stock a single type of fan for use in products to be powered from any line frequency and any line voltage. With fans operated directly from the ac line, you usually have to install different units in products you ship to 120V and 220V areas. Furthermore, the rotational speed of dc-operated fans is independent of line frequency, so you don't have to select a fan whose rotational speed is too high at 60 Hz in order to have it turn fast enough at 50 Hz.
- You can get your product approved by regulatory bodies more easily if the fans don't connect to the ac line.
- You can control the speed of fans that employ dc motors more easily and over a wider range than you can those employing ac motors; hence you can operate such dc fans at a speed that minimizes mechanical noise.
- Small dc fans do not use mechanical commutators but instead use integral solid-state inverters based on the Hall effect; therefore, their reliability is as good as that of ac fans.
- The efficiency of dc fans is two to four times higher than that of ac fans; therefore, in applications where a fan pressurizes an enclosure, the reduced heat load imposed by the fan can be significant.

You're looking into the heart of the brightest new idea in AlGaAs technology.



Increase the brightness of the LED's you design into your equipment by as much as 300% with HP's new red AlGaAs products. The price? Only 25% more than our standard high-efficiency red devices.

These brighter products are made possible by Hewlett-Packard's new opaque substrate, double hetero-junction (DH) AlGaAs technology. This technology enables us to offer you entirely new families of lamps and displays that are significantly more efficient than single heterojunction (SH) AlGaAs devices.

What does this mean for you? More ways to meet your price/performance targets. More ways to beat the competition. More ways to get the benefits of HP quality control. When you need LED brightness levels in the 50 to 1000 millicandela range...when you have an application that can benefit from displays that draw only 1 mA per segment...or need lamps that perform well at 1 mA, HP has a solution for you.

EDN 121087

Brighten your day with free samples.

Evaluate this significant next step in solid state technology for yourself. To get your free samples, mail this coupon *and your business card* to: Hewlett-Packard, Components Group, 1820 Embarcadero Road, Palo Alto, CA 94303.

CG08707

To order, contact your nearest HP distributor. In the U.S.: Almac Electronics, Hall-Mark, Hamilton/Avnet, or Schweber. In Canada: Hamilton/Avnet or Zentronics Ltd.

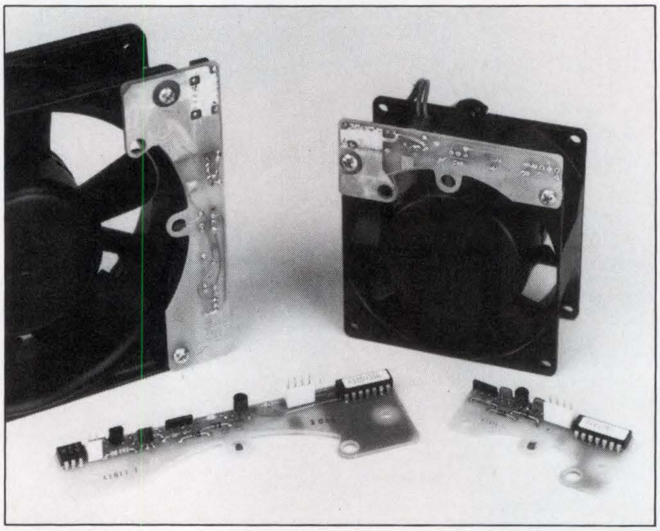
CG08707

HEWLETT PACKARD

Keep in mind the effects of back pressure when calculating fan or blower performance requirements.

The majority of small fans and blowers sold today use sleeve bearings. They are quieter and, in production quantities, cost roughly 8% less than fans with ball bearings. Ball bearings, on the other hand, have a reputation for exhibiting longer life than sleeve bearings. Fan manufacturers don't argue about the greater longevity of ball-bearing fans operated at air temperatures greater than 40°C or in applications in which airflow direction is not horizontal. However, some vendors claim that if end-of-life ratings were established by noise level, then fans with sleeve bearings, operated with horizontal airflow at temperatures below 40°C, last at least as long as those with ball bearings. Indeed, the probability is greater than 90% that a fan with either type of bearing, operated according to its manufacturer's recommendations, will still be running after five years of around-the-clock service. Nevertheless, if you are buying power supplies with integral fans, you might want to pay your vendor a premium to provide units with ball-bearing fans because power supplies—even those with switching regulators—usually run hot.

If you need to minimize the audible noise created by the fans in your product, you can regulate the speed of the fans so that they turn only as fast as necessary to maintain the desired operating temperature. Reducing the fan speed usually also reduces the fan's power dissipation. You can control the speed of a dc-operated fan simply by varying the voltage you apply to it. You can produce the voltage variations either by driving the fan with pulse-width-modulated dc or by using purely linear techniques, although the linear approach can introduce additional hot components into your product.



Prepackaged fan-speed controllers *(Smartfan)*

The solid-state commutators within dc-operated fans generate a pulse train whose repetition rate is proportional to the fan's rotational speed. For a modest additional charge (typically about 5% in production quantities), many fan manufacturers will bring the

For more information . . .

For more information on the CAD tools, fans and blowers, fan-speed controllers, heat sinks, and sockets discussed in this article, circle the appropriate number on the Information Retrieval Service card or contact the following manufacturers directly.

AMP Inc
Harrisburg, PA 17105
(717) 564-0100
TLX 842313
Circle No 692

Comair Rotron
Sawyer Industrial Park
Saugerties, NY 12477
(914) 246-3615
Circle No 693

EBM Industries Inc
525 New Britain Ave
Unionville, CT 06085
(203) 674-1515
Circle No 694

EG&G Wakefield Engineering
60 Audubon Rd
Wakefield, MA 01880
(617) 245-5900
Circle No 695

Indek Corp
2360 Qume Dr, Suite A
San Jose, CA 95131
(408) 432-1199
TLX 176476
Circle No 696

Nidec-Torin Corp
100 Franklin Dr
Torrington, CT 06790
(203) 482-4422
TLX 643963
Circle No 697

Pacific Numerix Inc
4180 La Jolla Village Dr, Suite 265
La Jolla, CA 92037
(619) 587-0500
Circle No 698

Piezo Electric Products Inc
186 Massachusetts Ave
Cambridge, MA 02139
(617) 547-1777
Circle No 699

Smartfan
Box 315
Harvard, MA 01451
(617) 456-8763
Circle No 700

Thermalloy Inc
2021 W Valley View Lane
Dallas, TX 75381
(214) 243-4321
TWX 910-860-5542
Circle No 701

3M-Textool
1001 Fountain Parkway
Grand Prairie, TX 75050
(214) 647-5939
Circle No 702

Torin Engineered Blowers
Fasco Industries Inc
500 Chesterfield Center, Suite 200
St Louis, MO 63017
(314) 532-3505
Circle No 703

pulse train out on a third wire, enabling you to monitor for fan stoppage or to construct a feedback system that controls the fan speed. Of course, controlling fan speed isn't the optimum method of keeping temperatures within predetermined limits. If you place a temperature sensor, such as a thermistor, in the air stream or in contact with a temperature-sensitive component, you can construct a feedback system that controls the temperature by adjusting the fan speed even though you don't measure the speed directly.

Comair Rotron has built single-resistor speed programming into a new line of fans called Therma-Pro V. Fans in this series have four leads: two for power and two for a low-wattage programming resistor, which can be a thermistor. Voltage regulation is part of the design, so you can supply loosely regulated dc and not be concerned about the effect of voltage variations on fan speed. Comair Rotron suggests that the programmable-fan-speed technology can save on inventory costs for its customers even if they don't take advantage of the fans' closed-loop speed-control capability; resistor programmability allows users to stock a single type of fan for several applications, each of which requires different air delivery. The programmable version of the 4.7×4.7×1.25-in. Muffin-DC, which provides maximum free-air delivery of 100 cfm, costs $26.50 in small quantities; the nearest nonprogrammable equivalent sells for $19.10 in similar quantities. The percentage premium you pay for programmability decreases as you increase the quantity you purchase.

Smartfan provides controllers you can use to control the speed of dc- and ac-operated fans and blowers that, themselves, incorporate no special speed-control features. For example, Smartfan's PC-DC Series controllers, intended for fans operating from 12 to 26V dc, attach to fans with mounting-hole spacing of 1.969, 2.812, 3.250, and 4.125 in. An evaluation kit, which includes three controllers, costs $38.44. **EDN**

Acknowledgment

EDN thanks the following people who provided information used in this article: William Hamburgen of Digital Equipment Corp (Palo Alto, CA), Todd Hendrix of Amperex Electronics Inc (Slatersville, RI), Charles Hutchins of Texas Instruments Inc (Houston, TX), and Mali Mahalingam of Motorola Inc (Phoenix, AZ).

Article Interest Quotient (Circle One)
High 473 Medium 474 Low 475

DESIGN NOTES

Number 5 in a series from Linear Technology Corporation *December, 1987*

Temperature Measurement Using the LTC1090/91/92 Series of Data Acquisition Systems

William Rempfer
Guy Hoover

Introduction

Accurate temperature measurement is a difficult and very common problem. Whether recording a temperature, regulating a temperature or modifying a process to accommodate a temperature, the LTC1090 family of data acquisition systems can provide an important link in the chain between the blast furnace temperature and the microcontroller. Features of the LTC1090 family can make temperature measurement easier, cheaper and more accurate.

The features of the LTC1090 family members make them very useful in temperature measurement applications. High DC input resistance and reduced span operation allow direct connection to many standard temperature sensors. Multiplexer options allow one chip to measure up to 8 channels of temperature information. Single supply operation, modest power requirements (~5mW) and serial interfaces make remote location possible. Switching power on and off lowers power consumption (560μW) even more for battery applications. Finally, because few sensors have accuracies as good as 0.1%, the 10-bit resolution and 0.05% accuracy of the LTC1090 family are just right for most temperature sensing applications.

Thermocouple Systems

The circuit of Figure 1 measures exhaust gas temperature in a furnace. The 10-bit LTC1091A gives 0.5°C resolution over a 0°C to 500°C range. The LTC1052 amplifies and filters the thermocouple signal, the LT1025A provides cold junction compensation and the LT1019A provides an accurate reference. The J type thermocouple characteristic is linearized digitally inside the MCU. Linear interpolation between known temperature points spaced 30°C apart introduces less than 0.1°C error. The code for linearizing is available from LTC. The 1024 steps provided by the LTC1091 (24 more than the required 1000) insure 0.5°C resolution even with the thermocouple curvature.

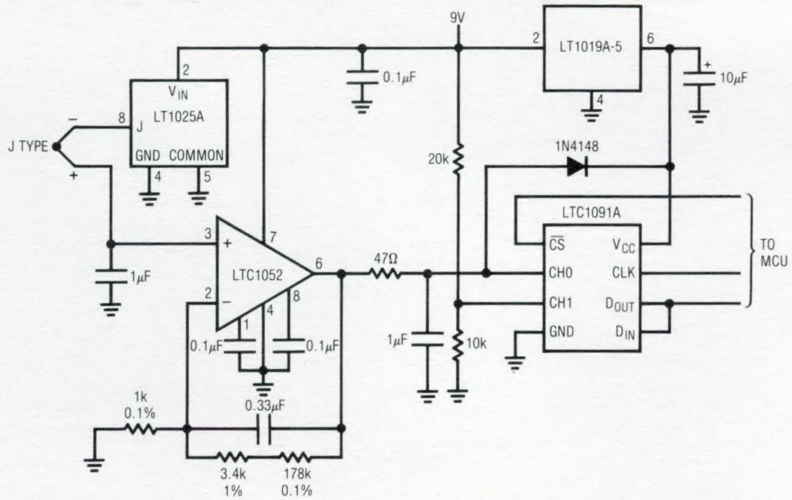


Figure 1. 0°C-500°C Furnace Exhaust Gas Temperature Monitor with Low Supply Detection

Offset error is dominated by the LT1025 cold junction compensator which introduces 0.5°C maximum. Gain error is 0.75°C max because of the 0.1% gain resistors and to a lesser extent the output voltage tolerance of the LT1019A and the gain error of the LTC1091A. It may be reduced by trimming the LT1019A or gain resistors. The LTC1091A keeps linearity better than 0.25°C. The LTC1052's 5µV offset contributes negligible error (0.1°C or less). Combined errors are typically 0.5°C or less. These errors don't include the thermocouple itself. In practice, connection and wire errors of 0.5°C to 1°C are not uncommon. With care, these errors can be kept below 0.5°C.

The 20k/10k divider on CH1 of the LTC1091 provides low supply voltage detection (the LT1019A reference requires a minimum supply of 6.5V to maintain accuracy). Remote location is easy, with data transferred from the MCU to the LTC1091 via the 3 wire serial port.

Thermilinear Networks

Figure 2 shows an 8 channel 0°C to 100°C temperature measurement system with 0.1°C resolution. The high DC input resistance and adjustable span of the LTC1090 allow it to measure the outputs of the YSI thermilinear components directly. Accuracy is limited by the sensor repeatability and precision resistors to 0.25°C.

Sensor input voltage (V_{IN}), not critical because of ratiometric operation, is set to around 1.5V to minimize self heating. The zero scale (COM pin) and full-scale (REF^+ pin) of the LTC1090 are set by the precision resistor string to directly digitize the roughly 0.2V to 1V sensor output. The LT1006 buffers the 10kΩ reference resistance of the LTC1090. 0°C and 100°C correspond to unipolar output codes of 0 and 1000 (decimal), respectively with an overrange of 102.3°C.

Thermistors

A thermistor is a cheaper alternative to thermilinear components in narrower temperature range applications. In Figure 2, CH7 is being used to digitize the output of a 5kΩ thermistor. The resistor shown linearizes the output voltage around the 30°C point. The output remains linear to 0.1°C over a 20°C to 40°C range but gets nonlinear rapidly outside this range. By correcting for the non-linearity in software this range can be extended to 0°C to 60°C. Beyond that, the repeatability error of the thermistor increases above 0.2°C making correction difficult.

Silicon Sensors

Because of its high DC input impedance and reduced span capability, the LTC1090 family can directly measure the output of most industry standard silicon temperature sensors, both voltage and current mode. Popular sensors of this type include the LM134 and AD590 (current output) and silicon diodes.

Figure 3 shows a simple connection between the LTC1092 and industry standard 1µA/°K current output sensors. Resolution is 0.25°C and accuracy is limited by the sensor and resistors. Standard 10mV/°K voltage output sensors can also be connected directly to the LTC1092 input in a similar manner.

For LTC1090/91/92 literature call **800-637-5545.** For help with an application call (408) 432-1900, Ext. 361.

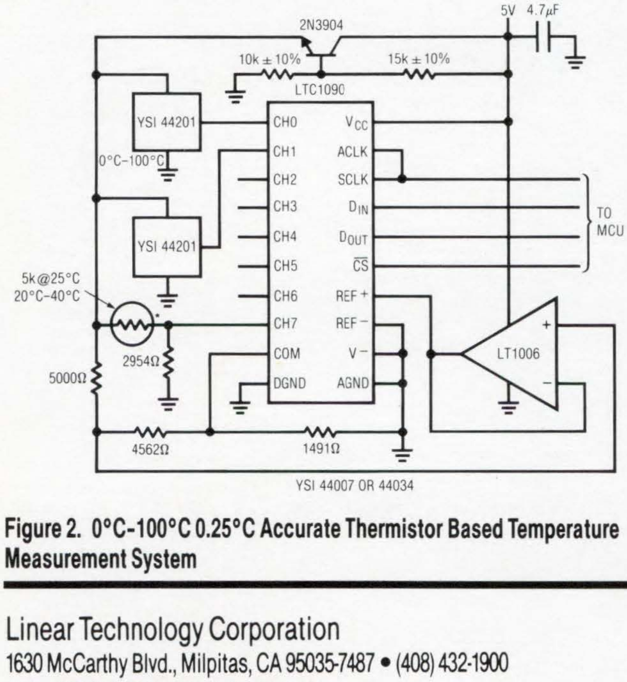


Figure 2. 0°C-100°C 0.25°C Accurate Thermistor Based Temperature Measurement System

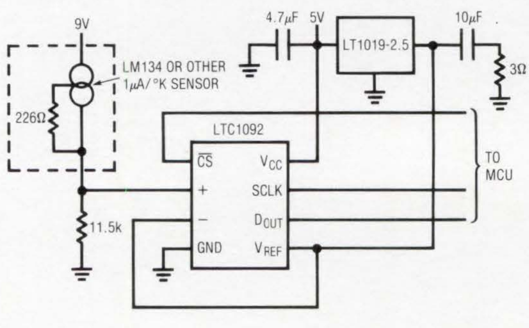


Figure 3. − 55°C to + 125°C Thermometer Using Current Output Silicon Sensors

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7487 • (408) 432-1900
FAX: (408) 434-0507 • TELEX: 499-3977

IM/GP 1287 160K

GET US INVOLVED EARLY ENOUGH AND YOU'LL GET MORE THAN YOU BARGAINED FOR.

Call us anytime and you're in line for hundreds of immediate "off-the-shelf" answers to specific interconnect requirements.

That's what you expect from us. After all, we do have one of the most extensive OEM connector lines in the business.

But give us an "early" call—while you're still designing your product—and see what happens. You get more than you bargained for.

First of all, you get the combined talents of a team of experts made up of specialists in connector technology, quality control, assembly techniques and delivery operations. When they attack an interconnect requirement, they mean business. They look at the total picture. Product design. Assembly operations. Inventory requirements. The bottom line. Everything!

Result? You get a total interconnect solution instead of just a connector. And whether it's an "off-the-shelf" connector or a totally new design, it almost always means lower installed costs. Improved product quality. Reduced inventory requirements and fewer inspection requirements. Little things like that can have a big influence on your bottom line.

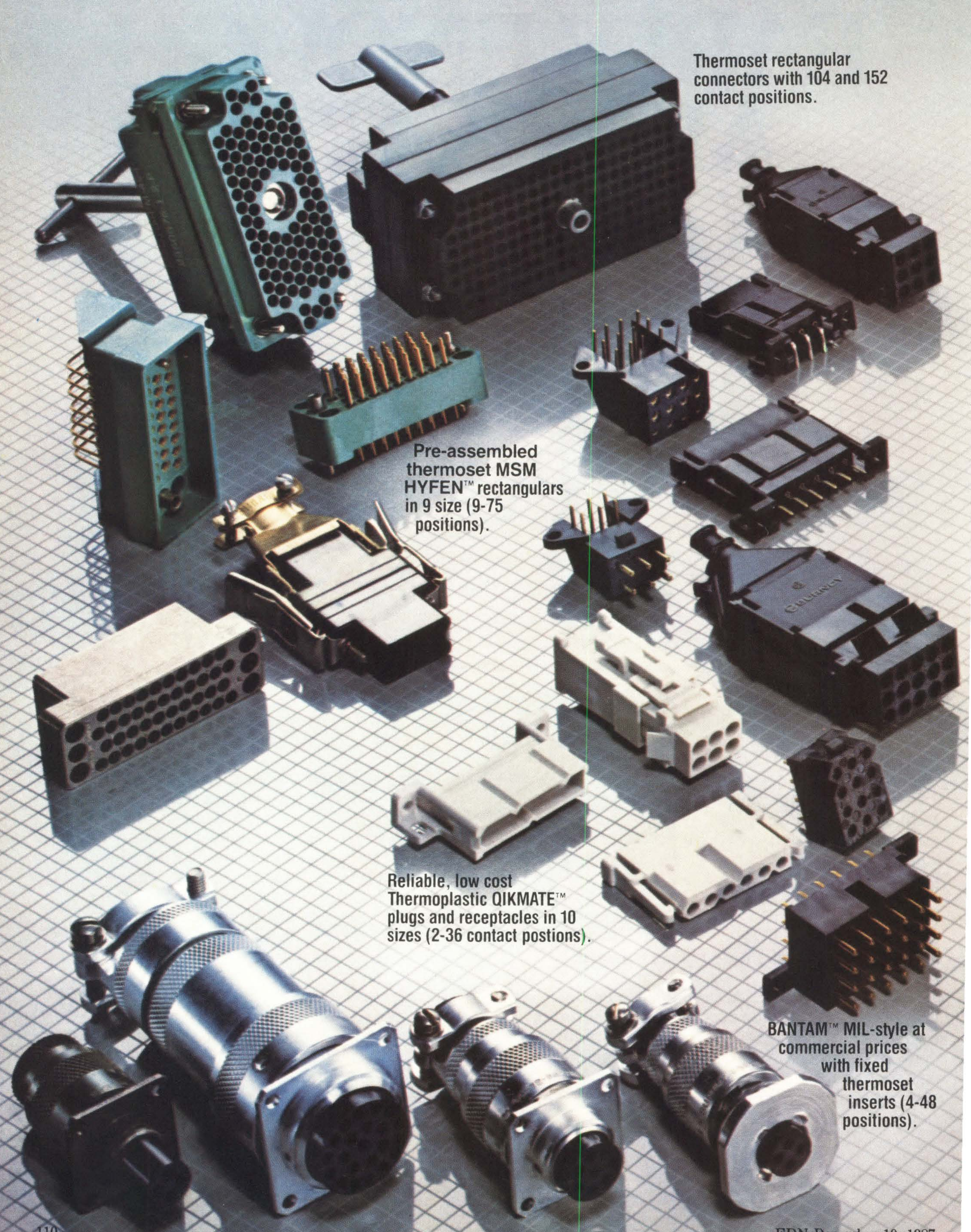
So let's get involved. Early. Make us a part of your design team—and you'll get more than you bargained for. The nice thing about it is that it may actually cost you less in the final analysis. Just call: 1-800-633-0034 (Ext. 25), in Rhode Island: 401-751-7450. See how fast we respond.

BURNDY

Offices in principal cities throughout the United States

VALUE BY DESIGN

The one interconnect system



you never outgrow!

TrimTrio™

Single contact system satisfies over 100,000 interconnect variations.

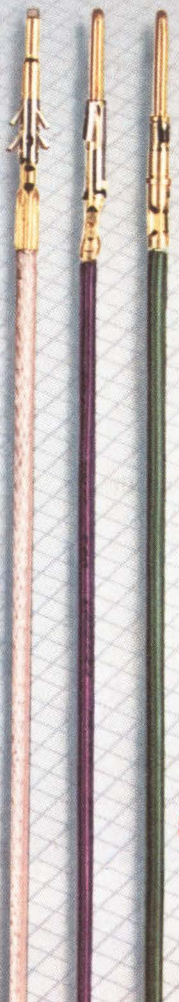
Designed for maximum flexibility, proven in millions of applications—Burndy's TRIM-TRIO contact/connector family lets you meet all your application needs—no matter how often they change—without changing your contact system! Your tooling! Or your installation procedures!

You simply select the contact/housing combination that best satisfies your current needs. Then, as needs change, you just change the combinations. Nothing else! Not your tooling! Not your operations. Nothing! And no matter what combination you choose—or how many—you still enjoy all the advantages of standardization. Which means faster, more economical assembly and greater quality control—all along the line.

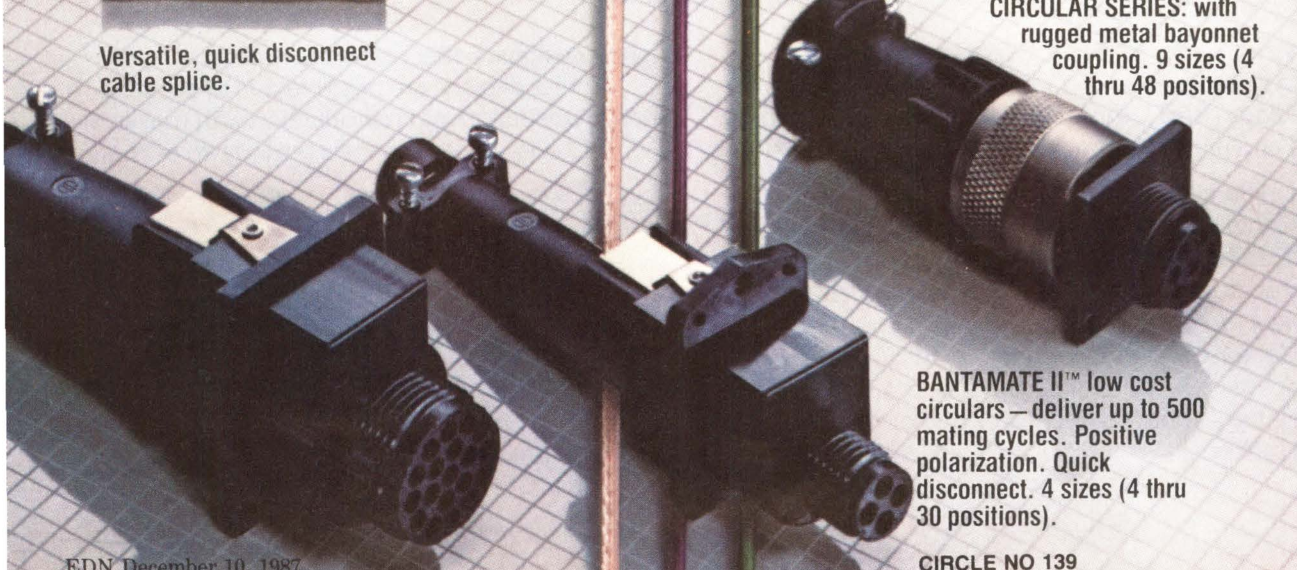
So make it easy on yourself. Standardize on the proven reliability of the Burndy TRIM-TRIO interconnect system. The one system that offers you thousands of variations. The one system you'll never outgrow. And to make things easier, all variations of the TRIM-TRIO family are available—off the shelf—at your local Burndy Distributor. For details, write: Burndy Corporation, TRIM-TRIO Product Manager, Norwalk, CT 06856. Or call: 203-852-8711.

THE TRIM-TRIO CONTACTS SYSTEM:
Closed barrel Machined Contacts for both crimp and wire-wrap power applications up to 13 amps. **Open barrel Precision Formed** contacts for power and signal applications. **Sub-miniature Coax** (one-piece or 2-piece) for coaxial cable, shielded conductors and twisted pairs. These three basic types (with variations for different conductors, contact platings and termination options) make up the TRIM-TRIO contact system. All can be intermixed in any of scores of Burndy connector housings designed around this contact system.

BURNDY
Offices in principal cities throughout the United States.



Versatile, quick disconnect cable splice.



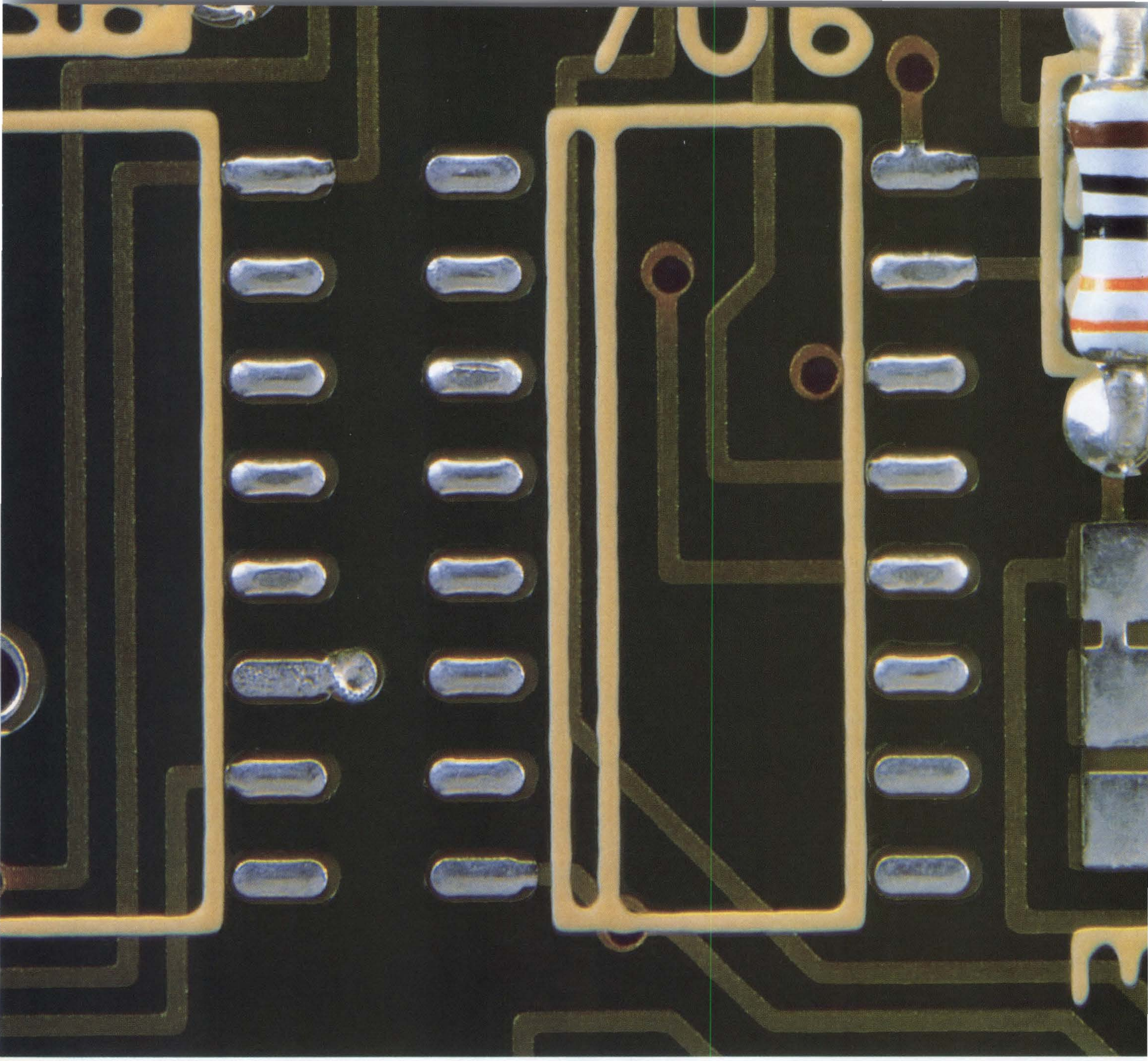
METALOK™ THERMOPLASTIC CIRCULAR SERIES: with rugged metal bayonnet coupling. 9 sizes (4 thru 48 positons).

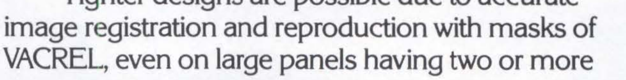
BANTAMATE II™ low cost circulars—deliver up to 500 mating cycles. Positive polarization. Quick disconnect. 4 sizes (4 thru 30 positions).

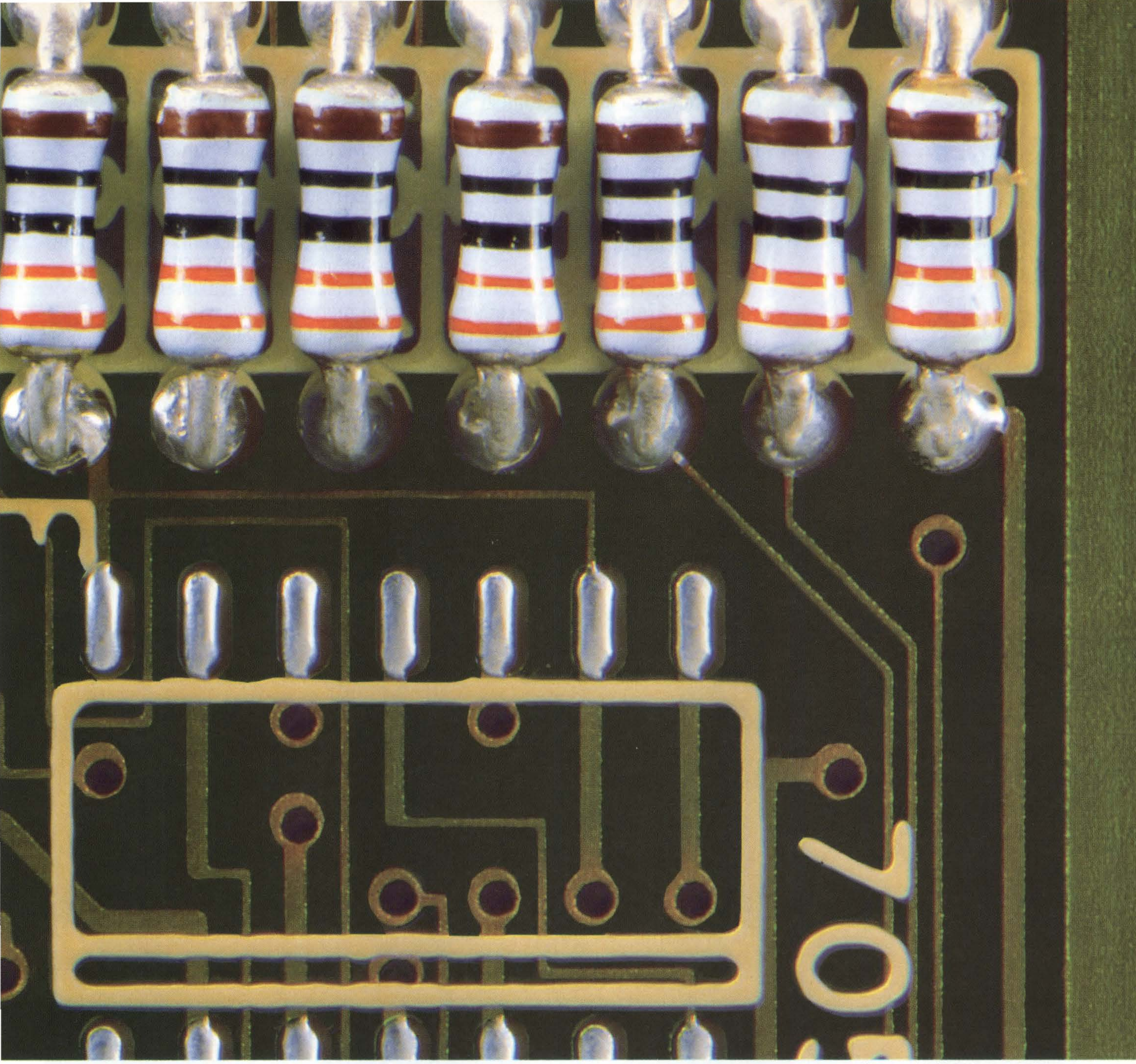
BURNDY CONNECTS

INTERNATIONAL SALES AND MANUFACTURING BRUSSELS, BARCELONA, PARIS, ROTTERDAM, STOCKHOLM, STUTTGART, TURIN, ZURICH, ST. ALBANS (ENG.), TORONTO, SYDNEY, TOKYO, MEXICO CITY, SAO PAULO

CIRCLE NO 139







Photograph is 13.47 times original size.

SEE HOW YOUR CONNECTOR MEASURES UP TO OURS.

If your present I/O connector can completely cover the new Fujitsu Series 230 pictured on this page, you've got a large problem.

You're wasting valuable board space.

Space you could use to cram in a few extra components. Or space you could eliminate entirely to reduce manufacturing costs.

Fact is, the Series 230's remarkably compact 1.27mm (.50″) pitch and remarkably efficient 4-row, zig-zag terminal layout pack provides all the pinout you're used to in 40% less real estate.

Impressive.

But that's just one small accomplishment. The big news is that you don't have to give up full-size connector convenience or reliability.

Every Series 230 connector includes features like a standard "D" shape polarization header, EMI shield, plug/socket lock and minimum-pressure insertion/withdrawal fitting. All with no extra size.

So before you run out of space in your next compact or portable system design, call us at **(408) 562-1000**. Or for a complete list of local distributors and representatives write to Fujitsu Component of America, Inc., 3320 Scott Boulevard, Santa Clara, California, 95054-3197.

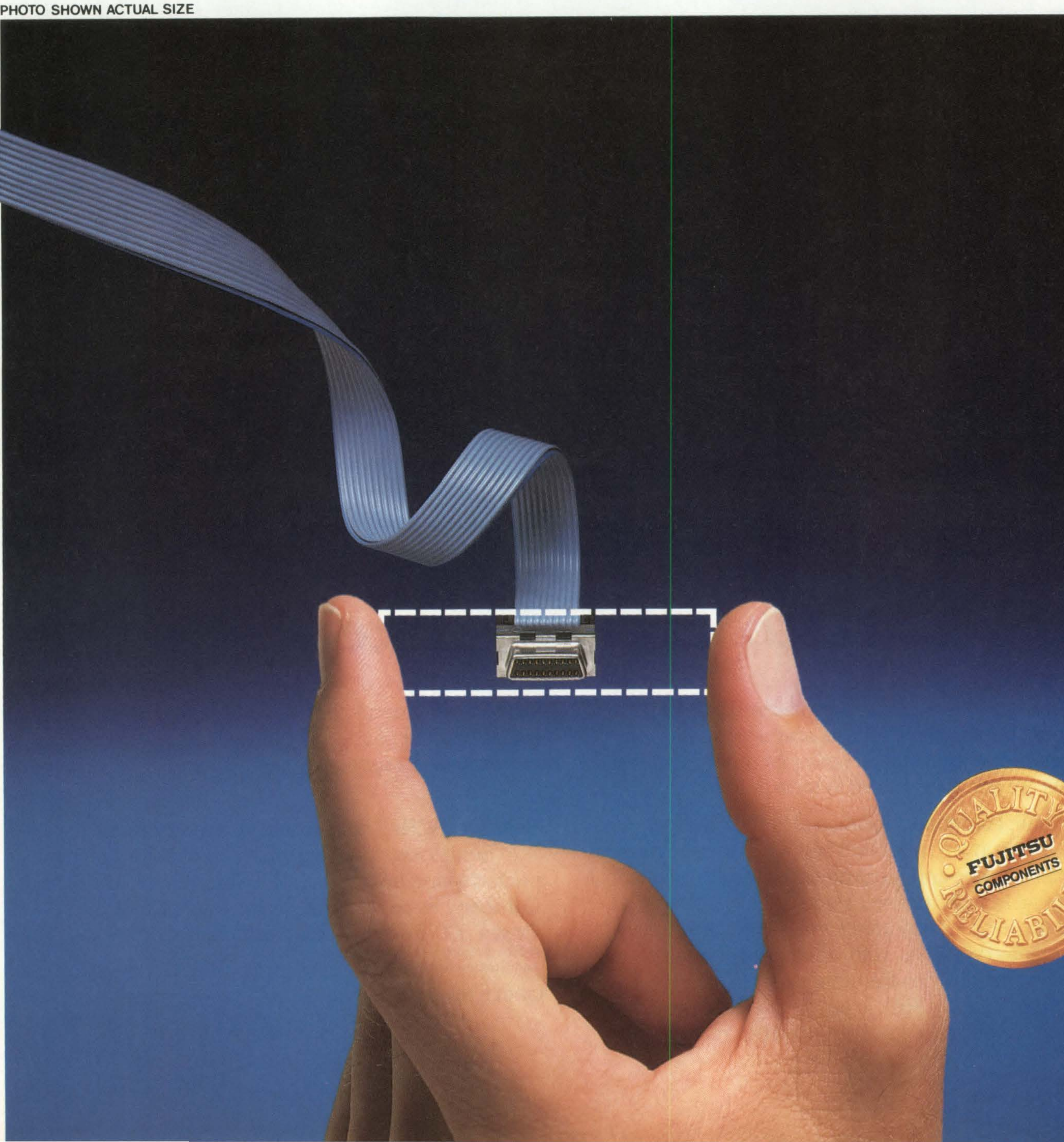
We'll keep you from coming up short.

CIRCLE NO 137

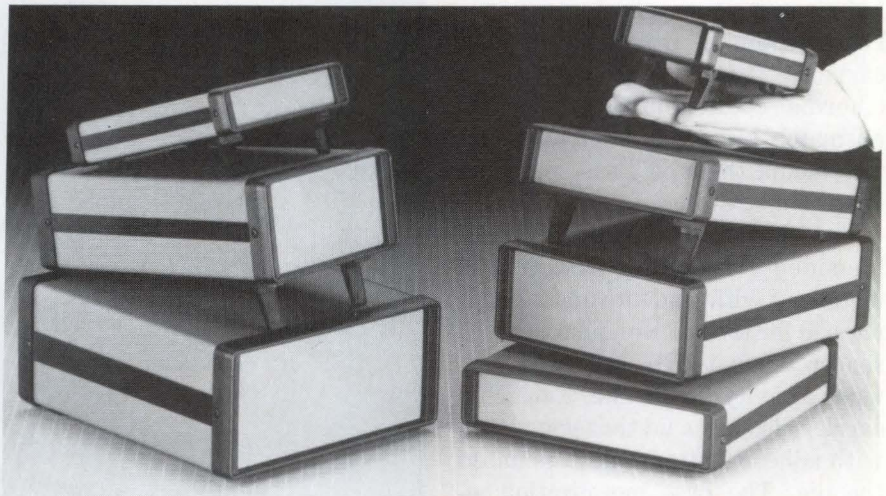
FUJITSU

FUJITSU
COMPONENT OF AMERICA, INC.

PHOTO SHOWN ACTUAL SIZE



Aluminum enclosures help to dissipate heat as well as provide EMI shielding



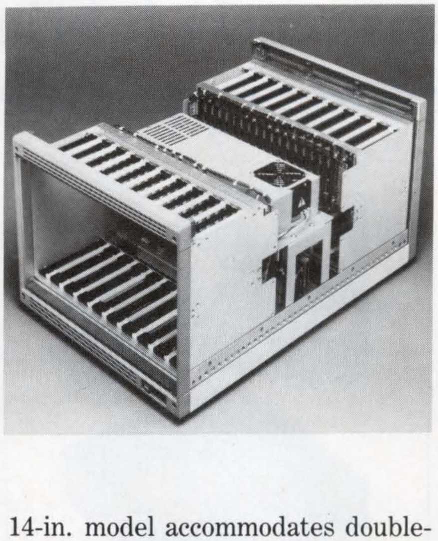
The SL Series consists of seven small aluminum enclosures that vary in size from 3.5×1×3.7 to 7.75×3×8 in. The enclosures are built from flat, removable aluminum panels that you can easily punch, silkscreen, or laminate. The extruded aluminum sides have a variety of slots that accept pc boards. You can place the pc boards in various locations within the enclosures. You can also remove the top and bottom covers to obtain access to the subassemblies you place inside.

The enclosures offer such options as a mounting bracket, belt clip, pistol grip, and chassis. The injection-molded polycarbonate bezels conceal the front- and rear-panel screws. The enclosures also feature pull-down, nonskid feet at no extra charge. The SL Series ranges in price from $21 to $26.

Tracewell Enclosures, 7032 Worthington Galena Rd, Columbus, OH 43085. Phone (800) 848-4525; in OH, (614) 846-6175.

Circle No 715

Enclosures for VME Bus and Multibus II are completely wired



The MaxChassis line of enclosures consists of 50 models: 34 for the VME Bus and 16 for the Multibus II. Each chassis includes a backplane and wiring appropriate for the bus system you choose. The enclosure comes with one or two card cages, a power supply, a fan, cabling, and wiring-control switches. Each card cage has 20 slots. The enclosures are available with either 20- or 26-in. depths. The 20-in. model can house cards as long as 280 mm; the 26-in. version holds cards as long as 400 mm.

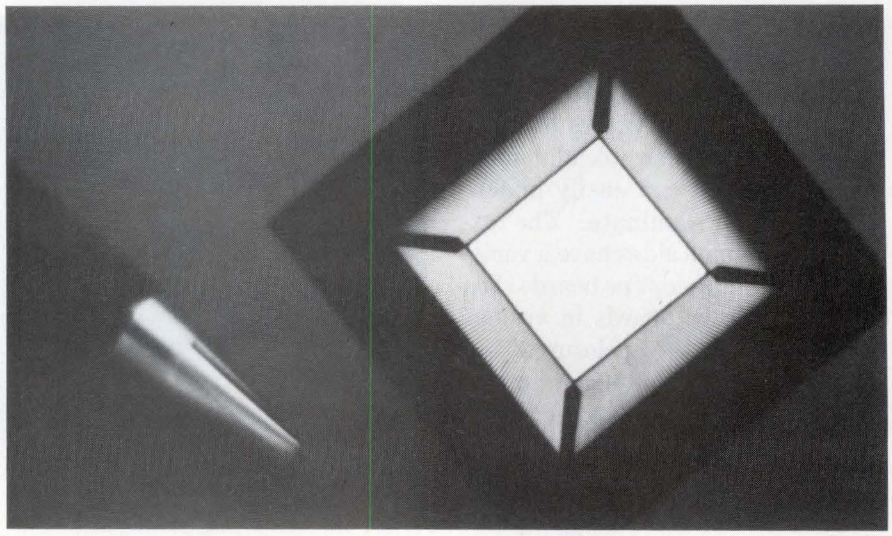
The dual-card-cage enclosure holds cards as long as 220 mm; you mount the cards in the front and rear of the enclosure. The 8.75-in. MaxChassis houses single-height cards while providing an air-intake and exhaust area for cooling; the 14-in. model accommodates double-height cards. The company plans a 19.25-in. enclosure that will suit Futurebus, Nubus, and custom applications.

The enclosures come completely wired and include ac and dc power connections, fans, a system-failure indicator, an ac-power-failure indicator, and a system-reset function. The MaxChassis comes with either a 400 or a 600W power supply. When you purchase two card cages for the enclosure, the vendor provides two 400W power supplies. The 400W supplies provide 60A at 5V and three channels of ±12V at 8A. Each of these supplies includes its own internal fuse in addition to the fuse that's part of the enclosure. Each supply also includes an internal fan. The MaxChassis costs $3295 to $3929, depending on configuration.

Scanbe, Box 4159, El Monte, CA 91731. Phone (818) 579-2300. TWX 910-587-3437.

Circle No 717

Glass-epoxy leadless chip carriers eliminate thermal-expansion problems



Fabricated from glass-epoxy pc-board laminate, Epic leadless chip carriers (LCCs) eliminate TCE (thermal coefficient of expansion) mismatch problems when you surface-mount them on glass-epoxy pc-board substrates.

The chip carriers feature a double-sided glass-epoxy base that is metalized with leadouts and a bonding pad for the semiconductor die. A spacer laminated to the base provides a cavity for the die. Each chip carrier also has a lid that you attach with adhesive after you've mounted the die. The base metalization allows you to use standard wire-bonding techniques between the die and the carrier. You attach the die to the chip carrier with thermal epoxy that is loaded with metal to improve its thermal resistance. The standard package's total thermal resistance is around 92°C/W; carriers having a thermal resistance as low as 4°C/W are available as an option.

The leadout metalizations have a typical resistance of $<0.1\Omega$ and an inductance of <5 nH. Combined with a lead-to-lead capacitance of approximately 0.2 pF, these parameters provide lead-induced propagation delays as low as 25 psec. Epic chip carriers are available in versions with 8 to 256 leadouts. A typical 16-leadout carrier costs £0.20 (1000), and a typical 84-leadout carrier costs between £1.50 and £2 (1000).

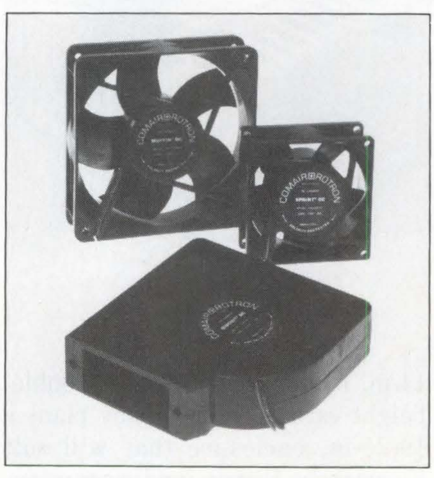
Tectonic Products Ltd, Oxford Rd, Wokingham, Berks RG11 2YD, UK. Phone (0734) 782340. TLX 847569.

Circle No 716

Blowers use permanently lubricated ball bearings for long operating life

The Muffin DC, Sprint DC, Biscuit DC, Patriot DC, and Major DC are precision-aligned blowers. The latest models of these fans have permanently lubricated ball bearings that give them an operating life of 85,000 hours at 40°C and allow them to operate in temperatures as high as 72°C.

The fans take advantage of the manufacturer's ThermaPro-V technology, which allows you to program the fans, regulate their voltage, and thermally control their speed. The blowers' current-limiting features lower the start-up and rotor currents.

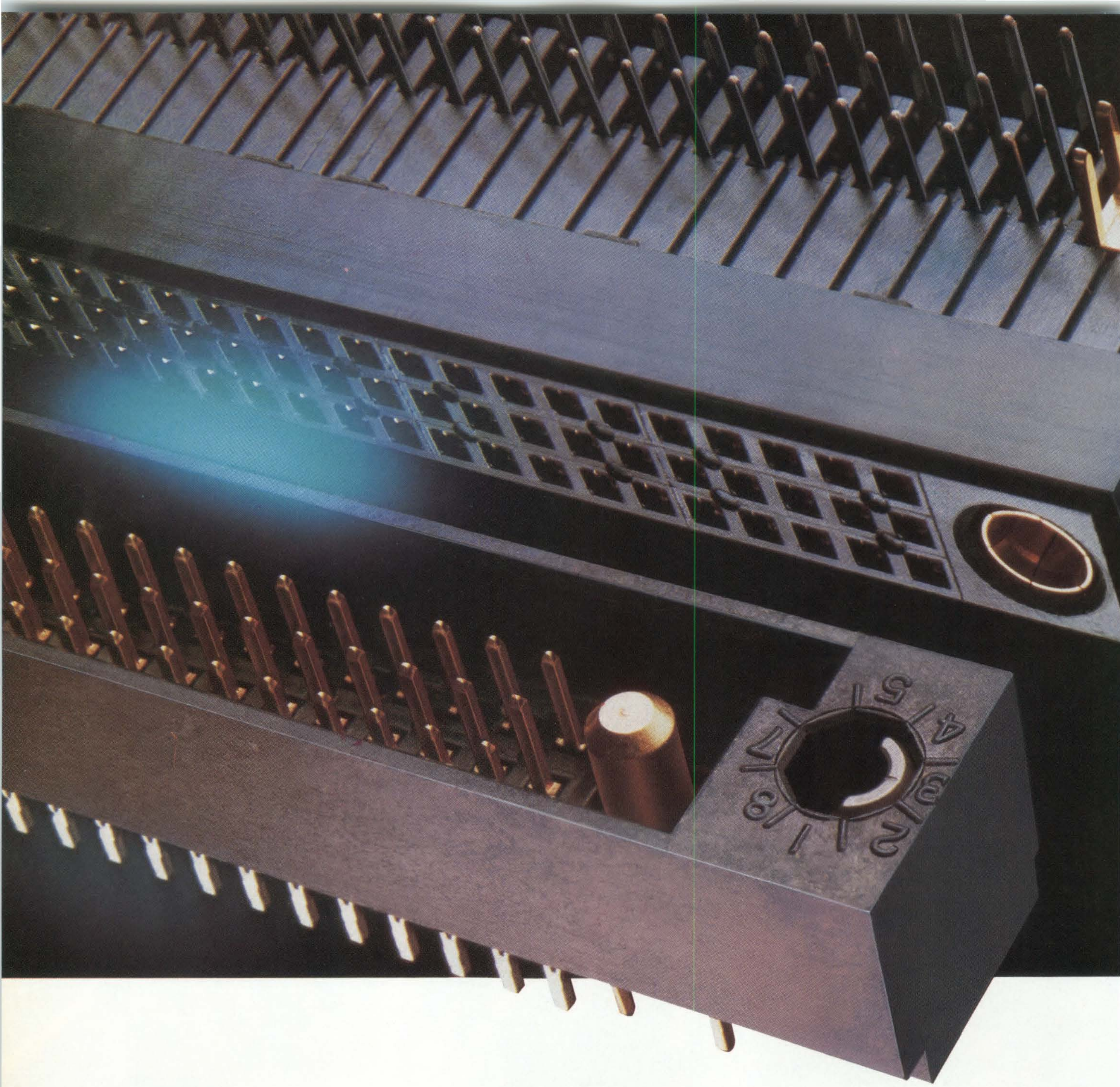


The ThermaPro-V controls internal temperature variations automatically; the fan's motor speed is controlled by a temperature-sensitive resistor that provides continuous temperature monitoring. Because the fan's speed is directly related to temperature, you can use a much smaller fan than your system would otherwise require. Muffin DC, \$19.10; Sprint DC, \$21.60; Biscuit DC, \$38.75. With thermal speed control, the Patriot DC and Major DC cost \$73.61 and \$75.40, respectively.

Comair Rotron, North St, Saugerties, NY 12477. Phone (914) 246-3615. TWX 510-247-1941.

Circle No 718


It doesn't take much
to make an impression on our
new mass airflow sensor.



Two-piece connections for every itinerary.

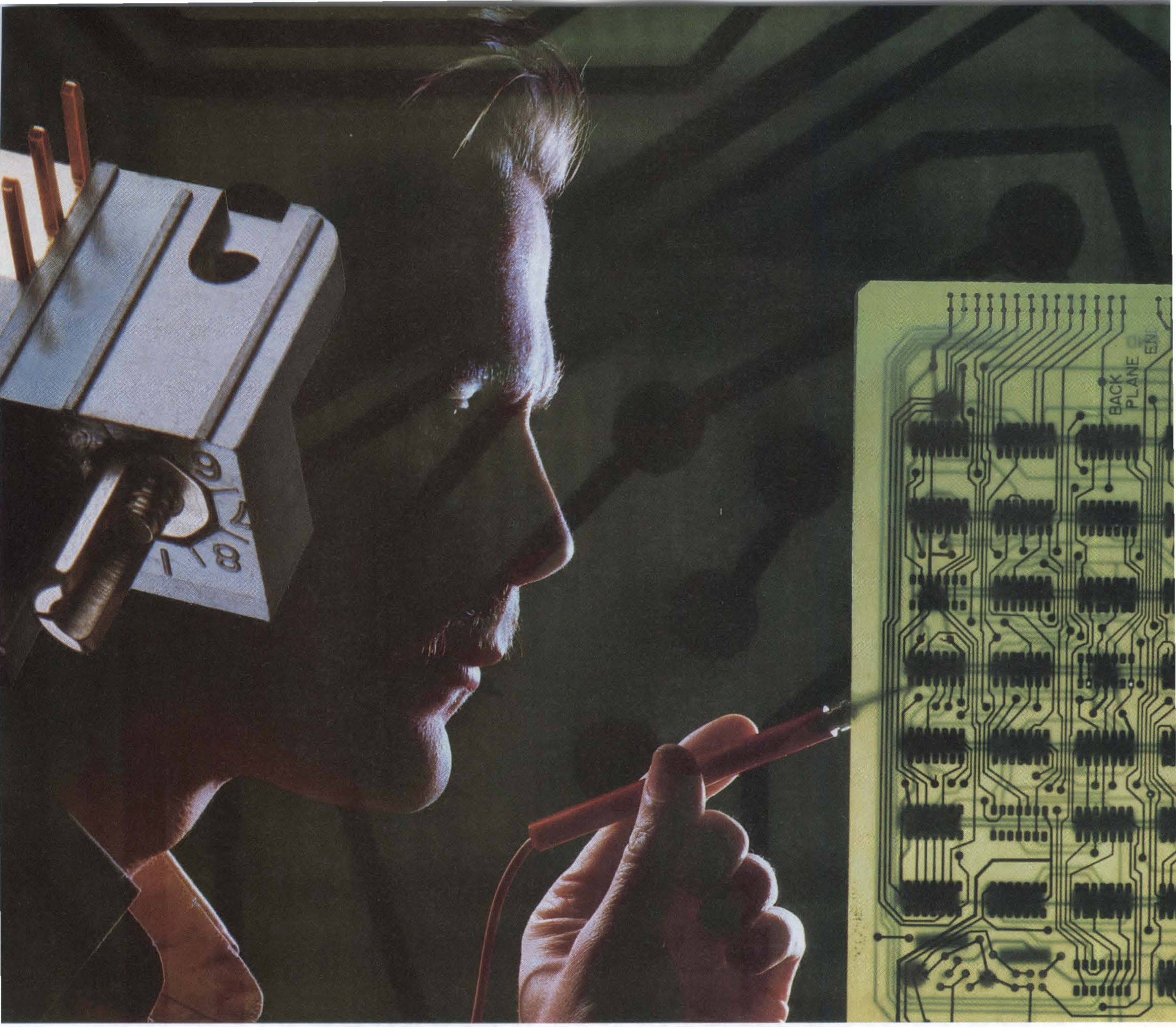
Get on board now with the world's biggest selection.

Name your application—our two-piece connector schedule covers every stop on the map.

Need maximum reliability and flexibility in a medium-to-high pin-count application? AMP Box Contact Connectors and high-density AMP-HDI Connectors feature four-way contact on every pin. Very reliable. Very forgiving of pin angle during mating and unmating. And both also offer power and coax contacts—big design help in those crowded little corners.

Headed for design-wide compatibility? AMPMODU two-piece connectors are part of a complete, cost-saving, modular system, featuring shortened signal paths for high-speed designs. Or, go Eurocard. The European standard for over 10 years, now used everywhere. And now available everywhere—from AMP.

Whatever your destination, AMP has the two-piece connectors you need, engineered for quality, reliability, and—especially with our compliant-pin option—increased productivity.


BACK PLANE

How To Keep Your Messages From Being Repeated All Over The Place.

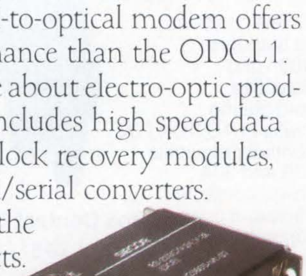
If your data communications network spans up to three kilometers, nothing will transmit information more reliably than Siecor's ODCL1—our optical digital communications link. Because unlike copper cable, our multimode fiber optic link lets messages go the distance without using repeaters. And since repeaters can compromise signal clarity, the link is superior for delivering data intact. So you don't have to re-send information.

Furthermore, the ODCL1 has a transmission rate from DC up to 2 MBd—many times faster than coaxial transmissions. And the ODCL1 is economical since it provides full duplex asynchronous transmission over one fiber optic duplex cable—cable that gives the greatest possible security.

In addition, the link can be used for RS232 DCE or DTE devices. And we offer it for RS422, RS423 and TTL standards, too, with each providing either SMA or DIN optical connectors.

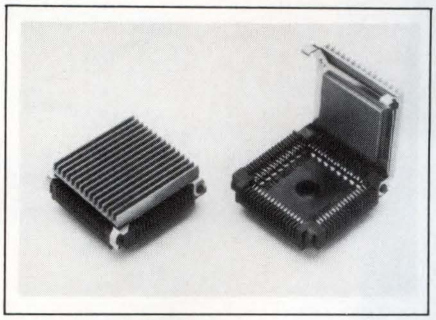
Fact is, no other electrical-to-optical modem offers faster, more reliable performance than the ODCL1. Because no one knows more about electro-optic products than Siecor. Our line includes high speed data links, fiber optic switches, clock recovery modules, clock oscillators and parallel/serial converters.

So find out more about the ODCL1 and all our products. Write Siecor Corporation, Electro-Optic Products, PO Box 13625, Research Triangle Park, NC 27709-3625. Or call 919 549-6571.



SIECOR

Hardware and Interconnect Devices

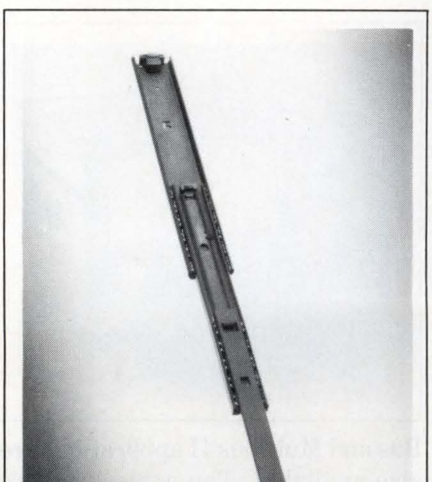


LCC SOCKETS

The IC75 Series sockets are used with 68-pin LCC devices. An aluminum heat sink is optional. Two versions accommodate either a 68-pin JEDEC type A or a 68-lead JEDEC type B ceramic LCC. The sockets feature polyphenylene sulfide bodies, stainless-steel covers, and beryllium copper with gold-over-nickel-plating for the contact material. The maximum operating temperature is 150°C. $4.01 (1000). Delivery, stock to six weeks ARO.

Nepenthe, 2471 E Bayshore Rd, Palo Alto, CA 94303. Phone (800) 637-3684; in CA, (415) 856-9332. TWX 910-373-2060.

Circle No 526



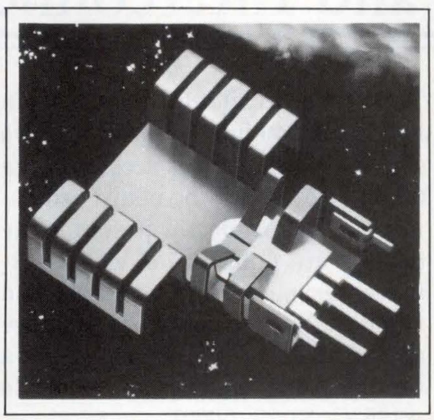
STEEL SLIDES

The 475/476 compact steel slide series accommodates the multiple-load ratings required in both low-cycle, high-load industrial applications and in high-cycle, low-load furniture environments. The series features a ball-bearing design in a ¾×2¼-in. configuration. Load ratings for the series vary from 175 lbs in high-cycle applications to 250 lbs in low-cycle applications. Slide lengths of 12 to 30 in., with travels of 13 and 31 in. respectively, are available.

The slides incorporate cushion stops at both the open and closed positions. A closed position detent holds the drawer of the chassis closed, and sequential slide action enhances slide life. Optional locking provisions are offered on some versions. The slides are fabricated of C1010 cold-rolled steel for strength, and they feature a full complement of ball bearings. $5 (OEM qty). Delivery, eight to 12 weeks ARO.

Jonathan Mfg Corp, Box 3J, Fullerton, CA 92634. Phone (714) 526-4651. TWX 910-592-1241.

Circle No 525

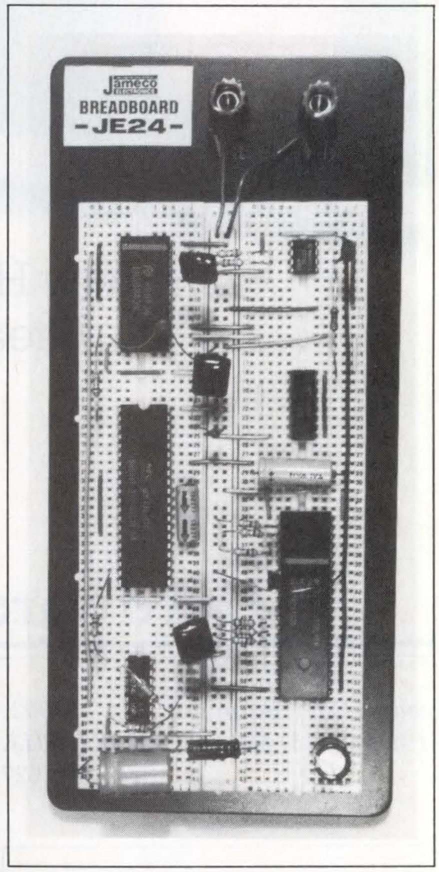


HEAT SINK

The 5922B heat sink features spring-action clips that permit quick mounting to TO-218 semiconductor devices. Because of the tight metal-to-metal contact provided by its spring-clip mounting, the black heat sink minimizes the problem of air gaps between the semiconductor device and the heat sink. Such air gaps decrease the efficiency of the device's thermal transfer. The device's dual-channel fins produce additional surface area for air circulation and heat removal. With an input of 8W, the 5922 has a thermal resistance of 8.75°C/W under conditions of natural convection. $0.43 (1000).

Aavid Engineering Inc, Box 400, Laconia, NH 03247. Phone (603) 528-3400.

Circle No 528



BREADBOARDS

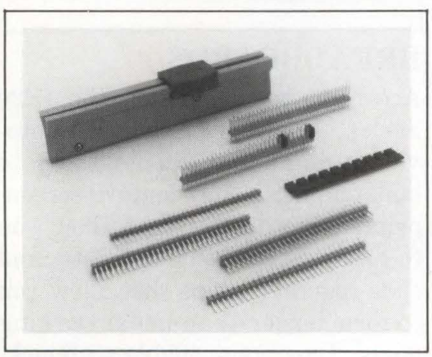
According to the vendor, the JE20 Series solderless breadboards provide a quick and efficient way to build circuits. They feature screen-printed coordinates that allow you to easily locate contact points, and slide-together strips that allow you to form larger-than-usual working areas. They are available with nickel-plated spring clips, which can withstand over 5000 insertion cycles; they are covered by a lifetime warranty. From $2.49 for a 100-contact breadboard strip to $39.95 for a 3220-contact board with an aluminum grounding plate and four binding posts.

Jameco Electronics, 1355 Shore-

Hardware and Interconnect Devices

way Rd, Belmont, CA 94002. Phone (415) 592-8097. TLX 176043.

Circle No 527



HEADERS

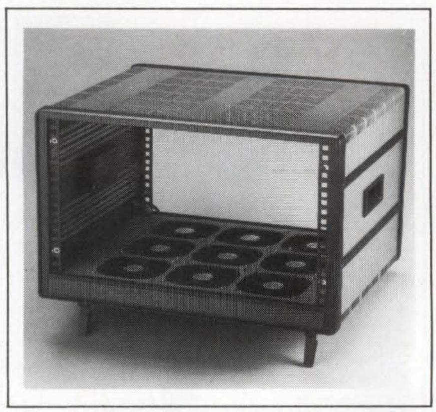
The 609-xxxxx-x family of pin-strip headers provide an interface to Ansley female sockets, Flexpac female socket systems, and other connector interfaces. The devices are available in single- or double-row versions and can be cleaned and separated at any desired length. They are available in two pin lengths: 0.240 in. and 0.318 in. Two solder-tail pin lengths accommodate 0.062- to 0.125-in.-board thicknesses. The connector posts for the devices are 0.025-in^2 on a 0.1×0.1-in. centerline spacing. Straight- and right-angle post configurations are also available. The headers have a temperature rating of −55 to +125°C. $1.29 (5000).

Thomas & Betts Corp, 920 Route 202, Raritan, NJ 08869. Phone (201) 469-4000.

Circle No 529

ENCLOSURES

The E Series enclosures feature a built-in fan-tray compartment that helps reduce design and fabrication costs. You can use them for 3U and 6U 19-in. subrack applications. Complete companion subracks and accessories that accommodate VME



Bus and Multibus II applications are also available. The enclosures are constructed of aluminum extrusions, sheet metal, and die-cast bezels. Retractable feet with nonskid rubber inserts are standard features. You can specify that from one to nine fans be installed in a variety of locations within the enclosures. A 3M filter media is also available in a variety of six densities to serve in different applications. The filters

Hardware and Interconnect Devices

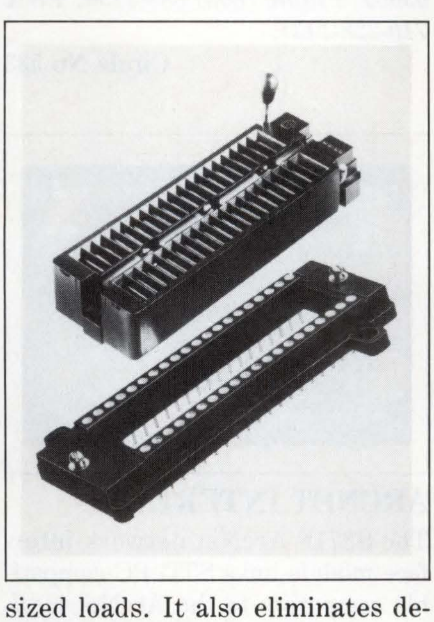
are available in snap-in modules. From $160 to $170.

Tracewell Enclosures, 7032 Worthington Galena Rd, Columbus, OH 43085. Phone (800) 848-4525; in OH, (614) 846-6175.

Circle No 530

TEST SOCKETS

This line of sockets for either test or burn-in applications is available with 24, 28, 32, 40, or 48 pins. The sockets' contacts are tin- or gold-plated beryllium copper for temperatures to 105°C (tin) or 150°C (gold) and for 200°C (50 μm NiBo over CuNiSn spinodal alloy). The sockets' broad contact area allows devices on 0.3-, 0.4-, and 0.6-in. centers to be tested in the same socket. The contacts are normally closed. This configuration provides consistent force of contact and prevents contact deformation due to over-



sized loads. It also eliminates dependence on plastic to sustain contact.

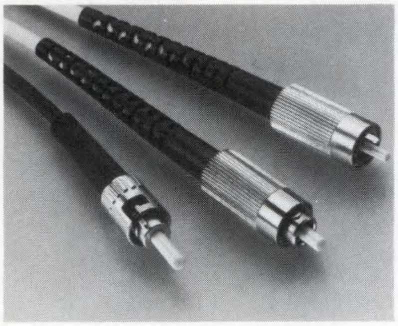
The socket bodies are UL94VO-rated plastic, with 1000-MΩ min insulation resistance, 1000V ac min dielectric withstanding voltage, and a 1A contact rating. The devices can sustain more than 50,000 insertion cycles, and the socket contacts accept leads that are from 0.015- to 0.045-in. wide. The sockets can be mounted directly on a pc board on either 0.3- or 0.6-in. DIP hole patterns. A 24-pin tin-plated socket, $3.87; a 24-pin gold-collet, tin-shell receptacle, $3.62 (100).

Aries Electronics Inc, Box 130, Frenchtown, NJ 08825. Phone (201) 996-6841

Circle No 531

F-O CONNECTORS

Optimate ceramic-ferrule, single-mode connectors offer physical contact (PC) tip geometry to minimize connector loss and back reflections. The insertion loss averages <0.3 dB; the return loss averages −36 dB. The 2.5-mm threaded, 2.5-mm bayonet, and 2.0-mm threaded



styles are compatible, respectively, with most FC/PC, ST/PC, and D4/PC types. They provide accurate and repeatable fiber-optic termination for 125-μm single-mode fiber in either a 2.5- or a 3.0-mm-diameter cable jacket.

The threaded styles are spring loaded. The spring loading and a cable-strength member crimp absorb cable stresses, thus maintaining undisturbed optical transmission during cable use. All three styles use a precision ceramic ferrule to maintain low insertion loss. These enhanced fiber-optic connectors are available as field-installable kits for fast termination, using the vendor's hand tools or as pigtails, jumpers, and hybrid assemblies. From $27 to $30 (100).

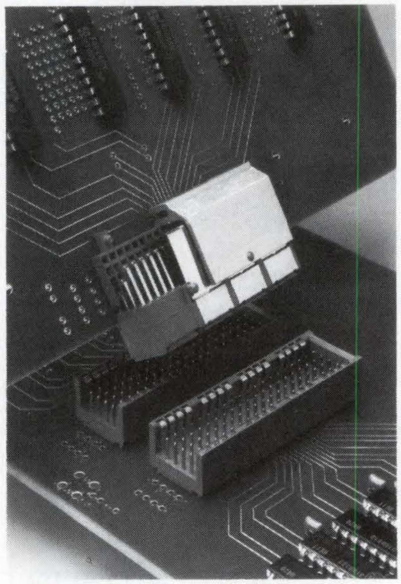
AMP Inc, Box 3608, Harrisburg, PA 17105. Phone (717) 564-0100.

Circle No 532

BACKPLANE

The High Density Plus Two line of modular-backplane and daughter-board connectors is a 6-row version of the manufacturer's High Density Plus family. Each connector module, no wider than a conventional 4-row connector and measuring no more than 2-in. long, contains four rows of signal contacts on a 0.1-in. grid plus two additional rows of low-inductance contacts placed on the edges of the insulator housing. These additional contacts are useful for ground or power applications, and eliminate the use of signal pins for power and ground routing.

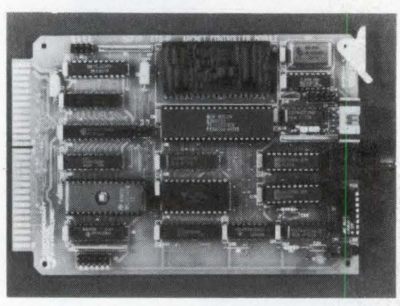
The modular continuous-grid architecture of the connectors allows



you to combine individual modules end to end in any high-density configuration. In addition to the standard signal modules, the system provides other modules for power distribution, polarizing, and guidance. From $0.20 to $0.26 per mated signal-contact pair. Delivery, eight to 12 weeks ARO.

Teradyne Connection Systems Inc, 44 Simon St, Nashua, NH 03060. Phone (603) 889-5156. TWX 710-228-1431.

Circle No 533

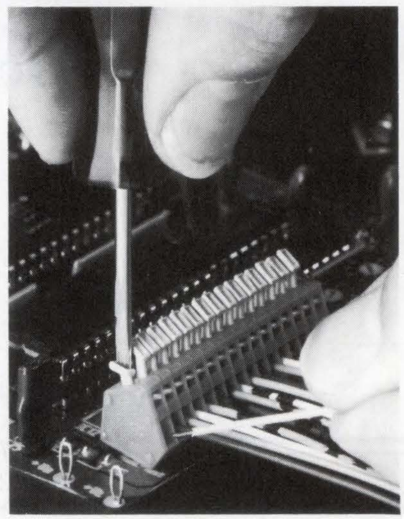


ARCNET INTERFACE

The S871P ArcNet network-interface module links STD PC-compatible computers to the ArcNet local-area network. It features an activity LED, which indicates proper network operation and remains lighted while the token is passed through the network. The device is also compatible with standard PC-network operating systems such as Novell's Netware and provides a low-impedance or fiber-optic output. The design is implemented in CMOS and features a 2k-byte data-packet buffer, which is memory-mapped. The control status ports are I/O mapped. The network provides a 2.5M-bit/sec token-passing protocol. $495.

Contemporary Control Systems Inc, 2500 Wisconsin Ave, Downers Grove, IL 60515. Phone (312) 963-7070. TLX 314990.

Circle No 534



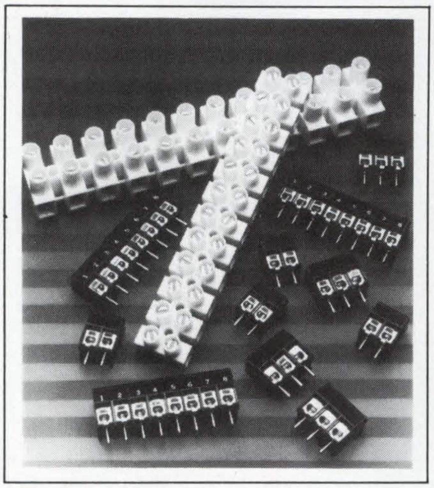
TERMINAL STRIPS

The 223 Series terminal strips provide a high-density printed-circuit-solderable terminal strip on 0.1-in. or 2.5-mm pin centers. Because they are modular, they can be quickly assembled to any desired length. The strips also incorporate an integral actuating lever that's used to open the clamp for wire insertion and removal. The stainless-steel cage clamp has high vibration, corrosion, and thermal resistance and can handle 28- to 20-AWG solid or stranded wire, or as high as 18 AWG, if the wires are not placed in adjacent positions. A version without an actuating lever is available, which can be factory or field wired with a small plastic tool or a small-bladed screwdriver. $0.22/position (1000).

WAGO Corp, 6657 N Sidney

Pl, Milwaukee, WI 53209. Phone (414) 352-1035. TLX 260123.

Circle No 535



TERMINAL STRIPS

The Beau Eurostyle Series 85 pc-board-mounted terminal blocks are constructed of thermoplastic and maintain center-to-center spacing when they're mounted end to end; they feature dead-front construction to prevent shocks and shorting. The manufacturer claims that the blocks' captive wire protectors provide better connection and hold wires more securely than other techniques.

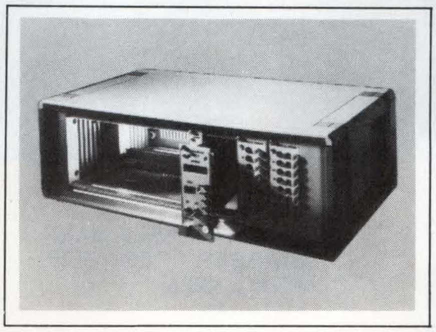
The devices have a high-density, 0.197-in. contact spacing in the terminal blocks. They provide as many as 5 terminations/in. and have an estimated UL current rating of 15A. The strips also feature captive screws that won't fall out and damage your equipment; large-wire entry that accepts wire to 14 AWG; and a closed side that acts as a wire stop. $0.12 per circuit (500).

Vernitron Corp, Beau Products Div, Box 10, Laconia, NH 03247. Phone (603) 524-5101. TWX 710-364-1843.

Circle No 536

DESKTOP ENCLOSURE

The Vario-Case desktop enclosure features sidewalls of extruded aluminum sections; the covers and rear wall are made of ABS plastic. ABS



is self extinguishing in accordance with UL 94 VI. The enclosure's design allows the mounting of either 19-in. subracks or modules, as well as direct modular assembly and insertion of pc boards.

The extruded aluminum sidewalls feature 0.49-in. vertical grooves that enable the 19-in. card frames and modular assemblies to be mounted at variable positions. The sidewalls also have tapped inserts at various depth positions.

The enclosure's feet, made of fiberglass reinforced polyamid, can be unfolded to ensure the safe stacking of several enclosures, without the risk of slipping. The feet cover the screw attachments when completely folded and can be unfolded to two positions, providing two angles of tilt with respect to the desk top. Vario-Case, $109.31 to $296.24; Vario-Rack, $799.88 to $1235.25.

Rittal Corp, Box 1284, Springfield, OH 45501. Phone (513) 325-1141. TLX 241354.

Circle No 537

TEST CLIP

According to the manufacturer, the Bug Catcher PLCC (plastic leadless-chip carrier), a test-clip adapter for integrated circuits, provides you with the first available method to help debug software and hardware in a PLCC. The device mates with a plastic leadless-chip carrier socket via the side pins and spacer block assembly. This interconnection scheme eliminates the need for long cables between the UUT and the test equipment, lowering the capacitance and inductance introduced in the circuit by the test setup.

Your Best Source for Test Clip Accessories is POMONA ELECTRONICS

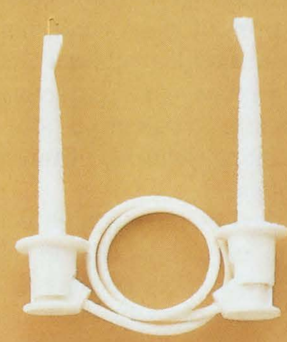
DO-IT-YOURSELF MICRO-GRABBER™ TEST CLIP: MODEL 4233

DO-IT-YOURSELF MAXI-GRABBER™ TEST CLIP: MODEL 4225

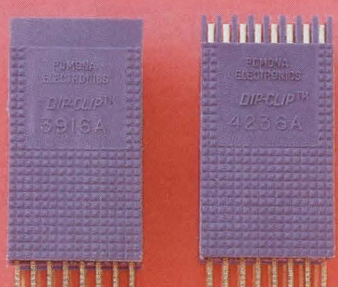
DO-IT-YOURSELF SMD GRABBER™: MODEL 5243

DO-IT-YOURSELF MINI-GRABBER™ TEST CLIP: MODEL 3925

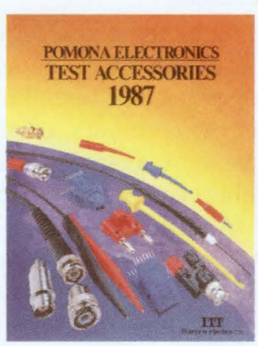
PATCH CORD; MINIGRABBER™ TEST CLIP BOTH ENDS: MODEL 3781



16 PIN DIP CLIP™ TEST CLIPS: MODEL 3916A (LEFT) STANDARD; MODEL 4236A (RIGHT) HIGH DENSITY



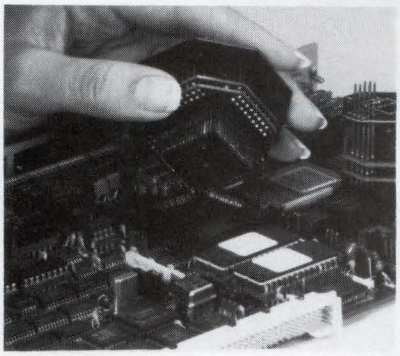
FREE 1987 GENERAL CATALOG



ITT Pomona Electronics
1500 E. Ninth St., Pomona, CA 91766
Tel: (714) 623-3463

SOIC CLIP™ TEST CLIP: MODEL 5250 (8 PIN); 5251 (14 PIN); 5252 (16 PIN) SHOWN; 5253 (20 PIN); 5254 (24 PIN)

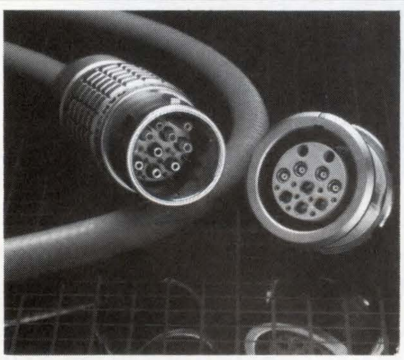
Our Products are available through your favorite electronics parts distributor.



The device utilizes two double-sided circuit boards, one JEDEC standard PLCC socket, 68 test points that are each 0.025-in^2, 68 side pins, one spacer block, and one overlay template. The spacer block prevents the collapse of the side pins from the force exerted by the PLCC socket after the adapter is inserted in the socket, and it ensures a secure fit. The template aids in pin identification. $160.

Emulation Technology Inc, 422 Ives Terrace, Sunnyvale, CA 94087. Phone (415) 960-0652. TLX 184817.

Circle No 538



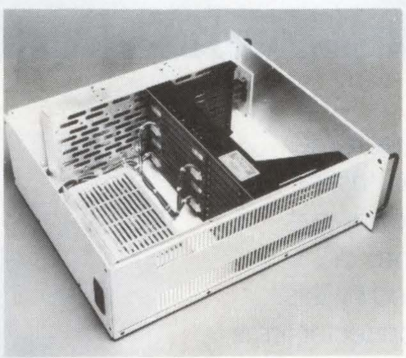
MIXED CONNECTOR

Designed for an industrial ink-jet manufacturer, the Peek mixed connector combines fluidic/pneumatic contacts with coaxial, high-voltage, and standard signal contacts. The connector is housed in the vendor's size 5B shell. Four 50Ω coaxial contacts, two 5-kV contacts, eight signal contacts, and four fluidic contacts permit the fluid to be transmitted to and from the printheads.

The Peek insulated connector is guaranteed for 5000 mating cycles and features a quick connect and disconnect self-latching system. The test voltage is 1800V, and the working voltage is 600V. The 8A rated current accommodates a 22-AWG max wire size, and the maximum working pressure is 10 Bar. The working temperature ranges from −40 to +80°C. The passage diameter for the fluidic connection is 1.3 mm and the tubing inside diameter is 1.6 mm. $266.24 per mated pair (500). Delivery, 20 weeks ARO.

LEMO USA Inc, Box 11488, Santa Rosa, CA 95406. Phone (707) 578-8811. TLX 340-933.

Circle No 539



ENCLOSURES

The 508 Series enclosures come in 3½-, 5¼-, 7-, and 8¾-in. sizes with four to 10 available card slots in the enclosures. The units are constructed of aluminum with a brushed or polyurethane textured finish. The configurations include the desktop model with EIA mounting flanges that allow you to remove the front panel when it is loaded in the 19-in. rack.

All the units feature positive pressurized filtered plenum air cooling for controlled air flow throughout the enclosure, as well as even cooling for both the power supply and the card rack. You can reach the fans by removing just two screws, and because of the airflow design, you can slide-mount the fans without any loss in the cooling capabili-

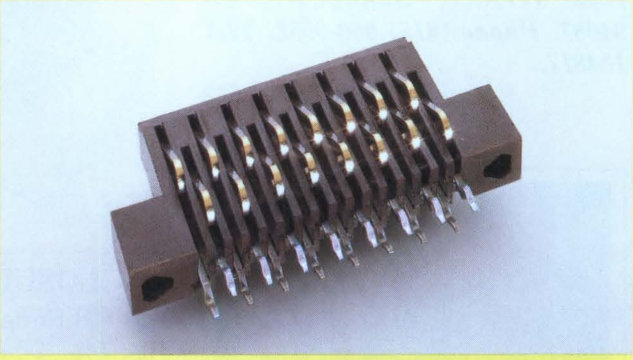
Text continued on pg 132

Four competitors had no solution to this tough connector problem.

Working closely with customer engineers the RN "P/Q Team" designed, produced, tested and delivered a state-of-the-art connector that *had never been made before.* And they did it within the 16-week time frame required by this major OEM customer. Four major connector firms had already indicated that it could not be done!

The incorporation of this new RN connector enabled our OEM customer to reduce his product size by 80%...improve operating reliability by 300%.

This is the RN "Partners in Quality Team" in action. It brings all of our engineering, production and quality control resources together with customer experts to solve socket and connector problems with speed and efficiency. Call on the RN "P/Q TEAM" for *your* interconnect solutions.

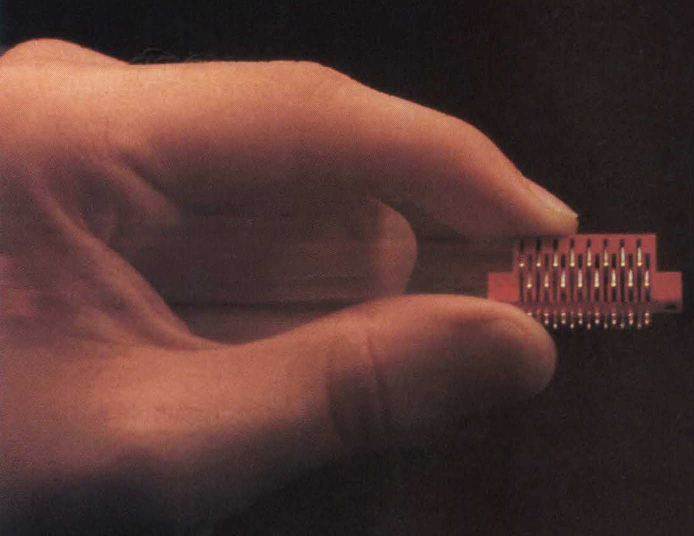


This is the connector competition couldn't make! It is a state-of-the-art compression connector with contacts on 50-MIL centers. It features retent solder tails for robotic board placement and withstands IR reflow surface mount soldering. It also maintains contact integrity in extremely difficult operating environments.

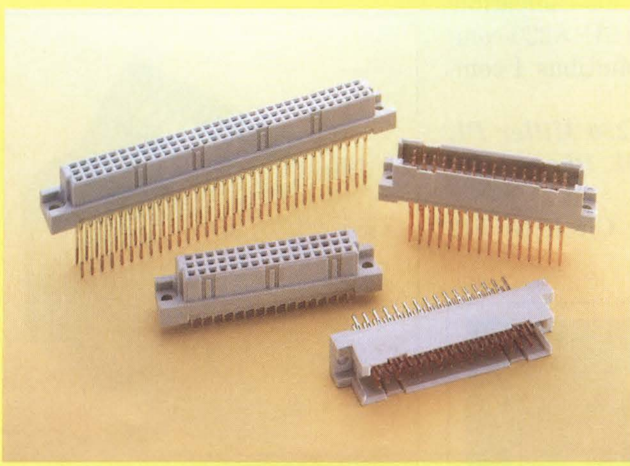
CIRCLE NO 112

Robinson Nugent

800 East Eighth Street, New Albany, Indiana 47150 • Phone: (812) 945-0211 FAX: (812) 945-0804
In Europe: Rue St. Georges 6, CH 2800 Delemont, Switzerland • Phone: (066) 22 9822 FAX: 011-41-622-9813



The RN "Partners in Quality Team" delivered a state-of-the-art connector in 16 weeks!

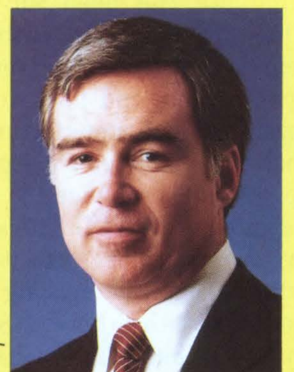


RN offers a wide variety of DIN Connectors. Half-size, standard and high density DIN connectors—120 or 150 positions. Completely repairable solderless FLEX PRESS™ contacts in male and female styles. Custom Early Mate/Late Break grounding pin location. Available in "better than gold" ROBEX® plating. Write for complete catalog.

CIRCLE NO 113

"The RN 'P/Q TEAM' concept brings all of our design, engineering and production skills to bear on *your* unique socket/connector problems. We work closely with your people to create solutions that are delivered on-time and defect-free. *You have my personal guarantee on it.*"

R. A. Lindenmuth
President/CEO



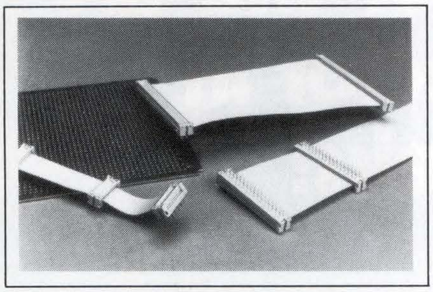
Write or call today for the comprehensive new brochure: *"The RN P/Q Team in Action".* You'll learn how smart companies are putting the brains, resources and experience of RN engineers to work to solve tough interconnection problems with speed and efficiency.

CIRCLE NO 114

PQ The RN "P/Q TEAM"...your Partners in Quality ty. The enclosures also accommodate any Mupac backplane for Multibus, Multibus II, and VME Bus systems. From $1400.

Mupac Corp, 10 Mupac Dr, Brockton, MA 02401. Phone (800) 225-0398; in MA, (617) 588-6110. TWX 710-345-8458.

Circle No 540



CONNECTORS

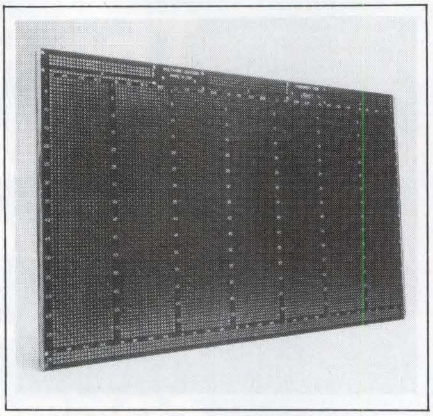
The Lat-Con 2-row transition connectors are 0.05-in. flat-cable connectors. Designed for permanent attachment to pc boards, they eliminate the need for headers. They are furnished with a preassembled socket and cover but are open on one end for lateral cable insertion. The manufacturer claims that this arrangement significantly speeds and simplifies the mass termination of 28-AWG flat cable. They are available for 10 to 64 circuits, with 0.1-in. row spacing. You can get them with either 0.118- or 0.157-in. solder pins plated with 315 μin. of tin. From $0.53 to $3.67.

Panduit Corp, 17301 Ridgeland Ave, Tinley Park, IL 60477. Phone (312) 532-1800.

