Look at it this way.

The first thing you’ll see is a flat-out screaming data mover. Namely, Motorola’s 68340 Integrated Processor with DMA. The first and only processor with the performance to meet the high speed data handling needs of next generation applications.

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A closer look at the 68340 will reveal a 32-bit integrated processor built on a 68020 foundation with a host of pertinent peripherals on-chip. Foremost among these is a two channel DMA (direct memory access) controller that delivers a sustained data transfer rate of 33 megabytes per second. Imagine for a moment what you could do with that.

Also on the chip are a pair of serial I/O channels, a couple of timers and a whole bunch of glue logic you won’t have to add elsewhere. And, of course, you get all that power in one tidy little package.

Speaking of power, the 68340 doesn’t use much at all. In fact, its low power consumption and standby mode make it perfect for a wide variety of battery-powered applications.

But then again, as the highest performance data mover you’ll see anywhere, the 68340 is perfect for a whole lot of applications.

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PROCESSOR
AS THE
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FULL MOTION
VIDEO.
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TOAT-R512
TOAT-124
TOAT-3610
TOAT-51020

<table>
<thead>
<tr>
<th></th>
<th>Accuracy (dB)</th>
<th>(+/-dB)</th>
<th>Accuracy (dB)</th>
<th>(+/-dB)</th>
<th>Accuracy (dB)</th>
<th>(+/-dB)</th>
<th>Accuracy (dB)</th>
<th>(+/-dB)</th>
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<tr>
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<td>1.5</td>
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<td>19.0</td>
<td>35.0</td>
<td>35.0</td>
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</tr>
</tbody>
</table>

bold faced values are individual elements in the units

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CIRCLE NO. 91

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<th>SPECIFICATIONS</th>
<th>dc-500MHz</th>
<th>500-2000MHz</th>
<th>2000-5000MHz</th>
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<tr>
<td>YSW-2-50DR</td>
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<tr>
<td>Insertion loss, typ (dB)</td>
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<td>1.3</td>
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<tr>
<td>Isolation, typ (dB)*</td>
<td>50</td>
<td>40</td>
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<tr>
<td>1dB compression, typ (dBm @ in port)</td>
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<td>24</td>
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<tr>
<td>RF input, max dBm (no damage)</td>
<td>22</td>
<td>22</td>
<td>26</td>
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<tr>
<td>VSWR (on), typ</td>
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<tr>
<td>Video breakthrough to RF, typ (mV p-p)</td>
<td>1.4</td>
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<tr>
<td>Rise/Fall time, typ (nsec)</td>
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</tr>
</tbody>
</table>

*typ isolation at 5MHz is 80dB and decreases 5dB/octave from 5-1000 MHz

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Integrated Circuits

ICs move into a variety of new applications 90

Do you ever wonder where all those little, black plastic-and-silicon ICs end up after they roll off the assembly line? The answer is, in some pretty innovative and unusual places.

—Charles H Small, Senior Editor

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Distributed power schemes simplify system design tasks 132

DC/DC converters are the key element in distributed power schemes. These units let you use a single voltage bus throughout the overall system and then convert this voltage to the specific levels needed for each subsystem. In most cases, the converters can mount right on the board for which they are supplying power.

—Tom Ormond, Senior Editor

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DSP software handles a broad spectrum of applications 194

Today’s powerful chips, boards, and software development tools for digital signal processing make the technology readily available. The challenge is in recognizing how your projects can benefit from it.—Richard A Quinnell, Regional Editor

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LabWindows...making industry standard programming languages work for you in data acquisition and instrument control.
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Software 201
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Judge rules software’s look and feel can be copyrighted
Lotus Development Corp vs Paperback Software International.
—Joseph S Iandiorio, Attorney at Law

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Table:

<table>
<thead>
<tr>
<th>Performance Comparison Chart (1)</th>
<th>SUN SPARCstation 1+</th>
<th>IBM 320/520</th>
<th>DECstation 5000 cx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphics &amp; Windowing (2)</td>
<td>0.24</td>
<td>0.71</td>
<td>1.59</td>
</tr>
<tr>
<td>Integer</td>
<td>1.04 (3)</td>
<td>1.34</td>
<td>1.61</td>
</tr>
<tr>
<td>Floating Paint</td>
<td>1.10 (3)</td>
<td>2.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Overall Performance</td>
<td>0.65</td>
<td>1.35</td>
<td>1.63</td>
</tr>
</tbody>
</table>

(1) All data normalized to DECstation 5000. Comparable configurations tested. Geometric mean used to combine results. Performance will vary depending on applications and environment. (2) Graphics and windowing data measured using X11perf benchmark. CPU Integer and Floating Point performance measured from running SPEC v1.0 workload. (3) SPEC performance estimate based on SUN 4/330 results published by Sun Microsystems, Inc.

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CIRCLE NO. 96
HIGH-END GRAPHICS FROM A 478 RAM DAC?

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BLINDING SPEED.

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Its blinding 120 Mhz speed makes our 478 RAM DAC the fastest such part ever made. Which means that besides cost-effectiveness in high-end graphics applications, it offers a migration path to higher resolution in products already using 478 RAM DACs. All three of our speedy RAM DACs are available now. For information on any of them, write to RAM DAC Marketing, Samsung Semiconductor, 3725 No. First St., San Jose, CA 95134. Or call 1-800-669-5400, or 408-954-7229.

CIRCLE NO. 97

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Before you send those fast ASIC designs off to production, make sure they’ll handle the stress of real-world operating conditions. Now, that’s possible—even for GaAs, ECL, and BiCMOS devices—with the new 400 MHz, HP 82000 IC Evaluation System. It’s a testing breakthrough . . .

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EDN December 6, 1990
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There is a better way.
DSP FAMILY USES SIBLINGS' ARCHITECTURE
The 56100 family of 16-bit DSPs from Motorola's Microprocessor Products Group (Austin, TX, (512) 891-2030) is architecturally compatible with the 24-bit 56001 and 32-bit 96002 DSPs. Sharing architectures lets the 16-bit chip use an instruction subset of its more powerful siblings' instruction set. In addition, the family members can share development tools. The 56100 family will initially contain the 56116 and 56156, both of which have 8k bytes of RAM, two serial ports, a parallel port, a timer, a host interface, an on-chip emulator, and a 5616 DSP core. The 56156 adds a 14-bit sigma-delta codec and a PLL. The 5616 core handles fast autoreturn interrupts and has a single-cycle 16×16-bit parallel multiply accumulator that can handle 40 million multiply and accumulates per second. An on-chip emulator provides access to internal registers and tracks the last five executed instructions for debugging. The 5616 is sampling now and costs $120. The 56156 will be sampling in early 1991 and will cost $145.—Michael C Markowitz

LOCAL OPERATING NETWORKS SUPPORT DISTRIBUTED CONTROL
Echelon (Palo Alto, CA, (415) 855-7400) has developed a complete set of ICs, development tools, and an operating system for creating a low-cost distributed control system. The local operating network consists of a collection of local control nodes that intercommunicate. Thus one node can read a sensor and another can use that reading to control a motor. The core of each node is a neuron IC that has three separate processors to handle local I/O functions, message processing, and communications hardware. The neuron ICs are preprogrammed with firmware implementing a complete 7-layer OSI model.

You treat nodes in the local operating network as objects when programming. Each node controls a local function and shares network variables with other objects. Communication between nodes is handled automatically by the neuron's firmware; all you add is the local control software. Because the nodes are all objects, the resulting network is flexible. For example, you can extend the network without reprogramming existing nodes.

The Lonbuilder starter kit costs $14,965 and contains a development station, a neuron emulator, software development and debugging tools, and a network analyzer. Motorola and Toshiba supply the neuron ICs, which cost less than $10.—Richard A Quinnell

IBM PC/AT-COMPATIBLE VGA BOARDS HAVE TIGA INTERFACE
You no longer have to choose between Texas Instruments' TIGA and IBM's 8514/A graphics for your computer's graphics subsystem. The Volante Series VMEbus and IBM PC/AT-compatible VGA boards from National Design (Austin, TX, (512) 343-5055) include a TI34020 graphics processor, TIGA-340 graphics interface, driver for Microsoft Windows, and both Super VGA and 8514/A emulation. The $995 AT1000 has a maximum bandwidth of 64 MHz and Super VGA resolution of 1024×768 pixels. The $2495 AT1200 has a bandwidth of 125 MHz and pixel resolution as high as 1280×1024. A VMEbus version of the AT1200 sells for $5495. Options include the TI34082 floating-point processor ($1395) and an AutoCAD optimizing driver with pop-up menus and garbage collection ($95).—J D Mosley
FOURTH-GENERATION CD ROM DRIVE HAS 40,000-HOUR MTBF

Two CD ROM disk drives from Laser Magnetic Storage International Co (Colorado Springs, CO, (719) 593-7900) provide average access times of 350 msec with reliability ratings of 40,000 hours MTBF. The CM 202 drive has a serial interface, and the CM 214 drive incorporates a SCSI port coupled with 64k bytes of cache RAM. Both drives also provide CD audio capabilities in addition to their digital data functions. In OEM quantities, the drives cost less than $350.—Steven H Leibson

BICMOS BUS INTERFACE CHIPS ARE 16 BITS WIDE

Signetics Co (Sunnyvale, CA, (408) 991-2000) has announced a family of advanced BICMOS bus-interface chips that feature 16-bit data paths. The Multibyte family provides 64 mA of drive current per output, a 4.6-nsec propagation delay, and zero static-power dissipation. The chips are available in 52-pin JEDEC-registered quad flatpacks that require 174 mm² of board space. Two equivalent 8-bit devices using small-outline surface-mount packages would occupy 310 mm². The first members of the family are the MB2244 16-bit line driver and the MB2245 16-bit transceiver. These parts are functionally equivalent to the '244 and '245 bus-interface devices, respectively. The company plans to introduce 20 family members over the next 18 months, including 16- and 20-bit parts to accommodate parity bits. Prices range from $1.80 to $3.70 (1000).—John Gallant

PC PLUG-IN CARDS SUIT INDUSTRIAL SYSTEMS

A range of IBM PC and compatible plug-in cards from Arcom Control Systems Ltd (Cambridge, UK, (223) 411200) lets you control and monitor industrial systems. The range includes digital I/O, counter/timers, serial communications, and ADC and DAC functions. Model PCIB40 contains 40 bidirectional I/O channels and costs £124. A buffer in each channel can sink 24 mA. Also onboard is a 1-MHz clock and three 16-bit counter/timers. The £148 model PICIC is a multifunction counter/timer, which provides nine 16-bit channels operating as high as 5 MHz. Both models link to another range of remotely sited signal-conditioning modules via a rear-panel connector.

The connector's pinout conforms to an internal standard, which 20 other vendors currently use for STEbus and VMEbus products. This arrangement provides compatibility with approximately 200 existing signal-conditioning modules. Other plug-in cards include model PCI24 and PC024, which provide optoisolation on 24 channels of digital input and output, respectively. Each model costs £185. Model PCSER4 contains four independent channels of serial asynchronous or synchronous communication with as much as 115k baud or 2M baud, respectively. PCSER4 costs £195. ADC and DAC cards are due the first quarter of 1991.—Brian Kerridge

FFT PROCESSOR PERFORMS 1024-POINT TRANSFORM IN 96 µSEC

The PDSP16510 FFT processor from Plessey Semiconductors (Scotts Valley, CA, (408) 438-2900) can perform a 1024-point transform in 96 µsec. The $1195 processor operates at 40 MHz and accepts real or complex data. It outputs both real and complex frequency components, which can be converted to magnitude and phase by the company's PDSP16530A Pythagoras processor, a $149 companion IC. —Steven H Leibson
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© 1990 Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134 Phone: (408) 943-2600, Telex: 821032 CYPRESS SNU UD, TWX: 910-997-0753.
ONE CHIP INTEGRATES PROGRAMMABLE PALETTE AND VIDEO

The TLC34075 programmable video interface from Texas Instruments (Houston, TX, (800) 336-5236, ext 700) provides functions that otherwise require as many as 30 chips to implement. The chip has pixel control logic, video overlay, high-speed timing logic, and an interface to video RAM; it allows VGA pass-through mode. You can program the chip for 1, 2, 4, or 8 bits/pixel. A 32-bit/pixel program level yields 24-bit true color with an 8-bit color overlay for photo-realistic images. This $20 (OEM) chip’s register-programmable dot rate lets you select from 640 x 480, 800 x 600, and 1024 x 768 noninterlaced display resolutions. A $30 (OEM) European version, the TLC34075-85, provides the same selection of display resolutions at European refresh rates.—J D Mosley

PATTERN-RECOGNITION SOFTWARE FINDS RULES IN RAW DATA

If you can’t seem to find clear patterns in your data, you may want to give Plogic a shot at it. This pattern-recognition software from Plogic Knowledge Systems Inc (Torrance, CA, (213) 378-3760) accepts data points, formulates rules based on trends in the data, and can make predictions based on those rules. The IBM PC version of the package can analyze problems with as many as 50 variables and 3000 data points. Based on the trends it finds in your data, the software can predict additional data points and even give you a confidence factor for that prediction. You can also use the package to make decisions based on your historical data. The product accepts data stored in ASCII, binary, Lotus 1-2-3, and Dbase III data files. It sells for $995, but you can buy it for $495 until December 31.—Steven H Leibson