Circle No 541

PROTOBOARDS

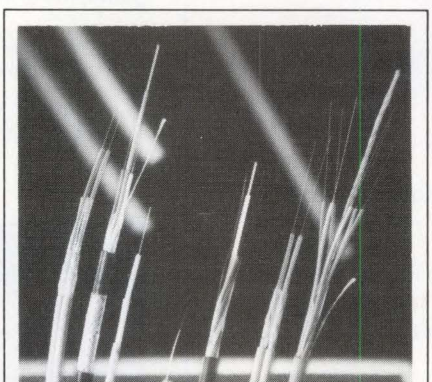
According to the manufacturer, the Protoboard Series prototyping panels have several advantages over wire-wrap prototyping panels. The boards are 100% tested on a bed-of-nails tester, allowing the debugging effort to concentrate on circuit design, rather than wiring errors; they feature a 0.1-in. hole pattern that allows you to use a variety of packaging types; the use of 38-AWG



wire provides high packaging densities; and you can mount the boards in single slots, allowing greater utilization of card racks. The boards' matrix of plated-through holes, all of which are drilled, makes it easy to add components at the bench. Four of the five new Protoboards are Mupac compatible and the other is Multibus compatible. Mupac 326-328-compatible Protoboard, $850; the Mupac 347-compatible board, $1500; Mupac 9U ×400-compatible board, $1700; Mupac 9U ×220-compatible, $830; and Multibus I-compatible, $485.

Multiwire/East, 250 Miller Pl, Hicksville, NY 11801. Phone (516) 933-8300.

Circle No 542



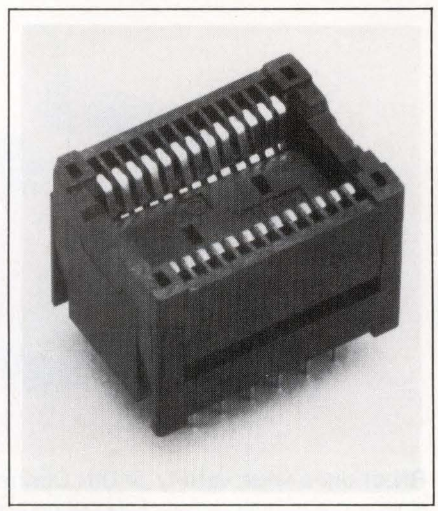
DATA CABLES

These 62.5/125-μm fiber-optic data cables for data and LAN applications are available in two performance levels: a high-performance 3.75 dB/km attenuation at 850 nm and a 160-MHz-km bandwidth; and a lower-performance cable that attenuates 5.0 dB/km at 850 nm and a 100-MHz-km bandwidth. The higher-performance cable's specifications meet the requirements of the IBM 3044 channel-extender system.

The cables come in both loose and tight buffer constructions with strength members of Kevlar, fiberglass epoxy rod, steel, or a combination of fiberglass, epoxy rod, and Kevlar. The number of fibers in each cable varies from one to 18. Standard lengths for the cables are 500, 1000, 3280, and 6560 ft. From $218 to $4321.

Belden Wire and Cable, Box 1980, Richmond, IN 47375. Phone (800) 235-3364.

Circle No 543



SOCKETS

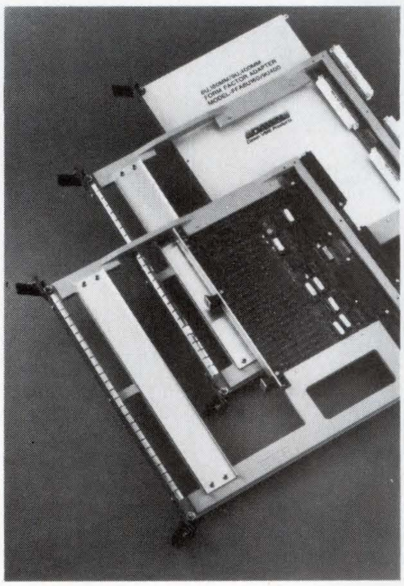
The IC134 Series SOJ autoeject burn-in sockets are intended for use in high-density burn-in applications. The low-insertion-force sockets have two options for loading and unloading: manual or automatic. Using the sockets' autoeject feature, you can easily extract the device after testing. The side gaps provide thermodynamic airflow for efficient heat dissipation. The socket material is polyetherimide, and the contact material is beryllium copper with

CIRCLE NO 128

gold-over-nickel plating. The operating temperature ranges from −40 to +175°C. The 26-lead model, $7 (1000). Delivery, stock to six weeks ARO.

Nepenthe, 2471 E Bayshore Rd, Palo Alto, CA 94303. Phone (800) 637-3684; in CA, (415) 856-9332.

Circle No 544



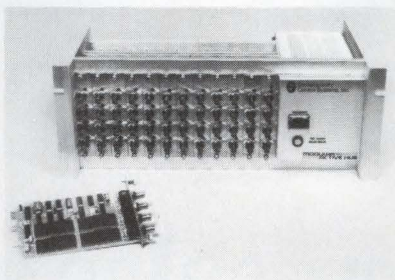
ADAPTERS

These form-factor adapters for interface to Sun Microsystems Computers provide size conversion from a standard 6U VME Bus to a Sun 9U configuration. They are available in five different models. Versions 1 and 2 are used as direct replacements for Sun models 160A and 160B. They differ from one another in that version 1 passes the A and C row signals to the Sun P2 proprietary bus, but version 2 doesn't. Version 2 isolates the P2 connector A and C signals from the Sun backplane. Both versions connect P2 A and C row signals to a 64- and a 50-position ribbon header.

Version 3 is a low-cost adapter for direct installation of a standard VME board into a Sun configuration. Version 4 is similar to version 1 except that it brings the front panel of your board forward to make it an integral part of the Sun front-panel system. This movement of the front panel provides you with direct access to connectors and displays. Version 5 performs a similar function for version 2 adapters. Versions 1 and 2, $400; version 3, $175; versions 4 and 5, $565.

Dawn VME Products, 47073 Warm Springs Blvd, Fremont, CA 94539. Phone (415) 657-4444.

Circle No 545



ACTIVE HUB

The 4012 rack-mounted active hub interconnects devices in an ArcNet local-area network and retransmits data to all nodes on the network. It supports various cabling schemes, such as coaxial, fiber-optic, and twisted-pair cabling. It supports these cabling schemes by using low-impedance, high-impedance, and fiber-optic expansion modules that plug into the hub.

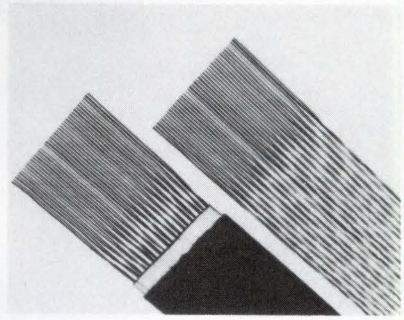
The device's master/slave design allows one master node to drive as many as 11 slave nodes. The hub is expandable from four to 48 nodes in groups of four: Twelve slots have four points/slot. The 7-in. panel height allows the hub to fit into a standard 19-in. rack. Further, you don't need to terminate any of the device's unused ports. $1095.

Contemporary Control Systems Inc, 2500 Wisconsin Ave, Downers Grove, IL 60515. Phone (312) 963-7079. TLX 314990.

Circle No 546

CABLE

The Trans-E-Twist Interconnect cable features alternating lengths of 18-in. sections of twisted pairs followed by 2 in. of flat parallel wires.



The cable is UL listed for internal and external interconnections on electronic systems. The twisted pairs have alternating lay directions to keep crosstalk at a low level. The flat areas allow mass termination of the cable. The cable is compatible with standard insulation-displacement connectors. The cable is available with as many as 36 twisted pairs, using 26-, 28- and 30-AWG stranded tin copper. Low-loss high-speed insulation systems are also available. For each 1000-ft length of twisted-pair cable, $50.

Brintec Corp, Brand-Rex Cable Systems Div, 1600 W Main Street Willimantic, CT 06226. Phone (203) 456-8000.

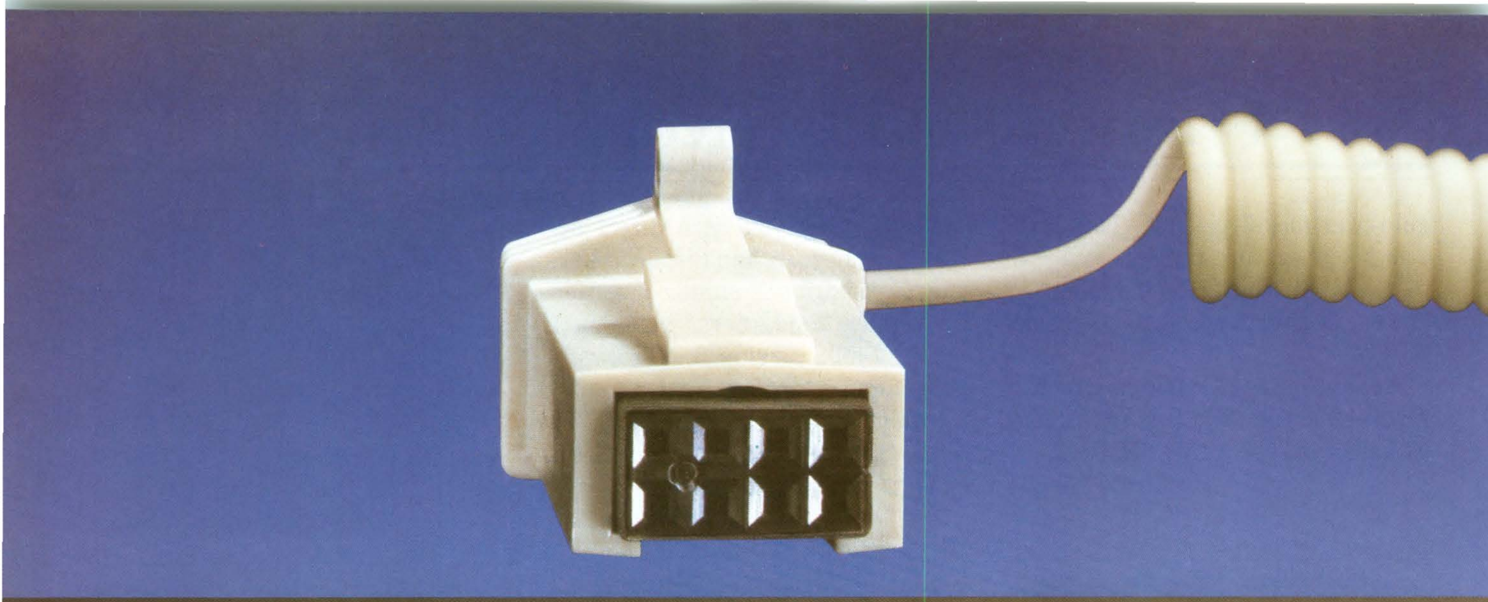
Circle No 547

CONNECTORS

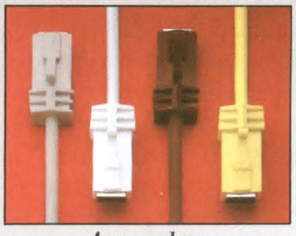
The D3 (also called NFC) Series fiber-optic connectors are compatible both performance-wise and mechanically with the industry standard FC fiber-optic connectors. They are packaged as a kit with only three pieces: a ferrule, housing, and a rubber boot. Because the connector uses a glass capillary instead of a ceramic capillary, it can be polished with inexpensive alumina films and water, rather than diamond films and ultrasonic cleaning. The connector also features four keyways that are built-in, allowing you to easily select the lowest-loss key position. Multimode ferrule and housing, $12; single-mode ferrule and housing, $18; multimode 5m patchcord, $93; single-mode 5m patchcord, $169.

NEC Electronics Inc, Box 7241, Mountain View, CA 94039. Phone

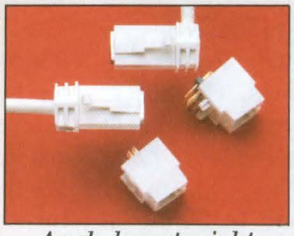
Text continued on pg 138



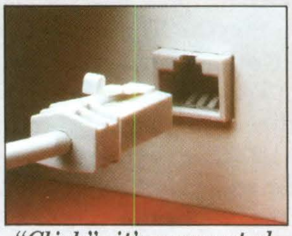
Plug new sales appeal into your system with Du Pont Latch-N-Lok™ Shielded Assemblies.



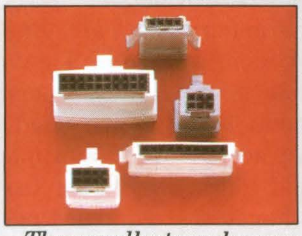
Any color.



Angled or straight.



"Click"–it's connected.



The smallest package.

Only Latch-N-Lok™ modular interconnections offer so many attractive, functional combinations in cords, colors and connectors to give your system the sales appeal it deserves.

Now you can specify the most compact plugs and receptacles available, in straight, right-angle or combination designs, with the latch on top, bottom or side of the plug. Receptacles come with panel, chassis or board mounts. Order your cords coiled or straight, in any length, with any number of conductors, with foil, serve or braid shielding, and in a variety of jacket textures. All elements can be color-coordinated to your system. You can even put your logo, trademark or pictogram on your connectors.

Uses the patented PV™ Receptacle and BergStik® Header.

The contact design used in Latch-N-Lok™ has been proven in millions of applications. This means Latch-N-Lok™ will stay on the job,

connection after connection, to keep your customer satisfied.

What's more, Latch-N-Lok™ is the industry's only quick disconnect pin-and-socket system. An audible "click" tells you a positive plug-to-receptacle connection has been made.

Even with all these benefits. Latch-N-Lok™ assemblies cost no more than standard types. Call toll-free **1-800-233-1173*** or write on your company letterhead to request a sample, our Latch-N-Lok™ brochure, or a demonstration.

Latch-N-Lok™ modular shielded interconnections: another development of Du Pont Electronics, 515 Fishing Creek Road, New Cumberland, Pa. 17070

**In PA, call 1-(800)-222-2194*

Du Pont Electronics

Share the power of our resources.

DU PONT

REG U.S. PAT & TM OFF

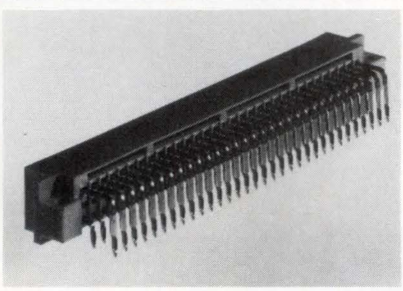
CIRCLE NO 127

(415) 965-6308. TWX 910-379-6985.
Circle No 548

SOCKETS

The IC120 Series sockets are a group of low-insertion-force, auto-eject PLCC sockets for use in high-density, burn-in applications. Both dead-bug and live-bug versions are available. The sockets feature an insulation resistance of 1000 MΩ min at 500V dc, breakdown voltage is listed at 700V ac for one minute, and contact resistance is specified as 30 mΩ max at 10 mA/20 mV. The operating temperature ranges from −40 to +170°C. The typical socket life is specified as 10,000 insertions min. A 68-lead device, $17.35 (250).

Nepenthe, 2471 E Bayshore Rd, Palo Alto, CA 94303. Phone (800) 637-3684; in CA, (415) 856-9332.
Circle No 549



CONNECTORS

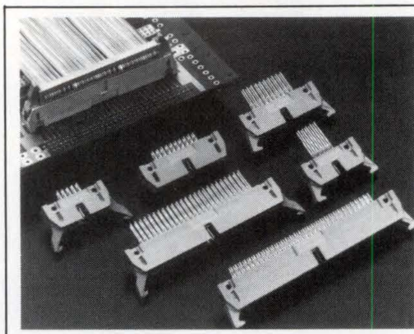
The DIN 41612 90°-connectors have right-angled press-fit pins for insertion in pc boards. The manufacturer has developed 64- and 96-place right-angle male connectors, female reversed Q, and female R right-angle connectors with compliant press-fit pins. A press-fit tool is used in conjunction with a standard hand-driven press that presses the connectors into place on a pc board. This tool eliminates the soldering process and also gets rid of the bonding and washing of the connectors that's usually required to prevent the soldering vapors from penetrating the connector. Male connector, $2.18; female connector, $5.67 (1000). Delivery, six to eight weeks ARO.

Erni Components, 520 Southlake Blvd, Richmond, VA 23236. Phone (804) 794-6367. TLX 559647.
Circle No 550

PROTOBOARDS

The JE400 Series prototyping boards feature a silkscreened legend on the component side which depicts the foil pattern and hole coordinate for the solder side of the board. The series covers a wide variety of sizes and applications that range from 2.7×4.5 in. to 5.0×13.25 in. It also includes a Commodore-compatible user-port interface pc board. The protoboards are made of laminated glass epoxy with 0.062-in.-thick, 2-oz copper that's clad with a solder-tin finish; all holes have a 0.042-in. diameter on a 0.1×0.1-in. grid pattern. From $7.95 to $19.95.

Jameco Electronics, 1355 Shoreway Rd, Belmont, CA 94002. Phone (415) 592-8097. TLX 176043.
Circle No 551



HEADER

Compatible with flat-cable female-socket connectors, the Flex-Fit pliant contact header minimizes pc-board, plated-through hole deformation and conforms to the requirements of MIL-STD-2166. It can be removed and replaced without compromising the part's mechanical or electrical performance.

The header, with contacts on a 0.1×0.1-in. grid pattern, is available in contact sizes from 10 to 64 pin positions, and it offers a number of options such as lock/eject latches for positive-contact easy ejection. Polarization options include center key, dual key, and MIL-C-83503 (612 version). The header's insulation material is a glass reinforced thermoplastic. The contacts are plated in the contact area with gold over nickel. The header has a temperature rating of −55 to +125°C. $1.15 (1000).

Thomas and Betts Corp, 920 Route 202, Raritan, NJ 08869. Phone (201) 469-4000.
Circle No 552

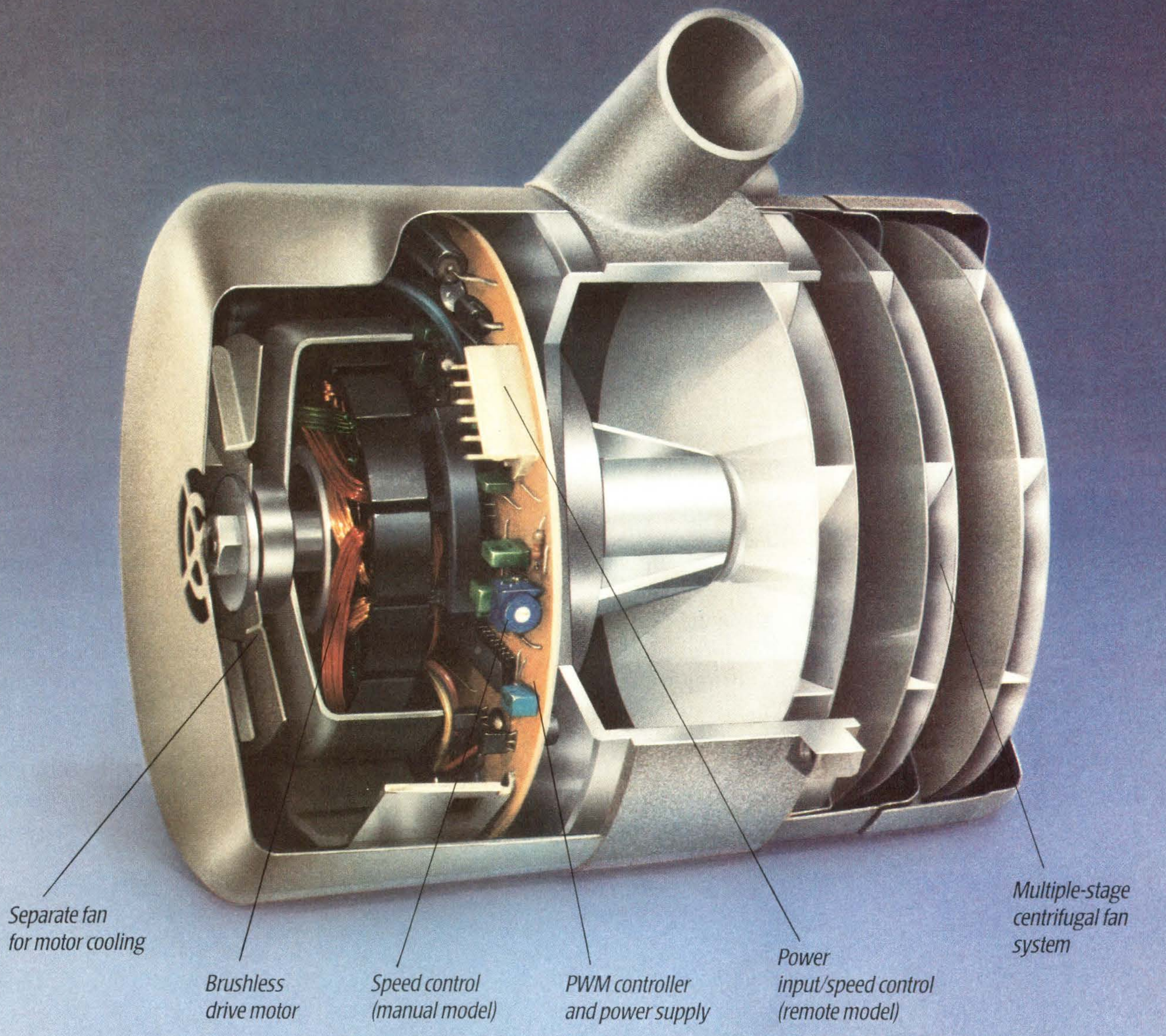
EXTENDER BOARDS

These two extender boards for the Apple Macintosh II consist of a multilayered design that offers high performance, low noise, and little crosstalk; and a 2-sided board for general-purpose use. The multilayered extender features a 5-layer design of copper-clad FR4 material with two 9-pin DIN connectors installed on the board. This board features decoupling capacitors and has a jumper field that allows each signal to be individually opened for testing. An additional DIN connector provides access to a bus analyzer, and a mounting bracket is available for attachment to the computer chassis. The 2-sided extender is constructed of 2-sided copper-clad FR4 material. Two 96-pin DIN connectors are installed on the board and a chassis mounting bracket is included. Multilayer version, $295; 2-layer version, $69.

Vector Electronic Co, 12460 Gladstone Ave, Sylmar, CA 91342. Phone (818) 365-9661. TLX 269303.
Circle No 553

SOCKETS

The company offers four versions of sockets for single in-line memory modules. These burn-in sockets accommodate 256k×8- or ×9-bit dynamic RAMs and 1M×8- or ×9-bit dynamic RAMs. The sockets are



Now, high performance vacuum/pressure blowers that operate from 120 VAC

Compact units feature brushless dc motors with integral controller and variable speed capability

These new Windjammer® blowers combine electronics, motor, and fan system in a compact, cost-effective package that operates from a standard 120 VAC input. An exclusive Lamb Electric design, they were developed for demanding, limited space applications such as business machines, medical equipment and

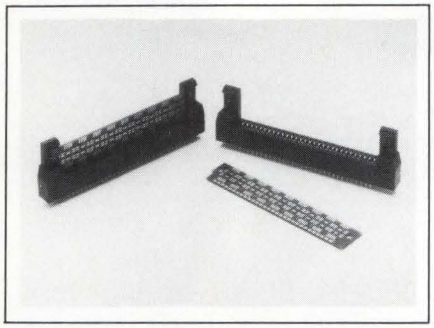
materials handling applications.

Just 5.7″ in diameter, the blowers have 1-, 2-, or 3-stage fans for performance from 50″ H_2O vacuum at 0 CFM to 110 CFM at 0″ H_2O. With one version, a 0 to 10 VDC signal from a sensor or other device will control motor speed and adjust air performance from 0 to 100%. Or, a second model provides manual speed control by means of a potentiometer located in the blower housing.

These blowers also feature low noise performance and are UL/CSA component recognized. Get complete details by contacting AMETEK, Lamb Electric Division, 627 Lake Street, Kent, OH 44240. (216) 673-3451. Telex: 433-2140. Cable: LAMETEK.

AMETEK
LAMB ELECTRIC DIVISION

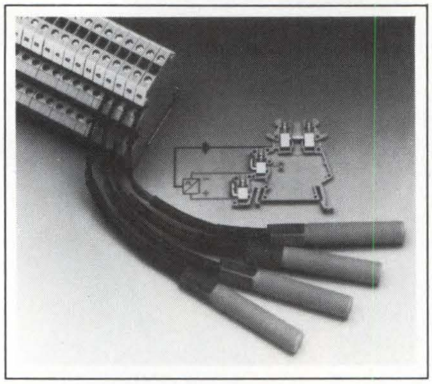
CIRCLE NO 126



available in 30, 35, and 72 pins (50- and 100-mil spacing, single or double density). Actuation latches provide quick insertion and extraction of memory modules. The sockets' body material is polyethersulphone/polyetherimide. The contact material is beryllium copper with gold-over-nickel plating, and the operating temperature ranges from −40 to +170°C. 30-pin sockets, $25 (1000).

Nepenthe, 2471 E Bayshore Rd, Palo Alto, CA 94303. Phone (800) 637-3684; in CA, (415) 856-9332.

Circle No 554



TERMINAL BLOCK

The Dik 1.5 3-level terminal block is designed to save cabinet space and labor time when terminating 3-wire process control devices. The 3-level configuration allows for 12 terminations/in. The two lower levels of the terminal block serve as the positive and negative power supply terminals, and the top level is used to terminate signal lines. Wiring and busing of the voltage-supply lower levels is done with one screw/position. The device mounts on any conventional DIN rail and is rated for 25A at 600V. It can accept wire sizes to 14 AWG. $2.30 (100).

Phoenix Contact, Box 4100, Harrisburg, PA 17111. Phone (717) 944-1300.

Circle No 555

COOLER

The Slimboy 17 Series air conditioner cools electronic controls housed in narrow enclosures. It features a cooling capacity of 2000 BTU/hr and has an overall package width of 12 in. The unit employs high-flow-rate ball-bearing fans and has built-in condensate evaporation. It's available in three mounting configurations: The standard model comes without mounting rails; a second model is available with top and bottom mounting rails; and a third model comes with side mounting rails. Its closed-loop design protects the sealed-in electronic controls and

CIRCLE NO 15

HARD-TO-FIND SIGNALS A SOURCE OF DELAY?

Look at the Tek 2465A with a 17-bit Word Recognizer. It's an easy, economical scope option that makes the critical difference when you need to trigger on data to monitor digital system performance. Parallel bus information **triggers** your display, so you can view up to four channels of real-time information. Add standard features such as 350 MHz bandwidth, on-screen cursors, 500 ps/div time base and trigger level readout, and you have a scope **made** for solving tough problems in digital design!

CUT IT OUT!

☐ Please send me your free videotape introduction, "The 2445A/2465A Family: From Performance to Productivity."

☐ Please send me your free 22-page brochure.

☐ Please have a Tek representative get in touch with me as soon as possible to arrange a demonstration.

In a hurry? Call Tek direct
1-800-426-2200

D888-6-38AX EDN

Yes! I want a closer look at the Tek 2445A/2465A Family.

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City ______________ State ______________ Zip ______________

( )
Phone ______________________ Ext

Tektronix
COMMITTED TO EXCELLENCE

SCOPES CUT OUT FOR YOUR KIND OF WORK.

You can tailor the 2465A for special needs. Or choose one of three multiple-option packages, the 2465A Special Editions. They are configured for specific application areas at a significant savings over the separately ordered options.

The 2465A CT with Counter/Timer/Trigger offers crystal-controlled timing accuracy plus the extra triggering power you need for digital systems.

Frequency and period can be measured with counter accuracy from any vertical channel directly. Or set up the scope to measure time intervals such as pulse width, rise time and propagation delay. Then store instrument setups in nonvolatile memory—for easy access and automatic execution.

Check Tek software development packages. They make it easy to generate automated and semi-automated test procedures, even without prior GPIB-programming experience. Use the simple, multi-level menus to develop sophisticated test programs.

Software is available to operate with the Tektronix 4041 controller, IBM PC, XT,™ AT® and compatibles.

Key Features	2465A DV	2465A DM	2465A CT	2465A	2445A
Probe Tip Bandwidth	350 MHz	350 MHz	350 MHz	350 MHz	150 MHz
No. of Channels	4	4	4	4	4
Horizontal Accuracy	2% (.001%*)	2% (.001%*)	2% (.001%*)	2% (.001%*)	2% (.001%*)
Max. Sweep Speed	500 psec	500 psec	500 psec	500 psec	1 nsec
Vertical Sensitivity	2 mV/div	2 mV/div	2 mV/div	2 mV/div	2 mV/div
Trigger Frequency	500 MHz	500 MHz	500 MHz	500 MHz	250 MHz
GPIB	Standard	Standard	Standard	Optional	Optional
Counter/Timer/ Trigger/Word Recognizer	Standard	Standard	Standard	Optional	Optional
Digital Multimeter	Standard	Standard	Not Available	Optional	Optional
Video Trigger	Standard	Not Available	Not Available	Optional	Optional
Probes	4	4	4	2	2
Warranty	3 years on parts and labor, including CRT				

*with Counter/Timer/Trigger

Get the full story! Return the reply card, or call your Tek Sales Engineer for a hands-on demonstration. To place an order or request product literature, call Tek direct: **1-800-426-2200.**

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 1 BEAVERTON, OR

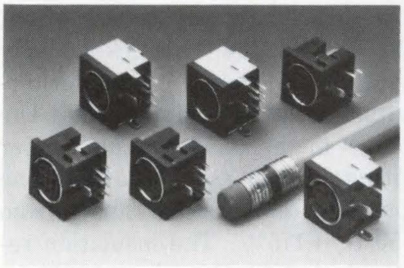
POSTAGE WILL BE PAID BY ADDRESSEE

Tektronix, Inc.
Del. Station 02-050
P.O. Box 500
Beaverton, OR 97077

prevents shutdowns caused by heat, humidity, dust, or other contaminants. $585 (25).

McLean Midwest, 4000 83rd Ave N, Brooklyn Park, MN 55443, Phone (612) 561-9400. TLX 290883. TWX 910-576-2951.

Circle No 556

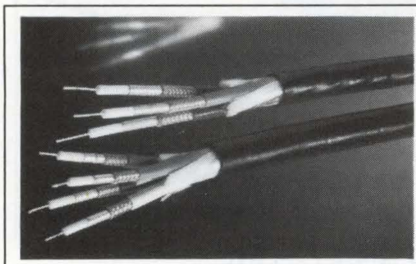


CONNECTORS

These miniature DIN connectors offer pc-board and right-angle mount, a selection of four to eight pins, and male- and female-molded cable versions. They are available in either shielded or nonshielded models and have complete custom-design capabilities. From $0.40 (OEM qty).

Shogyo International Corp, 287 Northern Blvd, Great Neck, NY 11021. Phone (516) 466-0911. TLX 12218.

Circle No 557



CABLES

The vendor's two low-loss miniature RGB coaxial cables are used with broadcast systems and color monitors. These 75Ω units eliminate the need for decoding equipment. They have a nominal capacitance of 17.3 pF/ft and a propagation-velocity factor of 78%.

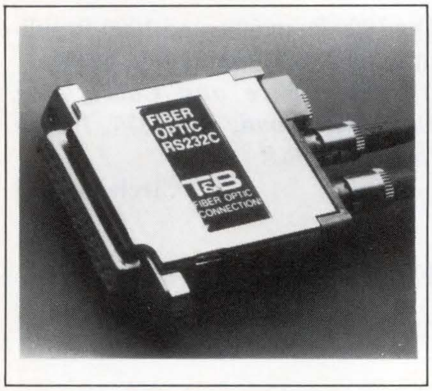
The 1164A and 1167A Series consist of mini coaxial cables under an overall Mylar tape and black PVC jacket. Each cable has a Datalene-insulated stranded 26-AWG silver-plated copper-alloy conductor that is surrounded by a Duobond II foil tape and a tinned copper-braid shield. The 1164A Series has an RGB color-coded jacket, and the 1167A Series has a color-coded jacket of red, green, blue, and white. Per 1000 ft, in 500- and 1000-ft pull-ups, 1164A, $1092; 1167A, $1473.

Belden Wire and Cable, Box 1980, Richmond, IN 47375. Phone (800) 235-3364.

Circle No 558

F-O MODEM

The Series 9481-1G RS-232C fiber-



optic modem extends the range at which you can operate an RS-232C link to 2 km and links data-communication equipment (DCE) and data-terminal equipment (DTE) via fiber-optic cable. It accommodates either duplex plastic or glass fiber-optic cables and handles data rates as high as 19.2k baud (asynchronous). In addition to transferring data in both directions, the modem provides support for six control/handshake lines via the same fiber.

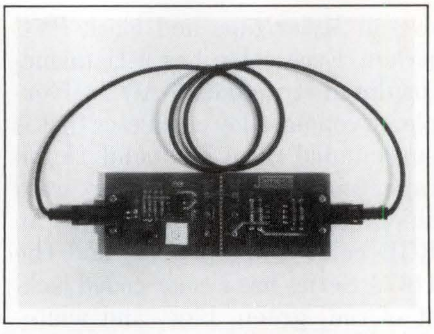
You can apply power to the modem directly through the DB25 pin connector or the optional external plug-in-jack power supply. The unit is available with either male or female contacts, in DCE or DTE configurations, and is compatible with ST-type fiber-optic connectors. The use of fiber-optic cabling with these modems eliminates ground loops, and the use of these modems requires no modifications for existing RS-232C equipment. $54 (500).

Thomas & Betts Corp, 920 Route 202, Raritan, NJ 08869. Phone (201) 685-1600.

Circle No 559

F-O KIT

The JE310 fiber-optic kit is an educational package, designed to give students and engineers hands-on experience with fiber-optic technology. It features separate transmitter-and-receiver circuit boards with separate test points for each signal on the board. The kit also includes fiber-optic cables and connectors, and requires a 6 to 9V power supply. $19.95.



Jameco Electronics, 1355 Shoreway Rd, Belmont, CA 94002. Phone (415) 592-8097. TLX 176043.

Circle No 560

EXTENDER BOARDS

The 3690-30 and 3690-31 extender boards are compatible with IBM PS/2 Series computers. The 3690-30 extender addresses PS/2 models 50 and 60; it's compatible with the PS/2's microchannel architecture and can be used with a 16-bit connector. The 3690-31 extender board is compatible with the PS/2 model 80, including a 32-bit connector, which you can use either with or without the matched-memory extension.

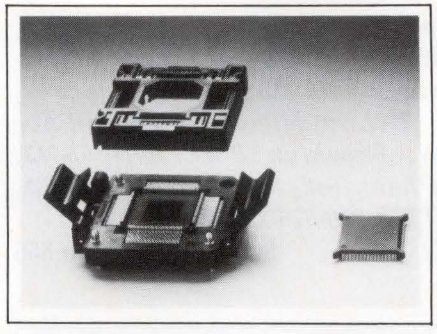
Both boards use a 3-layer design of copper-clad FR4 material. The inner layer is a crosstalk-reducing ground plane. The 3-layer design is impedance matched to the PS/2 backplane. The boards' edge-connector tabs are laid out on 0.05-in. centers on the backplane edge and an installed connector is located on the other edge of the board. Instructions and mounting brackets are included. 3690-30, $195; 3690-31, $248.

Vector Electronic Co, 12460 Gladstone Ave, Sylmar, CA 91342. Phone (818) 365-9661. TLX 269303.

Circle No 561

SOCKETS

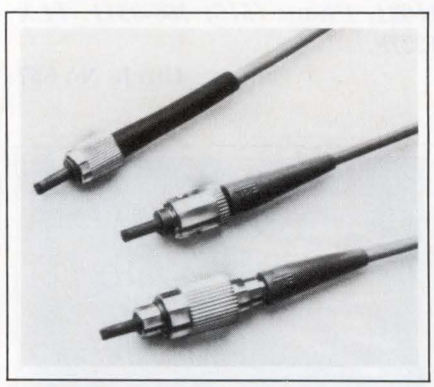
These test and burn-in sockets for fine-pitch plastic-quad flatpack (PQFP) packages come with hinged lids to accommodate naked in-house handling or as a socket/carrier combination for internal/external trans-



port. They have pin counts of 84, 100, 132, and 196. The sockets' body material is made of polyethersulphone/polyetherimide, and the contact material is beryllium copper with gold-over-nickel plating. The operating temperature ranges from −50 to +175°C. The insulation resistance is 1000 MΩ min at 500V dc. The dielectric withstanding voltage is 700V ac for 60 sec, and the contact resistance is 30 mΩ max at 10 mA/20 mV. The rated current for the devices is 1A max, and the sockets can withstand 25,000 insertion cycles. 100-pin model, $67.42 (100).

Nepenthe, 2471 E Bayshore Rd, Palo Alto, CA 94303. Phone (415) 856-9332.

Circle No 562



CONNECTORS

The Pre-Cap Series fiber-optic connectors are compatible with SMA, ST, and FC connectors. They combine the advantages of a composite polymer alloy with the precision tolerance of a glass capillary; as a result, insertion losses are <0.3 dB for multimode fiber applications. The connectors offer crimp and polish termination, and accommodate 125- and 140-μm multimode fibers.

FEATURE	BENEFIT
Standards Approval	Meets or exceeds all International standards approvals (UL, VDE, CSA, and TUV)
Product Range	Over 200 standard precision switching power supplies ranging from 25W to 1 KW
Price	Extremely competitive to meet your volume requirements
Warranty	2-year return to factory
Reliability	Consistently achieves less than 1/10th of 1 percent field returns
Size and Performance	Compact size with up to 100 KHz switching speed

It's easy to choose the exact KEC power supply to meet your requirements. Select from over 200 products or have KEC's engineers custom design a precision switching power supply just for you.

Choose from both open frame or modular styles, in a wide range of wattages. You also have a choice of 115 or 230 VAC inputs. KEC assures prompt delivery from its California warehouse.

When you choose a KEC power supply, you get over 70 years of design engineering experience dedicated to creating a standard for you.

Discover the real Multiple Choice in power supplies—Discover KEC!! Write for your FREE literature and information kit, or call KEC toll-free today.

1-800-255-5668

KEC

KEC ELECTRONICS, INC.
20817 Western Avenue, Torrance, CA 90501
(213) 320-3902, FAX (213) 618-1197

"KEC—BRINGING MORE POWER TO YOU"

CIRCLE NO 152

In addition, they can be terminated on all styles of fiber-optic cables available from major cable manufacturers. The series includes connectors, couplers, factory-assembled cables, and all the tooling necessary for fiber-optic interconnection. $9.50 (1000).

Thomas & Betts Corp, Technical Service, 920 Route 202, Raritan, NJ 08869. Phone (201) 469-4000.

Circle No 563

CONNECTORS

The DL 50 Series ribbon connectors utilize 0.085-in. centerline contacts on both the mating end and the pc-board interface. They accept standard 28-AWG flat cable, which is terminated by the insulation-displacement method. The connectors are available in 24-, 36-, and 50-position sizes. The series offers metal-shell straight and right-angle receptacles with ball locks, as well as mating plugs and receptacles for use with 0.050-in.-center cables.

The connectors spec a 3A current rating; the receptacles have a 500V ac voltage rating. Flat-cable limitations reduce current ratings for the plug and receptacles to 1A. Three contact options are available (8, 15, or 30 μin. of gold over nickel) for all the devices. $3.23 (1000) for a 24-position right-angle pc-board receptacle with 8 μin. of gold.

Molex Inc, 2222 Wellington Ct, Lisle, IL 60532. Phone (312) 969-4550.

Circle No 564

DRIVE ENCLOSURE

The SA-H163 enclosure is designed for applications that require removing, transporting, and storing dual 5¼-in. Winchester disk drives. It features pluggable drive capability along with a removable bracket (complete with power and data connectors) that you install on each drive. To remove a drive, you simply loosen two thumbscrews on the hinged cover, pull the handle on the bracket, and release the drive assembly from the docking connector.

No tools are required for drive installation or removal. The enclosure also includes a 100W supply, exhaust fan, write-protect switches, and LED indicators for each drive. The front-panel connectors provide daisy-chaining capability for the controllers that support as many as four Winchester disk drives. $1431.

Sigma Information Systems, 3401 E LaPalma Ave, Anaheim, CA 92806. Phone (714) 630-6553. TLX 298607.

Circle No 565

BACKPLANE

This VSB (VME system bus) backplane is designed for use in μP applications in high-performance 32-bit VME systems. It permits faster, more effective memory expansion without overcrowding the J1 backplane, the vendor claims. The backplane is available in 2-, 3-, 4-, 5-, and 6-slot versions. It features 4-layer construction (signal/5V/ground/signal) and is impedance matched. The device plugs onto the standard wire-wrappable tails of the 96-pin DIN connector on the J2 backplane without interfering with the power terminals or harness on the J2. From $123.

Mupac Corp, 10 Mupac Dr, Brockton, MA 02401. Phone (800) 225-0398; in MA, (617) 588-6110. TWX 710-345-8458.

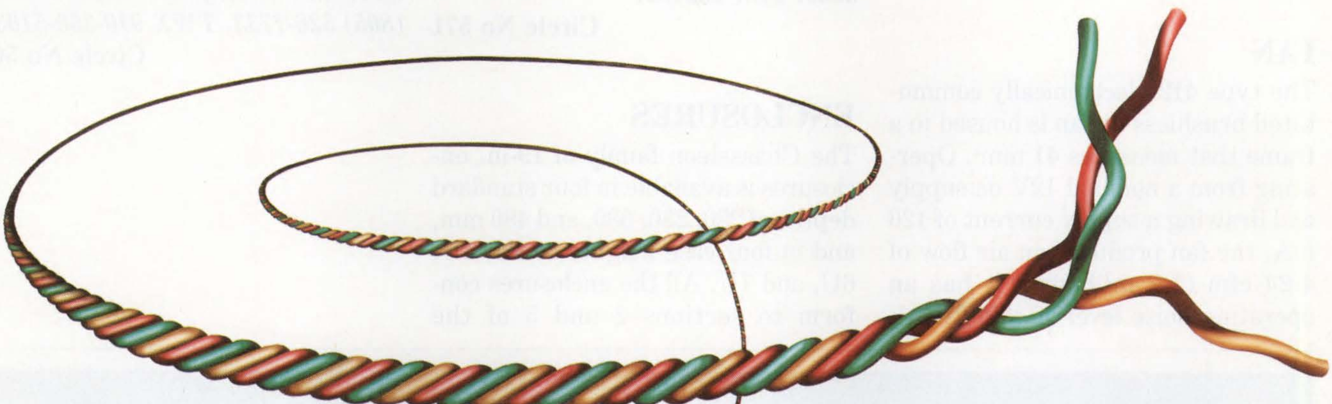
Circle No 566

HEAT SINKS

The Series 6380 heat sinks are designed specifically to cool ICs housed in a single in-line package (SIP) or a zigzag in-line package (ZIP). They dissipate heat in the 10 to 15W range and feature standard solderable roll pins. Roll pins with standoffs are available as an option.

At a 75°C mounting-surface

Wind up with a new twist in twisted magnet wire.



TWISTITE™

Magnet Wire gives you superior performance and tighter control over twisted wire construction. If you use twisted magnet wire in the production of custom toroid, ferrite or recording head coils, specialty audio and R.F. transformers, you'll be glad to discover TWISTITE Magnet Wire from MWS.

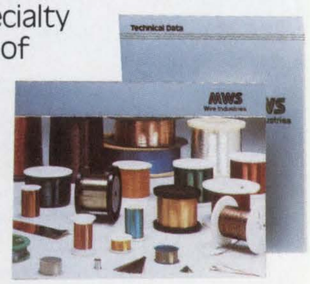
Only TWISTITE offers these advantages.

Because TWISTITE is custom produced by MWS, you get a wider range of twisting constructions. Manufacturing capabilities include:

- Up to 33 Twists Per Inch on fine wire.
- Twisting tolerance as tight as ± 1%.
- Tightly controlled capacitance, inductance and impedance characteristics.
- Up to 10 colors in some sizes for conductor identification.
- Huge selection of insulations: NEMA MW 1000, JW1177 105-220°C (single thru quadruple film builds).
- Wide range of sizes: 24AWG and finer.
- Wide variety of conductor materials: copper, silver, plated conductors and special alloys.

Discover MWS today.

Call or write for your FREE copy of the new MWS Technical Data Booklet. It's filled with useful information on all wire products produced and inventoried by MWS. You'll discover why MWS is the industry leader in specialty wire products. Samples of TWISTITE Magnet Wire are available upon request.



MWS®
Wire Industries

31200 Cedar Valley Drive, Westlake Village CA 91362
CALL TOLL FREE 800 423-5097
In California 800-992-8553.
In Los Angeles 818-991-8553

TWISTITE™ is a trademark of MWS Wire Industries

CIRCLE NO 151

temperature rise, the thermal resistance is 10°C/W for the 1-in. 6380B, 7.9°C/W for the 1.5-in. 6381B, and 6.5°C/W for the 2-in. 6382B. The devices are screw mounted through two holes on 0.78-in. centers in the device tab. The heat sinks are also available with optional self-clinching fasteners or threaded studs for easy assembly. \$0.56 (1000) for the 6380B.

Thermalloy Inc, Box 810839, Dallas, TX 75381. Phone (214) 243-4321.

Circle No 567

FAN

The type 412 electronically commutated brushless dc fan is housed in a frame that measures 41 mm². Operating from a nominal 12V dc supply and drawing a supply current of 120 mA, the fan produces an air flow of 4.24 cfm (7.2 m³/hour). It has an operating noise level of <30 dB(A), and its low level of RFI and EMI emission suits it for operation close to CRT displays. Ball bearings give the fan an operating life expectancy of 30,000 hours at 60°C. The fan weighs 65g. Approximately \$16 (100).

Papst-Motoren GmbH, Postfach 1435, 7742 St Georgen, West Germany. Phone (07724) 810. TLX 792413.

Circle No 570

Papst Mechatronic Corp, Aquidneck Industrial Park, Newport, RI 02840. Phone (401) 849-5930. TLX 952092.

Circle No 571

ENCLOSURES

The Chasseleon family of 19-in. enclosures is available in four standard depths of 220, 280, 380, and 480 mm, and in four case heights of 3U, 4U, 6U, and 7U. All the enclosures conform to sections 2 and 5 of the DIN-41494 specification. You can choose among five different front-panel designs and add a keyboard cover or plexiglass hood to the front of the case. An RF-shielded version is also available.

All versions are available with either vertical, horizontal, or diagonal ventilation slots. From £40.

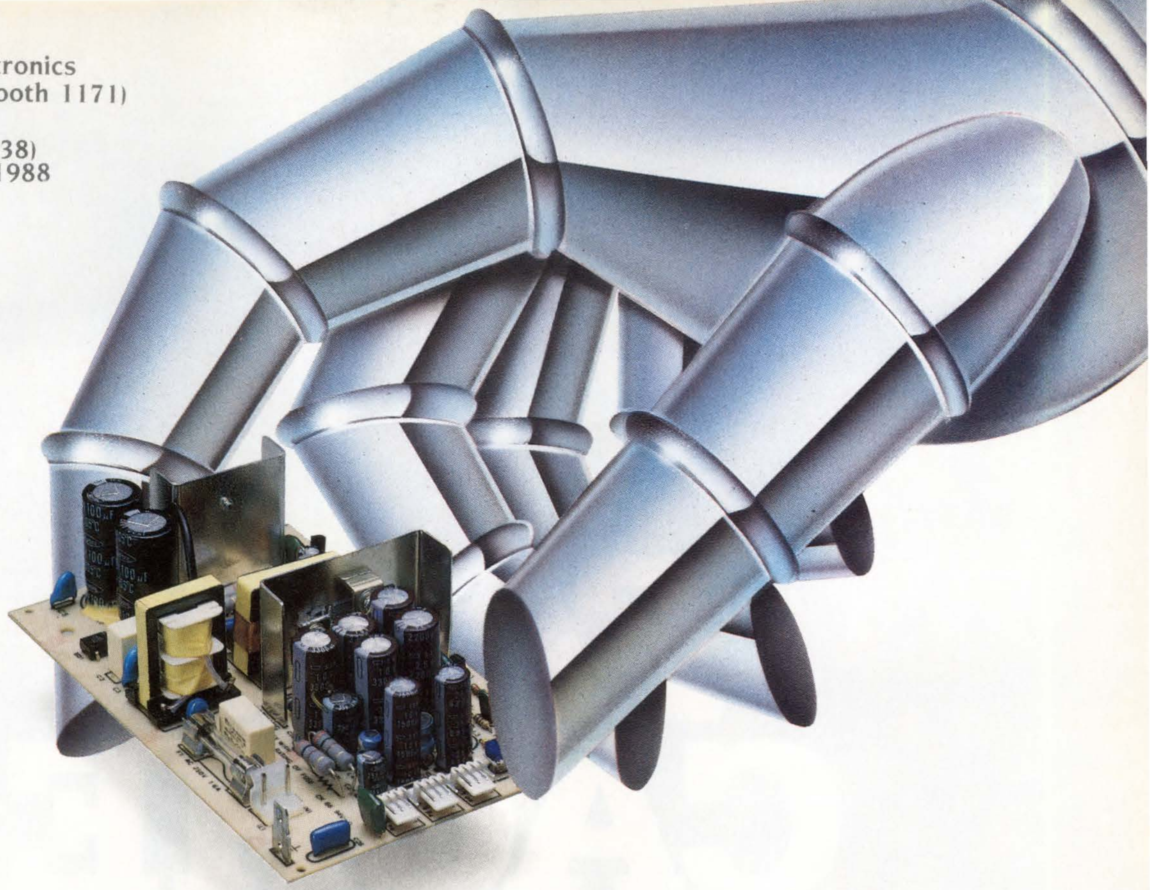
Knurr AG, Postfach 820369, Schatzbogen 29, 8000 Munich 82, West Germany. Phone (089) 420040. TLX 52960810.

Circle No 568

Dacobas Inc, 1830/A N Voyager Ave, Simi Valley, CA 93063. Phone (805) 526-7733. TWX 910-350-5103.

Circle No 569

See us at:
Taipei International Electronics Show, Oct. 6-12, 1987 (Booth 1171)
Comdex Fall Las Vegas, Nov. 2-6, 1987 (Booth B338)
CEBIT, Hanover, March 1988

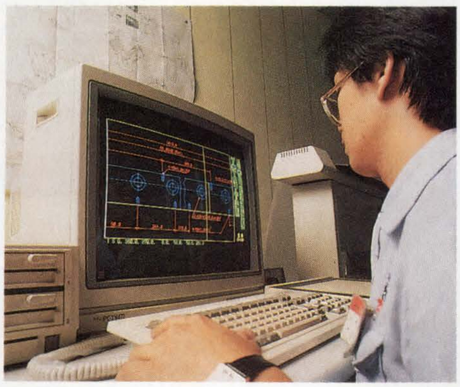


Switch with Liton

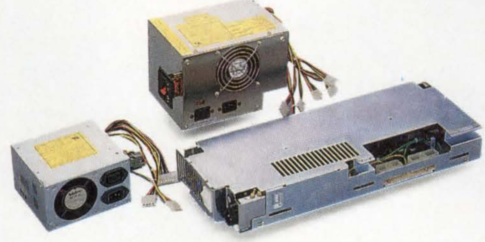
20-1,000W- Meets FCC, UL, CSA, TUV and VDE Standards

TTL-Compatible Power-Good Signal!

Taiwan Liton Electronic Co., Ltd. produces a greater range of high-performance switching power supplies than most any other manufacturer anywhere: 20-1,000W. By customizing cost-saving standard models with an alternative component or two, available SPS configurations run into the thousands.
Design and production fully meets FCC class "B", UL, CSA, TUV and VDE standards. Applications include PCs and workstations, telecommunications equipment, as well as OA equipment like facsimile machines, copiers and



printers. PC models are electrically as well as physically IBM PC/AT, PC/XT compatible and are full-power rated and wired for hard-disk or tape drives, as well as other peripherals. We've built our reputation with top-quality components. With gigantic facilities and modern equipment, we design and manufacture computer and communications products which meet the highest international quality control and performance standards.
Our R&D customizes a standard model or generates a 100% original design in a lead time worth switching for!



CIRCLE NO 149

Taiwan Liton Electronic Co., Ltd.

12th Fl., 25 Tunhwa S. Rd. Taipei, Taiwan, ROC
Tel: (02) 771-4321/8 Fax: 886-2-751-1962
Tlx: 24514/20211 TWLITON

*IBM PC/AT and PC/XT are trademarks of the International Business Machines Corp.

Introducing the MK41H80 TAGRAM.™ The industry's first and fastest integrated 16K CMOS cache tag SRAM dedicated for use in all high-speed processor environments.

TAGRAM gives you a 4K × 4 CMOS SRAM and a 4-bit comparator integrated on a single chip. It's optimum for interface with 16-25 MHz processors, and is backed by 1.2μ double level metal full CMOS process technology – the same proven process used in all of our 16K VF SRAMs.

TAGRAM comes in three speed grades: 20, 25 and 35ns. And every MK41H80 cache TAGRAM is available in 300 mil, 22-pin plastic and ceramic DIPs. What's more, TAGRAM's full-speed read access ensures that even copy-back designs can be implemented without ever having to wait. And it features Flash Clear – the function requested most often by cache system designers. So your cache can be wiped clean to all zeros in 40ns. Max.

High-performance cache applications demand high-speed solutions. If you'd like to realize a 30% reduction in access time compared to discrete solutions – plus a substantial reduction in the cost of component real estate – start increasing your cache flow with the newest member of our family. The MK41H80 TAGRAM.

U.S. and Canadian Sales Offices

Western Area:

Santa Clara, CA 408/970-8585
Irvine, CA 714/250-0455
Woodland Hills, CA 818/887-1010
Seattle, WA 206/632-0245
Longmont, CO 303/449-9000
Tigard, OR 503/620-5517

Eastern Area:

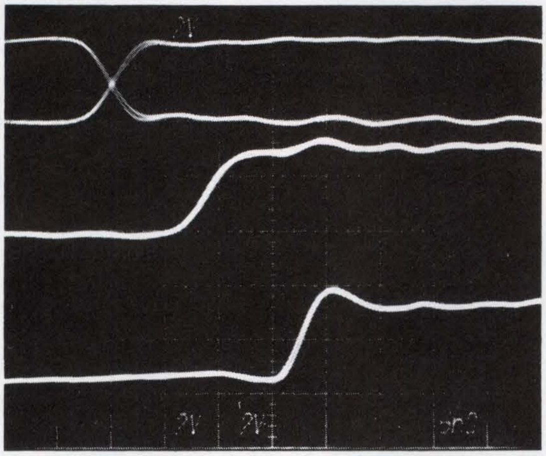
Burlington, MA 617/273-3310
Marlton, NJ 609/596-9200
Huntsville, AL 205/830-9036
Poughkeepsie, NY 914/454-8813
Dublin, OH 614/761-0676
Norcross, GA 404/447-8386

Central Area:

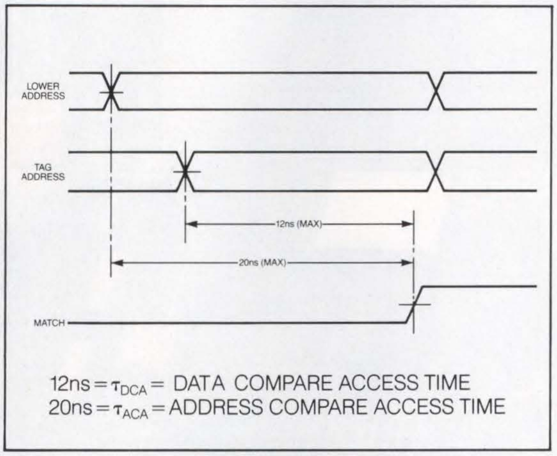
Carrollton, TX 214/466-8844
Schaumburg, IL 312/397-6550
Austin, TX 512/451-4061

Canada:

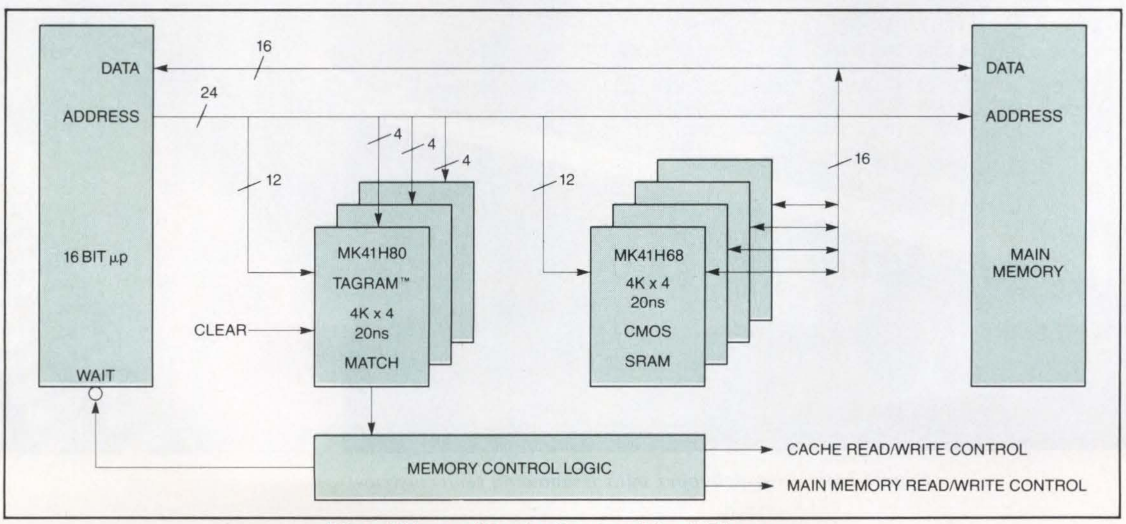
Brampton, Ontario 416/454-5252
Western Canada 503/620-5517



Actual MK41H80 TAGRAM Scope Trace Photograph



Match Access Timing



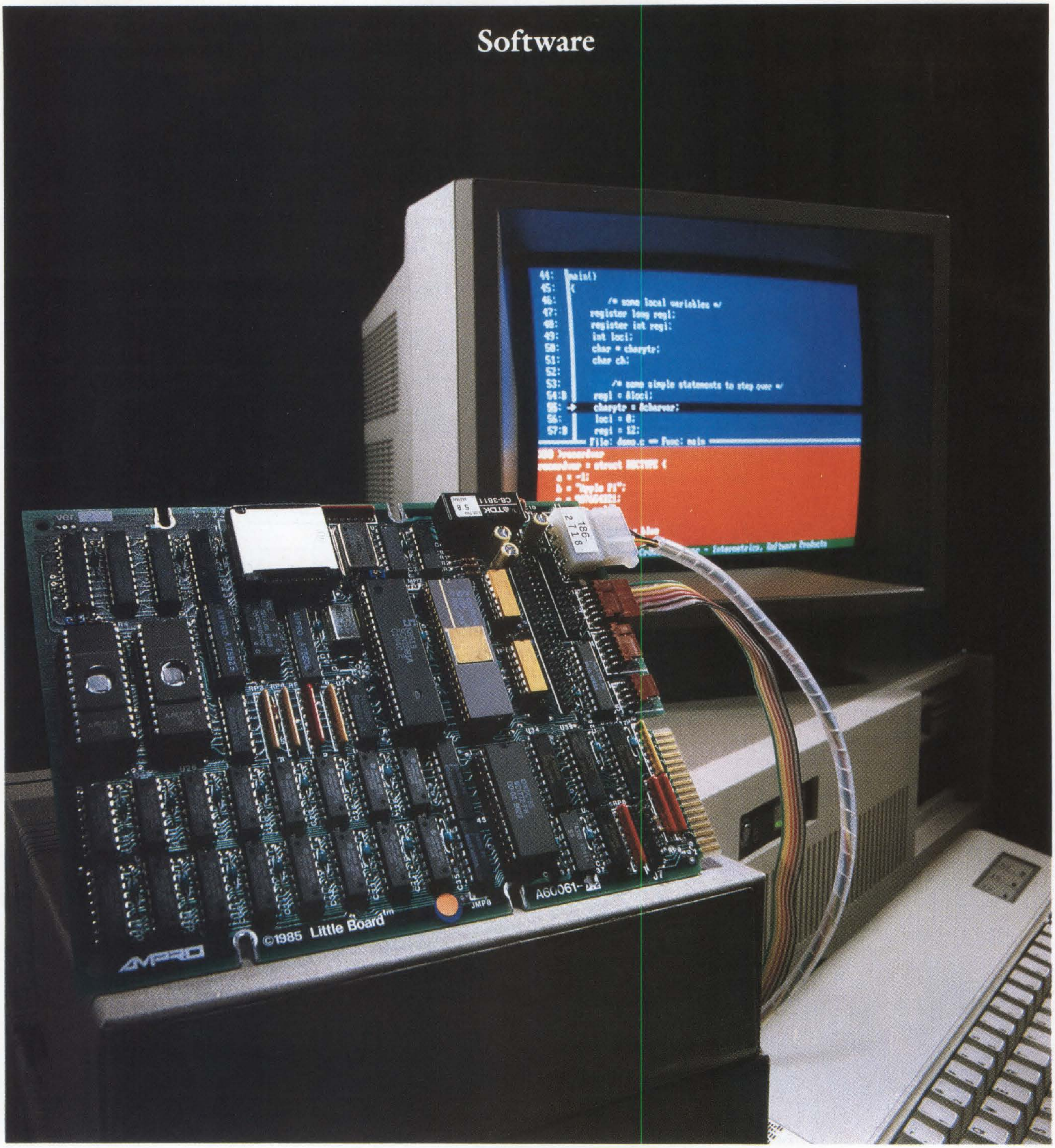
Direct Mapped Cache System Block Diagram

SGS-THOMSON
MICROELECTRONICS

Formerly known as Thomson Components-Mostek Corporation.

TAGRAM is a trademark of SGS-Thomson Microelectronics.

Software



Source-level cross-debugger with windowing (Intermetrics)

Because of the increasing use of high-level languages and real-time operating systems, assembly-language debuggers no longer suffice. They're giving way to debuggers that can correlate target-system activity with high-level source code and ones that can manipulate real-time operating systems.

Debuggers help you perfect high-level and real-time code

Charles H Small, *Associate Editor*

***In-circuit emulator and high-level-language debugger** (Applied Microsystems and Microtec Research)*

To help you adopt high-level languages and formal real-time operating systems, vendors are providing high-level-language debuggers that offer such features as breakpoints, program-trace capabilities, and memory-manipulation commands that accept the names of high-level-language constructs as arguments.

C is the language that debuggers cover most widely—followed by Pascal. However, Concurrent Sciences' Soft-Scope debugger works with Intel compilers for PL/M, Pascal, Fortran, C, and—amazingly enough—Jovial. The Tektronix Ada 68020 system includes a debugger for Ada code that you compile for the 68020 µP.

Older debuggers (see **box,** "Evolving requirements for debuggers"), based on a target-system ROM monitor and a simple CRT human interface, are like reluctant but entirely truthful witnesses; they answer all questions you put to them faithfully but never volunteer anything. Such monitor-ROM programs and preprogrammed ROMs are still available from all µP makers and from third parties like Allen Systems.

Genesis Microsystems' GeneScope ROM-based debug monitors for the 8086 family have a full-screen user interface, which comes in three versions. One is the company's standard interface. Two others mimic the interfaces of Applied Microsystems and Zax in-circuit emulators' interfaces. You can debug a target system with both the ROM monitor and an in-circuit emulator without having to contend with two different interfaces.

Newer, screen-oriented debuggers use multiple windows to display a wealth of information at each break in execution. Many, like Microtec Research's Paragon Xray debugger, allow you to set up your own windows to display any area of memory in any format you choose. Such capability proves useful, for example, when you are pulling data from one buffer, processing it, and writing the processed data out to another buffer. You could set up windows to display both buffers and then stepover (see **box,** "Glossary of high-level debugging terms") the data-processing routine repeatedly to observe its effect on the data.

Not just a passive window

Like many window-oriented debuggers, Sun Microsystems Inc's DBX has windows for source code, captured execution traces, and memory and register dumps. DBX's source-code window is more, however, *Engineers will be adopting high-level languages and formal real-time operating systems simply because software projects continue to grow in size and complexity.*

than just a passive window into the source code. You can also edit programs in this window without leaving the debugger. Most other debuggers do not have such a direct path back from the realm of finding bugs to the realm of correcting them.

Some of the software engineer's difficulties stem solely from working in a cross-development environment. Cross-development simply means developing programs on a computer other than the target—the one on which the code will execute. An example would be writing programs to control a microwave oven. Obviously, you cannot develop programs on a microwave oven, because it has no keyboard, screen, or mass storage.

If the high-level-language debugger is not intended as a universal debugger for a variety of high-level languages, then its vendor can make the debugger's command interface resemble a single high-level language. For example, the command language of both Oasys's C source-level debugger, CDEBUG, and Microtec Research's Paragon Xray debugger conform to standard C notation. TekDB from Tektronix has a strong expression evaluator that understands nearly any C expression.

Universal debuggers, on the other hand, force you to learn what amounts to another programming language if you are to take advantage of the debuggers' macro facilities.

High-level-language debuggers have commands that suit the style of high-level-language programming. In fact, using them resembles editing as much as it does classical debugging. For example, most have a so-called breakdown command that allows you to get out of a subroutine and back into your main program without stepping through the remainder of the subroutine. This command comes in handy when you inadvertently find yourself stepping through, or breaking into, an uninteresting subroutine.

Debuggers still come up short

Although new debuggers are more powerful than their forebears, they do have shortcomings. High-level-language debuggers purport to be symbolic debuggers, but not all so-called symbolic debuggers are equal. As a minimum, a symbolic debugger takes a symbol name as an argument for a memory reference. This simple-to-

Evolving requirements for debuggers

EDN surveys reveal that EDN readers do considerable cross-development of real-time programs for various target systems. Although many currently write their code in assembly language and handle the real-time chores with a control loop or a go-on-interrupt scheme, these *ad hoc* methods will have to give way as software projects continue to grow in size and complexity. Software engineers are more productive if they write their code in high-level languages; further, formal, real-time operating systems offer built-in protection against many of the common pitfalls of home-brewed real-time schemas.

But formal design methodologies, languages, and operating systems don't guarantee error-free code. Moreover, surveys show that debugging real-time code takes five times as long as debugging ordinary applications programs (that are written in a high-level language and that will run on the host development system, thus taking advantage of the host's operating system).

Traditionally, debuggers have handled only assembly language, so software engineers programming in high-level language could debug their code in the target system only in assembly language. These engineers not only had to become familiar with the target system's μP, they also had to learn the conventions their compiler used for such tasks as setting up storage for variables and passing parameters to procedures.

Further, to make sense of activity in their target system, software engineers had to be able to correlate assembly-language statements back to the high-level-language statements that generated them. They also had to determine which registers held which variables, decode the stack to find parameters, return addresses and local variables, and manually reformat memory dumps into high-level-language data structures.

It's only recently that debuggers, such as those discussed in the accompanying article, have begun keeping pace with advances in high-level languages and real-time operating systems.

implement feature is a time saver: You needn't refer to your compiler's cross-reference table each time you want to access a program location in the target system.

But this so-called symbolic capability speaks not at all to the **data** at the named location; simple symbolic debuggers are of little help when confronting multiple levels of indirection. Suppose, for example, that you are trying to *de-reference* a pointer. Your debugger will accept the pointer's name in lieu of the pointer's hex address as the argument of an examine-memory command. The debugger will return the hex value of what the pointer points to. But that pointer could be pointed at a named object. Unless the debugger has the ability to correlate the symbol table with fetched data, you will not be able to avoid flipping through the symbol table manually yourself.

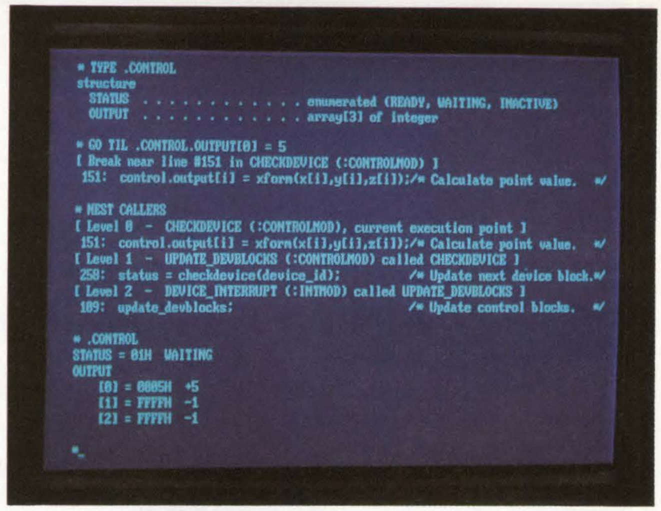
Systems & Software's SoftProbe II has a command format that, taking a cue from C-programming operators, allows you to go through as many as seven levels of indirection by appending a corresponding number of asterisks to a pointer reference. Similarly, Ready Systems' RTscope real-time operating-system debugger has a debugging command that traverses linked lists.

Name matching often fails

Further, not all symbolic debuggers can match an area in memory with the symbolic name for that area when fetching data from data structures. Suppose that your program is accessing an array. The compiler's symbol table will have an address only for the start of the array. The debugger will find an exact match, therefore, only between the address of the first entry in the array in the target system and the array's name in the symbol table.

Unless the debugger works like Computer Dynamics' RDSD debugger for the firm's line of single-board computers, the debugger will not be able to match a reference to the array's subsequent entries. RDSD attempts to find the nearest symbolic reference to a memory access (it displays the offset from the access to the symbol as well as the symbol's name). RDSD performs a similar match when decoding return addresses on the stack because the compiler supplies addresses for the entry points of a routine and not the exit points a routine calls other routines from.

Tektronix's debugger for its Pascal compilers can even format the contents of enumerated variables according to your Type declaration for the enumerated variables. For example, suppose you declare a variable STOPLIGHT that can only store enumerated variables of the type RED, GREEN, and AMBER. If you interrogate STOPLIGHT, the debugger will reply with RED, GREEN, or AMBER as appropriate; debuggers for other compilers could not make this correlation without your first writing an elaborate conditional macro.



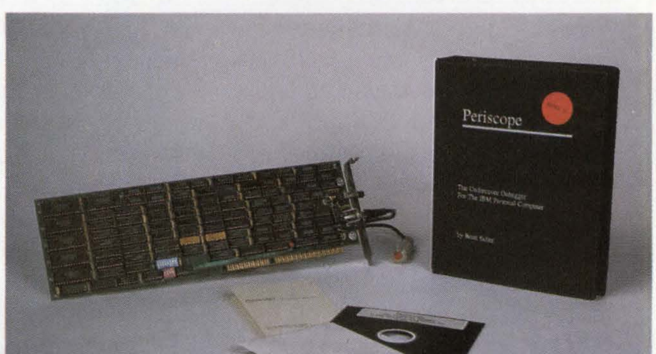
Debugger for stack-oriented high-level language *(Concurrent Sciences Inc)*

Four new forms

In general, the new debuggers come in four forms:

- Software simulators that run on the host computer;
- ROM-based high-level-language debug monitors that reside in the target system and communicate with the host computer;
- Hardware-based debuggers that integrate control software on the host computer with in-circuit emulators and logic analyzers that monitor and control the target system; and
- ROM-based real-time operating-system debug monitors that reside in the target system and communicate with the host computer.

These debuggers are not mutually exclusive; you can employ one or all of them on a given project (although having a high-level-language debug ROM and a real-



Hardware/software debugger package for IBM PC *(The Periscope Co Inc)*

Until recently, debuggers were not keeping up with advancements in high-level languages and real-time operating systems.

time operating-system debug ROM in the same target system can cause conflicts).

For years, the Boston Systems Office has supplied a powerful simulator, BSO/Debug, along with its VAX-based cross-development assemblers and compilers. The simulator was recently upgraded with a window interface that works with DEC's new color workstations and terminals. One user simulated an entire Intel iRMX real-time operating system, including simulated I/O and asynchronous interrupts, using BSO/Debug. Because of the wide diversity of target environments and emulators that the firm's customers use, BSO has only recently begun working on interfaces to common development hardware. Mecklenburg Engineering also makes µP simulators that can run assembly-language programs.

Several companies already make debuggers that use the same command interface when overseeing programs running in the host computer on a simulator or in the target system. Systems & Software's SoftProbe II for 8086 µPs is one such combination. This high-level-language debugger works with C, PL/M, Pascal, and assembly languages that use the Intel OMF file-output format. It runs as a simulator on VAX computers and IBM PCs and runs in target systems with the aid of a ROM-based monitor. It cannot, however, trace register variables.

A target-system's ROM-based debugger cannot debug certain portions of code. Because debug ROMs (or monitors, as they are sometimes called) use a software-based breaking mechanism, they can trace execution only through RAM-resident code and not through ROM-resident code without the aid of an in-circuit emulator's emulation memory. Intel debugger ROMs, for example, set breakpoints by replacing the instruction at the breakpoint with a software trap instruction. Also, ROM-based debuggers usurp target-system facilities. Typically, the debuggers need exclu-

In-circuit-emulator makers do an about face

The problems associated with debugging cross-developed code that was written in a high-level language are reversing a long-standing trend toward stand-alone, unbundled emulators. The first emulators came as a part of bundled development systems from µP makers and large instrument firms. These development systems were expensive. When the personal computer emerged, smaller manufacturers not involved in semiconductor production seized an opportunity to break out the in-circuit emulator from the bundled development system. They started a trend toward stand-alone in-circuit emulators.

The stand-alone in-circuit emulator is a good, low-cost approach for debugging small, cross-developed programs written in assembly language. But the pressure of big programs written in high-level languages is propelling third-party, stand-alone-emulator makers to link up with compiler and debugger vendors. For example, Applied Microsystems can now supply versions of two compiler/debugger combinations targeted for the firm's emulators: The Validate/Xray debugger that works with Microtec Research's Paragon compiler and the Validate/Soft-Scope debugger that works with Intel compilers. Intermetrics now has versions of its XDB debugger that interface to common third-party in-circuit emulators from firms such as Applied Microsystems, Zax (Irvine, CA), and Microtek Labs (Gardena, CA), as does First Systems Corp for its MicroScope ROM-based, target-system debugger.

These pre-existing debuggers now have simple additions to their command languages that allow them to function as transparent terminals to the emulator's native command language. The debugger and emulator software continue to operate more or less independently. Despite the availability of these package deals, the debuggers and emulators are not as well integrated as the packages from Hewlett-Packard, Tektronix, and Arium.

Another example of a high-level-language debugger coexisting with a lower-level debugger is Andyne Computing's PCMascot real-time operating-system kernel. This system runs on the IBM PC and comes with a suite of debugging commands for the real-time operating-system constructs. If you enter the PCMascot debugger via the native MS-DOS debugger, keying in a Break command on the PC's keyboard returns you to the DOS debugger.

sive use of at least one software interrupt and also the use of a communications port.

Even a cursory examination of the triggering schemes of software-based versus hardware-based debugging tools reveals one essential difference: Software-based tools have only a single level of conditional triggering; hardware-based tools (in-circuit emulators and logic analyzers) feature multiple levels of sequential triggering.

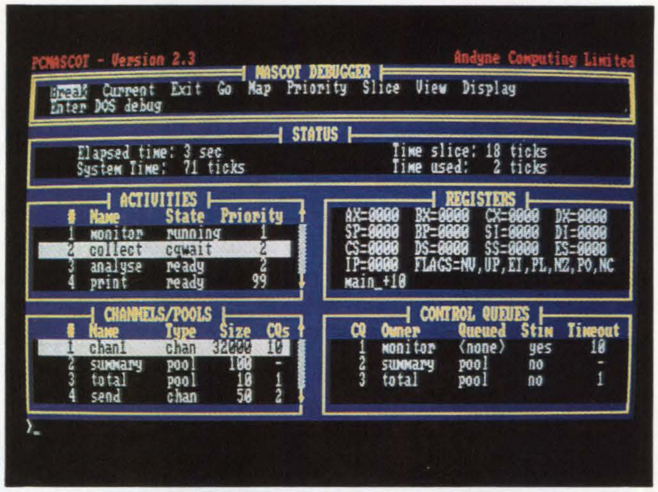
A software tool breaks whenever the program reaches a breakpoint or alters a watchpoint; you can set up a hardware-based tool to break only after a certain sequence of events occurs. Thus, a hardware-based tool can filter out extraneous activity and focus on problem areas more closely than software-based tools do. For example, you could set up a hardware-based tool to break execution only after a real-time operating system's supervisor program activates a certain task and that task jumps to a portion of re-entrant code or accesses a common data structure. A software-based tool would break no matter which task used the re-entrant code or accessed the data structure.

Once you've gotten into a procedure, you might want to find out how you got there, especially if this procedure has many different potential callers. A stack traceback command works directly from the current program stack; therefore, you need not have made any previous setup or issued any explicit trace-collection command, as you would have to do with a hardware-based tool. Unless your target-system debugging hardware includes logic-analysis capability, you could not collect such linkage information without slowing down execution anyway.

Finding your way

Stack traceback commands come in two forms. Simple traceback commands print out the stack and show you the sequence of calls that preceded the activation of the routine you are currently debugging. These commands let you view the results of dynamic, run-time nesting of the program as opposed to static, lexical nesting in your source code.

More advanced traceback commands allow you to retrace your steps to a higher-level calling routine or to adjust the stack to bypass a called routine that isn't working properly without recompiling and downloading the corrected module. In this case, you would have to use the debugger's commands to manually perform the correct action that the malfunctioning subroutine isn't performing.



Real-time operating-system debugger *(Andyne Computing Ltd)*

For serious hardware-level debugging, you need an independent, non-intrusive window into the target system—in short, an in-circuit emulator.

Having special hardware evaluate conditional breakpoints speeds up the debugging session and points out one of the advantages of debugging with in-circuit emulators. For example, when Tektronix's TekDB is working with one of the company's emulators, the firmware in the emulator determines whether the breakpoint condition qualifiers are True each time the software under test reaches a breakpoint. The debugger running on the host computer gets no notification of the Stop unless the condition being checked is True. This system eliminates your checking a variable manually each time the program stops to determine when the variable's value goes out of bounds. Tektronix's hardware can evaluate approximately 90 conditional expressions per second (including the time consumed by restarting execution).

Arium's Echo μP-development system serves as an example of the benefits of a closely integrated host, compiler, debugger, and in-circuit emulator. The unit costs $12,980 for 16-bit and $8960 for 8-bit μPs. The Echo's computer has a pair of 68000s—one for display and one to run the Regulus operating system (a Unix look-alike with real-time extensions).

The unit has two high-speed links: one optional Ethernet link for quickly downloading large files from other host computers and a serial link to its companion in-circuit emulator. Because the Echo's main memory is expandable to 2M or 4M bytes, the computer can hold your entire source file in RAM for very quick correlations between captured traces from the in-circuit emu-

Not all symbolic debuggers can match up an area in memory with the symbolic name for that area.

lator and the corresponding portion of source code; most other such systems have to get the source code from disk. The unit can not only disassemble and decompile captured code using your labels, it even appends the appropriate comments from your source code to captured traces.

The Echo understands the conventions of the Green Hills (Glendale, CA) C and Pascal compilers. These single-pass compilers (ones that produce no intermediate assembly-language file) compile code faster than some other, two-pass compilers.

The in-circuit emulator can reload its event recognizers dynamically. Once armed with stack offsets for local variables, the emulator can add the offsets to the value of the stack-pointer at the point that the software under test enters a routine to be debugged. The emulator can thereby set up its event recognizers to trace and trap on local variables. Hewlett-Packard's 64000 system is the only other system on the market that can trace and trap on local variables in real time without halting program flow.

Nearly all vendors of real-time operating systems, such as Ready Systems (RTscope), JMI Software Consultants (CE-View), Intelligent Machinery Co (imx/51), and Software Components Group (Probe), offer debuggers that allow you to examine and change the state of

Optimization and what it does to your program

Optimizing compilers further obscure the correspondence between your source code and the compiled object code. If you write real-time programs in a high-level language, in order to meet response-time specifications you might find yourself having to switch on your compiler's optimizer and then be forced to debug optimized code.

Among the many techniques optimizing compilers employ is register allocation by coloring. Coloring keeps the most commonly used values in registers at all times. The compiler examines the entire subroutine to determine which local variables and parameters get used most often in the routine. It allocates them to registers.

Further, the register allocator can use data-flow analysis to find the lifetime of each variable. Using this information, it can increase the number of variables that get stored in registers by using the same register for several variables in the same subroutine. Also, because some compilers know the lifetime of each variable, they may even allocate several variables to the same register if there are no places in the program in which both variables hold a value that will be needed later.

In addition, if the lifetime of a variable does not include any function calls, the variable can be put into scratch registers that do not need to be saved and restored, thus reducing variable overhead even further. Using these schemes to keep variables in registers can speed program execution but can also confuse your debugger horribly because it does not know just where a variable is at a given time or, conversely, just what the contents of a given register mean at a given time.

By default, your compiler can consider any integral, floating-point, or pointer variable as a candidate for register allocation if it never gets passed by reference and its address does not get taken by the C "&" operator at any point in the routine.

In other words, don't be fooled by the C-language mechanism that allows you to specify "automatic" variables; compilers will try to put as many variables as possible into registers. Conversely, if you specify more variables as automatic than there are registers in your target system's μP, the compiler may put your register variables on the stack. Worse yet, some compilers ignore the automatic-variable assignments altogether and put everything on the stack. The point here is that unless you are very familiar with your compiler's habits, you cannot be nearly as sure of just where your program's variables are as you would be if you were programming in assembler and making all the variable assignments explicitly yourself.

An optimizing compiler normally removes all dead code—code that never gets executed. Such code could be subroutines that never get called. Dead-code removal also includes removing WHILE loops that never get executed and DO-FOR loops that get executed only once. Obviously, if you set a breakpoint on a the operating system's tables and also to manipulate the operating system's mechanisms for scheduling tasks and managing intertask communication. For instance, you can freeze one task while leaving the remainder of the tasks up and running. What these debuggers generally do not allow you to do is to debug the code that the individual tasks are running.

Tektronix's Ada debugger is one high-level-language debugger that allows you to qualify a breakpoint by task. In addition to selecting which program you want to debug, you can also select a task to be the current task under debugging.

On the other hand, if you use a conventional ROM-based, high-level-language debugger to debug a task's code, jumping to the debugger ROM has the effect of changing context from the real-time operating system to the debugger. In other words, halt one process and you halt all task activity. Imagine that you're debugging a real-time system for a robot. Perhaps you want to halt the task that moves the robot's arm back and forth. If you use a high-level-language debugger instead of a real-time operating-system debugger, all the robot's software will halt. But just because you've stopped the arm doesn't mean it's okay for the robot to relax its grip.

Real-time operating-system debuggers, such as Soft-

---

line of dead code that has been removed from the executable code, the debugger could have trouble executing your command.

Optimizing compilers will also rearrange your code in several ways. One way is branch-tail merging, which refers to pulling common statements out of both branches of an IF-THEN-ELSE construct and putting just one instance of the common statements at the end of the construct. The compiler can also remove redundant jumps. That is, if you have a jump statement to yet another jump statement, the compiler will jump directly to the second jump statement's destination. Less obviously, if you have nested WHILE statements, an optimizing compiler will jump directly to the outer WHILE when the inner WHILE fails instead of jumping first to the inner WHILE's exit point.

Optimizing compilers can violate some of the overly restrictive rules of structured programming, such as requiring all routines to have a single exit point. If you turn on your compiler's optimizer, your routines can have only one entry point but multiple exit points. For example, an optimized CASE statement will have an EXIT for each clause; an unoptimized CASE statement could end up performing all the tests in the CASE structure even if the first test succeeds because the statement has its EXIT after the last test. Multiple exit points can make decoding the return address on the stack difficult. Further, many software tools, such as software performance analyzers, assume that the entry and exit points of routines always come in pairs.

Optimizing compilers also perform the intriguingly named operation of "code hoisting." The compiler will skip writing out the results of a calculation upon a variable if the calculation is followed by further calculations on the same variable without any intervening references to the variable. This operation is quite mysterious to high-level-language programmers but perfectly clear to assembly-language programmers.

To perform a calculation on a variable, the μP must first load the variable into a register. There's no point in writing the result back out from the register to the variable's location in memory if the program will be pulling the variable back in shortly for further calculations. It's better to simply leave the result in the register and write it out after all calculations are completed. But if you were to examine the variable's location in memory at any program steps between the first calculation and the final writing out of the register's value, you would not find the correct, updated value at the variable's address; the correct value is in a register.

More well known is the optimizing compiler's trick of pulling invariant operations out of a loop so that they get executed only once and not repeatedly each time the loop executes.

Several firms make debuggers that use the same command interface for programs running on the host computer or on the target system.

ware Components Group's Probe, do allow you to set breakpoints on addresses in your programs, but these simple facilities are a far cry from the power of high-level-language symbolic debuggers.

Microware Systems Corp has a pair of debuggers for its OS-9 real-time operating system. One, sysdbg, is a system debugger that takes over the entire operating system and halts all tasks. It communicates using the normal system port and its associated device handler and operating-system calls. The other, Debug, runs as a task and invokes the task to be debugged as a child process of the debugger. Debug can also access the symbol table produced by the firm's OS-9 linker. Therefore, it combines both a high-level-language debugger and a real-time operating-system debugger in one.

Loading multiple debuggers into one target system can present problems if both debuggers use the same software trap to gain control of the target system. You would have to develop a software mechanism for saving and restoring the software trap's contents when switching contexts from one debugger to the other.

Despite their different implementations, the various debuggers have many similar strengths and weaknesses. Delving into how the debuggers accomplish

Glossary of high-level debugging terms

Programmers sometimes use old words in different ways, coin useful, but obscure, new words, or—confusingly enough—use several words to describe more or less the same thing, depending on which language they are using—subroutine, procedure, pragma, object, or module, for example. Here is a glossary of words you may encounter in the literature of high-level-language debuggers.

Automatic variable—Another name for *local variable* (see *Stack frame*).

Breakdown—Not a reference to the mental state of the software engineer. A breakdown command sets a breakpoint in the procedure that called the current procedure (that is, one frame down from the current frame on the stack). This breakpoint allows you to get out of a subroutine and back into the main program automatically with one command.

Coloring—The process of a compiler examining variables' usage over an entire subroutine and then assigning the most commonly used local variables to registers and the less commonly used ones to the stack.

Conditional breakpoint—A breakpoint that distinguishes between two events: first, merely reaching a breakpoint, and second, a condition being true. If the condition is False when the program reaches the breakpoint, the program continues.

De-reference—Etymologically unsound (compare to "delouse," for example), but useful, neologism current among C programmers. It signifies getting the object pointed to by a pointer as opposed to directly referencing the pointer itself.

Disambiguate—Homing in on the specific instance of a specified name. It's a useful feature because many high-level languages allow you to use the same name in different parts of the program (see *overload*); thus, if you ask the debugger to find something for you, it may discover several different references.

Local variable—See *Stack frame.*

Maintenance—That portion of the software design and debug process that continues after the program is shipped to a paying customer (as opposed to a beta-site customer).

Overload—A condition in Ada attributed to a name that can refer to several things in different modules (called "pragmas"). See *disambiguate.*

Root—Used as a verb; for example: "For Ada programs, this name need not be fully *rooted* as in **standard.math.sin**—the simple name, **sin** may be used." It's derived from the notion of having a *root* directory in a hierarchical directory scheme.

Scope—Delimits the portion of a program over which a given instance of a named program construct is valid. An example is a local variable that gets used only in a subroutine. Its scope does not extend beyond the subroutine, and hence you can use the name with impunity in other subroutines.

Stack frame—A variable-length data structure. Languages such as Pascal and C use the stack, instead of main memory, for storing variables that will be used only inside a given subroutheir tasks helps explain these characteristics.

Concurrent Sciences' Soft-Scope serves as an example; when Soft-Scope first opens a module of your source program, it searches the listing file to find the beginning of each line and records these file locations. At the same time, the debugger searches the executable load file to find and record the address of each executable line. The association between source and executable code makes displaying source code during program execution possible. The debugger stores this information in a temporary disk file, so it needs to make this correlation only once during a debugging session for a given module. Note that Concurrent Sciences' debuggers work only with Intel compilers; the firm maintains that other compilers do not produce enough cross-reference information to power a comprehensive debugger.

Debuggers cannot always resolve all ambiguities when matching up raw hex data with the compiler's symbol tables. If the program is jumping to an address, or accessing a given address, the debugger can unequivocally substitute the name it finds in the compiler's symbol table for the raw hex address. But suppose the program is moving a hex number into a register. That

---

tine. They also use the stack for passing parameters and pointers to data structures between routines. And, of course, the stack still has to do its normal job of holding return addresses of calling procedures. Therefore, the compiler sets up a stack frame each time the program enters a routine. If you know the structure of the stack frame, the exit points of calling routines, and the form (type) of the variables on the stack, you can decode the stack frame to determine the sequence of calling routines from the return addresses and the state of local variables both in the currently active routine and in the suspended calling routines.

Static breakpoints—Sometimes called sticky breakpoints. They are active no matter how many times the program halts at them. Some debuggers distinguish between static and dynamic breakpoints. These debuggers insert a temporary—or dynamic—breakpoint as a part of a Go command that takes an argument (**Go** until <argument>). When the debugger reaches the point in the program signified by the argument, it halts and removes the breakpoint.

Stepover—An extension of the concept of single-stepping. A stepover operation allows you to execute subroutines in a single step while still single-stepping line by line through a higher-level routine.

Trigger and trap—Features that break program execution. Some debugger makers distinguish between *triggers* and *traps*. They use *trigger* to mean a hardware event recognizer in an in-circuit emulator or logic analyzer that can break execution, and they use *trap* to refer to a break in execution caused by a special instruction inserted in the program under test.

Viewport—Synonym for a CRT window that shows a formatted, predefined segment of memory.

Visibility—A debugger's rule that determines which named variable, structure, and other program constructs are visible at a given point in the program's execution. Generally, debuggers, by default, comply with the high-level language's scoping schema. However, a good debugger will allow you to exceed the high-level language's scoping and accord you visibility beyond the current procedure if you desire it (see *scope*).

Watchpoint—A breaking mechanism. Some software-debugger makers distinguish between a breakpoint and a watchpoint. To them, a breakpoint is a command inserted in a program's commands that causes the program to stop and transfer control to the debugger. A watchpoint is a macro that first examines a designated memory location after each instruction cycle to see if the memory location has been changed and then stops execution if necessary. Because of the different breaking mechanisms, software-debugger makers think of breakpoints and watchpoints as being different entities; hardware debugging tools do not, of course, distinguish between the two because they are both definable states of the μP's address, data, and status lines.

No matter how powerful your debugger is, you will probably always have to use your creativity and imagination to debug your programs.

number could simply be data that will be used in an arithmetic or logical operation, or it could easily be an address or pointer. If the debugger finds that particular hex value in the symbol table, the match could be pure coincidence.

Periscope's debuggers handle this ambiguity by displaying possible matches in the comment field of a disassembled listing rather than by plugging in the match in the instruction field **(Fig 1)**.

Not all programmers bother to put line numbers in their source code. Therefore, several debugger makers, including Systems & Software, supply utilities that insert line numbers in a file. Systems & Software also supplies utilities that print out Intel OMF files in a readable form so that you can study your program's symbol tables.

Oasys's CDebug high-level-language debugger comes with a utility program that goes even further than merely inserting line numbers into your source program. The firm's XPP preprocessor is an automatic editor (or stream editor) that will parse your source code, looking for anything a debugger might be interested in later on. When XPP finds something interesting, it sets up a pointer to it using the native C pointer mechanism and puts the pointer in a table.

Later, when you compile the preprocessed source file, the compiler will produce a custom-made symbol table in just the form the CDebug debugger is looking for. Thus, Oasys sidesteps the issue of accommodating different, and possibly incomplete, symbol tables from various compilers. The Periscope debuggers, for example, accept symbol information only from MAP files produced by Microsoft compilers.

```
                    START:
0C73:0137 E81700            CALL   GETMEM
0C73:013A A13301            MOV    AX,[TOTMEM]
0C73:013D BF1001            MOV    DI,0110         ; TMEMORY
0C73:0140 E82400            CALL   CONVERT
0C73:0143 A13501            MOV    AX,[FREMEM]
0C73:0146 BF2C01            MOV    DI,012C         ; AMEMORY
0C73:0149 E81B00            CALL   CONVERT
0C73:014C E83400            CALL   DISPLAY
                    DOSRET:
0C73:014F CD20              INT    20              ; Program terminate
                    GETMEM:
0C73:0151 B106              MOV    CL,06
0C73:0153 BE0200            MOV    SI,0002
0C73:0156 8B04              MOV    AX,[SI]
```

***Fig 1—Although most symbolic debuggers can** decompile or disassemble a program's activity using the names of your defined memory references and subroutines in place of raw hex values, few can resolve ambiguous data fetches. Note the references to TMEMORY and AMEMORY that appear in the comment field of this Periscope Co Inc disassembly listing. The disassembler inserted these references as possible matches with the data in the argument of the corresponding MOV commands on the same lines.*

No matter how powerful your debugger is, you will probably always have to use your creativity and imagination to debug your programs. Software engineers sometimes employ run-time schemata that pose the same problem to debuggers as the compilers' local and register variables do. Take, for example, overlays. If you load the overlays into the same area of memory every time, then you will be able to set up breakpoints within the overlaid code. Of course, if you're using a software-based debugger, you will have to set software breakpoints *after* your program loads the overlays, or else the software traps will get overwritten; conversely, you can set up hardware traps in advance.

If, however, your program determines the location of overlays dynamically, then you cannot determine memory locations in advance. The Intermetrics XDB has a mechanism for handling this problem. During the debugging session, you can extract the offset for the overlay and instruct the debugger to add the offset to all the addresses in the symbol table. Obviously, you cannot do this in real time.

Real-time systems pose problems similar to overlays —especially if they create and destroy tasks dynamically. Further, in real-time systems, different tasks can use the same piece of re-entrant code. If you set a breakpoint in the re-entrant code, you won't necessarily catch the task you are trying to debug. Generally, software-based debuggers offer no solution to this problem; luckily, hardware-based debuggers offer sequential triggering that can resolve this ambiguity.

Debuggers serve other uses

A high-level-language debugger's ability to relate the source code to the flow of execution makes it a useful tool when you must modify or debug code that someone else has written.

You can use a source-level debugger for learning the high-level language itself, and you can use it for maintenance and testing. If you choose to write your code with a high-level language, you may have planned to eventually port your software from one hardware environment to another. A debugger can help smooth the porting process. Further, you can use a debugger to demonstrate, document, and profile a program.

Many high-level-language debuggers can optionally keep a record, or journal, of your debugger commands in a file. You can edit this file and rerun the commands from the file. In this way, you can gradually build

For more information . . .

For more information on the debuggers described in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Allen Systems
2151 Fairfax Rd
Columbus, OH 43221
(614) 488-7122
Circle No 613

Andyne Computing Ltd
544 Princess St, Suite 202
Kingston, Ontario
Canada K7L 1C7
(613) 548-4355
Circle No 614

Applied Microsystems Corp
Box 97002
Redmond, WA 98073
(206) 882-2000
(800) 426-3925
TLX 185196
Circle No 615

Arium Corp
1931 Wright Circle
Anaheim, CA 92806
(714) 978-9531
TLX 754903
Circle No 616

Boston Systems Office
128 Technology Center
Waltham, MA 02254
(617) 894-7800
TWX 710-324-0760
Circle No 617

Computer Dynamics
107 S Main St
Greer, SC 29651
(803) 877-8700
Circle No 618

Concurrent Sciences Inc
Box 9666
Moscow, ID 83843
(208) 882-0445
TLX 4942758
Circle No 619

First Systems Corp
865 Manhattan Beach Blvd
Manhattan Beach, CA 90266
(213) 546-5581
Circle No 620

Genesis Microsystems Corp
196 Castro St
Mountain View, CA 94041
(415) 964-9001
Circle No 621

Hewlett-Packard Co
Fort Collins Systems Div
Customer Documentation
3404 E Harmony Rd
Fort Collins, CO 80525
Phone local office
Circle No 622

Intel Corp
5200 NE Elam Young Parkway
Hillsboro, OR 97124
(503) 681-8080
Circle No 623

Intelligent Machinery Co
2400 Westwood Dr
Longwood, FL 32779
(305) 869-8168
Circle No 624

Intermetrics Inc
733 Concord Ave
Cambridge, MA 02138
(617) 661-1840
TWX 710-320-7523
Circle No 625

Introl Corp
647 W Virginia St
Milwaukee, WI 53204
(414) 276-2937
Circle No 626

JMI Software Consultants Inc
Box 481
Spring House, PA 19477
(215) 628-0840
Circle No 627

Mecklenburg Engineering
Box 744
Chagrin Falls, OH 44022
(216) 338-1900
Circle No 628

Microtec Research
3930 Freedom Circle #101
Santa Clara, CA 95054
(408) 733-2919
TLX 4990808
Circle No 629

Microware Systems Corp
1900 NW 114th St
Des Moins, Iowa 50322
(515) 224-1929
TWX 910-520-2535
Circle No 630

Oasys
230 2nd Ave
Waltham, MA 02154
(617) 890-7889
Circle No 631

The Periscope Co Inc
14 Bonnie Lane
Atlanta, GA 30328
(404) 875-8080
(800) 722-7006
Circle No 632

Ready Systems
Box 61029
Palo Alto, CA 94306
(415) 326-2950
TLX 71510608
Circle No 633

Software Components Group
4655 Old Ironsides Dr
Suite 250
Santa Clara, CA 95054
(408) 727-0707
TLX 757697
Circle No 634

Sun Microsystems Inc
2550 Garcia Ave
Mountain View, CA 94303
(415) 960-1300
TLX 287815
Circle No 635

Systems & Software Inc
3303 Harbor Blvd, C-11
Costa Mesa, CA 92626
(714) 241-8650
TWX 910-695-0215
Circle No 636

Tektronix Inc
Computer Aided Software Engineering Div
Design Automation Group
Box 4600, Mail Sta 94-485
Beaverton, OR 97076
(503) 629-1573
Circle No 637

Visual Age
642 N Larchmont Blvd
Los Angeles, CA 90004
(213) 534-4202
(800) 732-2345
Circle No 638

A debugger's ability to relate the source code to the flow of execution makes it a useful tool when you must modify or debug code that someone else has written.

custom software tools that not only can save you time when repetitively performing complex debugging operations, but that can also serve as test programs for manufacturing and field service.

Many high-level-language debuggers, such as Introl's idb debugger for the firm's line of C compilers for single-chip μPs, have debugger variables that you can declare and use in debugger expressions. These variables reside in the debugger and not in your target system. Such variables prove useful as local variables in debugger macros.

Patch programs with debuggers

Using a high-level-language debugger's in-line assembler (or perhaps just jamming in a manually assembled set of machine-code instructions), you can patch programs without taking the time to recompile or reassemble. First, you replace the instruction at the beginning of the area you want to patch with a jump to a spare chunk of memory. You put the patch code in the unused area and finish it off with a jump back to the starting point or to the address just beyond the area you want to bypass. If your program doesn't have a scratch-memory area, you can reserve a portion of memory for patching by setting up a high-level data array that you do not use in the program. Your high-level language debugger can find the data array when given the array's name. You can then overwrite the data array with impunity.

You can also patch programs with a high-level-language debugger without bothering to go back to edit your source file and recompile it. You can use the debugger to break execution just before the section of code that needs patching. Then, you can execute a macro you have written that performs the correct operation on your data. Last, the macro can resume execution at the end of the code to be patched. If your debugger's command language mirrors that of your high-level language, you can later incorporate the patch in your source code with little effort.

Doing without source code

In some cases, you can trick the code under test into jumping to the debugger even if you do not have source code for it. For example, you could be calling your own assembly-level programs from another program written in a high-level language for which you have no source code. You could break on the entrance to your program and then use your debugger's backtrace feature to identify the calling routine. Then, using the examine and change routines in the debugger, you could replace the calling routine's jump command with a software trap to the debugger's entry point. That way, the next time you run the program, it will jump to the debugger just before entering your subroutine.

Generally, high-level-language compilers issue line-number symbols at the end of each statement or each line, whichever comes first. Therefore, if you concatenate statements on a single line (using a semicolon in C, for example), you can't set a breakpoint between the two statements because the high-level-language debugger can only find the beginning and end of the line. And if you write multiline statements—for instance, an IF statement with several phrases on separate lines for clarity—the high-level-language debugger will only be able to find the beginning of the IF statement and the beginning of the THEN and ELSE clauses, not the individual phrases.

Possible new favorites

Some debuggers have unique features that may become industry standards once they are better known. For example, Visual Age's TurboSmith debugger for TurboPascal programs written on an IBM PC lets you assign breakpoints to groups by appending a number ranging from 1 to 98 to your breakpoints' definitions. Later, you can activate, or deactivate, an entire group of breakpoints, signified by a given number, at once rather than turning them on and off one at a time.

Periscope's debuggers have a set of editor-like search commands, which can look through a range of addresses for instructions that reference a given memory address. This command comes in handy if you are debugging your code by first finding the symptoms of a program bug in the form of corrupted data. Once you find a variable going awry, you then need to find which instructions are modifying it. The firm's debuggers have similar search commands for subroutine calls and return addresses as well as groups of assembly-language statements.

Under the heading of eliminating excessive flipping through related listings, some debuggers, such as Concurrent Sciences' Soft-Scope, can let you look at other files of source code besides the one being debugged. **EDN**

Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

MAKE REAL-TIME FLY.

Now you can unleash all the raw power of the 80386 for real-time applications. All you need is our new iRMK™ real-time multi-processor kernel. It's the lean, clean core of a full-featured operating system.

Its blazing speed lets you keep up with the most demanding applications. Average interrupt response time is less than 10 microseconds. That's incredibly fast.

But more important is the iRMK

VISIT US AT DEXPO WEST, ANAHEIM, CA. DEC. 8-10, BOOTH 801.

kernel's feature set. Which includes interrupt management, time management, mailboxes, semaphores, multitasking, and preemptive, priority-based scheduling.

And if you want more power, the iRMK kernel lets you use more processors. It's the only kernel that delivers multiprocessing support for the MULTIBUS® II Message Passing Co-processor.

Besides running fast, your application will also run right. Because we offer more reliability features than any other real-time kernel. Like user-defined objects. And priority adjusting semaphores (regions) to avoid deadlock.

And if your application requires features beyond what a kernel can deliver, we offer the iRMX® 286. A complete real-time operating system that runs on the 80386 without modification.

In addition to basic kernel functions, it has reprogrammability, a human interface and on-target development.

iRMX 286 and the iRMK kernel are the latest developments in an operating system family we've been refining since real-time began for microprocessors. Currently, there are over half a million CPUs running iRMX, making it the most popular real-time O/S family in the world.

You'll also be glad to know that iRMX operating systems are solidly in touch with the rest of the real-time world. Our OpenNET™ Network connects it to VAX/VMS and even PC DOS compatibles.

REAL TIME COMPARISON			
	Interrupt Latency	Development Host	Regions
iRMK	10 μsec.	PC-DOS	yes
iRMX 286	13 μsec.	self hosted	yes
VAXELN	33 μsec.	VAX/VMS	no

What's more, iRMK and iRMX are easy to get started with. Because they run on our industry standard family of open system MULTIBUS hardware. Including our new 20 MHz 80386 MULTIBUS I and II boards. We even offer complete systems for OEMs like our new 80386-based System 320.

And we top it all off with re-entrant compilers, debuggers, utilities, customer training and consulting.

All designed to make your design task easier and faster.

So why waste any more time? For a real-time response from Intel, call our toll-free number: (800) 548-4725, and ask for Literature Department W-392.

We'll mail a complete information packet within one working day.

And you'll see how quickly time flies when Intel is on your side.

intel®

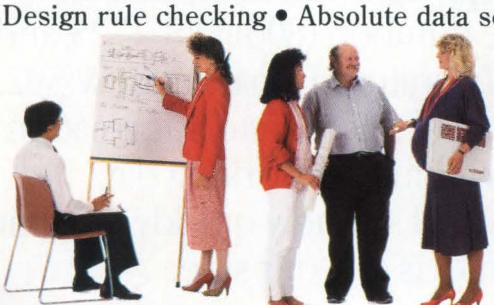
53.6 Reasons to Choose P-CAD for CAE and PCB design.

• End-to-end PCB design • Workstation performance • 53.6% market share* • New! SMT support

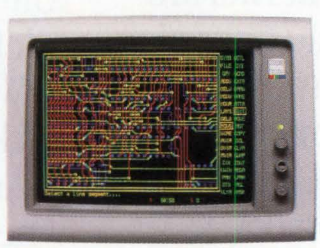
• Low cost schematic design • Auto place & route (45°) • Large board capacity • ASIC design kits

• Operates on standard hardware • Full range of system interfaces • 3000+ component library

• Design rule checking • Absolute data security • 3rd party software & services • 24-hour on-line support



• Local sales & training



To find out why 53.6% of engineers using PC-based CAD systems choose P-CAD® for workstation level performance, call toll-free:

800-523-5207 U.S.
800-628-8748 California

p-cad®
PERSONAL CAD SYSTEMS INC.

Personal CAD Systems, Inc.
1290 Parkmoor Avenue
San Jose, California 95126 USA
Telex: 371-7199 FAX: 408-279-3752

New! State-of-the-art Generation 2.0™

*Source: Dataquest, Inc.
P-CAD is a registered trademark of Personal CAD Systems, Inc.
Generation 2.0 is a trademark of Personal CAD Systems, Inc.

CIRCLE NO 144

User interface integrates incompatible computer-aided software-engineering tools

The Software Backplane, an integrated project-support environment (IPSE), provides a common user interface for software-development tools with different requirements and which run on network nodes that may have different architectures. It runs on Sun 3 workstations under Unix, or on any VAX workstation under VMS or MicroVMS.

The Software Backplane is a collection of software libraries that are organized into four layers. The monitor layer, based on the X Windows standard, provides each application with a consistent user interface. Forms, menus, icons, windowing functions, and mouse operations are the same regardless of the software-development tool.

The management-control layer provides version control and configuration management, and it establishes cross-reference relationships among arbitrary components that represent various phases in the life cycle of the software under development. The object-management layer provides tools and application programs with a common data repository for all project-related data.

Finally, the portability layer provides all tools and applications with a generic operating system that translates service requests into the form required by the native operating system, and it also translates operating-system responses to the form required by the tool or application. Once you integrate a tool into the portability layer, you can run it on any computer with which the Software Backplane can operate. Prices start at $5000.

Atherton Technology, 1333 Bordeaux Dr, Sunnyvale, CA 94089. Phone (408) 734-9822.

Circle No 640

CASE tools facilitate the design of real-time, embedded systems

Cardtools, a set of software-design and -development tools for CASE (computer-aided software engineering), provides the facilities to develop real-time, embedded systems. The tools automate the early, critical phases of software development such as high-level design, detailed design, documentation, and the analysis of system and software requirements.

Using the Control Maps Builder (CMB), you can define functional and data specifications and verify that the definitions are complete and consistent. From these definitions, you can use the Data Flow Diagram (DFD) Builder to define data flow through the system. You can use the Package Definition Facility to build a component library.

If you don't wish to construct your own DFDs, the Taskbuilder tool will do it for you automatically, using the specifications that you generated with the aid of the CMB. The Taskbuilder provides you with diagrams representing the required real-time, multitasking components such as hardware devices, tasks, mailboxes, semaphores, and queues; it also shows the intertask synchronization and communication requirements.

The Real-Time Performance Verification tool analyzes the synchronization and communication overhead. The Software/Hardware Interface facility prompts you for complete, detailed specifications of all signals and data that are processed both by hardware and software.

The specifications and definitions that the tools create are stored in a central database, Cardbus, from which the documentation tools can generate various reports, including reports that conform to DoD-STD-2167. Cardtools runs under VMS on VAX machines and under PC-DOS on IBM PCs and compatibles. Prices range from $10,000 to $60,000.

Ready Systems, Box 61029, Palo Alto, CA 94306. Phone (415) 326-2950. FAX 415-326-1427.

Circle No 641

PC-DOS extension lets C and assembly languages address 16M-byte RAM

DOS/16M lets C and assembly-language programs run in protected mode on 80286- or 80386-based computers. Programs written for DOS can address as much as 16M bytes of RAM without using code overlays, EMS bank switching, or data paging. The program and its data can reside in RAM, eliminating frequent disk accesses and speeding execution. DOS/16M switches to real mode only to process DOS functions or hardware-interrupt requests for which protected-mode handlers do not exist.

The package's run-time library contains routines for managing extended memory and for running programs in protected mode under PC-DOS version 3; a separate component allows you to start programs in protected mode. The package also includes a symbolic debugger for protected-mode programs, source code for the run-time library and start-up code, and a program to convert a real-mode .EXE program to a protected-mode .EXE program.

DOS/16M first adjusts your program for protected-mode addressing, then switches the computer into protected mode before executing the adjusted program. You don't usually need to rewrite or recompile your programs to use DOS/16M; you need only relink them with the run-time library. For example, you don't have to modify programs to omit EMS bank switching, and DOS/16M handles direct I/O and writes directly to video RAM without switching to real mode or adding overhead. You may have to modify any arithmetic operations that your program performs on segment-register values, and any parts of your program (such as interrupt handlers) that write into code segments of memory. If you have to recompile modified programs, you can use Microsoft C version 4.0, or a Lattice compiler, versions 2.15, 3.1, or 3.2. For linking object modules to the run-time library, you can use either Microsoft's Link or Phoenix's PLink86.

An initial-development license costs $5000 and includes replacement libraries for the supported compilers, the protected-mode debugger, and the .EXE file converter. The license confers the right to distribute as many as 200 copies (in .EXE form) of a program you have developed with DOS/16M. A royalty-free, 1-time fee of $29,000 allows you unlimited use and distribution and a source-code license.

Rational Systems Inc, Box 480, Natick, MA 01760. Phone (617) 653-6194.

Circle No 639

Expert system performs structured analysis of real-time software

Prosa, an expert system for software development, supports the structured analysis and design of data-flow, state-transition, and entity-relationship diagrams. It runs on an IBM-PC/AT or compatible and allows you to analyze real-time or data-processing systems. The system interactively maintains consistency between hierarchical data-flow diagrams and control transformations and their associated state-transition diagrams.

You can use Prosa to produce hierarchical designs. Its push-and-pop functions and consistency checking allow you to produce or evaluate systems on a top-down or bottom-up basis. Pop-up menus provide you with only functions that are legal in the context of the current design phase. The system's editing facilities include the placement, movement, and scaling of diagram elements, as well as on-the-fly text editing. You can store user-defined elements in a data dictionary for future use, and you can pan and zoom the display to support diagrams with page sizes equivalent to ISO standards A4 to A0, or ANSI standards A to E.

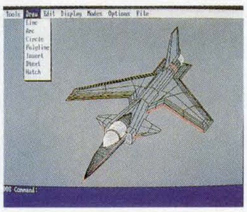
To ease the transfer of design information to other development tools, Prosa establishes a graphics database in ASCII files and a knowledge database in Prolog format. PC/AT add-ins required include an EGA card, two RS-232C ports, and either Mouse Systems' PC mouse or Logitech's mechanical mouse. Output is to an HP7475 or HPGL-compatible plotter. $3700.

Insoft Ky, Ilmarinkatu 16B, 90120 Oulu, Finland. Phone 981-226128. TLX 32004.

Circle No 642

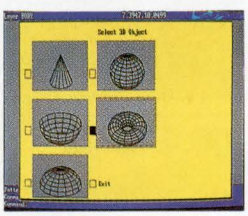
AutoCAD® Release 9. Its enhancements are evident.

AutoCAD's new release builds on the strengths of its eight predecessors. Here's how:



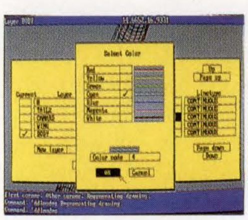
Pull-down menus.

Release 9's pull-down menus let you choose all of AutoCAD's fundamental commands with a click of your mouse or digitizer. You can also customize menus to provide your own frequently used commands. Pull-down menus are compatible with AutoCAD's proven system of screen and tablet menus.



Icon menus.

When you wish to select 3-D objects, text fonts, or hatch patterns, for example, you can pick them from an icon menu that appears on the screen. You can do the same thing with objects you create on your own. Icon menus make it easier and faster to choose the option you want.



Dialogue boxes.

These let you converse with AutoCAD; give it instructions by "filling in the blanks." They can simplify many of your tasks—entering layer information, for example.

File portability.

With Release 9, drawing files are directly compatible without any conversion steps across four different operating systems on four different machine architectures: PC-DOS/MS-DOS, Apollo AEGIS, DEC VMS, Sun UNIX.*

On a network with different types of computers you can access a single copy of a drawing from any machine.

More new features.

Release 9 also offers you twenty additional text fonts from the industry standard Hershey library, B-spline curve generation, and a direct link to the newly released AutoShade.™

Release 9 = More Power + Easier Access.

If you think CAD would boost your productivity, but you worry that a serious professional CAD package will take forever to learn, AutoCAD Release 9 is for you.

You'll be able to put its extraordinary capabilities to work faster than you ever thought possible.

AutoCAD is registered in the U.S. Patent and Trademark Office by Autodesk, Inc. AutoShade is a trademark of Autodesk, Inc.
2320 Marinship Way, Sausalito, CA 94965

AutoCAD the standard.

CAD is an essential productivity tool today, as essential as drafting boards and T-squares were yesterday.

With over 100,000 packages sold in seven languages around the world, AutoCAD is the CAD software of choice among architects, engineers and designers.

Call 800/445-5415 for details.

We'll put you in touch with an authorized dealer who will show you the unprecedented power and ease of use of AutoCAD Release 9.

Your dealer will also show you which graphics systems can support our new display capabilities.

*PC-DOS is a registered trademark of International Business Machines Corporation. MS-DOS is a registered trademark of Microsoft Corporation. Apollo AEGIS is a trademark of Apollo Computer, Incorporated. DEC and VMS are trademarks of Digital Equipment Corporation. Sun is a trademark of Sun Microsystems Incorporated. UNIX is a trademark of AT&T Bell Laboratories.

AUTODESK, INC.

Tools for the golden age of engineering.

CIRCLE NO 143

Now The Only Limit Is Your Imagination.

Introducing TeleSTAR, the first open system 386 engineering workstation.

The new TeleVideo® TeleSTAR/386™ Engineering Workstation is the first workstation to give you 16 MHz 80386 power, high resolution graphics and Ethernet™ networking. It even comes with an affordable price: just $10,995.

The new TeleSTAR/386 is an "open system," with all the features you expect to find on a Motorola 68020-based workstation. It's the only way to get all the flexibility, portability and connectivity you need.

It uses Microport™ DOSMerge 386™ for concurrent UNIX® system V.3 and MS-DOS™ operation to give you access to the widest range of technical and business software. It also features MIT's X Window,™ the de facto standard user-interface system for multitasking on one screen, plus GKS software for stan-

dard graphics applications.

To present your work at its best, there's a 1280 x 1024 pixel high-resolution display and 256 simultaneous colors from a palette of 4,096 (with 16.7 million colors optional), and a monochrome display with the same high-resolution and four grey levels. There's even a mathematical co-processor to help speed up your calculations.

And to help you share the wealth, there's a built-in Ethernet interface with TCP/IP and RFS software under UNIX system V.3 supporting NFS™ from Sun Microsystems. Together, they let you network heterogeneously with mainframes, stand-alone workstations and PCs.

Our TeleSTAR/386 Engineering Workstation comes with features you might not expect at such a low price. Including a 17-inch color monitor (a 19-inch monochrome monitor is optional). A 3-button optical mouse. And 4 Mbytes of 32-bit RAM memory that's expandable to 16 Mbytes.

If you're ready for a workstation that gives you the power you need at a price you can afford, you're ready for the new TeleSTAR/386.

Call us toll-free or write today, for more information.

TeleVideo Systems, Inc.,
1170 Morse Avenue, Sunnyvale, CA
94088-3568.

CIRCLE NO 142

TeleVideo®
THE VISION YOU NEED TO SUCCEED.

Call 1-800-835-3228

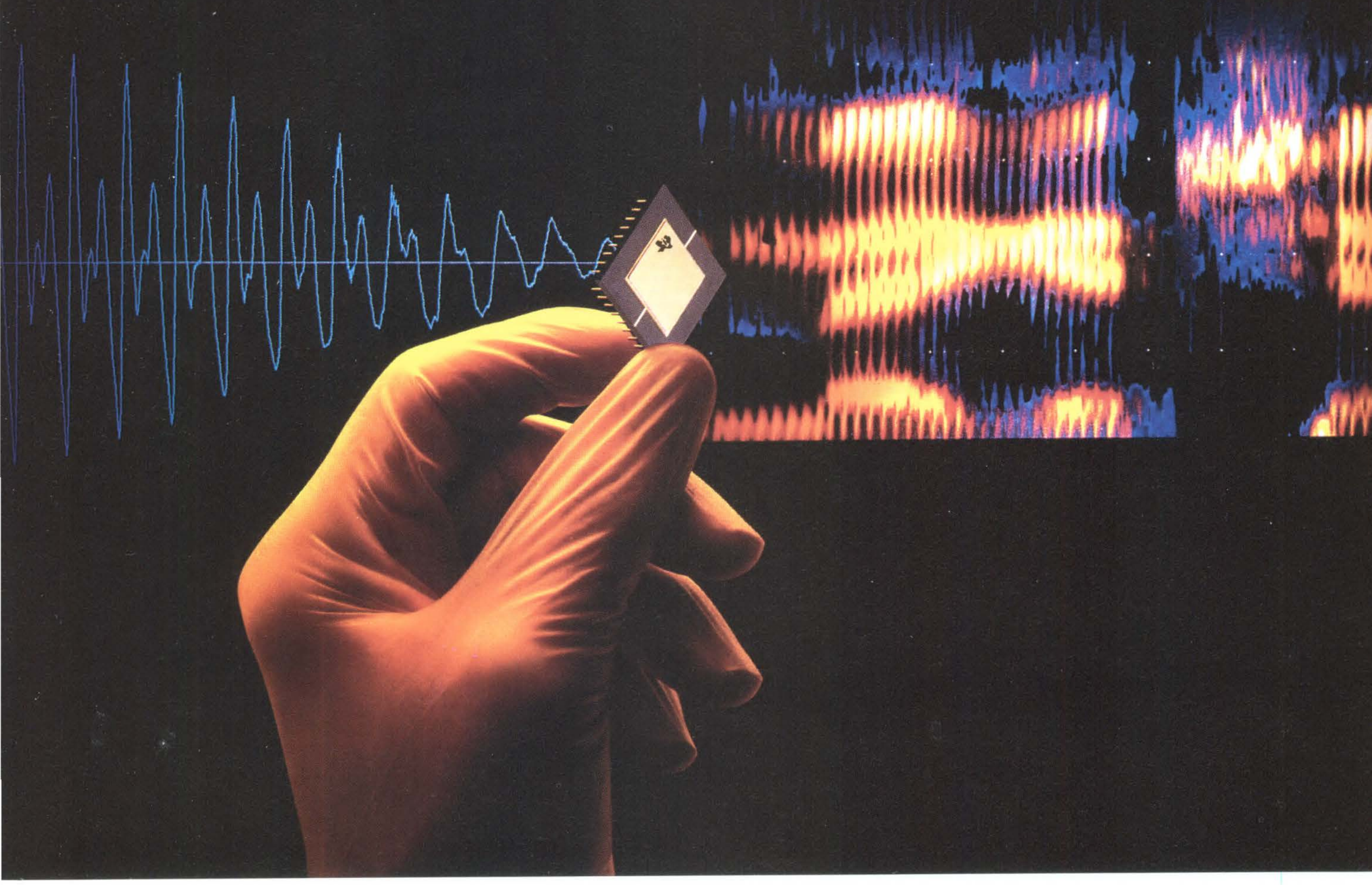
TEXAS INSTRUMENTS REPORTS ON

DSP

IN THE ERA OF

MegaChip

TECHNOLOGIES



DSP in the Era of MegaChip Technologies:

Digital signal processors are turning up winners

TI's TMS320 DSPs add high performance at costs low enough to open new worlds of applications — from a high-performance Formula 1 car suspension to an intelligent doll and everything in between.

The results are in. You can add more performance at lower cost desig ing with the standard in digital signal processors (DSPs), TI's TMS320 fami There are now even more reasons tha ever to get the advantages of TI DSP performance in applications wherever realtime number crunching is essenti

from Texas Instruments in all sorts of places.

hese advantages can make a differ-ce in applications as wide ranging as odems, disk servo controllers, sona-oys, and voice multiplexers to ectrum analyzers and graphics rkstations.

Getting started in DSP design is sier with Texas Instruments training and support. But once you see what the TMS320 family can do, you'll want the features TI DSP can give your designs.

"Handling performance is up there next to speed in Formula 1 racing. TI's TMS320 gives us a real advantage — enough to win a Grand Prix." Peter G. Wright, Technical Director, Lotus Engineering

Lotus designed the active suspension in their Camel-Lotus-Honda Formula 1 car to approach the theoretical maximum-control point which gives the best balance between handling and performance. At racing speeds, each wheel is positioned by the TMS320-controlled hydraulics. A single TMS320 chip measures wheel forces and displacements and reads data from a body-mounted inertial platform. Then, in real time, the chip computes wheel position and controls actuators that adjust the suspension components to precise settings.

The TMS320 can also handle closed-loop engine control and more responsive braking systems, as well as many other automotive applications.

"The TMS320 helps us with one of our toughest tasks — designing toys with exciting features at prices that will sell." Dave Small, VP Engineering, Worlds of Wonder, Inc.

Worlds of Wonder is a pioneer in developing interactive toys and now has an innovative new doll named Julie™ Using a single TMS320 chip, Julie's designers are able to give her voice-recognition ability, coupled with synthesized speech and coordinated facial movement.

The TMS320 design expands the applications for affordable consumer products like solid-state answering machines, cellular phones, improved hearing aids, and animated electronic games.

TI's MegaChip Technologies

Our emphasis on volume manufacturing of high-density CMOS circuits is the catalyst for ongoing advances in how we design, process, and manufacture semiconductors and in how we serve our customers. These are our MegaChip™ Technologies. They are the means by which we can help you and your company get to market faster with better, more competitive products.

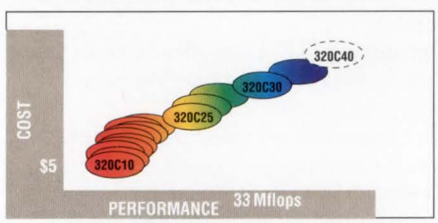
Winning designs come from a family of winners

There are 15 compatible members in the TMS320 family *(see the road map below)*, featuring two new DSPs with on-chip EPROM, the TMS320E15 and the TMS320E17. For applications requiring off-chip memory, there is the new CMOS EPROM, the TMS27C292, with 35-ns speed.

New interface alternatives include the low-cost CMOS TCM29C18/19 Combo Codecs with A/D, D/A, and filters all on a single chip.

The high-performance TLC32040 Analog Interface Circuit has 14-bit A/D and D/A and programmable filters.

For higher performance in digital signal processing, you can use building-block products like TI's microcodable ACT88XX 32-bit processor family.



From $5 to 33 Mflops: With three generations covering 15 products, the TMS320 family offers software compatibility to protect your development investment and provide a smooth path to future applications.

For more information on support for the TMS320 family, please turn the page.

REAL-TIME OS

VRTX32 is a real-time, multitasking operating-system kernel intended for use with embedded computers based on the Motorola 68020 or Intel 80386 μPs. The kernel employs a pre-emptive, priority-based scheduler that lets you create, delete, resume, and suspend tasks. It also handles all service calls, including those for task services, intertask synchronization and communication, memory allocation, real-time clock services, character I/O, and interrupt handling. You can combine the kernel with the vendor's IOX (Input-Output Executive), which provides advanced device-level I/O facilities for character, disk, and general-block peripherals. You can also combine the kernel with FMX (File-Management Executive), which implements the PC-DOS file system. The system is position-independent; it uses program-counter-relative and base-relative addressing, and you can locate it anywhere in the available address space without modification. The vendor guarantees that interrupts-off time will never exceed 15 μsec on a 16.7-MHz 68020 processor. Versions are available for 68000, 68010, 68020, and 80386 μPs; $6775 each.

Ready Systems, Box 61029, Palo Alto, CA 94306. Phone (800) 228-1249; in CA, (415) 326-2950. TLX 711510608.

Circle No 404

Ready Systems SARL, 16 bis Rue Grange Dame Rose, 78140 Velizy-Villacoublay, France. Phone 33-1-3946-89-86.

Circle No 405

PASCAL COMPILER

The Pascal-2 compiler runs on and generates code for 68000-, 68010-, and 68020-based computers. Two versions are available. One runs under the vendor's VersaDOS real-time, multitasking, multiprocessing operating system; the other runs under System V/68, which is the vendor's version of Unix System V, release 3. The compiler, developed for the vendor by Oregon Software Inc (Beaverton, OR), is configured so that the same package runs on any of the three μPs; you use a compiler directive to select the target machine for which the compiler will generate code. Both versions can generate code that makes use of the 68881 FPU. The compiler can generate ROMable code for both VersaDOS and System V/68 target machines; it can also generate position-independent code (PIC) and code for targets that don't have memory-management units (MMUs). System V/68 can't use PIC and doesn't run on non-MMU targets. The compiler provides new string-handling capabilities and I/O switches, and the package includes an assembler interface, an execution profiler, and several cross-reference utilities. If a run-time error occurs, the compiler's error-walkback feature generates a special listing showing (in Pascal notation) each procedure call that was performed, from the point of failure back to the main program. Each version, $2800.

Motorola, Microcomputer Div, Box 20912, Phoenix, AZ 85036. Phone (800) 521-6274.

Circle No 406

OS/2 DEVELOPMENT KIT

The OS/2 Software Development Kit allows you to start developing applications software to run under OS/2 on 80286- and 80386-based machines. The tool kit consists of a prerelease version of the OS/2 system kernel and technical specifications for the kernel and for the OS/2 LAN manager. It also includes new versions of the vendor's macroassembler (MASM) and C compiler, the CodeView debugger, and other software-development tools, including a programmer's text editor. The price of the development tool kit includes one year of technical support via the vendor's DIAL (Direct Information Access Line) electronic mail service and a subscription to the *Microsoft Systems Journal*. Updates will include the OS/2 Windows specification and software, as well as the LAN Manager software and associated utilities. $3000.

Microsoft Corp, Box 97017, Redmond, WA 98073. Phone (206) 882-8080. TLX 328945.

Circle No 407

C COMPILER

Turbo C is a C editor, compiler, and linker that runs on the IBM PC and compatibles. The compiler conforms to the Kernighan/Ritchie and proposed ANSI standards and is compatible with other compilers that follow these standards. The compiler can compile code for six memory models: Tiny, Small, Compact, Medium, Large, and Huge. Its use of near and far pointers lets you take full advantage of the 8086 μP's architecture by means of a mixed-model technique. The vendor claims that Turbo C has a compilation speed of 10,000 lines per minute. The run-time library contains more than 300 functions that you can call from within your C programs. The math functions conform to the IEEE floating-point standard, and they emulate an 8087 math coprocessor if one is not present in the system. The vendor offers complete source code for the run-time library at $235. The package includes a built-in editor, linker, and Lint error checker. Within the integrated environment, you can switch from one facility to another without returning to the OS. $99.95.

Borland International, 4585 Scotts Valley Dr, Scotts Valley, CA 95066. Phone (408) 438-8400. TLX 172373.

Circle No 408

EMULATOR

The Mime-600 emulator connects to a PC or host computer to provide program debug facilities for most popular 8-bit μPs. In addition to

Software

four breakpoint/trigger control tag bits for each of the μP's memory locations, the emulator has four 48-bit hardware breakpoint comparators. You can break on the nth occurrence of a comparator's break condition, or on logical combinations or logical sequences of breakpoint conditions. The emulator has an 8k×48-bit trace memory, which you can reconfigure to 4k×96 bits for time-stamped trace results. The emulator has a total memory map of 16M bytes, with 256k bytes of relocation RAM, and another 256k bytes of shadow memory. During program development on the host computer, the emulator provides a transparent link between the computer and a terminal. After developing your program, you can download program code and symbol tables to the emulator for use in debugging. £4300, including a target adapter board for one μP; additional target adapter boards, £1790.

Pentica Systems Ltd, Station Industrial Estate, Oxford Rd, Wokingham, Berks RG11 2YQ, UK. Phone (0734) 792101. TLX 848210.

Circle No 409

OPERATING SYSTEM

Suitable for use on IBM PC/AT and compatible computers, the RT/iX operating system allows you to execute real-time multitasking operations under MS-DOS (version 3.0 and up). The operating system controls application programs written in C, and after program execution MS-DOS remains available for the user without any rebooting. All access to mass storage remains under the control of the MS-DOS file manager, allowing you to transfer data from the application program to standard MS-DOS-based programs. The system comes on a 3½- or 5¼-in. disk, and includes source code for sample drivers, which you can use for interrupt-driven or polled systems. Around DM 1000.

Kontron Messtechnik, Oskar-von-Miller-Strasse 1, 8057 Eching/Munich, West Germany. Phone (08165) 77601. TLX 526719.

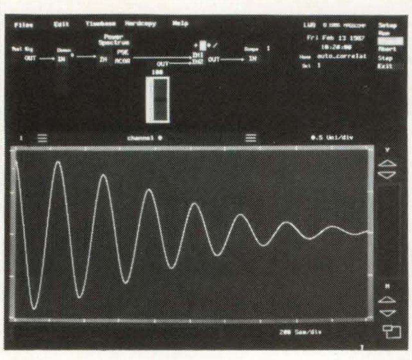
Circle No 731

Kontron Electronics Inc, 630 Clyde Ave, Mountain View, CA 94039. Phone (415) 965-7020. TWX 910-378-5207.

Circle No 410

DATA ACQUISITION

Laboratory Workbench software greatly simplifies the setup and control of high-performance data-acquisition modules operating under the Unix OS on the vendor's Series MC5000 real-time signal-processing computers. A file menu allows you



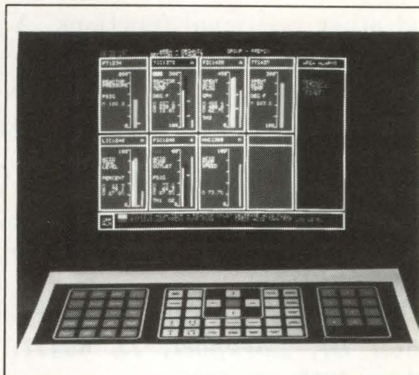
to save or to select previously created command files that control the sequence of operations; a timebase menu lets you choose timing and synchronization parameters; a hardcopy menu permits you to direct output to any one of a variety of printers and plotters; and a help menu lets you select on-line help screens. The package includes built-in signal-processing modules such as FFT, inverse FFT, and filtering functions; signal averaging; and power-spectrum calculations. You can also process data through a Fortran expression that you write into a window on the screen. You can display data as an X-Y plot or an oscilloscope trace, or, if you are dealing with slowly changing data, as a number that the program updates at specified intervals. Prices range from $3000 to $4500, depending on the host system configuration.

Masscomp, 1 Technology Park, Westford, MA 01886. Phone (617) 692-6200.

Circle No 412

PROCESS CONTROL

K-SCAN utilities configure process-control systems that run the vendor's Forum system on DEC computers. The utilities let you define the I/O devices to be read or controlled; these devices can include sensors, alarms, operator displays, data recorders and plotters, and



controlling elements. You can logically relate digital I/O bits with AND, OR, or Exclusive-OR functions and write programs for GPIB communications and device protocols. The menus also allow you to define the dynamic relationships between inputs, outputs, and storage elements by means of mathematical functions. The utilities store your definitions in a central database, together with calculations for PID loops, ramping functions, polynomial conversions, lead/lag functions, and other relational functions. A sequencer-control utility lets you define sequential operations in steps; each step can compare as many as nine variables to each other or to constant values. Prices range from $15,000 to $25,000, depending on the host configuration and the options selected.

KineticSystems Corp, 11 Maryknoll Dr, Lockport, IL 60441. Phone (815) 838-0005.

Circle No 413

OS FOR 80386

PC-MOS/386 version 1.02 is a multitasking, multiuser operating system for 8088-, 8086-, 80286-, and 80386-based computers, and it takes advantage of all the 80386's features. Those features specific to the 80386 CPU are isolated in a single system-driver file used only when an 80386 is present in the system. Systems based on the other chips in the family can use the extended-memory facilities of the OS, provided that the systems include extended-memory hardware. The OS provides software tools that let you assign 640k bytes of RAM to each task or user, including "ill-behaved" tasks that write directly to video hardware. You can also run multiple tasks in systems that don't have extended-memory-management hardware, but you are then limited to a total of 640k bytes (minus system overhead) for all tasks. Single-user version, $195; 5-user version, $595; 25-user version, $995.

The Software Link Inc, 3577 Parkway Lane, Atlanta, GA 30092. Phone (404) 448-5465. TWX 4996147.

Circle No 411

DATA ACQUISITION

LabWindows software helps you use your PC to develop software for data-acquisition, data-reduction, data-analysis, data-presentation, and instrument-control applications. The package consists of an interactive, menu-driven module that lets you select either Microsoft C or Microsoft QuickBasic as your programming language, and of libraries that contain routines for instrument control, data analysis, graphics, data formatting, and GPIB control. If you plan to work on complex applications, you can obtain other modules containing routines

for advanced analytical and processing functions and advanced graphics. The function menus let you construct and interactively execute function calls by selecting the function and entering the parameters; after you've done so, the LabWindows module automatically generates source code in the chosen language. The compiler creates a list of all errors that it detects during compilation; using the editor, you can correct all of these in one pass before recompiling. The package also provides run-time debugging tools. When you have created and debugged your program, you can save it as a QuickBasic or C source-code file; with an external compiler, you can compile this code and link it to the appropriate library modules to produce a stand-alone executable program. $495.

National Instruments, 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488.

Circle No 414

C COMPILER

SC-C is a C compiler that runs on the vendor's PC4000—a RISC coprocessor card that plugs into IBM PCs and compatibles. The PC4000's CPU is a Novix NC4016 RISC µP with 512k bytes of onboard memory, which delivers processing speeds in the 4- to 8-MIPS range. The C compiler provides all the features of the Kernighan and Ritchie standard, along with newer extensions of the language, such as *void* and *enum* data types, functions returning structures, structure assignment, *const* and *volatile* attributes, and others. The compiler generates a mixture of in-line and threaded code to improve efficiency; you can adjust the proportions of the mixture to optimize your program either for greatest execution speed or for smallest code size. The library includes routines that interface to the vendor's PCX executive; you can substitute other routines for use in a different run-time environment. PC4000 coprocessor board, from $1295; SC-C compiler, $595.

Silicon Composers, 210 California St, Palo Alto, CA 94306. Phone (415) 322-8763.

Circle No 415

CROSS-COMPILERS

The InterTools line of C and Pascal cross-compilers and cross-assemblers runs on IBM PC/XT or PC/AT hosts, as well as on a variety of workstations, and generates code for Intel and Motorola µPs and other 8-, 16-, and 32-bit target µPs. The most recent additions to the line are compilers, assemblers, and debuggers for 68020 target µPs; these compilers let you use all of the 68020's addressing modes and bit-

FUJITSU'S ½" CARTRIDGE TAPE DRIVE

Announcing an important development in ½" cartridge tape drives.

Immediate delivery.

We're shipping ½" cartridge tape drives in any quantity. Today. To give you an alternative to full-sized ½" reel-to-reel technology.

When you want it now, get it from Fujitsu America.

Small Size. Big Performance.

You'll get all the performance you need in a 5¼" form factor. Our ½" cartridge tape offers 130 MB of formatted storage. Back-up operations in a streaming mode at either 50 or 75 inches per second (ips). File management operations in the start/stop mode at 50 ips. Transfer rates of 225 KB/S. And an outstanding bit error rate of 1×10^{-12}.

Get ½" reel-to-reel performance in a 5¼" form factor.

Plus 15,000 hours MTBF. Design in the power and reliability of Fujitsu America.

Easy to Integrate.

For SCSI systems, optional high-performance M1008A SCSI controllers are available, too.

So don't settle for less. Call today for an evaluation unit. Or for more information on any of our world famous family of data storage products, including Winchester, tape, optical and flexible drives. 800-626-4686.

Or write Fujitsu America, Computer Products Group, 3055 Orchard Drive, San Jose, CA. 95134-2017.

Solve your tape problems today.

A COMPANY WITH CHARACTER AND DRIVE

FUJITSU

FUJITSU AMERICA
Computer Products Group

CIRCLE NO 124

Some of the best reasons for buying an Archimedes C Compiler have nothing to do with its amazing speed

Speed is one thing. But most programmers like the way Archimedes ANSI-C runs and debugs generic C-code with host C-compilers and debuggers, like Microsoft's C-86 and CodeView®.

Writing your own library routines can be frustrating. Except with Archimedes, which supports advanced math functions and lets you skip writing your own routines.

Compatibility with standard equipment means a great deal to those making purchasing decisions. Tell them that Archimedes runs on hosts like the IBM PC, MicroVAX and VAX systems.

Another reason to use C instead of assembly: You can easily update code, even if you're not the original programmer.

Archimedes also takes the trouble out of big projects: You can easily integrate code from several programmers via a special LINT-type feature.

Even the fastest programming language can be made faster if the code is reusable for other microcontrollers. And Archimedes is.

Speed is useless if you can't apply it to your favorite microcontrollers. And Archimedes supports the most popular: Intel 8051 and 8096 families, Motorola 68HC11 and 6801, Zilog Z80, Hitachi 6301 and HD64180, and more.

As you can see, there are many advantages of programming microcontrollers in C other than speed. But when it gets right down to it, speed is why you'll buy Archimedes Microcontroller C. Because C-Code is cleaner, clearer, easier to use–and using it is guaranteed to cut your development time by at least 50% over assembly.

Call Archimedes now at (415) 567-4010 for a free demo diskette and product guide on Archimedes Microcontroller C. So you can hurry up and start programming faster than ever.

Archimedes Software Inc.
2159 Union Street
San Francisco, CA 94123
TM

CIRCLE NO 123

manipulation features. The package also lets you use either the 68881 numeric coprocessor or software routines for floating-point operations, and it includes a library of mathematical functions for both modes. The compilers produce re-entrant, ROMable code and come with librarian, linker, locator, formatter, and Romp utilities for use in the creation of ROMable code. Prices depend on the host machine; they start at $1000 (compilers), $800 (assemblers), and $1500 (debuggers) for an IBM PC or compatible host.

Intermetrics Inc, 733 Concord Ave, Cambridge, MA 02138. Phone (617) 661-0072.

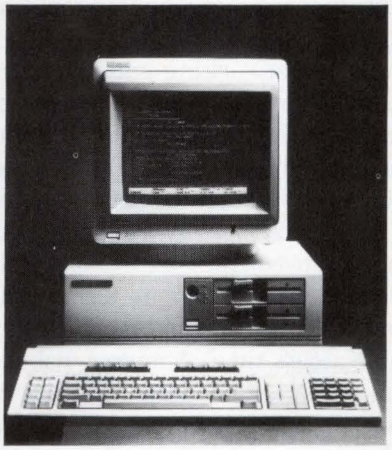
Circle No 416

C FOR 8096 μC

The C cross-compiler C-8096 runs on a variety of hosts, such as the IBM PC and compatibles and VAX and MicroVAX machines, and generates code for applications that will run on an embedded Intel 8096 microcontroller. The compiler provides all of the standard Kernighan and Ritchie features of the language, as well as the enhancements in the proposed ANSI standard. To simplify the development of embedded systems, the compiler also provides some 8096-specific enhancements such as *enable interrupt* and *disable interrupt*. The compiler supports the IEEE 32-bit floating-point arithmetic standard, and the library includes functions for trigonometric, logarithmic, and exponential functions, as well as the most important I/O functions for embedded-controller applications. All of the library functions are re-entrant to allow recursive code and interrupt handlers. The compiler provides the features necessary for generating ROMable code, including statically initialized variables. IBM PC hosts must have at least 512k bytes of RAM and MS-DOS 2.0 or later; MicroVAX and VAX versions will run under Unix or VMS. IBM PC version, $995; MicroVAX version, $3995; VAX version, $5995.

Archimedes Software Inc, 2159 Union St, San Francisco, CA 94123. Phone (415) 567-4010.

Circle No 417



CONTROL LANGUAGE

The HP Basic instrument-control language embodies many enhancements of the Basic language. These enhancements provide advanced I/O capabilities and facilitate the control and acquisition of data from instrumentation equipment. A new version of the instrument-control language is built into the HP 82300A Basic card, a 68000-based language-processor card that plugs into the vendor's Vectra PC or into an IBM PC or compatible. You can easily switch back and forth between HP Basic and applications such as Lotus 1-2-3 or a text processor. The features of the language card include a syntax-checking editor for writing or correcting programs, control structures that allow structured programming, and single-statement commands. The language-processor card includes 512k bytes of RAM (expandable to 4M bytes), an interface that provides access to an optional GPIB interface card, and a shared-resource manager that allows the host access to the vendor's workstation networks. $1320.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 418

PROLOG INTERPRETER

The interactive Prolog interpreter WProlog runs on IBM System/370 mainframes under the VM/SP CMS operating system. It provides command-line editing. You can use its CMS editor to edit your programs. The interpreter provides extensive syntax-checking and diagnostic features, and includes a built-in trace facility for debugging. This facility allows you to view the operation of selected predicates, even if these predicates are activated from within the body of a "hidden" predicate. Modules are independent; you can change and reload them individually. They are simple to use, because you need only declare the name and number of arguments of exported predicates—you don't have to make statements about the symbols within a module. The interpreter's programs use conventional CMS file-support statements to open, close, read, or write files, and they can directly execute any CMS Subset commands. Yearly license fees, $900 for educational users, $1800 for commercial users, and $3600 for third-party users.

Watcom Products Inc, 415 Philip St, Waterloo, Ontario N2L 3X2, Canada. Phone (519) 886-3700. TLX 06955458.

Circle No 419

MULTIUSER OS

The multiuser, multitasking operating system Wendin-DOS will run on any IBM PC or compatible and on 80386-based machines, but requires at least the computing power of a PC/AT to provide effective multiuser operation. The OS provides all of the PC-DOS commands and switches, and will run most popular MS-DOS application programs. Moreover, it provides many additional facilities that make operation easier. Among these are the Alias command, which lets you initiate a complex sequence of DOS commands with a single command name; the assignment and display of your access rights; a log-in command that grants you the privileges and attributes associated with your user name; a log-out command that resets these privileges and attributes; and many other features derived from the VAX/VMS operating system. The OS has a windowing facility. You can order an optional application-developer's kit to help you develop multitasking applications. Wendin-DOS, $99; Application-Developer's Kit, $99.

Wendin, Box 3888, Spokane, WA 99220. Phone (509) 624-8088.

Circle No 420

REAL-TIME OS

D-Nix/MP is a multiprocessor version of a real-time operating system that is fully compatible with Unix and conforms to the System V Interface Definition (SVID), yet offers features that make it particularly suitable for on-line transaction processing (OLTP). The OS runs on 68020-based machines; implementations for other processors are planned. A small and efficient kernel, a pre-emptive scheduler, and memory-resident processes allow the OS to provide the fast, predictable responses essential in real-time systems. The system provides extensive networking and data-communications facilities. It uses a bit map for file allocation, a technique that permits the creation of files with completely contiguous disk space and thereby reduces disk-head movement. According to the vendor, this technique also results in faster disk I/O and more predictable access time. A mirror-disk feature guarantees data integrity by writing all data to two disk drives simultaneously. Price depends on host configuration and other factors; licensing, from $25,000.

Diab Systems Inc, 323 Vintage Park Dr, Foster City, CA 94404. Phone (415) 571-1700. TLX 516020.

Circle No 421

ADA COMPILER

Tandem Ada runs on all the vendor's NonStop systems and has been validated by the Ada Joint Program Office (AJPO). The compiler meets all the requirements of the current ANSI/MIL-STD-1815A and ISO/ 8652-1987 Ada standards. It generates code that is native to the vendor's NonStop architecture and Guardian-90 operating system. The compiler supports as much as 4M bytes of code space and 128M bytes of user-data space in main memory. Because NonStop systems have multiple processors, compilations can run concurrently and can put object code into different libraries, thereby reducing the total compilation time for many programs. The Ada package consists of the compiler, a library manager, a binder that

links compiled modules together into an executable program, and a symbolic debugger. Prices start at $10,475 per system, with a monthly license fee of $400, for NonStop EXT and CLX systems.

Tandem Computers Inc, 19191 Vallco Parkway, Location 4-40, Cupertino, CA 95014. Phone (408) 725-6000.

Circle No 422

C COMPILER

Optimum-C runs on the IBM PC and compatibles and provides two modes of operation. During program development, you can increase compilation speed by running the compiler without optimization. The built-in EZ editor allows you to compile, link, and execute your program without leaving the editor; further, the editor will step through the errors detected by the compiler and allow you to correct them before recompiling. When you achieve error-free compilation, linking, and execution, you can switch to command-line operation and recompile the program using the global-optimization feature; because both compilation and linking in this mode require more free memory, you may not be able to work from within the editor. The resultant program will, according to the vendor, execute 30% faster than will corresponding code generated by any other compiler. $139.

Datalight, 17505 68th Ave NE, Suite 304, Bothell, WA 98011. Phone (206) 367-1803.

Circle No 423

CICS EMULATOR

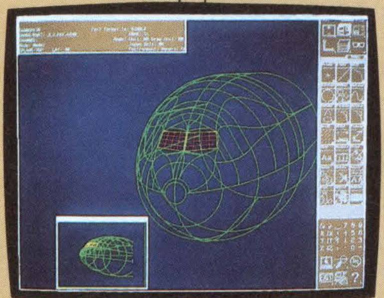
UniTECS runs on Unix systems and emulates the major features of IBM's widely used transaction monitor, CICS (Customer Information Control System). On an IBM machine, CICS supplements the functions of the DOS or MVS operating system in order to facilitate the development and operation of transaction-processing systems. In a similar way, UniTECS supplements Unix by providing an environment that emulates CICS. This emulator allows you to transfer much of the program-development and -maintenance load from your IBM mainframe to a Unix machine. On the Unix machine you can develop or maintain any application program that is written in Cobol, uses command-level CICS Release 1.6/1.7 standards, processes files organized under VSAM/DL1, and handles 3270-type displays through Minimum-Function BMS. During the development/maintenance, you have complete access to Unix development tools such as SCCS, Shell scripts, file-comparison programs, and Make facilities. Upon completion of the work you can transfer

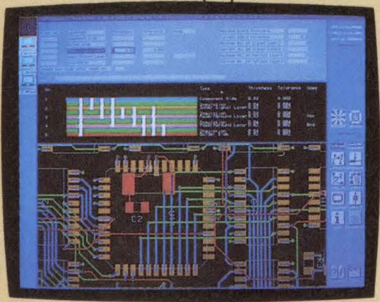
COMPUTERVISION CAD/CAM SYSTEMS

CAN MAKE YOUR IDEAS FLY.

Only Computervision offers the best CAE CAD CAM software on a full range of industry standard platforms. From our Personal Designer® series for simpler design tasks to CADDStation Systems™ which enable you to design, engineer and manufacture the most complex products.

Computervision can also help a company build, manage and protect its investment in its complete database through a series of modularized Product Data Management systems.

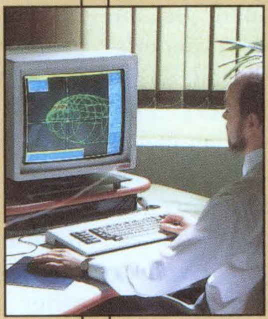




Left: Geometric modeling software enables designers to precisely define surface areas of the most complex products. Right: Newly available AUTOBOARD SMT is designed for the rigors of surface-mount technology. You can design PCBs using blind and buried vias and create them with components on both sides of the boards.

The newest generation of CADDStation systems combine advanced engineering and design capabilities, including production solid modeling, NURBSurface Design,™ finite element modeling and analysis and parametric component libraries. Other features such as 2, 3 and 5 axis machining carry designs forward through manufacturing.

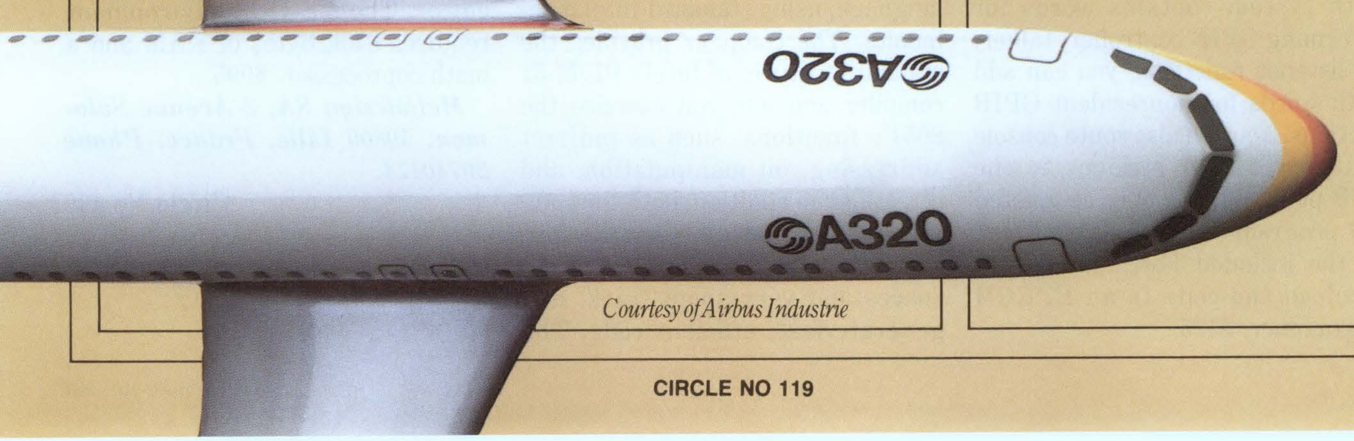
For electronics, CADDStation provides a wide range of fully integrated PCB design software including schematics, simulation analysis, design rule checking, AUTOBOARD® SMT and wiring diagrams.



So if you design, engineer or manufacture a product and want to get it off the ground faster, better and for less, come fly with us.

For more information, call or write: Computervision Corporation, Dept. 425B, 100 Crosby Drive, Bedford, MA 01730, (617) 275-1800.

COMPUTERVISION
World leader in CAD CAM technology



Courtesy of Airbus Industrie

your application back to the mainframe for normal production use. UniTECS also allows you to run a mainframe application on a Unix machine at a smaller site where the installation doesn't justify the cost of a mainframe. Price depends on the Unix machine configuration, and starts at $8000 for a system in which the combined cost of the processor, disk, and memory is less than $20,000. Versions are available for a number of different machines, including the Sequent Balance, NCR Tower 600, IBM 6150, and Hewlett-Packard systems that run HP/UX.

UniSoft Corp, 6121 Hollis St, Emeryville, CA 94608. Phone (415) 420-6400.

Circle No 426

FORTH DEVELOPMENT

The M/E260 is a standard 8080 fig-Forth system contained in an EPROM that plugs into the vendor's M/E200 or M/E300 Z80-based, STD-Bus, single-board computers. The system provides the following facilities: a system for editing source code and providing hard copy for documentation; a simple means of compiling ROMable code; and a means of linking the new code to the system on power-up. In developing your program, you can mix high-level language with assembly-language code for words that must execute at top speed (such as interrupt service routines). The Forth 8080 assembler is compact, simple, and well-known; you can poke in any Z80-specific instructions that you need, or define them and add them to the assembler's vocabulary. The Forth system contains words for performing GPIB controller, talker, and listener functions; you can add Forth words for nonresident GPIB functions. You can also route console input and output streams to the GPIB port. When you've completed your program development, you can use the included Forth utilities to download the code to an EPROM programmer. $125.

Mitchell Electronics, 8481 Rock Riffle Rd, Athens, OH 45701. Phone (614) 594-8532.

Circle No 428

GPIB DEVICE DRIVER

The memory-resident, BIOS-level device driver ROUTE-488, which runs under MS-DOS on the IBM PC and compatibles, lets you transfer data at high speed between a PC and devices connected to it via an IEEE-488 bus interface. In order to use the device driver, your system must have 96k bytes of free memory and must be running DOS 2.0 or higher. According to the vendor, the driver operates at least four times as fast as the DOS Device Handler. Moreover, the DOS Device Handler can transfer only one character at a time, whereas the vendor's driver allows DMA block transfer to and from the GPIB. Programs written in any language that runs under DOS can make use of the GPIB device driver by virtue of a multilanguage software interface. Although designed primarily for use with the vendor's LabPac software and IEEE-488 interface cards, the driver is also compatible with other vendors' IEEE-488 cards. $125.

Scientific Solutions, 6225 Cochran Rd, Solon, OH 44139. Phone (216) 349-4030.

Circle No 424

PL/M COMPILER

The PLM8051 cross-compiler runs on VAX machines and compiles PL/M source code to 8051 assembly language, using standard Intel mnemonics. The compiler provides the standard features of Intel's PL/M-51 compiler and lets you exercise the 8051's functions, such as indirect addressing, bit manipulation, and direct I/O; in addition, both the compiler and the assembler take into account the 8051's multiple address spaces and very small stack, and generate fast, efficient code. The full package consists of the compiler; an assembler with linker, librarian, and format converter to match the downloading requirement of various in-circuit emulators; and a debugger. Prices depend on the configuration of the VAX host, starting (for a VAXStation) at $3750 for the compiler, $1500 for the assembler package, and $2000 for the debugger.

Boston Systems Office, 128 Technology Center, Waltham, MA 02254. Phone (617) 894-7800. TWX 710-324-0760.

Circle No 427

GRAPHICS SOFTWARE

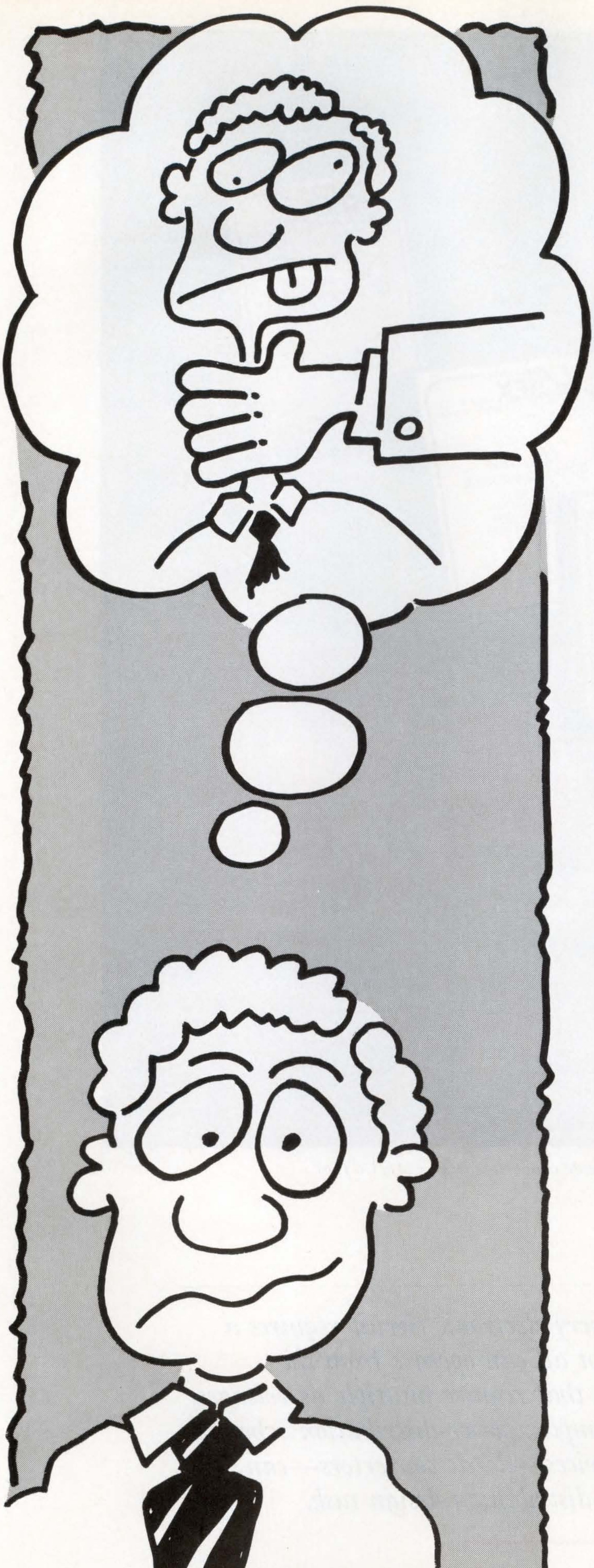
This GKS development kit operates under the MS-DOS operating system and features a language interface between the Alsys ADA programming language and the vendor's GKS graphics kernel. The development kit includes the GKS kernel and its associated device libraries, and permits programs written in Alsys ADA to use the peripherals supported by the kernel.

The GKS kernel supports display controllers ranging from CGA-level to 1280×1024-pixel resolution; A3 and A4 digitizers and plotters; and a mouse. The kit also contains a configuration utility that allows you to install your application program on a particular workstation.

Together, the kernel, display-controller library, and input/output device libraries occupy about 100k bytes of RAM. Options include a device driver for A0 digitizers and plotters, and an interactive graphics editor. The MS-DOS environment requires 640k bytes of RAM and a math coprocessor. $995.

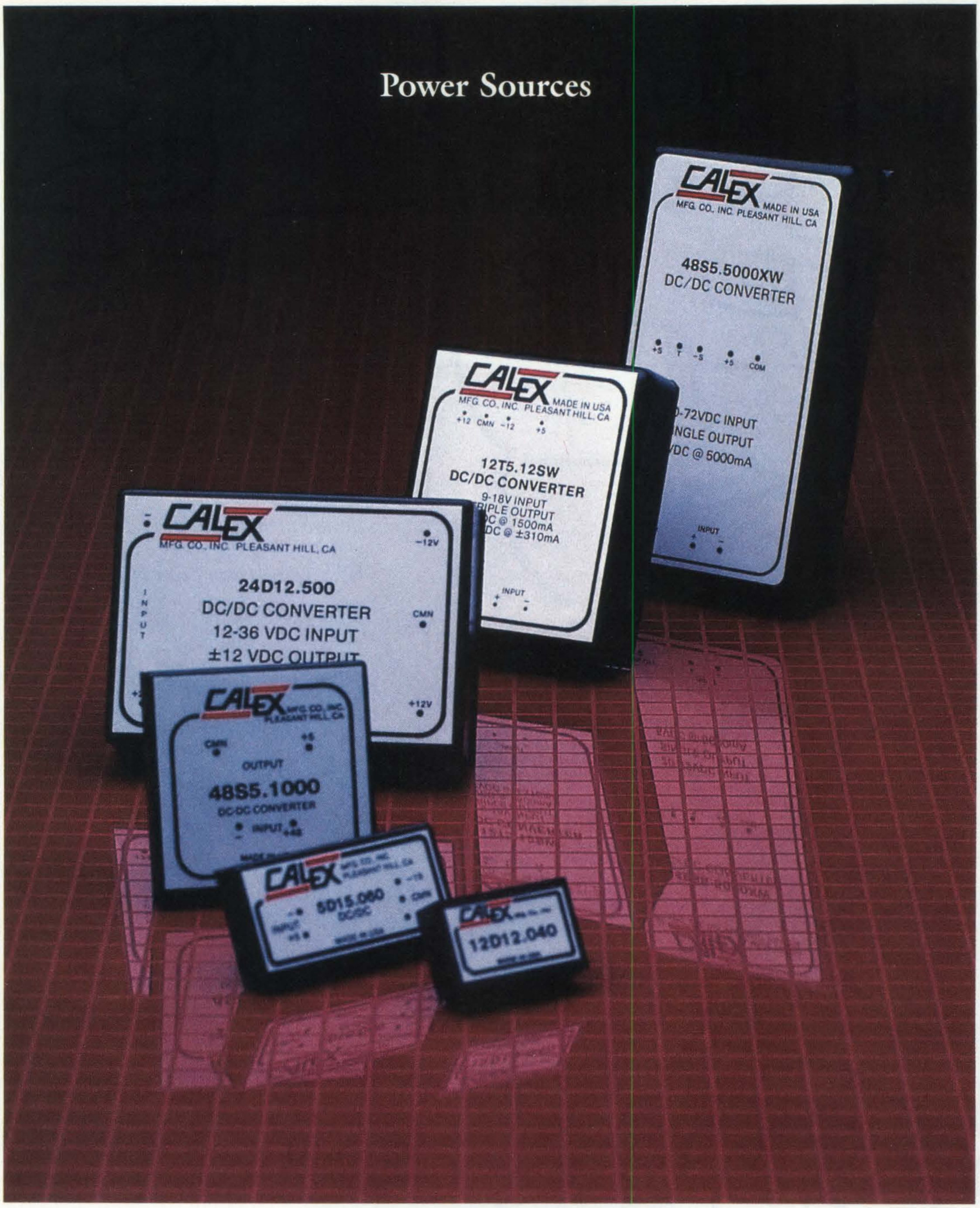
Metadesign SA, 2 Avenue Salomon, 59800 Lille, France. Phone 20740124.

Circle No 429



CIRCLE NO 118

Power Sources

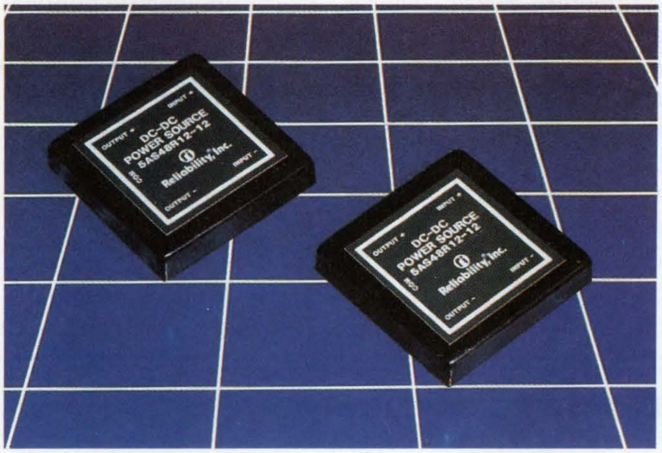


PC-board-mountable dc/dc converters *(Calex Mfg Co Inc)*

Although practically every electronic circuit requires a dc power source, not all can operate from the same dc level. For systems that require multiple dc voltages, you may have to design complex power-distribution schemes. Point-source power devices—dc/dc converters—can ease your power-distribution design task.

DC/DC converters simplify system power distribution

Tom Ormond, *Senior Editor*



***5W dc/dc converters** (Reliability Inc)*

Today's dc/dc switching converter modules significantly simplify the task of powering electronic systems. These pc-board-mountable converters provide the necessary power exactly where it's needed, so you don't have to design a complex power-distribution network for your system. Neither do you have to worry about intricate grounding and filtering systems. And although you must still take your system's noise performance into consideration, dc/dc converter modules can help minimize noise problems.

DC/DC converters come in various designs; which design you select depends upon the requirements of the circuitry you need to power. Most off-the-shelf dc/dc converters offer very similar performance. Although the available models do exhibit some differences in specifications—notably size, switching frequency, output power, and regulation—your choice of a converter will depend for the most part on your application. You might have to make a few tradeoffs among these features, but those tradeoffs will depend strictly on the system you're designing. Consult **Table 1** for the salient parameters of a representative selection of available off-the-shelf dc/dc converters.

As you peruse the **table,** you might want to give special consideration to the converter's size and its input voltage requirement. Both these items can severely limit your choice of a converter. No matter how well a particular converter suits your system's other requirements—such as output voltages, regulation, and isolation, for example—if it occupies too much pc-board space or if it requires an input voltage that's not available in your system, you may have to choose another converter.

As **Table 1** shows, today's dc/dc converter modules are very compact point-source power devices: Most require only 3.2 to 11 in.^{2} of pc-board space. Some manufacturers offer converters that require even less board area. Conversion Devices, for example, offers converters that require only 2 in.^{2} of board space. And International Power Sources and Melcher Inc offer converters that require even less pc-board area—only 1 and 1.07 in.^{2}, respectively. These numbers represent fairly significant reductions in board-space requirements. Note, however, that these converters provide fairly low output power, so you face a tradeoff of space vs power.

Converters offer input-voltage flexibility

When you go shopping for a dc/dc converter module, you'll find that a number of standard devices call for

DC/DC converters simplify the task of power distribution by providing power right where it's needed.

very specific input voltage requirements; they may need 5, 12, 15, or 24V, for instance. This requirement isn't necessarily a problem as long as the voltage in question is available in your system. But if that voltage isn't readily available in your system, your choice of a converter may be limited.

Fortunately, not all converters place such specific limits on their input voltage parameters. Power General and Wall Industries, for instance, offer converters with 2:1 input voltage ranges. Computer Products and Converter Concepts offer converters having input voltage ranges of 3:1. Converter Concepts also produces converters with a 4:1 range, and the input voltage range of converters from Calex is greater than 5:1. (**Table 1** gives the exact ranges for the converters listed.)

These wide-input converters offer you a little more flexibility than models that require very specific voltages. For example, a converter with an input voltage range of 9 to 18V dc will accommodate either 12 or 15V inputs—very popular voltage levels in today's systems. As a result, one converter can satisfy two different applications.

Radiation-hardened dc/dc converters

Some dc/dc converters also provide features that are useful in specific applications. The Model HPS-3015 dc/dc converter from IRT Corp, for example, is hardened against high radiation levels. It can deliver operate-through power in the presence of gamma-radiation rates as high as 5×10^{10} rad(Si)/sec, and it can survive as much as 1×10^{12} rad(Si)/sec without damage.

The converter continues to meet all its performance specs after exposure to a neutron flux of 1×10^{13} neutrons/cm^2 and a total gamma-radiation accumulation of 1×10^5 rad(Si). To certify each converter's operate-through characteristic, the vendor tests each device

TABLE 1—REPRESENTATIVE DC/DC CONVERTERS

MANUFACTURER	MODEL	INPUT VOLTAGE	OUTPUT VOLTAGE	TOTAL OUTPUT POWER	TYPICAL EFFICIENCY	ISOLATION
BURR-BROWN CORP	PWR5104, 5105	5V	±12V (5104), ±15V (5105)	9W	75%	750V DC
CALEX MFG CO INC	12S5.5000UW	7 TO 40V	5V	25W	91%	NS
COMPUTER PRODUCTS INC	LPS SERIES	20 TO 60V	5, 12, 15, ±12, ±15V	15W	80 to 85%	500V DC
CONVERSION DEVICES	E SERIES	5, 12, 24, 28, 48V	5, 12, 15, ±12, ±15V	2 TO 3W	60%	500V DC
CONVERTER CONCEPTS	VT15/VX15	10 TO 40, 20 TO 60, 100 TO 350V	5, 12, 15, −5, −12, −15V	15W	70 TO 75%	250V DC
INTERNATIONAL POWER	BA/BC SERIES	5, 12, 24, 28, 48V	5, 12, 15, ±12, ±15V	BA: 1.5W BC: 6W	65%	500V DC
IRT CORP	HPS-3015	18 TO 32V	5±15V	30W	70%	500V DC
MELCHER INC	1WR1	5, 12, 15, 24, 28, 48V (2 INPUTS MAX)	5, 12, 15V (4 OUTPUTS MAX)	1W, 2W	58%	3000V P-P
POWER GENERAL	720 SERIES	9 TO 18, 18 TO 36, 36 TO 72V	±12, ±15V	30W	86%	NS
RELIABILITY INC	—	42 TO 56V	5, 12, 15V (POSITIVE OR NEGATIVE)	5W	NS	500V DC
WALL INDUSTRIES INC	SI SERIES	12, 24, 48V	5, 12, 15V (SINGLE, DUAL, TRIPLE OUTPUTS)	15W, 30W	80%	500V DC

NS=NOT SPECIFIED

with simulated ionizing radiation.

Most switching converters have some sort of isolation between the input and output. Typical designs consist of an input circuit (filter and modulator), a transformer, and an output circuit (demodulator and filter).

The available dc/dc converters perform the conversion task by using one of three schemes: Royer, flyback, or forward conversion. In the classical Royer circuit, the transformer's secondary windings drive switching transistors (or FETs) that are configured in a push-pull arrangement. A voltage applied to the converter input causes one of the transistor switches to turn on. The transformer provides positive feedback, which turns this transistor on hard. The transistor remains on until the magnetic flux of the transformer saturates. The saturation causes the transformer voltages to reverse, turning off the first transistor and turning on the second one.

The resultant square wave is rectified and filtered, and then it passes through an output regulator. In addition to developing a constant output voltage, the regulator also provides current limiting and short-circuit protection for the converter's output.

To achieve a wide input voltage range (±20% min), today's switch-type dc/dc converters typically employ pulse-width-modulation techniques with a flyback- or forward-conversion circuit. Both types of conversion circuit use an IC-driven, switching-circuit signal. The flyback converter stores energy in the transformer's output winding. This energy transfers to the output when the modulator's switch is not conducting. Although the flyback converter is more cost-effective for the manufacturer than are the Royer or forward converters, it has the highest ripple of the three schemes.

In the forward converter, the output inductor stores the energy. This design provides a low-noise, full-wave

REGULATION	SWITCHING FREQUENCY (kHz)	PROTECTION	INPUT FILTER	SIZE (IN.)	COST	COMMENTS
0.02% LINE, 0.04% LOAD	50	SHORT CIRCUIT	YES	2×2×0.41	$29.75 (1000)	SIX-SIDED SHIELD, −40 TO +100°C OPERATING RANGE
0.02% LINE AND LOAD	75	OVERVOLTAGE, SHORT CIRCUIT	NS	3×2.56×0.83	$130	SIX-SIDED SHIELD, REMOTE ON/OFF CONTROL, ADJUSTABLE OUTPUT
SINGLE OUTPUTS: 0.5% LINE AND LOAD: DUAL OUTPUTS: 0.5% LINE, 1% LOAD	200	OVERVOLTAGE, OVERCURRENT, OVERTEMPERATURE	NO	1.6×2.0×0.46	$62.70 TO $65.35 (100)	REMOTE ON/OFF CONTROL
±0.3% LINE AND LOAD	200	OVERVOLTAGE, SHORT CIRCUIT	YES	1×2×0.35	$45 TO $54	SIX-SIDED SHIELD
0.3% LINE, 1 TO 1.5% LOAD	20	OVERLOAD, SHORT CIRCUIT	NS	VT15: 2.06×4.19×4.56 VX15: 2.13×3.58×4.50	$56 (100)	SINGLE, DUAL, OR TRIPLE OUTPUTS
BA: 0.3% LINE; 0.5% LOAD BC: 0.05% LINE; 0.1% LOAD	25	SHORT CIRCUIT	YES	BA: 0.8×1.25×0.4 BC: 2.0×2.0×0.4	$18 TO $29 (1000)	—
NS	125	OVERVOLTAGE, SHORT CIRCUIT	YES	3.6×3.0×0.6	$3500	RADIATION HARDENED
0.2% LINE, 0.1% LOAD	25	NS	YES	1.3×0.83×0.4	$53 TO $83	—
±0.2% LINE, ±1% LOAD	100	OVERVOLTAGE, SHORT CIRCUIT	YES	2.56×4.56×0.83	$169	REMOTE ON/OFF CONTROL, SIX-SIDED SHIELD
NS	NS	SHORT CIRCUIT	YES	2.0×2.0×3.75	$48.50 (1000)	—
±0.5% LINE, ±1 TO ±5% LOAD	100	OVERVOLTAGE, SHORT CIRCUIT	NS	15W: 2.56×3.0×0.83 30W: 2.56×4.56×0.83	15W: $80 TO $110 (100) 30W: $96 TO $110 (100)	REMOTE ON/OFF CONTROL

Although you must still take system noise performance into consideration, dc/dc converter modules can help minimize noise problems.

output. With the addition of a push-pull input, the circuit becomes a high-efficiency modulator circuit.

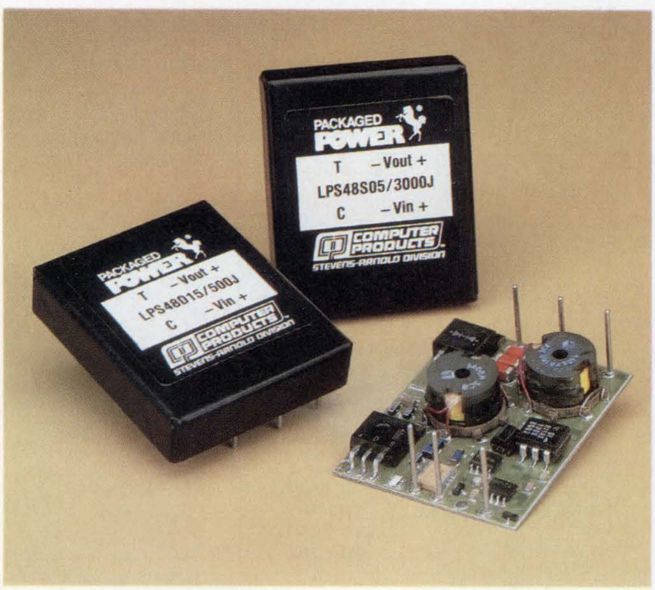
Transformer provides isolation

Today's dc/dc converters employ high-frequency ferrite materials for the transformer, which provides isolation and voltage translation. Because these ferromagnetic elements have high resistivity, ferrite-core transformers have much better loss properties than do laminated and powdered-iron-core transformers.

Bobbin and toroidal transformers are the two most common types of transformer used in today's converters. Because the bobbin lends itself to machine-automated winding, it is the more economical choice. To construct a transformer, the manufacturer typically lays the windings one over the other; isolation is provided by the wire insulation or a barrier molded into the bobbin.

Toroidal transformers have much better isolation and much closer coupling than bobbin transformers do. To provide isolation for a toroidal transformer, the manufacturer forms a barrier by physically separating the primary and secondary windings on the toroid. For applications in which isolation is critical (medical applications, for example), the toroidal transformer is the only practical choice. It does have one drawback, however—small-diameter toroids often must be hand-wired.

The converter's output stage includes demodulators and filters. The rectifier (either a full- or a half-wave type) is the most common type of demodulator. Once rectified, the transformer's signal is then filtered to minimize the output ripple or the EMI/RFI generated by the switching operation. The filter employed in modern converters can range from a simple capacitive design to a more complex pi-type circuit. Besides incorporating filtering, most switching converters come in a metal box that's shielded on all six sides to further minimize radiated interference.



Low-profile dc/dc converters *(Computer Products Inc)*

Cleaning up converter outputs

As noted, modern dc/dc-converter modules do moderate system noise problems: Many include output filters that curtail noise. However, in noise-sensitive applications such as medical electronics, you'll probably have to provide some external filtering as well.

By their very nature, switching dc/dc converters represent an inherent source of system noise. The noise appears as switching-frequency-related spikes on the converter's output voltage. Although considerations of size and cost can limit the amount of filtering it provides, a converter's internal filtering is usually adequate for most applications. If the inherent filtering capability is inadequate, one of two types of external filter—an LC filter or an output filter capacitor—can help.

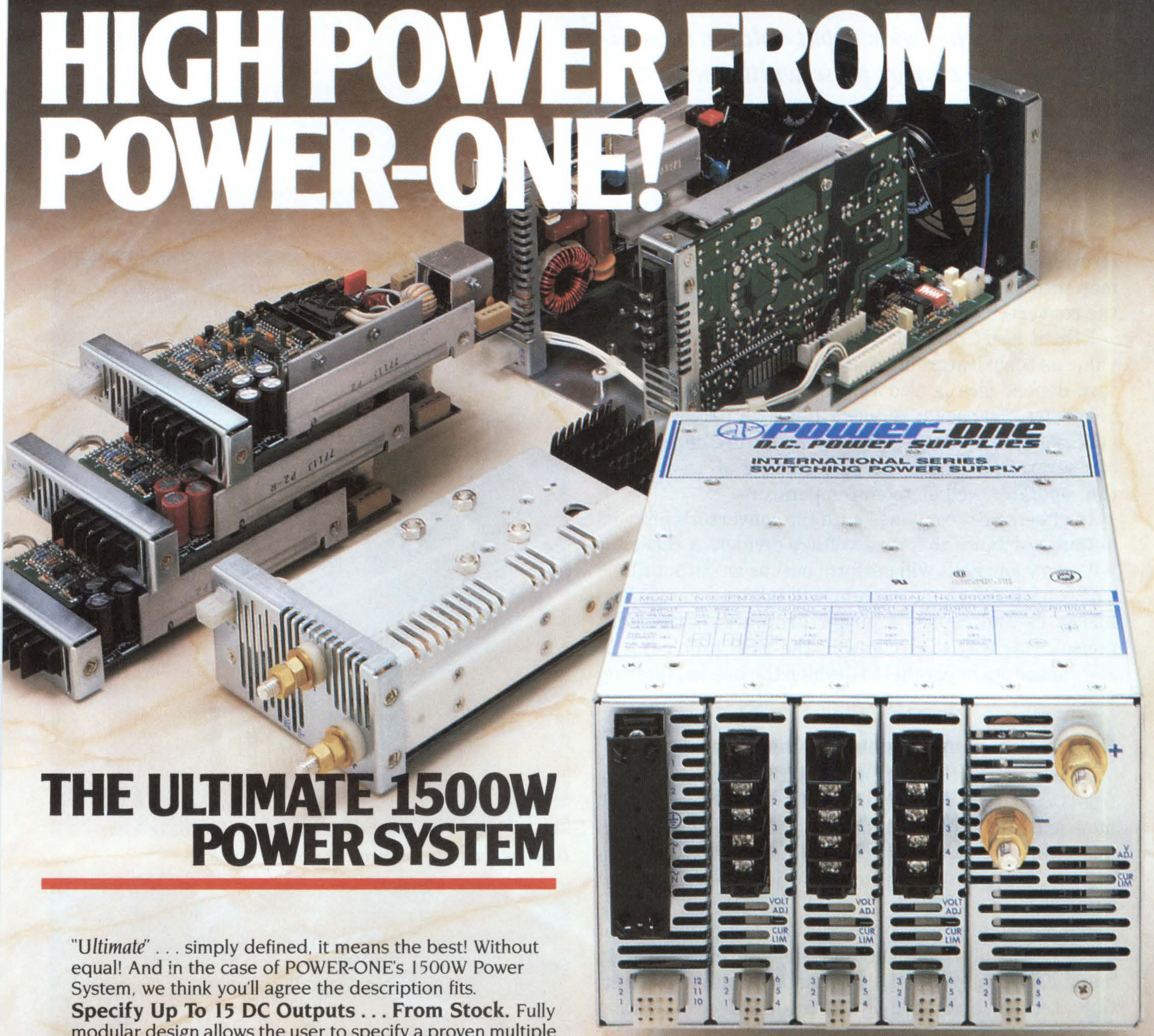
If your application demands high accuracy, it's best to employ an LC filter on each converter output channel to attenuate high-frequency noise. Most converters feature an internal output filter capacitor, so adding an external inductor and capacitor creates a low-cost pi filter. You must select the filter components carefully, however.

For example, the inductor's wire size must be able to carry the load current (plus a safety factor), and its core must not saturate under the expected load conditions. Note also that the inductor's dc resistance is outside the feedback loop of regulated converters, and that it can degrade the units' inherent regulation.

LC filters provide superior performance in applications that require very accurate analog measurements or that exhibit poor power-supply rejection at the ripple frequency. However, a much more common way to reduce noise is to use an output filter capacitor.

In selecting an output capacitor for a switching dc/dc converter, it's not a good idea to try to add some safety margin by overspecifying the capacitor, because the converter's basic design equations rule out any brute-force approach. The most critical capacitor parameter is effective series resistance (ESR). ESR results from

HIGH POWER FROM POWER-ONE!



THE ULTIMATE 1500W POWER SYSTEM

"*Ultimate*" . . . simply defined, it means the best! Without equal! And in the case of POWER-ONE's 1500W Power System, we think you'll agree the description fits.

Specify Up To 15 DC Outputs . . . From Stock. Fully modular design allows the user to specify a proven multiple output power system from a wide selection of single, dual and triple output power modules. Virtually any combination of output voltage and current ratings, including UPS capabilities, can be delivered from stock. No more time consuming and costly custom designs to contend with.

Industry's Highest Power Density. POWER-ONE's International High Power Series represents the most compact multiple output power systems available today. Up to 1500 watts of multiple output power in an industry standard 5 x 8 x 11 inch fan-cooled package.

On-Board UPS Capability. Only POWER-ONE offers a completely self-contained on-board Uninterruptible Power System module providing unlimited battery back-up of up to 1000 watts of DC output power. Available off-the-shelf, these standard UPS modules mount entirely within the main enclosure of any POWER-ONE International High Power Series model.

A True World Market Power System. The International High Power Series meets the toughest safety requirements of VDE, IEC, UL and CSA, plus the EMI limits of VDE and FCC. Along with worldwide AC input capabilities, it is the clear choice for products marketed not only in the U.S., but internationally as well.

And There's More. Call for details or return the reply card today! You'll see why the International High Power Series is the "*ultimate*."

TOLL-FREE LITERATURE HOT-LINE:
(800) 235-5943 Ext. 113
From California:
(800) 421-3439 Ext. 113

"Innovators in Power Supply Technology"

POWER-ONE D.C. POWER SUPPLIES

POWER-ONE D.C. POWER SUPPLIES
740 Calle Plano · Camarillo, CA 93010-8583
Phone: (805) 987-8741 · (805) 987-3891
TWX: 910-336-1297 · FAX: (805) 388-0476

Converters with wide input-voltage capabilities typically employ pulse-width-modulation techniques.

stray resistance inside the electrolytic capacitor, and is more critical at (and above) the switching frequency of the converter.

ESR is also a function of temperature, decreasing in value as temperature increases. A capacitor's temperature dependence is also very strong for temperatures below zero; capacitance value tends to decrease with decreasing temperature. This temperature dependence can severely degrade the performance of a converter that operates well at room temperature.

In effect, ESR combines with the converter's internal output resistance to form a voltage divider. A capacitor with very low ESR will perform best as an output filter. The capacitors' ripple current will increase as the load increases and causes a larger drop across the ESR (noise). One way to circumvent the ESR problem is to add capacitors in parallel to develop the needed filtering value.