HIGH-RESOLUTION, COLOR-DISPLAY BOARD SUITS CAD

The Nth Engine/150 noninterlaced 256-color display board from Nth Graphics (Austin, TX, (800) 624-7552) has four times the resolution of standard VGA displays. At $1995, it is currently the least expensive board of its type available. The 1280 x 1024-pixel board comes with display-list processing software for AutoCAD 386 Release 10 and 11 and uses AutoCAD 386’s protected-mode for 32-bit processing and automatic memory management for the display list. You can use this board with graphics applications that have an IBM 8514/A driver, including Microsoft Windows 3.0 and Presentation Manager. You can also buy a lower-resolution, but still noninterlaced, version of this board that displays 1024 x 768 pixels in 16 colors for $1495.—J D Mosley

FULL-FEATURED PLD SOFTWARE PACKAGE COSTS $795

In an update to its existing PLD design package, Philips Components/Signetics (Sunnyvale, CA, (408) 991-2000) will compete with third-party software vendors that currently offer packages costing several thousand dollars. Snap 1.6 costs $795 and includes gate-level and fault simulators, a logic optimizer, and a Boolean equation extractor. However, Snap supports only the company’s line of PLDs. The package can create a PLD design by merging descriptions made with waveforms, equations, and schematics. It can also reverse-engineer parts with an extractor that creates equations from existing JEDEC fuse maps. You can use this feature to consolidate several smaller PLD designs into one device. The package runs on IBM PCs and compatible machines. If you already own earlier versions of the package, you can get the updated product free.—Steven H Leibson
Cesium long term stability at a fraction of the cost

Better long-term stability than rubidium

Not dependent on ionosphere position changes, unlike WWV

Complete northern hemisphere coverage, unlike GPS.

The FS700 LORAN-C frequency standard provides the optimum, cost-effective solution for frequency management and calibration applications. Four 10 MHz outputs from built-in distribution amplifiers provide cesium standard long-term stability of $10^{-12}$, with short-term stability of $10^{-10}$ ($10^{-11}$ optional). Reception is guaranteed in North America, Europe and Asia.

Since the FS700 receives the ground wave from the LORAN transmitter, reception is unaffected by atmospheric changes, with no possibility of missing cycles, a common occurrence with WWV due to discontinuous changes in the position of the ionosphere layer. Cesium and rubidium standards, in addition to being expensive initially, require periodic refurbishment, another costly item.

The FS700 system includes a remote active 8-foot whip antenna, capable of driving up to 1000 feet of cable. The receiver contains six adjustable notch filters and a frequency output which may be set from 0.01 Hz to 10 MHz in a 1-2-5 sequence. A Phase detector is used to measure the phase shift between this output and another front panel input, allowing quick calibration of other timebases. An analog output with a range of ±360 degrees, provides a voltage proportional to this phase difference for driving strip chart recorders, thus permitting continuous monitoring of long-term frequency stability or phase locking of other sources.

FS700: The optimum frequency management system

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- greater than 40dB stopband rejection
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- rugged hermetically-sealed pin models • BNC, Type N; SMA available
- surface-mount • over 100 off-the-shelf models • immediate delivery

### low pass dc to 1200MHz

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>FREQ, MHz</th>
<th>STOP BAND, MHz (loss &gt;10dB)</th>
<th>STOP BAND, MHz (loss &gt;20dB)</th>
<th>VSWR band typ</th>
<th>PRICE $</th>
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<tr>
<td>PLP-10.7</td>
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### high pass dc to 2500MHz

<table>
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<tr>
<th>MODEL NO.</th>
<th>FREQ, MHz</th>
<th>STOP BAND, MHz (loss &gt;10dB)</th>
<th>STOP BAND, MHz (loss &gt;20dB)</th>
<th>VSWR band typ</th>
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<td>1.6</td>
<td>17</td>
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<td>17</td>
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<td>PHP-250</td>
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<td>150</td>
<td>160</td>
<td>1.3</td>
<td>17</td>
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<tr>
<td>PHP-300</td>
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<td>210</td>
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<td>PHP-400</td>
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<td>720</td>
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### bandpass 20 to 70MHz

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<th>PASS BAND, MHz (loss &lt;2dB)</th>
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<th>VSWR 1.3 typ, total band typ</th>
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<tr>
<td>PIF-21.4</td>
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<td>PIF-40</td>
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<td>19 320 24</td>
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<td>PIF-50</td>
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<td>20 380 26</td>
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<td>14 13.2 13</td>
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<td>16 15.6 15.2</td>
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### narrowband IF

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<th>MODEL NO.</th>
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<th>STOP BAND, MHz (loss &gt;20dB)</th>
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<tr>
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<td>190-1000</td>
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<tr>
<td>PBP-70</td>
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<td>6.0 5.9 6.0</td>
<td>195-1000</td>
<td>DC-1000</td>
<td>18.95</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Part #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSM6295</td>
<td>4-channel speech synthesizer</td>
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<tr>
<td>MSM6322</td>
<td>Pitch control IC</td>
</tr>
<tr>
<td>MSM6372</td>
<td>Speech synthesizer with 128K ROM, 5 secs</td>
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<tr>
<td>MSM6373</td>
<td>Speech synthesizer with 256K ROM, 10 secs</td>
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<tr>
<td>MSM6374</td>
<td>Speech synthesizer with 512K ROM, 20 secs</td>
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<td>MSM6375</td>
<td>Speech synthesizer with 1M ROM, 40 secs</td>
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<td>MSM6376</td>
<td>Evaluation chip for MSM6372/73/74/75</td>
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<td>MSM6378</td>
<td>Speech synthesizer with 256K OTP ROM</td>
</tr>
<tr>
<td>MSM6388</td>
<td>Solid-state recorder/1M serial register VF</td>
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</table>

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RealVoice is a trademark of Oki Semiconductor.
Thoughts on “Communicate or perish” editorial

Jon Titus’s editorial (EDN, June 21, 1990, pg 69) is a great article, but there is an even better way to communicate. Have you seen a company tell people the relative costs? Don’t turn the plebs into anarchists—give them the chance to become responsible citizens.

John Washington
Woking, Surrey, UK

Latch on to your children’s natural curiosity

Several recent letters have addressed things we parents should do to educate our children. All of the suggestions are worthwhile, but don’t forget that one of the greatest gifts we can pass on is the love of learning. Encourage a sense of wonder in your children. Let them marvel at the intricacy of a cell or the glory of the Milky Way. Avoid denigrating their ideas, no matter how absurd. “Let’s think about it” is a much better response than “No, that’s not right.”

Parenting is hard. We all get worn down by a 2 year old’s machine-gun-speed “Whys?” Make the effort to use this natural curiosity to shape your children into thoughtful, well-rounded individuals.

Jack G Ganssle, President
Softaid Inc
Columbia, MD

Compromise between copy “right” and “left”

In the Professional Issues section (EDN, October 1, 1990, pg 174), Jay Fraser very competently profiles Richard Stallman, a man we might describe as basically a “computer nut,” and more formally, as a professional computer programmer. Although I don’t consider “computer nut” in the derogatory sense, this perception is common among those who are not computer enthusiasts. I do, however, consider some of Richard’s logic and interpretations of law and common-law practices to be a little strange and inherently dishonest, and dangerous to the development of American industry, science, technology, and intellectual incentive, development, and property.

I agree with Richard’s argument that some of the copyright practices may be wrong and even illegal. But he is clearly wrong in his contention that we have an inherent right to copy from each other freely and without legal repercussions. I believe that Richard doesn’t understand the realities of the business world and, particularly, the enormous problems of starting up a high-technology company on the basis of a new and complex database.

As the CEO of my company, I must establish policy, develop corporate and financial structure, work out personnel procedures, maintain a working relationship with everyone, and keep everyone working with each other. As Chief Scientist, I am responsible for the development of the mathematical and engineering database that supports the product line.

Model 1, which I am presently trying to put into full production with a supporting database of more than 500 pages, has caused enormous problems. At least four separate attempts have been made to steal the supporting database.

Three months ago I hired an electronics-design engineer to design the prototype. Almost immediately I ran into serious problems with him. He wanted more data, demanded access to the full database, and began to criticize the program. He also criticized the use of a particular computer language, some of its logical lines of instructions, and its scientific and mathematical notations.

My immediate reaction was to be honest with him. Without understanding his vague criticisms, I admitted that I might be wrong and to the possibility of making some mistakes in both the development of the database and its subsequent computer program. Although he didn’t need to gain access to the database of the computer program, I allowed him partial access nonetheless.

After further incidents, he finally admitted that he couldn’t understand the theory and the mathematical relationships. He had difficulty in grasping the process of intuitively “jumping” over gaps of incomplete data to derive the relationships of the phenomena and to work them out mathematically.

Again, I was intellectually fair and honest with him. Of course I was not unaware of his possible ulterior motives. I just lacked the physical evidence to prove he was trying either to steal the database and technology or to take credit for some of its development.

Finally, he made a provable mistake. In the computer program for Model 1, under my name—representing a nonprintable comment in the statement for copyright protection—was “(and modified by)” followed by his name.

I studied the program carefully, but found no other modification other than his name under my name. The conclusion was obvious. He was trying to steal some credit for the development of the database when the computer goes before the US government for copyright protection. If I had not been intuitively suspicious of his ulterior motives and demands for data he did not need, I would have run into serious technical and legal problems within a few years.

And if it were not for the copyright-protection statutory provisions under the law, he could actually have manipulated himself into a legal declaration that he was partially responsible for the development of the database. Then he could demand monetary compensation.

I recognize Richard Stallman’s le-
gal concerns for intellectual freedom and certain rights to copy from each other. However, he must accept the responsibility for being competent in his position and for recognizing the need of American industry to protect itself from abuses, fraud, and criminal scams and conspiracies. Without this protection, we simply could not grow.

I suggest that Richard rethink his position and try to work out an intelligent compromise between our right to copy from each other and our right to protection from abuse and theft. I recognize our right to access more information than we need to know, and dislike the common practice of allowing people access to information and databases on a “need-to-know-only basis,” except under certain critical security conditions.

I like the idea of a consortium of engineers, scientists, and computer programmers for the explicit purpose of working out complex and expensive solutions in a “copyleft” protection provision. Richard should introduce legislation to make “copyleft” a legal entity with the help of his local congressman.

Alvah Buckmore Jr
CEO and Chief Scientist
Buckmore Enterprise
Westfield, MA

Where to contact Richard Stallman
The Professional Issues article, “Keeper of the Faith” (EDN, October 1, 1990, pg 174), has elicited a great deal of reader response. Anyone who wants to contact Richard Stallman can reach him at:
Free Software Foundation Inc
675 Massachusetts Ave
Cambridge, MA 02139
Phone (617) 876-3296.

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36

CIRCLE NO. 16

EDN December 6, 1990
Introducing Zilog's Smart Access Controller...
Z80 intelligence and SCC communications together in one package.

The Z80181™ SAC™ Controller is the Smart Access Controller™ that combines two powerful standards. You get Zilog's industry standard SCC™ controller for datacom connectivity together with the popular Z80 CMOS controller. And all that utility comes with the user-friendly Z80® code CPU compatible software.


The Superintegration™ SAC Controller packs the popular high performance Z80 architecture into a new cell suitable for many datacom and peripheral control applications. You get the SCC single-channel communication cell with two additional UARTS, a 4 x 8-bit counter timer (CTC) and onboard 16-bit I/O. The SAC Controller runs at 10 MHz and drives fast serial communications at 2.5 Mbits/sec. With the reduced 3 cycles per instruction, the SAC Controller gives you Z80 code performance 25% faster. That makes the SAC Controller the highest performance, low power embedded controller around.

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Whatever your application — data communications, modems, FAXs, printers, terminals, industrial controls — the SAC Controller combination gives you the best cost/performance ratio. Everything you need for your system is on the chip. The SAC Controller brings you all the advantages of Zilog's SuperIntegration technology. Off-the-shelf and backed by our solid reputation for quality and reliability.

To find out more about the SAC Controller, or any of Zilog's rapidly growing family of SuperIntegration products, contact your local Zilog sales office or your authorized distributor today. Zilog, Inc., 210 Hacienda Ave., Campbell, CA 95008, (408) 370-8000.

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This department will serve as a forum to solve nagging problems and answer difficult questions. EDN's editors will provide the solutions. If we can't solve a problem, we'll find an expert who can, or we'll print your letter and ask your peers for help. We can't answer every question, but we'll try to publish the ones that will help you most in your job.

Address your letters to Ask EDN, 275 Washington St, Newton, MA 02158. FAX (617) 558-4470; MCI: EDNBOS. Or, send us a letter on EDN's bulletin-board system. You can reach us at (617) 558-4241 and leave a letter in the /ask_edn Special Interest Group.