Choose aluminum or tantalum capacitors

In implementing an external filter, you can choose from two basic families of electrolytic capacitors: aluminum and tantalum. Aluminum types are available in many different quality grades and fabrication techniques. Tantalum devices come in foil, solid, and wet-slug types.

It's a good idea to avoid using low-cost (which might mean low-quality) aluminum electrolytic capacitors: In many cases, they'll actually generate, rather than attenuate, noise. If you must trade off cost against performance, high-quality aluminum electrolytics offer you the best compromise. Typically listed as "computer-grade" units, these capacitors are designed specifically for switching power supplies and converters. These devices are not inexpensive, but some are worth the premium because they employ a specialized construction that results in very low ESR.

High capacitance-to-volume efficiency is the outstanding feature of all tantalum capacitors, but particularly of the wet-slug types. Solid tantalum capacitors are the best choice for applications in which longevity (both shelf and operating life) is a critical design concern. Although the foil types are quite compatible with switching power supplies, they cost more than aluminum devices. If your system's switching frequencies will be high (1 MHz and above) and its current demands low, you can probably employ a nonelectrolytic capacitor for the filter. Such units are very effective at high frequencies, at which the equivalent series inductance (ESL) of electrolytics increases significantly.

Dual-output dc/dc converter *(Burr-Brown Corp)*

Radiation-hardened dc/dc converter *(IRT Corp)*

Your filtering task doesn't end with capacitor selection. To get good performance from the filter you've chosen, you need to use good circuit-layout techniques. For example, inductance can become a problem if you fail to use good wiring techniques. You need to place the capacitor as close as possible to the load instead of to the converter. This scheme allows you to take advantage of the inductance of the pc-board traces (or wires) and the converter's internal output capacitor to form a small pi filter that optimizes noise reduction. You should also minimize the lead length (including circuit wiring) on both sides of the capacitor. It's best to use short, wide straps, and run them in parallel to further reduce self-inductance in the leads. **EDN**

For more information . . .

For more information on the dc/dc switching converter modules discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Burr-Brown Corp
Box 11400
Tucson, AZ 85734
(602) 746-1111
Circle No 704

Calex Mfg Co Inc
3355 Vincent Rd
Pleasant Hill, CA 94523
(415) 932-3911
Circle No 705

Computer Products Inc
7 Elkins St
South Boston, MA 02127
(617) 268-1170
Circle No 706

Conversion Devices Inc
101 Tosca Dr
Stoughton, MA 02072
(617) 341-3266
Circle No 707

Converter Concepts Inc
Industrial Parkway
Pardeeville, WI 53954
(608) 429-2144
Circle No 708

International Power Sources Inc
10 Cochituate St
Natick, MA 01760
(617) 651-1818
Circle No 709

IRT Corp
Box 85317
San Diego, CA 92138
(619) 450-9990
Circle No 710

Melcher Inc
10 Cochituate St
Natick, MA 01760
(617) 653-9979
Circle No 711

Power General
Box 189
Canton, MA 02021
(617) 828-6216
Circle No 712

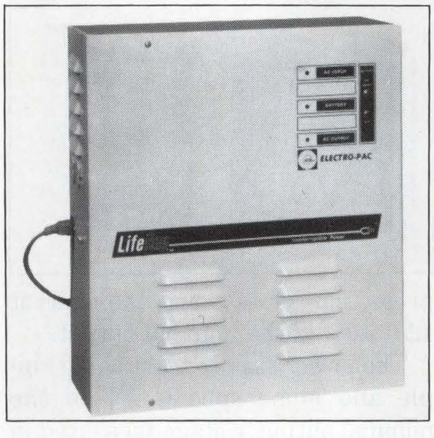
Reliability Inc
Box 218370
Houston, TX 77218
(713) 492-0550
Circle No 713

Wall Industries Inc
2 Franklin St
Lawrence, MA 01840
(617) 688-1287
Circle No 714

Article Interest Quotient (Circle One)
High 476 Medium 477 Low 478

CIRCLE NO 108

Uninterruptible ac power source protects data 100% of the time



The Lifeline is an uninterruptible ac power source that protects computers from power outages. The unit is always on line, so even when the utility fails, there's no chance of losing data while the computer waits for a standby system to switch over to battery power.

A maintenance-free internal battery handles the full power of the system for 5 or 10 minutes. An external battery may be used to extend operation for one hour or longer. When the utility comes back on, the unit will recharge the batteries automatically.

The unit accepts 120V ac at 60 Hz (with +10% to −15% tolerance) from a wall outlet and delivers 120V ac at 60 Hz (with ±3% regulation). Its output power is rated at 200 VA, 600 VA, and 1000 VA. It also offers a load power factor from 0.8 to unity; 90% efficiency when the line is present; a sine-wave output waveform with 5% maximum total harmonic distortion; and a NEMA 5-15R duplex output receptacle. It operates over 0 to 50°C.

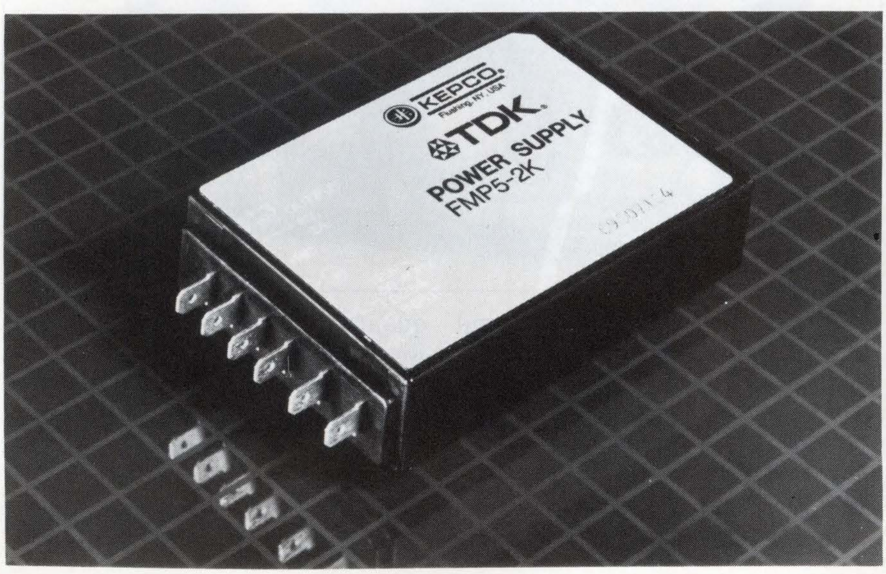
Prices range from $1235 for a 200-VA unit with 7 minutes of internal battery backup to $2780 for a 1000-VA unit with 25 minutes of internal battery backup. A 200-VA and a 600-VA unit come with no internal battery but are ready for an external battery hook-up. They cost $1180 and $1570, respectively.

Instrumentation and Control Systems Inc, Electro-Pac Div, 520 Interstate Rd, Addison, IL 60101. Phone (312) 543-6200. TLX 271503.

Circle No 719

Single-output ac-to-dc switching modules come in low-profile packages

FMP Series single-output switching modules come in low-profile plastic-encased packages. The series consists of two groups that have 3W and 16W outputs, respectively, at 50°C. The 3W versions are rated at 5V at 0.6A, 12V at 0.25A, 15V at 0.2A, and 24V at 0.13A. The 10W models are rated at 5V at 2A, 12V at 0.85A, 15V at 0.7A, and 24V at 0.45A. Both groups measure 2.17×0.75×3.16 in. The 3W units weigh 0.15 lb; the 10W units weigh 0.2 lb.



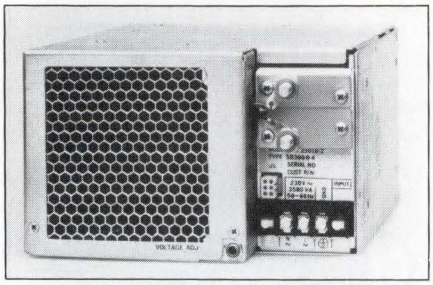
The switchers employ flyback circuitry to achieve 68 through 81% efficiency at maximum load. Their switching frequency ranges from 40 to 75 kHz, and their switching ripple voltage ranges from <50 to <100 mV, depending on the model. The units accept power from a 115V ac source and provide built-in overvoltage protection and current limiting.

All models' output voltages are adjustable to 10% of the nominal output voltage. The units are UL recognized and CSA certified, and they meet the FCC class B specification for conducted EMI. Prices range from $29 to $32.

Kepco Inc, 131-38 Sanford Ave, Flushing, NY 11352. Phone (718) 461-7000. TWX 710-582-2631.

Circle No 720

1500W switching power supply accepts a 3-phase ac input voltage



The PM-2501B-2-3P is a switching power supply that delivers 5V dc at 300A (1500W) and 50°C. It accepts a 3-phase input voltage of between 184 and 250V ac within a frequency range of 47 to 63 Hz. The unit comes in a 5×8×11-in. enclosure and weighs 20 lbs.

The supply meets VDE 0806 Class I SELV, IEC 380 and 435, and CSA 22.2-142/143/154 specifications. It is UL recognized (to UL 114, 1012, and 478 requirements), and it meets VDE 0871, level A, and FCC Docket 20180 standards for EMI protection. The supply has foldback-current overload protection at 105 to 120% of full output current: When the current exceeds that level, the supply reduces it to 65% of full output current. Overvoltage protection shuts down the unit at 125±10% of the nominal output.

The power supply's switching ripple and noise spec is 1% of the nominal output voltage measured in the bandwidth from 20 Hz to 20 MHz. The output voltage is brought out on a pair of 5/16-in., size 18 threaded-head studs. The ac inputs are on a terminal block that uses size 8-32 screws. The switcher's soft-start circuitry minimizes in-rush surges at power-on. Options for the supply include a crowbar circuit for overvoltage protection, 5-msec warning of ac power loss, and control of current-foldback circuitry (which allows you to parallel supplies). Another option lets you use a logic signal to turn the supply on. The supply's output is adjustable to ±10% of the nominal output voltage. $1200.

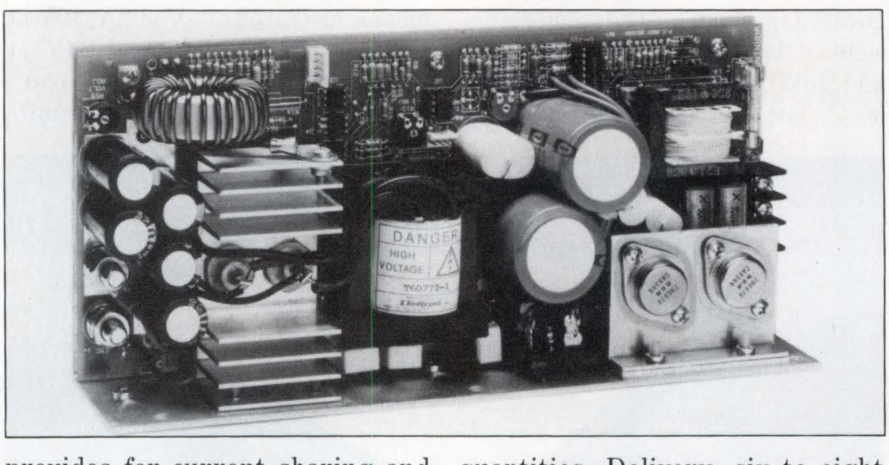
Pioneer Magnetics, 1745 Berkeley St, Santa Monica, CA 90404. Phone (800) 233-1745; in CA, (800) 848-1745. TWX 910-343-6249.

Circle No 721

Pioneer Magnetics, Kingswick House, Sunninghill, Ascot, Berkshire, SL57BJ, UK. Phone (990) 23491. TLX 848980.

Circle No 722

2 and 3.3V switching power supplies are suitable for use with IBM memory chips



Six different models of V Series switching power supplies provide dc outputs at 2 or 3.3V. Their low voltages make them ideal for use with IBM's memory chips and VLSI circuits. The six models are rated at 2V dc at 54A, 3.3V dc at 54A, 2V dc at 72A, 3.3V dc at 72A, 2V dc at 100A, and 3.3V dc at 100A.

The units accept 90 to 132V ac or 180 to 264V ac inputs in the frequency range from 47 to 440 Hz. They also have built-in overvoltage protection, remote sensing, and a soft-start feature. They maintain their current specifications over 0 to 50°C. Above 50 to 70°C, the current should be derated by 2.5%/°C.

For cooling, the V501G and the V501H units require 60 cfm of forced air; the other four units require 30 cfm of forced air. An option provides for current sharing and redundant parallel operation. No isolation diodes are needed. The V Series provides an optional power-fail monitor in the form of a TTL signal that occurs 2 msec prior to the loss of output power. Prices range from $145 to $210 in OEM quantities. Delivery, six to eight weeks ARO.

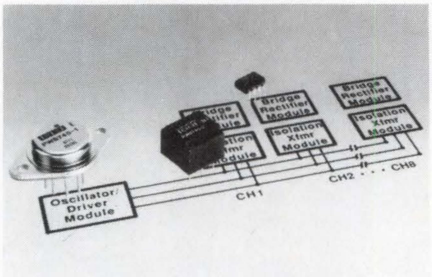
Deltron Inc, Box 1369, Wissahickon Ave, North Wales, PA 19454. Phone (215) 699-9261. TWX 510-661-8061.

Circle No 723

CIRCLE NO 106

Multichannel, isolated dc/dc converter provides multiple-channel outputs

The PWS740 is a multichannel, isolated dc/dc converter with a 1500V ac continuous isolation rating. It consists of three integrated components: the PWS740-1, a 400-kHz oscillator and driver in a TO-3 package; the PWS740-2, a trifilar-wound isolation transformer with a ferrite core encapsulated in a plastic package; and the PWS740-3, a rectifier bridge in a plastic, 8-pin miniature DIP. A typical isolation system using the PWS740 would consist of a transformer and rectifier for each channel; the oscillator would drive as many as eight channels.



The Sync pin on the oscillator module allows you to synchronize several oscillators. You can connect the Frequency Adjust pin to an external potentiometer to lower the oscillator frequency, thereby avoiding beat-frequency interference with other system signals. The Enable pin provides for output shutdown. Isolated dc outputs track the input voltage and can range from ±7 to ±20V at currents as high as ±30 mA.

Transformer impedance limits the converter's maximum input current to about 700 mA for a 15V input—a level that is within the unit's thermal limits. The unit operates over −25 to +85°C. Its typical efficiency for eight channels at rated loads is 80%. PWS740-1, \$12.75; PWS-2, \$2.50; PWS740-3, \$1.25 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

Circle No 725

350W switcher offers 3.10W/in^3, comes in a 9×5×2.5-in. package

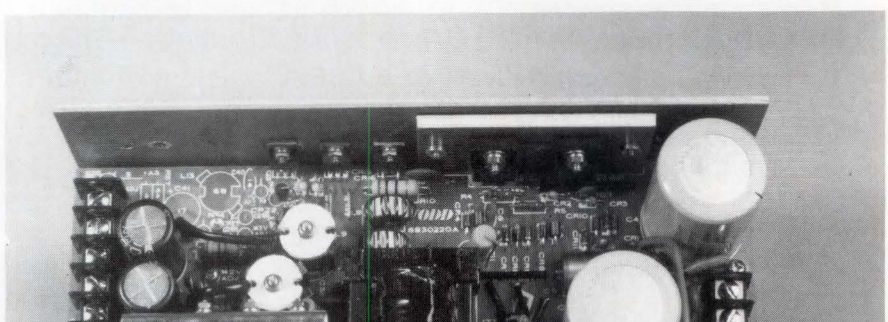
The MAX-350 350W switching power supply comes in a 9×5×2.5-in. package, which yields a power density of 3.10W/in^3. The MAX-350 offers three models, all of which provide 5V at 50A, 12V at 8 or 12A pk, and −12V at 4A. The MAX-354-1205 provides an additional output of −5.2V at 2A; the MAX-354-1224 has an additional output of 24V at 1.5A. The supplies are compatible with VME Bus and Multibus specifications and are designed with an ac-power-fail circuit that exceeds the ac-power-fail requirements (48-mA sink capacity) of the standard VME Bus.

The supplies accept 90 to 132V ac or 180 to 264V ac inputs in the frequency range from 47 to 63 Hz. They come with thermal, brownout, and overload protection, and they require 30 cfm of moving air for cooling.

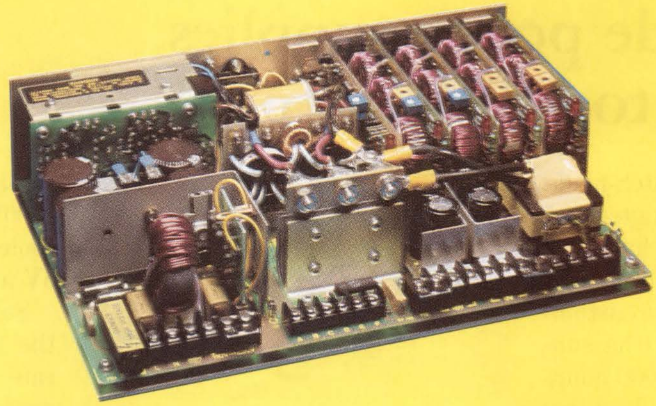
The units' typical efficiency is 75%, and the vendor specifies an MTBF of 100,000 hours. Their ripple and noise spec is 0.2% rms, 1% p-p, or 100 mV, whichever is greater. The units retain their full ratings over 0 to 50°C. An optional TTL ac-power-fail command provides an indication 5 msec before the 5V output goes out of regulation. \$336 (100). Delivery, stock to six weeks.

Todd Products Corp, 50 Emjay Blvd, Brentwood, NY 11717. Phone (516) 231-3366. TWX 510-227-4905.

Circle No 724



The latest Advance



New Powerflex 350-watt 5-output switching power supply

Go ahead. Design your microprocessor based equipment any way you want, and don't worry about the power supply. Whatever voltages you require, from 2V to 50V in either polarity, the Powerflex 350 switching power supply can provide them.

Because it's modular, we can easily configure the P350 for up to five outputs in standard or special voltages. And if your design changes, you can easily change outputs without changing your physical dimensions.

Just 2.9″ x 7.5″ x 11.8″, this high efficiency (75% at full load) 350-watt power supply takes both 110V and 220V inputs. Overvoltage and overcurrent protection on outputs is standard, along with margin testing (4.750V — 5.250V) on the main +5V 50A output. An optional signals board provides TTL compatibility.

The magnetic amplifier and soft switching technique assure high reliability and enable regulated auxiliary outputs to function without any minimum load on the main +5V output. Filtering is to VDE 0871, Curve A. The P350 is UL listed, CSA certified and meets other VDE, EC and FCC requirements.

Compare the calculated MTBF of over 52,000 hours with other power supplies in its class. There's no compromise on quality when you build around the P350 from Advance.

Contact your Advance Power Supplies representative for complete data on the P350 and other open and closed frame units from 25 to 1000 watts. Or call 1-216-349-0755 for more information.

Advance Power Supplies
32111 Aurora Road
Solon, OH 44139

ADVANCE POWER SUPPLIES

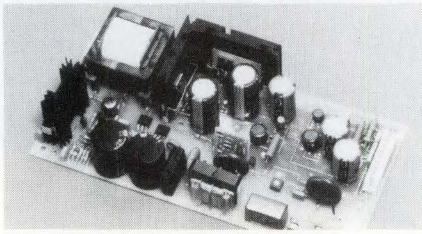
CIRCLE NO 105

703-001-1

Switch-mode power supplies offer 40W to 1-kW outputs

Series 190 open-frame switch-mode power supplies include single- and multiple-output versions that have power ratings of between 40 and 1000W. The vendor can also customize standard versions. All the supplies spec an MTBF of 40,000 hours under full load at 40°C. The five power ratings currently available are 40, 60, 150, 200, and 1000W; you can increase the power ratings of the 150 and 200W supplies to 220 and 300W, respectively, by using forced-air cooling.

The single-output versions of the 40, 60, and 200/300W power supplies each provide a 5, 12, or 24V output. (The user can adjust the 12V output to 15V.) The multiple-output versions of the 40 and 60W supplies typically provide ±12 or ±15V outputs, or a 5V output and ±12 or ±15V outputs. The multiple-output 150/220W supplies and multiple-output versions of the 200/300W supplies typically provide a 5V output and two 12/15V outputs. In the 150/220W supplies, the two 12/15V outputs have a common zero; in the 200/300W supplies they are isolated. Some versions of the 150/220W and 200/300W supplies provide an additional 5, 12, or 24V output. The 1000W supply is an enclosed, fan-cooled single-output unit providing 5V at 200A.



Series 190 supplies operate from the 110/220V ac line. They incorporate overload and overtemperature protection and have overvoltage protection on the 5V outputs. All versions are UL approved, CSA certified, and VDE registered. Typical prices for the 40W power supplies range from $80 to $100; the 60W models are $100 to $120.

Philips, Industrial and Electro-acoustic Systems Div, Box 218, 5600 MD Eindhoven, The Netherlands. Phone (040) 788620. TLX 35000.

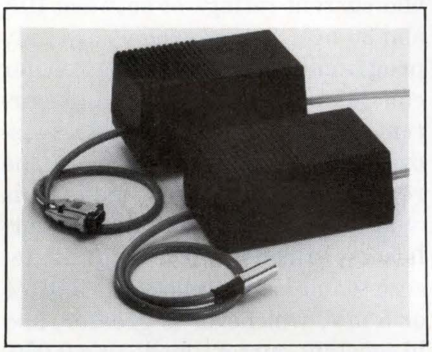
Circle No 726

1500W SUPPLY

The Model 6D Multimod is a 1500W modular switching power supply. It features a mainframe that houses six separately selectable output modules. The mainframe accepts 115 or 230V ac inputs and converts the ac power to 300V dc. Each module is a dc/dc converter that receives power from the 300V dc bus. The supply employs 100-kHz MOSFET switching components and meets international electrical safety and emission standards, such as VDE, CSA, and UL standards. You can choose single-output 300W modules ranging from 2 to 48V dc. Multiple-output modules will be available soon. All of the output modules are capable of current sharing. Outputs are adjustable to ±10% of nominal voltage, and line and load regulation are each 0.2% of the rated output. Current limiting, overvoltage protection, reverse-voltage protection, and remote sensing are standard features. The entire supply measures 5×8×13.5 in. A supply equipped with six single-output modules costs $1500.

Powertec Inc, 20550 Nordhoff St, Chatsworth, CA 91311. Phone (818) 882-0004. TWX 910-494-2092.

Circle No 430



25W SUPPLIES

The X and Y desktop linear power supplies provide 25W of output power and are available in single- and multiple-output versions. The standard outputs are 5, 12, and 24V dc. The supplies offer input voltage ranges of 105 to 130V ac or 220 to 240V ac. Their dielectric strength is 1500V, and they operate over 0 to 40°C. The output regulation is 5%. The supplies meet UL, CSA, and VDE requirements and feature short-circuit protection. The housings are made of durable fire-retardant plastic. $40 (100).

Jerome Industries Corp, 730 Division St, Elizabeth, NJ 07201. Phone (201) 353-5700. TLX 132001.

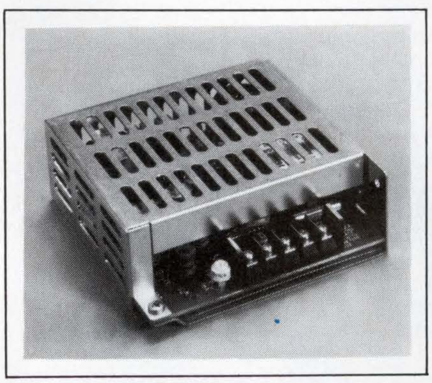
Circle No 432

DISK SUPPLY

Designed specifically for hard-disk-drive applications, the quad-output SQV350 350W switching supply provides power for two 8-in. drives or for as many as eight 5¼-in. drives. The unit features a 5V main-output rating of 10A. One of the three auxiliary outputs is rated for 12 or 24V at 16A peak to accommodate initial turn-on/spin-up loads. The remaining two outputs are rated at 5A each with 7A peak loads. The supply features built-in overload and overvoltage protection and remote sense capability. $251 (100). Delivery, three to six weeks ARO.

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

Circle No 431



SWITCHING SUPPLIES

Pony Series switching power supplies come in 14 models that deliver 15 to 30W. The supplies are enclosed units and are UL recognized and CSA certified. Each model features an input EMI filter, a 115V ac input voltage rating, built-in overvoltage protection, and a typical efficiency of 65%. The line regulation, from low to high line, is 0.4%; the load regulation (from no load to full load) is 1%. All models provide a 20-msec min holdup time. $24.90 (1000).

Computer Products Inc, 2900 Gateway Dr, Pompano Beach, FL 33069. Phone (305) 974-5500. TWX 510-956-3098.

Circle No 433

DC/DC CONVERTER

The 12Q15.050 operates from a 12V dc input and provides two ±15V dc outputs at ±50 mA each. Both dual output sections are isolated from the input and from each other. The unit has a 6-sided shielded case that eliminates RFI problems. The internal switching frequency (63 kHz free running) is unaffected by load or line changes. A switching-frequency synchronization pin lets you run the converters at frequencies ranging from 70 to 110 kHz. The input/output and output/output isolation equals 500V dc and the operating temperature range spans −25 to +90°C. $110. Delivery, stock to six weeks ARO.

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. TLX 338506.

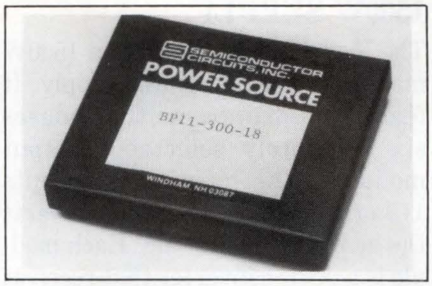
Circle No 435

SWITCH-MODE SUPPLY

The Model SA1000-3104 is a 1-kW switch-mode power supply that delivers 5V at currents as high as 200A. You can adjust the output voltage by ±2% with a potentiometer, or you can digitally program the output voltage from 4.2 to 5.75V. The supply's line regulation is 10 mV max over the full operating input-voltage range, and its zero- to full-load regulation is 20 mV max. The power supply operates from line input voltages ranging from either 90 to 135V or 180 to 265V, within a frequency range of 47 to 63 Hz. Its thermal protection includes a high-temperature alarm output that is activated at 50±5°C, as well as an overtemperature alarm output that is activated when the power-supply temperature exceeds 75±5°C. The supply automatically shuts down within 10 to 30 sec of an overtemperature alarm. It also provides output overvoltage and overcurrent protection. For applications requiring more than 200A, you can add slave units to the power supply. The device measures 8×4.5×11 in. From approximately £500.

Astec (USA) Ltd, 2880 San Thomas Expressway, Suite 200, Santa Clara, CA 95051. Phone (408) 748-1200. TLX 6839191.

Circle No 434



DC/DC CONVERTERS

B Series converters are available in 15, 24, and 25W models and have outputs ranging from 5 to 12V dc. The units are nonisolated, accept inputs ranging from 9 to 36V dc, and are optimized for battery operation. Each model offers continuous short-circuit protection, automatic restart, overvoltage protection, and remote logic on/off control. The 15 and 24W converters come in RFI-shielded cases measuring 2.5×3.0×0.4 in. $53.90

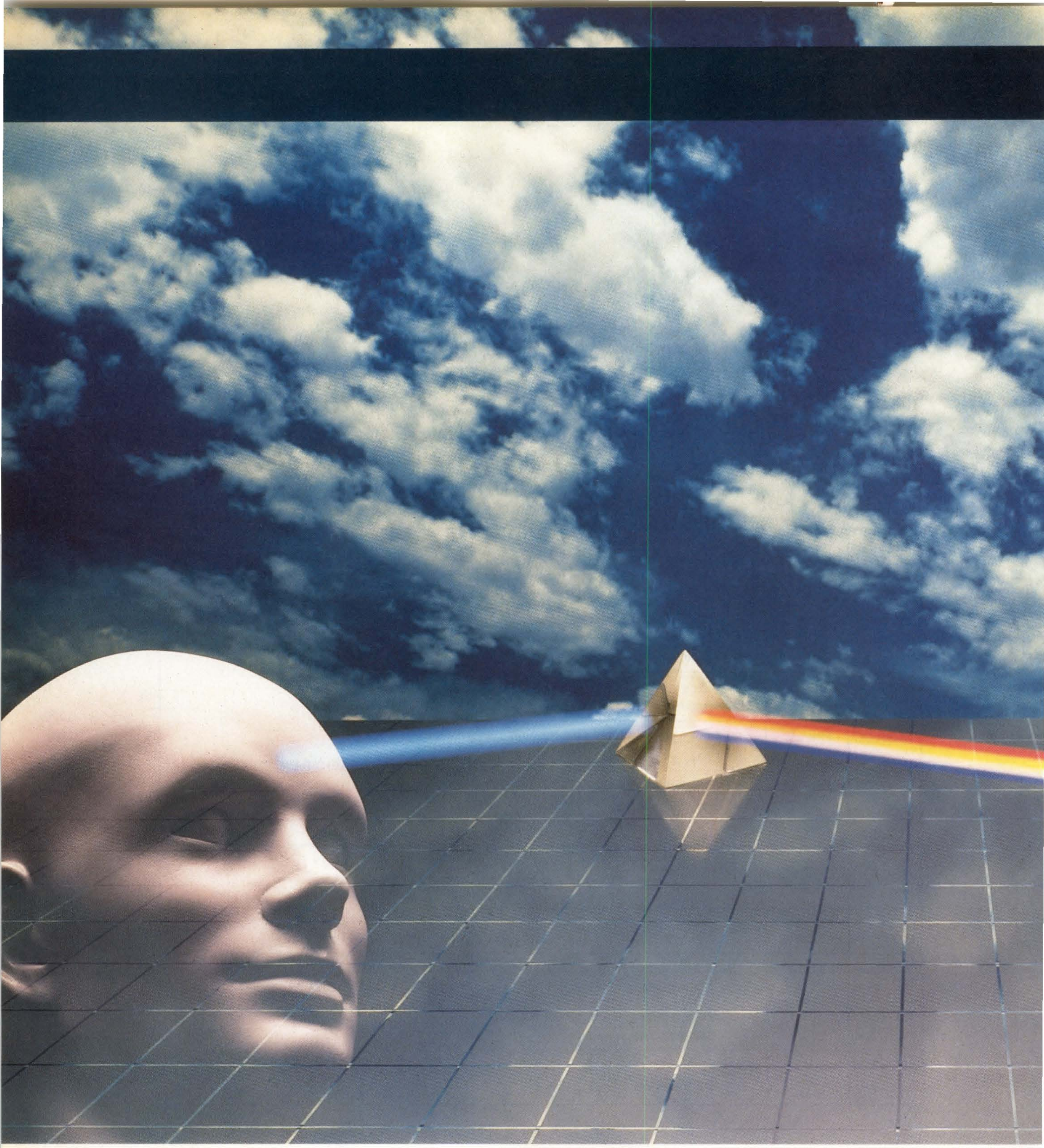
Semiconductor Circuits Inc, 49 Range Rd, Windham, NH 03087. Phone (603) 893-2330. TWX 710-366-0505.

Circle No 436

SUPPLY SERIES

The Series-1000 Mk II range of power supplies includes 26 different models with output-voltage ranges of between 0 to 35V and 0 to 1000V and current ratings of between 10A and 30 mA. All the models are fully programmable, providing either constant-voltage or constant-current operation with automatic crossover between operating modes. Line regulation in both modes is ±0.015% for ±10% line-voltage variation. In constant-voltage mode, zero to full-load regulation is 0.015% or 5 mV, whichever is greater, and in constant-current mode, it's 0.05% or 3 mA for a 50% output-voltage change. Options provide 0.01% regulation in constant-current mode and crowbar output protection. Programming inputs allow you to adjust the output voltage via a 0 to 5V input signal, and the current via a 0 to 1V input signal. The power supplies are housed in 19-in. rack- or

Text continued on pg 224



WIDE INPUT SWITCHING POWER SUPPLIES...A GOOD IDEA THAT WORKS WITHOUT MODIFICATION

A good idea is a powerful thing. It drives ordinary technology to the extraordinary. At Converter Concepts, ideas make our technology superior and our power supplies more reliable.

We specialize in wide-input AC/DC and DC/DC, high efficiency switching power supplies for worldwide OEM use. That means your product can operate anywhere in the world without modification.

Think about that for a moment.

Too good to believe? Well, believe it. Because only Converter Concepts' power supplies operate on any

CONVERTER CONCEPTS

IDEAS THAT POWER TECHNOLOGY

voltage in the world WITHOUT SWITCHES, JUMPERS, TAPS OR OTHER MODIFICATIONS. This exciting technology is made possible due to the work and dedication of our people.

Our people are thinkers as well as doers—pushing ordinary flyback technology beyond previous limitations. That's why we're an industry leader.

Since 1976, Converter Concepts has designed, manufactured and marketed power supplies which are revered for their quality and reliability.

Find out what we can do for you. Contact the Converter Concepts' representative nearest you or call us directly. You'll discover that at Converter Concepts, the difference is people with ideas.

CONVERTER CONCEPTS INC

Industrial Parkway • Pardeeville, WI 53954
(608) 429-2144 • TWX: 910-280-2630
Toll-Free 800/253-5227

CIRCLE NO 199

bench-mounting enclosures. They operate from 200/250V line supplies. From around £1000 to £4000.

Hunting Hivolt, 1008 W 9th Ave, King of Prussia, PA 19406. Phone (215) 265-7462.

Circle No 437

FOUR-OUTPUT SUPPLY

The Model 510EU 200W switching power supply has four outputs. Transient suppression devices allow it to withstand the 6000V IEEE 587 voltage transient test. The unit employs 50-kHz MOSFET switching circuitry. It accepts 105 to 130 or 198 to 265V ac, selectable on the barrier strip. The device delivers 5V at 20A, ±12V at 4A, and -5V at 0.5A. Its secondaries are adjustable to ±15V at 3A. All its outputs are current limited and have continuous overload and ac-input protection, short-circuit protection, overtemperature protection, self-recovering overvoltage protection, and no minimum load requirement. You can specify a power-failure signal and logic-inhibit capability as options. $395.

RO Associates Inc, 246 Caspian Dr, Sunnyvale, CA 94088. Phone (408) 744-1450. FAX 408-744-1521.

Circle No 438

CONVERTER SERIES

Series BA and Series BC isolated dc/dc converters have five output voltage configurations: 5, 12, 15,

±12, and ±15V dc. All of these outputs are available with nominal input voltages of 5, 12, 24, 28, and 48V dc. Series BA converters are housed in 24-pin DIPs and provide 1.5W of output power. Series BC converters come in industry-standard 2.0×2.0×0.4-in. packages and provide 6W of output power. Both series feature an input π-network filter; a 50-mV p-p ripple-and-noise specification; operation to 70°C without derating; and 500V dc isolation. The converters have a 25-kHz switching frequency and typical efficiency of 65%. Single-output Series BA units, $18; dual-output units, $19 (1000). Series BC single-output units, $25; dual-output units,

$27 (1000). Delivery, stock to eight weeks ARO.

International Power Sources Inc, 10 Cochituate St, Natick, MA 01760. Phone (617) 651-1818. FAX 617-655-7984.

Circle No 440

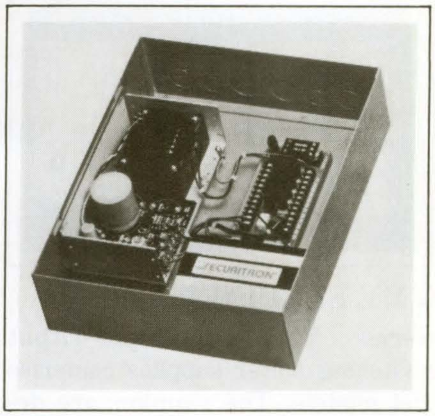
BUTTON CELL

The 4DK battery is a 1.2V NiCd button cell for solar-converter applications. The cell has a nominal capacity of 4 mAhr. It measures 2.1×9.5 mm and weighs 0.6g. The battery operates over −20 to +50°C. Its mass-plate construction allows it to retain 75% of its capacity when stored for 28 days at room temperature. You can charge the cell with 0.4 mA applied for 14 hours. The length-of-service-life specifications are 1000 IEC cycles within one year; 500 full cycles within two years; and 2000 shallow cycles within four years. You can trickle charge the battery with 40 μA for as many as six years, in the temperature range of 0 to 45°C. A pressure-relief vent protects the cell under abusive conditions. $0.87 (1000). Delivery, six weeks ARO.

Varta Batteries Inc, 300 Executive Blvd, Elmsford, NY 10523. Phone (914) 592-2500.

Circle No 439

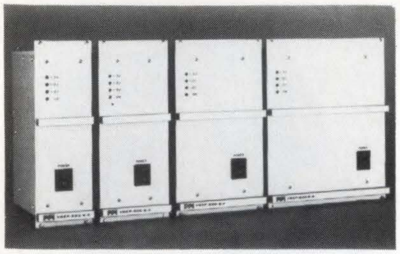
DC SUPPLY



BPS Series regulated adjustable dc power supplies deliver 12 to 24V dc voltages. Their amperage ratings range from 1 to 15A for 12V dc models and from 1 to 10A for 24V dc models. All of the units in the series are UL and CSA listed, except the 1A versions, which use UL-recognized ac sections. Screw terminals are provided for line-voltage input and dc output. Faston battery clips are provided for attachment of sealed lead-acid (gel) batteries. The supplies come in UL-listed hinged knockout boxes. All models with capacities greater than 1A include eight individual fused outputs for powering multiple loads; consequently, if a short circuit occurs on a load, only one of the eight fuses will blow. $110.

Securitron, 1815 W 205th St, Suite 103, Torrance, CA 90501. Phone (800) 624-5625; in CA, (213) 618-0204.

Circle No 442



VME SUPPLIES

Series VMEP multiple-output switching power supplies comprise 104 models. The supplies are designed specifically for the VME Bus and include VME Bus ACFail and SYSReset signal lines. The series is divided into four groups according to power rating: 200, 400, 600, and 800W. Voltage outputs of 5, 12, 15, 24, and 48V dc are available in two VME Bus-height formats: 6U and 3U. Designed for operation in standard VME Bus card racks, the supplies also come in modified packages for universal mounting outside the rack. The supplies accept inputs from 90 to 132V ac or from 180 to 264V ac over 47 to 63 Hz. Their switching frequency is 50 kHz, and all models provide three voltage outputs. Other features include load and line regulation to ±0.2% or 10 mV max; a 1% or 50-mV p-p noise-and-ripple specification; 70% min efficiency at full load; overvoltage and overcurrent protection for all outputs; and parallel power-sharing capabilities. $450 to $1200.

Power Pac Inc, Box 777, Norwalk, CT 06856. Phone (203) 866-4484.

Circle No 443

DC/DC CONVERTERS

Series E900VF^2 quad-output dc/dc converters (with an auxiliary ac filament output) are for use with vacuum fluorescent displays. They provide two dc anode and two ac filament voltages to power two-color vacuum-fluorescent displays or two

dissimilar displays requiring as much as 12W of total output power. The converters power standard displays from Noritake, Futaba, and NEC. You can order custom units for displays that require voltages not specified in the series. The units accept 5, 9, 12, 15, and 24V dc and have ±10% tolerance. They operate over 0 to 70°C and provide 600V rms I/O isolation at 60 Hz for one minute. The converters weigh 122g and come in aluminum pc-board mounts

CONFIGURE-YOUR-OWN

MIL SPEC • HIGH RELIABILITY

POWER SUPPLIES

A HIGHER LEVEL OF PERFORMANCE

INTRODUCING EL 2000 SERIES

Complete AC to DC and DC to DC multi output systems.

MORE BENEFITS

Save Space: Completely protected AC-DC systems with rugged high density packaging to 8 watts/in^3.

Less Heat: Efficiencies to over 80% with next generation circuitry.

Higher Reliability: MTBF to 500,000 hours with conservative design criteria including NAVMAT guidelines.

MORE CHOICES

- Up to 8 DC outputs to 500 watts.
- 1ø, 3ø and DC inputs.
- –55°C to +85°C operation.
- Mil-Std-704A-D, 1399 and 1275 input surge and spike protection.
- Meets many provisions of Mil-Std-810D, Mil-E-5400 and Mil-E-16400.

Call or write for our new EL 2000 Catalog today!

ARNOLD MAGNETICS

ARNOLD MAGNETICS CORPORATION

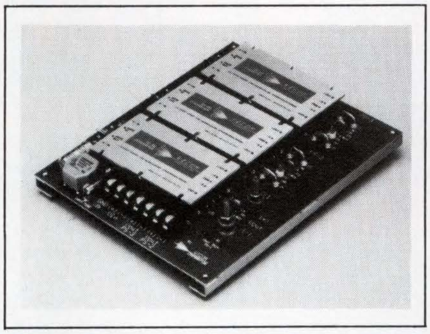
4000 Via Pescador, Camarillo, California 93010-5049
Phone: (805) 484-4221 • TWX 910-343-6468 • FAX: (805) 484-4113

CIRCLE NO 201

that measure 2.0×2.5×0.98 in. $29.72 (250).

Endicott Research Group Inc, Box 269, Endicott, NY 13760. Phone (607) 754-9187.

Circle No 444



EVALUATION BOARDS

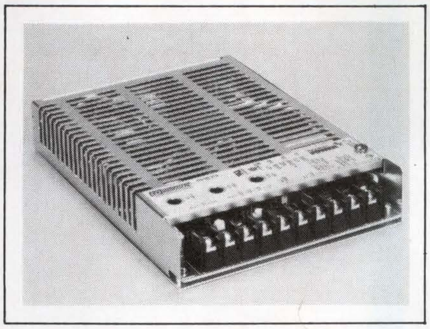
Series VI-MEB modular boards are designed to evaluate the vendor's Series VI-100 and VI-200 dc/dc converters. The VI-MEB-LV accepts modules with input voltages to 100V dc, whereas the VI-MEB-HV handles modules with input voltages to 400V dc. Each board comes with a barrier terminal, output lugs, measurement test points, and fuse. The 10×12-in. boards accept one, two, or three modules; you can configure the boards as single-, dual-, or triple-output power supplies. The boards deliver as much as 400W when configured as single-output supplies. Triple-output configurations deliver as much as 200W per output. A 32-pg manual covers measurement techniques and provides application hints. $295.

Vicor Corp, 23 Frontage Rd, Andover, MA 01810. Phone (617) 470-2900. TWX 910-380-5144.

Circle No 445

SUPPLY SERIES

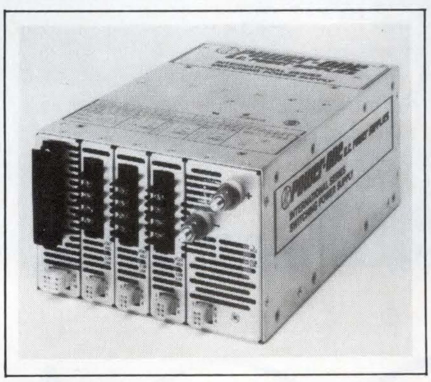
Mustang Series switching power supplies comprise 34 models at 25, 50, 70/80, 100, and 150W. Each model is encased and has a barrier screw-type terminal connector. Every power supply features an input EMI filter, inrush current limiting, ±5% minimum output-voltage adjustment, 72 to 75% effi-



ciency typ, and overload protection. The units have line regulation of 0.4% from low line to high line, and their load regulation is 0.8% from no load to full load. All models provide a 20-msec min hold-up time. Their ripple-and-noise specification is 1% or 50 mV p-p max, whichever is greater. Multiple- and single-output models accept ac input voltages from 90 to 132V ac. In addition, the multiple-output models accept voltages between 180 and 250V ac. Their input frequency ranges from 47 to 440 Hz, and their switching frequency is 100 kHz. The units operate over 0 to 71°C, with derating between 50 and 71°C. The series is UL recognized and CSA certified. From $59.50 (1000).

Computer Products Inc, 2900 Gateway Dr, Pompano Beach, FL 33069. Phone (305) 974-5500. TWX 510-956-3098.

Circle No 446

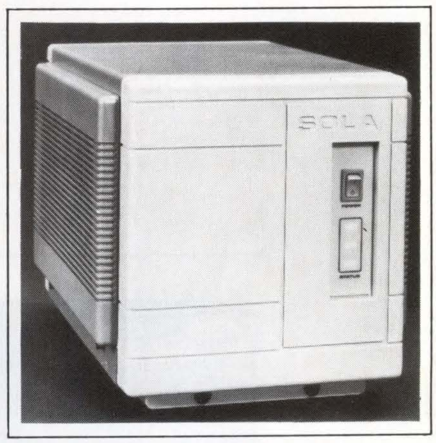


SWITCHER

The SPM5 is part of the International High Power series of switching power supplies. It provides 1500W in a 5×8×11-in. fan-cooled package. Its modular design lets you specify as many as 15 outputs from a selection of off-the-shelf single-, dual-, and triple-output plug-in modules. This modular construction can achieve a power density of 3.4W/in^3. The unit accepts input ac voltages from 90 to 132V ac and from 180 to 264V ac, in the field-selectable range of 47 to 440 Hz. An optional UPS (uninterruptible power system) module provides loss-of-power protection via battery backup to 1000W of dc output power. You can use the UPS module with parallel, connected dc output modules for redundant-mode operation in fault-tolerant systems. The supply meets VDE, IEC, CSA, and UL safety standards; it also meets FCC and VDE emission standards. $924 (250).

Power-One DC Power Supplies, 740 Calle Plano, Camarillo, CA 93010. Phone (800) 235-5943; in CA, (800) 421-3439. TWX 910-336-1297.

Circle No 447



POWER CONDITIONER

This series of µP-based electronic power conditioners (EPC) comprises models with 500, 1000, and 2000 VA output capacities. Each model regulates the output voltage to within ±5% of the nominal output for input voltage variations from +15 to −25%. The devices continuously measure output voltage and correct it every 16 msec. The units suppress to safe levels Class A and Class B input surge voltages of as much as 6000V peak per ANSI C 62 41-1980 (IEEE-587-1980). The units

Text continued on pg 233

☐ 400W air, 300W convection
☐ Five factory/user-adjustable outputs
Outputs | 1 | 2 | 3 | 4 | 5
Vdc | 5 ±5% | 12-24 | 5-15 | 5-15 | 5-15
Current Air | 50 | 6 | 6 | 6 | 6
Current Conv | 40 | 6 | 6 | 6 | 6
☐ ±0.2% regulation on all outputs
☐ The most compact unit on the market - measures only 13"
☐ UL, CSA, IEC and TUV approved. FCC and VDE approved for noise level A.
☐ Power fail and remote inhibit standard
Acme Electric
Power Products Group
Cuba, New York 14727
(716) 968-2400
CIRCLE NO 202

attenuate transverse-mode noise by 60 dB and common-mode noise by 130 dB. Each unit in the series maintains a sine-wave output and adds less than 0.5% harmonic distortion to the input waveform. The units shut down when the input voltage is more than 24% above or 40% below the nominal input voltage. The units automatically enable the output voltage when the input voltage returns to acceptable limits. The 60-Hz units are UL listed and CSA certified, and they conform to FCC Class B requirements. The 50-Hz models meet VDE and IEC requirements. The 60-Hz models are rated for nominal outputs of 120, 208, or 240V ac; they have rated outputs of 110, 220, 230, or 240V ac. $599 to $1279.

Sola, 1717 Busse Rd, Elk Grove Village, IL 60007. Phone (312) 439-2800. TLX 280538.

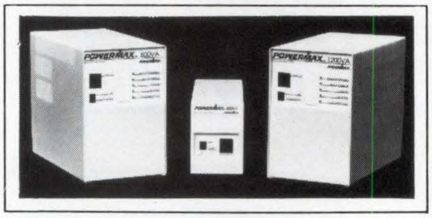
Circle No 448

POWER PACKS

Performaxx lithium power packs are designed to power downhole equipment. The line of power packs includes battery packs for several standard downhole tools and for custom models. The basic cells have a 3.9V dc open-circuit voltage (OCV) rating, come in four sizes, and have four capacities rated for 3.6V (loaded) at 150°C. These sizes and capacities are RMM 150 AA at 1.3 Ahr, RMM 150 C at 5.1 Ahr, RMM 150 D at 12 Ahr, and RMM 150 DD at 22 Ahr. The basic cells are packaged in an integral pack to meet a specific tool's power requirements. The integral-pack construction incorporates Kapton spacers (rated at >200°C) to allow for thermal expansion of the cells; welded nickel tabs to ensure cell-to-cell continuity; a nonconductive heat-resistive Nomex housing material; and a field-replaceable external fuse. The packs comply with DOT E-7052 safety standards, including altitude testing at 50,000 ft. The units are shock tested to 5000G and temperature tested to 150°C under heavy current drains. Individual cells, from $32.25 to $54.25.

Electrochem Industries/DRM, Box 50, Buffalo, NY 14226. Phone (716) 759-2828.

Circle No 449



BACKUP SUPPLY

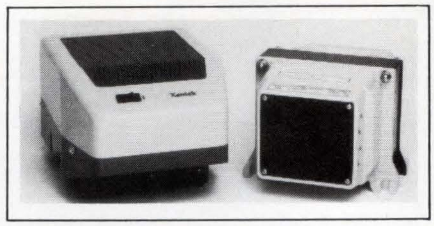
The PowerMax line of backup power systems provides protection against power blackouts. If a power failure occurs, the system switches from ac power to an internal battery within 2 msec. The battery can operate for as long as 80 minutes, depending on the power demands. The line consists of three units: the 450 VA model, with 300W capacity; the 800 VA model, with 600W capacity; and the 1200 VA model, with 1000W capacity. All models sound an alarm when the battery power of the system is nearing exhaustion. All models are UL recognized and CSA approved, and carry a one-year guarantee. The 450 VA, 800 VA, and 1200 VA models cost $599, $1099, and $1399, respectively.

Panamax Inc, 150 Mitchell Blvd, San Rafael, CA 94903. Phone (800) 472-5555; in CA, (800) 472-5540. FAX 415-472-5540.

Circle No 450

LINE CONDITIONERS

The vendor has added 56 models to its two lines of power-protection systems, the EIT extreme isolation



transformers and the XLC line conditioners, which provide data integrity and security for computer systems in the event of power-line disturbances. The isolation transformers feature output load regulation of ±3% of the input voltage from no load to full resistive load; isolation resistance of 10,000 MΩ; dielectric strength of 2500V ac; and 97% efficiency. All of the transformers meet CSA-22.2-066 and UL-1012 requirements; some meet VDE-0550 specifications. The line conditioners provide input regulation of ±3% of the output for inputs of 120V ac +10%, −20%; load regulation of ±2% from no load to full resistive load; 5% THD max for a resistive load; common-mode rejection of 120 dB or greater; voltage spike attenuation of 48 dB or greater; short-circuit protection with short-circuit current limited to 200% of rated value; and 85% efficiency. Isolation transformers, from $175; line conditioners, from $275.

Xentek, 760 Shadowridge Dr, Vista, CA 92083. Phone (619) 727-0940. TWX 910-322-1155.

Circle No 451

POWER SUPPLIES

Minivolt miniature power supplies measure 90×64×32 mm and are suitable for chassis or pc-board mounting. They operate from 110/250V line inputs. The single-output versions provide a 5V output at 0.5, 1.0, 1.5, 2.0, or 2.5A; a 12V output at 1.2A; or a 24V output at 0.6A. The dual-output versions provide ±15V outputs at 0.1, 0.2, or 0.5A. You can ground the positive or negative output of the single-output supplies to generate a negative or positive output. The dual-output versions have a common ground. The

line regulation is ±0.05%; the zero to full-load output regulation is 0.15% for single-output versions and 0.35% for dual-output versions. Output ripple is less than 1 mV. Around £100.

Hunting Hivolt Ltd, Riverbank Works, Old Shoreham Rd, Shoreham-by-Sea, W Sussex BN4 5FL, UK. Phone (0273) 454511. TLX 87466.

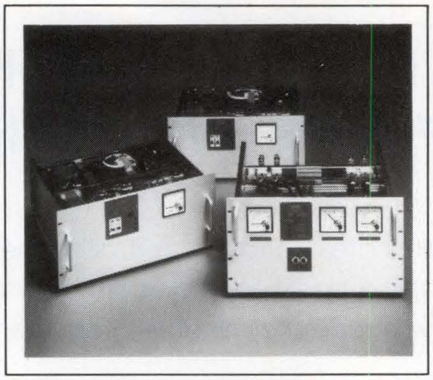
Circle No 454

Hunting Hivolt, 1008 W 9th Ave, King of Prussia, PA 19406. Phone (215) 265-7462.

Circle No 455

STANDBY SUPPLY

To eliminate unnecessary duplication of equipment in dc uninterruptible power-supply systems, you can use these 20 or 30A modular standby-power supplies to build a 24 or 48V system. Such a system can furnish a maximum of 120A, and a single switching unit can handle all load switching. The modules also ease future expansion or modification of your system.



The modules provide load current and battery-charging current for suitable lead-acid batteries. The switching unit automatically switches the load to the batteries if the line supply fails. Features include output overvoltage protection, automatic temperature compensation of the battery-cell recharge voltage, and a low-voltage disconnect facility that prevents deep discharge of the batteries. Remote alarm outputs are provided for line-input failure and out-of-limit voltage excursions. You can mount each module on a 19-in. rack. Power-supply modules, from £957; switching unit, £924.

F W O Bauch Ltd, 14 Gunnels Wood Industrial Estate, Gunnels Wood Rd, Stevenage, Herts SG1 2BH, UK. Phone (0438) 727684. TLX 27502.

Circle No 456

Numbers

That set the standard for high performance programmable ICs:

The company that brought you
CMOS programmable devices
with bipolar performance
now introduces the next logical step:
CMOS programmable devices that
surpass bipolar in speed, and in density.

1. Bigger PROM, faster.

Nothing this big ever went this fast with so little power.

16,384 words by 8 bits, with address-to-valid-output in 45 nanoseconds!

Isn't new technology wonderful?

Here's PROM with the speed and density to keep up with microprocessors running at 20MHz and beyond.

128K PROM
45ns. 100mA. 600 mil package.
Bipolar pin compatible. Reprogrammable.
(Military: 55ns, 120mA)
Actual size!

High performance PROM for program and table storage with the density and low power you need for cooler, smaller designs.

Beyond speed: CMOS advantages that make bipolar obsolete:

There are no viable bipolar PROM suppliers supporting this density.

A density that lets you design bigger systems with fewer devices.

Devices that, in turn, need less power.

100mA Active.

Two 64K bipolar parts would require nearly four times the power!

And bipolar PROM can't match our standby power-down features for lowest system power requirements.

30mA Standby Power, with no sacrifice in speed!

128K PROM
45ns. 100mA. 30mA Standby.
300 mil package.
Three fast chip selects.
Power-down chip enable.
Reprogrammable.
(Military: 55ns, 120mA, 35mA Standby.)
Actual size!

2. Small PROM, faster.

16K Registered PROM
18ns Set-up. 12ns tCO. 120mA.
Pipeline accelerator.
Reprogrammable.
(Military: 25ns Set-up,
15ns tCO. 120mA)

16K PROM
25ns. 120mA.
Reprogrammable.
(Military: 30ns, 120mA)

Prom II is here! Speed records tumble!

Sub-micron fabrication (0.8 micron, to be exact) means our newest 16K delivers record setting performance:

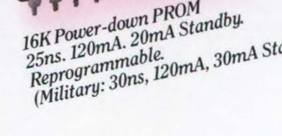
Clock-to-output of 12ns for the registered CY7C245A, 18ns set-up.

And access time of 25ns for the unregistered CY7C291A and CY7C293A.

The 25ns CY7C293A also offers unprecedented low standby power: Only 20mA, and with no loss in performance!

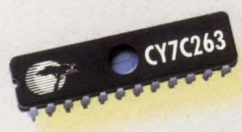
Plus a wide range of 4K, 8K, and 16K PROM

In registered and non-registered versions. Some with windows. And all with the key Cypress Semiconductor CMOS PROM Technology Advantages.



16K Power-down PROM
25ns. 120mA. 20mA Standby.
Reprogrammable.
(Military: 30ns, 120mA, 30mA Standby.)

3. Midsize PROM, faster.



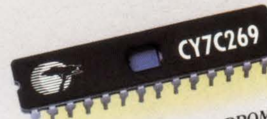
64K PROM
35ns. 100mA.
Reprogrammable.
(Military: 45ns, 120mA)

64K Performance PROM: Choices.

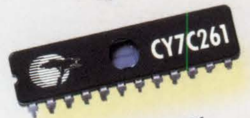
For highest performance, lowest power 64K PROM devices, you have little choice but Cypress Semiconductor. We give you the fastest low power parts in the industry. And we give you plenty of options:

Registered versions. Registered diagnostic versions. Reprogrammable versions. Power-down versions.

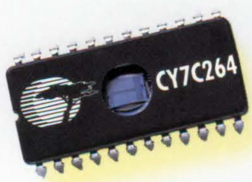
More *choices,* so you have more ways to configure the best system.



64K Registered Diagnostic PROM
40ns Set-up. 20ns t CO. 100mA.
28-pin, 300 mil package.
Reprogrammable.
(Military: 50ns, 120mA)



64K Power-down PROM
35ns. 100mA. 30mA Standby.
Reprogrammable.
(Military: 45ns, 120mA, 30mA Standby.)



64K PROM
35ns. 100mA.
Reprogrammable.
(Military: 45ns, 120mA)

4. Innovative PROM, faster.

64K Registered Diagnostic PROM 40ns Set-up. 20ns tCO· 100mA. 32-pin, SSR™ Compatible. Full Diagnostics. Reprogrammable. (Military: 50ns, 120mA)

First bytewide diagnostic PROM: 64K. Registered. 20ns.

Widely accepted in military applications, diagnostic PROM is now gaining in popularity for commercial applications.

Two new innovations should accelerate that acceptance: Our CY7C268 and our CY7C269.

Both function in the normal pipeline mode, with high performance.

Or, when selected, the Diagnostic Register can be loaded with the data on the bus, or the data in the Pipeline Register. Conversely, the system can load the contents of the Diagnostic Register into the Pipeline Register.

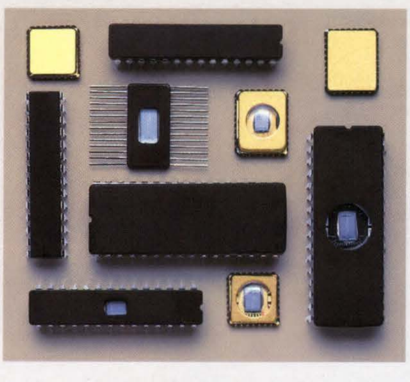
If board space is at a premium, the designer can select the 300-mil, 28-pin CY7C269.

The CY7C268 offers full compatibility with the SSR Diagnostic Standard, but with the important addition of bytewide capabilities.

Either way, the designer has powerful tools for system diagnostics.

Who uses diagnostics?

Designers of state machines. Controllers. Bit-slice machines. Debugging systems. Anyone who needs to step through programs.



And, you can specify these packages. Our robotic assembly makes your package requirements easy to satisfy.

How innovation gives you better, more reliable technology. With every Cypress PROM or PLD:

Speed: As we continue to exploit the capabilities of CMOS, you see CMOS surpassing bipolar performance, delivering the highest speed available.

Low Power: A fraction of the power of bipolar, in fact. Invaluable for today's highest performance systems. With power-down features that let you create the lowest overall system power possible.

Reliability: First, because our floating gate cell technology can be erased, we are able to test and erase every cell in every product prior to shipment, to assure you of the highest possible programming yields.

Second, our engineers have created designs that have the highest tolerance to static discharge and voltage fluctuation. Translation:

Tolerates 2001V Static Discharge.

Tolerates ±10% voltage fluctuation.

5. Innovative PLD, faster.

Second Generation Programmable Logic: Our best seller.

The Cypress 22V10 difference.

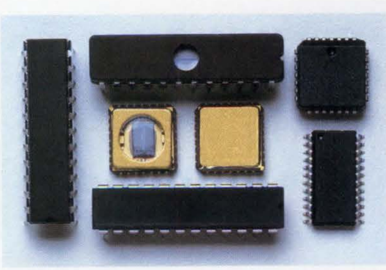
It is fast, 25ns with 15ns set-up time, and it is shipping in quantity.

It sips power. It is available in reprogrammable versions, to simplify your development cycle.

And our 22V10 features Programmable Macro Cells, which lets you define the architecture of each output, individually. Options include registered operation, combinatorial operation, selectable output polarity, and array-configurable output-enable; you have up to 22 input terms and 10 outputs at your disposal. These options let you configure the part to your system needs like no other PLD.

Our Variable Product Term architecture allows you the functions you need for most applications without burdening the performance of the part.

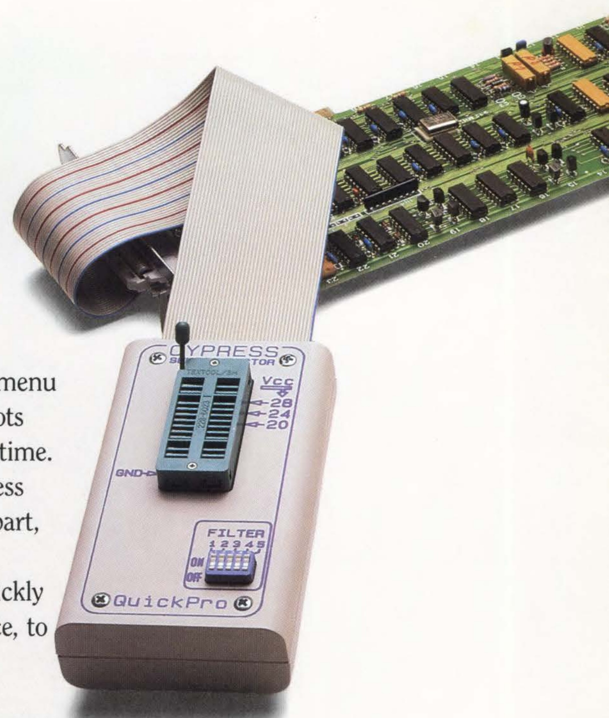
Finally, there is an array of enhanced test features to accelerate development. Not to mention our handy QuickPro™ for easy programming and diagnostics right on your PC-compatible.



The 22V10 is also available in these packages. Our robotic assembly means we can supply the package that's best for your system.

25ns. 33MHz. 55mA "L". 90mA Standard. 300 mil package. Reprogrammable. (Military: 25ns, 25MHz, 100mA)

6. Tools for design, faster.



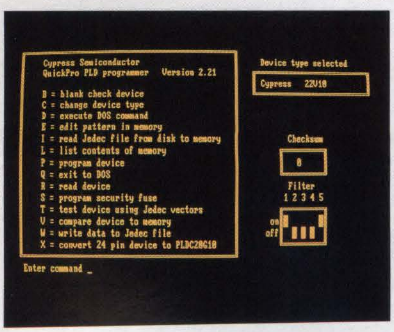
QuickPro: PROM and PLD programming and diagnostics right now, right from your PC-compatible.

QuickPro is fast becoming an essential complement to the PROM programmer in the development lab.

Menu-driven: PROM and PLD options are easily selected through hierarchical menus. Help screens make the system easy to learn and use.

Here's why:

1. You have the software updates you need to use the latest Cypress PROM and PLD releases quickly—typically several months before the updates are released by PROM Programmer vendors. Because the QuickPro is software driven, updates are simple floppy disk files; the system is future proof.



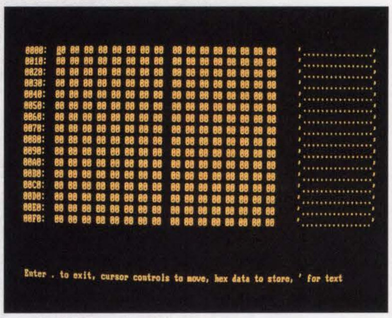
Powerful options: You select from a broad

2. You have an easy, screen and menu oriented system that gives you lots of options, and saves you lots of time.

3. You can program any Cypress Semiconductor programmable part, on PC-compatibles.

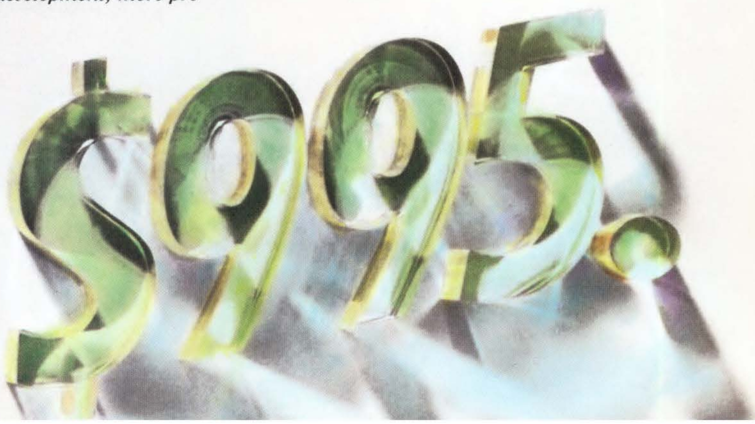
4. As you can see, you can quickly display the contents of any device, to speed debugging.

5. Using the JEDEC standard, (PC-DOS™ binary for PROM) QuickPro is compatible with the output of all the popular PLD programming tools, including CUPL,™ ABEL™ and PALASM.™

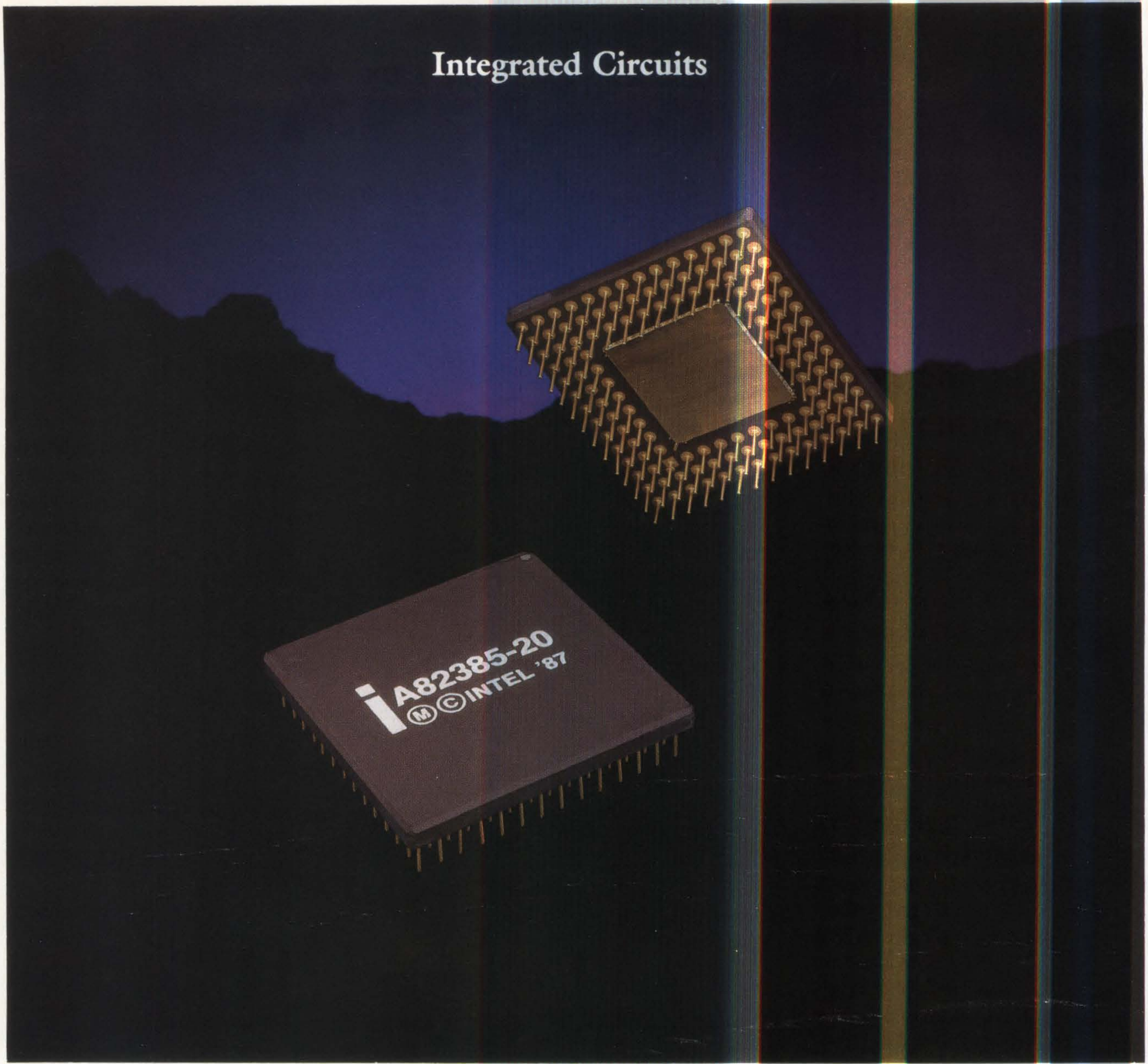


Memory display/editing: You can display the contents of PROM (shown) and PLD parts, for simplified debugging. You can also edit the contents of memory, and reprogram easily. Result: Faster development, more productive 'what-ifs'.

6. You can read the contents of virtually any 20- to 32-pin PLD or PROM. This allows you to copy your parts easily to Cypress devices, for comparative evaluations.



Integrated Circuits



Cache-memory controller with bus-watching capability (Intel)

As μP clock frequencies increase, the access time of the memories servicing the μPs must decrease. When you use a cache memory, you can use low-cost, relatively slow main memory and still keep up with the microprocessor.

Cache-memory systems benefit from on-chip solutions

David Shear, *Regional Editor*

The motivation behind using a cache is to improve a CPU's throughput by eliminating wait states. Not too many years ago, only those engineers designing advanced mainframes concerned themselves with cache memories. Nowadays, with the proliferation of high-performance 16- and 32-bit μPs and inexpensive, though rather slow, dynamic-RAM main memory, almost all systems can benefit from cache memories (see **box,** "Caches increase CPU throughput"). Your next μP design may very well require the performance gains afforded by an architecture with a cache.

To address this need, many IC vendors have introduced cache-memory controllers. You have a slew of choices, from simple cache-tag RAMs to complex and complete 4-way, set-associative subsystems. Before you can make an intelligent decision about which product to use, you have to be able to evaluate the various approaches and determine the effect each approach will have on the performance of the system you're designing.

The goal in using a cache is not necessarily just to achieve optimal cache efficiency—or even optimal processor performance. Rather, it is usually a more global objective, typically involving optimizing system performance within certain cost, size, and power limits. Simply stated, your main design goals are as follows:

- Minimize the probability of not finding a memory reference's target in the cache (the miss rate)
- Minimize the time to access information that is indeed in the cache
- Minimize the delay due to a miss
- Minimize the overhead of updating main memory and maintaining coherency.

The miss rate is a key parameter

One of the key variables in evaluating a cache implementation is the miss rate, the ratio of memory misses to the total number of memory accesses. The miss rate is a statistical estimate derived from the results of simulation or by actual measurement. (For more information on determining the performance advantage in using a cache, see **box,** "Estimate the performance gains possible with a cache.")

Using a cache requires many design decisions

You'll find many approaches to using a cache. The major differences you'll have to evaluate are the size of the cache, the placement policy, the use of either a write-through or a copy-back memory-update policy, the choice of a real or virtual implementation, the coherency policy, the single-vs-split implementation, and the replacement scheme.

The size of the cache is the most dominant cache parameter in terms of both cost and potential performance tradeoffs. You can't just make a large cache and expect great performance; you must use this resource well. Common cache sizes range from a few hundred bytes inside a μP chip to a few hundred kilobytes inside a mainframe. The cache controllers from Austek, Chips and Technologies, and Intel, for example, all have a size of 32k bytes **(Table 1).** The NEC single-chip implementation has only an 8k-byte cache, but because of its design it maintains a miss rate that's comparable to the others'.

Although a cache's miss rate varies significantly with the software that is being executed, it has been shown that increasing the size of the cache increases the hit rate **(Ref 1).** As the cache size increases, the miss rate is asymptotic to a miss rate of 0. Therefore, the increase in performance with an ever-increasing cache size reaches a point of diminishing returns. The main penalty in increasing the size of a cache is the cost incurred.

Another cache-design decision you'll be confronted with involves the placement policy. Placement determines how the main memory is mapped into the cache. You have three choices: direct mapped, set associative, or fully associative.

A direct-mapped cache is implemented as a RAM addressed by some of the low-order memory address bits **(Fig 1).** The incoming address bits (index) select

The most important, and elusive, parameter for evaluating the performance gains possible with cache memories is the miss rate.

one of the cache entries and the most significant address bits are compared to the stored tag. If a match is detected, then a hit has occurred. Direct mapping is the simplest of the placement policies, but has the disadvantage that the miss rate increases sharply when two or more references are made to memory locations with the same lower address bits (index).

A set-associative cache is similar to a direct-mapped cache, but the index selects a set of two or more entries. Each entry can use the same lower address bits. In a 4-way set-associative cache, for example, four separate addresses can use the lower address bits **(Fig 2)**. This approach greatly decreases the miss rate as compared with the direct-mapped approach.

A fully associative placement policy is implemented as a content-addressable memory by means of including a tag comparator with each entry. Few caches use this placement policy because it is such a complex approach, and because the decrease in miss rate (compared with that of a 4-way set-associative approach) is so small.

Fig 3 shows the decrease in miss rate possible with the various placement policies. All of the available cache-memory controllers use the set-associative approach (although Intel's 82385 can use a direct-mapped mode, too). Both Intel's and Chips and Technologies' ICs are 2-way, set-associative caches, whereas Austek's and NEC's are 4-way, set-associative types.

Keeping main memory up to date

You'll also have to determine which memory-update policy is best for your application; when data in the cache is modified, it is important that the main memory be modified as well. To meet this end, there are two basic approaches: write through and copy back.

In the write-through approach, all memory-write operations are written to both the cache and the main memory simultaneously. This approach greatly simplifies the updating process because the main memory always contains an up-to-date copy of the data. The drawback is that each write is treated as a cache miss because the CPU must wait for the main memory to be written to.

Using a buffered write alleviates this problem. The buffer holds the data that's to be written to main memory to meet the timing of the main memory, and it allows the CPU to continue processing without having to wait. The buffered write through is by far the most popular implementation: All of the controllers available use it. A good write-through implementation seldom has to wait while a write operation to main memory finishes.

Copy-back main-memory updating allows writes to the cache, but main-memory updates occur at a later time. Almost always, this approach results in less main-memory traffic because data is written to the main memory only when the data leaves the cache—when a miss requires that a cache location be relinquished, for example, or when task switching takes place.

Should it be virtual or real?

Your next design decision will involve the cache's implementation, which can be either virtual or real. The difference centers on where the cache is placed in the data and address paths relative to the CPU and the memory-management unit (MMU). If the cache is between the CPU and the MMU, then it'll deal with virtual addresses—hence the name "virtual implementation." This implementation can cause confusion when you consider that a virtual address can point to many

TABLE 1—CACHE-MEMORY CONTROLLERS

COMPANY	DEVICE	PART	SIZE	PLACEMENT POLICY	REPLACEMENT POLICY
AUSTEK MICROSYSTEMS	MICROCACHE	A38152	32k BYTE	4-WAY SET-ASSOCIATIVE	LRU
CHIPS AND TECHNOLOGIES INC	CACHE CONTROLLER	82C312 (PART OF CS8231 CHIP SET)	16/32k BYTE	2-WAY SET-ASSOCIATIVE	LRU
INTEL CORP	CACHE CONTROLLER	82385	32k BYTE	2-WAY SET-ASSOCIATIVE OR DIRECT-MAPPED	LRU
NEC ELECTRONICS INC	SINGLE-CHIP CACHE SUBSYSTEM	μPD43608	8k BYTE	4-WAY SET-ASSOCIATIVE	LRU

Caches increase CPU throughput

According to Webster's, a "cache" is a hiding place for concealing and preserving provisions. In the case of computers, the provisions are prefetched data stored separately from the main memory. When the μP accesses memory, the cache supplies the concealed provisions (data) if it is able. If it is unable, the main memory will supply the data while the CPU waits for the main memory to respond. At the same time, the cache stores the most recently requested data for future reference.

In essence, caches are small, fast memories placed between a processor and the main memory of a computer system to reduce the amount of time necessary for memory accesses **(Fig A)**. The only reason for having a cache is to increase CPU throughput with a rather small number of static RAMs (albeit more expensive) to make up for the rather slow access times of the dynamic RAMs.

When a cache satisfies a main-memory access, the overhead resulting from accessing the main storage memory is eliminated. This elimination frees the system bus for DMA or multiple-processor activity and provides a significant improvement in the cost/performance ratio of memory design. The μP can therefore operate at cache speeds while maintaining the economic advantages of a slower main-storage memory.

A cache works by means of what is called the property of locality. This property has two aspects, temporal and spatial. According to temporal locality, information that'll be in use in the near future is likely to be in use already. You can expect this type of behavior from program loops in which both data and instructions are reused.

According to spatial locality, portions of the address space that are in use generally consist of a fairly small number of individually contiguous segments of that address space. A cache memory buffers segments of information that have been used recently, and thus the property of locality implies that the needed information is likely to be found in the cache.

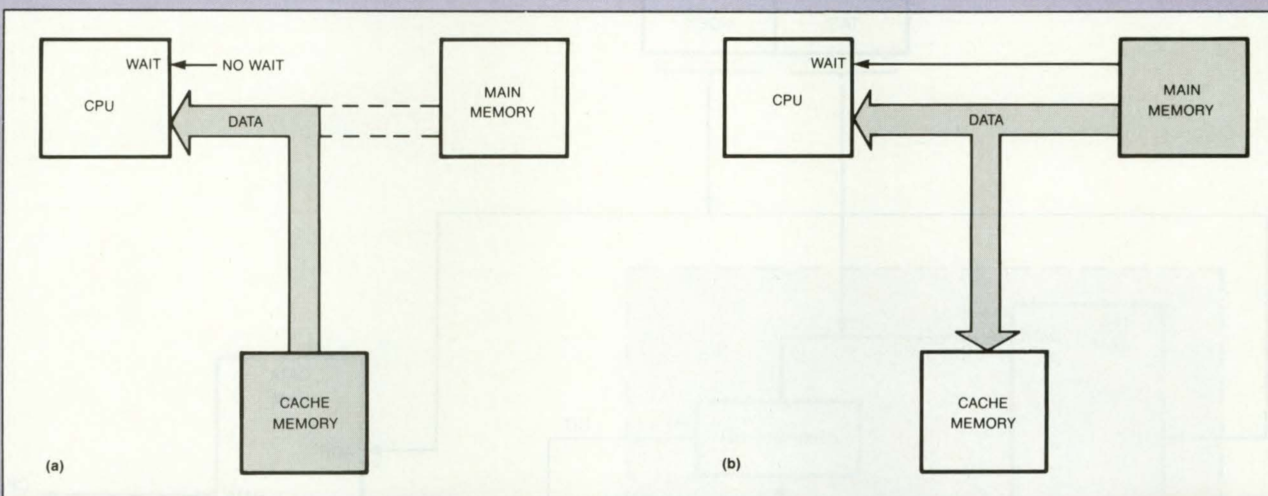


***Fig A—On a cache hit, the cache memory supplies** data to the μP with no wait states **(a)**. On a cache miss, the main memory supplies data to both the μP and the cache memory **(b)**. The next time this same data is needed, it will already be in the cache.*

WRITE BUFFER	BUS WATCHING	SPEED	ADDRESS SPACE	PACKAGE	COST	SPECIAL FEATURES
YES	NO	16 OR 20 MHz (80386)	4G BYTE	84-PIN PLCC	$58 (16 MHz) (10,000)	80386-BASED SYSTEMS; 5-CHIP SOLUTION
YES	NO	20 OR 25 MHz (80386)	64M BYTE	100-PIN PFP	$169.80 (20 MHz) (10,000) CS8231-20 CHIP SET	INTEGRATED DYNAMIC-RAM CONTROLLER
YES	YES	16 OR 20 MHz (80386)	4G BYTE	132-PIN PGA	$130 (16 MHz) $165 (20 MHz) (1000)	
YES	YES	READY, 70 nSEC DATA, 85 nSEC CYCLE, 125 nSEC	256M BYTE	132-PIN PGA	$260 (100)	16- OR 32-BIT CPUs; SINGLE-CHIP SOLUTION

The size of the cache is the most dominant parameter in terms of both cost and potential performance.

real addresses. In a real implementation, the cache is situated after the MMU, so each address in memory has only one address.

A virtual cache's advantage is that it doesn't have to wait while the MMU translates an address, and thus it can respond much faster. Faster response time notwithstanding, a virtual cache complicates the hardware design and adds some complexity to the software design because it has to keep track of which real address the virtual address is pointing to. As μP technology advances, however, more CPUs will have the MMU on chip. This will leave you with no choice—you'll have to use a real cache.

Another potentially critical design decision of which you should be aware is a cache's coherency policy. When several sources, such as multiple CPUs and a DMA controller, can change data in main memory, you can have a problem with the data's coherency (or consistency). You must make sure that the data you're using from the cache isn't stale. For example, if data from main memory also exists in a cache, and a DMA controller or other processor modifies the data in main memory, the computer must invalidate the old data in the cache.

There are many methods for maintaining coherency. The Intel 82385 takes one of the most sophisticated

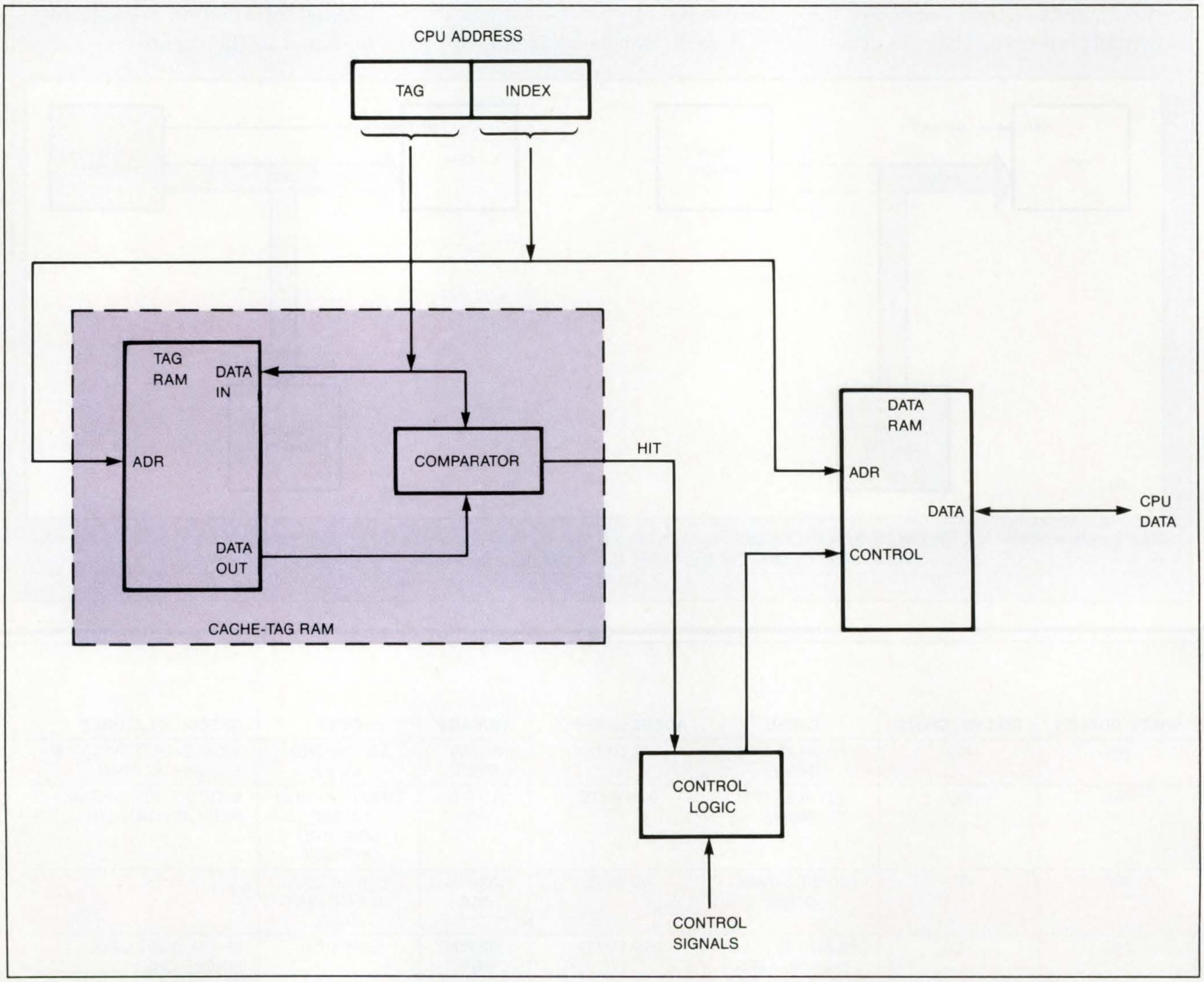


Fig 1—A direct-mapped cache implementation is the simplest *approach. The μP's address is split into an index, which points to a tag. The tag is then compared to the rest of the address. Note that only one main-memory location can be stored in the cache for each index.*

approaches, the bus-watching approach (**Fig 4**). By keeping an eye on all of the transactions on the system bus, the cache controller automatically invalidates data in the cache when an external source modifies main memory. The NEC μPD43608 also has bus-watching capability to maintain coherency.

As far as a split-vs-single cache implementation is concerned, most, if not all, of the available controllers are single-cache implementations. You can have more than one cache in a system, though. A split cache is an architecture that uses more than just a single cache. A typical approach is to have an instruction cache and a

Text continued on pg 252

Estimate the performance gains possible with a cache

You can use the equations below to evaluate the increase in performance afforded by a cache implementation. By playing with various values of the miss rate, you can see how much of an improvement is possible.

The average memory-access time is often useful in evaluating the performance gains that various cache implementations can provide. You can calculate the average access time from a combined relationship between cache use and main-memory use:

$$Tav=R((1-M)Tcr+M\ Tmr)+W\ Tw,$$

where Tav=average memory-access time, R=percentage of memory cycles that are reads (typically 85%), W=percentage of memory cycles that are writes (typically 15%), M=cache miss rate, Tcr=cache read-cycle time, Tmr=main-memory read-cycle time, Tw=write-cycle time (main-memory time for unbuffered systems or cache-memory time for buffered systems).

Many times, you can gain further insight by estimating the average number of wait states that a system will require when accessing memory:

$$Ncw=R((1-M)Ncr+(M\ Nmr))+(W\ Nw),$$

where Ncw=average number of wait states, R=percentage of memory cycles that are reads (typically 85%), W=percentage of memory cycles that are writes (typically 15%), M=miss rate, Ncr=cache read-cycle wait states, Nmr=main-memory read-cycle wait states, Nw=write-cycle wait states (main-memory write-cycle wait states for unbuffered systems or cache-memory write-cycle wait states for buffered ones).

Evaluate throughput increase

It is possible to evaluate the increase in system performance by comparing the speed of a design using a cache with one that doesn't. You can define CPU throughput as the CPU clock frequency divided by the number of clock states per memory cycle. The CPU clock frequency is constant, and therefore the speed improvement provided by the cache can be expressed as a ratio: the clock states per memory cycle provided with a cache to the clock states per memory cycle with full wait states. That is,

$$FC=(No+Nm)/(No+Ncw),$$

where FC=throughput with cache relative to without, No=number of processor states per memory cycle with no wait states, Nm=number of wait states for main memory, and Ncw=average number of wait states with cache system.

For example, a 68010 μP requires four clock states per memory cycle (No=4). Assume you have a 12.5-MHz clock and a 250-nsec main memory requiring two wait states (Nm=2). With a buffered write and a cache requiring no wait states, having an access time of 50 nsec, and having a miss rate of 10% (M=0.1), you end up with the following estimation: average memory-access time=67 nsec, average number of wait states=0.170, and increase in CPU throughput=44%.

Note that with a RISC-based CPU, the potential for increasing performance by using a cache is higher. Because a RISC machine has only one clock state per memory cycle, the number of wait states makes a much larger difference. If you use a RISC machine with a memory that has two wait states, a cache similar to the one in the previous example would yield a 156% increase in throughput.

National Semiconductor

Finally, graphics to match your imagination...now more than ever.

INTRODUCING THE FIRST EFFECTIVELY PARTITIONED VLSI ARCHITECTURE FOR TRULY FLEXIBLE GRAPHICS SYSTEMS DESIGN

Imagine a graphics architecture so powerful, you can achieve 16K-by-16K resolution. So effective, you can add virtually unlimited planes of color without degrading performance. So flexible, you can integrate it into an existing design or use it to build an entire range of new systems.

That's the Advanced Graphics Chip Set from National Semiconductor.

By using a multiple-chip, modular approach, the Advanced Graphics Chip Set avoids the design compromises and limitations of single-chip solutions.

That gives you two unprecedented benefits: *performance* and *flexibility*.

Which means you can design exactly the type of system you need with exactly the level of performance your application demands.

For example, you can integrate part of the chip set with an existing general-purpose microprocessor for a low-end display.

Or you can utilize the chip set's full capabilities for a high-end, high-performance, high-resolution CAE/CAD workstation or laser printer — with virtually unlimited planes of color. Yet with the same high-speed performance as a black-and-white application.

In fact, you can design an entire range of graphics systems without having to "reinvent the wheel" each time, by using the same hardware building blocks and the same central software in each of the systems.

THE ADVANCED GRAPHICS CHIP SET

Now expanded for even more design flexibility and freedom.

2 BitBlt Processing Units (BPUs). 20-MHz devices that control data movements within their own dedicated memory planes or between those planes and other memory planes in multi-color systems. AVAILABLE NOW.

4 Video Clock Generators (VCGs). Timing and control generators providing all the synchronization signals needed by a graphics system. Pin-programmable pixel frequencies for both low-frequency (125 MHz) and high-frequency (225 MHz) applications. AVAILABLE NOW.

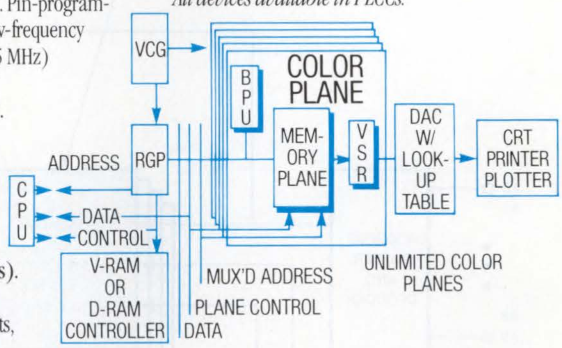
2 Video Shift Registers (VSRs). Parallel-to-serial shift registers capable of serial-output rates up to 225 MHz. Compatible with 10K ECL outputs or with 100K ECL outputs. AVAILABLE NOW.

3 Video RAM Controllers (VRCs). Memory-array controllers for dual-port video RAMs from 256K to 4 Mbits, including dual-access arbitration logic for multiple-CPU applications. AVAILABLE NOW.

A total of 11 chips — all introduced in a single year between Siggraph 1986 and Siggraph 1987. An unmatched commitment to graphics system design.

And soon another family member, now in beta-site testing: **Raster Graphics Processor (RGP).** A fully programmable, high-performance microprocessor specially tuned for graphics applications.

All devices available in PLCCs.



THE MULTIPLE-CHIP SECRET

The secret to all this flexibility and performance is our unique multiple-chip, modular approach. Rather than trying to squeeze all the important graphics functions onto a single chip — which would require some significant design and performance compromises — we've partitioned appropriate functions onto individual building-block ICs. This allows us to optimize the design of each chip, and allows you to optimize your own design for your particular application.

GRAPHICS WITHOUT LIMITS

What matters most about the Advanced Graphics Chip Set, of course, is what it does for *you*. And that answer is clear when you consider its high performance, its modular approach, its open architecture, and its programmability: It gives you graphics without limits. It gives you true design freedom. It gives you the opportunity, for the first time, to design a graphics system "custom fit" to your exact specifications.

So what are you waiting for? If you're tired of those limited single-chip solutions bogging down your designs, take a look at the Advanced Graphics Chip Set. And learn how you can design a graphics system to match your needs . . . as well as your imagination.

For more information and availabilities, just contact your local National Semiconductor Sales Engineer or write:

National Semiconductor
Advanced Graphics, MS 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor

CIRCLE NO 82

When data in the cache is modified, it is important that the main memory be modified as well.

data cache or to have separate user and supervisor caches.

Next, you'll have to consider the replacement scheme. When a cache miss occurs and all of the available cache memory is used up, you have to ensure that the data in the cache is replaced with the most recently requested data. If you have a direct-mapped cache, you have no choice but to replace the data pointed to at the index. With a set-associative approach, you have to decide which set to replace. Common replacement schemes employ random, FIFO, or LRU (least recently used) algorithms. The LRU algo-

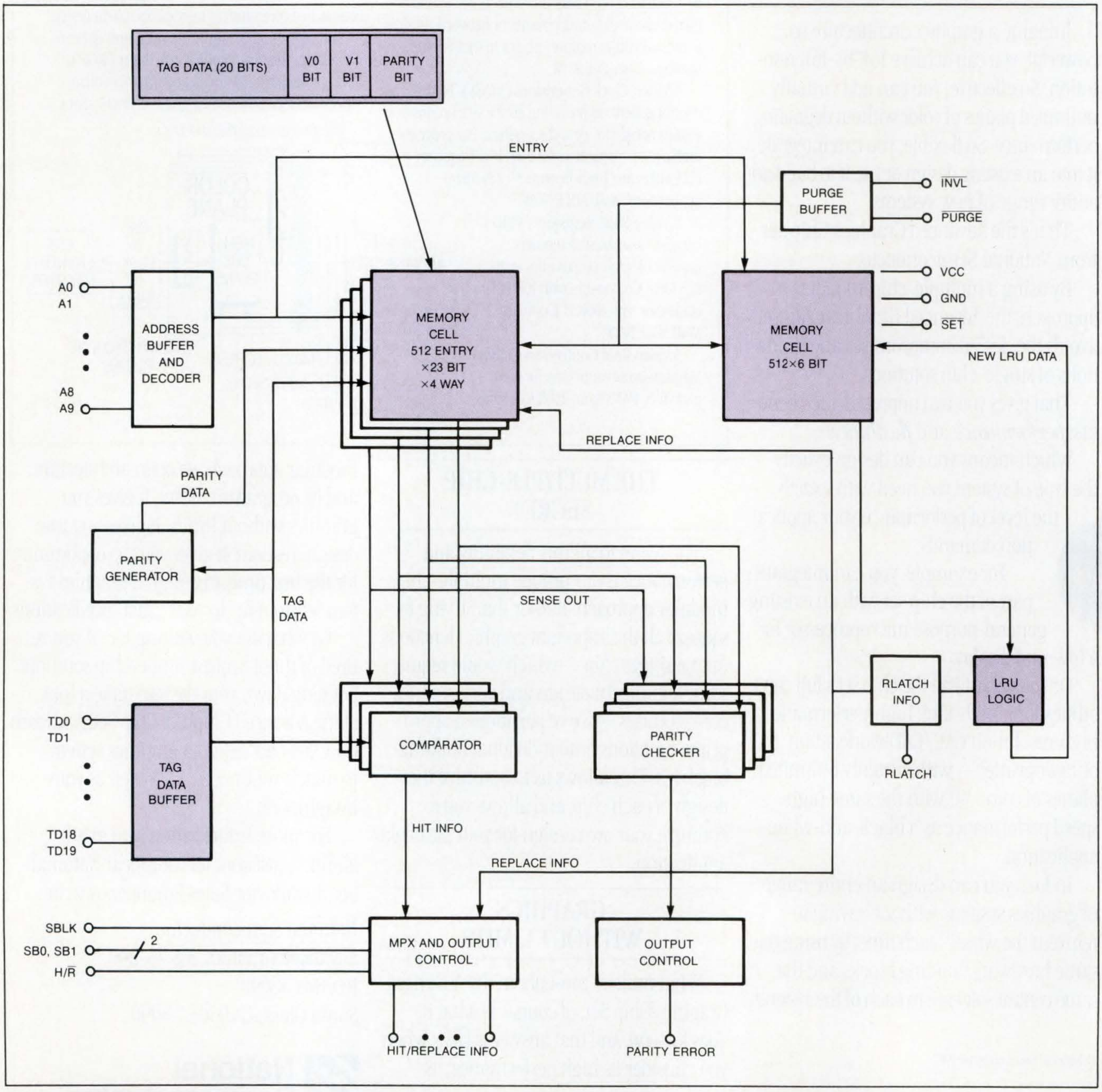


Fig 2—In a set-associative cache, *each index points to more than one tag. In this diagram, the Fujitsu MB81C50 provides four different tags to decrease the probability of a miss. The MB81C50 also includes the logic for the LRU replacement policy.*

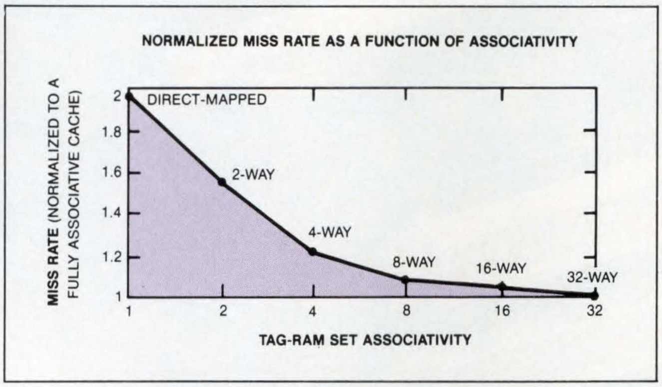


Fig 3—As the number of sets increases *in a set-associative cache, the miss rate decreases. The gain in system performance with a cache larger than an 8-way, set-associative type rarely outweighs the increase in system cost.*

rithm constantly keeps track of which set has the least recently used data, and it is this set that is then replaced. The LRU algorithm is the most efficient replacement scheme, and all of the available controllers use it.

Cache-tag RAM is the basic building block

In any cache-memory system, the basic building block is the cache-tag RAM. This RAM includes the comparator used to detect a cache hit. Cache-tag RAMs are built into all cache-memory controllers and provide the highest speed and the most flexible design solution. If the existing cache-memory controllers don't fit your needs, you can use these RAMs and devise your own system. They are especially useful in simple cache

Text continued on pg 258

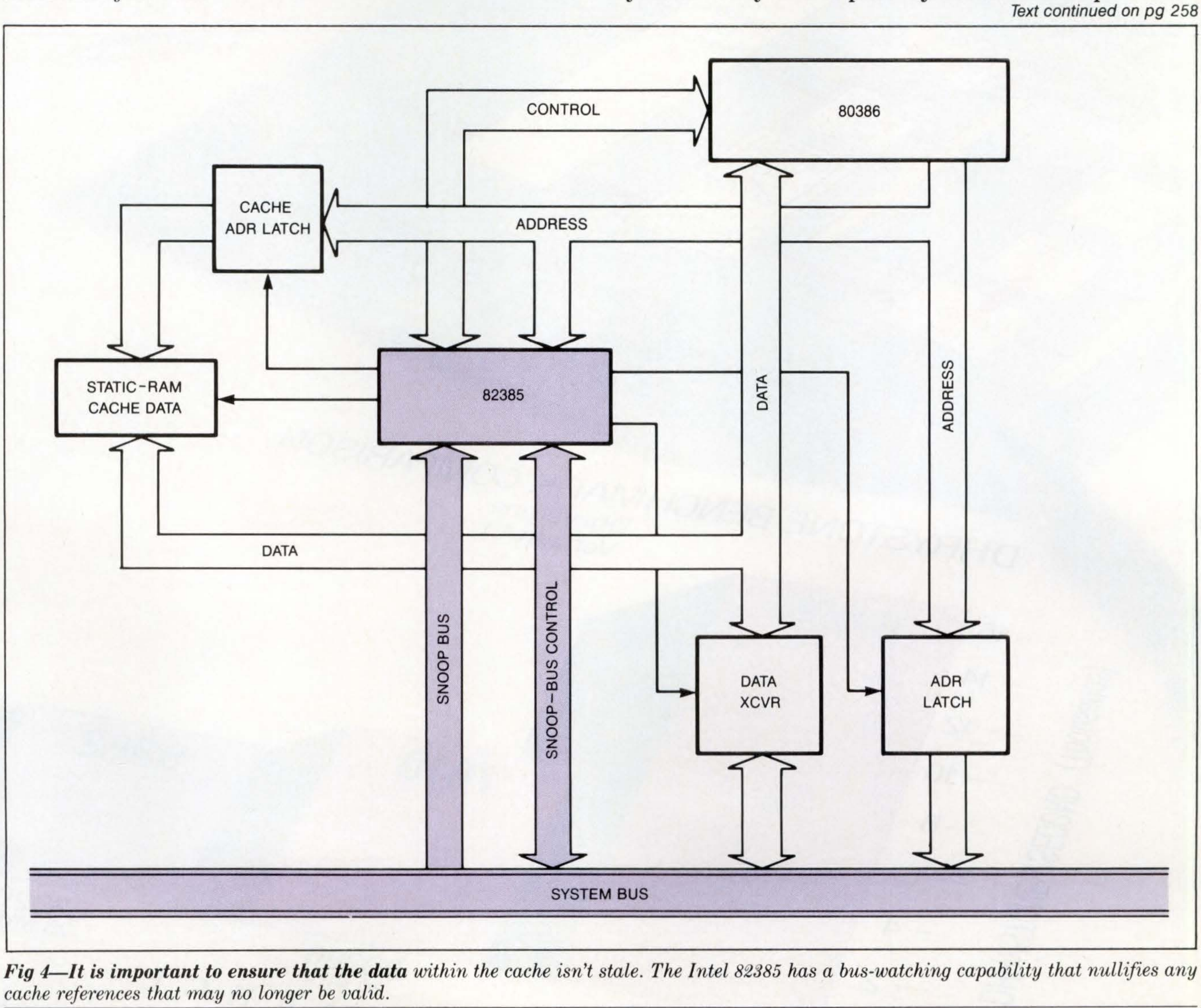
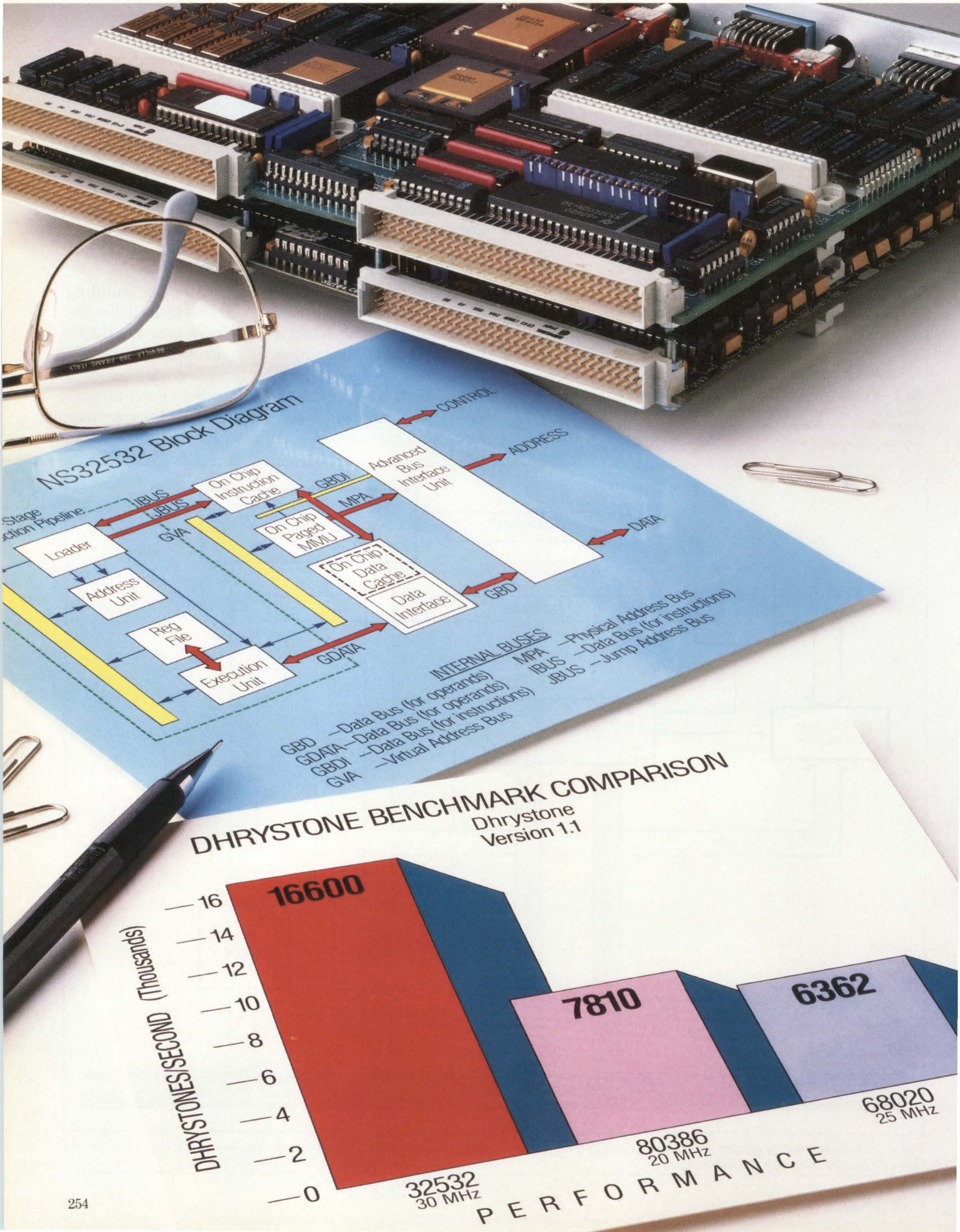


Fig 4—It is important to ensure that the data *within the cache isn't stale. The Intel 82385 has a bus-watching capability that nullifies any cache references that may no longer be valid.*


NS32532 Block Diagram
CONTROL
ADDRESS
DATA
Advanced Bus Interface Unit
On Chip Instruction Cache
On Chip Paged MMU
On Chip Data Cache
Data Interface
Loader
Address Unit
Reg File
Execution Unit
IBUS
JBUS
GVA
GBDI
MPA
GBD
GDATA
INTERNAL BUSES
GBD —Data Bus (for operands)
GDATA—Data Bus (for operands)
GBDI —Data Bus (for instructions)
GVA —Virtual Address Bus
MPA —Physical Address Bus
IBUS —Data Bus (for instructions)
JBUS —Jump Address Bus
DHRYSTONE BENCHMARK COMPARISON
Dhrystone
Version 1.1
DHRYSTONES/SECOND (Thousands)
16
14
12
10
8
6
4
2
0
16600
7810
6362
32532
30 MHz
80386
20 MHz
68020
25 MHz
PERFORMANCE

The NS32532: Real-world performance for real-world applications.

At National, we believe that a high-performance 32-bit microprocessor should be worked with, not around.

That's why the NS32532 offers you some of the highest performance specs in the industry.

Yet it's performance you can *use*. Because the NS32532 was created for real-world designers working on real-world systems to meet real-world needs.

PERFORMANCE YOU CAN COUNT ON

The NS32532 is capable of delivering 15 MIPS peak performance, 8-10 MIPS sustained, at 30 MHz.

Not "no-ops" MIPS. Not benchmarking MIPS. Not RISC MIPS. But genuine VAX® 11/780 MIPS.

You're looking at 16,600 Dhrystones per second.

Not to mention high integer performance *and* high floating-point performance. With a range of FPU solutions that deliver up to 8 million double-precision Whetstones per second.

Below: NS32532 chip
*Left: VME532 evaluation board; NS32532 block diagram; competitive performance comparison**

* *Sources:*
NS32532 — August 1987 Performance Evaluation Tests
80386 — "The 80386: A High-Performance Workstation Microprocessor," Intel Corp., June 1, 1986
68020 — SUN 3/20 @ 25 MHz, as published by Sun Microsystems

The NS32532

- 8-10 MIPS sustained, 15 MIPS peak
- 20-, 25-, and 30-MHz devices
- On-chip 1,024-byte 2-way set associative physical data cache
- On-chip 512-byte direct mapped physical instruction cache
- Hardware cache invalidate for high-performance cache coherency
- On-chip demand-paged memory management including 64-entry fully associative Translation Lookaside Buffer
- 4-stage instruction pipeline including instruction prefetch and branch prediction
- 2-clock basic READ/WRITE cycle
- 1-clock burst-mode transfers
- Unique bit-manipulation and string-handling instructions
- Highly symmetrical and orthogonal instruction set producing compact code
- Extremely fast context switch (3.6 μs) and interrupt service (1.3 μs)
- Fabricated in M²CMOS
- 370,000 transistor sites
- SAMPLES AVAILABLE NOW

SUPER-MINI PERFORMANCE ON A CHIP

The NS32532 achieves its superior performance because it integrates key systems functions on a single piece of silicon.

Only the NS32532 incorporates on-chip data and instruction caches, demand-paged virtual memory management, and a 4-stage instruction pipeline. With instruction prefetches and branch prediction. Plus a hardware cache invalidate mechanism that ensures cache coherency.

SCALABLE PERFORMANCE

The NS32532 is one of seven CPUs based on the same 32-bit architecture. With the same orthogonal, highly symmetrical instruction set.

Which means you can migrate your design throughout the entire performance range without having to re-engineer your software at any level. And you can build consistently competitive systems without resorting to some "more innovative" architecture that leaves you and your software investment in the lurch.

PERFORMANCE THAT'S READY FOR YOU TODAY

We've already begun sampling silicon. We've already ported UNIX® System V.3 and VRTX®. And we've already produced a board-level implementation — a fully integrated, fully populated, plug-and-go VME-compatible native environment... available now for evaluation. So are nearly 150 other members of the Series 32000® family, including coprocessors, peripherals, development tools and optimizing compilers.

To talk about putting our performance into practice in your application, call our Application Engineers toll free: **800/538-1866, ext. 532 or 800/672-1811, ext. 532** (within California).

National Semiconductor

National
Semiconductor

With 242 passengers on final approach into O'Hare, the last thing they're thinking about is your voltage regulator.

For devices with a critical performance envelope — devices that *have* to deliver, especially in harsh environments or hazardous conditions — you never compromise reliability.

And neither do we.

RELIABILITY FOR FOUR GENERATIONS

National has set the standard for reliability in IC voltage regulators since we introduced the world's first 3-terminal fixed regulator in 1970.

And we've maintained that standard into our *fourth generation,* in the world's first — and largest — family of low dropout (LDO) voltage regulators.

Fabricated in a deep-base PNP process, our LDO regulators give you low quiescent current (0.75 mA typ), low dropout voltage (input-output differentials of 0.6 V typ), tight line-to-load regulation (0.05% typ), low output noise (150 μV_{RMS} typ), and high ripple rejection (60 dB typ).

Which not only means you can design-in the highest levels of reliability, but means you can design smaller, cooler, quieter systems that operate with lower input voltages. And that means you can boost system efficiency by 30-50% while cutting system cost substantially.

RELIABILITY FOR EVERY APPLICATION

National LDO regulators give you a choice of single-output, dual-output, and three-output configurations.

All with 60-volt load-dump and reverse-transient protection. And all with "drop-in" design ease, regardless of your applications:

- Avionics
- Marine electronics
- Cellular telephones
- Computer power supplies
- Medical instrumentation
- Automotive systems
- Battery-powered systems
- CMOS-based systems
- Solar-powered systems

And you can choose from a variety of packages, including TO-220, TO-92, 8-pin miniDIP, and small outline (SO) surface mount. And soon, mil-spec TO-3 steel cans.

And, in addition to our LDO family, National has 478 other voltage regulators — positive and negative, fixed and adjustable, switching and tracking — to match your exact design needs.

RELIABILITY FOR NO EXTRA COST

At National, we subject all our LDO regulators to the most rigorous reliability screening flow in the industry.

Our unique P+ Thermal Limit Burn-in program is an *abnormal* test for devices that have to perform in potentially abnormal conditions.

Going beyond even A+ screening, P+ involves a dynamic self-heating accelerated burn-in that tests a device at thermal shutdown. This approach has been proven more effective than standard 125° C burn-in as an early screen for infant mortality defects in power devices, such as regulators.

The result of P+? Zero defects.

The cost of P+? Zero price adder.

Which means you get the highest reliability available in the industry, while sharply cutting the cost of your own incoming testing program, and without having to pay a price premium for ours.

For more information on P+, ask your National sales engineer or distributor for a free copy of "The Secret Behind the Most Reliable Voltage Regulators in the World." And see for yourself how this unique screening program gives you devices you can depend on — for the people depending on you.

National's Low Dropout Regulator Family

LM2925	Low dropout, 5 V, 750 mA with delayed reset
LM2930	Low dropout, 3-terminal, 5 V or 8 V, 150 mA
LM2931	Low dropout, low quiescent current, 5 V or adjustable, 100 mA
LM2935	Low dropout, dual 5 V for memory keep-alive, 750 mA or 10 mA
LM2940C	Low dropout, 5 V, 12 V, or 15 V, 1 A
LP2950/2951	Low dropout, micropower, 5 V or adjustable, 100 mA
LM2984	Low dropout, 3 tracking 5 V outputs with watchdog

National Semiconductor
Linear Solutions
P.O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor

CIRCLE NO 205

One problem with having a cache in a system is the difficulty of determining the execution speed of an application.

implementations, but suffer in large caches because of their high chip count.

As you can see by looking at **Table 2,** the cache-tag RAMs from Integrated Device Technology, Saratoga, Texas Instruments, and Thomson/Mostek have a 4- or 8-bit tag width. The Saratoga SSL2152/4 has a 9-bit width. The Thomson/Mostek MK4202 is a 2048-index×20-bit device, and it can map a simple 2k-word cache into a 31-bit address.

The Fujitsu MB81C50 cache controller provides the flexibility of a cache-tag RAM, but also includes some of the control logic for implementing a complete cache-memory system. The device contains the circuitry for a 2- or 4-way set-associative placement policy as well as the LRU algorithm.

Once you've evaluated the various approaches and determined your design needs, you can measure various important performance ratios. You can easily do this, at least to a first-order approximation, by using a

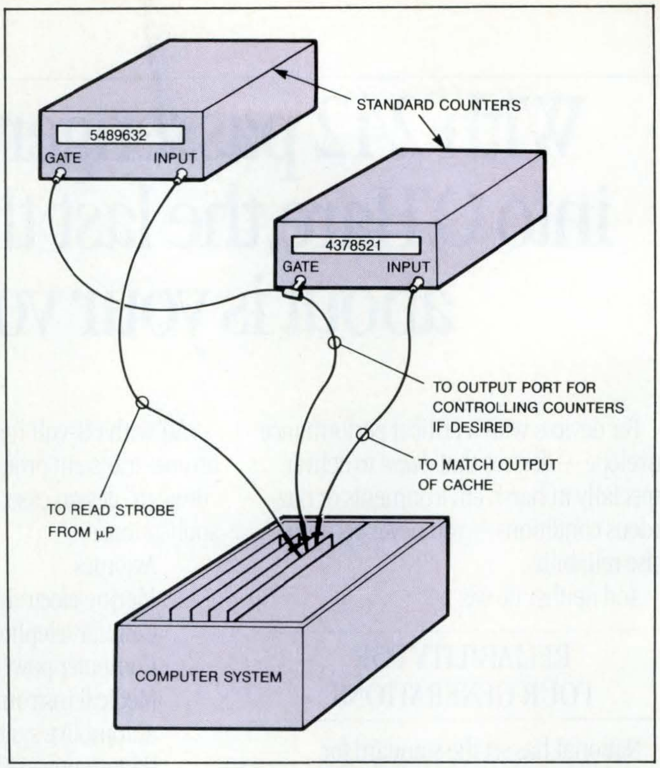
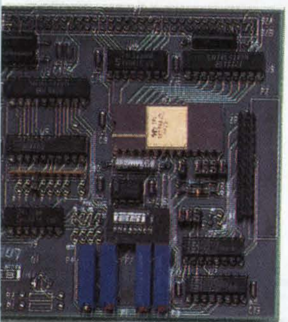


***Fig 5—You can evaluate the real-world hit rate** by connecting two counters to your system. The counters can determine the ratio of hits to total memory reads, the ratio of reads to writes, the ratio of no-wait-state writes to total memory writes, as well as other important ratios. An output port can control the counters so that you can isolate sections of your code that do not use your memory system efficiently.*

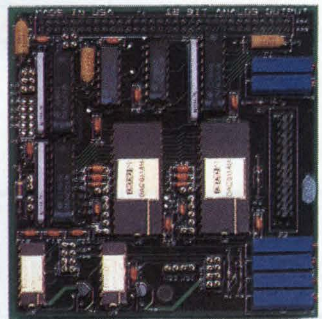
TABLE 2—CACHE-TAG RAMs

COMPANY	DEVICE	PART	SIZE (INDEX/TAG)	SPEED	MATCH OUTPUT TYPE	PACKAGE	COST
FUJITSU	INTELLIGENT CACHE-TAG RAM	MB81C50	512 OR 1024/20 (4- OR 2-WAY SET-ASSOCIATIVE)	ADR TO HIT 35 nSEC DATA TO HIT 18 nSEC	TOTEM POLE	64-PIN PGA	$35 (1000)
INTEGRATED DEVICE TECHNOLOGY INC	CACHE-TAG RAM	IDT7174S	8196/8	ADR TO HIT 37/45/55 nSEC DATA TO HIT 28/35/45 nSEC	OPEN DRAIN	28-PIN 600-MIL DIP 28-PIN 400-MIL DIP 32-PIN LCC/PLCC	$51.75 (37 nSEC) (100)
SARATOGA SEMICONDUCTOR	TAGRAM	SSL4180	4096/4	ADR TO HIT 20/25/35 nSEC DATA TO HIT 12/15/20 nSEC	TOTEM POLE	22-PIN 300-MIL DIP	$39.50 (20 nSEC) (1000)
	TAGRAM	SSL4181	4096/4	ADR TO HIT 20/25/35 nSEC DATA TO HIT 12/15/20 nSEC	OPEN DRAIN	22-PIN 300-MIL DIP	$39.50 (20 nSEC) (1000)
	TAG-CACHE	SSL2152	2048/9	ADR TO HIT 25/30 nSEC DATA TO HIT 17/20 nSEC	TOTEM POLE	28-PIN 600-MIL DIP	$41.50 (25 nSEC) (1000)
	TAG-CACHE	SSL2154	2048/9	ADR TO HIT 25/30 nSEC DATA TO HIT 17/20 nSEC	OPEN DRAIN	28-PIN 600-MIL DIP	$41.50 (25 nSEC) (1000)
TEXAS INSTRUMENTS INC	CACHE ADDRESS COMPARATOR	TACT2150	512/8	ADR TO HIT 20/30 nSEC DATA TO HIT 15/20 nSEC	TOTEM POLE	24-PIN 300-MIL DIP	$16.20 (20 nSEC) (10,000)
	CACHE ADDRESS COMPARATOR	TACT2152	2048/8	ADR TO HIT 25/35 nSEC DATA TO HIT 16/18 nSEC	TOTEM POLE	28-PIN 600-MIL DIP 28-PIN PLCC	$23.60 (25 nSEC) (100)
	CACHE ADDRESS COMPARATOR	TACT2154	2048/8	ADR TO HIT 25/35 nSEC DATA TO HIT 16/18 nSEC	OPEN DRAIN	28-PIN 600-MIL DIP 28-PIN PLCC	$23.60 (25 nSEC) (100)
THOMSON COMPONENTS/ MOSTEK CORP	TAGRAM	MK41H80	4096/4	ADR TO HIT 20/25/30 nSEC DATA TO HIT 12/15/20 nSEC	TOTEM POLE	22-PIN 300-MIL DIP	$29.93 (20 nSEC) (100)
	TAGRAM	MK48H74	8196/8	ADR TO HIT 35/45/55 nSEC	TOTEM POLE	28-PIN 600-MIL DIP	$25.64 (35 nSEC) (100)
	TAGRAM	MK4202	2048/20	ADR TO HIT 20/25 nSEC	TOTEM POLE	68-PIN PLCC	$71.43 (20 nSEC) (100)

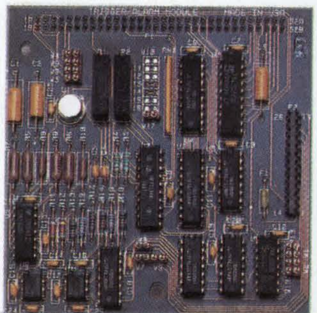
One PC data acquisition system grows up: PCI-20000.



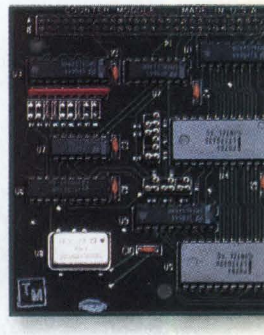
Analog input modules: programmable gain or high speed (180kHz).



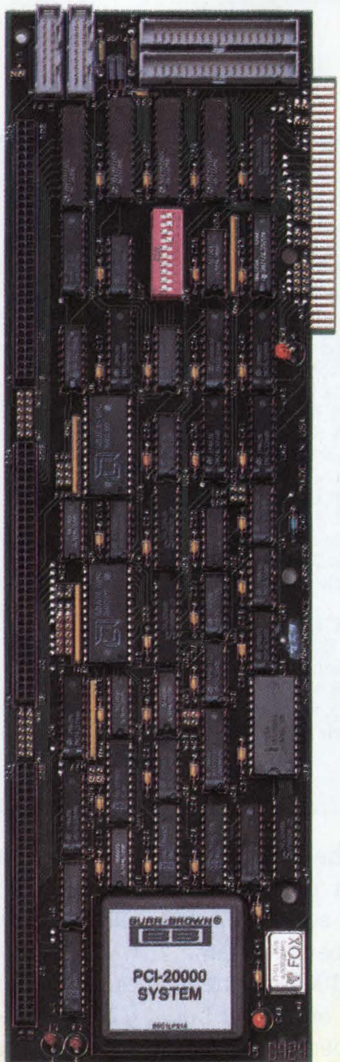
Analog output modules: 2 or 8 channel, 12 or 16 bits, V_O or I_O.



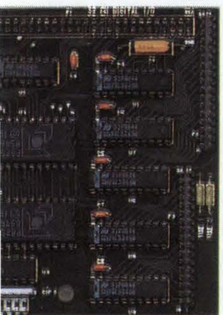
Special function modules: trigger/ alarm, simultaneous sample/hold.



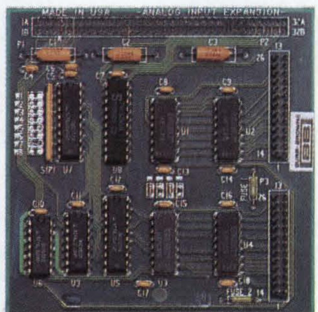
Counter/timer, clock, pulse generator & frequency measurement module.



DMA carrier board with clock and digital I/O transfers data at 360 kBytes/sec. Holds 3 modules.



Expandable digital I/O module (to 128 points per carrier).



Expandable analog input module (to 80 channels per carrier).

The others just grow old.

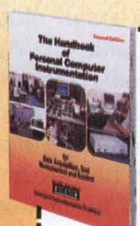
Some personal computer data I/O systems make you pay for functions you don't need. These same inflexible systems can't be updated—at any price.

The unique PCI-20000 modular system, on the other hand, is easily configured to provide literally thousands of data acquisition, test, measurement and/or control options. Just plug the application-specific modules you need into a carrier board. Then plug the carrier into your IBM/compatible PC. Change or add modules as your needs change. In other words, the PCI-20000 grows up, not old!

Up to 128 digital I/O points or 80 analog inputs can be configured on a single carrier board. A unique DMA carrier/module combination transfers analog, digital and/or counter data at speeds limited only by your computer. Capture, analyze and react to real-world events in real-time. Plus, ruggedly constructed termination panels provide long-lasting screw-in connections to analog and digital I/O signals.

No programming experience needed. Many easy to use, menu driven software packages support the entire PCI-20000 family. Multiple language software drivers are also available. Best of all, years from now when other systems are collecting cobwebs, your PCI-20000 will still be collecting data.

BURR-BROWN®



Free 300 Page PC Data Acquisition Handbook.
For fast service, call 602/746-1111, or return the coupon to Burr-Brown PCI Handbook, P.O. Box 11400, Tucson, AZ 85734.

Name____________________

Title____________________

Company____________________

Address____________________

City/State/Zip____________________

Phone (   )____________________

Circle 78 for General Information

Circle 117 for OEM/VAR Program

In the future, you can expect to see large, high-speed cache systems on single chips, tightly coupled to the CPU and to the system bus for bus watching.

For more information . . .

For more information on the cache-memory controllers and cache-tag RAMs discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Austek Microsystems Inc
444 Castro St, Suite 1020
Mountain View, CA 94041
(415) 960-1315
FAX (415) 960-0799
Circle No 458

Chips and Technologies Inc
3050 Zanker Rd
San Jose, CA 95134
(408) 434-0600
Circle No 459

Fujitsu
3320 Scott Blvd
Santa Clara, CA 95054
In CA, (800) 556-1234
Outside CA, (800) 441-2345
Circle No 460

Integrated Device Technology Inc
3236 Scott Blvd
Santa Clara, CA 95054
(408) 727-6116
TLX 887766
Circle No 461

Intel Corp
3065 Bowers Ave
Santa Clara, CA 95051
(800) 548-4725
Circle No 462

NEC Electronics Inc
401 Ellis St
Mountain View, CA 94039
(415) 960-6000
TWX 910-379-6985
Circle No 463

Saratoga Semiconductor
10500 Ridgeview Ct
Cupertino, CA 95014
(408) 864-0500
Circle No 464

Texas Instruments Inc
Semiconductor Group (SC-725)
Box 809066
Dallas, TX 75380
(800) 232-3200
Circle No 465

Thomson Components/Mostek Corp
1310 Electronics Dr
Carrollton, TX 75006
(214) 466-6000
TLX 463-0093
Circle No 466

couple of counters. Put one counter on the read line of the μP and the other on the hit output of the cache controller **(Fig 5).** Run your application software and look at the counters after an appropriate period of time. You may have to put a divide-by-10 or -1000 circuit in front of the counters so that they won't overflow, but this extra circuitry won't have any effect because all you need is the counters' ratio.

You can also determine the ratio of reads to writes and the ratio of writes without wait states to writes with wait states. With a small amount of software overhead, you can even enable the counters in certain sections of your code by controlling a bit on an output port to isolate where a low hit rate occurs.

You should be aware, however, that in the real-time control world it's difficult to determine the response time of the system. When using worst-case analysis, you have to assume that all memory accesses will be misses, and thus you have to assume that the cache doesn't even exist. In such applications, therefore, you may decide against using a cache at all.

Although cache-memory controllers provide subsystem-on-a-chip solutions, they don't have many options to offer—most are cast in silicon. Their advantage lies in the fact that you can capitalize on the knowledge and insight of the chip designers when you design your system, thereby avoiding a lot of reinvention of the wheel. The NEC μPD43608, for instance, is a complete cache subsystem, including the data RAM.

In the future, you can expect to see large, high-speed cache systems on single chips, tightly coupled to the CPU and to the system bus for bus watching. The devices available are already quite complex: The Austek part has 128,000 transistors; the NEC chip has 680,000 transistors. With the speed of CMOS RAMs getting close to 10 nsec and the promise of BiCMOS around the corner, it should be easy for cache memories to keep up with the ever-increasing speeds of μPs. **EDN**

References

1. Smith, Alan, "Cache Memories," *Computing Surveys*, Vol 14, No 3, September, 1982, pg 473.
2. Nalesnik, Robert, "Cache accelerates operation of 32-bit μP systems," *EDN*, May 28, 1987, pg 183.

Article Interest Quotient (Circle One)
High 479 Medium 480 Low 481

• RIFA MICROELECTRONICS DIVISION •

BIG ENOUGH TO COPE • SMALL ENOUGH TO CARE •

BIG ENOUGH TO COPE • SMALL ENOUGH TO CARE •

Driver circuits that spoil you for choice. Intelligence and power on one chip. Load fault indication as well, with high current sink or source capability. Your pick of resistive or conductive loads up to 2 A. PBD 3545 and 3548 – the drivers tough enough for what you have in mind.

- built-in protection diodes
- short circuit protection/detection
- open circuit detection
- LS-TTL, CMOS compatible inputs
- 5–45 V operating voltage
- TO 220, 5-pin package

from

RIFA

RIFA INC, GREENWICH OFFICE PARK 3, P.O. BOX 3110, GREENWICH, CT 06836, 3110 USA, TEL 203-625 73 00, TELEFAX 203-625 73 57

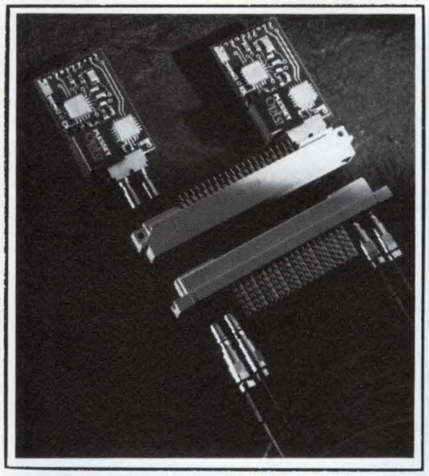
• RIFA MICROELECTRONICS DIVISION •

CIRCLE NO 84

Chip set provides physical-layer interface to fiber-optic data links

The SP9960 encoder/LED-driver, SL9901 transimpedance amplifier, and SP9921 decoder provide most of the interface hardware required to implement a 50M-bps Manchester-encoded fiber-optic communications link. The SP9960 encoder/LED-driver accepts either TTL- or ECL-level clock and data signals and encodes them by using Manchester biphase-mark coding. It has an output that can directly drive the fiber's transmission-end LED, and you can program the LED drive current to 15, 25, 45, 80, 115, or 150 mA by using dedicated IC inputs.

The SL9901 transimpedance amplifier accepts the output of the fiber's receiving-end PIN-diode detector and converts it to a voltage drive for the decoder IC. The amplifier has a 3-dB bandwidth of 50 MHz, so it is suitable for use in systems having NRZ data rates reaching 100M bps.



The SP9921 decoder can operate at a data rate of between 20M and 50M bps, recovering both clock and data signals from the received signal. It incorporates two phase-lock-loop circuits in a Costas-loop circuit, which gives the recovered clock signal a high degree of immunity to input signal noise. In addition, the decoder can detect idle-code patterns that violate normal Manchester codes; it can operate in links that utilize burst-data modes. The decoder has ECL-level outputs.

All three devices are available in die form or in surface-mount packages. The encoder and decoder ICs are also available in DIPs. The chip set requires a single 5V supply and operates over −40 to +85°C. In surface-mount packages, the SP9960, SL9901, and SP9921 sell for £11.74 ($21.04), £4.66 ($7.78), and £23.17 ($38.69) (1000), respectively. Delivery, 60 days ARO.

Plessey Semiconductors Ltd, Cheney Manor, Swindon, Wiltshire SN2 2QW, UK. Phone (0793) 36251. TLX 449637.

Circle No 583

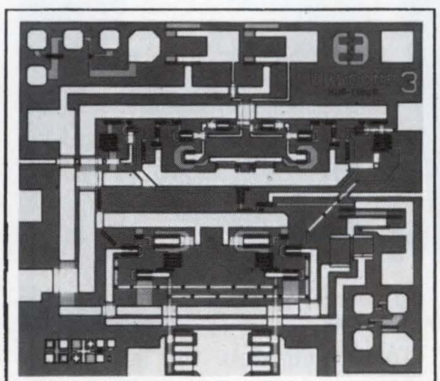
Plessey Semiconductors, 9 Parker, Irvine, CA 92718. Phone (714) 472-0303.

Circle No 584

Gallium arsenide comparator features a data rate of dc to 2G bps

The HMD-11685-2 is a gallium arsenide (GaAs) ultra-high-speed comparator for use as a line driver, line receiver, system clock-driver, pulse driver, or buffer amplifier. All its inputs and outputs are both GaAs and ECL compatible. With an input-to-output propagation delay of 500 psec, the chip's processing speed is typically four times faster than ECL products of equivalent function.

The comparator's output capability is adequate for driving a fan-out of 3 into a 50Ω terminated transmission line. The HMD-11685-2 also



provides a latch function that lets you use the part in sample/hold mode. The comparator functions normally when the latch-enable input is held high. At the time of the latch input transition, when the latch enable is driven low, the outputs are locked into their existing logical status.

The device features a Ti/Pt/Au metalization system and operates over −55 to 85°C. Packaged in a 16-pin hermetic flat pack, the HMD-1165-2 costs $155 (100).

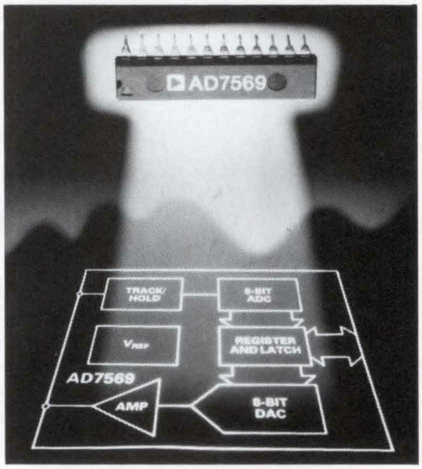
Harris Microwave Semiconductor, 1530 McCarthy Blvd, Milpitas, CA 95035. Phone (408) 433-2222.

Circle No 590

Analog I/O port includes an 8-bit ADC, an 8-bit DAC, and a T/H amplifier

The AD7569 is a monolithic, analog I/O port that combines an 8-bit A/D converter, an 8-bit D/A converter, a track-and-hold (T/H) amplifier, a buffer amplifier, and a voltage reference. The ADC's maximum conversion time (to 0.5 LSB) is 2 μsec; the DAC is buffered by the on-chip amplifier and settles to 0.5 LSB in 1 μsec max. The AD7569 can replace as many as five separate ICs.

The manufacturing process combines low-power CMOS devices and high-speed, high-accuracy bipolar transistors on a single chip. The IC uses CMOS transistors for the converters' switches, the T/H amplifier, and the chip's logic interface. Bipolar devices are used to build the high-speed JFET-input buffer amplifier, comparator, bandgap reference, and DAC current sources.



Because all the necessary conversion circuitry is on the chip, the AD7569 simplifies logic timing; a single command generates a hold signal for the T/H amplifier, delays an A/D conversion until the T/H amplifier has acquired the signal, and initiates the conversion. The fast logic interface, compatible with high-speed μPs and DSPs, is a result of the 75-nsec bus-access time and the <80-nsec write-pulse width.

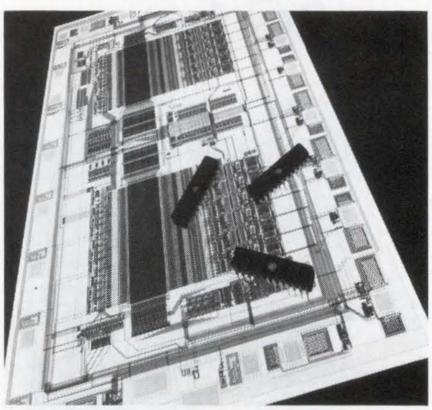
The AD7569 consumes <60 mW and is suitable for battery operation. The part comes in six grades for use over three temperature ranges. Package options include a 24-pin plastic DIP, a 24-pin ceramic DIP, a 28-pin LCC, and a 28-pin PLCC. The commercial version in a plastic DIP costs \$6, the industrial version in a ceramic DIP is \$9, and the military part in a ceramic DIP is \$27 (100).

Analog Devices, Box 9106, Norwood, MA 02062. Phone (617) 320-4700. TLX 174506.

Circle No 586

CMOS erasable programmable logic device features 25-nsec propagation delay

According to the manufacturer, the 5AC312 is the first CMOS erasable programmable logic device (EPLD) to combine a total propagation delay of 25 nsec with previously unavailable architectural features in a 24-pin package. Based on the company's advanced CHMOS technology, the 5AC312 accommodates logic functions—such as decoding, wait-state generation, data latching, and bus arbitration—in critical timing paths of high-performance applications, such as 80286- and 80386-based systems. Under typical high-speed operating conditions, the device draws <50 mA of current, which is reportedly 45% less than other techniques require.



To accommodate the latching or holding of incoming data, the 5AC312 offers a flexible input structure that you can configure in one of five different ways. The 5AC312 also features a user-controllable product-term (P-term) allocation scheme that reallocates unused logic resources to functions with high P-term demand.

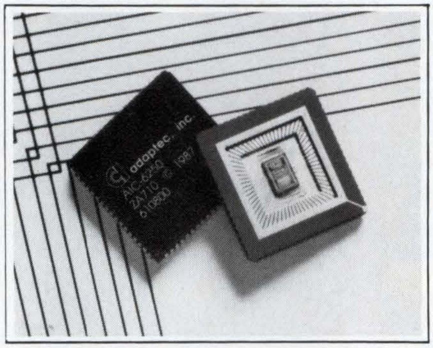
The 5AC312 is supported by the vendor's Programmable Logic Development System II (IPLDS II) version 1.5, which contains the software and hardware necessary to turn EPLD design concepts into working silicon on an IBM PC/XT, PC/AT, or fully-compatible system. The 5AC312, in a 24-pin ceramic DIP sells for \$22.50 (100). IPLDS II V1.5 costs \$3450.

Intel Corp, Dept W-388, Box 58065, Santa Clara, CA 95052. Phone (916) 351-2747.

Circle No 587

SCSI protocol IC employs dual data bus, performs 20M-byte/sec host transfers

The AIC-6250 CMOS IC supports asynchronous and synchronous data transfers across the SCSI bus. The chip includes a dual data-bus interface on the host side, and the host interface supports data transfers as fast as 20M bytes/sec. Single-ended bus transceivers are included on chip, but you can also interface directly with external differential transceivers to the on-chip logic.



The AIC-6250 includes state machines for performing the SCSI protocol, and it automatically performs such functions as arbitration, selection, and preselection. The IC fits both target and initiator applications. As a target, the IC automatically generates a response to selection or reselection.

The chip's architecture serves to offload the host's bus. The chip uses a 16-bit bus to handle 8- or 16-bit data transfers in DMA or programmed I/O modes. A separate 8-bit data port allows the controlling µP to access the control registers at all times, even during DMA transfers.

On the SCSI-bus side, the IC performs 3M-byte/sec asynchronous transfers and can achieve 5M-byte/sec synchronous transfers. An 8-byte FIFO buffer links the SCSI bus and the host-bus interface. The chip can burst data into or out of the buffer at 20M bytes/sec.

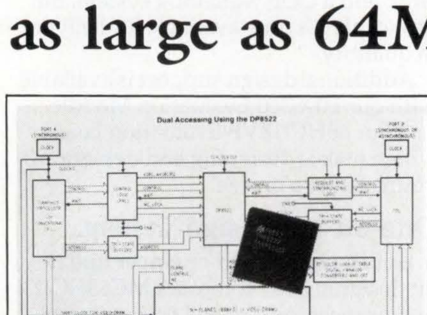
The chip also features automatic parity generation and checking, and it has two general-purpose I/O ports. In differential applications, the I/O ports control the differential transceivers. You can interface the SCSI chip to a µP without using glue logic, even if the µP uses a multiplexed data/address bus. The IC costs $20 (1000) and comes in a 68-pin plastic leaded chip carrier.

Adaptec Inc, 580 Cottonwood Dr, Milpitas, CA 95035. Phone (408) 432-8600.

Circle No 578

Programmable video RAM controller can drive arrays as large as 64M bytes

Part of an advanced graphics chip set, the DP8522 video RAM controller/driver can directly address and drive an array of 4M-bit video RAMs as large as 64M bytes in size. The company's chip-set architecture permits resolutions as high as 16k×16k pixels and a virtually unlimited number of color planes under the control of a single raster-graphics processor. By employing a separate video RAM or dynamic RAM controller, the advanced graphics chip set lets you decide which type of memory component best fits your system's cost and performance goals.

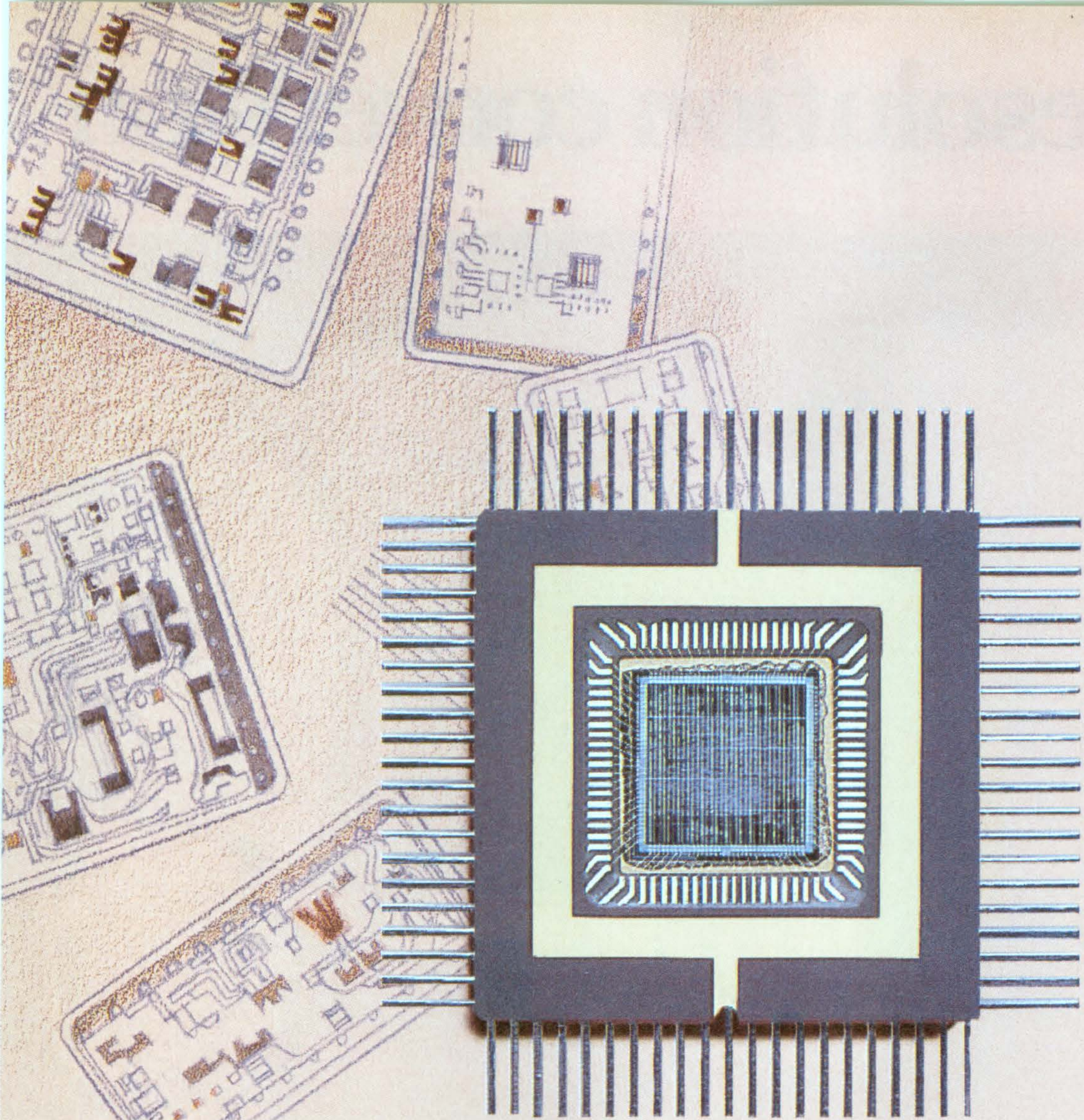


The fully programmable DP8522 works with a variety of computer systems. Its adjustable control-signal pulse widths let you use microprocessors operating at frequencies to 20 MHz. The device supports video RAMs that provide simultaneous read/write functions through a dual-port configuration. The DP8522 also supports dual accessing, provided that a second graphics controller, CPU, DMA, or LAN controller has access to the same memory bank.

The DP8522 supports memory interleaving, and the chip's programmable wait-state logic helps to improve the overall performance of this CMOS device. All major aspects of video-RAM interface, control, and drive functions are fully integrated in the DP8522. Features such as on-chip address latches, bank-select logic, dual-porting, a refresh counter, and a high-speed row/column/refresh multiplexer are built in. The DP8522 comes in an 84-pin plastic chip carrier and costs $28 (1000).

National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 721-5404. TLX 346353.

Circle No 581



A compact 1553 that carries a busload.

The UT1553B BCRT data bus system proves that big things do come in small packages. It's loaded with features including both MIL-STD-1553B Bus Controller and Remote Terminal functions and advanced, specialized memory management — all on one low-power CMOS chip.

It's the next generation product in our 1553 family. The BCRT was designed to reduce host intervention with automatic DMA and address generation. It automatically executes message transfers, provides interrupts, and generates status information. UTMC's BCRT allows you to implement a pseudo-transparent dual-port RAM configuration.

The BCRT's bus controller uses a linked-list message scheme to provide the host with message "chaining." Memory space is optimized by using programmable address pointers. As an RT, the BCRT implements time tagging and message history functions. It also supports multiple-message buffering — up to 128 — including variable-length messages to any subaddress.

The BCRT complies with the standard LAN used for military systems while meeting selected tests in MIL-STD-883C. It is available in 84-pin LCCs, PGAs, or Cerquads.

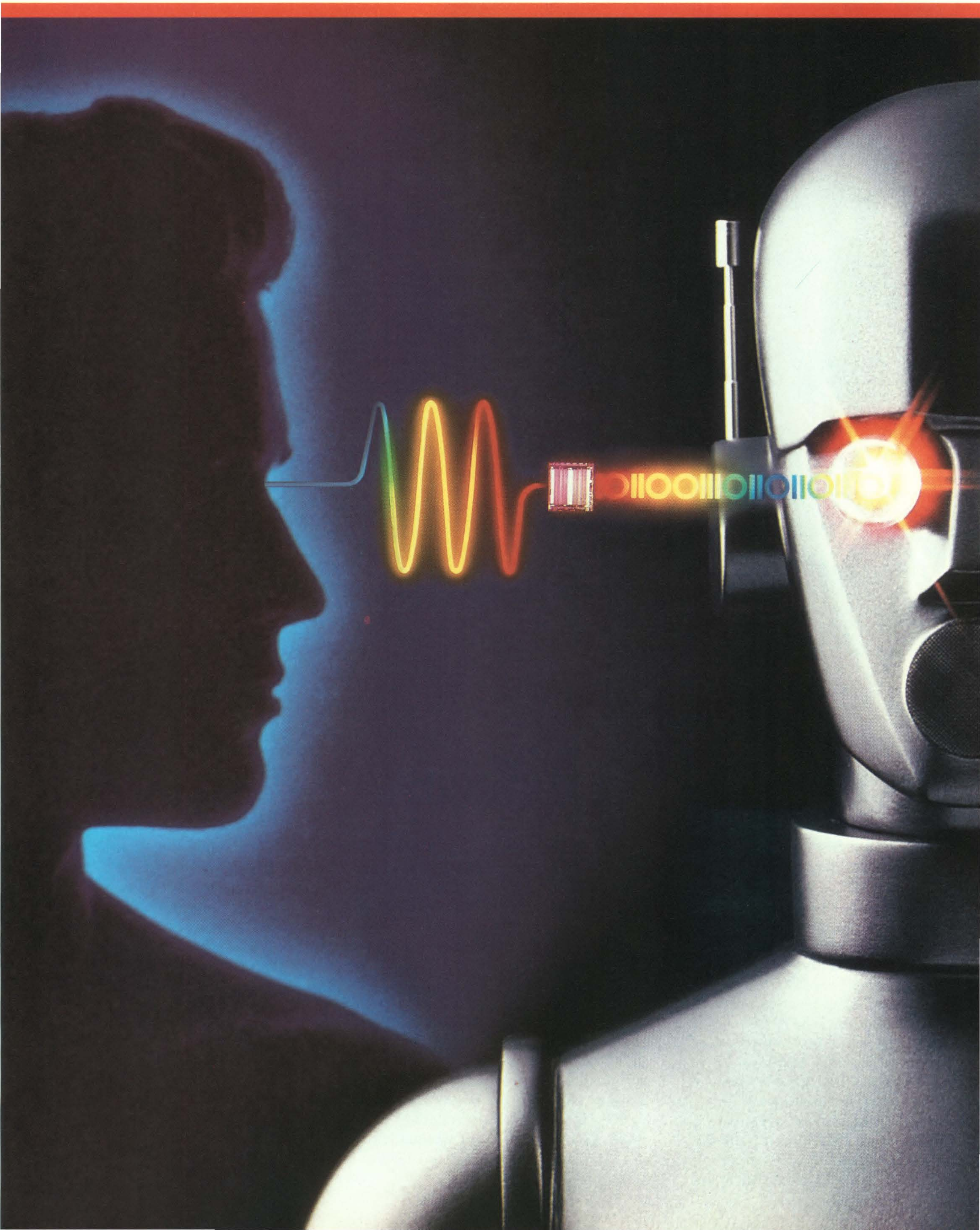
Don't miss the bus on your 1553 system needs. Call UTMC.

Product Marketing
United Technologies
Microelectronics Center
1575 Garden of the Gods Road
Colorado Springs, Colorado 80907
1-800-MIL-UTMC

UNITED TECHNOLOGIES MICROELECTRONICS CENTER

CIRCLE NO 83

High-resolution conversion



in the blink of an eye.

Get video speed, low power consumption, high resolution and superior price/performance with our new CMOS data converters.

We've expanded our line to include more CMOS flash ADC's, a charge balancing ADC, an SPI ADC and a DAC. All featuring single 5V supply operation.

We also offer a new high-speed op amp especially well-suited to driving ADC's or video cables.

4, 6 and 8-bit CMOS flash ADC's.

Choose from 4, 6 and 8-bit ADC's. All operate at video speeds, with clocking speed and input bandwidth specified at 5V. What makes these flash ADC's special is silicon-on-sapphire construction, resulting in low cost, high speed, very low input capacitance, low power consumption and inherent latch-up resistance.

10-bit CMOS charge balancing ADC.

This 10-bit successive approximation ADC captures fast moving signals, providing excellent resolution.

It features a built-in fast track and hold, with conversion rates of 150 KHz and an input bandwidth of 1.5 MHz. Even at the maximum rate, power consumption is less than 20 mW.

10-bit CMOS serial ADC.

The CDP68HC68A2 is selectable for either 8- or 10-bit resolution and has an 8-channel multiplexer allowing up to 8 channels of inputs. The device can be used directly with our CDP68HC05C4, C8 or D2 microprocessors or other similar SPI (Serial Peripheral Interface) buses.

8-bit CMOS R-2R video-speed DAC's.

These CMOS/SOS digital-to-analog converters operate from a single 5V supply at video speeds and can produce "rail-to-rail" output swings. Typical update rate is 50 MHz. Settling is fast (20 ns typical) to 1/2 LSB. "Glitch" energy is minimized by segmenting and bar graph decoding of upper 3 bits.

High-speed op amp.

Specially designed for use with data converters, the CA3450 op amp has excellent speed and transmission line driving capabilities.

For 10-bit accuracy, it settles to within 1/2 LSB in 40 ns with a 2V input signal. And it can drive up to four 50 ohm transmission lines.

ADC's	Res. Bits	Conv. Rate Hz	Power Diss. (MW)	Pkg. Leads	1K Price
CA3304E	4	20M	30	16	2.95
CA3304AE	4	25M	35	16	4.50
CA3306CE	6	10M	65	18	5.50
CA3306E/3306AE	6	15M	70	18	6.25/11.25
CA3318E/3318CE	8	15M	150	24	38.50/24.00
CA3310E/3310AE	10	150K	15	24	6.00/8.00
CDP68HC68A2E	10	10K	15	16	3.75
DAC's					
CA3338E/3338AE	8	50M	100	16	6.00/8.40
OP AMP	**UGBW Hz**	**Slew Rate (X10)**	**I_{OUT} MA**	**Pkg Leads**	**1K Price**
CA3450E	200M	300V/μSec	±75	16	2.70

Data in a flash.

For data sheets of these new products, call toll-free 800-443-7364, extension 19. Or contact your local GE Solid State sales office or distributor.

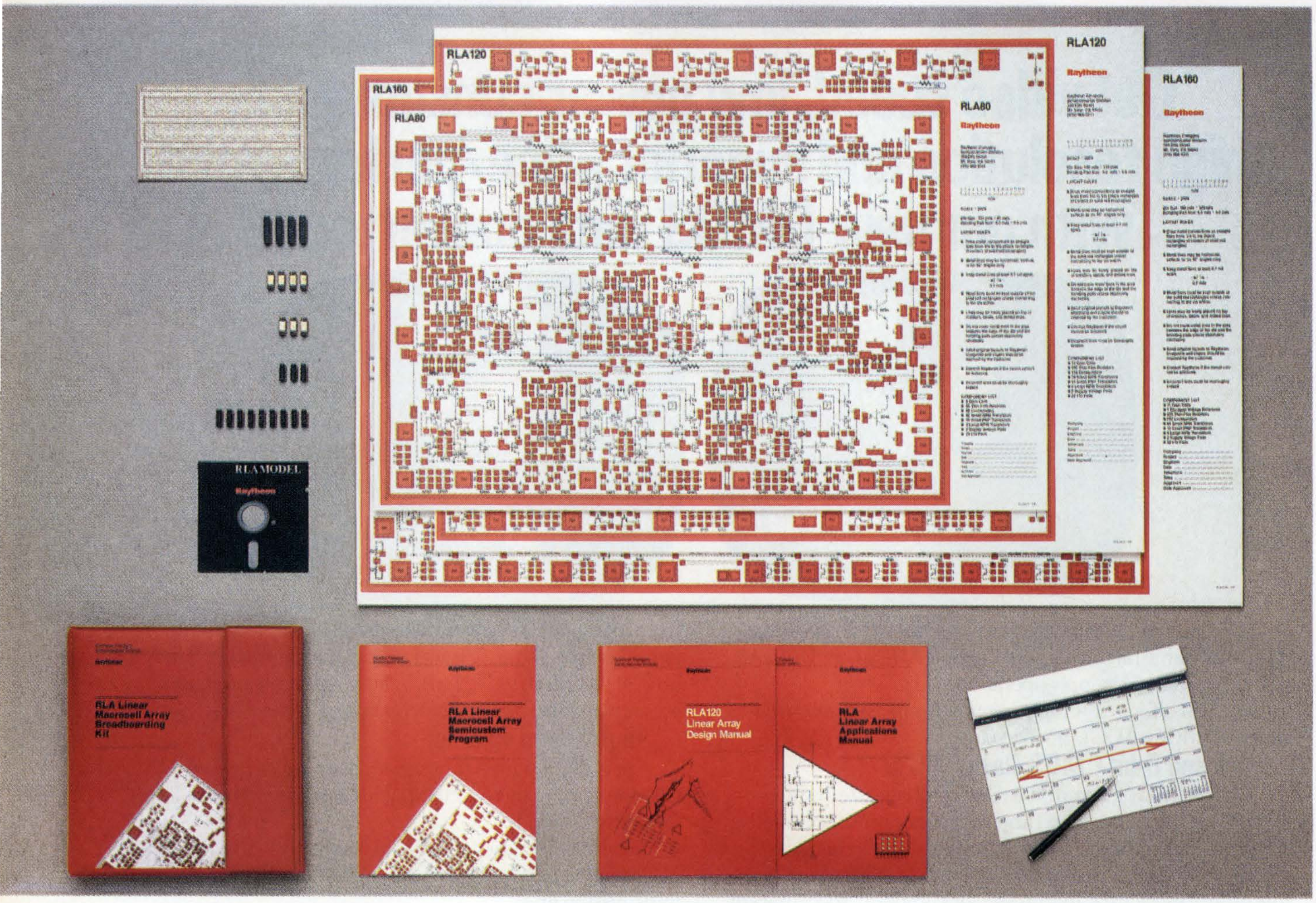
In Europe, call: Brussels, (2) 246-21-11; Paris, (1) 39-46-57-99; London, 0276-685911; Milano, (2) 82-291; Munich, (89) 63813-0.

GE Solid State

GE/RCA/Intersil Semiconductors

These three leading brands are now one leading-edge company. Together, we have the resources—and the commitment—to help you conquer new worlds.

The One Week Analog ASIC.



The leading technology . . . the best support . . . go!

The leading analog ASIC family: RLA80, RLA120, and RLA160 user-configurable macrocell arrays. On-chip thin film SiCr resistors and dual-layer metal for ease of interconnect routing and maximum array utilization and performance. Wide supply voltage range — ±1V to ±16V. And simplified design procedures that take days, not weeks.

☐ **Configurable macrocells:** 8, 12, or 15 gain blocks in any combination as general purpose op amps, open collector output comparators, or as input amplifiers with ground sensing function for single-supply systems. RLA160 has a preconfigured on-board adjustable ±30 ppm voltage reference.

☐ **Thin-film resistors:** on-chip SiCr resistors exhibit 1% matching and temperature drift characteristics comparable to discrete film resistors. High performance and high values (1.25 kΩ to 150 kΩ) handle a wide variety of applications.

☐ **Design support:** The RLA Breadboarding Kit contains complete design and applications documentation, 200x plots, a pre-drilled printed circuit board, and 23 ICs. Friendly RLAModel software includes menu-driven user interface program for PSPICE[1], SPICE[2] model library for RLA series, documentation files, and full screen editor. Not to mention the attention you get from applications engineers who have 15 years experience meeting custom and semi-custom requirements.

Call Raytheon for access to RLA program information and details on the RLA Macrocell Array Breadboarding Kit. We promise you a week that will go down in history.

Raytheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94039-7016
(415) 966-7716

[1]PSPICE is a trademark of MicroSim Corporation.
[2]SPICE developed by University of California.

Access to the right technology

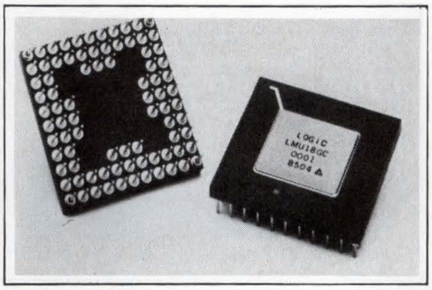
Raytheon

Integrated Circuits

Fast CMOS multiplier-chip family offers high speed for DSP applications

This family of four multiplier chips derives its speed from an optimized architecture implemented in a 1.8-μm CMOS process. Three of the devices (the 8-bit, 12-bit, and 16-bit parts) are straight multipliers that can compute a product in as little as 35 nsec. The fourth device is a 12-bit multiplier that has a built-in accumulator and can compute a product and add it to the accumulator in 45 nsec.

The 16-bit LMU18 multiplies two 16-bit inputs and then delivers the full 32-bit product in 35 nsec. Much of the LMU18's speed advantage (twice that of its nearest competitor, according to the manufacturer) comes from its ability to produce the entire 32-bit product at once. Other multipliers can produce only 16 bits at a time, so they require a 2-step process.



The 12-bit LMU12 multiplies two 12-bit inputs and produces a 24-bit product in 35 nsec. It is pin and function compatible with TRW's MPY-12HJ. The 8-bit LMU08 can multiply two 8-bit inputs to produce a 16-bit product in 35 nsec. You can choose a 16-bit output that's read in parallel or an output that's multiplexed to a single 8-bit bus for more compact designs. You can also load the inputs in parallel, or individually from an 8-bit bus.

The LMA1009 multiplier-accumulator (MAC) chip has a built-in accumulator, which lets you build algorithms that require the successive addition of products. The device multiplies the values loaded into its two 12-bit inputs, adds the resultant product to the accumulator, and produces the result in 45 nsec. The LMU18 (in a PLCC package) costs $30.53. In DIPs, the LMU12 is $22.29, the LMU08 costs $17.06, and the LMA1009 (DIP) sells for $26.95 (100).

Logic Devices Inc, 628 E Evelyn Ave, Sunnyvale, CA 94086. Phone (408) 720-8630.

Circle No 582

Flat-panel display driver scans LCDs at multiplex rates as high as 1:256

Providing an interface between industry-standard flat-panel display controllers and liquid-crystal displays, the PCF2201 LCD driver can control as many as 81 row lines or 80 column lines of a dot-matrix LCD. As a result, you need only 21 of the drivers to scan a 640×400-pixel display. The PCF2201 can drive twisted-nematic LCDs and super-twisted birefringence-effect LCDs at multiplex rates as high as 1:256.

To operate the device as a row driver, you serially clock row-select data through an internal 81-stage shift register. The maximum clock rate for the shift register, and hence the maximum row-scan rate for the display, is 100 kHz.

When the IC operates in column-driver mode, the shift register functions as a set of static latches that holds parallel output data for 80 of the display's column lines. A data buffer, provided by 80 more data latches, allows you to assemble more column information while the driver sends the current column information to the LCD. You can enter data in the data buffer either serially or in 4-bit nibbles.

The PCF2201 provides internal level shifters that shift the logic-level row/column data contained in the shift register to the voltage levels required by the LCD. The driver can handle drive voltages as high as 25V, and the level shifters require four bias voltages between 5V and −25V.

The display driver draws a typical operating current of 0.4 mA and a standby current of 15 μA, and it provides on-chip overtemperature protection. All its data and control inputs are 5V CMOS compatible. The driver is supplied on reels in a tape-automated-bonding package with 120 leadouts. It costs around Swiss Fr 8 (10,000).

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

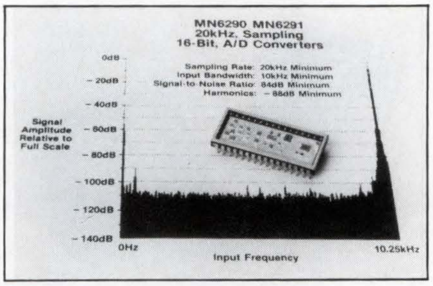
Circle No 579

Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.

Circle No 580

16-bit, sampling A/D converters digitize high-frequency signals

The MN6290 (10V input span) and MN6291 (20V input span) are high-speed, 16-bit, sampling A/D converters designed for digital-signal-processing (DSP) applications. The devices feature internal, user-transparent, track-and-hold (T/H) amplifiers that let these ADCs accurately sample and digitize dynamically changing input signals at sampling rates to 20 kHz. When sampling and digitizing at 20 kHz, both devices maintain an 84-dB min S/N ratio and a minimum of 88 dB of harmonic-distortion attenuation.



The T/H amplifier is necessary because of the device's successive-approximation (SA) technique. By itself, the SA type of ADC is inherently incapable of accurately converting rapidly changing analog input signals. The T/H amplifier overcomes this shortcoming by holding the signal constant whenever the ADC performs a conversion. A high-impedance input buffer isolates the T/H amplifier from its signal source, and the T/H amplifier's operational mode is internally controlled by the ADC's status line.

The vendor tests each device both statically and dynamically with a series of 512-point FFTs on the stored digital output data. The devices come in 32-pin, double-width DIPs and are available in commercial, industrial, and military temperature grades. Pricing varies from \$180 to \$270 (100), depending on the bit-accuracy specification and the temperature range.

Micro Networks, 324 Clark St, Worcester, MA 01606. Phone (617) 852-4000.

Circle No 589

CMOS DSP IC offers 80-nsec cycle time; operates on IEEE floating-point numbers

The Model WE DSP32C CMOS floating-point digital signal processor (DSP) features cycle times as low as 80 nsec. The processor is compatible with the IEEE standard floating-point format. Three 512×32-bit banks of RAM on the IC ensure fast access to memory.

The chip includes 15 general-purpose registers, five increment registers, two external interrupts, eight vectored interrupts, and a 16M-byte address space. You can program the DSP chip for 8-, 16-, or 32-bit accesses to external memory. The chip automatically inserts as many as three wait states when used with slow main memory. On-chip I/O resources consist of a 16-bit parallel port and a serial port capable of operating as fast as 22.5M bps.

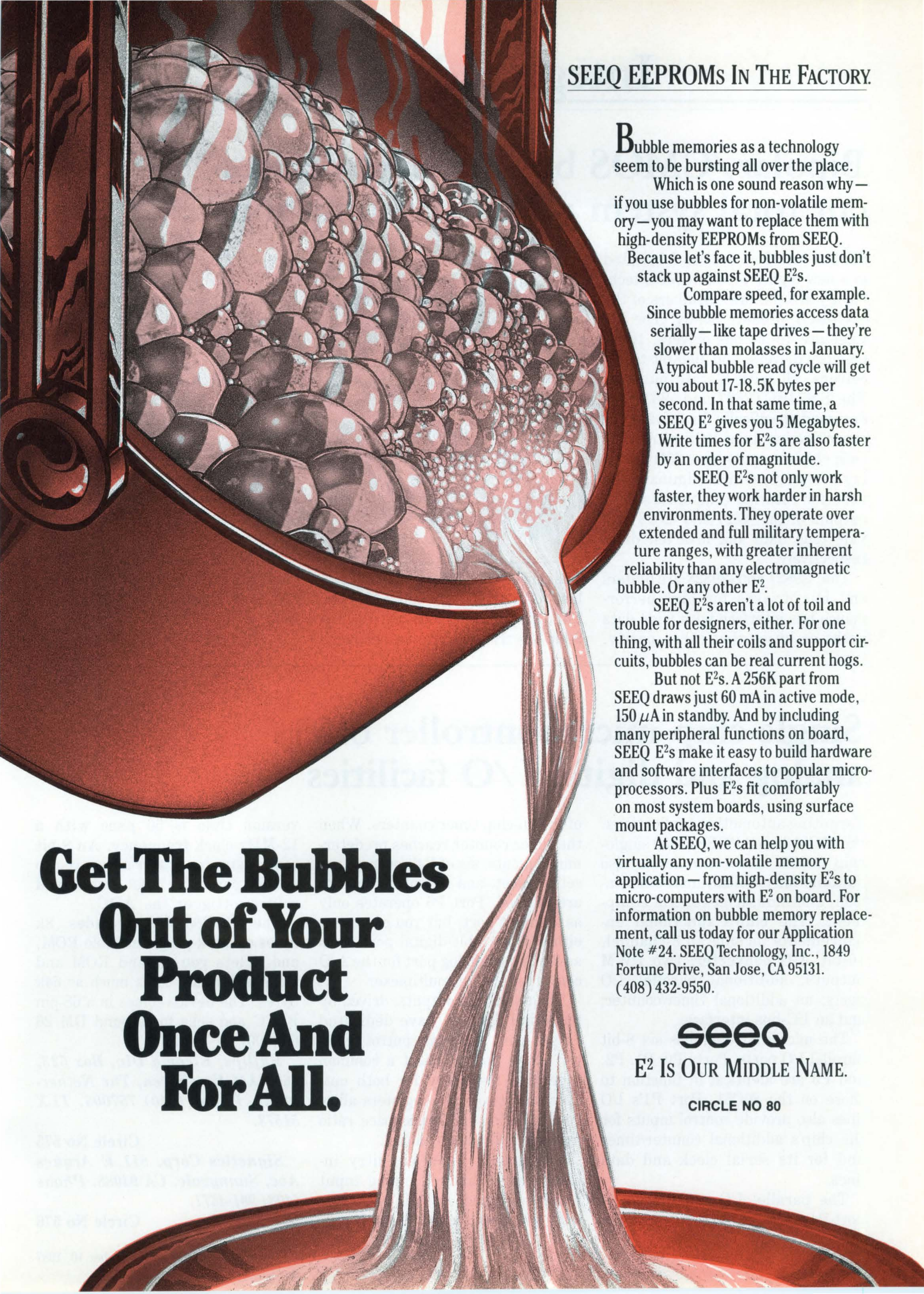
The DSP32C can fetch two 32-bit numbers from memory, multiply and accumulate the result, and write it to memory in one 80-nsec instruction cycle. Because the DSP32C is source- and object-code compatible with its predecessor, the NMOS WE DSP32, you have direct access to a large library of applications code.

The DSP32C internally uses a 24-bit mantissa and 8-bit exponent floating-point format. For access to IEEE databases, it includes logic that converts between the IEEE floating-point format and the IC's internal format in a single cycle. To support access to external data, the DSP32C interfaces to codecs, other DSP32s and DSP32Cs, and time-division-multiplexed lines without requiring glue logic. The on-chip serial port is double buffered, and an on-chip DMA controller supports simultaneous DMA transfers between the serial port and the parallel port without program intervention.

A full complement of development tools—including a C-like assembler, a link editor, a simulator/debugger, and a C compiler—support software development for the DSP IC. The software-development package executes on systems running MS-DOS and costs \$995. Samples are available now, and production quantities will be shipped in the first quarter of 1988. The \$70 (10,000) device will be packaged in a 133-pin PGA.

AT&T Technology Systems, 555 Union Blvd, Allentown, PA 18103. Phone (800) 372-2447.

Circle No 577



SEEQ EEPROMs In The Factory.

Bubble memories as a technology seem to be bursting all over the place.

Which is one sound reason why—if you use bubbles for non-volatile memory—you may want to replace them with high-density EEPROMs from SEEQ.

Because let's face it, bubbles just don't stack up against SEEQ E²s.

Compare speed, for example. Since bubble memories access data serially—like tape drives—they're slower than molasses in January. A typical bubble read cycle will get you about 17-18.5K bytes per second. In that same time, a SEEQ E² gives you 5 Megabytes. Write times for E²s are also faster by an order of magnitude.

SEEQ E²s not only work faster, they work harder in harsh environments. They operate over extended and full military temperature ranges, with greater inherent reliability than any electromagnetic bubble. Or any other E².

SEEQ E²s aren't a lot of toil and trouble for designers, either. For one thing, with all their coils and support circuits, bubbles can be real current hogs.

But not E²s. A 256K part from SEEQ draws just 60 mA in active mode, 150 μA in standby. And by including many peripheral functions on board, SEEQ E²s make it easy to build hardware and software interfaces to popular microprocessors. Plus E²s fit comfortably on most system boards, using surface mount packages.

At SEEQ, we can help you with virtually any non-volatile memory application—from high-density E²s to micro-computers with E² on board. For information on bubble memory replacement, call us today for our Application Note #24. SEEQ Technology, Inc., 1849 Fortune Drive, San Jose, CA 95131. (408) 432-9550.

Get The Bubbles Out of Your Product Once And For All.

seeq

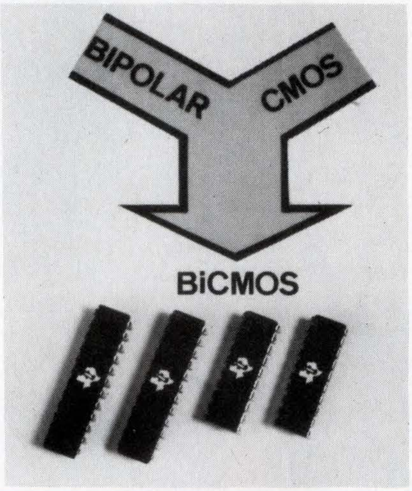
E² Is Our Middle Name.

CIRCLE NO 80

Bipolar/CMOS bus-interface devices cut total system power consumption

Six bus-interface devices fabricated in a new digital bipolar/CMOS technology are the first members of the SN74BCT product family. The devices are 10-bit bus drivers, 10-bit memory drivers, and 10/9-bit transceivers, all with 3-state outputs. The SN74BCT2827 and -2828 are designed specifically for driving the capacitive inputs of MOS memories; each chip's outputs have 25Ω damping resistors, which eliminate the need for external components. The outputs of the -2827 and -2828 provide true data and inverted data, respectively.

The -29827 and -29828 are buffers and bus drivers for high-performance bus interface with wide data paths or buses that carry parity. The devices are functionally equivalent to the AM29827 and AM29828. The -29861 and -29863 are 10- and 9-bit bus transceivers, respectively; they are functionally equivalent to the AM29861 and AM29863.



Characterized for operation over 0 to 70°C, the devices are available now in 24-pin DIPs. The company plans to offer plastic leaded chip carriers and SOIC packages for surface mounting. In DIPs, the -29827, -29828, -29861, and -29863 cost $3.46 (1000) each. The -2827 and -2828 are $3.60 (1000). The vendor plans to offer versions for the military temperature range; they'll be available in ceramic DIPs and leadless ceramic chip carriers.

Texas Instruments, Semiconductor Group, Box 809066, Dallas, TX 75380. Phone (800) 232-3200 ext 700.

Circle No 588

Single-chip microcontroller offers analog and digital I/O facilities

Targeting automotive applications, the 80C51-based PCB83C552 single-chip CMOS microcontroller is also suitable for medical, instrumentation, and industrial-control equipment. The chip's functional enhancements include an 8-channel, 10-bit A/D converter; two PWM outputs; additional parallel I/O ports; an additional timer/counter; and an I²C-bus interface.

The microcontroller has six 8-bit parallel I/O ports. Ports P0, P1, P2, and P3 are identical in function to those on the 80C51. Port P1's I/O lines also provide control inputs for the chip's additional counter/timer and for its serial clock and data lines.

The parallel I/O capabilities of port P4 allows you to couple it to one of the on-chip timer/counters. When the timer/counter reaches predetermined points, six of P4's outputs are set or reset, and two of its outputs are toggled. Port P5 operates only as an input port, but you can use it either as an 8-bit digital port or as an 8-channel analog port for the A/D converter's input multiplexer.

The two PWM outputs, driven by push-pull drivers, have dedicated output pins. An 8-bit control register allows you to select a common repetition frequency for both outputs, and two more registers allow you to define the mark/space ratio for each individual channel.

The analog input circuitry includes an 8-channel analog input multiplexer and an A/D converter with 10-bit resolution. The A/D-conversion time is 50 μsec with a 12-MHz clock frequency. An 8-bit control/status register allows you to select a particular input channel and software-trigger the ADC.

The PCB83C552 includes 8k bytes of mask-programmable ROM, and it lets you expand ROM and RAM externally to as much as 64k bytes. The device comes in a 68-pin PLCC and sells for around DM 26 (10,000).

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

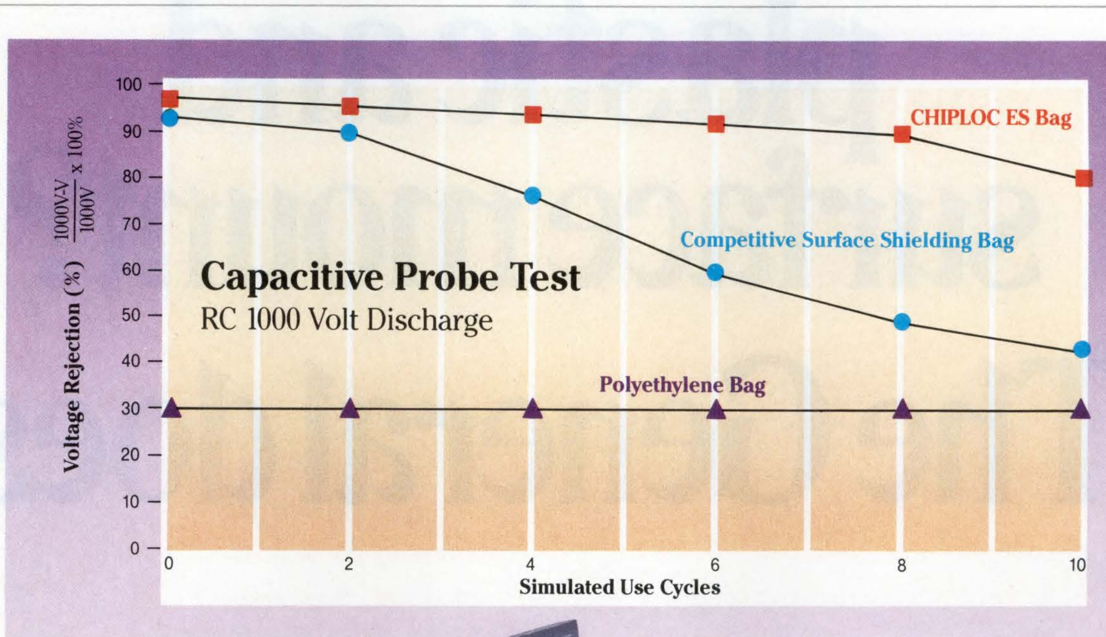
Circle No 575

Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.

Circle No 576

Introducing CHIPLOC Bags from Dow:

CHIPLOC ES Delivers *Up To 80%* More Static Protection Than The Leading Surface Shielding Bag.



Capacitive probe tests show that CHIPLOC* ES static shielding and dissipative packaging from Dow has up to 80% more shielding capability than the leading surface shielding bag on the market.

CHIPLOC ES has a thin, high-quality conductive metallized layer† designed specifically to minimize the penetration of electric fields from highly charged objects. It provides superior Faraday cage protection of the most sensitive electronic devices.

It is reusable, too, because of the exclusive "buried shield" construction used in CHIPLOC ES. Two layers of static dissipative film protect the metallized layer against abrasion, tears and punctures. Such damage, more common in bags with surface metallized layers, can dramatically reduce shielding effectiveness. In fact, tests†† show that after just eight simulated use cycles, competitive exposed-film bags retain only 52% of their shielding ability. CHIPLOC ES retains 92%.

Free Samples

For the complete CHIPLOC story, including free samples and a copy of the brochure "Two New Solutions to ESD Problems," call 1-800/258-2436, Extension 32/CHIPLOC. Or write: The Dow Chemical Company, Packaging and Industrial Foams Dept., 2020 Willard H. Dow Center, Midland, MI 48674.

Advancing The Science of Electronics

†Manufactured of STATICURE* static dissipative films.
††Test results available upon request.

DOW*

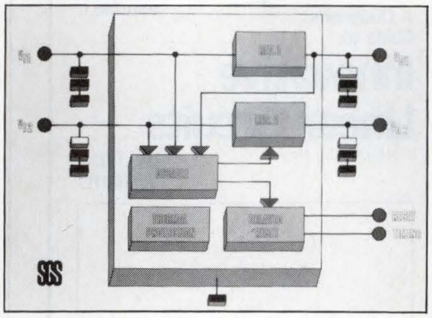
*Trademark of The Dow Chemical Company

CIRCLE NO 91

Dual-output 5V regulators simplify battery-backup circuitry

To simplify the design of systems that require battery backup for some of their circuitry, the L4901, L4902, L4903, and L4904 voltage regulators have two separately regulated 5V outputs, one of which specs a leakage current of <1 μA. The low-leakage regulator sections' quiescent input-current drain is only 0.6 mA, so it's suitable for operation from battery input sources. The second 5V output is suitable for driving circuitry that doesn't require backup.

The regulators also generate a μP-compatible reset signal during power-up conditions, after brief supply interruptions, or when the output to the battery-backed section of your circuit falls below a safe value—4.9V typically. You can control the reset-period timing with a single external capacitor.



The L4901 and L4902 are housed in 7-lead Heptawatt plastic packages. They provide a 5V/0.3A output for battery-backed circuitry and a 5V/0.4A output for other circuitry. The L4903 and L4904 come in 8-pin miniature DIPs. Both their outputs are rated at 5V/0.1A, and both devices have separate inputs to their two regulator sections. The L4901 has a separate input for each of the two regulator sections.

The L4902 has a common input for both regulator sections. Both the L4902 and the L4903 have a TTL/CMOS-compatible disable input that controls the output that's not designed for battery back-up circuitry. All the regulators have input overvoltage protection to 60V, as well as output short-circuit and thermal-overload protection. They cost around $1.30 (1000).

SGS Microelettronica SpA, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 596

SGS Semiconductor Corp, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 597

Single-chip token-bus modem supports MAP networks

The SAB82511 baseband modem provides the functions of layer 1 of the OSI communications model for IEEE-802.4 token-bus networks. It is therefore suitable for use in MAP (manufacturing automation protocol) networks. The modem is also compatible with Motorola's token-bus controller.

Using phase-coherent FSK modulation, the modem transmits data at 5M or 10M bps. It also includes a digital demodulator to decode received data. The modem chip generates the receive and transmit clock signals from a 20-MHz crystal or an external frequency source. It also provides station-management functions, and it has an electrical interface that you can connect directly to a network-medium coupling transformer.

The modem recognizes five distinct transmission states from the media-access control (layer 2) functions of the token-bus controller—silence, non-data, pad-idle, data one, and data zero—and modulates the transmit carrier signal accordingly. The SAB82511 also supports station-management functions that include a loop-back mode for use in fault diagnosis. In addition, it incorporates a watchdog timer that prevents the modem from going into continuous-transmit mode and thus locking up the network.

The SAB82511 comes in a 44-pin ceramic leadless chip carrier or plastic leaded chip carrier and operates over 0 to 70°C. It operates from a single 5V supply and draws a maximum supply current of 290 mA. All inputs and outputs that interface the modem to the token-bus controller are TTL compatible. Samples are available at $175 each.

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 592

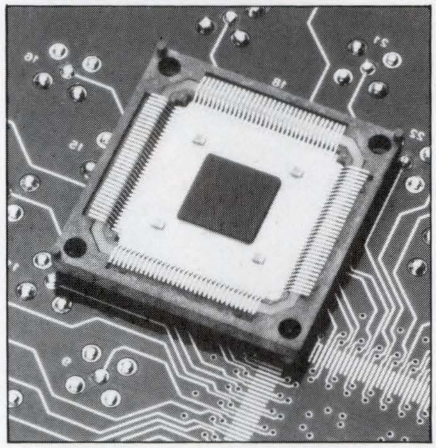
Siemens Components Inc, 2191 Laurelwood Rd, Santa Clara, CA 95054. Phone (408) 980-4500.

Circle No 593

1-GHz, 3000-gate GaAs array targets high-speed digital applications

Supporting LSI applications at toggle rates as high as 1 GHz, the TQ3000 GaAs gate array is fabricated in the company's Q-ED process, a 1-μm enhancement/depletion MESFET (metal-epitaxial-semiconductor FET) construction that features two layers of interconnect metal, including air-bridge technology for the second layer.