Vacuum tubes still in demand

I collect and repair antique radios. I need to purchase old vacuum tubes from Unity Electronics (Elizabeth, NJ, (201) 351-1200), but they either sold out or went out of business. They had a stock of more than two million radio tubes—too many to merely trash. Can you find out who bought them out and who has old vacuum tubes for sale today? Thanks.

Henry Ewald
Livonia, MI

Efforts to contact this company and to find out who now has its two million tubes were fruitless. However, both Editor Jon Titus and Associate Editor Mike Markowitz are radio buffs, and they dug up some alternate sources of radio parts:

Antique Electronic Supply
Box 1810
Tempe, AZ 85281
(602) 894-5903
FAX (602) 894-0126

Fair Radio Sales
Box 1105
Lima, OH 45802

Fala Electronics
Box 1376-1
Milwaukee, WI 53201
Send SASE for tube listings.

Southern Radio Supply
1909 Tulane Ave
New Orleans, LA 70112
(504) 524-2343
FAX (504) 523-1000.

Two antique-radio publications are

Antique Radio Classifieds
Box 802-B7
Carlisle, MA 01741
$24 per year

Antique Wireless Association
Newsletter
Route 3
Holcomb, NY 14469
$10 per year.

If you're interested in antique radio restoration but don't know where to start,

Classic Radio Service
Box 764
Woodacre, CA 94973

sells radio restoration kits that contain schematics; detailed restoration instructions for cleaning, alignment, and tuning; and replacement parts. Mike Markowitz would like to hear from readers who are also radio buffs. You can contact him via EDN bulletin-board system; his User-ID is EDNMarko.

RF-transceiver sources come forward

In the October 1, 1990, issue of EDN, Joe Thomas asked for a source of RF transmitter/receiver building blocks or modules. He wanted the devices for digitally transferring data over 100 ft under the control of Motorola's 146805E2 microcontroller. Among the companies that replied that they offer such devices are

Magnavox Electronics Systems Co
1313 Production Rd
Fort Wayne, IN 46808
(219) 429-6000
FAX (219) 429-6598

Metscan Inc
1450 Rochester St
Lima, NY 14485
(716) 624-9384
FAX (716) 624-5619

Toko America Inc
1250 Feehanville Dr
Mt Prospect, IL 60056
(708) 297-0070
FAX (708) 699-7864.

All replies are being forwarded to Mr Thomas.
Nobody does ferrites like DEXTER. We offer the industry's broadest selection of quality ferrites and associated hardware from world-class manufacturers: SIEMENS, MAGNETICS, FAIR-RITE, HITACHI, MMG/KRYSTINEL. From prototype quantities to production runs. From off-the-shelf to a wide range of value-added services — precision fabrication, E-core and pot-core gapping and testing, sorting and selecting by electrical specs.

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Besides burning calories it strengthens the heart, tones the muscles and improves stamina. And it's much less stressful on the body than running and high-impact sports. Working out on NordicTrack also boosts creativity and productivity and lowers stress, making you feel as good as you look.

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Unlike most in-home exercisers, NordicTrack works all the major muscle groups of the body including the arms, legs, buttocks, shoulders and yes, even stomach.

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World's best aerobic exerciser.

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It burns more calories in less time than any other kind of exercise machine. Up to 1,100 calories per hour according to tests at a major university.

CALENDAR


Winter 1991 UNIX Technical Conference, Dallas, TX. Usenix Association, 22672 Lambert St, Suite 613, El Toro, CA 92630. (714) 588-
MEGA MEMORY.

SONY HIGH-DENSITY SRAMS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>CONFIG.</th>
<th>SPEED (ns)</th>
<th>PACKAGING</th>
<th>DATA RETENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CXK581000P*</td>
<td>128K x 8</td>
<td>100/120</td>
<td>DIP 600 mil</td>
<td>L, LL</td>
</tr>
<tr>
<td>CXK581000M*</td>
<td>128K x 8</td>
<td>100/120</td>
<td>SOP 525 mil</td>
<td>L, LL</td>
</tr>
<tr>
<td>CXK581100TM*</td>
<td>128K x 8</td>
<td>100/120</td>
<td>TSOP (reverse)</td>
<td>L, LL</td>
</tr>
<tr>
<td>CXK581100YM*</td>
<td>128K x 8</td>
<td>100/120</td>
<td>TSOP (reverse)</td>
<td>L, LL</td>
</tr>
<tr>
<td>CXK581001P</td>
<td>128K x 8</td>
<td>70/85</td>
<td>DIP 600 mil</td>
<td>L, LL</td>
</tr>
<tr>
<td>CXK581001M</td>
<td>128K x 8</td>
<td>70/85</td>
<td>SOP 525 mil</td>
<td>L, LL</td>
</tr>
<tr>
<td>CXK581020SP</td>
<td>128K x 8</td>
<td>35/45/55</td>
<td>SDIP 400 mil</td>
<td>L, LL</td>
</tr>
<tr>
<td>CXK581020J</td>
<td>128K x 8</td>
<td>35/45/55</td>
<td>SOJ 400 mil</td>
<td>L, LL</td>
</tr>
</tbody>
</table>

*Extended temperature range available. L = Low power. LL = Low, low power.

MEGA COMMITMENT.

As you can see, Sony's more committed than ever to meeting your high-density SRAM needs. Just consider the enhancements we've made in a few short months: TSOP and TSOP-reverse packaging. Low data retention current. And extended temperature range. All based on our unique 0.8-micron CMOS technology, and available in 32-pin DIP and surface-mount plastic packages.

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CIRCLE NO. 18

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CIRCLE NO. 20

EDN December 6, 1990


We build to suit.

How in heaven do you construct a microminiature connector capable of meeting the unearthly demands of a space suit?

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CIRCLE NO. 84

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FAST CACHE.
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Ultra-high speed cache. Via a unique 0.8-micron latch, memory and transceiver within one IC. Ready for user configuration as either an 8k x 16-bit memory or as two 4k x 16-bit memories.

What you see here is a demonstration of Sony’s intense commitment to your each and every SRAM need.

A commitment made even more impressive by the fact Sony’s only been engineering and producing SRAMs for just over five years.

And when you consider we’re pouring all our resources into SRAM technology—including a new production facility in Nagasaki, Japan—this demonstration merely hints at the Sony SRAM technology yet to come.

First, there’s our Model CXK7701J, designed specifically for the Intel 80386.

This application-specific memory (ASM) combines address

<table>
<thead>
<tr>
<th>MODEL</th>
<th>CONFIG.</th>
<th>SPEED (ns)</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKK7701J*</td>
<td>8K x 16</td>
<td>30/35/45/55</td>
<td>PLCC</td>
</tr>
<tr>
<td>CKK5863AP</td>
<td>8K x 8</td>
<td>20/25/35</td>
<td>DIP 300 mil</td>
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<tr>
<td>CKK5863AJ</td>
<td>8K x 8</td>
<td>20/25/35</td>
<td>SOJ 300 mil</td>
</tr>
<tr>
<td>CKK5466P</td>
<td>16K x 4</td>
<td>15/20</td>
<td>DIP 300 mil</td>
</tr>
<tr>
<td>CKK5466J</td>
<td>16K x 4</td>
<td>15/20</td>
<td>SOJ 300 mil</td>
</tr>
<tr>
<td>CKK5467P**</td>
<td>16K x 4</td>
<td>15/20</td>
<td>DIP 300 mil</td>
</tr>
<tr>
<td>CKK5467J**</td>
<td>16K x 4</td>
<td>15/20</td>
<td>SOJ 300 mil</td>
</tr>
</tbody>
</table>

*For Intel 80366 **O/E

As you scan the chart above, keep in mind even higher speeds will be available soon.
Ultra-high density.
Sony solves your board-space problems with three new 1-Mbit SRAMs.
Each is based on our 0.8-micron CMOS technology. Configured as 128K x 8 bits. And available in 32-pin DIP and surface-mount plastic packages.

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2201 Laurelwood Road, Santa Clara, CA 95056
The Sunday *Boston Globe* has a section that announces auctions of homes, real estate, personal property, and businesses. It’s a sad commentary on the times that this section is expanding weekly. It’s particularly sad that so many small, technical businesses are going bust. It would be good if every high-tech venture capitalist took the time to attend a few auctions, at which they’d see the life, soul, and dreams of entrepreneurs sold for 10 cents on the dollar. Often it’s the venture capitalists who, expecting a quick profit, force these small businesses into insolvency. Dumping companies overboard happens more often when venture capitalists see the companies they back face a stormy market or an economic squall.

But auctions may not be the best place to see the broken dreams of entrepreneurs, engineers, and business people because they move quickly from lot to lot. The equipment gets scooped up and whisked away before the enormity of a loss of an entire business and the fate of its employees can sink in. For a better exposure to reality, stop in at the Weird Stuff Warehouse, 715 Sycamore Dr, Milpitas, CA 95035 (408) 434-0168. Every venture capitalist should visit this warehouse before signing their next high-tech business deal. The warehouse displays stacks of products that companies have declared obsolete or surplus to their needs, along with the inventory of businesses that died. The warehouse floor is an open classroom—for those who are willing to sift through its piles—on what can go wrong with products and companies.

Brand-new chassis, unstuffed circuit boards, reels of components, tubes of ASICs, and stacks of disk drives attest to designs and products that died. Perhaps those products found no market or came to the market too late. In any case, here they lie, scattered remnants of an engineer’s best efforts at a new product that was going to storm into the market and make a fortune.

The lessons are many: strive for quality; get your product to market on time; plan your strategy; have clear and meaningful goals; let customers—not engineers—develop products; have enough working capital; and on and on. Venture capitalists aren’t the only ones who should go to an auction or stop at an electronic-surplus outlet. Would-be entrepreneurs should visit them, too. Viewing the bits and pieces of products that would have been is a sobering experience. Some will take the lessons to heart, and others will come away with false confidence in their own plans and ideas.

All of this may sound morbid and pessimistic, but I’m very optimistic about the electronics industry and the many innovative entrepreneurs, venture capitalists, and engineers who will help direct it and harness its capabilities. However, every new venture needs a realistic outlook. Looking at others’ failures can provide it.
DESIGN WITH ANALOG WORK
YOU WON'T HAVE TO MANUFACTURE
Go ahead, explain it.

Tell them how small variations in component tolerances, process parameters and operating temperatures can cause an analog design to fail in manufacturing. Or worse yet, in the field. Even though it worked in the lab or in SPICE.

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P.O. Box 7241
Mountain View, CA 94039-7241
1-800-632-3531/1-415-965-6158

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FAX 1-800-729-9288

**CIRCLE NO. 86**
Power-supply IC controls both PWM and power-factor correction

Limited energy supplies, the nature of today's office electrical loads, and new standards are forcing power-supply designers to pay more attention to power-factor correction. The ML4819 makes implementing power-factor correction easier and cheaper by combining both PWM and power-factor-correction control in one IC.

The input capacitor of an uncorrected power supply only charges—draws current from the ac line—during the peaks of the ac line's cycle. Thus, the input current looks like a series of peaks rather than a sinusoidal waveform. This input current waveform contains unwanted harmonics of the line frequency and contributes to heating in the distribution wires. The goal of power-factor correction is to make the current drawn from the ac line more sinusoidal and in phase with the voltage waveform. Uncorrected power supplies exhibit power factors around 0.65. Using this controller, you can build a supply with an input range of 90 to 260V ac, which exhibits a power factor between 0.994 and 0.996.

A continuous inductor boost topology is a common implementation of power-factor correction. This device includes a boost-mode control circuit based on a patented current-sensing technique. The boost inductor acts as an extra storage element. The IC controls the current that flows into the inductor; the inductor in turn delivers energy to the supply's capacitor. This boost topology consumes continuous line current, generates low input noise, and imposes low peak current in the power-supply switch.

Although discrete and IC implementations of this correction scheme exist, combining the power-factor control and PWM control reduces the size of the supply's control section by eliminating many passive components. Because the PWM and correction circuits share the same oscillator, synchronization of the two stages is inherent. Without synchronizing the two stages, the correction circuit's switching frequency could interfere with the converter's chopping frequency and create beat frequencies.

The PWM controller section of the IC is a conventional current-mode PWM circuit with additional features such as a maximum duty-cycle clamp. The controller's output drivers supply 1A peak current and are internally clamped to 15V. During undervoltage lockout, the IC consumes 1 mA. During active operation, it typically consumes 25 mA.

The ML4819 is available in 20-pin DIPs for $3.95 (100). Typical applications for the IC include power supplies for PCs in the 150 to 400W range, instruments, computer peripherals, plotters, printers, and other off-line power supplies.

—Anne Watson Swager
Micro Linear Corp, 2092 Concord Dr, San Jose, CA 95131. Phone (408) 433-5200.

Circle No. 734
Ruggedized 8088- and 80386-based PCs withstand automotive and factory applications

The MDC family of ruggedized IBM PC-compatible computers targets applications in harsh environments such as factories, remote locations, and inside vehicles. You can operate the systems in environments with temperatures ranging from -40 to +85°C. The company offers 8088- and 80386-based models with a choice of monochrome or color flat-panel displays.

The MDC family comprises three modular components—the display, the keyboard, and processor/storage-unit modules. You can locate the keyboard and display modules as far as 15 ft from the processor/storage modules. For example, you can mount the processor/storage module in the trunk of a car for automotive applications. The display module includes a numeric keypad and a set of function keys that can eliminate the need for a keyboard in embedded applications.

The display modules also allow direct viewing in sunlight and feature backlighting for use in low light. As a standard feature, the company offers a choice of a 9.125 × 5.75-in. display module that supports 600 × 400-pixel resolution or an 8.75 × 3.75-in. display module that has 600 × 200-pixel resolution. You can set up the standard displays to operate in CGA, MDA, or Hercules monochrome modes. A VGA color display is available as an option.

Both the MDC-088 and MDC-386 models include one parallel and two serial ports, a connector for an external floppy-disk drive, and support for an internal modem. The 8088-based MDC-088 includes 640k bytes of RAM, and the 80386-based MDC-386 hosts 4M to 8M bytes of RAM. You can add standard IBM PC-compatible boards to either system with an optional expansion module.

The company conformally coats the pc boards used in the systems to increase resistance to humidity and liquid spills. The systems can withstand a 20g shock for 11 msec while operating. The systems exceed the EIA RS-374A specification for vibration. You can also operate the systems at altitudes ranging from 10,000 ft to 200 ft below mean sea level.

The systems include two 512k-byte RAM disk cartridges for storage. The 80386 model also includes a standard 40M-byte hard disk, and you can power down the disk drive via software during periods of extreme vibration. The company also offers optional 20M-and 40M-byte drives for the MDC-088.

The systems operate from a dc power source that ranges from 7 to 26V. You can also power the systems with an ac adapter. The company's battery pack powers the systems; it also can function as an uninterruptible power source.

The MDC-088 weighs 14.8 lbs, and the MDC-386 weighs 16.7 lbs. Both systems include the MS-DOS 4.01 operating system.

The MDC-088 costs $7425, and the MDC-386 is $10,500. Both models are available now. The MDC-386 with a VGA color display costs $12,300 and will be available in the second quarter of 1991.

—Maury Wright

MobileData Communications Corp, 10850 N 24th Ave, Suite 101, Phoenix, AZ 85029. Phone (602) 678-3788. FAX (602) 678-4471.

Circle No. 732
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*Novell certification applies to the EtherStar LAN adapter which incorporates the Fujitsu chip set.

EDN December 6, 1990 CIRCLE NO. 87
Parallel processing pushes performance of layout-rules checker

To improve software runtimes, LRC-2000 layout-rules-checking software lets you partition the evaluation on multiple workstations. The software also performs dynamic load balancing, which optimizes CPU usage. You control CPU options via the software's graphical user interface.

In addition to parallel processing, the layout-rules checker utilizes the hierarchy of your layout to build its database and shorten runtimes. Hierarchical analysis eliminates redundant evaluation of identical components. The software's error identifiers, resizers, and Boolean operators all work within the database hierarchy, so you can locate rule violations and operate on the layout without compromising the design.

The layout-rules checker includes standard operators such as area, internal, external, enclose, intersect, and length. The vendor claims that the two database operators, Contain and Minmax, are unique because they perform oversizing and undersizing on the hierarchical data. The software lets you mask structures, evaluate data in multiple windows, set the number of hierarchical levels to check, and flag non-45° elements. To eliminate redundant checks and false-error reports, an option allows you to assign different distance values for orthogonal, angle, and corner checks in the same run.

For simplicity, you can combine layers and data types and specify each layout-rules check in a single line. Alternatively, a translation utility converts run sets from the popular Dracula design-rules checking software to the LRC-2000 format.

The software accepts LTL, GDSII Stream, CIF, and Appleion 860 format data and creates LTL or GDSII Stream data. You can run the software on workstations from Sun, Apollo, and Sony, and on some high-end 80386/486 IBM PCs. The software costs $20,000 and doesn't include layout vs schematic (LVS) or electrical-rules checkers (ERC).

The company expects to announce both LVS and ERC packages near the end of this year.

—Michael C Markowitz
Circle No. 735
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FPGA family offers speed, density, on-chip RAM, and wide-decode logic

The XC4000 field-programmable gate array (FPGA) family offers more than the performance and density improvements you expect of a next-generation device. The ICs incorporate features that will help you sweep up the RAM and high-speed decode logic you may have previously left outside the FPGA.

Similar to the earlier generations, the 4000-series FPGAs are arrays of programmable logic blocks with programmable I/O blocks and interconnect matrix. All of the programming is RAM based, allowing you to reconfigure the part at any time.

Each logic block has dual D-type flip flops and 4-input Boolean function generators for implementing your logic design. A third function generator in each block combines the output signals of the first two generators with an additional signal line, allowing each block to handle as many as nine input signals. You can preset the flip flops during programming.

Logic blocks are great for logic designs, but terribly inefficient for implementing RAM. If designers using earlier FPGAs needed a bit of RAM in their circuit, they usually used an external device. The 4000-series, however, allows you to convert the RAM normally used for programming a logic block into RAM accessible by your circuit.

You can trade half of a logic block for 16×1 bits of RAM when programming the IC. You can combine logic blocks to increase either bit width or depth as needed. The resulting RAM has a 5-nsec read- and a 10-nsec write-access time. You can also preset the data values of the RAM, allowing you to use the memory as ROM.

One drawback of FPGAs has been the limited width of their logic-block input lines. For example, with a 4-input logic block you would have to use 11 blocks, 8 in parallel and 3 to combine the output signals, in order to decode a 32-bit address. The resulting 3-level logic delay may be too slow for some applications, forcing you to use an external high-speed decoder in your design.

The 4000-series provides a wide-input logic function at its I/O pins,
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independent of the logic blocks. Each side of the IC can produce as many as 4 wired-AND terms from as many as 40 input terms. You can also split the logic into two half-wide groups. The wired-AND decodes in 10 nsec.

Other features of the family include programmable input pullup or pulldown resistors, 12 mA output drive capability, JTAG (Joint Test Action Group) boundary scan, and 8 low-skew global networks for clock distribution within the chip.

An upgraded design software package supports the ICs, giving you automatic place-and-route capability with access to the RAM and wide-decode features. The software also provides 276 soft and 50 hard macros for implementing higher-level functions. Soft macros are functions that the software maps into available logic blocks using logic synthesis. Hard macros are functions with guaranteed performance characteristics, for which the software has a prepartitioned, fixed-routing blueprint.

The ICs handle system speeds of 60 MHz and will come in sizes from 5000 to 10,000 gates. The first family member, the XC4005, has 5000 gates, costs $192.50 in sample quantities, and is available immediately. The XC4010, with 10,000 gates, will be available in the first quarter of 1991 for $686.50. ICs with 6000 and 8000 gates will follow.

The development system with design software costs $7840 for PC-based systems and $15,950 for workstations. Current users can upgrade their PC-based systems for $1750, $3300 for workstations.

—Richard A Quinnell
Xilinx Inc, 2100 Logic Dr, San Jose, CA 95124. (408) 559-7778. FAX (408) 559-7114.

Circle No. 731
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IC layout tools ensure integrity and maintain flexibility

Construct PI is not a TV series about a detective going undercover on a hard-hat job. Compose Architect won't calm an irate building designer. Construct PI and Compose Architect are IC design and layout tools that provide process independence (hence the PI) and layout flexibility.

Construct PI uses a process-technology database to store design rules and process information. Removing this data from the design allows the design—or portions of it—to migrate among various processes. You can redo or reuse a design by editing the database and issuing an update command.

The tool's all-layer device-compaction feature causes the layout widths and spacings to shrink or expand to meet the database's design rules. The graphical-device-generation feature lets you sketch a layout, paying attention only to the layers on which you place polygons and paths and their relative relationships. The software then correctly sizes and spaces the layout based on the information you've got in the database. The software also generates a C-language program that you can use as a parametrized cell. You can define or edit constraints in either the layout or in the C program. You may need to assign constraints to certain structures before the software can generate a properly sized, design-rule-correct layout.

Construct PI uses the schematic and net list to ensure a correct-by-construction layout. Among the information the software reads from the design files are gate sizes, wire widths, and device groupings. With the schematic and layout in side-by-side windows on your workstation, you can select a gate in the schematic window, drag it into the layout window, and place it in the layout. For bookkeeping, placed components appear in your schematic in a different color than unplaced components.

Compose Architect is a floor-planning and analysis tool that works with hard- and soft-function blocks. Soft-function blocks, which don't have associated layout data, need port assignments and area definition. You define area via a manual estimation or by entering a gate-size area estimate that the software extrapolates to the whole function block. Soft blocks aren't limited to rectangular shapes. With area and port information, you can modify aspect ratios and swap port assignments to optimize the layout.

Power-, delay-, and path-analysis tools contained in Compose Architect let you correctly size, taper, and place power buses and clock signals. The software calculates pin-to-pin delays and creates the files necessary to use the delay information in logic simulation. Obviously, the software works best with the vendor's own simulator and the static timing analyzer that the company resells.

The Compose Architect software communicates with the Construct PI software to track the progress of each of its components through
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Interphase's FDDI 100 Mb/s offerings are a logical choice for the industry. The V/FDDI 3211 Falcon received *UnixWorld* magazine's Product of the Year designation and was the industry's first 6U VMEbus FDDI solution. Interphase's newest FDDI product is the V/FDDI 4211 Peregrine, a RISC-based high-performance node controller capable of link level operation or on-board protocol processing. The Peregrine provides single or dual attach configurations, with SMT (Station Management Software) running on-board, all in one 6U VME slot.

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Interphase also offers two Ethernet design options. The V/Ethernet 4207 Eagle 32-bit protocol platform is the high-performance standard for the industry, and offers on-board TCP/IP support. The V/Ethernet 3207 Hawk is designed specifically for cost-sensitive VMEbus applications.

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(214) 919-9000
The i750 video processor chip set helps you mix text, graphics, and video images in your computer-display application. The 2-chip set comprises a microprogrammable pixel processor for manipulating image data and a display processor for handling the video interface.

The 82750PB pixel processor chip handles image decompression, windowing, and video mixing at the pixel level. It uses a 48-bit-wide instruction word and can manipulate 16-bit data on 2 independent internal buses simultaneously. Its ALU uses 16-bit data but is configurable to provide an 8-bit dual-add-with-saturate operation for handling pixel arithmetic.

The chip has an onboard 512-word x 48-bit instruction memory and a 512-word x 16-bit data RAM, as well as 16 general-purpose registers. The ALU can reload its instruction memory from external memory for programs longer than 512 words. The chip offers 32-bit address and data buses to external memory and uses a FIFO input/output buffer.

To speed up processing, the pixel processor has several common image-handling functions in hardware. These functions include a built-in Huffman decoder, a single-cycle n-bit barrel shifter, and a pixel interpolator with \( \frac{1}{8} \)-bit resolution. The processor also offers two loop counters to save instructions during software loops; automatic addressing of external video memory by the I/O FIFO buffer; and a horizontal line counter to keep track of the display's use of memory.

The pixel processor's companion piece, the 82750DB display processor, handles the timing and control of image data. The chip has fully programmable horizontal and vertical display parameters, permitting it to handle many display formats, including NTSC, PAL, SECAM, and VGA. You can also synchronize the chip to an external video source.

You can use the data display to display data from the pixel processor or to mix that data with an ex-
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CIRCLE NO. 28

UPDATE

ternal video source. To drive the display, the chip has three 8-bit D/A converters, each of which has an associated 256 x 8-bit color look-up table. The chip supports both the RGB (red-green-blue) and YUV (chrominance-luminance) color maps.

The display processor provides several hardwired functions to ease the handling of multiple display formats. The features include a 2-line horizontal interpolator for mixing video and graphics, a hardwired YUV-to-RGB converter, and automatic line doubling for displaying video on noninterlaced monitors.

The pixel processor operates at 25 MHz and the display processor at 28 MHz. These clock rates are fast enough to provide real-time image processing and display, including handling JPEG (Joint Photographic Experts Group) image decompression at 30 images/sec. The chips will not handle MPEG (Motion Picture Experts Group) motion video, but they will handle other real-time video decompression algorithms.

The chips come in 132-pin plastic quad flatpacks. Samples are available now, though production quantities won't be available until the first quarter of 1991. The display processor costs $46, and the pixel processor sells for $39 (10,000). Enabling software is available, including compression algorithms, host-system software, and a microcode developer's kit.

—Richard A Quinnell

Intel Corp, Box 58130, Santa Clara, CA, 95052. Phone (800) 548-4725; in CA, (408) 765-8080.

Circle No. 736
INCO SPECIALTY POWDER PRODUCTS
RESEARCH AND DEVELOPMENT...
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Victor Ettel, Director of Battery Powder Research, Sheridan Park, Mississauga, Ontario, Canada. His job is to find new uses for carbonyl technology.