The gate array supports 64 dedicated high-speed I/O pins that the user can program to interface with TTL, CMOS logic, or ECL. Internally, the array has 1020 cell locations containing 3000 equivalent gates. You can, for example, create 255 master/slave flip-flops by using the available gates. The part's power consumption is 0.75 mW per



equivalent gate and 2.4 mW per cell. The array operates from a single 2.6 or −2.6V supply. The cell library for the TQ3000 is fully supported on Daisy, Mentor, and Tektronix CAE workstations.

The TQ3000 is available in die form or in a 132-pin multilayer ceramic package. A high-speed evaluation board with a quick connect socket is available for rapid prototyping and system characterization. Nonrecurring engineering cost for the TQ3000 is $80,000 and includes design manuals and workstation software. The vendor delivers five tested and packaged parts plus a high-speed evaluation board. The typical turnaround time from customer input to delivery of the packaged parts is 16 weeks.

TriQuint Semiconductor, Group 700, Box 4935, Beaverton, OR 97075. Phone (503) 629-3535.

Circle No 585

IC supports PS/2 graphics modes and 800×600-pixel, 16-color resolution

The PVGA1 is a single-chip graphics controller for use with IBM's Video Graphics Array (VGA), which is the standard graphics interface for the Personal System/2. The company also offers two VGA-compatible boards based on the chip.

Because the chip is compatible with the VGA at the register level, you can program the graphics hardware directly instead of programming only through the software-interface portion of the VGA BIOS (basic input/output system). This hardware compatibility confers a greater degree of confidence that a PVGA1-based board will be VGA compatible: In the past, application programs for the PC have bypassed the BIOS and accessed the graphics hardware directly to gain a speed advantage.

Besides supporting the VGA functions, the chip also supports the graphics standards developed for MS-DOS systems: the EGA (enhanced graphics adapter), MDA (monochrome display adapter), CGA (color graphics adapter), and Hercules and AT&T Model 6300 graphics boards. Note, however, that the chip supports the EGA standard only to the BIOS level, not to the register level.

The PVGA1 implements a proprietary mode that offers 16 colors and a resolution of 800×600 pixels. Its monochrome mode provides 1280×1024-pixel resolution. The vendor's proprietary bus interface for the PVGA1 allows data transfers of 8 bits over the PC bus and 16 bits over the PC/AT bus.

Another mode, Mode 13, specifies a resolution of 320×200 pixels and 256 colors. In your search for higher resolutions, don't forget that although pixel resolution is the most important factor in 2-D images, when you perceive 3-D images your eye is most sensitive to color resolution.

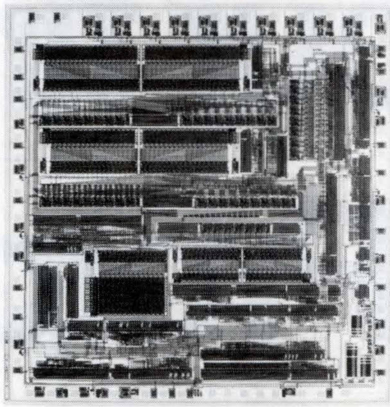
The PVGA1 chip costs $60 (100) and comes in a 100-pin plastic pin-grid array, plastic leaded chip carrier (PLCC), or plastic flat pack. It comes with a VGA-compatible BIOS.

Paradise Systems Inc, 217 E Grand Ave, South San Francisco, CA 94080. Phone (415) 588-6000.

Circle No 598

Echo-canceling chip set links ISDN to existing subscriber lines

By using DSP techniques to perform echo cancellation at either end of a telephone line, the PCB2390 ISDN (Integrated Services Digital Network) chip set allows existing 2-wire subscriber wiring to carry ISDN information over distances as great as 8 km. Two of the chip sets, incorporated in a repeater, can span distances as great as 14 km. The chip set's operation complies with the West German PTT's U_{K0} specification for the CCITT U-interface.



Capable of operating at a data rate of 144k bps, the chip set provides full-duplex transmission of two 64k-bps B channels of encoded voice or data and a 16k-bps D channel of signaling and low-speed data —the requirements for basic ISDN access. To achieve this transmission rate, the PCB2390 encodes the bit stream by using a 4B/3T line code (four binary digits compressed into three ternary digits) so that the data-signaling rate is reduced to 108k bps. A 1-kHz maintenance channel, and 11-bit frame words added to the bit stream, results in a line-signaling rate of 120k baud. In addition to its U-point interface, the chip set has an industry-standard IOM (ISDN-oriented modular) interface that connects it to circuits that implement other CCITT interface functions.

At initial power-up, the PCB2390 injects a signal into the telephone line to evaluate the required filter coefficients for its adaptive DSP echo-cancellation and equalization filters. Additional adaptive filters allow you to connect the devices to loops that contain bridged taps. The 2-chip CMOS implementation of the PCB2390 currently costs around \$80. A single-chip version is under development.

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 594

Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.

Circle No 595

Data-acquisition chip contains 10-bit ADC, S/H circuit, and multiplexer

The LTC1090 data-acquisition system contains a 10-bit A/D converter, an S/H circuit with a 1-µsec acquisition time, and an analog input multiplexer, all on a single piece of silicon packaged in a 20-pin DIP. The secret of its low pin count is the device's full-duplex, serial µP interface. Selected versions of the part feature a total unadjusted error of ±0.5 LSB over the full operating temperature range.

You can configure the analog input multiplexer as eight single-ended inputs, four differential inputs, or a combination of single-ended and differential inputs by means of the chip's 8-bit input data word. This data word selects a multiplexer input channel, picks single-ended or differential operation for the selected analog input, sets the polarity of the input pins for a selected differential-input pair, selects unipolar or bipolar A/D operation, defines the output word width, and determines whether the LSB or the MSB of the conversion will emerge first from the serial output. The internal S/H circuit operates only for single-ended conversions.

You can select either 10-bit unipolar or 9-bit-plus-sign bipolar conversions by means of the chip's serial input data word. A conversion requires 20 µsec. The total unadjusted error for either the unipolar or the bipolar conversion mode over the device's full temperature range is ±0.5 LSB for the LTC1090A and ±2 LSB for the LTC1090. The LTC1090CN, in a plastic package and rated for −40 to +85°C operation, costs \$11.95 (100). A similarly packaged LTC1090ACN costs \$18.95 (100).

Linear Technology Corp, 1630 McCarthy Blvd, Milpitas, CA, 95035. Phone (408) 942-0810. TLX 172110.

Circle No 574

You've seen the advantages offered by the A100 Digital Signal Processor. The single-chip DSP solution that features 32 multiply-accumulators, executes up to 320 MOPs, and easily attaches to microprocessors.

Now INMOS speeds A100 system development with the new D704, the complete DSP Development System. The D704 overcomes the clutter normally encountered in developing DSP systems such as hand-crafted assemblers, interleaved busses and power-hungry glue. And since it is tailored for the A100, your end product is first to market and second-to-none in performance.

The D704 combines a comprehensive set of software tools, PC plug-in card and extensive documentation, providing a powerful yet easy-to-use DSP environment. You can experiment with the technology, simulate DSP algorithms in software and run them in real time on the A100's provided on the board.

The A100 is quickly becoming the number one choice in everything from avionics to ultrasonics. And with MIL-STD 883C devices available soon, it will be a natural for military DSP programs of all types. With the D704 Development System, creating DSP solutions has never been easier.

So if you'd like to cut through the clutter, start by clipping the coupon.

THE A100 DSP FAMILY

IMS A100	Single-Chip 32-Stage Cascadable Transversal Filter—16-Bit Data, 16-Bit Coefficients, 320 MOPs
IMS B009	PC Plug-In Card Including Four A100's
IMS D704	IMS B009 + Interactive Software Simulator/ DSP Development Suite

inmos®

I'd like to cut through the clutter. Please send me full details of the IMS D704 DSP development system.

Name ____________ Title ____________

Company ____________

Address ____________

Telephone ____________

EDN 121087

INMOS Corporation, PO Box 16000, Colorado Springs, Colorado 80935. Tel (303) 630-4000.

INMOS Limited, PO Box 424, Bristol BS99 7DD. Tel (0454) 616616.

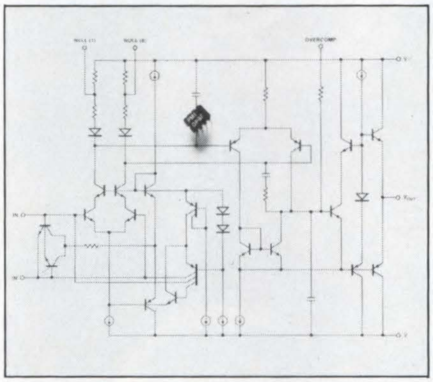
INMOS ® and IMS are trademarks of the INMOS Group of Companies.

CIRCLE NO 74

Low-power precision op amp needs only 600 μA of supply current

The OP-97 is a low-power alternative to the industry-standard OP-07 precision amplifier. Except for its noise specification, the OP-97 maintains the original standards of performance set by the OP-07, but needs only 600 μA of supply current—less than ⅙ that required by the OP-07.

Several of the OP-97's specs are improved over those of its predecessor. The OP-97's bias current is 100 pA max at 25°C, and it remains below 250 pA over the full military temperature range. These characteristics let you use the OP-97 without external offset adjustments in the majority of applications. The device's 25-μV offset voltage and



0.6-μV/°C drift, combined with its low bias current and improved common-mode rejection (114 dB), practically eliminate the op amp as a contributor to system error.

The OP-97's guaranteed noise specs (at 10 Hz) are <30 nV/$\sqrt{\text{Hz}}$. At 1 kHz, the noise drops to 22 nV/$\sqrt{\text{Hz}}$ max; at 10 kHz, the typical noise level is 17 nV/$\sqrt{\text{Hz}}$.

Suitable for battery-powered equipment, the OP-97 is characterized for use with supply voltages from ±2 to ±20V. Its power-supply-rejection spec is 114 dB. The OP-97 is available in 8-lead, TO-99 metal cans and in ceramic and plastic miniature DIPs. Prices start at $2.50 (100) for an OP-97 in a plastic miniature DIP for use over the industrial temperature range.

Precision Monolithics Inc, 1500 Space Park Dr, Box 58020, Santa Clara, CA 95052. Phone (408) 727-9222. TWX 310-371-9541.

Circle No 591

New low price

Score a Whole In One

Score the MS-DOS-Compatible System On a Chip from NEC

Now you can score on your next round of systems designs *and* parlay your MS-DOS investment. Simply use our CMOS V25™ Whole in One™ — the new 16-bit microcomputer on a chip from NEC.

It lets you tee off with features like a 16-bit ALU, two full-duplex UARTs, true STOP and HALT modes, and a whole lot more.

The result is a master performance with a two-cycle data bus (250 ns minimum information transfer time) and ultra-high-speed interrupt service (typically 5 μs).

Keeping score? In direct match play, *EDN* and *Byte* benchmark tests show the V25 clearly higher in performance.

MS-DOS is a trademark of Microsoft Corporation. Whole In One and V25 are trademarks of NEC Electronics Inc.

Really Learn the Score

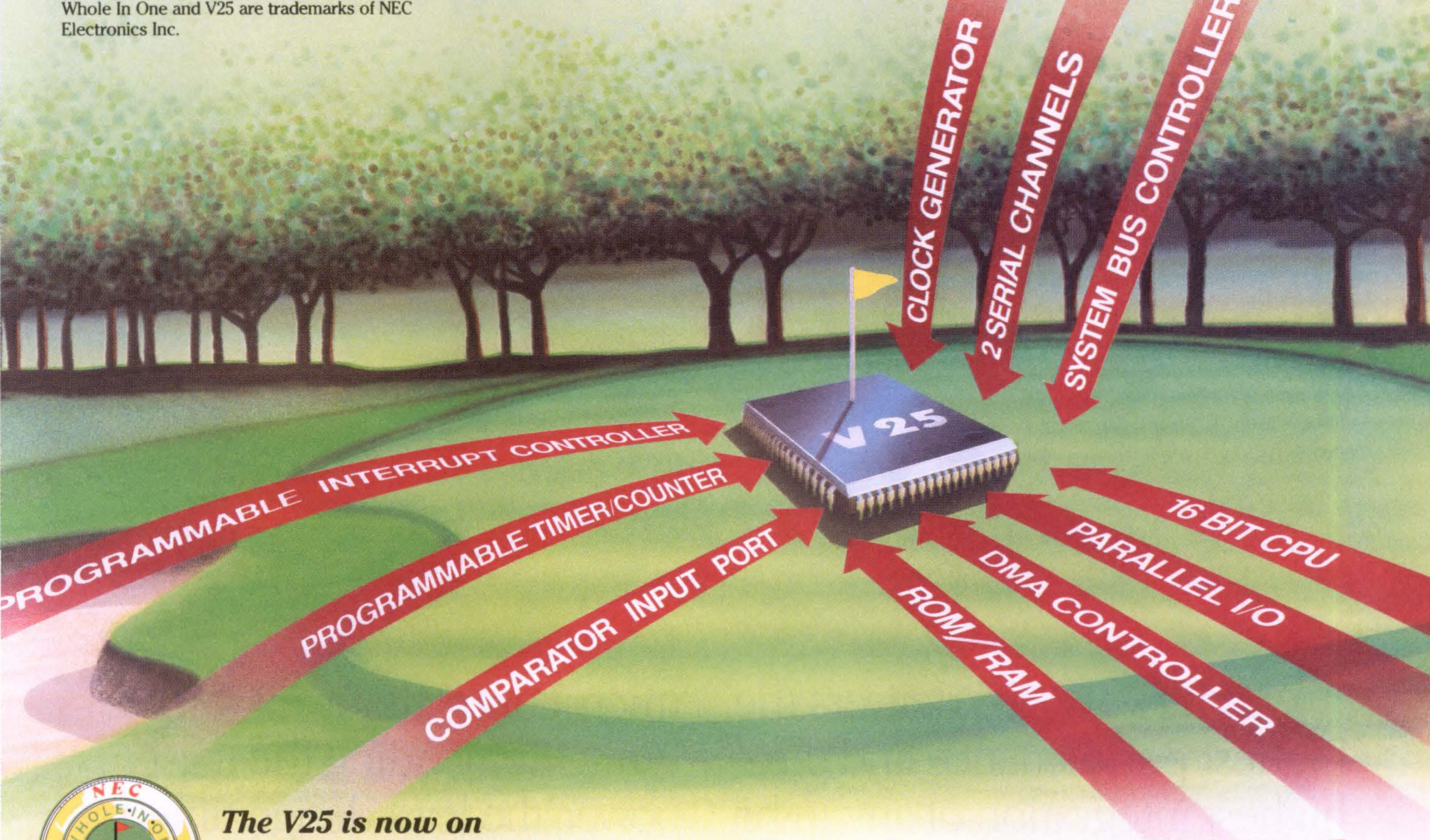
Check out the V25's real strengths. Full support, for one. It's here now with hardware and software tools including EPROM/OTP parts. And you're supported by regional design centers with an increasing number of application engineers.

Stand-alone ICE and PC-based mini-ICE use our relocatable assembler and C compiler to provide powerful development capability for system designers.

Production is another winning shot. The V25 is in full production in multiple fabs with high yields allowing very competitive pricing. Now add NEC's traditional high quality and leadership in CMOS manufacturing for a par-beating system on a chip.

For complete technical documentation and the number of your local Distributor Pro Shop, call 1-800-632-3531. In California, call 1-800-632-3532 and score your own Whole In One: the V25 from NEC.

NEC Electronics Inc.
401 Ellis Street, P.O. Box 7241
Mountain View, CA 94039



The V25 is now on distributor shelves for immediate delivery

NEC

CIRCLE NO 73

least hassle. Which means you can spend more time perfecting the rest of your application.

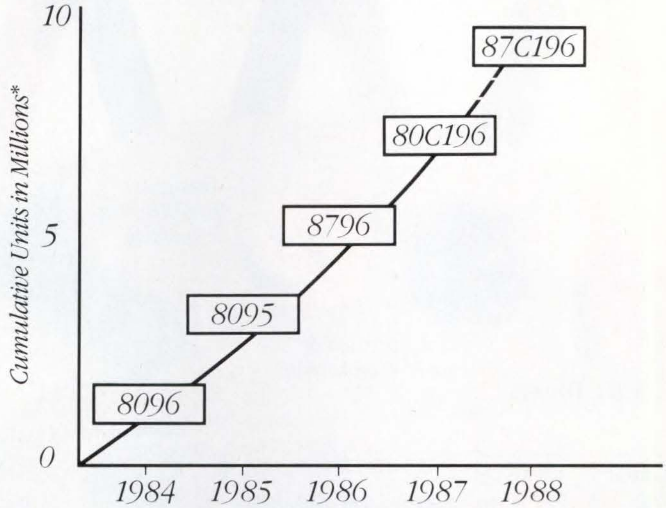
The 12 MHz 80C196 is the latest member of our proven MCS-96 family of embedded controllers. It offers the low-power requirements of CMOS technology while doubling the performance of the 16-bit 8096. Which means that it can perform a 16 x 16 multiply in 2.3 microseconds. That's faster than any other microcontroller.

Yet you still get all the features of the 8096. And more. Resident on the highly-integrated 80C196 are a 16-bit cpu with an 8/16-bit bus (reconfigurable), 256 bytes of RAM, PWM, 10-bit A/D, two 16-bit timer/counters, 40 I/O pins, full duplex serial port, and a high-speed I/O subsystem. And speaking of getting more features in less space, we're working on an EPROM version of the 80C196 for an even easier design path (available Q2 1988).

Our low cost ICE™-196 PC development tool gives you more for less, too. Together with high-level languages like PL/M and C, it delivers the easiest, lowest-cost design support you can get.

Further support is available from the world's largest network of field applications engineers. Plus customer workshops to get you up to speed fast.

8096 FAMILY OF 16-BIT EMBEDDED CONTROLLERS



*Includes proprietary products based on 8096 architecture

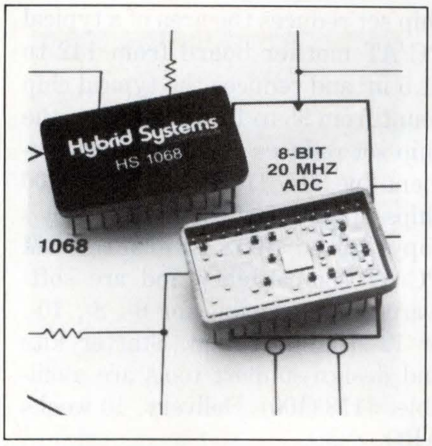
So you see, there's really no easier or more powerful answer to embedded real-time control than Intel's 80C196. For complete technical information, call toll-free (800) 548-4725 and ask for Literature Department W398.

Do it now. And relax.

Because we're ready to meet your demands.

intel®

CIRCLE NO 88



FLASH A/D CONVERTER

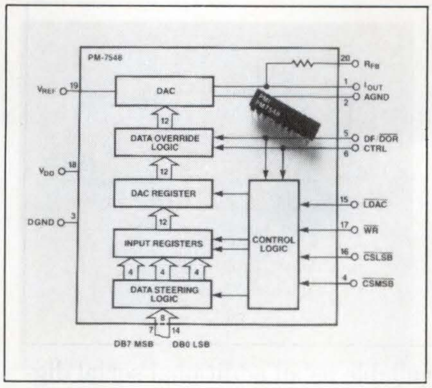
The HS1068 20M-sample/sec, flash A/D converter includes all necessary analog-support circuitry in the package: a wideband input amplifier, a precision 1.2V voltage reference, and a 3-state output register. The 8-bit device comes in a 24-pin DIP that occupies less space than the original 28-pin-DIP TDC1048. You pin-program the converter to accept an input range of either 0 to 1V or ±0.5V, and you can select straight binary, inverted binary, 2's complement, or inverted 2's complement output code. Separate digital outputs flag input overranges at zero and full scale.

Power supplies are 5V and −5.2V, drawing 101 and 207 mA, respectively. Power dissipation is 1.67W. Other key specs are ±½-LSB integral and differential linearity errors, 60-psec aperture time, 2% differential gain, and 1° max differential phase. HS1068C, $295; HS1068B, $375 (100). Delivery, eight to 12 weeks ARO.

Hybrid Systems Corp, 22 Linnell Circle, Suburban Industrial Park, Billerica, MA 01821. Phone (617) 667-8700. TWX 710-347-1575.

Circle No 351

CMOS D/A CONVERTER



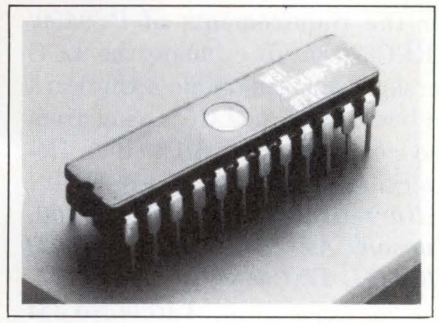
The PM-7548 CMOS D/A converter combines 12-bit resolution with an 8-bit data-bus interface that accepts left- or right-justified data. The digital inputs are buffered; you can update the converter immediately or retain data in the input latches for later use. In addition, a data-override function lets you load the converter with all zeros or all ones without altering data in the input latches. It features ±½-LSB integral and differential linearity error over temperature, ±1-LSB gain error, and 0.03-LSB max zero-scale error.

Compared with the original industry-standard equivalent, the converter offers a 30% reduction in glitch energy, a 30% reduction of input capacitance, and a 20-dB improvement in PSR. The internal voltage regulator ensures TTL compatibility while operating with supply voltages from 5 to 15V. The device comes in two electrical grades for each of the commercial, industrial, and military temperature ranges. From $7.58 to $30.92 (100). Delivery, eight to 10 weeks ARO for the commercial grade; the industrial and military grades are available from stock.

Precision Monolithics Inc, Box 58020, Santa Clara, CA 95052. Phone (408) 727-9222. TWX 310-371-9541.

Circle No 352

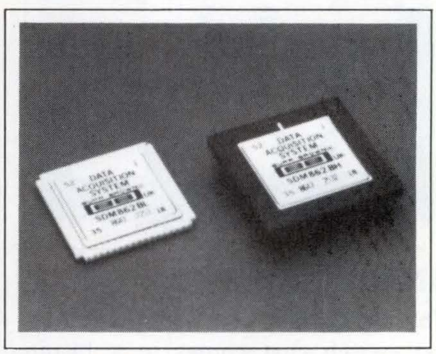
CMOS EPROM



The 35-nsec WS57C49B is the world's fastest 8k×8-bit CMOS EPROM, according to the manufacturer. As a pin-compatible, programmable alternative to bipolar PROMs, the device consumes a fraction (400 mW) of the power bipolar PROMs use. Available in a 35-nsec commercial version or a 45-nsec military version, the EPROM comes in a 300-mil-wide ceramic DIP, a 600-mil-wide DIP, or a 28-pin ceramic LCC. 35-nsec version in a 300-mil ceramic DIP, $29.50 (100).

Waferscale Integration Inc, 47280 Kato Road, Fremont, CA 94528. Phone (415) 656-5400.

Circle No 353



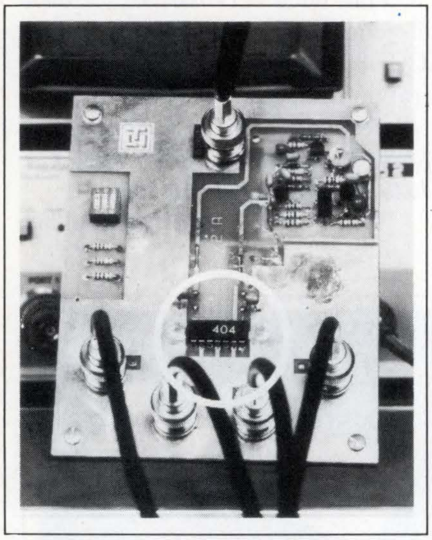
DATA ACQUISITION ICs

The SDM862 and SDM863 are miniature, complete data-acqûisition systems, available either in a 68-lead LCC or a 68-lead pin-grid array. They both include an input multiplexer (the 16-channel, single-ended SDM862 or the 8-channel, differential SDM863); an instrumentation amplifier that is jumper-programmable for gains of 1, 10, and 100; an S/H amplifier; an A/D converter with a µP-compatible interface; and 3-state output buffers.

The throughput rate for both devices is 22.22k samples/sec in the serial mode or 33.33k samples/sec in the overlap mode. Both have input ranges of 0 to 10V, ±5V, and ±10V and come in accuracy grades of 0.024% FSR and 0.012% FSR in the commercial-, industrial-, and military-temperature versions. Both models come in versions qualified for the requirements of BS9450/CECC63000. To evaluate the LCC versions, you can obtain a Eurocard pc board with an LCC socket from the company. From $103 (100). Delivery, stock to eight weeks ARO.

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491.

Circle No 354



ANALOG SWITCH

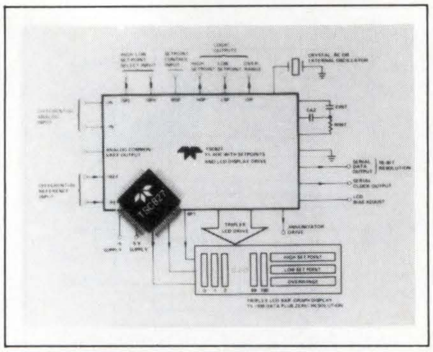
The LR404 is a 4×1 crosspoint analog switch that comes in a 14-pin plastic DIP. The device is suitable for use in video signal-switching matrices; using multiple devices, you can switch many outputs to a common output. The chip provides differential phase and gain of 0.05° and 0.05%, respectively, at 3.58 MHz. Crosstalk amounts to <−77 dB at 10 MHz. $4 (moderate quantities).

Linear Technology Inc, Box 489, Station A, Burlington, Ontario, Canada L7R 3Y3. Phone (416) 632-2996. TLX 0618525.

Circle No 355

A/D CONVERTER

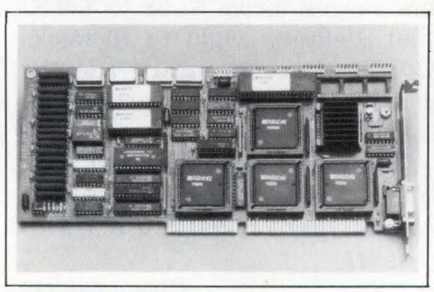
The TSC827 is a CMOS integrating-type A/D converter that includes on-chip drivers for a 101-segment bar-graph LCD. The internal resolution is 1000 counts (±0.1%), and the result of each conversion is



available as an additional serial digital output for use in driving numeric displays. The converter accepts positive inputs with full scale ranging from 0.1 to 2V, and the differential signal and reference inputs simplify the interface to a variety of signal sources. You can use switches or software programming to specify two setpoints; separate annunciators then flag underrange and overrange inputs. The typical conversion rate is 7.5 samples/sec. The device consumes 15 mW and operates from a 9V battery. It comes in a 68-pin PLCC or a 60-pin flatpack. From $10.80 (100).

Teledyne Semiconductor, Box 7267, Mountain View, CA 94039. Phone (415) 968-9241. TWX 910-379-6494.

Circle No 356



CHIP SET

The FE3400 chip set provides PC/AT peripheral-control and CPU functions with only four ICs. Implemented in 2-μm HCMOS technology, the four chips replace eight support ICs, including the 8284 and 82284 clock generators, the 82288 bus controller, two 8237 DMA controllers, two 8259 interrupt controllers, an 8254 timer, and numerous SSI and MSI logic chips. Using the chip set reduces the area of a typical PC/AT mother board from 142 to 21.5 in^2 and reduces the typical chip count from 95 to 19. In addition, the chip set reduces the power requirement by 50% (16W). The FE3400 chips operate under the company's copyrighted BIOS to ensure IBM PC/AT compatibility and are software-programmable for 6-, 8-, 10-, or 12-MHz operation. Starter kits and design-support tools are available. $118 (100). Delivery, 10 weeks ARO.

Faraday Electronics, 749 N Mary Ave, Sunnyvale, CA 94086. Phone (408) 749-1900. TLX 706738.

Circle No 357

QUAD OP AMP

Suitable for use in compact-disk players and other digital-audio systems, the LM837 quad op amp generates less than 0.0015% distortion over a 140-dB dynamic range. The output stage can drive a 600Ω load. The standard pinout (in a 14-pin DIP) lets you upgrade an existing system with few or no design changes. The chip is also available in a molded small-outline package. The monolithic, unity-gain-stable device specs an 8-V/μsec slew rate, a 140-kHz power bandwidth, and a 15-MHz gain-bandwidth product. The input noise voltage is 0.5 μV rms. $1.25 (25,000).

National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 721-5856. TLX 346353.

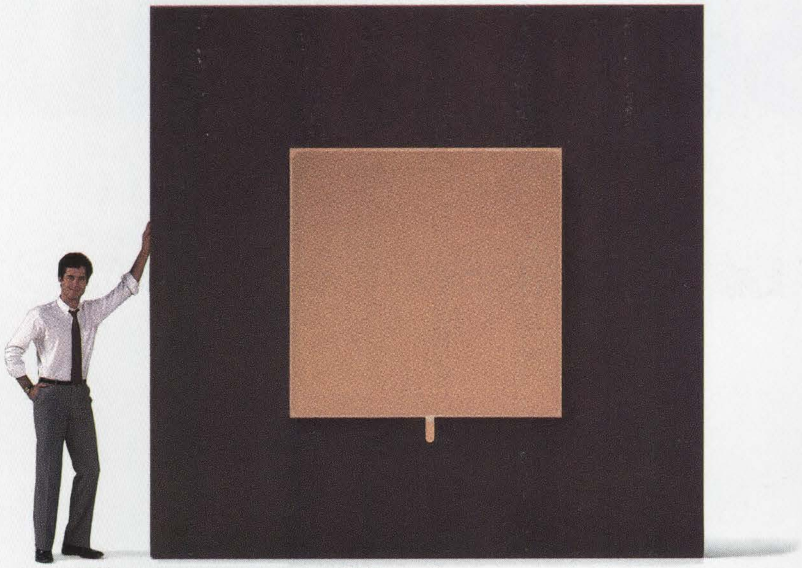
Circle No 358

A/D CONVERTER

Using a 2-pass conversion architecture, the ADC-974 A/D converter accomplishes a 16-bit conversion in 2.5 μsec. The integral-linearity error is guaranteed to ±½ LSB max for resolutions as high as 14 bits. The converter accepts inputs over the ±5V range and produces 2's complement output code. The output is configured as two octal 3-state latches. The offset drift is ±1

Text continued on pg 300

A LOT OF PEOPLE THINK WE ONLY HANDLE GIANT PROJECTS.



The entire state of New Jersey on a chip.

EVEN THOUGH WE OFFER 100,000 GATES, YOU DON'T HAVE TO USE THEM ALL.

It's no wonder people expect big things from LSI Logic.

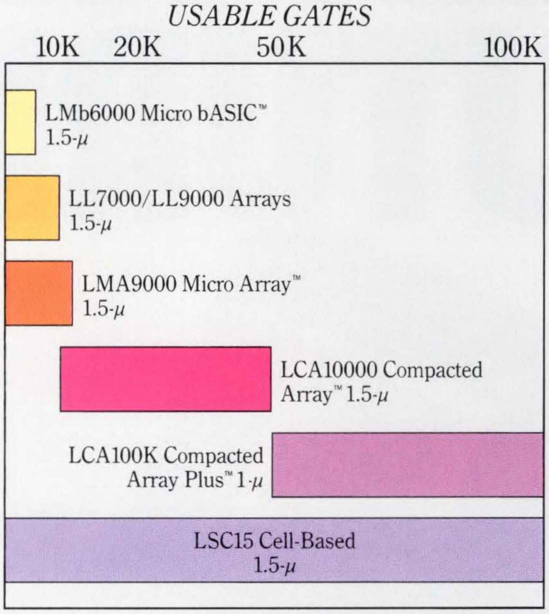
We're the largest HCMOS ASIC company there is.

But that doesn't mean you have to be the largest in your field to come to us.

You just need to be doing ASIC. No matter if it's a few hundred gates or a complete system on a chip. Or even a multi-ASIC system.

It's plain and simple, really: We understand your ASIC might not need 100,000 gates today. But it's good to know it's here when you need it.

To simplify your ASIC design task, we have the largest library available of SSI and MSI building blocks. And more than 400 industry-standard LSI and VLSI building blocks for Channeled and Channel-Free™ Arrays, and Cell-Based designs.



LSI Logic's family of products covers the entire ASIC spectrum.

So whether you need an array or cell-based product, you're covered.

If you change methodologies, you don't have to re-design or change vendors. Or worse, change design tools. Simply, our design tools support both.

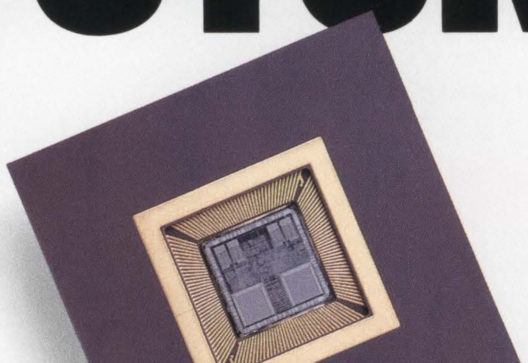
There's something else you won't get anywhere else. Our turnaround for prototypes.

It's only two to three weeks for arrays and five to six weeks for cell-based prototypes. All fully tested and guaranteed to work to your specifications.

If you need your arrays even sooner, we can deliver fully tested prototypes in just seven days. And when cost is an issue, we have a whole range of cost-effective solutions, too.

So don't worry about how big or small your ASIC need is. We're the right size for you.

WE HAVE SEEN THE FUTURE.



Mini on a chip.

AND IT IS VERY TINY.

Saying our new Modular Design Environment (MDE)™ is the most advanced ASIC design software anywhere isn't small talk.

Using MDE, we've already accurately designed and simulated systems with more than two million gates of logic. And that's just for starters.

Our software easily migrates into the latest technology. So your design will always have the highest performance and densities.

MDE is actually comprised of three modules.

The *Logic Integrator*™ is an entry-level module containing the design and simulation tools for building single ASIC chip designs.

The *Silicon Integrator*™ module handles the design and simulation of complex ASICs ranging from a few hundred to 100,000 usable gates. Its Silicon Compilers allow you to automatically develop logic and memory. Your compiled designs, of course, all have complete simulation and test vectors.

MDE's interactive graphics deliver fast, flawless design and simulation.

You can also effortlessly convert PALs to arrays with our Logic Synthesizer.

Our *System Integrator*™ module has mixed-mode behavioral and gate-level simulation capabilities. Use it to design your entire system, including multiple ASICs and standard components.

All with surprising ease and economy. So you can "electronically breadboard" your complete system before going to prototype.

And you can design your ASICs on more platforms than anywhere else. Like all the popular workstation and mainframe environments. Or commercial CAE systems through our CAD Connection Program. Or at one of our 24 Design Resource Centers—the world's largest ASIC support network.

MDE is also tightly coupled to our worldwide manufacturing facilities. Which is why LSI Logic delivers working parts 100% of the time. Guaranteed.

And why you'll see your future a lot sooner with us.

With more than 4,000 working designs under our belt, one clear fact emerges.

Our system works.

That's true whether your needs call for an entry-level gate array or cell-based design. Or for the world's most advanced ASIC-based system.

Whatever direction your designs take, you can always use the same proven software: LSI Logic's MDE.

MDE can be tailored to your specific situation. Just select the appropriate design modules.

We have all the performance you'll need. Such as ECL-like speed in 1 or 1.5-micron HCMOS technology with gate delays of 460 picoseconds. And even more coming soon.

We also have more than 230 package options with up to 299 pins. Including a full range of plastic, ceramic pin grid arrays and chip carriers.

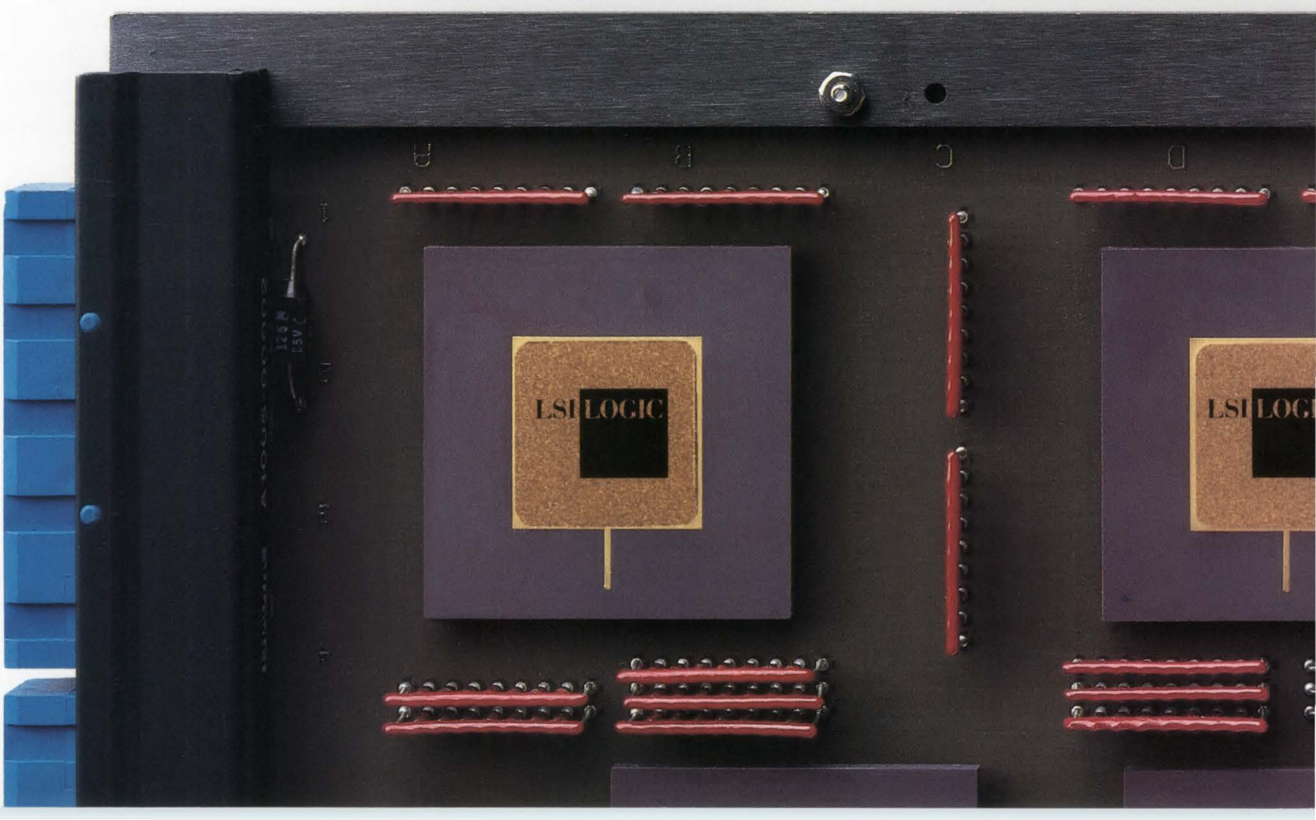
Just as important as our high level of technology is our high level of service. Choose as much as you need. You can design at your own workstation. Or at one of our Design Resource Centers. Or we'll do the entire design for you.

What's most important is that our relationship with you works as well as your device.

We see to it that it does. With an iron-clad guarantee that states that your device must operate precisely as simulated.

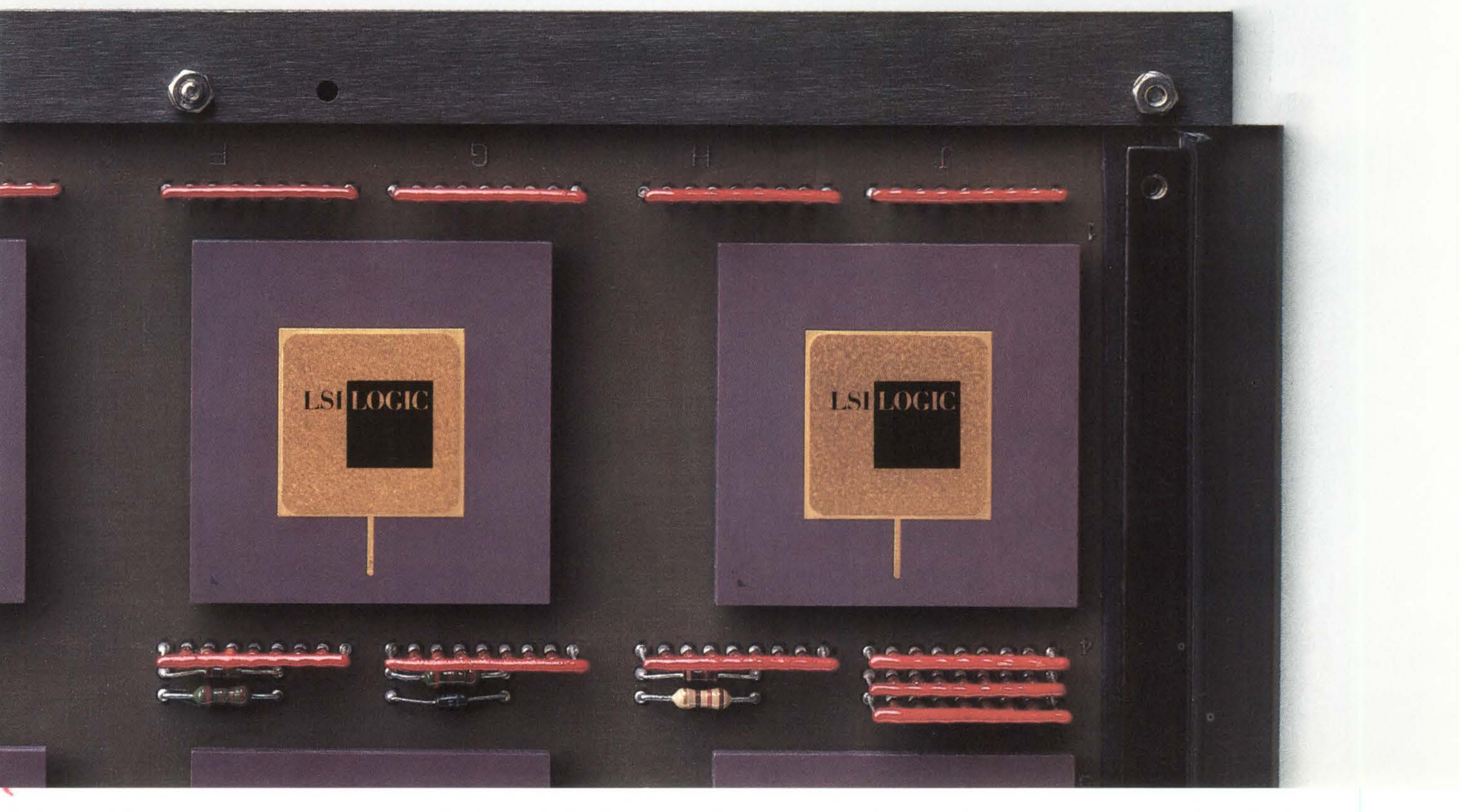
That's our system.

You can't beat it.

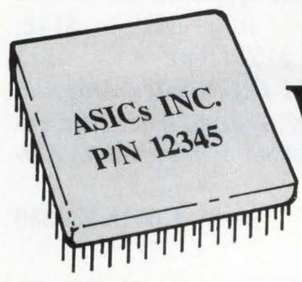


WE HAVE ASIC DOWN TO A SYSTEM.

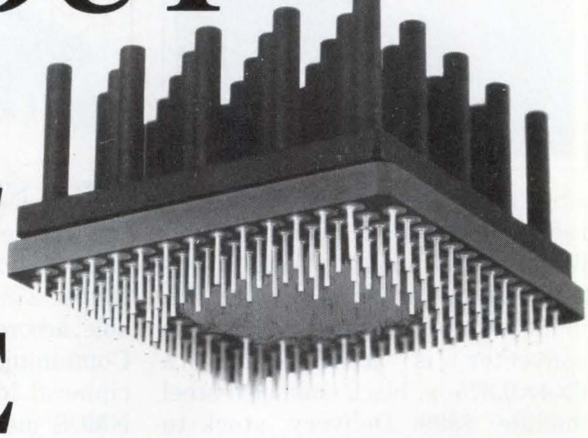
Supercomputer on a board.



BLAZING SPEEDS



WITHOUT THERMAL FAILURE



Blazing speeds in a microprocessor or semi-custom logic chip? Demanding performance requirements for array processors, ASICs, ALUs? Now you can match power demands with an innovative family of high-efficiency, **truly omnidirectional** heat sinks designed specifically for high lead count chips packaged in ceramic pin grid arrays.

The EG&G Wakefield 840 Series (patent pending) Pin Fin heat sinks are ideally suited for natural convection, serial-flow forced convection, and impingement cooling of critical components. The 840 Series utilizes a pedestal base for optimal heat transfer from the heat source — the die itself. The pedestal base will minimize thermal fatigue and cracking of the ceramic substrate with application of an appropriate adhesive to the substrate at the point of contact.

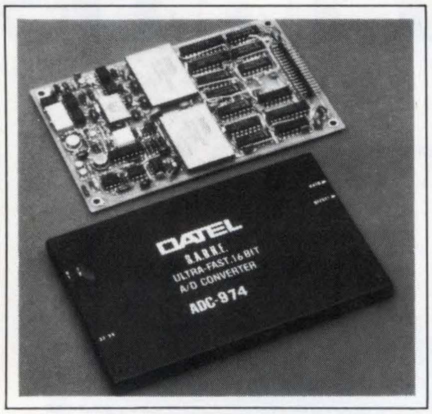
A choice of pin heights allows you to match optimum thermal performance requirements with available board-to-board spacing. Horizontal board mounting? No flat disks or plates in these designs will impede natural convection streams. Round pins optimally spaced in a staggered pattern yield the highest film heat transfer coefficient of any practical heat sink design available. Innovative design allows for clean, burr-free manufacturing and yields the lowest cost per watt dissipated.

If increased speeds in high-density bipolar, ECL, and VLSI MOS designs create junction-to-ambient (θ_{ja}) temperatures that threaten die life and ceramic reliability, call EG&G Wakefield Engineering for innovative solutions from **the** thermal management component company.

EG&G WAKEFIELD ENGINEERING

Components Division
60 AUDUBON ROAD, WAKEFIELD, MA 01880
(617) 245-5900 • TWX: 710-348-6713
FAX: (617) 246-0874

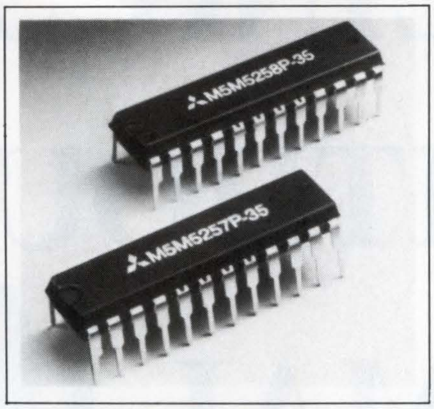
Western Sales Office
3777 RUFFIN ROAD, SAN DIEGO, CA 92123
(619) 279-2253 • TWX: 697938 GAMBI
FAX: (619) 576-9286



LSB (at 14 bits) over 0 to 70°C. The reference-voltage temperature coefficient is ±5 ppm/°C. Supply voltages are ±5 and ±15V; the maximum power dissipation is 8.4W. The converter is packaged in a 6×4×0.375-in. black enameled-steel module. $999. Delivery, stock to eight weeks.

GE/Datel, 11 Cabot Blvd, Mansfield, MA 02048. Phone (617) 339-9341. TWX 710-346-1953.

Circle No 360



CMOS STATIC RAMs

The 35-nsec M5M5257 (256k×1 bit) and M5M5258 (64k×4 bits) are the fastest 256k-bit static RAMs available, according to the manufacturer. Combining silicon-gate CMOS peripheral logic and a high-density NMOS memory array, the devices are suitable for use in cache and main-memory applications. Both chips are also available in 45- and 55-nsec versions. They come in 300-mil, 24-pin plastic DIPs or plastic SOJ (small-outline J) packages for surface-mount applications. 35-nsec M5M5257P in DIP, $142; M5M5258P, $152 (100).

Mitsubishi Electronics America Inc, 1050 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 730-5900.

Circle No 359

MOTOR DRIVER

Housed in an 18-pin plastic DIP, the L6202 motor-driver IC can deliver 70W of power. It has a full H-bridge output and interfaces directly to TTL-level control logic. Operating at a switching frequency of 100 kHz and a junction temperature of 120°C, the driver can deliver continuous rms currents as high as 1.5A at motor supply voltages as high as 54V. The peak nonrepetitive output current limit is 5A. Within this limit, the available output current is limited only by power dissipation.

Six pins on the 18-pin DIP connect to copper traces on the pc board that function as a heat sink. A similar device, the L6203, can deliver as much as 4A rms to provide 250W of motor power. The L6202, $5 (100).

SGS Microelettronica SpA, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 732

SGS Semiconductor Corp, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 361

TELEPHONE IC

The MA534 CMOS loop disconnect dialer IC features an integrated speech circuit that complies fully with BS-6305 and -6317 requirements for class A complex matched telephones. The IC also features a 21-digit last-number-redial memory, a selectable make/break ratio of 2:1 or 3:2, and a selectable interdigit pause of 800 or 400 msec. The dialer can perform earth-loop and timed-break recall, and no dial output is generated if more than one dial-pad key is pressed simultaneously.

All timing is derived from an external, low-cost, 560-kHz ceramic resonator. To compensate for the lower attenuation characteristics of short lines, the device automatically adjusts the gain of its speech circuits so that the volume of received speech is independent of line length. The speech circuits are suitable for dynamic or electret transducers. The MA534 is housed in a 16-pin DIP, and you can power it directly from the telephone line. £3 (100).

Marconi Electronic Devices Ltd, Doddington Rd, Lincoln LN6 3LF, UK. Phone (0522) 688121. TLX 56380.

Circle No 362

Marconi Electronic Devices Inc, 45 Davids Dr, Hauppauge, NY 11788. Phone (516) 231-7710. TLX 275801.

Circle No 363

PS/2 CHIP SET

The 82C100 system-control chip supports 8088/V20 and 8086/V30 microprocessors at speeds to 10 MHz and is targeted for high-performance IBM PS/2 Model 30s, PC/XTs, and compatible computers. It includes a memory controller that supports the Lotus-Intel-Microsoft expanded memory specification and offers power-management features for laptop systems to help reduce battery drain.

The 82C101 chip supports 8088 and V20 8-bit processors. It's aimed at lower-cost PC/XT-compatible computers and terminals and does not include power-management features. The three companion chips are the 82C606 ChipsPak and the 82C605 ChipsPort—both multifunction peripheral controllers—and the 82C764A floppy-disk data separator. 82C100, $51.30; 82C101, $41.10; 82C606, $23.40; 82C605, $17.60; 82C764A, $7.80 (100).

Chips and Technologies Inc, 521 Cottonwood Dr, Milpitas, CA 95035. Phone (408) 434-0600.

Circle No 364

DUAL-PORT RAM

The MK4511 512×9-bit dual-port RAM features independent interrupt outputs for each port, which you can software control via two interrupt registers. Each port, which operates with multiplexed address and data signals, can simultaneously access RAM locations. The RAM is available with access times of 120, 150, or 200 nsec. The MK4511 is supplied in a 28-pin DIP or 28-pin plastic leaded chip carrier. From $9.56 to $12.65 (1000), depending on access-time rating.

Thomson Semiconducteurs, 45 Ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 204780.

Circle No 733

Thomson Components-Mostek Corp, 1310 Electronics Dr, Carrollton, TX 75006. Phone (214) 466-6000. TLX 730643.

Circle No 365

MOSFET DRIVERS

The SG1626 and SG3626 are dual, inverting drivers suitable for driving power MOSFETs and for applications that require digital signals to drive large capacitive loads. The devices' 3A-peak current capability can drive 2500-pF loads in less than 40 nsec. The drivers use high-voltage Schottky logic that converts TTL signals to 18V outputs without driving the outputs deeply into saturation. The package options include 8-pin plastic and ceramic DIPs and 16-pin bat-wing, TO-99, and TO-66 packages. An 8-pin plastic DIP, 0 to 70°C version, $0.90 (10,000). Delivery, 12 weeks ARO.

Silicon General Inc, 11861 Western Ave, Garden Grove, CA 92641. Phone (714) 898-8121. TWX 910-596-1804.

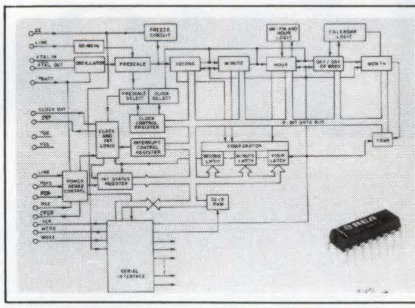
Circle No 366

GATE ARRAYS

The four devices in the BC series of BiCMOS gate arrays offer densities from 430 to 2160 3-input gates. Their propagation delay is 550 psec, and the typical power dissipation is 0.25 mW/gate. The input and output buffers' propagation-delay times are 3.0 and 5.5 nsec, respectively. The BC family offers either 10-mA or 24-mA TTL-compatible output drive; the output buffer's power dissipation is 4 mW at 10 mA and 8 mW at 24 mA. BC400 in a 44-pin PLCC, from $7.85 (1000). Delivery, eight weeks ARO for initial silicon samples; 14 weeks ARO for production quantities.

Fujitsu Microelectronics Inc, 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 727-1700. TWX 910-338-0190.

Circle No 367



CLOCK IC

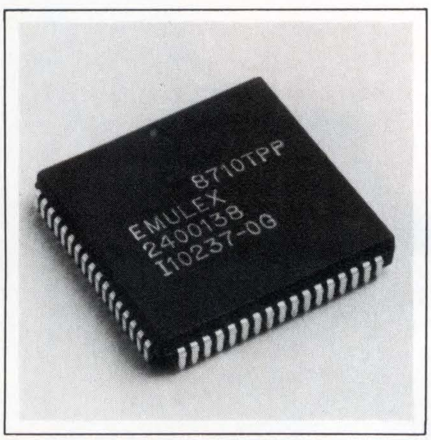
The CDP68HC68T1 is a CMOS real-time clock for μP systems. The monolithic chip indicates seconds, minutes, hours, day of the week, and date. It also lets μC systems implement timer, power up/down, and power-sensing functions. The IC communicates with the μC over the SPI (Serial Peripheral Interface) bus of the 68C05 or 68HC11, or the four I/O-port lines of μCs such as the 1804A, 80C51, and the 65C02. The chip also includes a power-moni-

tor function and a 50-Hz, 60-Hz, or crystal-clock reference.

The chip's 32 bytes of internal static RAM provide parameter storage, computer handshaking, and an interrupt structure. Any one of three internal sources can provide an interrupt: the alarm circuit (seconds, minutes, hours); one of 15 periodic signals (subsecond to daily events); or power failure. The timer functions include a 12- or 24-hour format with an AM/PM indicator. The calendar counters provide day of the week and day/month/year with automatic leap year. The device operates on 3 to 6V; at 2.2V, it can maintain timekeeping functions while drawing 10 μA of supply current. The package options are a 16-lead plastic or ceramic DIP or a 20-lead SO (small-outline) package. Plastic-DIP version, $3.16 (100).

GE/RCA Solid State, Box 2900, Somerville, NJ 08876. Phone (201) 685-6771.

INQUIRE DIRECT

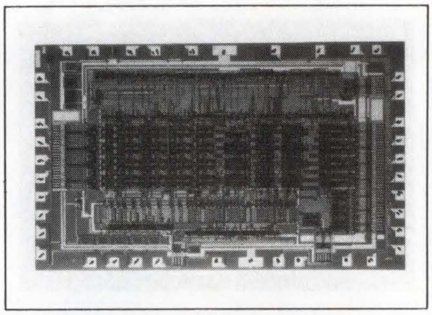


SCSI PROCESSOR

The ESP chip is a VLSI device that implements the communications protocol of the SCSI bus. As a host adapter embedded on a CPU mother board or as a controller embedded with drive electronics, the chip replaces existing discrete devices, external drivers, and any earlier SCSI-interface chip. It features a dual-ranked command and transfer counter; bus sequences implemented without μP intervention; a 16-byte FIFO memory; single-ended, 48-mA bus transceivers; and a sustained transfer rate of 3M bytes/sec (asynchronous) or 4.8M bytes/sec (synchronous). It comes in a 68-pin PLCC. $25 (1000).

Emulex Corp, Box 6725, Costa Mesa, CA 92626. Phone (800) 368-5393; in CA, (714) 662-5600.

Circle No 368



INTERFACE ADAPTER

The monolithic CMOS R65NC22 provides 68000-based systems with two 16-bit counters, one serial bidirectional port, and two 8-bit bidirectional parallel I/O ports. Other features include 5V operation, TTL-compatible control lines, an expanded handshake capability that allows positive control of data transfers between the processor and peripheral devices, and latched input and output registers on both I/O ports. Commercial- and industrial-temperature versions are available in a 40-pin plastic or ceramic DIP or a 44-pin PLCC. Including a 5-year warranty, $5.20 (1000).

Rockwell International Corp, Box C, Newport Beach, CA 92658. Phone (714) 833-4700.

Circle No 369

FIFO MEMORIES

The SSL7401-SSL7404 family comprises four BiCMOS FIFO memories that are suitable for use in high-speed communications and controller applications, as buffers between digital systems with widely differing bit rates, and as A/D-converter buffers. All parts offer a 50-MHz throughput rate, a 15-nsec data-access time, a 2-nsec data-setup time, and a 1-nsec data-hold time. Each device is expandable in width and depth and conforms to industry-standard pin configurations: SSL7401, 64×4 bits in a 16-pin DIP; SSL7402, 64×5 bits in an 18-pin DIP; SSL7403, 64×4 bits with output enable in a 16-pin DIP; and SSL7404, 64×5 bits with output enable in an 18-pin DIP. Products come graded for 10-, 15-, 25-, 40-, or 50-MHz operation. 50-MHz SSL7401, $68.18 (100).

Saratoga Semiconductor, 10500 Ridgeview Ct, Cupertino, CA 95014. Phone (408) 864-0500.

Circle No 370

QUAD POWER DRIVER

Combining NAND logic gates and high-current bipolar outputs, the UDN-2540B power and relay driver provides an interface between low-level signal-processing circuits and power loads to 350W. In the On state, each of the four independent outputs can sink as much as 1.5A. In the Off state, the drivers can withstand at least 60V. Internal clamp diodes and a minimum 35V sustaining voltage allow the use of these drivers with many inductive loads. Applications include relay and solenoid drivers and dc stepping-motor drivers. $0.97 (1000). Delivery, eight to 12 weeks ARO.

Sprague Electric Co, Box 9102, Mansfield, MA 02048. Phone (617) 853-5000.

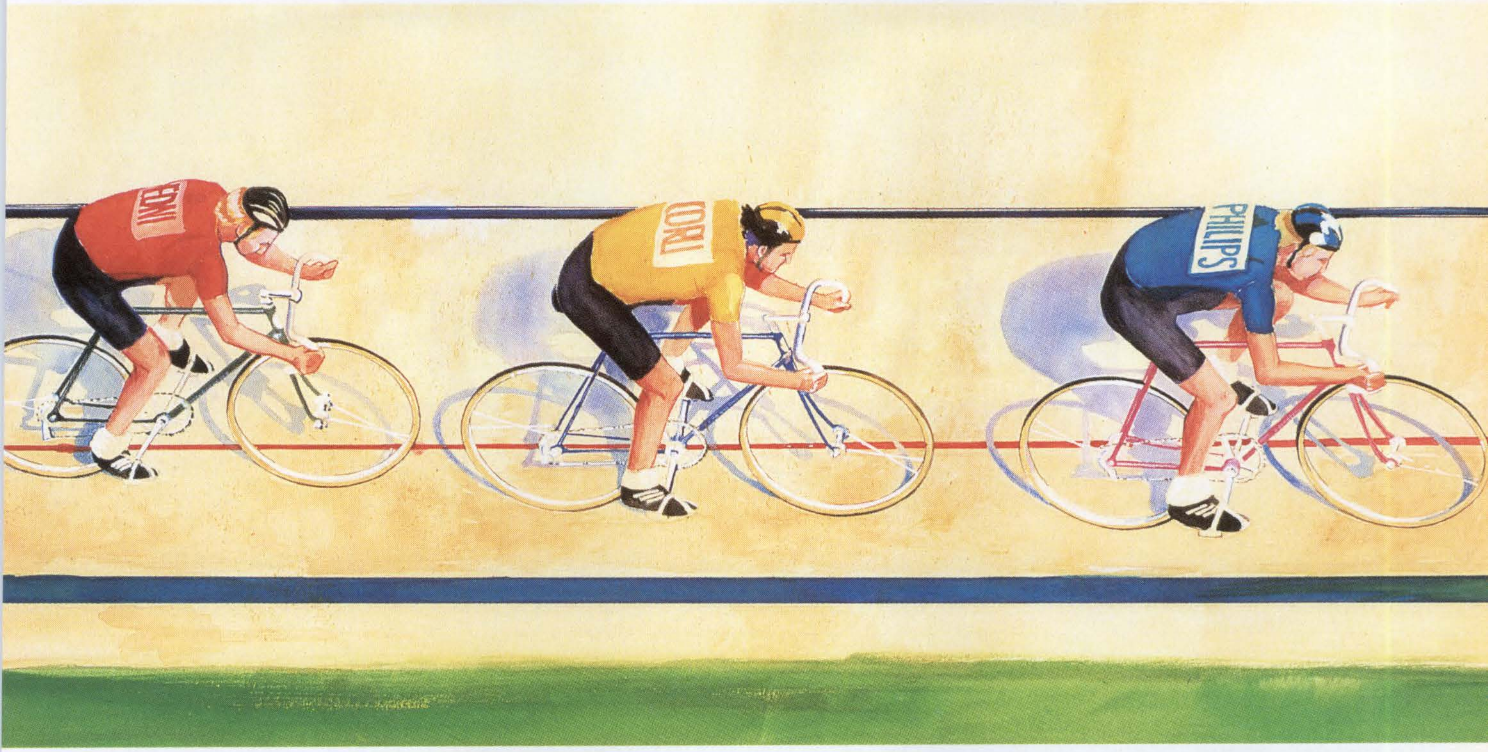
Circle No 373

FM RECEIVER

A narrowband-FM, dual-conversion low-voltage (2V) receiver, the MC3362 IC incorporates all essential VHF-receiver functions from the antenna input to the audio preamp output. The chip handles RF inputs as high as 180 MHz, or over 400 MHz if you provide the first local-oscillator signal externally. It consumes between 6 and 35 mW and features dual-conversion circuitry, a

Text continued on pg 309

PHILIPS IR LED'S SPEED AND ENDURANCE



INTRODUCING THE FASTEST, LONGEST LASTING INFRARED LED EVER MADE.

Still going strong after 10,000 hours. Philips brings you the world's first infrared LEDs based on a single heterojunction gallium aluminum arsenide technology. A new technology that allows them to operate at 80% of their initial intensity after 10,000 hours of continuous operation. When you get that kind of longevity in your remote controls, why settle for anything less?

New technological advantages; Faster response (50ns). Complementary technology for use with existing circuits. Ability to operate at low and high currents makes them well suited to carrier frequencies up to 1MHz. 830nm emission wavelength for standard photodiodes and transistors, 740nm for integrated photoreceivers. Available in 3mm, 5mm and flat pack packages. In stock now.

GET THE JUMP ON YOUR COMPETITION

Call (401) 232-0500, ext. 267 or write for information on how to obtain free product samples and specifications on our new heterojunction GaAlAs infrared LEDs. EDN 121087

Name__________

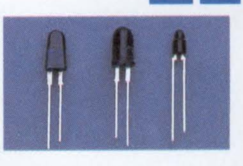
Title__________

Company__________

Address__________

City__________ State_____ Zip_____

Telephone/ext.__________



Amperex®
A NORTH AMERICAN PHILIPS COMPANY

OPTOELECTRONIC PRODUCTS GROUP
PHILIPS

Amperex Electronic Corporation, George Washington Highway, Smithfield, RI 02917, (401) 232-0500.
In Canada: Philips Electronics Ltd., 601 Milner Ave., Scarborough, Ontario M1B 1M8, (416) 292-5161

Our new X.25 Link Level Controller opens new lines of communications.

Announcing the MK5025 X.25 Link Level Controller, the CMOS device that provides complete Link Level data communications control in a single-chip. Our monolithic design saves you months of programming time and valuable board space.

Fluent in X.25 LAPB, ISDN LAPD, X.32, and X.75, the MK5025 also features a transparent mode making it compatible with other HDLC protocols. And it can be used with virtually all of the popular 8 and 16-bit microprocessors.

At up to a 7 Mbs transfer data rate, it's one of the fastest controllers available, performing in systems clocked up to 10MHz. Internal DMA and buffer control of independent receive and transmit memory rings provide high-speed data packet transfers. And for quicker diagnostics in complicated systems, 25% of the MK5025 ROM code is dedicated to a BIST (built-in self test) feature.

Available in a 48-pin DIP, the MK5025 shares a similar pin-out with our Ethernet controller, making future design for both LAN and wide area network implementations easy. In addition, a 52 PLCC package is planned.

So if you have a data communications control project you'd like to simplify – from central office and packet switching to PBX and point-to-point communications – call us at 214/466-6316. Or write SGS-Thomson, 1310 Electronics Drive, Carrollton, Texas 75006, MS2205.

U.S. and Canadian Sales Offices

Western Area:

Santa Clara, CA
408/970-8585

Irvine, CA
714/250-0455

Woodland Hills, CA
818/887-1010

Seattle, WA
206/632-0245

Longmont, CO
303/449-9000

Tigard, OR
503/620-5517

Eastern Area:

Burlington, MA
617/273-3310

Marlton, NJ
609/596-9200

Huntsville, AL
205/830-9036

Poughkeepsie, NY
914/454-8813

Dublin, OH
614/761-0676

Norcross, GA
404/447-8386

Central Area:

Carrollton, TX
214/466-8844

Schaumburg, IL
312/397-6550

Austin, TX
512/451-4061

Canada:

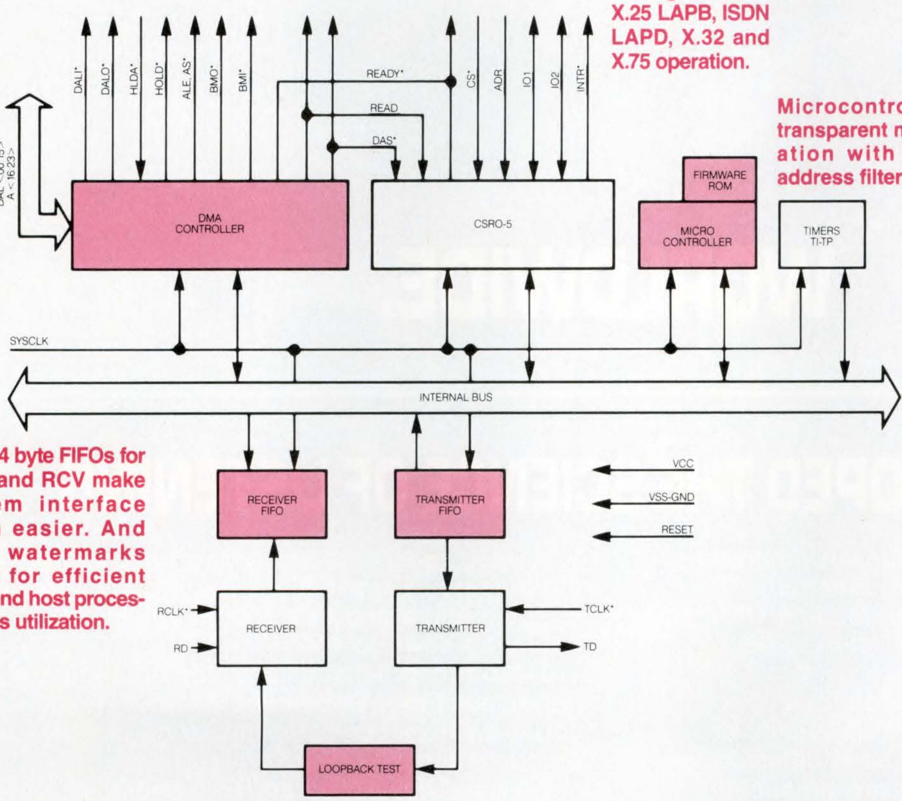
Brampton, Ontario
416/454-5252

Western Canada
503/620-5517

DMA and Buffer Management takes the load off the host CPU and software engineering staff.

On-chip ROM is configured for X.25 LAPB, ISDN LAPD, X.32 and X.75 operation.

Microcontroller allows transparent mode of operation with or without address filtering.



Dual 64 byte FIFOs for XMIT and RCV make system interface much easier. And FIFO watermarks make for efficient DMA and host processor bus utilization.

Three loop back features simplify system troubleshooting.

SGS-THOMSON
MICROELECTRONICS

Formerly known as Thomson Components-Mostek Corporation.

CIRCLE NO 166

LEADING MANUFACTURERS RELY ON GENNUM IC's

WORLDWIDE.

WE DEVELOPED THE SCIENCE OF LISTENING

Listening to the needs of our customers has always been our philosophy at Gennum Corporation. That's the reason leading OEM's in Japan and 17 other countries listen to our experts.

For 15 years we have manufactured specialty linear IC's without compromise in quality or service. From masking and silicon diffusion to chip packaging, our products are produced inhouse, allowing us to monitor and maintain our high standards of excellence.

Our lineup of special application products includes high frequency power supply controller IC's, AGC amplifiers and video switches. We are the leaders in applications requiring low power IC's like audio and operational amplifiers operating down to 1.0V.

Custom and semicustom play an important role in our business. Depending on your needs we can draw from our complete range of ASIC products and services.

We have developed an RF monolithic capability for applications up to 500 MHz, including high linearity amplifiers.

We would like to listen to **your** needs. Call or write for our free brochure.

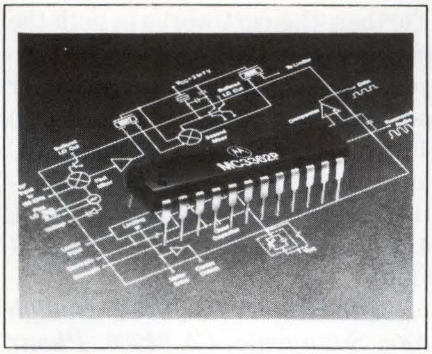
P.O. Box 284
Buffalo, N.Y.
14220
Toll Free: 1-800-263-9353

CIRCLE NO 165

GENNUM
CORPORATION

P.O. Box 489
Station "A"
Burlington, Ontario
Canada L7R 3Y3
(416) 632-2996
Telex: 061-8525
Fax: (416) 632-2055

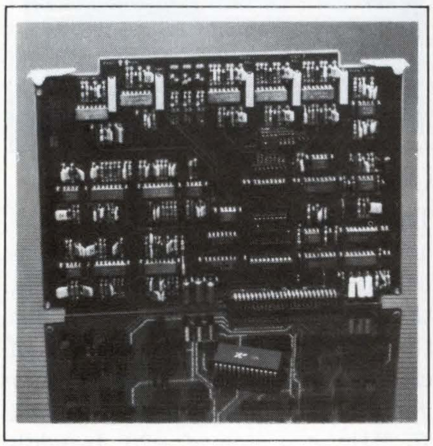
GENNUM CORPORATION IS AN LTI COMPANY



received-signal-strength output, and a data-slicing comparator that allows recovery of FSK data at rates as high as 30k bps. The operating temperature range is −40 to +85°C. $1.80 (100).

Motorola Inc, Box 52073, Phoenix AZ 85072. Phone (602) 897-3842.

Circle No 371



FILTER

You can configure the XR-1020 as one of 10 filters that can characterize telephone lines and other telecommunications links. It conforms to the IEEE standard 743/Bell Systems technical reference 41009 and the CCITT (International Consultative Committee for Telephony and Telegraphy) Series 0 recommendations. The device requires only external 3.579-MHz-crystal and digital control inputs. The repertoire of filter functions includes a C-message and a C-notch filter, a psophometric filter, and an 825-Hz notch filter. The device also functions as a program-weighting filter, 3- and 15-kHz flat filters, a 1-kHz bandpass filter, the lowpass portion of a 50k-bps filter, and a peak-to-average ratio filter. It has a power-down mode for battery-powered operations and comes in a 28-pin ceramic DIP. $63 (100).

Exar Corp, Box 3575, Sunnyvale, CA 94088. Phone (408) 732-7970. TWX 910-339-9233.

Circle No 374

CMOS EEPROMs

The 38C16 (2k×8-bit) and 38C32 (4k×8-bit) CMOS electrically erasable PROMs (EEPROMs) offer 35-nsec access times. This speed matches that of traditional bipolar-type PROMs. The EEPROMs offer low power consumption (350 mW) and in-circuit programmability. The key features include a guaranteed 10k erase/write cycles/byte (1M cycles typical), a 50-msec chip erase, 5V operation, and power up/down protection circuitry. In addition, the chips have data-bar polling, a 20-nsec chip-enable output time, a JEDEC-approved pinout, and a latched timer that allows an automatic byte-erase before write. The 38C16 comes in a 24-pin ceramic DIP, and the 38C32 is available in a 28-pin ceramic DIP. Both models are also available in a 32-pin chip carrier. 38C16, $27; 38C32, $38 (100).

Seeq Technology Inc, 1849 Fortune Dr, San Jose, CA 95131. Phone (408) 432-9550.

Circle No 372

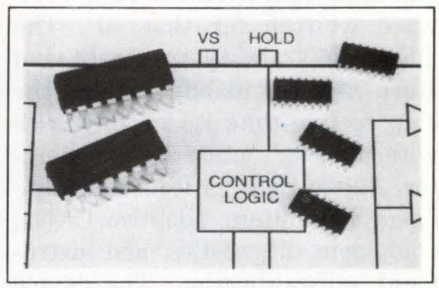
A/D CONVERTER

The ADC1600-2 A/D converter performs a 16-bit conversion in just 2 μsec. Its internal sample/hold amplifier requires another 2 μsec, bringing the conversion time for the combination to 4 μsec max. The separately controlled, byte-wide, 3-state outputs allow interface to an 8- or 16-bit data bus. The package is a 3.576×5.50×0.062-in. module that has EMI shielding on five sides. The device operates with 5V and ±15V

supplies and consumes 7.65W typ. $1120 (100).

Intech Advanced Analog, 2270 Martin Ave, Santa Clara, CA 95050. Phone (408) 988-4930. TWX 910-338-2213.

Circle No 375



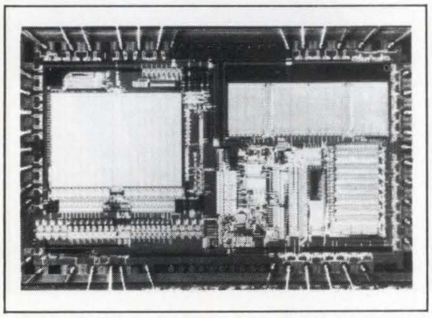
SUPPLY MONITOR

The S2862 power-supply monitor can detect positive or negative transients that appear on any one of the three power-supply voltages it monitors simultaneously. The device contains three window comparators with external resistor-programmable switch points, a 2.5V bandgap reference, a hold comparator, and four open-collector output drivers. All four drivers turn on (low) when the chip detects a fault on any of the three supplies, and they remain low for an interval determined by an external hold capacitor. You can set thresholds within 1.25% of desired values. Available in a 16-pin DIP or SO (small-outline) package, the device operates with supply voltages in the range from 4.3 to 16V. $3.20 (1000).

Siltronics Ltd, 436 Hazeldean

Rd, Kanata, Ontario K2L 1T9, Canada. Phone (613) 836-5003. TLX 0533936.

Circle No 376



DSP EEPROM

The DSP320EE12 is the industry's first monolithic digital-signal-processing μP that includes EEPROM, according to the manufacturer. Operating at 20.5 MHz, the CMOS device is pin compatible with the standard 32010, and it runs software written for that μP. The EEPROM's ability to accept and store new commands enables the chip to fine-tune its performance without intervention by an operator. Applications for it include intelligent FIR filters, adaptive LANs, equipment diagnostics, and instrument self-calibration. The device features an 8- and a 16-bit data interface, special operating modes for improved factory testing, the capability for reprogramming on a standard PROM programmer, and an inhibit circuit that prevents inadvertent data writes during power-up or supply glitches. Security mechanisms prevent unauthorized internal or external access to the EEPROM code. \$100 (100).

General Instrument Microelectronics, 2355 W Chandler Blvd, Chandler, AZ 85226. Phone (602) 963-7373.

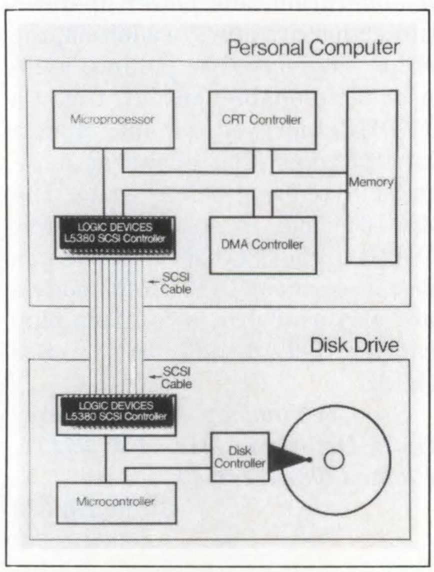
Circle No 377

VIDEO BUFFER

The hybrid LH4002 is a unity-gain buffer amplifier that can drive 50Ω and 75Ω loads at frequencies greater than 200 MHz. The device is suitable for video distribution, for impedance transformation, and for increasing the output-current capability of conventional op amps. Intended for operation with ±5V supplies, the buffer provides a 1000V/μsec min slew rate, 2° phase linearity (from 1 to 20 MHz), and less than 0.1% distortion. The LH4002 is pin compatible with the industry-standard LH0002, and it comes in a 10-pin plastic DIP or an 8-pin TO-5 metal can. The plastic DIP has better heat transfer than the metal can, providing a thermal impedance of 120°C/W (vs 125°C/W for the metal can). MIL-processed versions are available. From \$9.50 (100).

National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 721-5856. TLX 346353.

Circle No 378

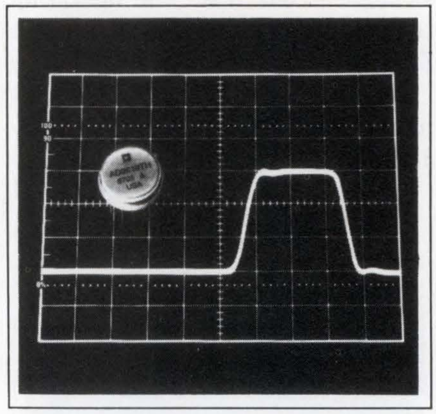


SCSI CONTROLLER

You can directly substitute the L5380 asynchronous SCSI-controller chip for existing devices without modifying your circuit board. Substituting the CMOS part gives you 2.5 times the speed (4M bytes/sec) and one tenth the power dissipation (75 mW typ) of the NMOS device it replaces. The L5380 implements the asynchronous SCSI interface as defined by the ANSI X3T9.2 committee in the X3.131-1986 document. Further, the part works in both the initiator and the target modes, so you can use it in both the computer and the disk drive. It comes in a 40-pin plastic DIP or a 44-pin PLCC and is graded for 2- or 4-MHz operation. 2-MHz version in a DIP, \$8.53; 4-MHz version in a PLCC, \$18.71 (100).

Logic Devices Inc, 628 E Evelyn Ave, Sunnyvale, CA 94086. Phone (408) 720-8630.

Circle No 379



OP AMP

The AD9610 is a hybrid transimpedance op amp. Using current feedback instead of voltage feedback, the amplifier provides bandwidth that is relatively independent of closed-loop gain: 100 MHz at unity gain, 95 MHz at a gain of −10, and 75 MHz at a gain of −20. In addition, different gains have little effect on the op amp's 3.5-nsec rise and fall times, its 18-nsec settling time (to within ±0.1%), and its 3500V/μsec slew rate. Laser trimming reduces the input offset voltage to ±0.3 mV; the V_{OS} drift is 4 μV/°C. The equivalent input noise over the frequency range from 5 to 150 MHz is 0.7 nV/$\sqrt{Hz}$ typ and 23 pA/$\sqrt{Hz}$ typ.

The amplifier has internal frequency compensation and an internal 1.5-kΩ feedback resistor; you add one resistor to set the closed-loop gain. The AD9610 comes in a 12-pin TO-8 metal can, operates with ±15V supplies, and dissipates 630 mW typ. Industrial-tempera-

Harris guarantees ASICs to specs after irradiation! (There — we put it in writing!)

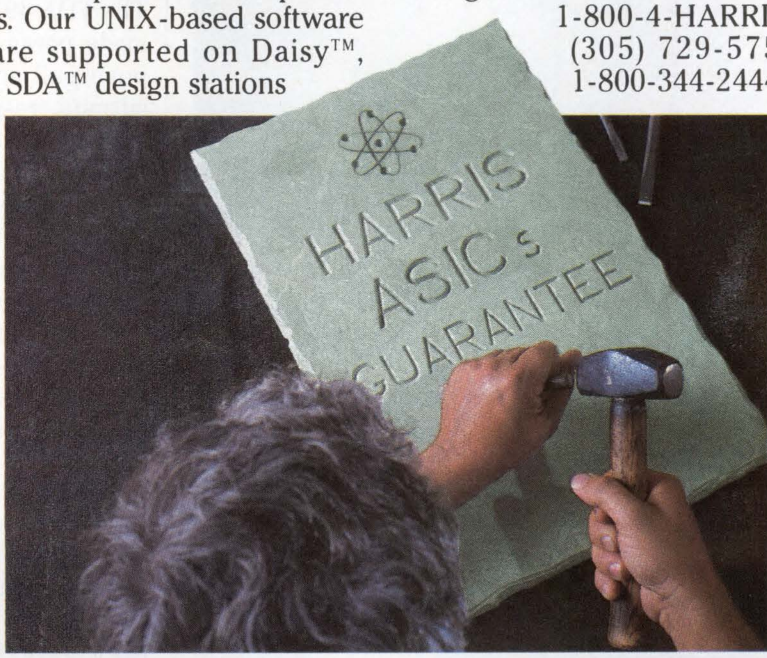
We're hard-liners about reliability in rad-hard ASICs.

Hey...it happens to the best of 'em...your rad-hard ASIC design's first pass requires first aid!

For better results, avoid rigid design systems that lock you into the wrong solution and keep you there. Come to Harris: nobody offers you more front-end flexibility.

- **Advanced rad-hard library...**Primitives, 7400 and 4000 equivalents, 80C86 peripherals — cells and macros you can intermix to enhance design
- **Broad workstation support...**Simulations include both pre- and post-radiation performance models. Our UNIX-based software and library are supported on Daisy™, Mentor™, and SDA™ design stations with Silicon Compilers due soon
- **Guaranteed parametrics...**Harris can guarantee your ASICs to specs **after** irradiation exceeding 1 megarad
- **Packaging options...**Select from ceramic DIPs, chip carriers and pin grid arrays; screenings to Class S standards
- **More on the horizon...**Soon, JEDEC functions and scan-path testability will further enhance your design flexibility

So what does it all mean? More ASIC design options. Less design risk. For a faster time to market, it's time to call Harris Custom Integrated Circuits Division. In U.S. phone 1-800-4-HARRIS, Ext. 1910, or (305) 729-5757. In Canada: 1-800-344-2444, Ext. 1910.



IN RAD-HARD/HI-REL, THE NAME IS

HARRIS

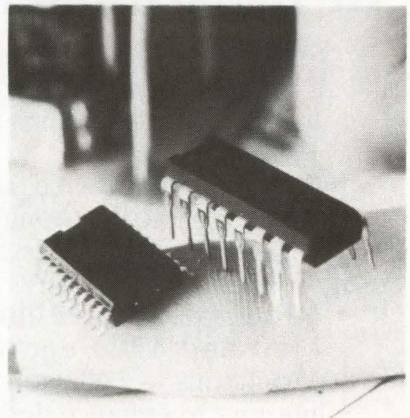
Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS

Trademarks:
Daisy: Daisy Systems Corp.
Mentor: Mentor Graphics
SDA: SDA Systems Inc.

ture version, $49.88; military-temperature version, $79 (100).

Analog Devices Inc, Box 9106, Norwood, MA 02062. Phone (617) 329-4700. TWX 710-394-6577.
Circle No 380



SMPS IC

The TDA-4918 and -4919 are switch-mode power-supply control ICs for push-pull and single-ended driver outputs, respectively. Their output stages are optimized for driving MOSFET power transistors, sinking a current of 1A to turn the MOSFET off, and sourcing 300 mA to turn it on. This asymmetrical drive current helps to match the turn-off and turn-on times of the MOSFET, so that the MOSFET switching is symmetrical, even at clock frequencies as high as 200 kHz.

The ICs have an integral frequency generator that operates to frequencies as high as 300 kHz. In addition, the ICs have three on-chip comparators that monitor the supply's output for overvoltage and undervoltage conditions and provide dynamic current limiting. The ICs also provide soft-start facilities. The maximum supply current to the devices in standby mode is 2 mA. The TDA4918 comes in an 18-pin DIP; the TDA4919 is housed in an SO-20L surface-mount package. $2.50 (1000).

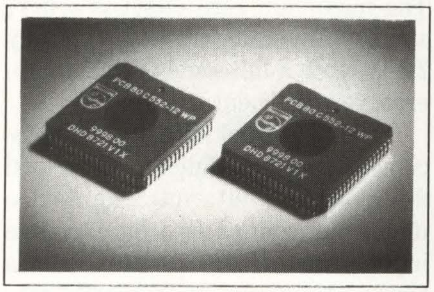
Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone

(089) 2340. TLX 5210025.

Circle No 387

Siemens Components Inc, 2191 Laurelwood Rd, Santa Clara, CA 95054. Phone (408) 980-4500.

Circle No 388



MICROCONTROLLER

In addition to the 80C51's usual on-chip functions, the PCB83C552 CMOS microcontroller includes an 8-channel analog multiplexer, a 10-bit, 50-μsec A/D converter, two PWM outputs, additional parallel I/O ports, an additional timer/counter, and an I²C-bus interface. It retains the 80C51's internal architecture and instruction set.

In total, the microcontroller has six 8-bit parallel I/O ports, several of which function either as conventional I/O ports or as control inputs and outputs for the chip's additional functions. The two PWM outputs have dedicated output pins, and you can control a repetition frequency, common to both outputs, in the range of 92 Hz to 23.5 kHz for a clock frequency of 12 MHz. You can then define the mark/space ratio for each individual output in the 0 to 1 range, with 8-bit resolution. Only simple external filtering is required to derive analog outputs from the PWM outputs. You can arrange for the on-chip timer to automatically set, reset, or toggle certain I/O bits, and to generate interrupts.

The 83C552 has a 15-source, 2-level interrupt structure and incorporates the 80C51 instruction set; a watchdog timer detects program crashes. The microcontroller has an 8k-byte on-chip program ROM and a 256-byte on-chip RAM, both of which are externally expandable to

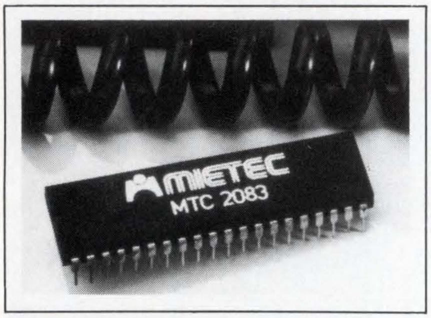
64k bytes. The 83C552 is packaged in a 68-pin plastic leaded-chip carrier. A ROMless version is also available. Approximately DM 26 (10,000).

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 395

Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.

Circle No 396



PHONE ICs

The MTC-2083 telephone IC incorporates a DTMF/pulse repertory dialer that supports on-hook dialing, and speech circuits that provide 4-wire/2-wire conversion and background-noise reduction. It also contains line impedance matching and load/gain regulation circuitry so that it provides all the functions necessary to interface telephone sets with PSTN or PABX networks. The speech circuit incorporates an additional receive amplifier that you can use either to drive a loudspeaker or to increase the receiver gain in phones made for people who are hard of hearing.

For the PABX or central-office end of the line, the MTC-6042 provides a single-chip solution to many of the Borsht functions of the subscriber-line interface. These functions include a high- or low-ohmic-value battery feed, overpower, and 2-wire/4-wire conversion circuitry, and supervisory functions that monitor hook-switch status, ring-trip, and ground-wire conditions. The MTC-6042 also has a driver for relay-operated or electronic ringing-signal injection circuitry. MTC-2083 and MTC-6042, approximately £1.55 and £3, respectively (OEM qty).

Mietec, Westerring 15, B-9700 Oudenaarde, Belgium. Phone (055) 332211. TLX 85739.

Circle No 397

16-BIT μP

Suitable for application in industrial equipment control and office automation, the HD641016 16-bit μP has a RAM-based architecture that joins register and memory storage in a 1k-byte array. The chip's multiple programmable register banks (sixteen 32-bit registers) alleviate the context-switch bottleneck encountered during subroutine jumps and during switching between interrupts. In response to an interrupt, the μP can execute a bank-switch instruction in less than 1 μsec.

It also features a 1k-byte RAM that's used for general-purpose CPU registers and for high-speed data memory; a 4-channel DMA controller; a 16-bit, 2-channel timer; a 2-channel ASCI interface; an interrupt controller with 22 internal interrupt sources; a memory-access controller; and a clock generator. Intended for running C-language programs, the HD641016 is supported by a real-time in-circuit emulator and a complete development and debug system. It comes in an 84-pin PLCC or plastic pin-grid array. $75 for a sample. The IC will be available in the first quarter of 1988.

Hitachi America Ltd, 2210 O'Toole Ave, San Jose, CA 95131. Phone (408) 435-8300. TLX 171581.

Circle No 382

D/A CONVERTER

The ZN559 is a μP-compatible 8-bit D/A converter with an on-chip 2.5V bandgap reference. After a full-scale output change, the output settles to ½ LSB typically within 1.25 μsec. The typical settling time for a 1-LSB output change is 800 nsec. The maximum linearity error is ±1 LSB, and maximum differential nonlinearity is ±¾ LSB, with monotonicity guaranteed over the full operating temperature range. The maximum zero offset is 6 mV, and the full-scale output is typically 2.55V with a full-scale output temperature coefficient of 2 ppm/°C.

On-chip latches with TTL/CMOS-compatible inputs allow you to load 8-bit parallel data into the device under the control of a latch-enable input. The ZN559 operates from a single 5V supply and typically consumes 20 mA of supply current. It's available in a 16-pin DIP that operates over the commercial or military temperature range, or you can order it in an SO-16 surface-mount package that operates over the commercial temperature range. $2.98 (100) for commercial-temperature-range devices.

Ferranti Electronics Ltd, Fields New Rd, Chadderton, Oldham OL9 8NP, UK. Phone 061-624-0515. TLX 668038.

Circle No 391

Ferranti Electric Inc, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200. TLX 6852104.

Circle No 392

GATE ARRAYS

The MAF Series gate arrays employ a 1.2-μm, silicon-gate CMOS technology to achieve typical gate delays of 1 nsec—making the devices suitable as low-power replacements for bipolar PLDs. Gate complexities range from 250 to 1200 gates. Typical power dissipation for the 1000-gate array, operating from a single 5V supply at a clock speed of 10 MHz, is around 250 mW.