Frank Heck, Technical Director, Novamet Specialty Products Corp. Wyckoff, New Jersey. Frank is always looking for new ways to produce a better powder.

Eurof Rees, Pilot Plant Superintendent, Clydach Nickel Refinery, Wales, U.K. Eurof has been involved in carbonyl coating of substrates for more than twenty years.

George Tyro/er, Technical Superintendent, Copper Cliff Refinery, Sudbury, Canada. George likes working on the edge of developing nickel powder products.

INCO Specialty Powder Products is continuing to develop advanced powders and applications. Our mission is to develop new products for new technologies. INCO SPP personnel from marketing, manufacturing and research work together as a team, bringing to bear their disciplines to serve you and your needs.

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INTERNATIONAL RESEARCH GROUP

INCO Specialty Powder Products is conducting research and development at the Novamet Specialty Products Corp. in the US, at the Clydach Refinery in Wales, UK, and Sheridan Park Corporate Laboratory and Copper Cliff Refinery in Ontario, Canada. We are fortunate to have some of the leading powder technology researchers on our staff.

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PRODUCT UPDATE

Arcnet controller IC and µC make up a complete 2-chip LAN node

The COM20020 Arcnet IC combines controller and transceiver functions in a single chip and targets low-cost embedded applications such as process control, factory automation, medical equipment, and automobile LANs. In effect, the IC and a microcontroller compose a complete Arcnet node. Available in both 24-pin DIPs and 28-pin plastic leaded chip carriers, the IC includes a 2k x 8-bit dual-port static-RAM buffer, provides a glue-free interface to most microcontrollers, and includes a variety of hardware diagnostics capabilities.

On-chip buffers allow the Arcnet IC to support zero-wait-state accesses for both itself and the attendant microcontroller (including arbitration). Incorporating the buffers on chip also eliminates cumbersome memory interface and related control circuitry—a feature that helps reduce the number of devices required to implement an Arcnet node by a factor of five. With the addition of a microcontroller, the IC provides a complete 2-chip Arcnet node solution.

The IC implements the Arcnet token-passing protocol. Featuring a 2.5M-bit/sec data rate, the device supports as many as 256 nodes in a wide variety of network topologies, including rings, stars, buses, and trees. The device also includes a self reconfiguration protocol with software programmable node IDs that enables the protocol to automatically reconfigure the network when nodes are added or deleted, or when certain timeout conditions aren't met.

The IC includes a command-chaining feature that speeds packet processing and enables it to support consecutive transmissions without host intervention. A dual 2-level FIFO buffer handles command transmission and reception, and status bits in a pipeline manner. Therefore, the chip can receive new packets before the interrupt for the previous packet has been acknowledged and serviced. When the IC is used with a microcontroller whose interrupt latency is less than 100 µsec, it can process packets indefinitely without host intervention.

You can interface the controller IC to a variety of popular microcontrollers, including Zilog's Z-80, Motorola's 68XX family, Intel's 80XX family, and NEC's V Series, with no glue logic. The device automatically detects microcontroller features such as a nonmultiplexed or a multiplexed bus and configures itself accordingly.

The IC also provides a flexible media interface. The chip supports a traditional transformer hybrid interface for applications that require long transmission distances. The IC includes an RS-485 differential interface for low power and for low-cost applications. Finally, you can use an open-collector mode for short-distance applications that require a direct-line interface.

On-chip hardware diagnostics improve network adaptability and facilitate fault prevention and isolation. Before joining a network, the device first checks to see if there is any activity. Next, the device

Support for an RS-485 differential interface, a transformer hybrid interface, or a simple open-collector bus makes the COM20020 suitable for a wide range of applications. The IC also directly supports connections to microcontrollers with multiplexed buses or nonmultiplexed ICs such as the 6801.
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Extended modeling capabilities increase simulator accuracy

A simulation is only as good as your models. And your models can only be as good as the underlying simulator will allow. You can build models for the Hilo 4 simulator using a number of new capabilities.

Models have often been built using either inertial or transport delays. Inertial delays limit the propagation of a pulse through a gate to some minimum pulse width. Transport delays propagate all pulses with a gate-dependent delay. Hilo 4 uses a 3-band paradigm that lets you build your models to reject too-short pulses, pass long-enough pulses, and propagate ambiguous pulses as unknowns.

The simulator also allows you to build models using precise functions for delay characteristics. These functions can contain, but are not limited to, such variables as temperature, voltage, process, and cell loading. You can also build your models to incorporate pin-to-pin dependencies. The models can also emulate point-to-point variations through the use of resistor-capacitor (RC), inductor-capacitor (LC), and resistor-inductor-capacitor (RLC) functions.

There are more than 12,000 device models for the software. Among these models are standard components, hardware modeling shells for the Logic Modeling (Milpitas, CA) LM-1000, third-party models, C models, Altera and Xilinx PLD models, and foundry supported ASIC libraries. The company also offers a modeling service.

The simulator runs behavioral and structural models built using the company's own proprietary Genrad Hardware-Description Language (GHDL) models. The simulator uses the CAD Language Systems (Rockville, MD) VHSIC Hardware-Description Language (VHDL) front-end to compile VHDL models to an intermediate format. Internal software translates the intermediate models into GHDL. The simulator accepts VHDL models that conform to a superset of the VHDL models you can synthesize, using the Synopsys (Mountain View, CA) synthesis software.

You can debug GHDL and VHDL models using a source-level debug capability. This debugger lets you use breakpoints, single-stepping, variable examinations, and variable modification. By changing variables during a simulation, you can experiment with your design.

To describe stimuli and response, the Design Waveform Language (DWL) also incorporates behavioral features such as procedures, processes, and functions. If you know the behavioral circuit is correct, you can write behavioral stimuli and use a learn capability within the DWL to capture the response. You can then use these learned patterns to verify synthesized structural implementations.

System Hilo 4 contains a range suite of design tools. The suite comprises the Hisim logic simulator for
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design verification; Hitime for timing analysis; Hifault for fault grading; Hitest for test pattern generation; and Hichip for hardware modeling.

System Hilo 4 uses the Motif user interface and offers a tight integration with the Valid Logic (San Jose, CA) software system. In addition, Logic Automation (Beaverton, OR) models work with the simulator.

The software runs on workstations from DEC, HP/Apollo, IBM, Intergraph, NEC, and Sun. The software costs about $18,000 and will be available in the first quarter of 1991.—Michael C Markowitz

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Everybody knows ICs are everywhere, but some of their applications might surprise you. For example, new driver ICs are at the heart of the remarkable recent advances in LCDs. These displays allow manufacturers to squeeze a full-function personal computer into a briefcase.

Masterminding Grid System's (Fremont, CA) 1810 notebook-sized computer's 10-in. LCD is Cirrus Logic's CL-GD6/620 LCD-driver IC. The LCD driver, in conjunction with a 10-MHz NEC V30 µP, gives the $2895 diminutive computer a complete IBM EGA display.

Recently introduced ICs are lurking inside some futuristic-looking products for engineers, too. For example, the Ramtek (Santa Clara, CA) Millennium image processor uses a Texas Instruments 34020 DSP µP to perform imaging functions, such as FFTs and convolutions, as well as graphics. The DSP µP combines specialized signal-processing instructions, and internal hardware, with general-purpose data-processing µP facilities. Thus, the µP can perform DSP and conventional processing. For example, the processor also mates with MIT's X-Window System—a graphical user interface for networked Unix computers.

We all knew that eventually semiconductor companies would pack a supercomputer into a chip, giving engineers awesome power right on their desks. Now Texas Instruments claims to have done just that for engineering workstations. Three-D graphics workstations, like the Silicon Graphics' (Mountain View, CA) Iris II, use a 320C20 to perform graphics operations as fast as a supercomputer does.

ICs have also benefited consumer products. They’re included in products people use everyday. For example, they run automobile fuel-injection systems, antilock brakes, and automatic transmissions. In addition to these glamorous tasks, ICs are performing more mundane, but nonetheless important, jobs in modern automobiles.

BMW (Munich, Germany) and Analog Devices have jointly developed the AD22001 filament-sensing IC. This 5-channel device monitors as many as five lamp filaments to ensure that the lamps work. The IC checks lamps that are either on or off. Thus, drivers can be sure...
that an unilluminated trouble light is out because there is no trouble, not because the lamp is burned out.

Meanwhile, anyone who has used a cellular car phone while driving knows that interference frequently obscures the voice reception. A Texas Instruments fixed-point DSP µP in the Ericsson GE (Bohemia, NY) Hotline earphone works in real time to clean up transmissions. The µP handles all of the functions that the Electronic Industries Association stipulates for bandpass filtering, syllabic companding, pre-emphasis, de-emphasis, limiting, and post-limiting filtering. The chip also generates and decodes DTMF signals. Further, the chip provides echo suppression and a total loop attenuation of at least -40 dB in its ADC/DAC path, allowing you to make phone calls hands free.

**The talk of the town**

The videophone is finally here—but not quite in the form science-fiction writers envisioned. Overcoming the phone lines' limited bandwidth to transmit a widebandwidth video signal is no mean feat. A Texas Instruments 320C25 DSP µP compresses video images in real time so that the Videotelecom Co (Riverside, CA) Conference

To make sense of the complicated color files printers must print out, they need lots of smarts. This color printer has an internal RISC µP processing files.

Squeezing a full-function PC into a notebook-sized case, the Grid Systems' 1810 uses a 10-in. LCD.
The pressure to squeeze a full-function PC into a briefcase has prompted remarkable advancements in LCDs and LCD-driver ICs.

System 300 can give conferees a visual link over conventional phone lines. The system can send both live TV “snapshots” and graphical material bidirectionally between conferees. However, live, 30-frame/sec video over conventional phone lines is still a dream.

Further, the scourge of the 80s has become the darling of the 90s. Answering machines are like opinions: everybody has one. Having wormed their way into our affection, answering machines are acquiring new responsibilities. Now they can handle digital communications, such as fax transmissions or FSK data, as well as voice. For example, the Phonemate (Torrance, CA) Adam is an all-digital answering machine that uses its Texas Instrument’s TMS320C17 DSP µP to perform audio signal-processing chores, such as companding, as well as manage a pair of RS-232C ports.

Printers are becoming as smart as answering machines. Transforming complex images, such as Postscript files, into something that a color printer can actually print requires considerable processing. Consequently, Seiko’s (Torrance, CA) latest Colorpoint PS Series of desktop color printers uses an Intel 80960 reduced instruction-set computer (RISC) µP to execute Phoenix Technology’s (Norwood, MA) Phoenixpage conversion program internally.

The printers have 300-dpi resolution, and various models produce the usual A- or B-size images ($6999 and $9999, respectively). There are also “super-A” and “super-B” sized drawings that are as large as standard magazine pages. Because the printers can convert Postscript files internally, you can connect them to virtually any computer.

The security industry is also becoming more intelligent. Polaroid (Cambridge, MA) is doing its bit to help mankind in its never-ending search for identity. Using an electronic medium instead of film, Polaroid’s ID-2000 digital security and identification system electronically processes individual portraits, personnel information, and signatures to produce tamper-resistant ID cards instantly. The device uses a Texas Instruments TMS320C25 DSP µP for image and data compression.

What you see is what you get

ICs are in the eyes of NASA’s proposed space station. General Dynamics Convair Div (San Diego, CA) will soon flight-test an advanced image processor for the space station. The image processor...
is a 22-µP system. It uses Inmos Transputers and a distributed Ada runtime software system to achieve 200M-flops, 200-MIPS performance.

If you want to monitor fish activity, you have to be able to find them. Find them, that is, if you were careless enough to lose your fish in the first place. The Techsonics's (Eufaula, AL) Hummingbird Dimension 3 Sonar Fish Finder locates fish and places them in three categories; small, medium, and large. It also displays a map of the bottom of the body of water. Unlike other fish finders, it can do this either obliquely or straight on. The fish finder uses a Signetics NE604A low-power, FM-IF demodulator that detects the RF signals which indicate the presence of fish. (See box “Animal magnetism and other electronic wonders” for more fun fish facts.)

On a more serious note, steady advances in rugged, low-power analog ICs are improving established industrial devices as well as scientific instruments. A common position-sensing device for industrial electronics is the linear variable differential transformer (LVDT). The Lucas Schaevitz (Pennsauken, NJ) Accu/Sens series of LVDTs measures ranges from as wide as ±10 in. to as narrow as ±0.050 in. to an accuracy of 0.125% of full scale. As well as being rugged, the units are temperature and shock resistant.

Unlike older units, this series produces a simple ±10V output signal that is proportional to measured displacement. Older units developed complex ac-waveform outputs. The key component for the new units' performance is an Analog Devices AD598 LVDT signal conditioner.

Animal magnetism and other electronic wonders

Some alarmists are concerned that modern electronics allows snooping into our most intimate secrets. If stingrays could talk, they'd agree. Researchers have discovered that stingrays, sharks, and related animals possess a "sixth sense." These animals can perceive electric fields with organs called Ampula of Lorenzini. Discovering if elasmobranchae use animal magnetism to detect potential mates meant that researchers had to simulate precisely the tiny nV/m field these animals generate underwater.

It turns out that female stingrays, lying buried in the sea bottom during mating season and otherwise invisible, produce a characteristic electric field associated with their breathing. One theory postulates that male rays in the area sense this field and, their ardor sparked, come like a flash to the buried female.

Testing this theory involved first making a system that could record and then play back the stingrays' signals. The stingrays generate a very weak, 500 nV/m de electric field modulated at less than 1 Hz. (For comparison, the mean field intensity of the earth at sea level varies between 100 and 300 nV/m.)

Researcher Timothy Tricas of the Washington University School of Medicine coupled a Compaq (Houston, TX) laptop computer with an Analog Devices AD7845 12-bit DAC and AD210 isolation amplifiers. He enclosed the resultant system in a waterproof plastic housing. He tested various frequencies and found that the male rays did indeed respond.

When they came within a few meters of the buried electrodes, they dug in vain looking for the elusive female. Female rays were also attracted by the signals, burying themselves nearby.

The findings of this "sixth-sense" experiment may have more timely uses for humankind. For example, electric fields in the earth change before an earthquake and some animals and fish are able to detect this.
Solid-State Power Controllers (SSPCs) replace electromechanical circuit breakers in land, sea, air, and space vehicles. They provide status outputs and permit logic input control. DDC’s 28 Vdc, SSP-21110 series, can be remotely located near the load because of the digital controls they support. The series offers five models, differing in rated current, so that fault (“instant trip”) and true $I^2T$ trip characteristics can be selected to protect wiring and loads.

Utilizing power MOSFET switches, these power controllers offer low "ON" resistance, low voltage drop, high "OFF" impedance, and low power dissipation. Built with power MOSFETs and custom monolithics many options such as $I^2T$ trip curve tailoring, output rise and fall times, and a variety of custom current ranges are possible. They offer small size, low power, and high reliability, since there are no mechanical parts.

Built-In-Test (BIT) has been provided to monitor, in real time, the status of the internal circuitry as well as circuitry external to the SSPC. This BIT monitors reverse current flow, MOSFET failure or degradation, unit overtemperature, and control circuit failure. The status outputs also provide BIT and an indication of light and heavy overloads as well as minimum load current. The status lines are TTL/CMOS compatible in order to support microprocessor or logic integration of a consolidated electrical load management center (ELMC) of control.

The SSP-21110 series will operate over the full military temperature range from -55°C to +125°C. Military screening and optional packaging are available upon request. The SSP-21116, 270 Vdc, series, will be available before the end of the year.

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NEC Microprocessors

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FPGA family boosts circuit density to handle 8000-gate designs

A member of the Act 2 family of field-programmable gate arrays (FPGAs), the A1200 runs at 60 MHz and has as much circuit capacity as an 8000-gate gate array. The device contains an array of logic modules, separated by channels of 32 parallel conductors. Overlaying the array are sets of 29 additional conductors running at right angles to the channels. At each intersection lies an antifuse. When you apply a programming voltage across the conductors, the antifuse changes state to become a permanent connection. Three antifuses are sufficient to connect any two logic elements. The impedance of a programmed antifuse can be as low as 200Ω, allowing a fast rise time.

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- 90dB SNR, -100dB harmonics.
- FFT testing.
- Serial and parallel data outputs.
- Four user-selectable input voltage range configurations.
- Available with environmental stress screening.

The MN6400’s 16-bit performance makes it ideal for industrial and military data acquisition applications including instrumentation, ATE and spectrum analysis.

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324 Clark St., Worcester, MA 01606
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CIRCLE NO. 151
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Our 1-megabit monolithic 128Kx8 SRAMs clock in at 25 and 35ns. Very fast. They’re ideal for microprocessor applications where fast access times are a must to avoid wait states: workstations, supercomputers, image processing, telecommunications switches, and radar/sonar systems. Packages include DIPs, CSOJs, and flatpacks for commercial/industrial/military applications.

1-megabit SRAMs on time

Inova was first to ship 1-megabit monolithic SRAMs, and we’ve been shipping them since 1988. We’ve established a reputation for on-time delivery — even during the memory crunch of 1988 and 89. Like our delivery, our high-speed, high-density monolithic devices are getting faster all the time. Inova has devices with access times ranging from 100ns to 25ns in stock now.

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Inova makes the only monolithic 1-megabit SRAM specified on DESC drawing #5962-8958. Both our 1-megabit and 256K devices are DESC listed. Inova 64Kx16 devices are listed on DESC drawing # 5962-90858. All our military grade devices are MIL-STD-883C compliant.

The first and only 64Kx16 monolithic SRAM

This year Inova introduced the industry’s first 64Kx16 monolithic 1-megabit SRAM. At 45ns, these devices complement our family of 45ns 128Kx8 SRAMs. They feature our proven 4-transistor cell CMOS process with high-speed access and low active and standby power characteristics. And they’re listed on DESC drawing #5962-90858.

Inova... for your high-speed, high-density SRAM solutions

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AVAILABLE NOW!

<table>
<thead>
<tr>
<th>Part #</th>
<th>Organization</th>
<th>Speed*</th>
<th>Packages</th>
<th>Availability</th>
<th>Part #</th>
<th>Organization</th>
<th>Speed*</th>
<th>Packages</th>
<th>Availability</th>
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<td>MT5C1001</td>
<td>1 MEG x 1</td>
<td>25ns</td>
<td>PDIP, CDIP, SOJ, LCC, Flatpack</td>
<td>NOW</td>
<td>MT5C6401</td>
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<td>12ns</td>
<td>PDIP, CDIP, SOJ</td>
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<td>MT5C6404</td>
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<td>12ns</td>
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<td>NOW</td>
<td>MT5C6405</td>
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<td>12ns</td>
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<td>MT5C2561</td>
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<td>NOW</td>
<td>MT5C6406/7</td>
<td>16K x 4 S. I/O</td>
<td>12ns</td>
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<td>64K x 4</td>
<td>20ns</td>
<td>PDIP, CDIP, SOJ, LCC</td>
<td>NOW</td>
<td>MT5C1601</td>
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<tr>
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<td>64K x 4 I/O</td>
<td>20ns</td>
<td>PDIP, CDIP, SOJ, LCC</td>
<td>NOW</td>
<td>MT5C1604</td>
<td>4K x 4</td>
<td>12ns</td>
<td>PDIP, CDIP, SOJ</td>
<td>NOW</td>
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<td>NOW</td>
<td>MT5C1605</td>
<td>4K x 4 I/O</td>
<td>12ns</td>
<td>PDIP, CDIP, SOJ</td>
<td>NOW</td>
</tr>
</tbody>
</table>

* Slower speeds also available.
Introducing Just The Thing For Just-In-Time E-PROM Users.

The JIT-ROM. The Just-In-Time ROM from UMC. Now you can use it to replace expensive E-PROMs—and cut your costs by up to 40%.

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UMC JIT-ROM Family

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Part Number</th>
<th>Organization</th>
<th>Speed(ns)</th>
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<tr>
<td>64K</td>
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<tr>
<td>128K</td>
<td>UM23C128</td>
<td>16K x 8</td>
<td>120/150</td>
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<tr>
<td>256K</td>
<td>UM23C256</td>
<td>32K x 8</td>
<td>150</td>
</tr>
<tr>
<td>512K</td>
<td>UM23C512</td>
<td>64K x 8</td>
<td>150</td>
</tr>
<tr>
<td>1Mb</td>
<td>UM23C304A/5</td>
<td>128K x 8</td>
<td>120/150/200</td>
</tr>
<tr>
<td>2Mb</td>
<td>UM23C2001</td>
<td>256K x 8</td>
<td>120/150/200</td>
</tr>
<tr>
<td>4Mb</td>
<td>UM23C4000/1</td>
<td>256K x 16/512K x 8</td>
<td>200/250</td>
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<td>8Mb</td>
<td>UM23C8001</td>
<td>1M x 8</td>
<td>200/250</td>
</tr>
<tr>
<td>16Mb</td>
<td>UM23C16000</td>
<td>2M x 8</td>
<td>200/250</td>
</tr>
</tbody>
</table>

JIT-ROMs include DIPs and SOs. 16 Mb available 2nd quarter 1991.
Low-Skew Clock Buffer
The GA1110 multiphase clock buffer provides six clock signals that are phase locked to an external clock. The typical output skew is $\pm 100$ psec with a maximum of $\pm 250$ psec. A 500-MHz oscillator in the phase-locked loop uses one of the six output clocks for feedback. The IC forces the feedback signal to the same phase as the input clock, with no more than a 500-psec delay from input to output.

Two control pins let you select one of four patterns of output clocks. Using a zero-phase clock for feedback, you can obtain combinations of inverted signals and phase shifts of $\pm 2$ and $\pm 4$ nsec on the other output lines. By using one of the modified clocks for the feedback signal, you can extend the phase shifts to $\pm 6$ nsec. Altogether, there are 14 possible combinations. The IC comes in speed grades of 25, 33, or 40 MHz. In a 16-pin DIP, $\$35$ in sample quantities.

**Gazelle Microcircuits Inc., 2300 Owen St, Santa Clara, CA 95054. Phone (408) 982-0900. Circle No. 351**

Controller
The Z80181 Smart Access Controller (SAC) combines the features of three ICs with additional I/O ports. The device contains a 10-MHz Z180 µP, a Z84C30 quad counter/timer, and one channel of a Z85C30 serial communications controller. Also included are two 8-bit parallel ports, two software-controlled chip-select signals, and a clock oscillator. Built into the Z180 µP are two UARTs, a clocked serial I/O port, two 16-bit timers, two DMA channels, and a programmable dynamic-RAM refresh circuit. An on-chip memory-management unit extends the Z180's address space to 1M byte, and a programmable wait-state generator accommodates slow memory.

The Z84C30 counter/timer section offers four 8-bit timers with 8-bit prescalers to extend the timer's count resolution. The timers share I/O pins with one of the parallel ports. The parallel ports are bidirectional, and each I/O pin's direction is individually programmable. The Z85C30 communications controller handles both synchronous and asynchronous protocols. In a 100-pin quad flatpack, $\$22$ (1000).

**Zilog Inc., 210 Hacienda Ave, Campbell, CA 95008. Phone (408) 370-8000. Circle No. 352**

Self-Contained FFT Processor
A completely self-contained FFT processor, the PDSP16510 performs forward or inverse FFTs on both real or complex data sets. The device features 16-bit data and coefficients, with block floating-point arithmetic for increased dynamic range. An internal 32k-bit RAM can hold as many as 1024 complex data points. In the continuous mode, the processor uses three internal control units, which overlap new data, present data, and previous results.

The user can choose to overlap data blocks by zero, 50, or 75%. Inputs and outputs are asynchronous to the 40-MHz system clock used for internal operations. The processor can complete a complex transform with 1024 points in 96 µsec. You can apply either a Hamming or a Blackman-Harris window operator to the incoming data. These operator values are calculated internally and do not require an external ROM. Samples in 84-pin pin-grid-array package, $\$1195$.

**Plessey Semiconductors Corp., 1500 Green Hills Rd, Scotts Valley, CA 95066. Phone (408) 438-2900. FAX (408) 438-5576. TLX 4940840. Circle No. 353**

Single-Chip Controllers
The 10/20-MHz PC87120 SuperAT and the 16/20-MHz PC87130 SuperAT/SX controllers integrate all of the peripheral support needed in 80286- or 80386SX-based IBM PC/ATs, respectively. As a result, it is possible to design a complete mother board with just the PC87120 or PC87130, the CPU, memory devices, and from five to ten TTL devices. Each single-chip device has 8- and 16-bit BIOS ROM selectability, 512k- to 8M-byte dynamic-RAM support, shadow RAM support for system BIOS, video ROM and video RAM, software-configurable conventional or page-mode-interleaved memory, and software-configurable wait states and command delays.

On-chip peripherals include two 8237 DMA controllers, two 8255 interrupt controllers, and one 8254 timer/counter. The PC87120 SuperAT and PC87130 SuperAT/SX cost $40 and $47 (100), respectively.

**National Semiconductor, Box 15090, M/S 16-300, Santa Clara, CA 95052. Phone (408) 721-5000. Circle No. 354**

Closed-Loop Buffer
The EL2012 high-speed buffer amplifier features a wide bandwidth, accurate gain, and high output current. With a 50Ω load, the buffer has a bandwidth of 80 MHz, gain is 0.999, and output-current capability is 250 mA. The device, which needs only 17 mA of quiescent current, operates from ±15V supplies and provides an output swing of ±12V. The device uses a process
The Phone.

Motorola's Micro T•A•C™ cellular telephone was the winner of both the Fortune Magazine and Nikkei Electronics Product of the Year Awards, which isn't surprising. It's so small and lightweight, it can be carried in a shirt pocket. And it carries the most technically advanced cellular phone features on the market today.

Features like Call Message, which appears in the display when a call is received while the user is away, and Automatic Redial, that attempts to place a call for up to four minutes.