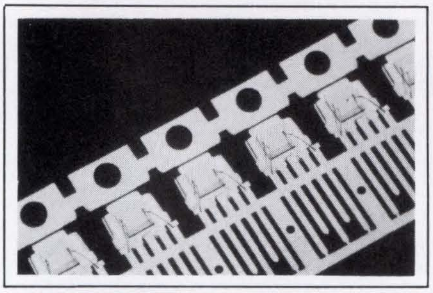
Because they are architecturally the same as the company's MA Series gate arrays, you can use the same design tools and libraries that are supplied for the MA Series. Software that allows you to develop

designs on a range of computers and workstations, including the IBM PC, Daisy workstations, or VAX computers, is available.

The package options include DIP and surface-mount packages, and pin-grid arrays. Packages can have as few as eight or as many as 68 pins. 40-pin plastic DIP, from \$2.30 to \$4.30 (100), depending on gate complexity.

Matra-Harris Semiconducteurs, Centre de Guyancourt, 38 Blvd Paul Cezanne, BP 309, 78054 Saint-Quentin-Yvelines Cedex, France. Phone (1) 30607000. TLX 697317.

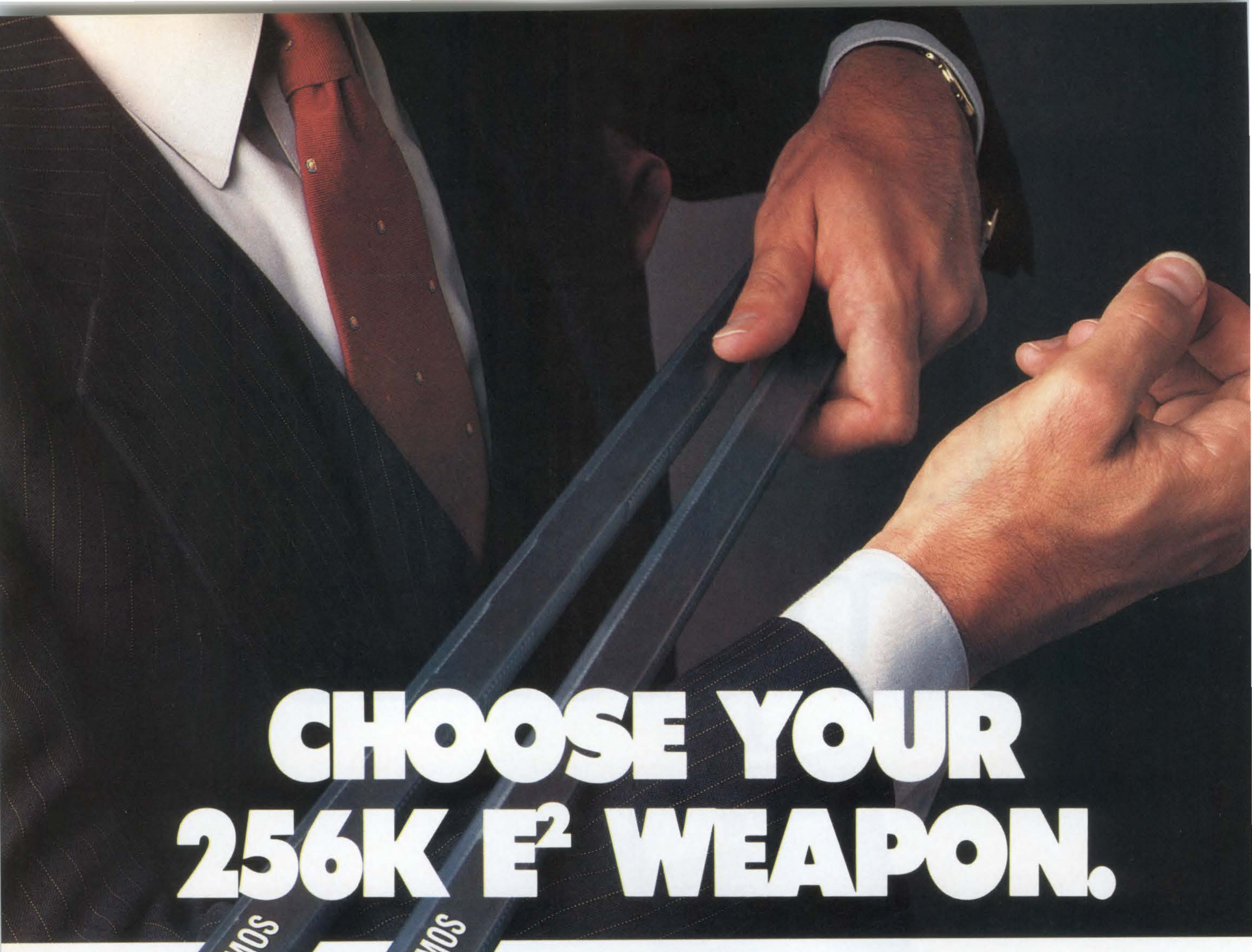
Circle No 398



HIGH-SIDE DRIVER

Targeted at automotive applications, the L9801 high-side driver suits 12V/6A, inductive or resistive load-switching applications where one side of the load is connected to ground. It is manufactured with the company's Multipower-BCD process. The chip incorporates a DMOS power transistor having an R_{ON} of 0.08Ω, and it includes on-chip control, diagnostic, and protection circuitry.

The driver is suitable for lamp switching because it limits the inrush current to 25A, using a linear technique, which does not generate EMI. It has a TTL/CMOS-compatible control input and an open-drain diagnostic output, which is activated when output short-circuit, open-circuit, or overvoltage conditions occur, or when the device goes into thermal shutdown. The L9801 is housed in a 5-lead Pentawatt package with the tab connected to the ground terminal. Approximate-



Don't be foiled when you need both CMOS and NMOS E²PROMs.

If you're designing with high-density E²PROMs, you've just met your match. Because with Xicor's 256K CMOS E²PROMs, now you can more easily match your system's power needs. And with our 256K NMOS E²PROM parts, you can optimize your budget requirements.

Cut design cycles down to size. Compared with alternative solutions, Xicor 256K E²PROMs reduce design complexity and simplify interface tasks. They're full-featured, 5V only nonvolatile devices, ideal for applications where *field reprogrammability* and ease of use are critical. In convenient, byte-wide 32K organizations, these parts deliver effective byte write times of 78 µsec, in 64-byte page mode operation. In addition, $\overline{\text{DATA}}$ Polling or Toggle Bit schemes can be used to detect the early completion of a write cycle.

Safeguard data integrity with Software Data Protection. To prevent inadvertent writing to the device during power-up, power-down or any unexpected condition, Xicor's 256K E²PROMs include Software Data Protection — pioneered by Xicor. *This JEDEC-approved feature eliminates the need for external hardware protection.*

Back your designs with Xicor. Our CMOS and NMOS E²PROMs score extra points for design freedom, too. They're volume-manufactured in JEDEC-approved 28-pin DIPs, and 32-lead LCC or PLCC configurations for surface mounting. Plus they come in commercial, industrial and military temperature ranges. And we back them with onsite technical design support.

So if you're adding up the price and performance of 256K E²PROMs, check with Xicor. We're the only supplier who can help you settle the score — in both CMOS and NMOS. Call (408) 432-8888 today, or write: Xicor, Inc., 851 Buckeye Court, Milpitas, CA 95035.

Xicor®

MAKES IT MEMORABLE

CIRCLE NO 162

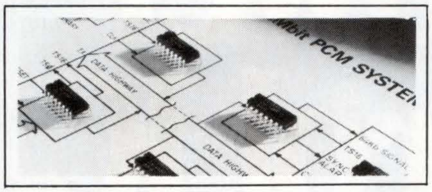
ly \$3 (1000).

SGS Microelettronica SpA, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 399

SGS Semiconductor Corp, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 400



COMM CHIP SET

The ZN1440 chip set performs all the common signaling and error-detecting functions required in a 2.048M-bps, 30-channel PCM transmission link. All the devices conform to the appropriate CCITT recommendations. The ZN1440E simultaneously and asynchronously codes and decodes data to and from the HDB3 format used on the link and detects any coding errors.

At the transmission end of the link, the ZN1444E generates a synchronizing word and injects it into the PCM data highway during time slot 0 of alternate transmission frames. At the receiving end of the link, the ZN1445E detects the frame synchronization word and synchronizes the receiver. It also flags synchronization errors. The ZN1446E operates at either end of the data link, transmitting or receiving signaling information during each frame's time slot 16. It accepts information in either binary or AMI format.

All the devices operate from a single 5V supply, and all their relevant inputs and outputs are TTL compatible. They are available in either ceramic or plastic 16-pin DIPs and are pin and function compatible with corresponding MJ1440 Series devices. ZN1440E, \$6.20; ZN1444E, \$10.18; ZN1445E, \$6.20; ZN1446E, \$7.38 (1000).

Ferranti Electronics Ltd, Fields New Rd, Chadderton, Oldham OL9 8NP, UK. Phone 061-624 0515. TLX 668038.

Circle No 402

Ferranti Electric Inc, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200. TLX 6852104.

Circle No 403

THYRISTORS

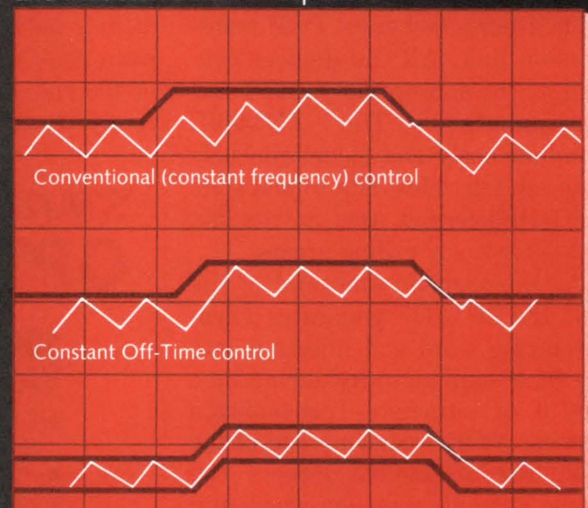
Suitable for use in power-conversion equipment operating at power levels between 10 kW and 1 MW, ZTO (zero turn-off time) thyristors allow you to design high-power choppers and inverters that operate at frequencies in excess of 20 kHz, and resonant converters that operate at 50 kHz or more. The initial offerings include the ZT340 and ZT570, which have peak forward current ratings of 400 and 700A at 20 kHz, respectively. Both devices are available with blocking voltage ratings as high as 1600V. The company plans to extend the range to 2000A/2500V devices in 1988.

ZTO thyristors are gate-assisted turn-off devices that require only small commutation components and simple gate-drive circuitry. The advantages over GTO (gate turn-off) thyristors include a maximum controllable current approximately 10 times greater than that of a similar-sized GTO, and no minimum on-time or off-time requirement In addition, because the anode current falls to zero before the anode voltage starts to increase, turn-off switching losses are small. As a result, you can use ZTO devices at higher frequencies than GTOs. From \$200 to \$300 (1000).

Thomson Semiconducteurs, 43 Ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 204780.

Circle No 401

Introducing The World's Most Advanced Power Supply Control IC.



The CS-320 from Cherry Semiconductor Corporation

The CS-320. A power supply control IC so advanced it is the first to provide for unconditionally stable Hysteretic control.

The CS-320. A power supply control IC so advanced it is the world's first to offer power supply designers the option of working in any one of three modes of control: Hysteretic, Constant-Off-Time or Conventional (constant frequency).

The CS-320. A power supply control IC so advanced it offers better short circuit protection than any other control chip in the world.

Three Types of Control

The CS-320 offers power supply designers greater range and flexibility. While conventional control can be used, Hysteretic and Constant-Off-Time are both superior. Conventional control does **not** instantaneously respond to load current demand. Hysteretic and Constant-Off-Time control, by comparison, **do** provide instantaneous response, which guarantees that the power supply will remain well-controlled and stable.

CSC CHERRY SEMICONDUCTOR

Cherry Semiconductor Corp., 2000 South County Trail, East Greenwich, RI 02818
(401) 885-3600 FAX (401) 885-5786 Telex: WUI6817157

WE'VE REDUCED THE COVER CHARGE ON EPROMS.

Our new plastic One-Time-Programmable CMOS EPROMs hand you ceramic performance at less than two-thirds the cost.

You'll get everything you expect from ceramics except the price. And you'll also get the versatility only plastic delivers.

Because, unlike fragile ceramics, our advanced plastic packages stand up to automated assembly. And you know what that can mean to manufacturing costs. Not to mention system reliability.

Of course, there's also the inherent benefit of OTPs. You can order as many as you want to minimize unit cost, but you only have to program what you need immediately. You can make last-minute code decisions without wasting inventory.

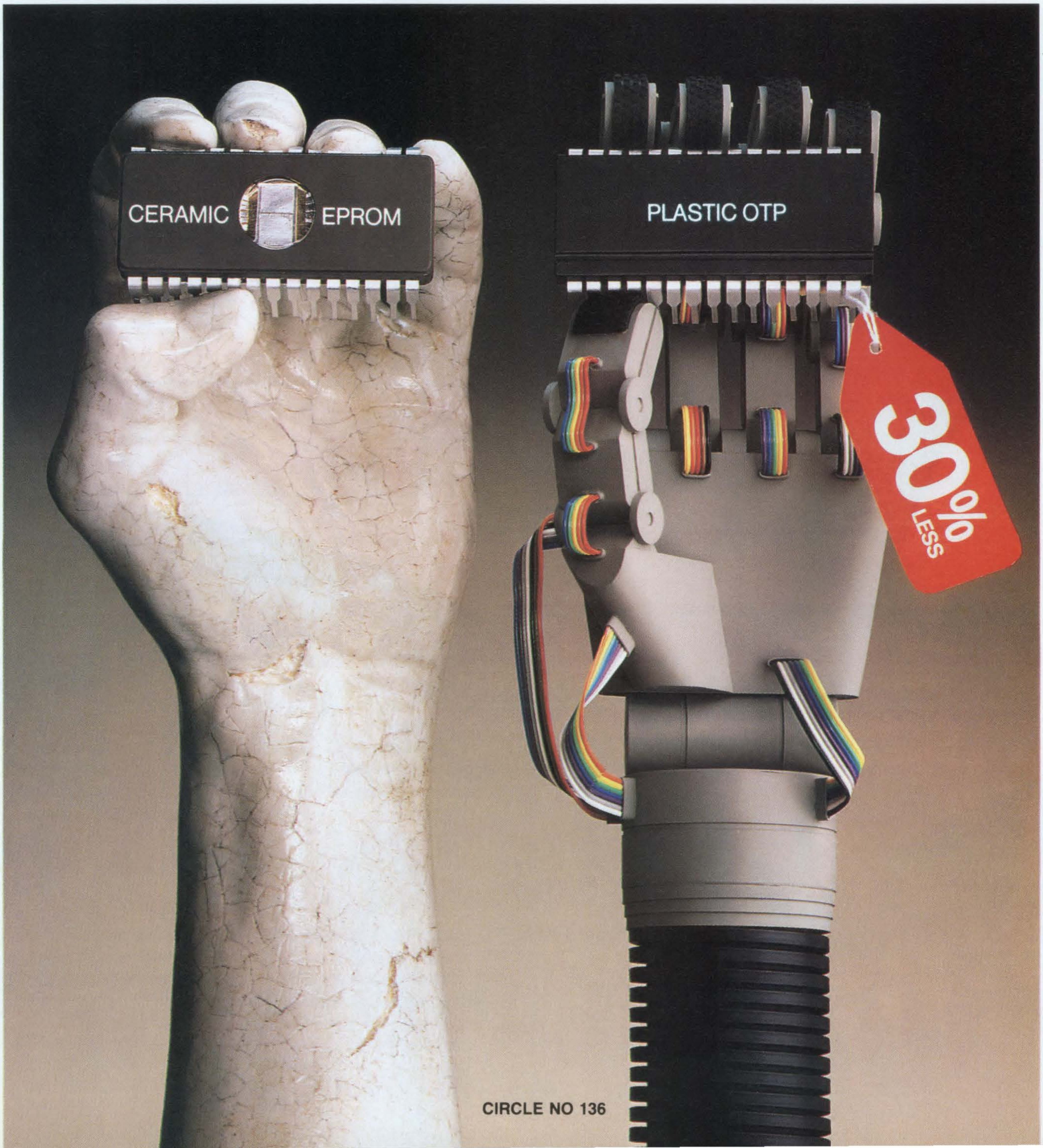
Our plastic OTPs are CMOS, so they run cooler than NMOS ceramics. And, they're available in densities that let you upgrade your system without changing your design: 128K, 256K, 512K, and soon, 1Mb. All 100% pin and plug compatible with the ceramic EPROMs you're using now.

You won't have to sit on your hands waiting for delivery, either. We have plenty available, right off the shelf.

Call our Hot Line today at (800) 556-1234, Ext. 82; in California (800) 441-2345. You'll get great EPROM performance, without being held up for the cover charge.

FUJITSU
FUJITSU MICROELECTRONICS, INC.

Technology That Works.



CIRCLE NO 136

Component Solutions For Your Power System? Talk To VICOR!

INPUT Nominal (Range)	POWER Up to 600 Watts	OUTPUT Nominal (Adjustable)
300 (200-400) VDC		5 (0-5.5) VDC
150 (100-200) VDC		12 (0-13) VDC
72 (55-100) VDC		15 (0-16) VDC
48 (42-60) VDC		24 (0-26) VDC
36 (21-56) VDC		48 (0-52) VDC
24 (21-32) VDC		
12 (10-20) VDC	EFFICIENCY 80-90%	

VI-L00 Series
up to 200W 2.5″ x 4.9″ x 0.62″

VI-M00 Series
up to 400W 4.9″ x 4.9″ x 0.62″

VI-N00 Series
up to 600W 7.3″ x 4.9″ x 0.62″

Call VICOR today for our new Catalog
VICOR Corporation, 23 Frontage Road, Andover, MA 01810
Tel: 617-470-2900, TWX: 910-380-5144, FAX: 617-475-6715

VICOR CORPORATION

CIRCLE NO 160

EDITED BY TARLTON FLEMING

Circuit protects solenoids in dot printer

Emile Hebert
Comtrex Systems Corp, Mount Laurel, NJ

In **Fig 1**, chips IC_1 through IC_4 constitute a drive circuit for seven solenoids of a dot-matrix printer. Following the activation of one or more solenoids, the remaining chips (IC_5 through IC_9) protect the solenoid coils by automatically de-energizing them. (The alternative is software protection, in which the µP de-energizes the coils by asserting an all-zeros control word and another latch pulse.) Fuse F_1 provides backup protection.

During operation, the system writes a control word to the latch IC_1. The latch pulse transfers this word via the buffer IC_2 to the Darlington drivers IC_3 and IC_4, where each high input produces a low output, placing 28V across the corresponding solenoid coil. This voltage must be removed immediately after the coil-actuation time (550 µsec in this case) to avoid heat damage.

A 200-nsec pulse at the CLR input (pin 1) of latch IC_1 deactivates the coils by setting the latch outputs to zero. The circuit generates this pulse as follows:

NOR gates IC_{6A} through IC_{6C} monitor the control lines. The all-lines-low condition prevents the 250-kHz clock signal from reaching counter IC_{9A} by producing a low level at the pin-1 input of gate IC_{7D}. This gate opens when one or more control lines are high, allowing the clock signal to drive the IC_9 counters. Decoder IC_8 issues a 4-µsec pulse 548 µsec later. The leading edge of this pulse produces a 200-nsec pulse that first resets the counters and then resets the IC_1 latch, deactivating the solenoids. **EDN**

To Vote For This Design, Circle No 748

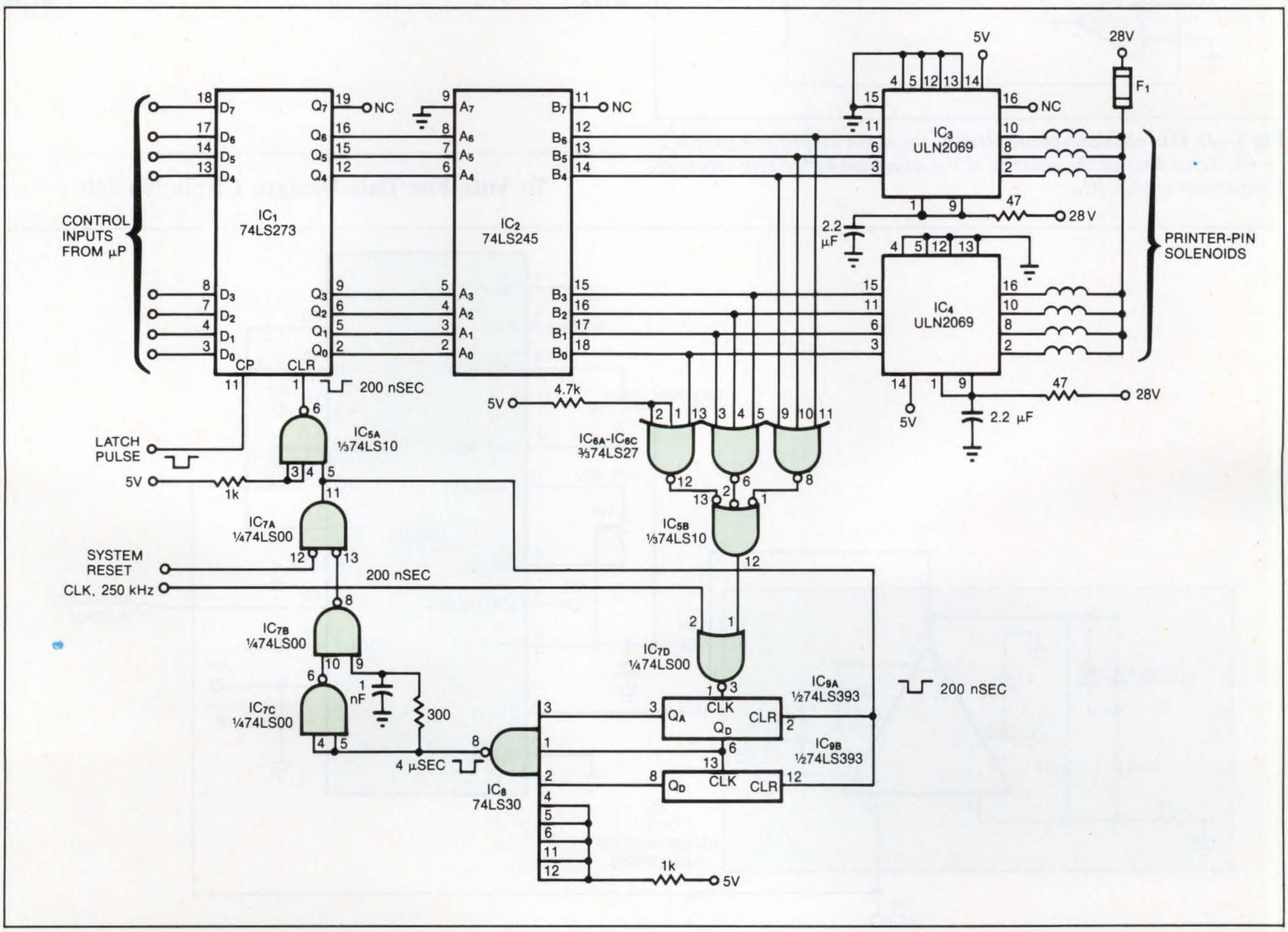


Fig 1—Following a command to activate one or more *solenoids, chips IC_5 through IC_9 first generate the proper coil-activation interval (550 µsec) and then deactivate the coils by producing a 200-nsec pulse that clears latch IC_1.*

Compressed amplifier improves dynamic range

Ralph Lu
Litton Applied Technology, Sunnyvale, CA

You can increase the dynamic range of an absolute-value circuit by adding a preamplifier that reduces the comparator's minimum required overdrive. The basic circuit of **Fig 1**, for example, has a maximum V_{IN} of 5V and a minimum V_{IN} of 1.5 mV, set by the comparator (part of IC_1). The dynamic range is 20log(5V/1.5 mV)=70.5 dB.

In **Fig 2**, the preamplifier (compressed amplifier), IC_2, has a gain of 1.1 for V_{IN} near 5V, and it has a gain of 20 for a small V_{IN}. Thus, a V_{IN} of 80 μV, for instance, produces enough overdrive for the comparator (80 μV×20=1.6 mV), yet a V_{IN} of 5V won't saturate the comparator's input. The resulting dynamic range is 20log(5V/80 μV)=95.9 dB.

The comparator's time error in sensing V_{IN}'s zero crossing increases for smaller amplitudes of V_{IN}. Conversely, the significance of a given comparator error increases with frequency. For the **Fig 2** circuit, dynamic range exceeds 95 dB for input frequencies as high as 1 kHz.

EDN

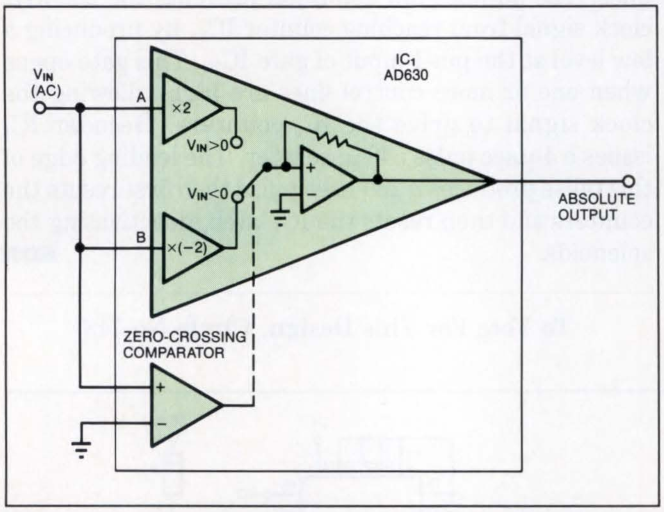


*Fig 1—**In this absolute-value circuit,** the main amplifier's gain is 2 or −2, depending on the polarity of V_{IN} as sensed by the zero-crossing comparator within IC_1.*

To Vote For This Design, Circle No 749

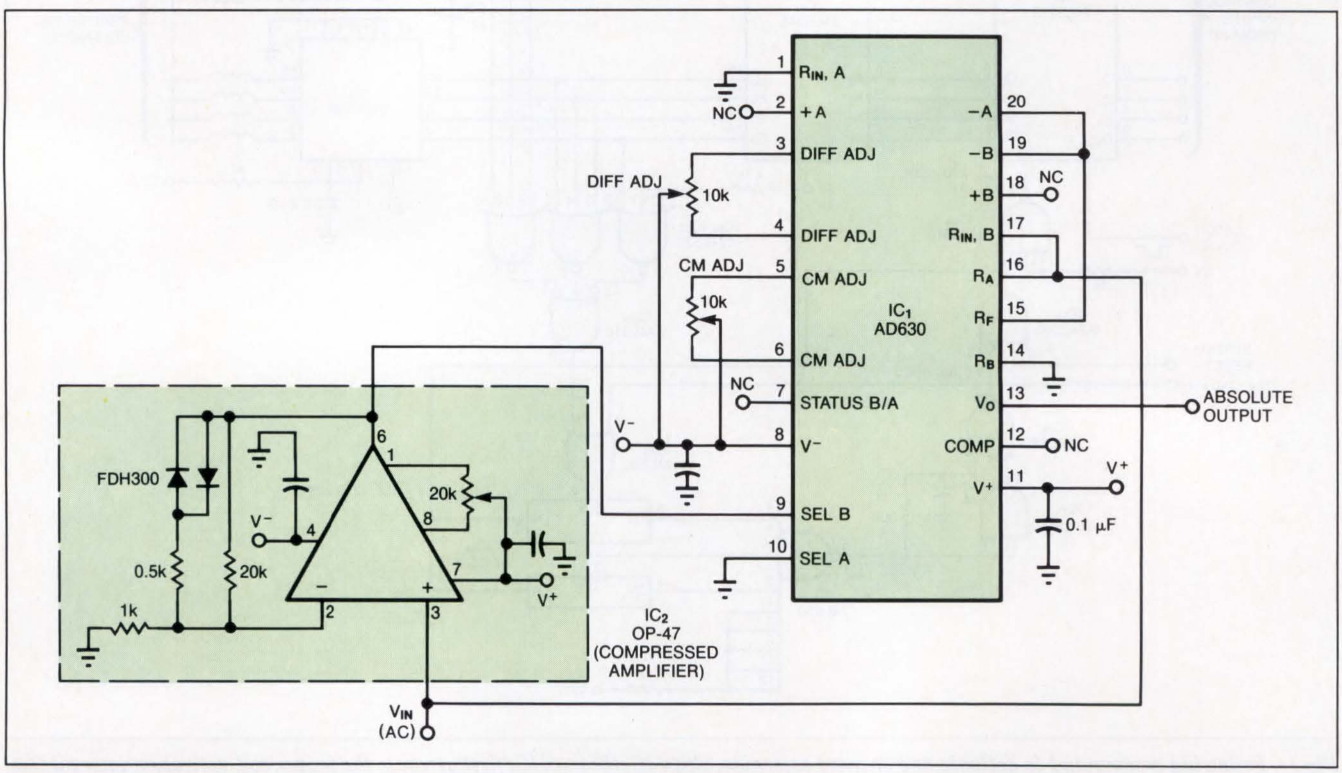


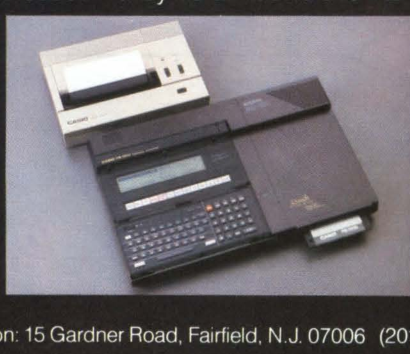
***Fig 2—By amplifying low levels of V_{IN},** this absolute-value circuit's compressed amplifier (IC_2) adds 26 dB to the overall dynamic range.*

Introducing touch-sensitive computer power for the price sensitive.

The Casio PB-1000 hand-held computer. Don't let its size fool you. When it comes to power, the PB-1000 is a real handful—with 8K bytes, in fact, which can be easily expanded to 40K, with an optional RAM pack.

Besides impressive power for its small size, the PB-1000 has an LCD large enough for 32 columns of 4 lines of data. And the screen is touch-sensitive, so you can step through programs and data with the touch of a finger. To that you can add, as a low cost option, a 3.5" floppy disk drive that includes both an RS-232C and printer port. All this has made the PB-1000 the computer of choice for many different professionals.

Business and salespeople, bankers, insurance and real estate brokers, construction engineers, auto dealerships and other small, inventory intensive businesses—they've all found the PB-1000 to be useful for expanding productivity both in the office and in the field. And new applications are being discovered daily.



Let Casio or our VAR network show you how it can be custom-structured with the appropriate hardware and software to suit your requirements exactly. The PB-1000 starts at less than $200. So you can make the most of its handful of power, without having to reach deep into your pockets.

CASIO®
Where miracles never cease

Casio, Inc. Consumer Products Division: 15 Gardner Road, Fairfield, N.J. 07006 (201) 882-1493, Los Angeles (213) 803-3411

CIRCLE NO 155

Amp provides 100V common-mode range

Mark Stitt
Burr-Brown Corp, Tucson, AZ

The unity-gain amplifier of **Fig 1** can reject common-mode voltages as high as 100V. For an application that does not require galvanic isolation, this circuit is an inexpensive alternative to the conventional isolation-amplifier solution.

IC_1 is a monolithic gain-of-10 difference amplifier. By reversing normal connections to the on-chip resistor network, you place 100-kΩ resistors (instead of the 10-kΩ ones) at the amplifier's input, which attenuates the normal- and common-mode signals by a factor of 10. Then, resistors R_1, R_5, and R_6 form a T network in the feedback path that boosts the normal-mode gain to unity.

Because the addition of R_5 and R_6 degrades common-mode rejection by unbalancing the internal resistor ratios, you should restore the balance by adding about 158Ω (R_7) in series with R_3. A fixed-value R_7 that differs by 2% from the T network's equivalent value degrades CMR by only a few dB, but note that IC_1's CMR is already 20 dB below its specified value (100 dB min) because the amplifier is operating at a gain of 0.1 instead of 10. You can improve the CMR by using a 500Ω potentiometer for R_7, as shown.

The differential-gain accuracy is within 2% if you use 1% resistors for R_5 and R_6. Adjusting the R_6/R_5 ratio can improve the gain accuracy, but calibration is difficult because the gain and CMR adjustments interact. You can eliminate this interaction and improve the gain accuracy by using the **Fig 2** circuit.

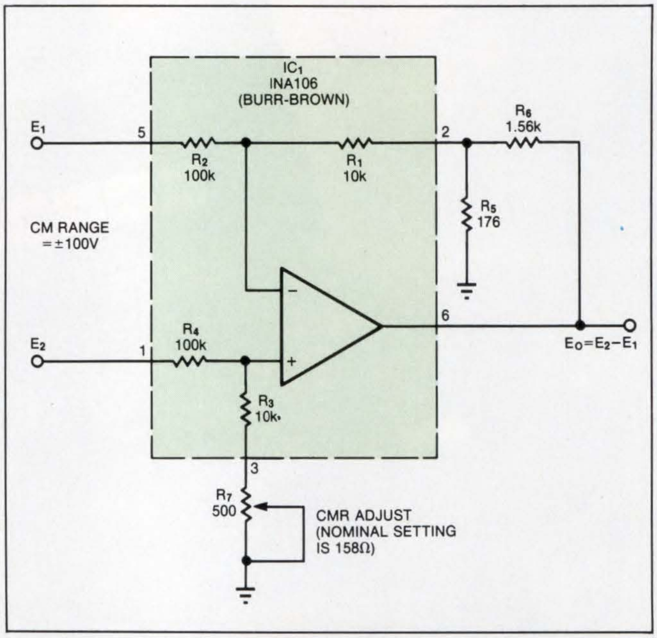


***Fig 1—This amplifier offers unity gain** to E_2-E_1 signals while rejecting common-mode voltages as high as ±100V.*

In **Fig 2**, IC_2 preserves IC_1's CMR by buffering the R_5/R_6 network. Again, IC_1's gain-of-0.1 connection reduces the guaranteed CMR by 20 dB—to 80 dB min. (This CMR estimate is reliable because the IC_1 amplifi-

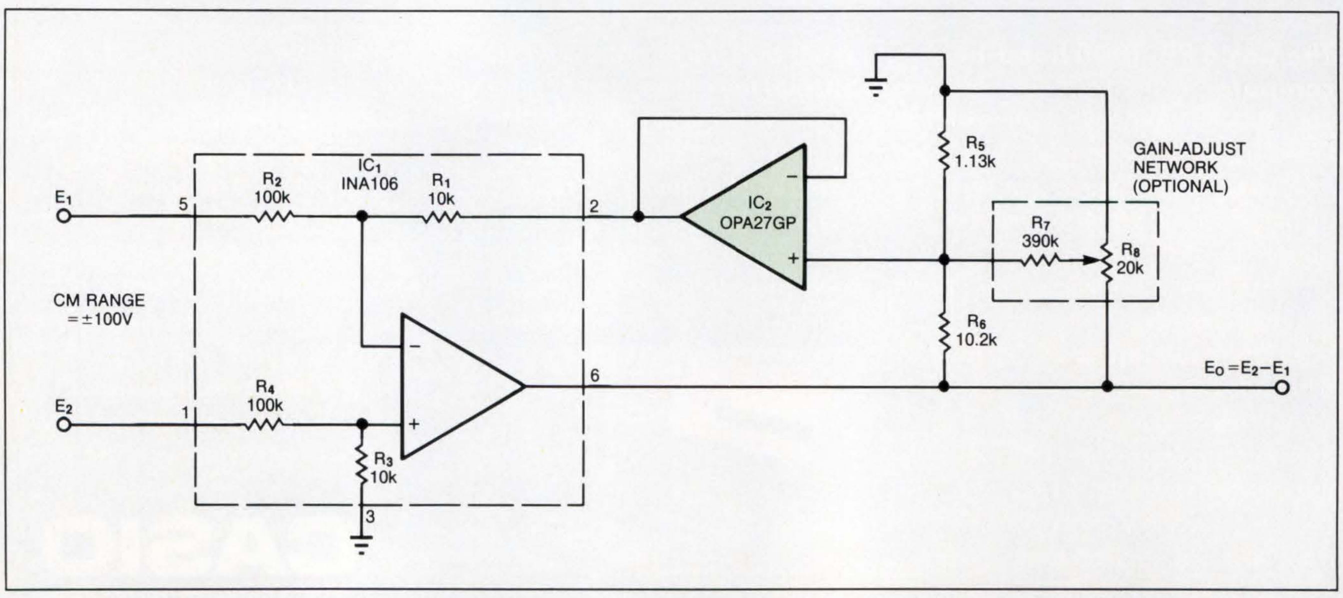


***Fig 2—Adding an op amp to the Fig 1 circuit** eliminates interaction between the gain-adjust potentiometer and the CMR-adjustment pot (not shown).*

This is the only true military power op amp in the world.

Can you afford anything less for your program?

OPA501/883B is a unity-gain stable, high power operational amplifier capable of 260W peak output. It drives heavy loads, including motors, with a wide margin of safety.

Full Military Processing, Fully Certified Lines

A true military hybrid part, like the OPA501, has to be fully compliant with MIL-STD-883, Rev. C, Class B processing. And it has to be manufactured on lines which are DESC certified to MIL-STD-1772. Burr-Brown is the **only** manufacturer of power op amps who currently meets these rigorous requirements, and we hope you won't settle for anything less than the real thing.

Key OPA501/883B Features

- wide ±10V to ±40V supply range
- high ±10A peak output current
- high 260W peak output power
- low 2.2°C/W DC thermal resistance
- full /883C, Class B processing; other processing available, including Class S
- complete test and reliability documentation
- off-the-shelf delivery

If your systems require true military power amps, you can obtain complete details from your Burr-Brown technical rep, or contact Applications Engineering, 602/746-1111. Burr-Brown Corporation, P.O. Box 11400, Tucson, AZ 85734.

BURR-BROWN®

CIRCLE NO 154

SMALL IS POWERFUL!
Power Tronic's new PTS Series Switching Power Modules are the smallest in the world and its compact DC-DC converters can meet the strictest requirements.
What's more, they are reliable due to their innovative design, rigid quality control and powerful production, which makes them versatile enough for all OEM applications.
Power Tronic — For profitable OEM partnership.
NEW POWER SUPPLY
PTS-1010BC
INPUT
OUTPUT
POWER TRONIC CO., LTD.
PTS-10 Servies
Directly mountale on PCB
93×63×14 mm
DC/DC CONVERTER
DC-DC Converters
PTA-4075 DF
PTA-4100 DA
PTA-4135 CF
PTA-4195 CF
PTA-4200 DA
PTA-4200 CF
PTA-3050 DF
Safety Approval:
E 102868
LR 65702
POWER TRONIC CO., LTD
Taipei Office:
11/Fl., 45, Fu Shin S. Rd., Sec. 2,
Taipei, Taiwan, R.O.C.
Tlx: 27001 ZEKIN
Tel: (02)703-5501/5
CIRCLE NO 195

er (distinct from its thin-film resistor network) contributes only −120 dB of CMR error. Therefore, the resistor network is responsible for most of the residual CMR error that remains after laser trimming. This trim error affects CMR by about the same amount whether operating with a gain of 10 or a gain of 0.1.)

You can improve this circuit's CMR by adding 10Ω in series with R_1 (pin 2) and adding a 20Ω potentiometer in series with R_3 (pin 3). To adjust CMR, connect the inputs and drive them with a 1-kHz square wave whose amplitude is in the range from ±10V to ±100V. (A sine wave will introduce unwelcome CMR-vs-frequency effects.) Adjust the 20Ω pot for a minimum-amplitude signal at E_O.

As before, $1+R_6/R_5$ sets the gain. The tolerance on this expression plus ±0.01% (contributed by IC_1) determines the overall gain accuracy. You can improve gain accuracy by using higher-precision resistors or by adding the optional gain-adjust network shown (R_7 and R_8). Gain and CMR adjustments don't interact in the **Fig 2** circuit.

One application for the circuit of **Fig 1** or **Fig 2** is in monitoring high-side load current in a regulator or power supply. By connecting the difference amplifier across a 1Ω resistor in series with the supply's output, you can interpret the difference amplifier's output as one ampere of load current per volt for supply voltages in the range from −100V to 100V. **EDN**

To Vote For This Design, Circle No 750

Multiplexers enhance timer's capabilities

Dan Sporea
Central Institute of Physics, Magurele, Romania

You can use a single 8253 programmable timer to accomplish multiple timing jobs by multiplexing the timer's clock and gate signals and demultiplexing the output **(Fig 1)**. The timing jobs must not overlap.

One or more I/O ports control the multiplexers as shown, allowing the system to optimize timer use by executing various tasks in sequence. Moreover, the demultiplexed timer outputs can drive an interrupt controller that dynamically selects the appropriate servicing subroutines. Different combinations of input clock and gate signals can summon the same subroutine. Or, by selecting different outputs, you can service the same input conditions with different subroutines. **EDN**

To Vote For This Design, Circle No 747

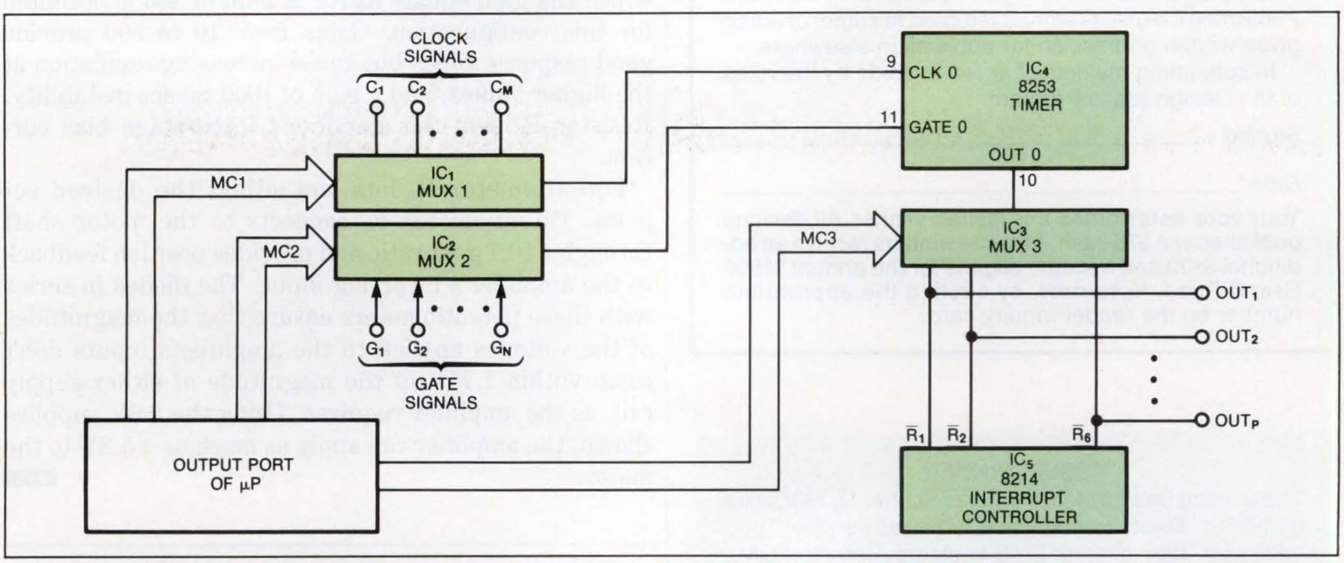


***Fig 1—In this circuit, multiplexers** let you port a single programmable timer (IC_4) from one timing job to the next. The interrupt controller IC_5 lets the system select a desired service subroutine.*

ISSUE WINNER

The winning Design Idea for the September 17, 1987, issue is entitled "Direction detector doubles as decoder," submitted by Tracy Allen of EME Systems (Berkeley, CA).

Power op amp forms position controller

Dennis Eichenberg
WL Tanksley & Associates Inc, Brook Park, OH

You can build an inexpensive closed-loop position controller by driving a permanent-magnet motor with a power op amp **(Fig 1).** Bipolar power supplies allow the op amp to provide bidirectional motor operation. The motor is a 6V permanent-magnet type whose starting current must not exceed 0.5A.

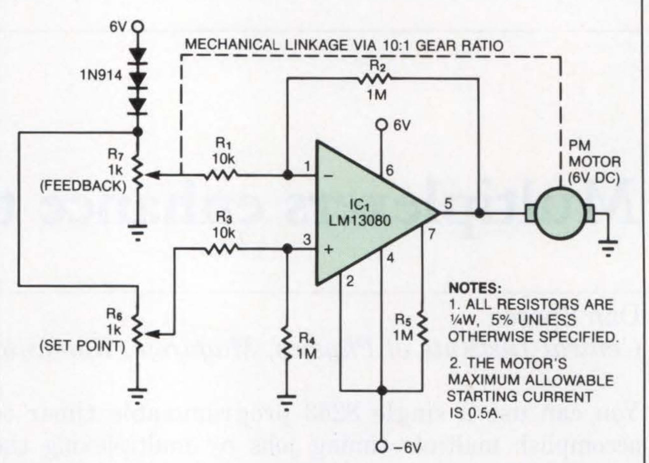
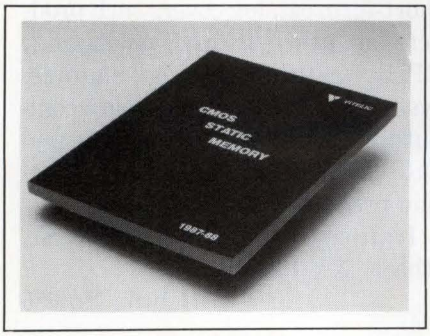


Fig 1—Power op amp IC_1 drives the motor *according to the wiper position you set on potentiometer R_6.*

You configure the op amp as a differential amplifier in which the gain equals R_2/R_1. A gain of 100 is optimum for this configuration. Gains from 10 to 500 provide good response times but cause increasing oscillation at the higher values, and a gain of 1000 causes instability. Resistor R_5 sets the amplifier's input-stage bias current.

Potentiometer R_6 lets you adjust the desired set point. Potentiometer R_7 connects to the motor shaft through a 10:1 gear ratio and provides position feedback to the amplifier's inverting input. The diodes in series with these potentiometers ensure that the magnitudes of the voltages applied to the amplifier's inputs don't come within 1.75V of the magnitude of either supply rail, as the amplifier requires. Using the ±6V supplies shown, the amplifier can apply as much as ±5.2V to the motor. **EDN**

To Vote For This Design, Circle No 746

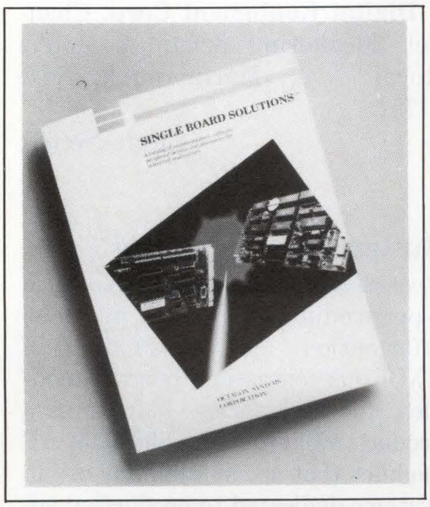


Catalog presents static and dual-port RAMs

The 121-pg 1987-88 CMOS Static Memory catalog describes the vendor's line of high-speed static RAMs and dual-port RAMs for use in mini- and microcomputers, control-system applications, and graphics systems. Covered are 16k×8-bit, 8k×8-bit, and 32k×8-bit static RAMs. The publication also includes data sheets for 1k×8-bit and 2k×8-bit dual-port RAMs.

Vitelic Corp, 3910 N First St, San Jose, CA 95134.

Circle No 678

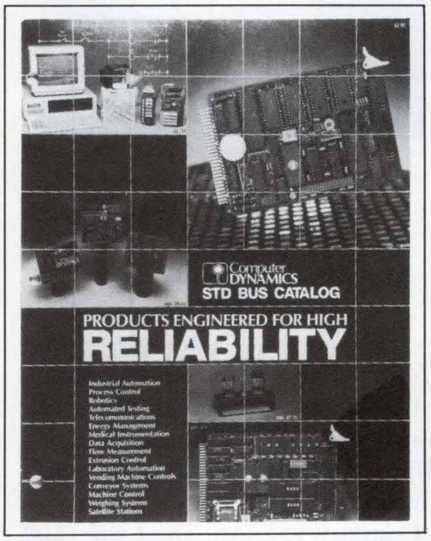


Publication discusses CMOS microcontrollers

Single-Board Solutions lists the vendor's SBS Series CMOS-Z80 microcontrollers and accessories that are designed for a variety of applications, including process control, data acquisition, test and measurement, and environmental control. The 44-pg catalog provides specifications for the series and information about peripheral devices and related software such as CAMBasic and PC SmartLink.

Octagon Systems Corp, 6510 W 91st St, Westminster, CO 80030.

Circle No 679



Publication covers buses

The vendor's 1988 Standard Bus Catalog *Products Engineered for High Reliability* highlights over 400 board-level products, development systems, software, and support products. It features the CDI-Ladder system, which implements relay ladder logic, programming on the STD Bus, new SBX boards, an expanded card cage line, and an enlarged process-control software section. Also included are sections on CPU boards, memory boards, communications boards, controller boards, industrial I/O boards, stepper-motor controllers, and ADCs. The 44-pg booklet includes engineering specs, block diagrams, and illustrations.

Computer Dynamics, 107 S Main St, Greer, SC 29651.

Circle No 680

Handbook lists industrial computer products

The 400-pg *Systems Data Book* covers the vendor's line of 8088 μP-based industrial computer systems and boards. It provides specifications and applications for the System 1 programmable control computer with relay ladder logic; the System 2 IBM PC/XT-compatible industrial computer; and MS-DOS-compatible computer systems and subsystems. Also covered are 8088-compatible STD Bus cards, I/O expansion cards, and accessories. The appendixes contain specifications and application notes for the STD Bus, a description of the 16-bit STD Bus, and a discussion on how to increase the MTBF.

Pro-Log Corp, 2560 Garden Rd, Monterey, CA 93940.

Circle No 681

Reference set details HCMOS programming

The M68HC11PM/AD, a Programming Reference Manual, is the basic software reference document for the MC68HC11 family of high-speed, CMOS single-chip μC devices. Besides general information, it presents descriptions of CPU register and addressing modes, instruction-set details, cycle-by-cycle CPU bus activity, and miscellaneous conversion tables. The MC68HC11-A8RG/AD, a pocket programming reference guide, includes sections on programming models, crystal-dependent timing, interrupts, memory and opcode maps, addressing modes, execution times, Hex/decimal conversions, and an ASCII chart.

Motorola Inc, Microprocessor Products Group, 6501 William Cannon Dr W, Austin, TX 78735.

Circle No 684

Brochure features industrial computer

This 12-pg pamphlet details the features, specifications, configuration options, packaging and power supplies, and pricing information for the System 2 IBM PC/XT-compatible industrial computer. Also included in the brochure is a list of STD Bus cards (peripheral, I/O, memory, and utility) that can be configured for users' needs as well as PC/XT-compatible programs for use with the System 2.

Pro-Log Corp, 2560 Garden Rd, Monterey, CA 93940.

Circle No 682

Book references computer industry

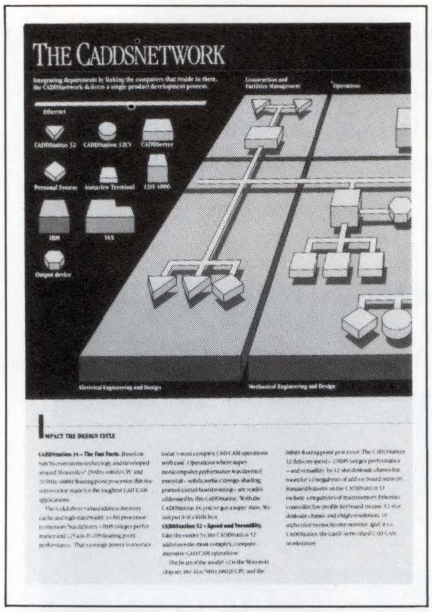
According to recent figures published in the *Computer Industry Almanac*, a 780-pg reference book, the US can lay claim to more than half of the world's computing power. The volume presents an inside view of the computer world. It includes a computer industry overview; a ranking of companies, company award winners, and a company business directory; a ranking of hardware and software companies; product trends and product award winners; a ranking of international companies and statistics; financial facts; forecasts; organizations and agencies; publications; and research activities. Soft cover, $29.95; hard cover, $49.95.

Computer Industry Almanac Inc, 8111 LBJ Freeway, Dallas, TX 75251.

INQUIRE DIRECT

Networking system described in brochure

This CADDSnetwork pamphlet presents the networking capabilities of the CADDStation family of CAE/CAD/CAM workstations. It describes the data highway that allows access to computers from IBM and Digital Equipment Corp, as well as from the company. At the



CADDStation level, networking is enhanced by windowing, which allows simultaneous access to Unix, IBM's VM, Digital Equipment's VMS, and the design data base.

Computervision, Dept 615, 100 Crosby Dr, Bedford, MA 01730.

Circle No 685

Brochure and synopsis on PC-based courses

The R200 series PC-based instrumentation laboratory courses contains a 500-pg course text with a variety of hardware packages. The applications include teaching labs, PC-based workstations, university courses, vocation technology for classrooms, and company training courses. Topics cover assembly and high-level programming languages, data acquisition, instruments, operating systems, and data links and buses. The text, with a selection of hardware packages, is priced from $999 to $2995.

Rapid Systems Inc, 433 N 34th St, Seattle, WA 98103.

INQUIRE DIRECT

Catalog of VME Bus products

This 4-color, 16-pg catalog describes the manufacturer's VME Bus boards, systems, and software. The short-form catalog covers such products as systems and packaging, CPUs, multiprocessing engines, system resources, single-board computers, memory, analog I/O and DSP devices, displays, special-function products, and peripherals.

Ironics Inc, 798 Cascadilla St, Ithaca, NY 14850.

Circle No 686

Literature package has app notes, product guide

This package of publications comprises four application notes, a VAXBI Third-Party Directory, and a product guide entitled *New Opportunities*. The notes explain how the vendor's products interact with other companies' products to make manufacturing tasks easier. The directory lists tool and service vendors and licensed option vendors. Finally, the guide describes the company's microcomputer systems, local-area networks, and local-area VAX-cluster systems.

Digital Equipment Corp, Channels Marketing Group, 2 Mount Royal Ave, Marlborough, MA 01752.

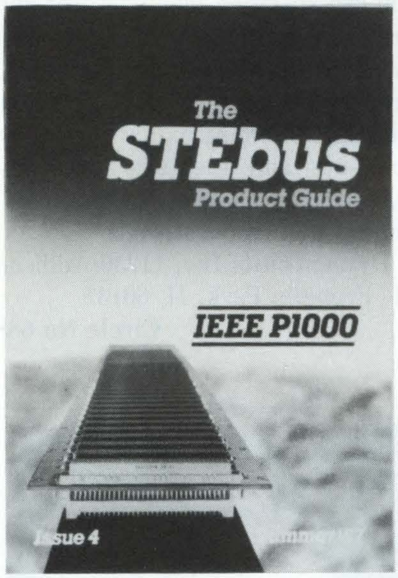
Circle No 687

Bus products described

Everything for the EXORbus is a 6-pg product guide that provides information on a family of EXORbus-compatible boards, modules, and accessories. It features a product overview on 6800/6809 µP modules that are suitable for use in systems dedicated to production automation, process control, data acquisition, and materials testing. Other sections deal with processor modules, memory modules, I/O modules, microcomputer systems, enclosures, and packaging and accessories.

Creative Micro Systems, 3822 Cerritos Ave, Los Alamitos, CA 90720.

Circle No 689



Guide details STE Bus products

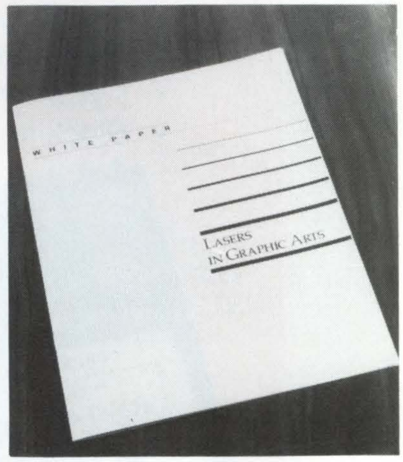
The fourth edition of *The STEbus Product Guide* presents more than 750 products for the 8-bit STE Bus backplane computer system. Published on behalf of the STE Bus Manufacturers' and Users' Group, the publication describes products from more than 30 manufacturers and lists STE Bus product suppliers. New items include processor boards based on the Z280 μP and the Transputer, and Bitbus interface, DSP, speech synthesis, and motor controller cards.

The STE One Number Source, Dean Microsystems Ltd, 7 Horseshoe Park, Pangbourne, Reading, Berks RG8 7JW, UK.

Circle No 690

Report addresses use of laser for graphics

The 8-pg paper, *Lasers in Graphic Arts*, discusses laser technology as a bridge between typographic output, and hardware and software used for publishing. The report deals with three graphics-arts applications: image setting, scanning, and printing.



Compugraphic Corp, Literature Div, 65 Industrial Way, Wilmington, MA 01887.

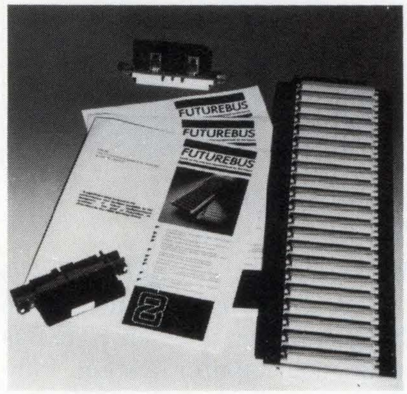
Circle No 683

Slide chart features specs for pc boards

This double-sided slide chart makes it easy to refer to material specifications for pc boards. For example, you can specify a manufacturer and grade of material to see physical, mechanical, electrical, or thermal properties at a glance. The reverse side of the chart explains tooling concepts and includes a recommended panel layout for the maximum use of raw materials.

Dynacircuits Inc, 11230 Addison St, Franklin Park, IL 60131.

Circle No 688

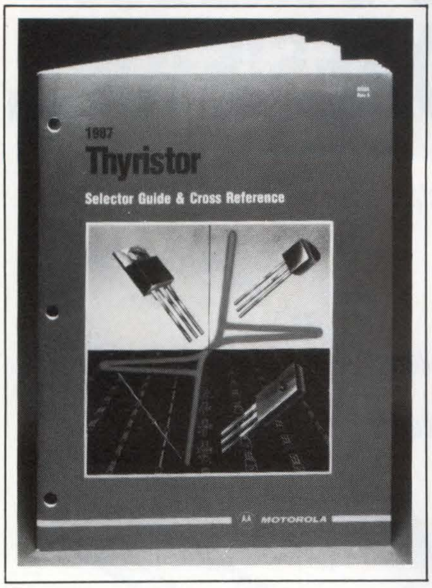


Brochure examines key features of Futurebus

This 6-pg awareness brochure covers key features of the IEEE-896 (Futurebus) specification. Formatted as a set of questions and answers, the brochure addresses such issues as which processors and architectures you can use on the bus, how Futurebus overcomes the bus driving problem, how the bus handles multiprocessing, and how it supports cache memories. Also included is information about message passing, fault-tolerant systems, and silicon support.

Futurebus Information Service, Unit 2, Rowan Close, St Peters Park, Brackley, Northants NN13 5UP, UK.

Circle No 691

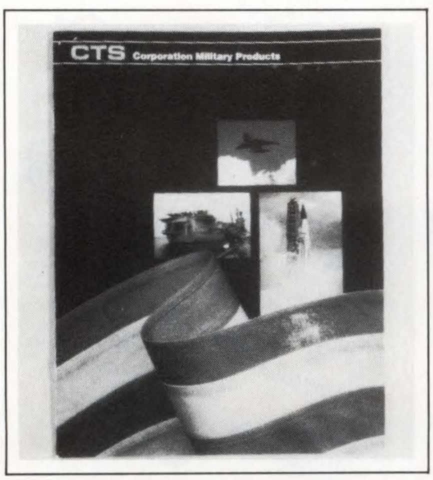


Guide summarizes thyristor product line

The fifth edition of the vendor's *Thyristor Selector Guide* includes sections on SCRs, triacs, and trigger devices. The vendor has reduced its thyristor product offering by eliminating odd-value voltage parts and replacing them with the next highest voltage part.

Motorola Inc, Literature Distribution Center, Box 20924, Phoenix, AZ 85063.

Circle No 663

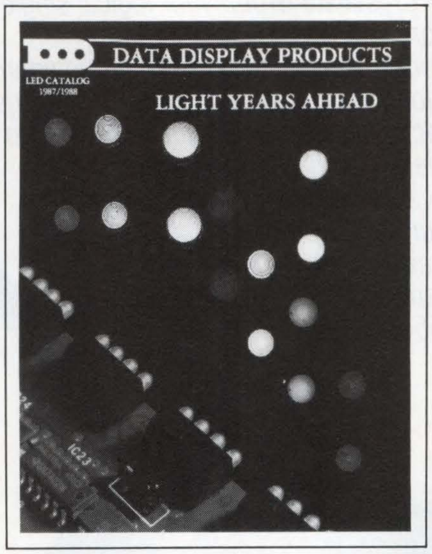


Brochure presents military products

This 12-pg, 4-color booklet describes the vendor's line of electronic components for military applications. It consists of five sections that include thick- and thin-film hybrid microcircuits, quartz crystals, molded pc-board connectors, memories—core and semiconductor, and DIP switches.

CTS Corp, 905 North West Blvd, Elkhart, IN 46514.

Circle No 665



LED source book

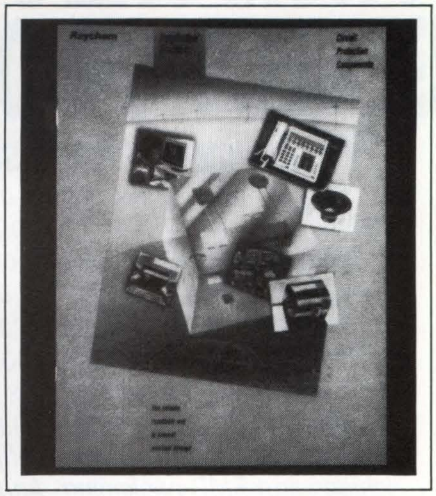
Light Years Ahead is the vendor's 48-pg, 1987-88 users' guide to LEDs. It covers a range of products: pc-board-mounted LEDs; standard or snap-in panel lights; and LED multichip, lamp-based incandescent replacements. The product specifications include dimensional drawings, actual-size photos, applications, and electrical specifications. You can order custom configurations from a wide range of lenses, bezels, LEDs, bases, and terminations. The catalog also provides an alphanumeric index and selector guide.

Data Display Products, Box 91072, Los Angeles, CA 90009.

Circle No 664

Packet explains circuit-protection devices

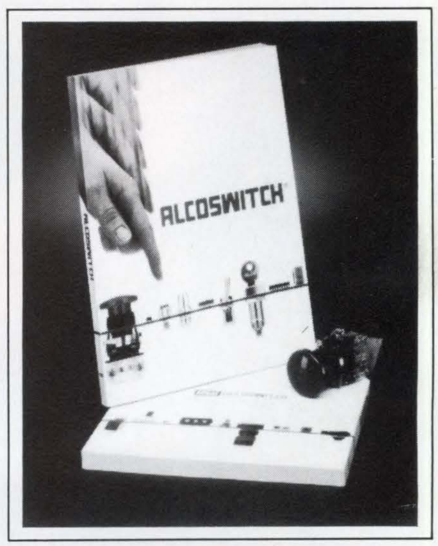
This literature kit contains a brochure, data sheets, and application notes that provide an overview of the company's circuit-protection products. It includes descriptions of devices that provide protection for subscriber-line interface circuits,



PBX and key telephone systems, telecommunications networks, loudspeakers, and batteries. The kit contains a press release introducing the company's newest family of devices.

Raychem Corp, 300 Constitution Dr, Menlo Park, CA 94025.

Circle No 666



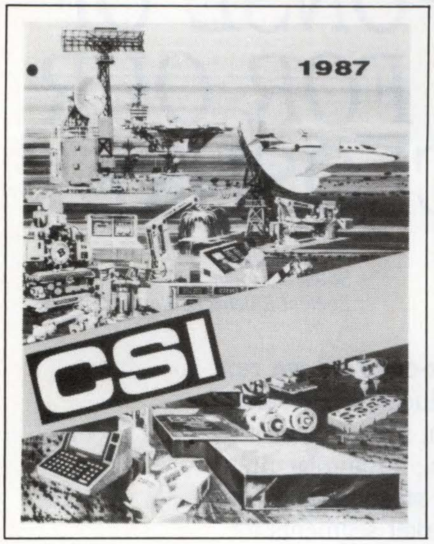
Miniature switches categorized

The 288-pg catalog provides information on the vendor's full line of miniature and subminiature switches. A table of contents and an alphanumeric product index will assist you in locating a particular device. The book also includes a price list.

Augat/Alcoswitch, 1551 Osgood St, North Andover, MA 01845.

Circle No 668

CIRCLE NO 209



Synchro/resolver LVDT converters described

This short-form catalog presents more than 45 families of products for conversion of synchro-, resolver-, Inductosyn-, and linear-variable differential transformer (LVDT) signals to digital codes. The listing includes single- and 2-speed converters, having 8- to 24-bit resolution. Applications for the devices include portable testers, multichannel data acquisition, airborne attitude synchro amplifiers, and angle-position indicators.

Control Sciences Inc, 9509 Vassar Ave, Chatsworth, CA 91311.

Circle No 667

Listing of digital switches

This catalog describes a wide range of switches, including Digiswitch, Minilever, Digivider, and Digidecade switches, as well as Minikey keypad systems. Its easy-reference format guides you through military and commercial switch selection. The catalog also includes a features and options chart, truth tables listed by product series, engineering parameters, and layout drawings. It covers thumbwheel switches, lever/toggle switches, pushbutton switches, custom products, accessories, and switch-and-assembly ordering instructions.

Digitran, 3100 New York Dr, Pasadena, CA 91107.

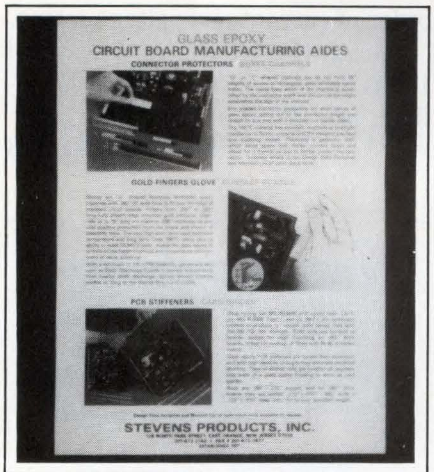
Circle No 671

Paper discusses PWM amplifiers

The 6-pg reprint, *Pulse Width Modulated Power Amplifiers*, introduces PWM amplifiers, starting with their basic principles. It discusses applications and compares PWM-amplifier technology with alternative linear amplifiers and SCR power systems. The article explains how applications fit into four broad categories: coil drivers, ac/dc power sources, motion control, and high-power function generators. Photographs and schematics highlight the text.

Copley Controls Corp, 375 Elliot St, Newton, MA 02164.

Circle No 674



Data sheet summarizes manufacturing aids

This data sheet describes three circuit-board manufacturing aids: connector protectors, a gold-fingers glove, and pc-board stiffeners. Product specifications are included in each description.

Stevens Products Inc, 128 N Park St, East Orange, NJ 07019.

Circle No 670

Brochure presents IR pyroelectric detectors

This 6-pg app note, *Introduction to Infrared Pyroelectric Detectors*, describes the basics of lithium tantalate pyroelectric detectors. Three introductory topics are entitled "When to Use Infrared," "Beyond Photodiodes," and "Pyroelectrics are Practical." Other topics include electrical considerations and laser applications.

Eltec Instruments Inc, Box 9610, Daytona Beach, FL 32020.

Circle No 675

Brochure discusses traveling-wave tubes

This brochure covers the vendor's line of microwave tubes and amplifiers for manufacturers of communications and military products. It describes products for military electronic counter measures (ECM) and radar. It also details products you can use for stationary and mobile transmitters, transmitter amplifiers for satellite up-link ground stations, and point-to-point satellite transmission of business data. The 20-pg booklet includes a section on product safety.

Stantel Components Inc, 636 Remington Rd, Schaumburg, IL 60173.

Circle No 672

Catalog aids in choosing ceramic filters

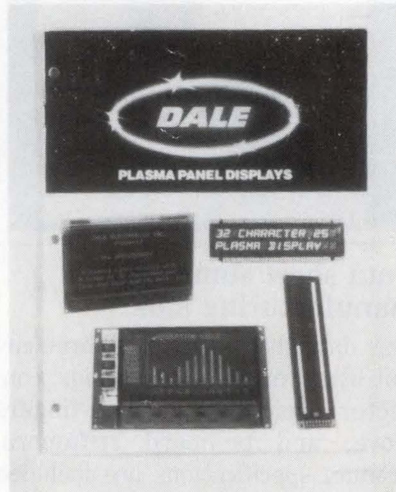
Ceramic EMI/RFI Filters features descriptions of filter-circuit configurations and functions. It includes a filter-selection flow chart, installation guidelines, definitions of terms, and military test procedures. Catalog FD-129 is divided into dc-rated and ac/dc-rated sections. Subcategories are defined by circuit function. Within each general circuit category, devices are shown in

LITERATURE

order of current and voltage rating.

Sprague Electric Co, Technical Literature Service, Box 9102, Mansfield, MA 02048.

Circle No 673



Product guide to panel displays

This 40-pg catalog of flat-panel plasma displays is divided into three sections: segmented displays; displays with drive electronics/interfaces; and bar-graph displays. A product guide and a list of customer representatives are included on the inside covers.

Dale Electronics Inc, 2064 12th Ave, Columbus, NE 68601.

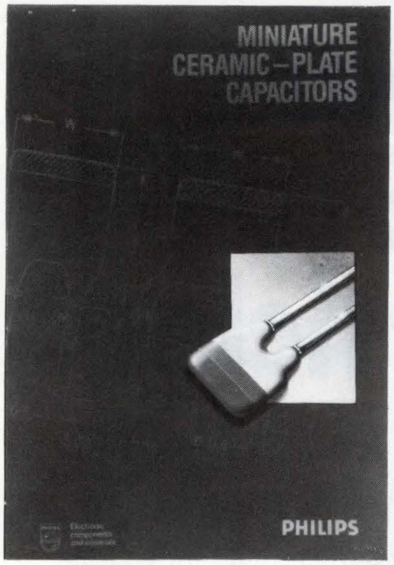
Circle No 669

Guide details optoelectronics products

The 45-pg, 4-color *Optoelectronics Product Guide* is a combination data book/selector guide that provides electrical and optical characteristics, package outlines, and pinout specifications. It also describes product features and applications. The book provides sections that cover visible-light lamps; single- and multiple-digit displays; integrated displays; custom capabilities; infrared emitters and detectors; and optocouplers.

Three-Five Semiconductor Inc, Box 111, Tempe AZ 85282.

Circle No 676

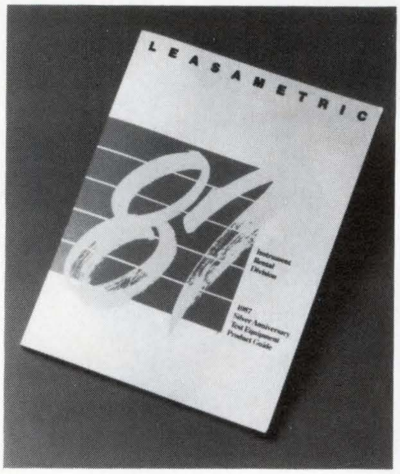


Brochure details miniature ceramic-plate capacitors

The 20-page color brochure entitled *Miniature Ceramic-Plate Capacitors* describes a range of ceramic-plate capacitors that are suitable for use in such applications as coupling, decoupling, timing, and resonant circuits. The brochure also describes the manufacture, quality control assessment, and ordering information for these components, and outlines some advantages of their mechanical design.

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands.

Circle No 677



Instrument-rental catalog

Featuring instruments from vendors such as Hewlett-Packard, Tektronix, and Fluke, this illustrated catalog presents more than 1000 models of electronic test, industrial, and telecommunications equipment that the company offers for rental. The instruments listed include oscilloscopes, analyzers, signal sources, recorders, temperature equipment, power-line monitors, and laser-measurement equipment. Also included are protocol analyzers, microwave analyzers, fiber-optic test equipment, signal generators and video equipment, µP test-and-development systems, logic analyzers, PROM programmers, plotters, and printers. The publication features a manufacturers' index and a product index.

Leasametric, Instrument Rental Div, 1164 Triton Dr, Foster City, CA 94404.

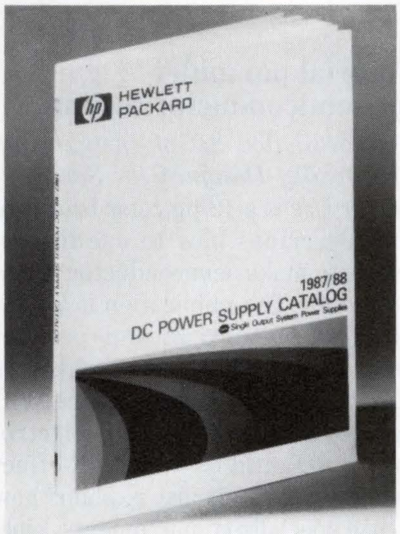
Circle No 647

App notes discuss waveform digitizing

Application notes AN-2017, *Principles of Digital Waveform Recording,* and AN-2018, *Digital Signal Processing,* provide an overview of waveform digitizing and analysis. The two papers fill 28 pages with text, diagrams, and illustrations. They address such topics as the fundamentals of ADC technology, understanding digitizer specifications, digitizer applications, digital signal processing, and computer-aided-test system design.

LeCroy, 700 S Main St, Spring Valley, NY 10977.

Circle No 651



Product guide for dc power supplies

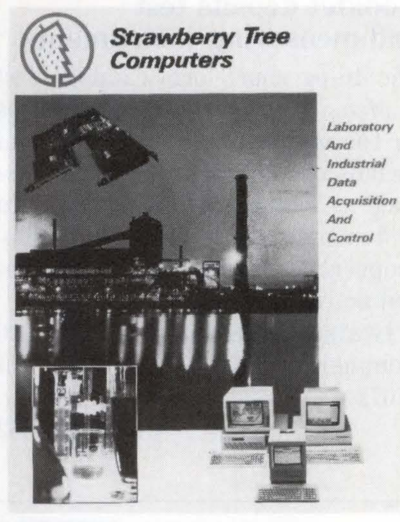
The 132-pg *1987/88 DC Power Supply Catalog* describes the vendor's manually controlled and computer-controlled dc power supplies. It's divided into three general categories: system, analog-programmable, and special-purpose and lab-bench power supplies. The book includes voltage-rating and model-number indexes, a guide for replacing discontinued models, a listing of sales and support offices, and a section on applications-information and terminology.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303.

Circle No 648

Data-acquisition and control equipment

This 56-pg booklet categorizes the vendor's data-acquisition and control equipment for IBM and Apple computers. It highlights 55 hardware and software products used for process control and laboratory measurements, and for monitoring



temperature, strain, and pressure. The publication also features a hardware-software cross-reference guide.

Strawberry Tree Computers Inc, 150 N Wolfe Rd, Sunnyvale, CA 94086.

Circle No 649

Oscilloscope-probe kits and test accessories

The 32-pg, 4-color publication *Perfection for Quick Connection* presents the vendor's clip, insulator, test-lead, and interconnect offerings from A to W (adapters to wire). It lists product specifications, presents engineering drawings, and describes applications.

Mueller Electric Co, 1583 E 31st St, Cleveland, OH 44114.

Circle No 650

Booklet depicts test and measuring instruments

The 16-pg short-form catalog, *Test & Measuring Instruments,* focuses on the company's complete line of oscilloscopes. It also features scope wagons, trace-recording camera systems, a selection chart of oscilloscope accessories, and a passive- and active-probes chart.

Iwatsu Instruments Inc, 430 Commerce Blvd, Carlstadt, NJ 07072.

Circle No 652

Test and measurement instruments categorized

This 16-pg catalog on test and measurement instruments outlines performance features, applications, and specifications for 22 instruments. The products featured include digital multimeters, data-acquisition and logging instruments, dynamic analysis and vibration equipment, and communications test sets.

Solartron Instruments, 2 Westchester Plaza, Elmsford, NY 10523.

Circle No 655

Brochure highlights electronic products

This 4-color brochure (Publication No 5953-7040) presents information on 22 basic electronic measuring instruments that are grouped into four types: digital multimeters; counters; pulse and function generators; and power supplies. Included in the leaflet are brief product descriptions, specifications, and prices.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303.

Circle No 653

Tutorial pamphlet for semiconductor testing

A Coordinated Set of Instruments Specifically Designed for Semiconductor Use is a 12-pg color brochure that describes how to use instruments to make semiconductor measurements. The publication is a combination of tutorial and product descriptions. It explains techniques such as low-level, capacitance-voltage tests, resistance and electromigration studies, and Hall-effect measurements. It also explains how to use specialized instruments, electrometers, switch systems, picoammeters, and capacitance-voltage instruments.

Keithley Instruments Inc, 28775 Aurora Rd, Solon, OH 44139.

Circle No 657

Instrument catalog

This 32-pg catalog presents the company's line of products for industrial and laboratory test and measurement applications. Products covered include handheld thermometers, temperature controls, panel meters, calibration equipment, temperature loggers, IR thermometers, thermocouples, RTDs, handheld probes, humidity instruments, anemometers, digital voltmeters, temperature baths, pH meters, oxygen analyzers, and tachometers. Also listed are multifunction instruments that can measure several different parameters by using plug-in modules and sensors; the listing describes each product, giving its operating specifications and price.

Owen Instruments Inc, Box 2193, Provo, UT 84603.

Circle No 661

Listing of test and measurement instruments

This 64-pg catalog presents more than 1400 products from A W Sperry, Amprobe, B&K Precision, Check-It, Fluke, Simpson, TIF, and Yokogawa. Among the products listed are leak detectors, counters, oscilloscopes, a variety of meters, and power supplies. The products described fill the requirements of electronic-, electrical-, and industrial-equipment users.

W W Grainger Inc, 1250 Busch Parkway, Buffalo Grove, IL 60015.

Circle No 654

Booklet summarizes features of spectrum analyzer

The 16-pg, 4-color brochure *400-MHz Spectrum Analyzer 2382* illustrates Model 2382's RF design and details specifications. A section on measurement problems shows you how to speed up measurements at a single frequency, how to display demodulated FM signals, and how to get permanent records of tests.

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401.

Circle No 658

Signal sources bulletin

This 4-pg technical bulletin describes the series 6150A AM/FM signal sources. It details the modulation, harmonics, and stability of the instruments, which are solid-state oscillators employing a GaAs FET as the active element. The pamphlet also contains specifications and a description of the vendor's 6140 GPIB adapter.

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401.

Circle No 659

Book describes licensing of broadcast equipment

Procedures for Granting Licenses for the Operation of RF Devices, Radio and TV Receivers in Western Germany, an EMI guide published in English, provides information to help equipment manufacturers understand West German regulations. The 206-pg booklet examines the laws and VDE regulations concerning radio-interference suppression. It also presents a list of Deutsche Bundespost decrees on the subject along with brief summaries of the decrees. A flow chart depicts approval procedures for equipment, and the final chapter gives examples of test setups prescribed by a number of VDE regulations. DM 23.

Rohde & Schwarz, Muhldorfstrasse 15, 8000 Munich 80, West Germany.

INQUIRE DIRECT

Note discusses programming on simulator system

Product Note 8770S-2, *Effective Use of the HP 8770S Signal Simulator System*, offers programming help with the HP 1177A Waveform Generation Language. The 64-pg document presents principles of digital synthesis and provides product-specific information about the features and operation of the HP 8770S. It explains how to program six different waveforms, from sine waves to frequency-hopped and multiple-tone carriers. Another section examines pulsed waveforms, pulsed carriers, and those with phase tagging, variable repetition rates and jitter, and pulse trains with AM and scan characteristics. Seven appendices complete the booklet.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303.

Circle No 656

Frequency synthesizers described

This catalog gives general information about frequency synthesizers and outlines their characteristics. It lists specifications for the product line and provides illustrations of each device. The 20-pg catalog also includes ordering information, and data sheets for the company's newest models.

Programmed Test Sources Inc, Box 517, Littleton, MA 01460.

Circle No 660

Technical report describes modal analysis

To help you evaluate the complex behavior of vibrating structures, the technical report *Modal Testing Principles* describes the steps involved in using the company's model 1202 structural analyzer in modal analysis experiments. With the aid of diagrams, the 100-pg report highlights the factors involved in setting up the experiment, in analyzing the problem theoretically, and in assessing the quality of the modal data. Some of the chapters focus on how to identify modal parameters and how to achieve structural modifications. The report also provides a detailed explanation of 42 different equations related to modal analysis.

Solartron Instruments, Victoria Rd, Farnborough, Hants GU14 7PW, UK.

Circle No 662

Digital plotter media for computer-aided design

This brochure describes digital-plotter materials for computer-aided design. It describes the vendor's Diplomat and PermaScale media, and provides an applications guide of media characteristics. Further, its plotter-suitability charts list the products available for flatbed or drum plotters.

Dietzgen Corp, 250 Wille Rd, Des Plaines, IL 60018.

Circle No 643

Newsletter provides CAE coverage

Design Line, a quarterly newsletter, publishes news about and editorial comment on CAE trends, applications, and events. It features user stories as well as articles on workstations (large systems), simulation, performance, and testability analysis.

Aida Corp, 5155 Old Ironsides Dr, Santa Clara, CA 95054.

Circle No 645

Newsletter contains CAD/CAM information

Published since 1981, the *Computer Aided Design Report* newsletter covers computer-aided design and manufacturing topics. The May and June issues provide a comparison of personal-computer CAD software from three Fortune 500 firms and software from two smaller companies. The results show that buying software from major manufacturers won't necessarily be the solution that best meets your particular needs. Copies of both issues are available for $23. An annual subscription costs $138.

CAD/CAM Publishing Inc, 841 Turquoise St, Suite D, San Diego, CA 92109.

INQUIRE DIRECT

Catalog features CAD products

This 37-pg product guide deals with the vendor's hardware, firmware, software, and custom designing and consulting. It also focuses on the CAD software packages HiWire and SmartWork. The HiWire section describes the product as an aid that shortens and simplifies the electronic-design process; the section covers features, specifications, and system requirements. The SmartWork section describes how SmartWork makes pc-board design easier and less tedious.

Wintek Corp, 1801 South St, Lafayette, IN 47904.

Circle No 644

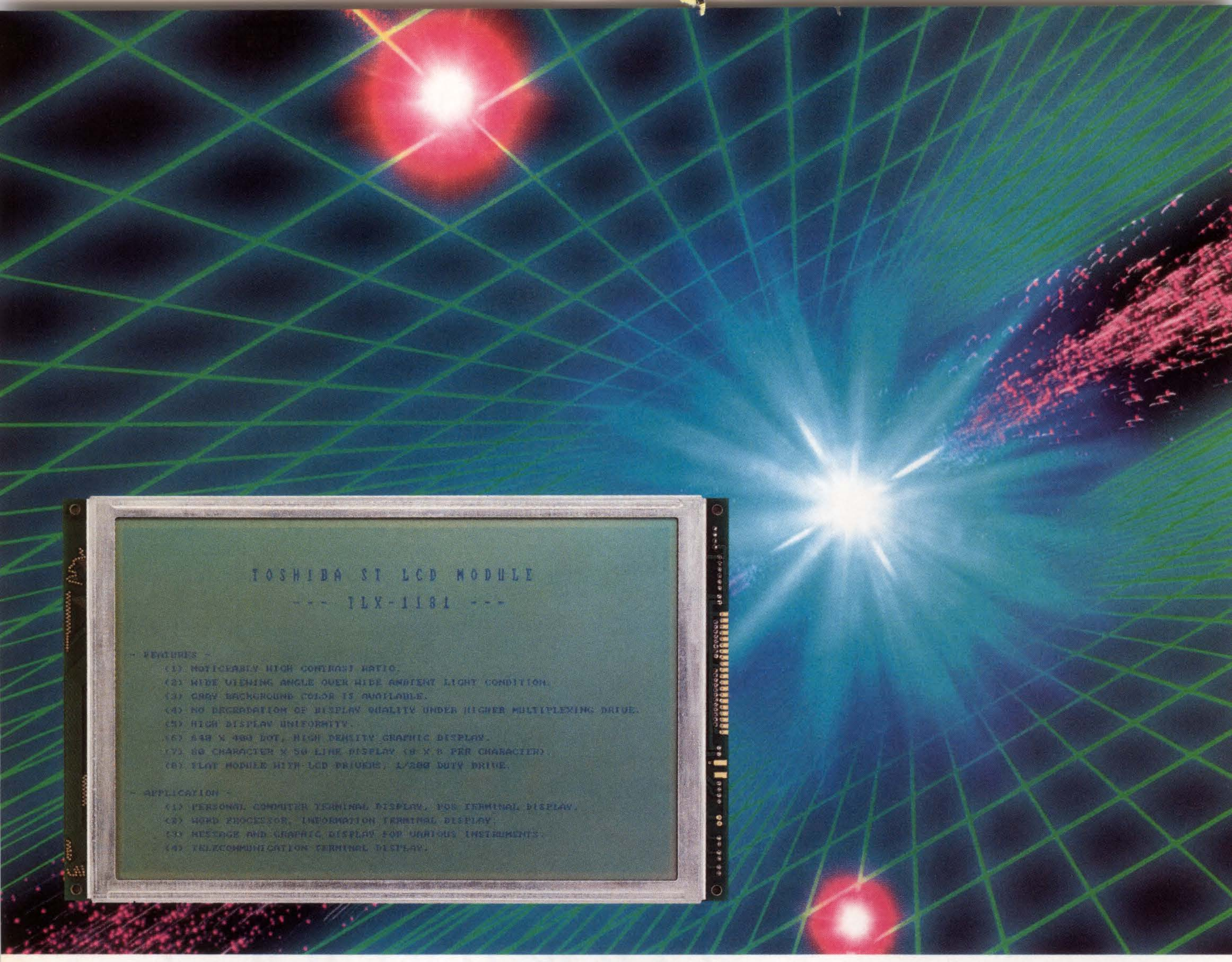
Brochure on data-acquisition system

This brochure describes the P-CAM system, which includes software packages for data acquisition/analysis and process control applications. The 4-color publication covers the product's applications and provides illustrations, figures, and specifications.

KineticSystems Corp, 11 Maryknoll Dr, Lockport, IL 60441.

Circle No 646

TURN TO PAGE 366



When your eyes need high quality displays, you need the Toshiba ST LCD.

Once again Toshiba has made a breakthrough in display quality. Clear and beautiful displays are achieved with the ST LCD. The LCD for the new age. And for your eyes. Now, by employing a new operating mode, this module provides excellent readability from a viewing angle perpendicular to the LCD panel. This was difficult to achieve with conventional LCDs. The aim was to make our LCD easier on the eyes. We succeeded with the ST LCD. Just another improvement in the man-to-machine interface by Toshiba.

ST LCD Module Specifications

Model name	Number of dots	Duty	Dot pitch (mm)	Outline dimensions (mm)	EL Back Light (Option)	Recommended controller
TLX-1181*	640 × 400	1/200	0.35 × 0.35	276 × 168 × 12	Yes	T7779
TLX-932	640 × 200	1/200	0.375 × 0.375	293 × 97.6 × 14	No	T7779
TLX-561	640 × 200	1/200	0.35 × 0.49	275 × 126 × 14	Yes	T7779
TLX-711A*	240 × 64	1/64	0.53 × 0.53	180 × 65 × 12	Yes	T6963C**
TLX-341AK*	128 × 128	1/64	0.45 × 0.45	93.2 × 86.6 × 12	No	T6963C

*Under development, **Built-in controller

In Touch with Tomorrow

TOSHIBA

CIRCLE NO 194

Toshiba America, Inc., Chicago Office: 1101A Lake Cook Rd., Deerfield, IL 60015 Tel: 312-945-1500 **Northwestern Area Office:** 2021 The Alameda, Suite 220, San Jose, CA 95126 Tel: 408-244-4070 **Eastern Area Office:** 67 South Bedford Street, Suite 200W, Burlington, MA 01803 Tel: 617-272-4352, 5548

EDN PRODUCT MART

This advertising is for new and current products.

Please circle Reader Service number for additional information from manufacturers.

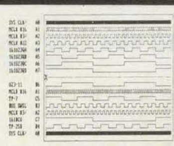
AXELEN LOGIC ANALYZER

ALA 24100

FOR IBM® PC/XT/AT PC-BASED LOGIC ANALYSIS SYSTEM

- 24 CHANNELS; 100MHz
- A NEW STANDARD AND CONCEPT OF L.A. OPERATION
- EASY-TO-USE WITH ONLINE HELP MENU

- 8CH at 100MHz 8176 bits/CH
- 24CH at 25MHz 2044 bits/CH
- FOUR LEVELS SEQUENTIAL TRIGGER
- MORE THAN 4,000 COMBI-NATIONS OF TRIGGER CO-NDITIONS
- DATA QUALIFICATION TO RECORD ONLY EVENTS OF INTEREST
- FAST SCROLLING AND PAGING
- QUICK SEARCH AND LOCATE FEATURE
- BIN/OCT/HEX/ASCII DISPLAY BASE
- HARD COPY



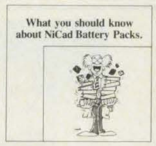
AGENT WANTED! AGENT WANTED! AGENT WANTED!

AXELEN INDUSTRIAL INC.
P.O. BOX 24-650 Taipei Taiwan R.O.C.
FAX: 886-2-7529768 · Tlx: 10305 AXELEN
Tel: 886-2-7529819/7714867

CIRCLE NO 325

FREE

What you should know about NiCad battery packs.



This 12-page booklet tells you how:

- You can make battery packs last longer
- Your storage system may be robbing battery life
- Proper disposal prevents accidents
- Why and how NiCad battery packs work
- Why today's battery packs are more reliable than yesteryear's battery packs

Powering Your Portable World

Alexander Batteries
NEW PRODUCT/OEM DIVISION

P.O. BOX 28880, SAN DIEGO, CA 92128 619-480-4445 FAX 619-480-1350

CIRCLE NO 326

FREE!

Switching Power Supply Catalog

- Complete performance data for 46 multiple output switchers (160 to 700 watts), 16 single output switchers (150 to 520 watts; 5-48 volts) • Up to 31% smaller packages with power densities to 4 watts/in^3 for design flexibilities • Organized for easy selection by recommended primary OEM product application.