No other cellular phone offers so much in so little space. So it's little wonder the Micro T•A•C ranks number one in the industry.
The Operator.

The 68HC11 is the powerful microcontroller Motorola called on to operate the Micro T•A•C. It's highly integrated, yet compact—ideally suited to the advanced capabilities of this phone.

Moreover, the superior quality of Motorola microcontrollers gives Micro T•A•C the reliability customers demand. That's why Motorola microcontrollers are the first choice of leading electronics manufacturers worldwide—including our demanding sister divisions. And one reason Motorola was the first company to win the United States' Malcolm Baldrige National Quality Award.

From cellular phones to race cars, the world's most innovative and award-winning products are powered by Motorola.
that insulates the metal heat-sink tab on the 5-lead TO-220 package from all supply voltages. $8.07 (100).

**Elantec, 1996 Tarob Ct, Milpitas, CA 95035. Phone (408) 945-1323, ext 303. Circle No. 355**

### Transceiver Chip

Interfacing with DS-3 lines, the SSI 78P236 transceiver operates at a multiplex rate of 44.736M bps. The chip can also operate at the Synchronous Optical Network (SONET) STS-1 data rate of 51.84M bps, and the CEPT E-3 data rate of 34.368M bps. The receiver section of the transceiver accepts B3ZS-encoded alternate-mark-inversion (AMI) inputs and implements a low-level input signal indication. The transmitter section converts clock and data input signals into AMI pulses of the appropriate shape for transmission. A line-buildout circuit lets you attenuate the outgoing pulses for various line lengths. The transceiver also eliminates the need for crystals or tuned components. The 78P236 is fully compliant with AT&T Compatibility Bulletin 119 and Bellcore Technical Reference 000009. $25 (10,000).

**Silicon Systems, 14351 Myford Rd, Tustin, CA 92680. Phone (714) 731-7110, ext 3575. FAX (714) 669-8814. Circle No. 356**

### Monolithic Rail-To-Rail Silicon Pressure Sensor

The MPX5100D 0-to-15 psi, signal-conditioned pressure sensor integrates the sensing element, offset calibration, temperature-compensation circuitry, and signal amplification on a monolithic silicon chip. The sensor's output scale is calibrated from 0.5 to 4.5V, which makes the device suitable for µP-based systems having analog-to-digital inputs. The device, which uses a patented silicon shear-stress strain gauge, is temperature compensated over the range of 0 to 85°C. The sensor is available in the basic-element package, single- and dual-ported versions, and with customized outputs. From $45 (100).

**Motorola Inc, MD Z201, 5005 E McDowell Rd, Phoenix, AZ 85008. Phone (800) 752-3621; in AZ, (602) 244-4556. Circle No. 357**

---

**Once it took this to protect 12 lines from surges.**
Integrated Circuits

**Single-Chip Fax Modem**
The RI44EFX is a member of the company's line of single-device Monofax facsimile modems. The synchronous, half-duplex (2-wire) modem operates at a speed of 14.4-kbps over the public telephone network. According to the company, an RI44EFX-based fax machine operates 50% faster than a Group 3 9600-bps V.29 machine during the actual page transmission.

Additional benefits include the use of trellis-coded modulation to achieve 14.4, 12, 9.6, and 7.2k-bps operating modes and boost modem performance under poor line conditions. The modem's architecture also incorporates the function of a serial I/O device to assist in the implementation of error detection and correction. Samples are available now, with OEM quantities expected for the first quarter of 1991. The device is housed in a 64-pin quad in-line package or a 68-pin plastic leaded chip carrier. $68 (10,000).

**Rockwell International Corp,**
**Digital Communications Div, Box C, Newport Beach, CA 92658.**
**Phone (800) 854-8099; in CA, (800) 422-4230.**

**1M-Bit Dynamic RAMs**
Featuring an access time of 60 nsec, these 1M-bit dynamic RAMs are available in two organizations. The M5M41000B is a 1M x 1-bit device; the M5M44256B is a 256k x 4-bit device. Both devices have a maximum standby current of 500 µA. Low-power versions are available with a maximum standby current of 200 µA.

The DRAMs are available in 20- and 24-pin, 300-mil wide, thin small-outline packages, which offer the industry's smallest profile surface-mount packages. You have a choice of both standard and reverse pinout versions, which allow placement on both sides of a pc board, sharing a single metal trace for added density. Other package options include 18- and 20-pin DIPs, a 20-pin ZIP, and a 26-pin SOJ package. $7.75 (100).

**Mitsubishi Electronics America Inc, Semiconductor Div, 1050 E Arques Ave, Sunnyvale, CA 94086.**
**Phone (408) 730-5900. FAX (408) 730-4972.**

**Text continued on pg 112**
While many companies have deserted the military ASIC business, our commitment hasn’t changed. So if you’re looking for a long term strategic partner, stand at ease.

LSI Logic has earned its stripes by successfully completing more military gate array designs than all other ASIC manufacturers combined. Led by a dedicated Military Aerospace group, we’re ready when you are to make those designs a production reality.

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ACROSS THE BOARD
CIRCLE NO. 112
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4M-Bit EPROM

Organized as 512k x 8 bits, the Am27C040 is a 4M-bit ultraviolet EPROM with an access time of 140 nsec. The device operates from a single 5V supply and features fast single-address-location programming. In the standby mode, current drain is 20 µA typ. The EPROMs are available in windowed ceramic DIPs and LCC packages as well as one-time programmable DIPs and plastic leaded-chip-carrier packages. In a 32-pin windowed ceramic DIP, $57.20 (100).

Advanced Micro Devices, Box 3453, Sunnyvale, CA 94088. Phone (408) 732-2400. Circle No. 360

Smart-Power Chip

Featuring eight low-side drivers in a single 15-lead multiwatt package, the L9822 smart-power chip can deliver 750 mA continuously from each driver. All eight drivers can operate simultaneously. The device is controlled through a 4-wire serial bus, which is used both to load a control byte and read a status byte. This diagnostic feature allows a microcontroller to detect fault conditions due to overloads or open-circuit outputs. When an overload is detected, the device turns off the faulty driver to prevent damage. The chip's outputs are also protected by internal 34V zeners that suppress overvoltages caused by inductive loads. $3.50 (1000).

SGS-Thomson Microelectronics, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. FAX (602) 867-6290. Circle No. 361

D/A Converters

The single-channel DSP201 and dual-channel DSP202 D/A converters are designed for ease of use with modern DSP ICs. Complete with internal glue logic, both parts feature sampling rates to 500 kHz and provide a single-chip interface to standard DSP chips, such as those from Analog Devices, AT&T, Motorola, and Texas Instruments. By eliminating the need for external logic and design time, the devices provide an easy analog signal-processing output for DSP circuit designers. Running full-speed on a DSP IC serial port, both devices are faster than most of the bit clocks...
Simple Signal Mixing

Our new MPY600 gives you simple signal mixing solutions for a wide range of RF, IF and video applications. This monolithic, four-quadrant analog multiplier features extra-wide bandwidth and exceptional spurious-free dynamic range. Inputs are DC-coupled, eliminating the need for cumbersome coupling transformers and input biasing circuitry.

Sharper Signals with -65dB SFDR

MPY600 key specifications:
- -65dB SFDR
- Bandwidth, 30MHz (75MHz with external OPA621 op amp)
- -55dBc Distortion (0dBm, 5MHz)
- -60dB Feedthrough @ 5MHz
- ±2V full-scale input voltage range
- Supply range: ±4.75V to ±8V
- Low input noise, 120nV/√Hz for Vout, 50 nV/√Hz for Iout (Lower noise with reduced input range)
- -25/+85 temp range, 16-pin plastic DIP package
- From $9.95*

MPY600 delivers performance plus spectral purity at substantial savings. For more information and data sheets, contact your local Burr-Brown sales office or call 1-800-548-6132 toll-free for immediate assistance.

*U.S. OEM prices, in 100s
that DSP ICs can currently handle.

The DSP201 offers a single voltage-output channel, accepting either 16 or 18 bits of input data; the DSP202 has two voltage-output channels with either two separate input ports or a mode to drive both output channels from a single 32-bit word. The DSP201 costs $19.95; the DSP202 costs $24.95 (1000).

Burr-Brown, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. Circle No. 362

Dual-Channel 18-Bit ADC

Operating from a single 5V supply, the AT76C120 A/D converter features 18-bit resolution, a conversion speed of 10 µsec, and an input bandwidth of 50 kHz. The device has a guaranteed linearity accuracy of 15 bits and can resolve input signals of <10 µV. The ADC provides system designers with 96,000 18-bit conversion samples/sec on each of its two channels. Other features include a minimum S/N ratio of 86 dB and a 2’s-complement format for the device’s digital-output code. In a 24-pin plastic DIP, $25 (1000).

Atmel, 2125 O’Nel Dr, San Jose, CA 95131. Phone (408) 441-0311. Circle No. 363

“Kickstarter” Chip

The DS1239 MicroManager chip contains special circuitry that cold-starts a computer from the key-board. In addition to convenience, the chip enhances safety by keeping 110/220V ac power cabling distant from the person activating the on/off switch. When equipment power is off, a pushbutton closure is detected by the chip, which then sources a small amount of energy from a 3V lithium battery. This energy lights an optoisolator to kick on a triac, which powers up the system. The chip also monitors a second pushbutton to reset a processor when the operator wants to intervene. The DS1239 also has provisions to monitor power. If the 5V power supply dips out of tolerance, a warning signal interrupts the processor, allowing for storage of information in nonvolatile RAM. $3.50 (1000).

Dallas Semiconductor, 4350 S Beltwood Pkwy, Dallas, TX 75244. Phone (214) 450-0448. FAX (214) 450-0470. Circle No. 364

Venture into the Modulation Domain and
Integrated Circuits

4-Channel, 12-Bit ADC
The ADC7802 4-channel, 12-bit A/D converter is optimized for accurate multiplexing of dc signals. The ADC is self-calibrating and needs no offset or gain adjustments. Operating from a single 5V supply and dissipating only 10 mW, the device accepts unipolar inputs from 0 to 5V. Total conversion time is 17 μsec, and conversion results are available in two bytes with “no missing codes” guaranteed. Channel separation is typically 92 dB and channel-to-channel mismatch is 1/4 LSB max. The IC contains a monolithic capacitor-array with an on-chip S/H device, a 4-channel multiplexer, autocalibration circuitry, and an 8-bit μP interface port. A special register permits full control over the converter through the μP bus, eliminating the need for hard-wired control lines. The ADC7802 is available in a 28-pin DIP or a 28-lead plastic leaded chip carrier. $19.95 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. FAX (602) 889-1510. TWX 910-889-1510.
Circle No. 365

20-Bit Audio DAC
Designed specifically for high-performance digital audio applications, the AD1862 20-bit DAC features a typical S/N ratio of 119 dB, THD + N of -96 dB, and a dynamic range of 102 dB. Gain linearity is ±1 dB at a -90-dB amplitude. The monolithic converter uses proprietary digital-offset circuitry to enhance low-level signal linearity and eliminate the need for deglitching circuitry.

An external midscale trim pin lets you adjust the DAC for the lowest possible distortion for signals <60 dB in amplitude. The DAC can perform 16× oversampling and has a digital interface that accepts 2's-complement 20-bit serial words. The DAC operates from ±12V supplies and comes in two performance grades. The device is available in 16-pin plastic DIPs. From $17.20 (100).

Analog Devices, 804 Woburn St, Wilmington, MA 01887. Phone (617) 937-1428. Circle No. 366

High-Speed PLD
According to the company, a maximum propagation delay of 7 nsec makes the GAL16V8B-7 the fastest E²CMOS PLD available and the only low-power device in this speed range. The 20-pin device, which can operate to 100 MHz, typically draws only 100 mA of current. The PLD emulates all standard 20-pin PAL devices with full functional,

improve your powers of observation.

When characterizing VCO responses and frequency agile signals, most designers depend on their powers of deductive reasoning. The Modulation Domain offers a more direct approach. It brings changes in frequency vs. time clearly into view. So you can see the transient response and post-tuning drift of a single-shot VCO step, or the chirp linearity and staggered PRI of a frequency agile signal. On a single display. In seconds.

Find out how looking at frequency vs. time in the Modulation Domain can make you a better designer, call Hewlett-Packard at 1-800-752-0900.* Ask for Ext. 1827, and we'll send you a Visitor’s Guide to the Modulation Domain on floppy disk, complete with a list of sights and excursions you won't want to miss.

There is a better way.

*In Canada, call 1-800-387-3867, Dept. 419.
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Integrated Circuits

fuse-map, and parametric capability. The device is available in sample quantities. 20-pin DIPs, $15; plastic leaded chip carriers, $13.80 (100).