For your free catalog, call 1-800-223-TODD, 516-231-3366, or write:

TODD
PRODUCTS CORP.
50 Emjay Blvd., Brentwood, NY 11717

CIRCLE NO 327

Only a Specialized Manufacturer Could Provide Versatile and Economic Products

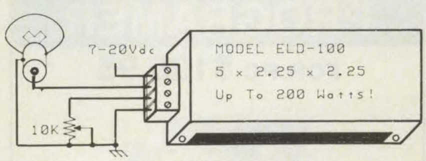
With more than 11 years' experience in this field, we proudly offer you various types of conductive silicone rubber pads, rubber pads with multicolor and screen printing, silicone rubber overlay, rubber pads with screen printing on plastic keytops, 0 rings, washers, inner caps, tubes, etc., and screen printing flexible circuit boards. Please contact us for more information.

GENERAL SILICONES CO., USA
650 W Duarte 305, Arcadia CA 91006, U.S.A.
Tel: (818) 445-6036. Telex: 3716189 GSCUI.
Fax: 818-4456084

CIRCLE NO 328

DON'T ROLL YOUR OWN!

DC to DC Switchmode Power Convertor



Don't Waste Money or Sanity to Control LAMPS, MOTORS, HEATERS, CHARGE BATTERIES!

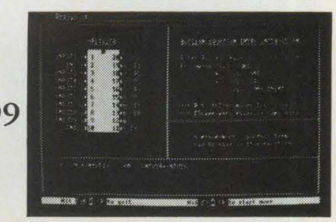
Just provide a ground referenced signal or resistance!
—MODULATE OUTPUT FROM ZERO TO 100%!—
up to 10 AMP loads, Vripple < 10MV/AMP
Stable, Fast Response / Low E.M.I.
7 to 20 VDC in, **VERY HIGH EFFICIENCY**
Convenient Plug W/ Screw Terminals
$110 IN SINGLES + + QUANTITY DISCOUNTS!

MONAD ONE INCORPORATED
"Panoptic Of Inventive Technologies"
P.O. BOX 573 OAKDALE, N.Y. 11769
(516) 563-4695

CIRCLE NO 329

PAL® COMPILER

$149.99



Boolean equation or Truth Table Entry, Minimizer, JEDEC output Simulation Option

PAL is a registered trademark of MMI.

From A Name You Can Trust

LOGICAL DEVICES INC.
1321 N.W. 65th Place
Ft. Lauderdale, FL 33309

1-800-331-7766 (305) 974-0967
Telex 383142 Fax (305) 974-8531

CIRCLE NO 330

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

VOICE SCRAMBLING

Choose from 3 levels of security, with the only CMOS scramblers made. Analog for no-lag. Economical, high voice quality. Send for a FREE demo cassette of all 3 options from simple inverter to rolling code scrambler.

MX·COM, INC.
TOLL FREE 1-800-638-5577

CIRCLE NO 331

DROP-IN DUPLEX CVSD CODEC

Don't settle for the either-or codecs of Motorola and Harris. Spec the full-duplex MX609 and get simultaneous decode/encode, space-saving on-chip filters, 8 - 64 kb/sec. programmable sampling, and extended temp range.

MX·COM, INC.
4800 Bethania Station Road • Winston-Salem, NC 27105-1201
TOLL FREE 1-800-638-5577 • (919) 744-5050

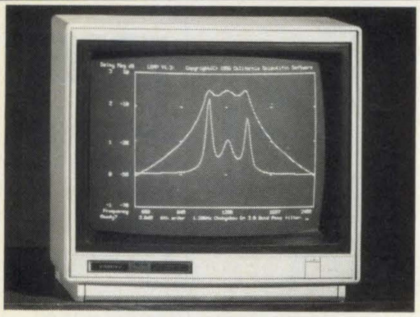
CIRCLE NO 332

PACKET RADIO

For 1200 baud radio telemetry, remote data terminals, and packet radio, the full duplex MX519 Minimum Shift Key Modem offers high noise immunity, on-chip filtering, and easy μP interface. Now in both DIL and PLCC.

MX·COM, INC.
TOLL FREE 1-800-638-5577

CIRCLE NO 333

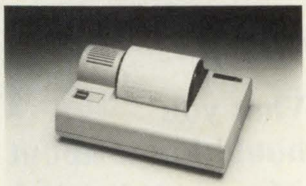


NEW ENGINEERING SOFTWARE

Filter designs active filters up to order 30. Bessel, Butterworth, Chebyshev, Allpass; High, Low Bandpass and Bandstop. Fully menu driven, Filter designs, plots, and selects component values for any filter in seconds. **LSAP analyzes linear systems** producing Bode, Nyquist, Impulse, Step Response and Root-Locus plots. **Micro-CSMP simulates control and servo systems** with full support for non-linear behavior. Filter is $900, LSAP is $450, Micro-CSMP is $900 for the IBM PC.

California Scientific Software
1159 North Catalina Ave, Pasadena, CA 91104
(818) 798-1201

CIRCLE NO 334



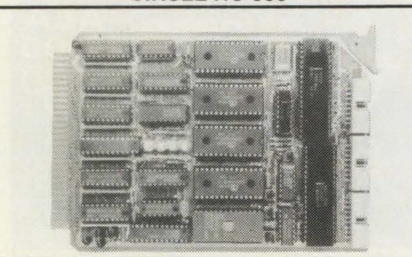
ALPHACOM 42®

The ideal printer for **MEDICAL, SCIENTIFIC** and **INDUSTRIAL INSTRUMENTATION.**

- Fast – 2 lines/sec.
- Quiet – Thermal Dot Matrix Printing
- Low Cost – Less than $125 in OEM quantity
- Plug-In Interface for Serial or Parallel

Alphacom® is a Trade Name of
BROWN KELLOGG, INC.
2108-C Bering Drive
San Jose, CA 95131
(408) 436-0801

CIRCLE NO 335



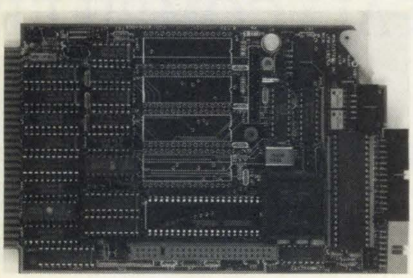
STD BUS SINGLE BOARD COMPUTER THE STD8809

- Up to 256K of ROM
- Up to 128K of RAM
- Optional DM86 Monitor
- "C" language software development tools available
- Supports both 8088 and Z80 vectored interrupts
- Serial port with on board RS 232C drivers
- Two 8 bit parallel I/O ports
- Five counter/timer channels
- Direct addressing of up to 1MB
- Eight level priority interrupt controller
- Optional 8087 math coprocessor
- Quantity 1 Price — $275 without memory

Call TOLL FREE 1-800-521-0714 Ext. 229

M.K. HANSEN COMPANY
634 Industry Drive, Seattle, WA 98188

CIRCLE NO 336



16-BIT CMOS SINGLE BOARD COMPUTER

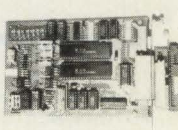
The LPM-SBC50 is an all CMOS STD Bus V-50 (CMOS 80186) SBC featuring 1M byte addressing, DMA, 32-pin memory sockets, serial RS-232/422 channel, 3 timers, 24 parallel I/O lines, real time clock, and watch-dog timer. −40° to +85°C operating temperature. Very low power consumption. Available as NMOS/TTL or CMOS from

WinSystems, Inc.
P.O. Box 121361, Arlington, TX 76012
(817) 274-7553

CIRCLE NO 337

EPROM PROGRAMER

FOR PC $129.95

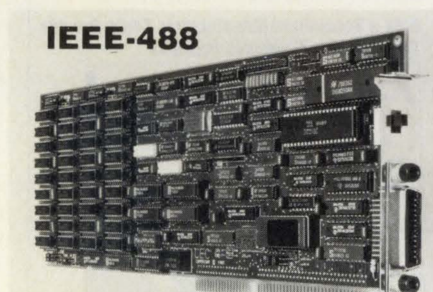


- 2716 to 1 MEG
- Updateable to 32 MEG
- Programs 2764 A in 10 Seconds
- Menu Driven Software
- External 40 PIN ZIF (PC only)
- Adapter 8748, 49, 51, 52, 55, TMS 7742 $50 PC only
- 1 Year Warranty
- 10 Day Money Back Guarantee
- Available for **APPLE II** $92.50 — VISA | MC
- For More Information Call

NEEDHAM'S ELECTRONICS
4535 Orange Grove, Sacramento, CA 95841
(916) 924-8037 (M-F) 8 AM to 5 PM PST

CIRCLE NO 338

IEEE-488



IEEE-488, PARALLEL, and SERIAL PORTS PLUS 4M BYTES of MEMORY

- Control any instrument. RS232 or '488.
- 4Mbytes of extended/expanded memory.
- Software library and memory manager.
- High speed DMA. Risk free guarantee.

cec Capital Equipment Corp.
99 South Bedford St.
Burlington, MA. 01803

FREE demo disk. Call (617) 273-1818

CIRCLE NO 339

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

THE WIDEST RANGE OF DIGITAL SIGNAL PROCESSING TOOLS AVAILABLE...

SPECTRUM

DSP Development Systems:
- TMS32020 & TMS320C25 Dev't Systems
- DSP-16 Real Time Data Acquisition Processor (TMS32020/C25)
- 77230 Development System (NEC μPD77230)
- ADSP2100 Development System
- DF-1 Dataflow Processor (NEC μPD7281)

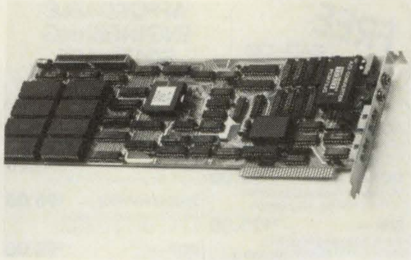
DSP Applications Systems:
- 77230 Co-Processor (NEC μPD77230)
- 2-Channel & 4-Channel Data Acquistion

Voice Systems:
- μPD7763/64 Speech Recognizer/Synthesizer
- Speech Synthesis Module

SPECTRUM SIGNAL PROCESSING INC

Boston: 1-800-323-1842 **or** 890-3400
USA, West: 1-800-663-8986
In Canada: (604) 438-7266

CIRCLE NO 340



TMS 320C25 DSP DEVELOPMENT SYSTEM

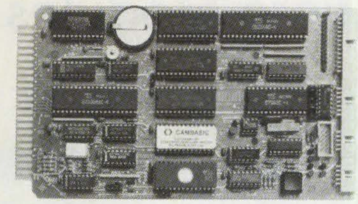
IBM-PC based DSP development system for TI's TMS320C25. With 16-bit 50KHz A/D & D/A, sample and hold, 16K×16 RAM (35ns) expandable to 128K on board, I/O expansion. Supports multi-board applications. Debug monitor provides single-step, breakpoints, and full speed operation. **US $2,595.** TI's Macro Assembler/Linker avail sep. **US $395**.

SPECTRUM

CIRCLE NO 341

NEW

CMOS CONTROL COMPUTER

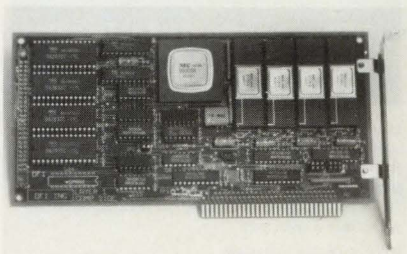


SBS-1000 has turbo speed, 20K industrial BASIC. Runs 5 times faster than BASIC-52 systems. All CMOS with Z80 CPU, EPROM/EEPROM programmer, 96K static RAM, 2 RS-232C serial ports, 32 lines digital I/O, 4 channels-12 bit A/D, battery backed calendar clock, keypad and display ports, expansion port, autorun mode, interrupts handled by BASIC, industrial quality, 5V and stand alone operation. From **$396** in 100s.

For Immediate Response: **303-426-8540**

OCTAGON SYSTEMS CORPORATION
6510 W. 91st Ave.
Westminster, CO 80030

CIRCLE NO 342

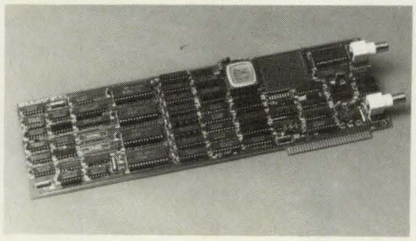


DF-1 DATAFLOW PROCESSOR

DSP development & applications with world's first dataflow chip. Four 10MHz NEC μPD7281 Dataflow Processors, 20 MIPS ALU power, 20 MIPS Flow Control 64k×18 RAM, PC access via μPD9305 MAGIC chip, DMA interface with PC's controller. Complete with menu-driver DFOS monitor program, 'C' Library Assembly language drivers, demo software.
US $1,495

SPECTRUM

CIRCLE NO 343



77230 DSP DEVELOPMENT SYSTEM

DSP development for NEC μPD77230 (CMOS 32 bit floating point DSP). IBM-PC plug-in board with μPD77230, COMBO/CODEC with on-chip A/D, D/A, anti-aliasing & reconstruction filters, prototype area, 12K×32 RAM expand. to 48K on-board, 4 MHz serial I/O interface. Complete EDSP Dev't S/Ware: debug monitor, Signal Generator, 'C' Library, Plotter.
US $1,995

SPECTRUM

CIRCLE NO 344

EPROM/PAL Programmer

- ★ **PAL MODULE** **$295**
- Programs 20 & 24 pin MMI (A,B), NS TI PALS
- Read JEDEC file format
- Security, DIR, LOAD, SAVE, EDIT, READ, WRITE, VERIFY,
- User friendly menu driven S/W.

*** EPROM MODULE (1, 4, 8 socket)** **$145**
-16K to 1024K EPROM, CMOS EEPROM.
-Read Intel, Motorola, TEK HEX file
-Very fast (Quick pulse), reliable, easy to use

*** BIPOLAR ROM MODULE** **$295**
-MMI, NS, TI & Signetics parts
-Read Intel, Motorola, TEK HEX file

*** 8741/42/48/49/50 Module** **$195**
-1, 4, 8 socket module available
-8748 Disassembler included
-Read Intel, Motorola, TEK HEX file

*** 8751/52/252/44 Module** **$245**
-Normal, Intelligent programming algorithm
-Read Intel, Motorola, TEK HEX file

*** TTL & MEMORY IC TESTER MODULE** **$195**
-Test almost TTL, CMOS, Dynamic, Static IC's
-Auto search for unknown IC part No.
-User can make his own test pattern

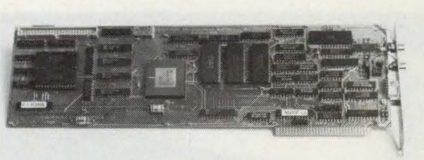
*** INTERFACE CARD & CABLE** **$50**
-This card is common to all above modules
-Fits in any PC/XT/AT or compatibles
-Space saving half size.

XELTEK

473 Sapena Ct., #24
Santa Clara, CA 95054
(408) 727-6995

CA residents add 6.5% tax.
Add $5 for S/H

CIRCLE NO 345

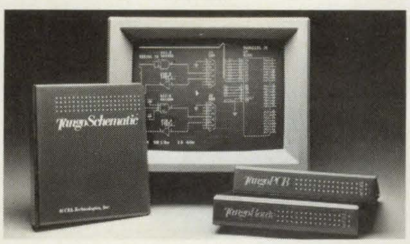


ADSP2100 DEVELOPMENT SYSTEM

PC plug-in board with ANALOG DEVICES' ADSP2100 processor for DSP and high-speed numeric processing applications. With 40k RAM (45ns) user expandable to 112k, 12-bit A/D & D/A (200 kHz), input sample-and-hold, I/O expansion supports multi-board applications. Debug monitor & documentation.
US $2,595.
COMPLETE WITH ANALOG DEVICES' Development software, Assembler/Linker, Simulator Application routines. **US $2,995.**

SPECTRUM

CIRCLE NO 346



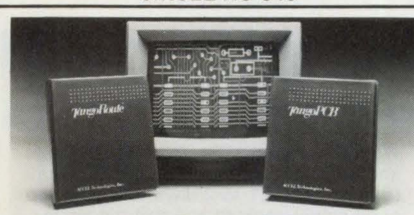
Great Designs Start With Tango-Schematic.™ Just $495.

Designs quickly come to life with Tango-Schematic's easy-to-use drawing editor and extensive component libraries. Features four line types, four text sizes, repeat and block functions, unique built-in word processor. Includes DRC, BOM, Wire List, Net List outputs and crisp plots, prints, or laserprints. The perfect front end to our popular Tango-PCB and Tango-Route board design systems.

For IBM PC/XT/AT/PS2. Just $495. Full-function Demo Package: $10. Order toll-free 800 433-7801. VISA/MC. Thirty-day money back guarantee.

ACCEL Technologies, 7358 Trade St., San Diego, CA 92121
Outside N., S. America contact HST Technology (Australia)
Phone: 61-02-34-8499 FAX: 61-02-23-8771

CIRCLE NO 347



Glide Through PCB Design.

TangoPCB™ Create the toughest board designs with powerful layout software that's a snap to use. Function-rich **Tango-PCB** supports eight layers, 1 mil grid, **OrCAD**™ or **Schema**™ netlist input, print/plot/photoplot output, and more.

TangoRoute™ Get impressive completion rates and remarkable speed with **Tango-Route**, a four layer, eleven pass autorouter.

Just $495 each.

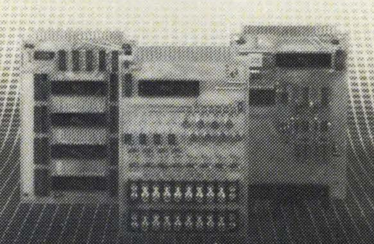
For IBM PC/XT/AT/PS2. Compare features and you'll buy **Tango**. Or try full-function Demo Package, just $10. Order toll-free: 800 433-7801. VISA/MC. Thirty-day money back guarantee.

ACCEL Technologies, 7358 Trade St., San Diego, CA 92121

CIRCLE NO 348

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

6800/6809 Micro Modules



OEM 6800/6809 MICROCOMPUTER MODULES for dedicated control and monitoring. Interfaces for sensors, transducers, analog signals, solenoids, relays, lamps, pumps, motors, keyboards, displays, IEEE-488, serial I/O, floppy disks.

WINTEK

Wintek Corp.
1801 South Street
Lafayette, IN 47904
317-742-8428
800-742-6809

CIRCLE NO 349

FREE CATALOG AND APPLICATIONS GUIDE

AFFORDABLE ENGINEERING SOFTWARE

PC/MSDOS—Macintosh—CP/M

ACNAP — $125.00
AC Network Analysis, Component Libraries, Macros, AUTO Execute

DCNAP — $95.00
DC Network Analysis, Component Libraries, Macros, AUTO Execute

SPP — $125.00
Signal Processing Program Macros, AUTO Execute, Windowing

PLOTPRO — $72.95
Scientific Graph Printing

PCPLOT3 — $95.00
High Resolution Engineering Graphics Package

LOCIPRO — $95.00
Root Locus Stability Analysis. Multiple, Nested Loops

ACTFIL — $95.00
Active Filter Design, Analysis, Synthesis

MICRO-3 — $125.00
Design & Analyze Microstrip Circuits, Filters, Hybirds, Couplers, Transformers

LCFIL — $95.00
LC Filter Design/Analysis/Synthesis

LSP — $95.00
Logic Circuit Design/Simulation

RIGHTWRITER — $95.00
Report Proofreader Program. Applies 3000 Rules of English

PDP — $95.00
Scientific Plotting Program for Pen Plotters

TEKCALC — $95.00
Programmable Scientific Calculator/Statistics/Curve-fitting

COMCALC — $72.95
Communications Budget Calculator and Spreadsheet Program

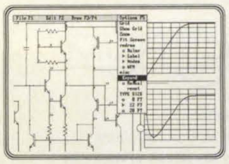
XFER — $95.00
Transfer Function Analysis and Circuit Synthesis

SPANNER — $95.00
Integrated Word Processor, HP11C Calculator, and Scientific Graphics

BV Engineering Professional Software
(714) 781-0252
2200 Business Way, Suite 207, Riverside, CA 92501 U.S.A. TELEX-3089864

CIRCLE NO 350

Analog Circuit Simulation



NEW
SPICE_NET

Make SPICE input files from schematic drawings using pull down menus and a mouse to draw and connect parts. Use an **IBM** PC with any UC Berkeley compatible SPICE program. Purchase the program for the special introductory price of $245.00 before Feb. 1, 1988.

Simulation Programs for IBM PC's from *intusoft*

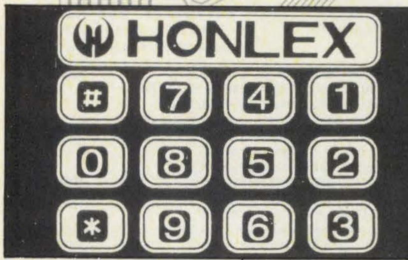
- **IS_SPICE, $95.00.** Performs AC, DC and Transient analysis.
- **PRE_SPICE $200.00:** Adds Monte Carlo Analysis, Sweeps, Optimization, libraries and algebraic parameter evaluation.
- **Intu_Scope $250:** A graphics post processor works like a digital oscilloscope. Easy to use with all the waveform operations you will ever need.

(213) 833-0710
P.O. Box 6607
San Pedro, CA
90734-6607

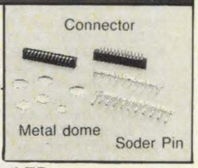
CIRCLE NO 751

High quality and Prompt delivery

Send in your special designs and specifications to Honlex, one of Taiwan's Leading Manufacturers.



We offer:
1. Membrane Keyboard
2. Flexible printed circuit board
3. Plastic name plates and Labels.
4. Connector, 2 pins to 24 pins.
5. Metal dome switch 6Ø-13Ø
6. Solder pins.



HONLEX INDUSTRIAL CO., LTD.
ADD: NO.3, LANE 10, PIENG HO RD., CHUNG HO CITY TAIPEI HSIEN. TAIWAN, R.O.C.
FAX: (02)2235739 CABLE: "HSUCH" TAIPEI
TEL:(02) 2235737-8 TELEX: 27722 JOENUNG

CIRCLE NO 752

5W REGULATED, SINGLE & DUAL OUTPUT ECONOMY DC/DC CONVERTERS, E SERIES

- 5W Max. Output @75°C Ambient
- Single and Dual Output Models
- 5 Input Voltage Ranges
- Internal Pi Filter
- 100MOhms @ 500VDC Isolation
- Efficiency @ FL 70%, Typ.
- Industry Standard Pinout
- 5 Output Voltage Ranges
- ±0.3% Line/Load Regulation
- Short Circuit Protection
- 20mV P-P Typ. Output Ripple and Noise
- 2"×2"×.375" 6-sided shielded case
- Optional ON/OFF Control for Battery Operation

Prices from $44.00 ea. (100's), Delivery stock to 3 wks. ARO

CONVERSION DEVICES, INC.
101 Tosca Drive, Stoughton, MA 02072
Tel. (617) 341-3266, TLX 920014

CIRCLE NO 753

DEVELOP ROMABLE SOFTWARE IN "C" WITHOUT AN EMULATOR

ROM C86™ is a software package that works in conjunction with the Aztec C86 c™ compiler. ROM C86 provides a cost effective means of developing efficient, ROMable software for 8088, 8086, 80188, 80186, and 80286 based microcomputers. The only hardware required is an XT/AT and a functional target system with a serial port.

WITH ROM-C86 YOU CAN:
- Use "C" library functions including PRINTF, FPRINTF, SCAN, FSCAN, MALLOC, and CALLOC.
- Specify the size and location of the stack and heap.
- Download programs from an XT AT to target RAM via a serial link using the DBR86 loader debugger program and the DM86 target system monitor.
- Debug programs in target RAM using the powerful symbolic debugging capabilities provided by the DBR86 loader debugger working in conjunction with the DM86 target system monitor.
- Use the HEXCON conversion program to convert relocatable .EXE files to extended hex format for down loading to an EPROM programmer.

ROM C86 Price — $499

Call TOLL FREE 1-800-521-0714 Ext. 229

M.K. HANSEN COMPANY
634 Industry Drive, Seattle, WA 98188
Aztec C86 c is a trademark of Manx Software Systems.

CIRCLE NO 754

PROTOTYPE P.C. BOARDS

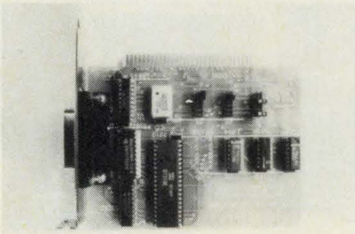
We have been making them for 20 years and the normal delivery time from artwork to prototype is 1 to 2 days; 3 days if you need soldermasking and part markings.

PCB's prepared directly from your **smARTWORK, EE Designer, Tango, AutoCAD, Generic CADD, CADDY, PADS-PCB, PROJECT:PCB, PROCAD, DRAFTSMAN-EE, Quik Circuit** or **McCAD** file.

We can work from the following:
1. 5 ¼" disk containing your PC Board design.
2. Transmit your PC Board design to our IBM/PC via modem.
3. Of course, we can use your 2:1 artwork.

PRECISION ETCHING LABORATORY, INC.
1205 Generals Highway Crownsville, MD. 21032
(301) 987-4023

CIRCLE NO 755



IEEE488 $145
LOW COST PC/XT/AT INTERFACE FOR IEEE-488 (GPIP/HPIB)

- SHORT CARD FOR PC/AT/XT & COMPATIBLES
- 1 OF 6 INTERRUPT LEVELS
- 1 OF 2 DMA CHANNELS
- UP TO 4 BOARDS/COMPUTER
- CONTROLLER/TALKER/LISTENER
- QUANTITY DISCOUNTS
- COMPATIBLE WITH MOST SOFTWARE PACKAGES

Call today for datasheet!

B&C MICROSYSTEMS
355 West Olive Ave., Sunnyvale, CA 94086
Ph: (408)730-5511 Fax: (408)730-5521 Visa & MC

CIRCLE NO 756

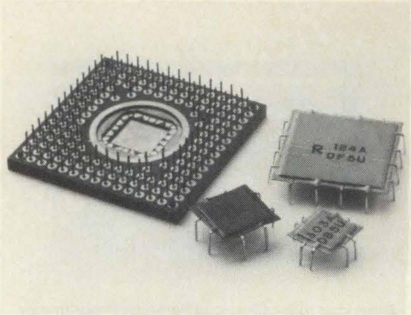
LeCROY MODEL 9100 HIGH SPEED CUSTOM WAVEFORM GENERATOR

LeCroy's new Arbitrary Function Generator features an output rate of up to 200 megapoints/sec to permit the generation of wide bandwidth custom waveforms not previously possible with simple digital techniques. The 9100 offers 2 channels, 10 V output range, 5 nsec risetime, 350 KB of non-volatile waveform storage and 64 KB of high speed operating memory. Standalone operation as either a standard function generator or pulse generator is built in. Easy-to-use waveform creation software is MS-DOS compatible. Price, $8900 (U.S.A.), plus options.

LeCROY CORPORATION, 700 Chestnut Ridge Rd. Chestnut Ridge, NY 10977-6499 (914) 578-6020

CIRCLE NO 757

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



STOP NOISE IN PGA, LCC PACKAGES

PGA MICRO/Q decoupling capacitors provide low-inductance, high-frequency noise decoupling for PGA, LCC packages on complex board layouts. Fit under PGA or LCC sockets use no extra board space. Choose from many pinout configurations. **Rogers Corp.**, 2400 S. Roosevelt St., Tempe, AZ 85282. 602/967-0624.

CIRCLE NO 758

Yours Free

...our newest LVDT design guide and catalog.

At last, a complete compendium of LVDT working parameters. Call us now for fast solutions to your OEM requirements.

800-323-7115

® In PA, 800-323-7114

Robinson-Halpern COMPANY

A Subsidiary of Teleflex Incorporated (USA)

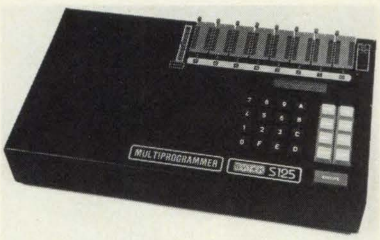
CIRCLE NO 759

Temperature: 820 pages cover all aspects of temperature measurement and control. Shows hundreds of probes, accessories, wire, handheld and panel readouts, controllers, recorders and computer interface equipment. Many new products have been added this year, including humidity measurement systems, and data acquisition devices.

Call or write TODAY for more information!

Contact:
OMEGA ENGINEERING, INC.
AN OMEGA Group Company
One Omega Drive
P.O. Box 4047
Stamford, CT 06907
Telephone: (203) 359-7613
Telex: 996404

CIRCLE NO 760



TWO-IN-ONE EPROM MULTIPROGRAMMER™

only $995.00

BYTEK's S125-EG is a SET EPROM PROGRAMMER that's also a GANG EPROM DUPLICATOR.

DESIGN ENGINEERING TOOL provides SET Programming of 16 & 32 bit words. Multiple EPROMs with different sets of data can be programmed in one easy operation.

STAND ALONE: 25 Keys/32 char. LCD provide User Friendly operation to EDIT, SPLIT or SHUFFLE Data. RS232 PC Interface: Operates from a PC or terminal. Optional IBM PC driver.

PRODUCTION GANG EPROM PROGRAMMER: Duplicates up to 8 devices from RAM or Master. (Optional 16)

RAM: 64K bytes (512K bit), expandable to 1 Meg.

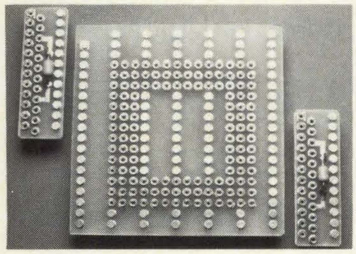
VERSATILE: MOS/CMOS/NMOS EPROM/EEPROM, 24 & 28 pin devices. Options for 32 & 40 pin devices.

Free Device Support Updates. 1 Year Warranty.
FOR IMMEDIATE DELIVERY ORDER TOLL FREE:
1-800-523-1565 (In FL 305-994-3520)

BYTEK Corporation
1021 S. Rogers Cir., Boca Raton, FL 33487
FAX: (305)994-3615 TELEX: 4998369 BYTEK

CIRCLE NO 761

PGA & LCC PROTOTYPE

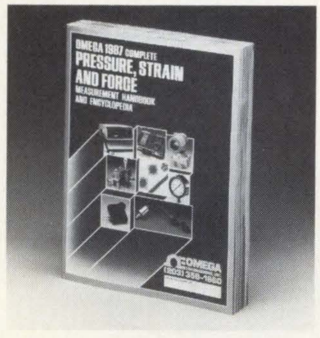


TEST ADAPTORS - VLSI

Ironwood's line of **VLSI prototype adaptors** allow prototyping of devices from 24 pin (video RAM **ZIP**), **Shrink DIP**, to **240 pin PGA**, ***PIP*** families **80X86 and 680X0** along with many other patterns. **Annotated test adaptors** for 68010, 68020, 80186, 80386. All gold Machined pins / most wirewrap panel patterns. **Customs - quick turnaround.**

IRONWOOD ELECTRONICS, INC
P.O. BOX 21-151
ST. PAUL, MN 55121
(612) 431-7025

CIRCLE NO 762



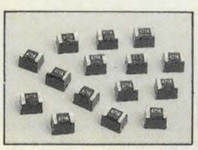
Pressure, Strain and Force: 320 pages, with a new section devoted to pressure switches. New for 1987 are force measurement products, along with a wide selection of pressure transducers, strain gage sensors and load cell systems.

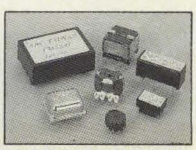
Call or write TODAY for more information!

Contact:
OMEGA ENGINEERING, INC.
AN OMEGA Group Company
One Omega Drive
P.O. Box 4047
Stamford, CT 06907
Telephone: (203) 359-7613
Telex: 996404

CIRCLE NO 763

CHIP COILS
DC-DC CONVERTERS
PULSE TRANSFORMERS





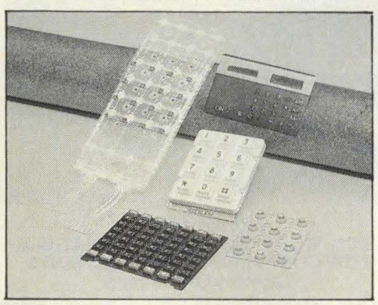
Our Chip Coils is good for your miniaturization & surface mounting. DC-DC Converters, pulse transformers & band pass filters is now complete with excellent functions. We also supply choke coils, power chokes, linearity coils, toroidal coils, pulse transformers, coupling transformers, power transformers and others. Send for details today.!

ABC — OEM and Agent Inquiries Invited

ABC TAIWAN ELECTRONICS CORP.
No. 422, Sec. 1, Yang Fu Rd., Yangmei 32627, Taoyuan, Taiwan, R.O.C.
Tel: (03) 4788088, Telex: 32379 ABCEC
Fax: (03) 4755503

CIRCLE NO 764

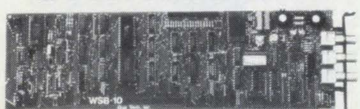
SILICONE RUBBER PADS
FLEXIBLE PRINTED CIRCUIT
O.E.M. KEYBOARD ASSEMBLIES

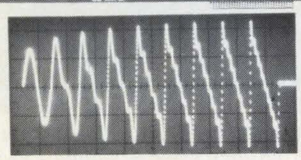


ENCOUNTERS PRODUCTS CORP.
6/F., Diamond Mansion, 20, Hsing An St. Taipei, Taiwan, R.O.C.
Tel: (02)5031876 [4 lines]
Telex: 26267 ENCOUNTS
Fax: 886-2-5029391

CIRCLE NO 765

WAVEFORM SYNTHESIZER





- For IBM-PC/XT/AT and compatibles
- Generates user-definable signal
- Up to 2000 points per envelope

$795.00

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726
800-553-1170

CIRCLE NO 766

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

Don't Burn, Shoot, or Blow ... Program with the EP-1 EPROM PROGRAMMER

$349 Made in America

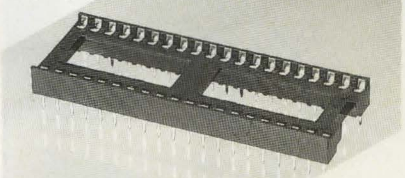
- Free PCDOS software or RS-232 to any computer.
- Reads, Programs, and copies over 250 EPROM's and EEPROM's from AMD, Intel, SEEQ, TI, Fujitsu, Hitachi, Toshiba, and 21 others.
- 2716-27512, 27011, 25XX, 28XX, 87XX, 687XX, Including CMOS and -A suffix.
- Programs 87C51, 8749, 8741A, 8742 and other microcontrollers with optional heads.
- Splits 16- and 32-bit files.
- Generates and checks checksums.
- Batch mode operation works with Make.
- Reads and Generates Intel, Motorola, Tekhex, Straight hex, and binary files.
- 30 day money back guarantee.
- UV Erasers from $34.95.

CALL TODAY FOR MORE INFORMATION

BP MICROSYSTEMS
10681 Haddington, #190 / Dept. E1
Houston, Texas 77043
(800) 225-2102 (713) 461-9430 Telex: 1561477

CIRCLE NO 767

All You Can Expect From AYE. A Professional. IC Socket Maker



8, 14, 16, 18, 20, 22, 24, 28, 40-pin and your custom-design inquiries will be answered immediately.

A.Y OEM & Overseas Agents Wanted!

AYE ENTERPRISE CO., LTD.
No. 56, 5 Alley, 524 Lane, Hua Cheng Rd., Hsin Chuang City, Taipei Hsien, Taiwan, R.O.C.
Cable: AYECO TAIPEI Tel: 886-2-994-9181
Fax: 886-2-993-1956 Telex: 24559 CLIMAXTP

CIRCLE NO 768

America's most advanced Personal Programmer

One programmer, one socket, one price, one thousand and one devices.

The most advanced firmware controlled pin driver system available means you never have to worry about buying another expensive module or PAK again. The "IQ" Personal Programmer line offers the power and features comparable to many of the $10,000 programmers, but at a fraction of the costs.

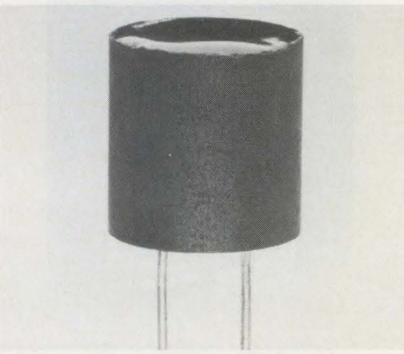
Support for CMOS, NMOS, ECL, Bipolar, PROMs, EPROMs, eEPROMS, PLDs, ePLDs, IFLs, FPLDs, up to 40 pin DIP packages.

AMD, Atmel, Cypress, Excel, Fairchild, Fujitsu, GI, Hitachi, Hughes, Intel, Lattice, Mitsubishi, Motorola, National, NEC, MMI, Samsung, Seeq, Sierra, Signetics, SMOS, TI, Toshiba and Waferscale.

Whatever your need is, Digital Media can help you solve it. And you won't believe how little it costs.

Call (714) 751-1373 to receive a complete product specification package immediately.

CIRCLE NO 769



GR MINI-INDUCTOR

AIE Magnetics introduces a new miniature inductor, for use in .1 to 1 amp switching regulators, that offers a lower cost and smaller size than previous units. They also provide higher efficiencies as well as high inductance and increased current levels. The units are self-shielding for less radiated noise and sealed for compatibility with all types of cleaning systems. **Vernitron Corp., 2801 72nd Street North, St.Petersburg, FL 33710. 813/347-2181.**

CIRCLE NO 770

Quelo® 68000 Software Development Tools

First release 1983 - MOTOROLA compatible - produces ROMable code, S-records, extended TEK hex, UNIX COFF. Portable SOURCE CODE. Native and cross versions on: ATARI ST, AMIGA, Masscomp, Sun, Apollo, Charles River, VAX VMS and UNIX.

68020 Cross Assembler Package
Supports 68000, 68010, 68020, 68881 and 68851
For CP/M-68K and MS/PC-DOS - $750

68000/68010 Cross Assembler Package
For CP/M-80, -86, -68K and MS/PC-DOS - $595

68000 "C" Cross Compiler
For MS/PC-DOS by Lattice, Inc. - $500

NEW ITEMS

68020 Disassembler
Supports 68000, 68010, 68020, 68881, 68851
For CP/M-68K and MS/PC-DOS - $495/295,
Amiga and Atari ST - $119/79, CRDS UNOS - $995/595

68000/68010 Software Simulator
For MS/PC-DOS by Big Bang Software, Inc. - $285, VAX - $1900

Call **Patrick Adams** *today:*

Site, Corporate, OEM licenses
COD, Visa, MasterCard

Quelo, Inc.
2464 33rd. West, Suite #173
Seattle, WA USA 98199
Phone 206/285-2528
Telex 910-333-8171

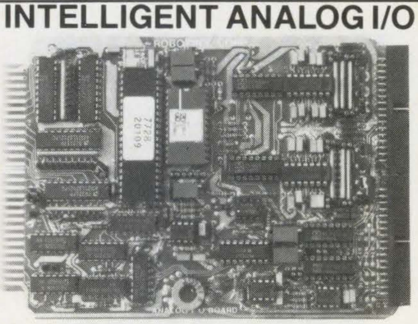
TM: Quelo, Quelo, Inc.; MS, Microsoft Corporation; CP/M, Digital Research

CIRCLE NO 771

Introduce new products and literature
♦
Build awareness in the marketplace
♦
Supplement your advertising campaign
♦
EDN Product Mart

CIRCLE NO 772

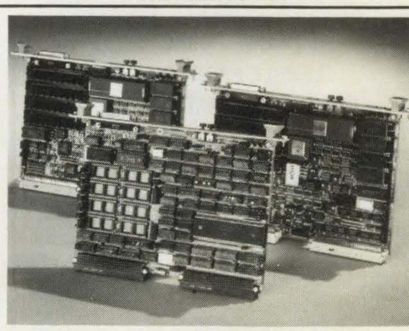
INTELLIGENT ANALOG I/O



The RSD-7728 is STD bus compatible w. 16 S.E. or 8 diff. inputs and 8 outputs, all with 12 bit resolution. Onboard microprocessor has 13 programmable modes, 6 for outputs, 7 for inputs. Inputs have software programmable gain. I/O may be either voltage or current loop. Several jumper connected voltage ranges. Memory or I/O mappable. Vectored interrupt.

ROBOTROL CORPORATION
16100 Caputo Drive, Morgan Hill, CA
95037 (408) 778-0400.

CIRCLE NO 773

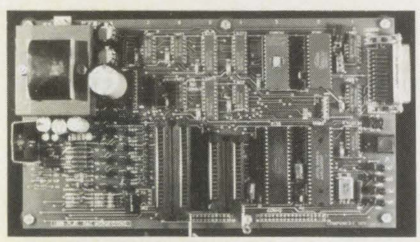


VMEbus CPUs -
100% MOTOROLA MVME COMPATIBLE
LOW COST PLUG-IN REPLACEMENTS
Quantity One Pricing

- **TVME 1611** (MVME 117-3 Compatible) $895
  Up to 4 MB DRAM
- **TVME 1612** (MVME 110-1 Compatible) $620
  System Control at 8 or 10 MHz
- **TVME 1613** (MVME 110-1 Compatible) $795
  Up to 1 MB Shared DRAM

TL Industries, Inc. Toledo, OH 43619
Call Now – Toll Free 1-800-227-8144
or 419-666-8144

CIRCLE NO 774



UNIVERSAL EPROM PROGRAMMER KIT FROM $95!

- On board power supply, 110/220 VAC;
- Menu selection; No personality modules;
- Built in monitor for easy I/O debugging;
- User friendly softw; Full tech. support;
- Detailed 50 page manual with schematics;
- Quick pulse alogrithm: 27256 under 60 sec;
- All 24/28 pin parts to 1 Mbit; CMOS; **EEPROMS**;
- Micros: 8741, 48, 48H, 49, 49H & CMOS
- **IBM-PC, Apple, CPM or Unix driver; Autobaud RS232**;
- Offset/split Hex, Binary, Intel & Motorola 8, 16 & 32 bit files, 2 board cased unit $495!

Call today for datasheets!!

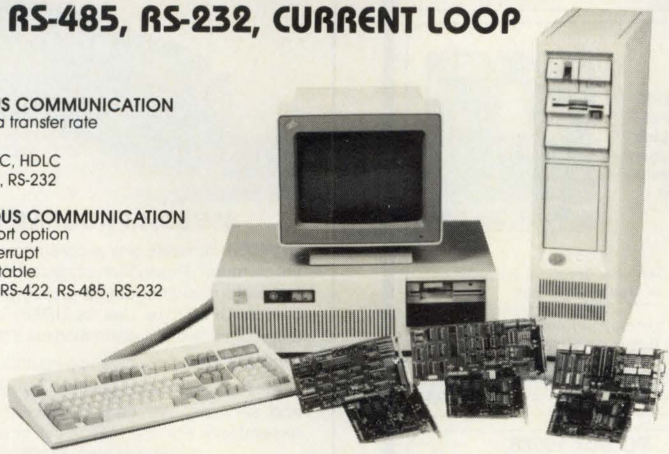
B&C MICROSYSTEMS
355 WEST OLIVE AVE., SUNNYVALE, CA 94086
Ph: (408) 730-5511 VISA & MC

CIRCLE NO 775

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

SYNCHRONOUS/ASYNCHRONOUS

RS-422, RS-485, RS-232, CURRENT LOOP



SYNCHRONOUS COMMUNICATION
- 1 Mbaud data transfer rate
- DMA facility
- Byte sync, SDLC, HDLC
- RS-422, RS-485, RS-232

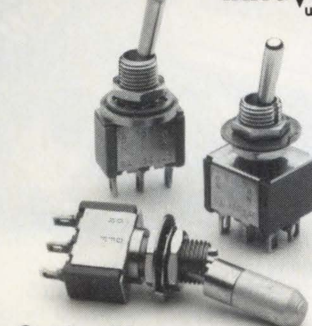
ASYNCHRONOUS COMMUNICATION
- Single/dual port option
- Selectable interrupt
- Address selectable
- Current Loop, RS-422, RS-485, RS-232

QUA TECH INCORPORATED
Leaders in Communication Technology

TOLL FREE: 1-800-553-1170
478 E. Exchange St. Akron, Ohio 44304
(216)434-3154 TLX:5101012726 FAX:(216)434-1409

CIRCLE NO 777

we make **innovation** work for you



Cutler-Hammer miniature sealed toggles

Qualified to MIL-S-83731

These rugged miniatures are available in 1 and 2-pole configurations, with standard lever or lever lock operation. And they're yours at a miniature price. Technical assistance and customer service are always part of the product. Another innovation from: Eaton Corporation, Aerospace/Commercial Controls Division, 4201 N. 27th St., Milwaukee, WI 53216.

EATON

CIRCLE NO 778

Join Forces

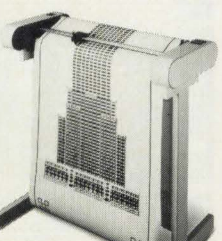
Combine your larger ads with EDN Product Mart ads for a total marketing program.

♦

EDN Product Mart

CIRCLE NO 779

"D" SIZE PLOTTER



$2295.00
RETAIL

$1695.00
INTRODUCTORY OFFER

- Model PC 3600
- Repeatability .001″
- Speed at 7″ Per Second
- Vacuum Paper Hold Down
- High Resolution Circles: Suitable for PCB Artwork

(415) 490-8380 **ZERICON**
4423 ENTERPRISE ST. • FREMONT, CA 94538

CIRCLE NO 780

EE DESIGNER™

CAE/CAD Integrated Software Package for IBM PC, XT or AT

$995

At only $995, no electrical engineer can afford to be without this end-to-end circuit design, simulation and PCB layout tool.
You can pay up to 15 times more and still not get all the features offered by EE Designer—Schematic Capture. . . Circuit Simulation. . . PCB Layout.
30 day money back guarantee. Full purchase price refunded if not completely satisfied.
Call 1-800-553-1177 today to order your package. Bank cards welcome.

VISIONICS
343 Gibraltar Drive
Sunnyvale, CA 94089

CIRCLE NO 781

SMT & VLSI TEST ACCESSORIES

ARE YOU USING:
ASIC'S, SMD'S, 8/16/32 BIT MPU'S SMD PROGRAMMABLE LOGIC OR MEMORIES?

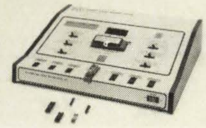
WE PROVIDE SOLUTIONS TO MANY INTERCONNECT PROBLEMS . . . .

- ★ Test Adapters (Socketed LCC/PLCC/PGA)
- ★ Test Clips (Surfaced Mounted SOIC/PLCC)
- ★ 150 Types of Prototyping Board Adapters
- ★ 125 Types of Programming Socket Converters
- ★ Many Types of Emulator Pod Converters
- ★ PGA/PLCC Extraction/Insertion Tools
- ★ And Much, Much More...

ET
Emulation Technology, inc.
STATE OF THE ART VLSI AND SURFACE MOUNT ACCESSORIES
2368-B Walsh Ave • Bldg D • Santa Clara, CA 95051
TEL (408) 982-0660 • FAX (408) 982-0664

CIRCLE NO 782

THE BETTER RAM TESTER



WITH BETTER COST/PERFORMANCE

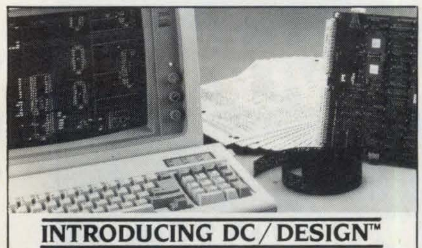
IST Model 6400 ADVANTAGES:

- Tests most Static RAMs or DRAMs up to 1Mbit.
- Automatically rejects any out-of-tolerance device (in power consumption or speed) by testing operating current and access time.
- A software controlled edge deskew procedure generates the most precise timing waveforms for DRAMs testing.
- Tests function with a group of specialized test patterns to detect all possible faults.
- Interface to automatic IC handlers with front panel control sorting capability.
- Stand alone or slave to a terminal or computer (via RS-232C) for detailed test result display or failure analysis.
- Modular architecture eliminates set-up time when changing over from one device to another.
- Low cost/high performance with one-year warranty. Price: $2,500.

INFORMATION SCAN TECHNOLOGY
IST
487 Gianni Street
Santa Clara, CA 95054
FAX: (408) 980-1794
TELEX: 372 4348 INFO SCAN

FOR LOW COST/ HIGH PERFORMANCE, call:
(408) 988-1908

CIRCLE NO 783



INTRODUCING DC/DESIGN™

Design Computation's complete PCB design package with schematic capture **$975**

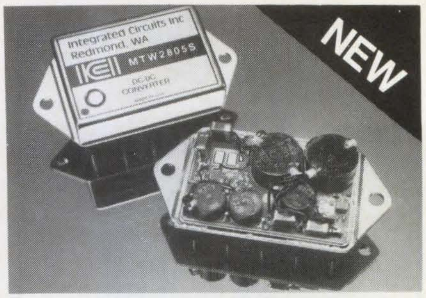
A true high-end CAE/CAD design tool that every electrical engineer can afford. For IBM PCs and compatibles, DC/DESIGN is feature-packed with schematic capture, parts placement, interactive autorouting and much more.
Our professional one-mil, diagonal autorouter is also available.

We challenge you to find a better PCB design package.
30 day money-back guarantee. Call today to place your order or for more information. Demo available.

DESIGN COMPUTATION
Ten Frederick Avenue
Neptune, NJ 07753
(201) 922-4111 TWX: 510-601-8352
Visa and MasterCard accepted

CIRCLE NO 784

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



MTW2805S – MINIATURE DC-DC CONVERTER – 30 WATTS

Integrated Circuits Inc. announces the MTW2805S, the latest complement to their line of high efficiency, thick film hybrid, DC-DC Converters.

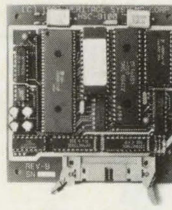
Measuring only 1.95″×1.35″×0.50″ the hermetically sealed MTW2805S generates a fully isolated +5VDC/6amp. output over the input rate of 19-40 VDC from −55°C to +85°C with 82% efficiency (typ.) Other features include short circuit protection, remote load voltage sensing, internal I/O ripple filters, an inhibit function and optional environmental screening $420/100 stock. For additional information, contact:

INTEGRATED CIRCUITS INCORPORATED
10301 Willows Road, Redmond, WA 98052
Telephone (206) 882-3100
FAX (206) 882-1990 TWX 910-443-2302

CIRCLE NO 785

Heritage Systems Corporation

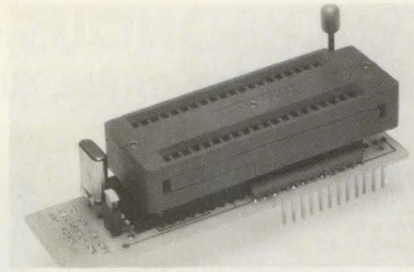
HSC-9100
80 By 24
Or 25 Line
Alpha-numeric
Video Terminal
Card



ANSI X3.64/Other Terminal Emulations
50 To 38.4K Baud Serial Port
RS-232 Or TTL/CMOS Versions
IBM PC Compatible Keyboard Input
EEPROM Based On Screen Config
Composite or Separate Video
100 By 100mm Card 5V Only @ 200mA
$139 TTL/CMOS **$149 RS-232**

PO Box 10588,
Greensboro, NC 27404-0588
(919) 274-4818

CIRCLE NO 786



$95 8751 PROGRAMMER

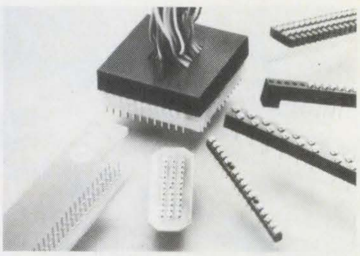
UPA8751 converts any programmer into an 8751 programmer. Production programming of 8751s is fast and cheap with your gang programmer and one or more UPA8751s. Use the UPA8751 to copy protect your code by programming the 8751 security bit.

Price $95 UPS Ground shipping included.

Logical Systems also provides development tools and services. We carry Simulators and Cross-Assemblers. For information call or write:

Logical Systems
6184 Teall Station
Syracuse, NY 13217 USA
(315) 478-0722 Telex: 6973150 EJB

CIRCLE NO 787



SAMTEC PROVIDES "BALL PARK PRICING SERVICE" FOR CUSTOM INTERCONNECTS

Samtec's "Ball Park Pricing Service" enables engineers to quickly estimate development and production costs for custom interconnects from modifications of standard products to completely new 100% custom designed parts.

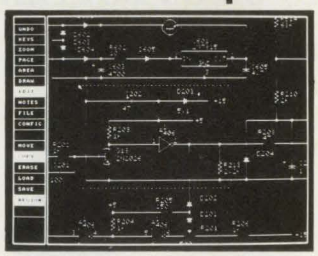
Capabilities include custom molding of standard and high temperature polyesters for vapor phase and infra-red soldering applications; lead socket and terminal design choices, including solder tail, wire-wrap and surface mount terminations; and plating options including gold, tin and selective plating. Capabilities also include flat and round cable assemblies in both soldered and IDC designs.

For information contact:

Samtec, Inc.
P.O. Box 1147, 810 Progress Blvd.
New Albany, IN 47150
Phone: **(812) 944-6733** FAX: (812) 948-5047 TELEX: 333-918

CIRCLE NO 788

SCHEMA II Schematic Capture



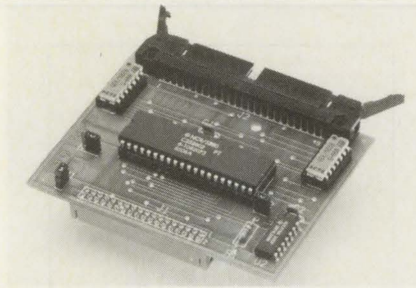
FREE Demo Disk: 1-800-553-9119

SCHEMA's success is the talk of the CAE industry and *thousands* of satisfied SCHEMA owners know why. Incredible speed, ease of use, and power have made SCHEMA a best-selling schematic capture program for engineering professionals the world over.

Now, SCHEMA II is available. SCHEMA II sells for $495 and supports most common IBM PC/XT/AT configurations. Please call today for a *free* SCHEMA II demo disk.

OMATION
In Texas Call (214) 231-5167

CIRCLE NO 789



SCSI BUS INTERFACE MODULE

The SBSxSCSI provides the industry standard SCSI interface (ANSI X3T9.2) on a single-width SBX module. Intel iSBX™ multimodule (IEEE P959 I/O Bus) compatibility assures you of a reliable connection to your host board. A software driver example is available to simplify programming.
Call or write for more information.

Single Board Solutions, Inc.
20045 Stevens Creek Blvd.
Cupertino, CA 95014
(408) 253-0250

CIRCLE NO 790

ADVERTISE IN PRODUCT MART AT LOW COST

Fill out this form to advertise in Product Mart. EDN 121087

ISSUE(S) REQUESTED ____________________

RATE:	**1x**	**4x**	**7x**	**13x**	**19x**	**26x**	**39x**	**52x**
(Please circle)	$780	750	730	660	640	630	620	595

Company ____________________
Address ____________________
City ____________________ State__________ Zip __________
Telephone ____________________
Signature ____________________

AD ENCLOSED ☐ AD TO FOLLOW ☐

Mail to: EDN / 275 Washington Street / Newton, MA 02158-1630

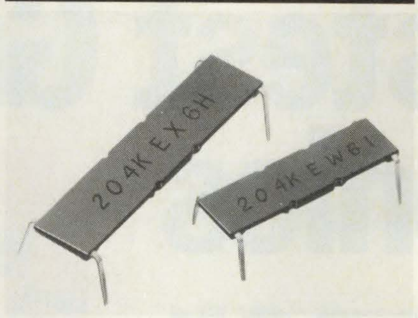
EDN PRODUCT MART appears in every issue — 26x a year!

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

smARTWORK® PCB SOFTWARE. In a fraction of the time hand taping requires, create double-sided printed-circuit boards with smARTWORK and your IBM PC. The program's features include interactive routing, autorouting, continual design-rule checking, automatic pad shaving, a silkscreen, and text for all three layers. **smARTWORK** is $895 and comes with a 30-day money-back guarantee. Credit cards accepted.

Wintek Corporation
1801 South Street, Lafayette, IN 47904
(800) 742-6809 or (317) 742-8428

CIRCLE NO 220



MICRO/Q II

FOR A DECOUPLING CAPACITOR THAT SAVES SPACE, DEFEATS NOISE, IS SUITABLE FOR MILITARY APPLICATIONS AND BEATS HUMIDITY, HEAT AND COLD:
ROGERS MICRO/Q® II
Rogers Corp., 2400 S. Roosevelt,
Tempe, AZ 85282. 602/967-0624

CIRCLE NO 221

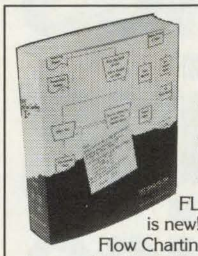
KEY TO PCAD™ SOFTWARE

- Hardware decoder for all **PCAD™** software
- 100% protocol compatible with **PCAD™** security device
- Used through system RS232-C input port
- Also provides RS232-C input for your mouse
- One **PC-WIZZ decoder** per PC/XT/AT enables it to run all **PCAD™** software
- Price: only **$995.**, shipping included
- 90 day warranty

PC-WIZZ SYSTEMS, INC.
P.O. BOX 2190, HARVARD SQ.
CAMBRIDGE, MASS. 02238
1-800-363-8022

PCAD™ is a trademark of Personal CAD Systems, Inc.

CIRCLE NO 222



Flow Charting II+

The New Plus for Fast Flowcharting

FLOW CHARTING is new! It's now Flow Charting II+, with more speed + more functions + more printing options;

• 10 text fonts; 26 shapes; • Line mode can stop at a shape; • Backspace key can erase a line to its origin; • Free text entry anywhere, or select auto-centering; • Vertical or horizontal printing; one chart or multiple charts.

Used by Fairchild, Bechtel and more than 500 other major corporations. Edit quickly and accurately — even major edits — with Flow Charting II+, the Specialist.
See your retail store or call:

PATTON & PATTON
Software Corporation
800/672-3470, ext. 897 California
800/538-8157, ext. 897 National
408/629-5044 International)

CIRCLE NO 223

Low-Cost

In-Circuit Emulators!

NEW! **68010**
68000 Z80 Z80+
8085 8088
NSC800

- Real time or single step execution.
- Small enough to plug into µP socket.
- RS-232 interface to terminal or PC.
- Up/download HEX/S-record files.
- Hardware or software break points.

— *$550 to $1995!* —

Nicolet 800-NICOLET (642-6538) or 608-273-5008

CIRCLE NO 224

PC BOARD TRACE AMMETER

Solve your next printed circuit test or analysis problem twice as fast by measuring trace currents in addition to voltages.

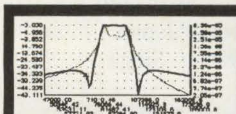
The IEX-1500 uses a single four-point probe to measure 0 to 1500 milliamps DC with 1 milliamp resolution in un-cut PCB traces. It does not depend on in-line resistors, field measurements or knowledge of trace resistance.

Operation is as simple as placing the probe on the trace and reading the current.

CALL FOR RISK FREE TRIAL: (904)-335-7730

WAYNE ENGINEERING
5426 NW 32ND STREET
GAINESVILLE, FL 32606

CIRCLE NO 225

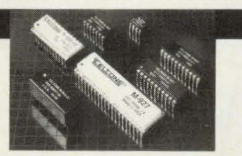


Design Scope™

Save *time and money* as you speed up system level design. Analog and digital systems can be assembled, simulated, changed, and resimulated in a matter of minutes. Waveforms can be imported/exported via text files. Includes up to 16th order VC filters (with response plots), PLL's, VCO's, digital logic gates, FFT's, dual-trace oscilloscopes, amplifiers, comparators, and more. DesignScope, system level simulation on any Macintosh with at least 512K, is $250. Demo disk: $10.

BrainPower, Inc.
(818) 884-6911 / (800) 345-0519

CIRCLE NO 226

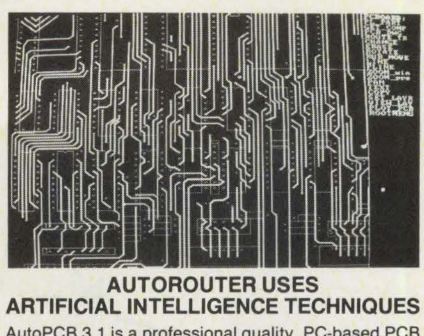


For all your telecom equipment design needs:

- ***Call Progress Tone Detectors & Generator***
  CMOS detectors for telephone system tones (dial tone, ringback, busy, special information); CMOS generator for standard call progress tones.
- ***DTMF Receivers***
  High quality receivers for all applications.
- ***MF Receivers & Generator***
  CCITT R1 & R2 receivers; CMOS generator IC.
- ***DC Signalling Products***
  Line sense relay; Dial pulse counter & hook status monitor IC; Binary input pulse dialer IC.

TELTONE®
10801-120th Ave. NE, Kirkland, WA 98033, (206) 827-9626
1-800-426-3926

CIRCLE NO 227



AUTOROUTER USES ARTIFICIAL INTELLIGENCE TECHNIQUES

AutoPCB 3.1 is a professional quality, PC-based PCB design system. No co-processor board is required. It features schematic capture, interactive part placement and route editing, and includes AutoROUTE, a powerful autorouter that uses artificial intelligence techniques to identify optimal routing patterns, such as the S turn and C patterns shown above, as part of the routing process. All layers of multilayer boards are routed simultaneously (up to 24). Post processors for photoplotters and drill tapes are available. A large, 4500 component part library lets you start designing boards immediately. A 30-day, full refund guarantee is provided.

PRO. LIB, Inc.
624 E. Evelyn Ave., Sunnyvale, CA 94086
Tel. (408) 732-1832, FAX 408-732-4932

CIRCLE NO 228

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

An experimental graduate-engineering program opens new study opportunities

Deborah Asbrand, *Associate Editor*

Design engineer Daniel Sternlicht has always been good at making the most of opportunities. Shortly after graduating from the University of Pennsylvania with a degree in marine biology, Sternlicht abandoned a planned oceanographic career and decided instead to pursue an interest in engineering. He headed for the mecca of engineering, California, and after several months of door-knocking, succeeded in getting a job as an engineering technician at Teledyne Microwave in Mountain View.

To supplement his on-the-job learning, Sternlicht immediately began taking courses in advanced math and electronic technology at local colleges. Two and a half years after joining Teledyne Microwave, he was promoted to design engineer. But there was one area in which there were few opportunities available to him: education. What he really wanted was a master's degree in engineering, but without a bachelor's degree in the subject, the chances were slim that he would gain admission to a traditional program.

Now, though, Sternlicht is enrolled in a master's program and slowly working his way toward an advanced engineering degree. He's one of many students taking advantage of an innovative program that the University of Santa Clara has set up to aid people who, like him, have technical positions in electronics companies but who have risen through the ranks minus undergraduate engineering degrees.

Nearly 100 students are enrolled in the university's largely experimental program, known as Program 2. Although many of them are studying graduate-level material, others have been accepted into the program on the condition that they first complete undergraduate math requirements. Only one student has been graduated to date, and Ken Haughton, dean of engineering at the small Jesuit college, says the school wants to keep the program's enrollment small while it fine-tunes the curriculum.

> ***Haughton expects that engineering education will someday be conducted primarily on the graduate level in professional schools, much as medical and legal education is today.***

While Sternlicht was wondering how he'd get the advanced engineering education that he wanted, Haughton was wrestling with the educator's side of the same problem. Engineers weren't the only ones looking for programs that offered alternative forms of study. From time to time, marketing and administrative professionals in the electronics industry would phone Haughton looking for part-time engineering programs that would complement their business expertise. Except for recommending that the callers enroll in undergraduate night classes, Haughton had no solutions.

The phone conversations nagged at him, though, because the callers' dilemmas were not new to him; he had known many people in similar predicaments during his 25-year career at IBM. "I often saw people who'd had their responsibilities expanded to the point where they felt frustrated at not having a technical background," he recalled. "No matter where you start [in a technology company], if you have the inclination, you're somehow going to wind up involved in the technology."

When Haughton left industry in 1982 to become dean of the University of Santa Clara's engineering school, he suddenly found himself in a position to solve the problem. During informal round-table discussions between the university and industry representatives, Haughton broached the idea for a graduate engineering program tailored for individuals with undergraduate degrees in liberal arts and natural sciences. The participants' reactions were positive. "Typically, the response was 'My God, I wish I had had a chance at a program like that,'" Haughton remembers.

The changing face of education

Haughton had another reason for wanting to start Program 2: his expectation that engineering education as a whole will someday be conducted primarily on the graduate level in professional schools, much as medical and legal education is today. "I think the . . . day is coming when we're going to have to re-evaluate engineering education in this country . . . . We are experiencing enormous technical progress, and it's becoming increasingly difficult for undergraduate programs to keep up."

With those thoughts in mind, Haughton decided in 1983 to undertake his grand experiment. Students in the program give it rave reviews. Sternlicht says the five-credit course in microelectronics that he's currently enrolled in teaches him the theories behind the work he's been doing. "I've used a lot of the equipment and devices that we learn about, and now I'm really learning the theory."

Design engineer Andrei Bostan believes that Program 2 has given him an opportunity to study that he might not otherwise have had. In 1978, Bostan and his family immigrated to the United States from Rumania, where he had been a violinist with the state-national orchestra. Arriving in San Francisco, he joined the musicians' union and paid his $400 dues only to discover that he was one of roughly 240 out-of-work professional violinists in the Bay Area. Looking for a field that offered a better chance of employment, Bostan took a job as a badge assembler. After climbing the ladder through a variety of engineering-technician positions, he was promoted to design engineer in 1982.

Although Bostan questions whether a person must have a degree to succeed as an engineer—"I don't think Edison or Faraday had degrees"—he expects the degree he's working toward to "legitimize" his engineering work. Bostan has taken 20 undergraduate classes in mathematics, C and assembly languages, and microprocessor design. In 1983, he was conditionally accepted into Program 2. He's been gradually completing his mathematics requirements while taking engineering courses, but nonetheless anticipates another four years of study before he graduates.

Haughton concedes that because the program is largely an experiment—as he carefully explains to each enrollee—there are still aspects of it to be worked out. For instance, he fears that Program 2 graduates, though skilled in their areas of expertise, will miss out on the breadth of engineering experience from which typical engineering students benefit. "That's the thing that worries me most," he says. "Our undergraduate civil engineering students, for example, take a couple of major courses in mechanical engineering and three in electrical engineering."

Among Haughton's concerns is that the graduates, though skilled in their areas of expertise, will miss out on the breadth of engineering experience from which typical students benefit.

Haughton also worries about the long years of study that most students need to complete the required courses. He estimates that part-time students will need six to eight years of study to complete the program. "Our objective isn't to grant students degrees because they've served [time] but rather because they've learned a certain body of knowledge. We're trying to make that as streamlined as possible."

His greatest worry, though, is the program's experimental nature. Response to the program by the school's 37 engineering faculty members has been lukewarm, Haughton says. "Half of them say it's worth trying, and the other half think I'm nuts." Mention of the program to other engineering educators can also elicit skepticism. "Usually they raise their eyebrows and say 'You're what?' But I haven't heard anyone badmouth the program. Most people are taking a wait-and-see attitude."

Haughton, too, takes a wait-and-see attitude toward the program. The biggest test will come after its graduates have been in industry several more years and their progress can be reviewed. But he's optimistic that individuals who have the motivation to plow through several years of rigorous part-time study will also have the fortitude to succeed in industry. For now, he's proud of the opportunities that the program offers. "What a degree does is give you a chance to demonstrate what you know. People may hire you based on your degree, but what you do is the real payoff."

EDN

Article Interest Quotient
(Circle One)
High 518 Medium 519 Low 520

EDN's CHARTER

EDN is written for professionals in the electronics industry who design, or manage the design of, products ranging from circuits to systems.

EDN provides accurate, detailed, and useful information about new technologies, products, and design techniques.

EDN covers new and developing technologies to inform its readers of practical design matters that will be of concern to them at once or in the near future.

EDN covers new products
- that are immediately or imminently available for purchase
- that have technical data specified in enough detail to permit practical application
- for which accurate price information is available.

EDN provides specific "how to" design information that our readers can use immediately. From time to time, EDN's technical editors undertake special "hands-on" projects that demonstrate our commitment to readers' needs for useful information.

EDN is written by engineers for engineers.

EDN

275 Washington St
Newton, MA 02158
(617) 964-3030

BUSINESS/CORPORATE STAFF

F Warren Dickson
Vice President/Publisher
Newton, MA 02158
(617) 964-3030
Telex 940573
Diann Siegel, Assistant

Peter D Coley
VP/Associate Publisher/
Advertising Sales Director
Newton, MA 02158
(617) 964-3030
Ora Dunbar, Assistant/Sales Coordinator

NEW ENGLAND
John Bartlett, Regional Manager
Chris Platt, Regional Manager
199 Wells Ave
Newton, MA 02159
(617) 964-3730

STAMFORD 06904
George Isbell, Regional Manager
8 Stamford Forum, Box 10277
(203) 328-2580

NEW YORK, NY 10011
Daniel J Rowland, Regional Manager
249 West 17th St
New York, NY 10011
(212)463-6419

PHILADELPHIA AREA
Steve Farkas, Regional Manager
487 Devon Park Dr
Suite 206
Wayne, PA 19087
(215) 293-1212

CHICAGO AREA
Clayton Ryder, Regional Manager
Randolph D King, Regional Manager
Cahners Plaza
1350 E Touhy Ave, Box 5080
Des Plaines, IL 60017
(312) 635-8800

DENVER 80206
John Huff, Regional Manager
44 Cook St
(303) 388-4511

DALLAS 75243
Don Ward, Regional Manager
9330 LBJ Freeway
Suite 1060
(214) 644-3683

SAN JOSE 95128
Walt Patstone, Regional Manager
Bill Klanke, Regional Manager
Philip J Branon, Regional Manager
James W Graham, Regional Manager
3031 Tisch Way, Suite 100
(408) 243-8838

LOS ANGELES 90064
Charles J Stillman, Jr
Regional Manager
12233 W Olympic Blvd
(213) 826-5818

ORANGE COUNTY/ SAN DIEGO 92715
Jim McErlean, Regional Manager
18818 Teller Ave, Suite 170
Irvine, CA
(714) 851-9422

PORTLAND, OREGON 97221
Pat Dakin, Regional Manager
Walt Patstone, Regional Manager
1750 SW Skyline Blvd, Box 6
(503) 297-3382

UNITED KINGDOM/BENELUX
Jan Dawson, Regional Manager
27 Paul St
London EC2A 4JU UK
44 01-628 7030
Telex: 914911; FAX: 01-628 5984

SCANDINAVIA
Stuart Smith
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FRANCE/ITALY/SPAIN
Alasdair Melville
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

WEST GERMANY/SWITZERLAND/AUSTRIA
Wolfgang Richter
Sudring 53
7240 Horb/Neckar
West Germany
49-7451-7828; TX: 765450

ISRAEL
Igal Elan
Elan Marketing Group
13 Haifa St, Box 33439
Tel-Aviv, Israel
Tel: 972-3-268020
TX: 341667

EASTERN BLOC
Uwe Kretzschmar
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FAR EAST
Ed Schrader, General Manager
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422; Telex: 183653

TOKYO 160
Kaoru Hara
Dynaco International Inc
Suite 1003, Sun-Palace Shinjuku
8-12-1 Nishishinjuku, Shinjuku-ku
Tokyo 160, Japan
Tel: (03) 366-8301
Telex: J2322609 DYNACO

TAIWAN
Acteam International
Marketing Corp
6F, No 43, Lane 13
Kwang Fu South Rd
Mailing Box 18-91
Taipei, Taiwan ROC
760-6209 or 760-6210
Telex: 29809
FAX: (02) 7604784

KOREA
Korea Media Inc
Rm 110, A-11 Bldg 49-4,
Hoihyundong 2-Ka, Chung-Ku
CPO Box 2314, Seoul, Korea
Tel: 82-2-755-9880
Telex: K26249

SINGAPORE
Cheny Tan Associates
1 Goldhill Plaza
No 02-01
Newton Rd
Singapore 1130
Tel: 2549522
Telex: RS 35983 CTAL

PRODUCT MART
Joanne Dorian, Manager
249 West 17th St
New York, NY 10011
(212) 463-6415

CAREER OPPORTUNITIES/ CAREER NEWS
Roberta Renard
National Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8602

Janet O Penn
Eastern Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8610

Dan Brink
Western Sales Manager
18818 Teller Ave
Suite 170
Irvine, CA 92715
(714) 851-9422

Diann Siegel
Boston Sales Representative
Newton, MA 02158
(617) 964-3030

Maria Cubas
Production Assistant
(201) 228-8608

Cahners Magazine Division
William Platt, President
Terry McDermott, Executive Vice President
Frank Sibley, Group Vice President
Tom Dellamaria, VP/Production & Manufacturing

Circulation
Denver, CO: (303) 388-4511
Sherri Gronli, Group Manager
Eric Schmierer, Manager

Reprints of EDN articles are available on a custom printing basis at reasonable prices in quantities of 500 or more. For an exact quote, contact Joanne R Westphal, Cahners Reprint Service, Cahners Plaza, 1350 E Touhy Ave, Box 5080, Des Plaines, IL 60018. Phone (312) 635-8800.

CAREER OPPORTUNITIES

1988 Editorial Calendar and Planning Guide

EDN

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN News
Jan. 7	Dec. 14	Computers & Software, Communications ICs	Closing: Dec. 21 Mailing: Jan. 14
Jan. 21	Dec. 30	Microprocessors, Software, Components	
Feb. 4	Jan. 14	Semicustom ICs, Computors & Peripherals	Closing: Jan. 21 Mailing: Feb. 11
Feb. 18	Jan. 28	Materials & Hardware, CAE, Power Sources	
Mar. 3	Feb. 11	Communications, CAE, High-Speed Logic	
Mar. 17	Feb. 25	Graphics, Filters, Software/CAE	Closing: Mar. 3 Mailing: Mar. 24
Mar. 31	Mar. 10	Power Semiconductors, Memory/Graphics, Fiber Optics	
Apr. 14	Mar. 23	Communication Technology Special Issue, Communication Systems	Closing: Mar. 31 Mailing: Apr. 21
Apr. 28	Apr. 7	Software, Industrial Computers, Interface ICs	
May 12	Apr. 21	Analog Technology Special Issue, Analog Converters	Closing: Apr. 28 Mailing: May 19
May 26	May 5	CAE, Software, Sensors/Transducers	
June 9	May 19	CAE, Analog ICs, Test & Measurement	Closing: May 29 Mailing: June 16
June 23	June 2	Data Communications, DSP, Components	
July 7	June 14	Product Showcase—Vol. I, Power Sources, Software	Closing: June 23 Mailing: July 14
July 21	June 30	Product Showcase—Vol. II, CAE, Test & Measurement	

Call today for information:
East Coast: Janet O. Penn (201) 228-8610
West Coast: Dan Brink (714) 851-9422
National: Roberta Renard (201) 228-8602

Some will follow the old standards. Some will create the new.

An engineer has only a few precious opportunities to create a new industry standard. This is one of them. If you're traveling within the limits of today's technology, but want to break through to the next generation of microprocessing, AMD has some exciting news for you... **Your appointment with destiny has arrived.**

AMD has gone way beyond the limits of existing microprocessing to create the super chip of the 1990s — the Am29000. At 32 bits and 17 MIPS, the Am29000 RISC-based microprocessor is 400% faster than the current industry standard. This exciting evolutionary breakthrough will make a whole new range of applications possible, bringing the power of a mainframe to desktop workstations; and providing embedded controller applications such as fiber optic networking and laser printer and communications controllers.

The Am29000 is just one of many significant developments at AMD. Our recent merger with Monolithic Memories makes us stronger and more versatile than ever before. The opportunities are better than ever for experienced hardware and software engineers to set new standards, with the following opportunities now open.

Am29000

Software Support Engineers

Experience in UNIX and C, plus MS DOS, PASCAL, FORTRAN, and Assembler makes you an ideal candidate. Be involved in customer support, developing tools and utilities, testing S/W packages, user manual review, documentation, writing application notes and magazine articles.

Hardware Strategic Marketing Engineer

Join the team that will provide marketing support for languages, operating systems, and support tools for the Am29000. Blend into our superb talent bank your 3 to 5 years' experience in marketing, design or applications of software for fixed instruction set microprocessors or large minicomputer products. Bring along experience in C, FORTRAN or PASCAL, UNIX*, VRTX or large operating systems, and you will be a prime candidate to be involved in all phases of defining and introducing products, including product definition and market research.

Sr. Product Planning Engineer

You will provide microprocessor and systems architecture design support for Am29000 follow-on products. This includes support for chip design, marketing, and tools development. Requires solid background in hardware and software systems, with knowledge and experience of RISC system architectures preferred.

Senior H/W — S/W Applications Engineers

Support the design-in of the Am29000 using your experience in H/W and S/W design of digital systems in computers and embedded controllers. Required experience ranges between 5 and 10 years for individuals with strong system architecture backgrounds, good communication skills, and knowledge of system optimization.

Software QA Applications Engineers

Develop test plans and perform S/W QA testing, develop and implement test suites for O/S, compilers and assemblers and develop tools and utilities to aid in testing.

Applications Engineers

Join in the design and support of Am29000 demo/evaluation boards and systems, do customer support and publish documentation. You will need experience in H/W design of digital systems and familiarity with Assembler, C, UNIX and MS DOS.

AMD is writing a new chapter in the history of technology for those who dream of creating the new. **You see, at AMD we figure that, if you don't make history, you're history.**

For immediate consideration, please call (408) 749-3119 or send your resume, indicating position of interest, to Advanced Micro Devices, Professional Employment, MS-57, 901 Thompson Place, P.O. Box 3453, Sunnyvale, CA 94088. An equal opportunity employer.

*UNIX is a trademark of AT&T Bell Labs.

Advanced Micro Devices

One Great Company

HAVING THE BEST TECHNOLOGY IS ONLY HALF THE BATTLE.

The Trojan Horse was a very progressive technological idea for its day — but what was it without those ingenious and determined soldiers inside? Nothing but an oversized wooden horse on wheels.

At Litton Data Systems we understand that it's the people behind technologies that make them work. And the people inside a company who make things happen.

Over twenty-five years of excellence in the design and manufacture of vital military C^3 systems mark our commitment to an entrepreneurial atmosphere that encourages our professionals to do what's necessary to conquer today's technologies.

If you're interested in joining a company with a classically simple strategy for success, consider one of the following positions:

SYSTEMS ENGINEERING

Air Defense Systems

Will assist in preparation of Requirements Documents, Mission Analysis, Functional Flows/Allocations, System Synthesis and perform required Trade Studies. Requires a minimum of 10 years experience in C^3I systems and working knowledge in one or more of the following type systems: Tactical Air Command Center, Tactical Air Operations Center, Direct Air Support Center, Command Operation Center, Forward Air Command Post, Forward Area Air Defense.

SOFTWARE/FIRMWARE ENGINEERING

- Requires 5-10 years' experience in Assembly language programming for military systems and a minimum 5 years' experience in digital signal processing applications.
- Will be responsible for programming state-of-the-art digital and voice communication systems. Requires experience in the programming of the ZILOG Z80, INTEL 8748 and TI TMS32020 microprocessors. 3-5 years' experience in the development of communication firmware and a solid understanding of hardware design is necessary.

Above positions require a BS in Computer Science or Engineering.

- Will be responsible for contributing to the design and modeling of new algorithms. Requires an MS/PhD in Computer Science or Engineering and a minimum of 15 years' experience applying signal processing theory in the development of tracking systems.
- Will implement firmware for high speed digital data bus and impeded computer peripherals. Requires a BS in Computer Science, EE or Math and 3-5 years' experience in Assembly language, programming techniques and use of the UNIX* Operating System.

Jr. & Sr. Level Programmers

- Will generate PDL from detailed design documents, coding of programs in CMS2 and Assembly language and unit testing of the programs. Requires 1-8 years' software experience.

Send your resume to: Employment, Dept 605, 8000 Woodley Ave., Van Nuys, CA 91409-7601.

Litton

Data Systems

Principals Only/Equal Opportunity Employer

*UNIX is a registered trademark of AT&T.

THE EDN MAGAZINE/EDN NEWS

Recruitment Package

The most cost-effective way to reach the most professionals!

EDN reaches more than 137,000 engineers and engineering managers, the largest circulation in the electronics field. EDN News reaches EDN's U.S. circulation of more than 121,500. And, when you place equivalent space in both the *Career Opportunities* section of EDN, and the *Career News* section of EDN News in the same month, you'll get a ⅓ discount off the EDN News rate!

EDN MAGAZINE/EDN NEWS

Where Advertising Works.

ADVERTISERS INDEX

Recruitment Advertising

*Advertiser in US edition
**Advertiser in International edition

This index is provided as an additional service. The publisher does not assume any liability for errors or omissions.

EDITED BY CYNTHIA B RETTIG

PROJECTED WORLWIDE REVENUE
ALL OPTICAL DISK DRIVES

($ MILLION AT OEM SUBSYSTEM LEVEL)	1986	1987	1988	1989	1990	1991	1992
READ-ONLY	20.3	44.3	71.7	97.8	124.3	143.1	158.1
WRITE-ONCE	74.2	265.1	499.8	766.7	1031.5	1367.3	1730.9
ERASABLE	0.0	0.3	8.5	59.7	155.5	278.9	387.5
TOTAL DRIVES	94.5	309.7	580.0	924.2	1311.3	1789.3	2276.5
GROWTH FROM PREVIOUS YEAR		70%	47%	37%	30%	27%	21%

(SOURCE: FREEMAN ASSOCIATES)

Erasable optical drives to surge into marketplace

As erasable optical disk drives become a commercial reality, they promise to alter dramatically the revenue pie currently shared by the two other optical storage methods, read-only drives and write-only, read-many (WORM) devices, according to the management-consulting firm Freeman Associates (Santa Barbara, CA). Over the next several years, substantial numbers of OEMs and system integrators will choose the erasable optical drives. Indeed, revenues from sales of these drives will overtake the annual earnings of read-only devices by 1990, even though samples of the erasable optical drives are just now entering the market.

For the three categories of drives, Freeman Associates distinguishes between revenues and units shipped. In 1990, for example, vendors will ship 338,100 read-only drives, 235,600 WORM drives, and only 119,100 erasable optical drives. But revenues in that year are projected to be $124.3 million, $1.032 billion, and $155.5 million, respectively. By 1992, the total market should yield $2.3 billion (see EDN, June 25, pg 350, for a related report on the same market).

Read-only drives will dominate the market from 1986 to 1992 in terms of unit shipments, although WORM drives will maintain a strong lead in revenues each year, ranging from 79% of optical-drive revenues in 1986, to 76% in 1992. In 1986, 97% percent of all read-only shipments were CD ROMs, and these will continue to constitute the great majority of read-only units shipped.

Because the CD-ROM business is totally dominated by a combination of various Japanese makers and by Philips of the Netherlands, US manufacturers are unlikely to enter it. US activity, albeit substantial, will be in publishing, marketing, systems integrating, and disk manufacturing.

For market analysis, the write-once market can be divided into three groups defined by drive storage size: <1G-byte drives, 1G- to 3G-byte drives, and those with even higher capacities, which will be available in low-volume production quantities next year. Manufacturers established the middle range in the marketplace early, and this range will continue to generate the most revenues through 1991. The lowest capacity group, however, will surpass the middle range in number of unit shipments within the next year. By 1992, the difference in unit shipments between these two groups will lessen considerably, although an aggressive pricing strategy for the devices with less than 1G byte will keep their share of revenue down; in that year, their portion of revenue will amount to only 17% of the market total. High-capacity drives should gain a 12% share of revenues within the same period.

In the erasable-device segment, manufacturers will begin by offering capacities below 1G byte. Drives of larger capacity should reach the market in 1990 as specialized mainframe devices.

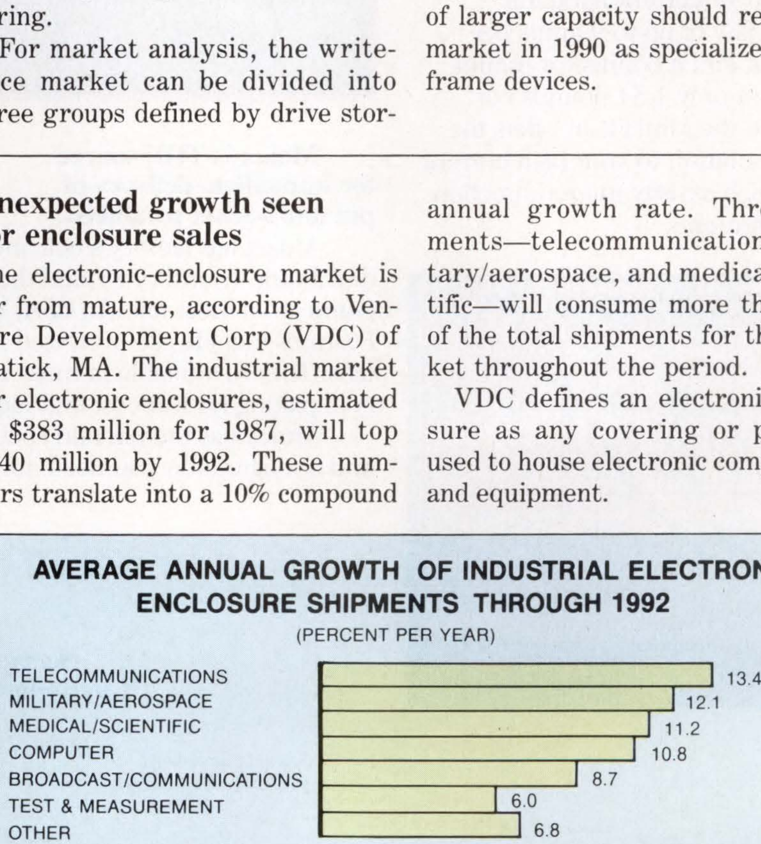
Unexpected growth seen for enclosure sales

The electronic-enclosure market is far from mature, according to Venture Development Corp (VDC) of Natick, MA. The industrial market for electronic enclosures, estimated at $383 million for 1987, will top $640 million by 1992. These numbers translate into a 10% compound annual growth rate. Three segments—telecommunications, military/aerospace, and medical/scientific—will consume more than 60% of the total shipments for this market throughout the period.

VDC defines an electronic enclosure as any covering or package used to house electronic components and equipment.

AVERAGE ANNUAL GROWTH OF INDUSTRIAL ELECTRONIC ENCLOSURE SHIPMENTS THROUGH 1992

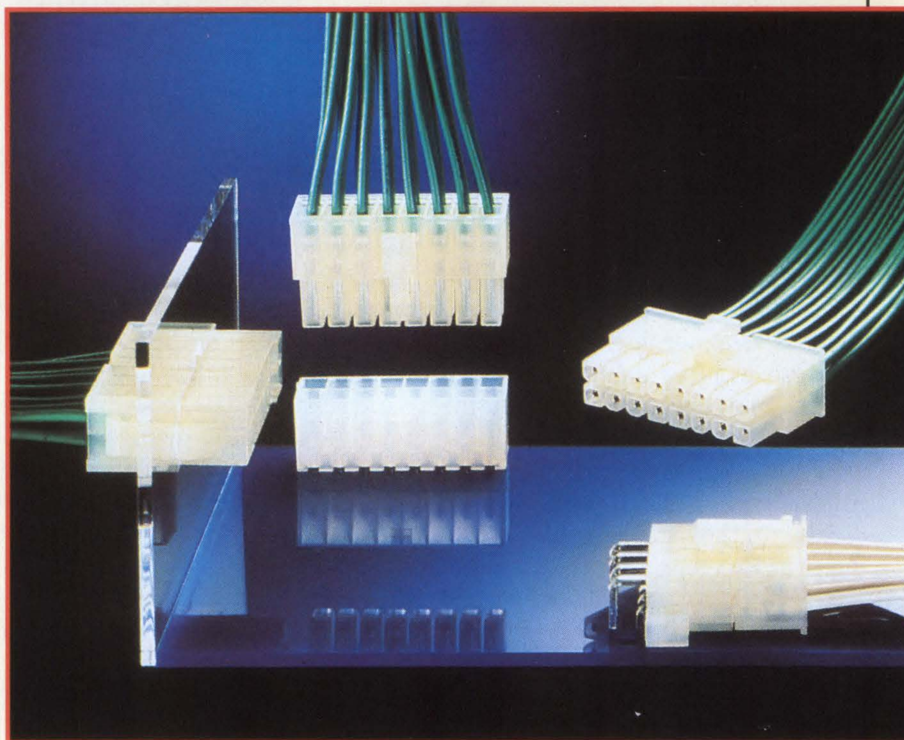
(PERCENT PER YEAR)



(SOURCE: VENTURE DEVELOPMENT CORP)

Molex Is Making The Connection Between...

HIGH CURRENT & HIGH DENSITY



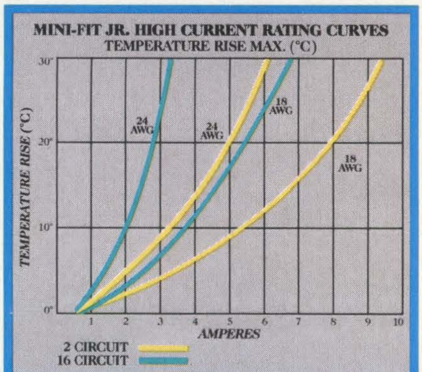
Mini-Fit Jr. is our new generation power connector for your panel-to-wire, wire-to-wire, and board-to-wire applications.

From power supply to power distribution, Molex makes the connection.

Molex, the industry leader, now offers the most complete line of pin and socket connectors available. From standard wire-to-wire and wire-to-board versions, to the new high-performance "Mini-Fit Jr."

Mini-Fit Jr. meets today's demand for miniaturized design components.

With current handling capability of up to 9 amps per circuit, and a connector mating force of only 1.54 pounds per circuit, the Mini-Fit Jr. offers the ideal solution to your high current and high density interconnection requirements.



Mini-Fit Jr. can handle high current (up to 9 amps) despite its small size.

Molex is THE source for immediate delivery of pin and socket products.

Molex has factory stock and distributor inventory around the world. Our pin and socket connectors meet full UL, CSA, VDE, and EAMCL standards. Features include silo protected terminals, positive lock, and pull tabs. They're available in brass or phos-bronze, with tin or selective gold plating for low cost and high performance.

Molex has the pin and socket connector you need, in the size and configuration you need, for every discrete wire application.

Service To The Customer... Worldwide

molex®

Corporate Headquarters: *2222 Wellington Ct., Lisle, IL 60532 USA, (312) 969-4550 •* ***European Headquarters:*** *Aldershot, England, (0252)318221*
Northern Asia Headquarters: *Tokyo, Japan, 03-478-8777 •* ***Southeast Asia Headquarters:*** *Jurong Town, Singapore, 65-261-9733*

CIRCLE NO 206