**Lattice Semiconductor**, 5555 Northeast Moore Ct, Hillsboro, OR 97124. Phone (503) 681-0118. FAX (503) 681-0347. Circle No. 367

**Octal S/H Chip**
The SMP-08 combines eight independent S/H channels on a single chip. The device incorporates internal capacitors that hold the input signal and output amps for buffering the signal held on each of the hold capacitors. A TTL/CMOS-compatible, one-of-eight decoder controls a series of eight internal switches that connect the analog input to the selected S/H channel. Through the multiplexer, each channel can be addressed to program a different output voltage. The chip operates from single supplies of 5 to 15V or dual supplies of ±3 to ±7V. It provides make-before-break channel addressing and TTL compatibility over the full supply range. Acquisition time is only 7 µsec; the droop rate, the device’s hold storage capability, is <1 mV/sec typ. The chip is available in 16-pin plastic DIPs, ceramic DIPs, and SO packages. From $6.25 (100).

**Precision Monolithics Inc**, Box 58020, Santa Clara, CA 95052. Phone (408) 562-7181. FAX (408) 727-1550. Circle No. 368

**Motor Drive Chip**
The TDA 5140 drives a 3-phase brushless dc motor in either a star or delta configuration. The chip contains commutation and delay circuits that detect zero crossing points in the motor’s back EMF.

These signals control the timing of the 3-phase push-pull output drive and produce a tachometer output. The TDA 5140A has a 0.6A drive capability. The supply voltage is 4 to 18V, and power consumption is 4 mA. It is available in sample quantities. Other chips include the TDA 5141 with 1.8A drive capacity and the TDA 5142 for higher outputs using external power transistors. The TDA 5140 comes in an 18-pin DIP, SO-20, or SO-24 package and costs Gld 3.7 (10,000).

**Philips Components**, Box 218, 5600 MD Eindhoven, The Netherlands. Phone (40) 724324. FAX (40) 724825. Circle No. 369

**P-Channel DMOS Power FETs**
The VP22A family of p-channel, enhancement-mode vertical DMOS power FETs feature low on-resistance and are available in three breakdown-voltage ratings. The VP2210N3, VP2206N3 and VP-2204N3 have respective drain-to-source voltage ratings of 100, 60, and 40V. The on-resistance of these devices is 0.9Ω at VGS=10V, ID=3.5A and 1.5Ω at 5V and 1A. The drain-to-source on-state current is a minimum of 4A. Available in low-cost, space-saving TO-92 packages, the devices have a power-handling capability of 1W. VP2210N3, $0.91; VP2206N3, $0.90; VP2204N3, $0.89 (1000). Delivery, four to six weeks ARO.

**Supertex Inc**, 1225 Bordeaux Dr, Sunnyvale, CA 94088. Phone (408) 744-0100. FAX (408) 734-5247. Circle No. 370
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Lower the cost of your system upgrades with Flash EEPROMs on-board reprogramming. In workstations, office automation equipment and telecommunications systems, our 10K erase/write cycles ensure the reliability of your product.

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Integrated Circuits

Disk-Drive Controller
The CL-SH360 disk-drive controller implements Reed-Solomon error-correction code (ECC) while transferring data at a continuous 24M-bps rate. Using this correction, the chip can double the density of a single-platter 3½-in. drive from 40M to 80M bytes with no change in heads or media. The chip automatically performs correction of data errors during disk read operations without any local µP intervention. The controller can also continue data transfer from the disk to the buffer while correcting previously read data. The CL-SH360 features an 88-bit Reed-Solomon ECC with on-the-fly hardware correction. Other features are a power-down and an automatic wake-up mode that reduce power consumption by about 75% when the drive is not in use. A proprietary split-data field allows skipping defects within a sector. The CL-SH360 is packaged in a 100-lead quad flatpack. $24 (1000). Samples are available now, with production scheduled before the end of 1990.

Cirrus Logic, 1463 Centre Pointe Dr, Milpitas, CA 95035.
Phone (408) 945-8300. FAX (408) 263-5682.
Circle No. 371

Single-Chip PC/AT Controllers
The VL82C310 laptop and VL82C311 desktop controllers are single-chip devices for use in IBM PC/AT applications. The devices operate in 80286 and 80386SX microprocessor-based systems with clock speeds from 10 to 20 MHz. Both chips meet complete PC/AT system standards and require only six inexpensive TTL devices for PC/AT bus buffering. The controllers contain the standard mother-board peripheral functions, and the required memory, CPU, and expansion bus controls in a single 160-lead quad flatpack. The VL82C311 includes advanced features such as interleaved page-mode memory control, and the VL82C310 adds power-down modes for laptop operation that are normally found only in high-performance chips such as the company's Topcat 286/386SX and...
+5V TO ±15V DC-DC CONVERTERS
POWER UP TO 30W LOADS

No Design Required — Just Drop In

Maxim's MAX742 and MAX743 dual-output DC-DC converters provide the simplest solutions for generating ±15V or ±12V analog supplies from low input voltages, such as +5V digital supplies. To make designing with the parts as simple and reliable as plugging in modules, we not only specify all critical components, we also provide them.*

- Generates ±15V or ±12V
- 82-92% Typical Efficiency
- Uses Inductors, Not Transformers
- 0.3% Typical Noise and Ripple
- Current-Mode Control
- 200kHz Switching Frequency
- Two PWM Controllers Per Package

Using surface mount components, the MAX743 DC-DC converter delivers 3W in less than half the board space of the smallest modules. Power density is a healthy 18W per cubic inch.

<table>
<thead>
<tr>
<th>MAX742</th>
<th>MAX743</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>4.2V - 10</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>±12V or ±15V ±4%</td>
</tr>
<tr>
<td>Output Power</td>
<td>30W</td>
</tr>
<tr>
<td>Power Switch</td>
<td>External</td>
</tr>
<tr>
<td>Price</td>
<td>$5.82**</td>
</tr>
</tbody>
</table>

** MAX742 and MAX743, 1000-up, FOB USA

Evaluation Board Simplifies Prototyping

A MAX743 (through-hole) evaluation board containing a MAX743 and all the components required to build a 3 Watt DC-DC converter is available from Maxim for only $20. To order your evaluation board, send check or money order to Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086. For applications assistance or information on other Maxim products call (408) 737-7600, ext. 4000 or FAX (408) 737-7194.

* MAXL001: 100µH Low-Loss Toroid Inductors ($1.47, 1000-up) and MAXC001: 150µF Low-ESR Capacitors ($0.29, 1000-up)
MAX743CPE Production Kit ($8.18, 1000-up) includes:
1 - MAX743CPE
2 - 100µH Low-Loss Toroid Inductors
3 - 150µF Low-ESR Capacitors
2 - Schottky Rectifiers

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The smallest, lowest power, complete dual redundant 1553 interface. It is a user friendly total solution to the problem of interfacing a subsystem to the 1553 Bus. The NHI-1553RT appears as 8 or 16-bit wide Ram to the Host, requiring only two standard transformers to complete the bus interface. Standard Ram signals are used to interface the hybrid to all popular processors. The internal Ram is dual ported making the Host and Bus totally transparent to each other. Ram arbitration and control logic is all contained in the hybrid.

- Two +5V only transceivers
- 4K words of internal memory
- Message illegalization without external prom
- Supports notices I and II
- Programmable interrupts
- Interrupts stored internally in FIFO
- Internal 32 bit time tag clock
- Broadcast flag for each message
- Discrete I/O pins
- Complies with Mil-Std 1760A
- Plug-in package 1.33 x 1.83
- Flat package .95" x 1.85"
- Software and interface support
- On-site demonstrations available

Integrated Circuits

386DX chip sets. Both the 82C10 and 82C11 chips use a standard AT BIOS and provide LIM EMS 4.0 hardware support. VL82C10, $75; VL82C311, $65.

VLSI Technology, 8375 South River Pkwy, Tempe, AZ 85284. Phone (602) 752-8574. FAX (602) 752-6000. Circle No. 372

Silicon MMIC

Designated INA-02184 in the 85-mil plastic “pill” package and INA-02186 in the 85-mil surface-mount plastic package, this monolithic-microwave integrated circuit has a 3-dB bandwidth from dc to 800 MHz. At 500 MHz, the amplifier has a gain of 31 dB, a noise figure of 2 dB, and output power of 11 dBm at 1-dB gain compression. At 1.5 GHz, the amplifier’s gain is typically 26 dB. Either version is available in tape-and-reel packaging, with 1000 units in a 7-in. reel or 4000 units in a 13-in. reel. $3.40 each (100).

Avantek, M/S M82, 481 Cottonwood Dr, Milpitas, CA 95035. Phone (408) 943-3038. Circle No. 373

Math Coprocessor For Software Programs

Using a 1-µm process, the latest version of the industry-standard 387-DX math coprocessor runs as much as 20% faster than previous versions. The device is available in 16-, 20-, 25- and 33-MHz versions. Software programs such as Borland’s Quattro Pro, Autodesk’s
2 AA CELL TO 5V CONVERTER EXTENDS BATTERY LIFE

The MAX654-658 Family of regulated DC-DC converters provide the simplest and most compact solution available for efficiently generating 3V or 5V from a 1.5V or 3V battery input. An auxiliary, low-power, +12V converter guarantees start-up under load even when your battery is almost completely discharged. This +12V supply also provides a simple means of turning on and off intermittent loads via an external N-Channel MOSFET — further extending battery life.

- +5V at 170mA From 2 Cell Input
- 85% Conversion Efficiency
- 1.15V Guaranteed Start-Up (MAX654/6/8), 1.5V (MAX655/8)
- Starts Up Under Load
- Auxiliary 12V/100µA Supply
- Low Battery Indicator
- 14-Pin SO and DIP Packages

MAX655 EVALUATION KIT AVAILABLE

An evaluation board containing a MAX655 and all the components necessary for building a 2 AA cell to +5V converter is available from Maxim for only $20.

<table>
<thead>
<tr>
<th>Battery Input</th>
<th>Part</th>
<th>V&lt;sub&gt;OUT&lt;/sub&gt;</th>
<th>I&lt;sub&gt;OUT&lt;/sub&gt;</th>
<th>Price**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cell: 1.15V - 1.6V</td>
<td>MAX654</td>
<td>5V</td>
<td>45 - 80mA</td>
<td>$3.34</td>
</tr>
<tr>
<td></td>
<td>MAX656*</td>
<td>5V</td>
<td>190 - 380mA</td>
<td>$3.34</td>
</tr>
<tr>
<td></td>
<td>MAX657</td>
<td>3V</td>
<td>50 - 110mA</td>
<td>$3.34</td>
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<tr>
<td>2 Cells: 1.5V - 3.2V</td>
<td>MAX655</td>
<td>5V</td>
<td>60 - 170mA</td>
<td>$3.34</td>
</tr>
<tr>
<td></td>
<td>MAX658*</td>
<td>5V</td>
<td>205 - 450mA</td>
<td>$3.34</td>
</tr>
<tr>
<td></td>
<td>MAX655EVKIT</td>
<td>EVALUATION BOARD</td>
<td>$20.00</td>
<td></td>
</tr>
</tbody>
</table>

* Plus IRF541 MOSFET
** MAX654-658CPD, 1000-up, MAX655EVKIT, 1-up, FOB USA

To order your evaluation board, send check or money order to Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086. For applications assistance or information on other Maxim products call (408) 737-7600, ext. 4000 or FAX (408) 737-7194.

WARNING: The Typical Operating Circuit and Figures 1 thru 4 shown in the MAX654-658 data sheet published 1/90 and in our 1990 New Releases Data Book ARE IN ERROR. Contact factory for a corrected data sheet, published 11/90.

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- Updates analog or digital outputs to 250,000 values/second

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The ATT3000 series of field-programmable gate arrays (FPGA)s offers compatibility with similar parts from Xilinx Corp. The basic architecture includes five input-variable core logic blocks (CLB), two flip-flops per CLB, enhanced routing resources, and 3-state drivers for wide ANDs.

The ATT3020, the first device in the series, contains an 8 x 8 CLB matrix and 2000 equivalent gates. It comes with toggle rates of 70 and 100 MHz, allowing its use in systems with operating speeds to 50 MHz and higher. The ATT3000 series will consist of five basic devices with sizes ranging to 9000 equivalent gates. The parts will be available by the first quarter of 1991. ATT3020 in 84-pin, 100-MHz plastic leaded chip carriers, $36.70; 70-MHz versions, $28.50; in 68-pin plastic leaded chip carriers, 100-MHz version, $35.60; 70-MHz version, $27.30 (100).

ATT &T Microelectronics, Dept 52AL300240, 555 Union Blvd, Allentown, PA 18103. Phone (800) 372-2447; in Canada, (800) 553-2448. Circle No. 376

Integrated Circuits

AutoCAD, and Lotus's Freelance Plus, which use floating-point mathematical operations, can benefit by the faster speeds of the latest devices. 16-MHz version, $570; 20-MHz version, $647; 25-MHz version, $814; 33-MHz version, $994.

Intel Corp, Box 58065, Santa Clara, CA 95052. Phone (800) 538-3373; in CA, (916) 351-2747. Circle No. 374

12-bit Buffered Multiplying CMOS DAC

The AD7545 monolithic 12-bit multiplying DAC has on-chip data latches. The device loads data in a single 12-bit-wide word, which allows interfacing directly to most 12- and 16-bit bus systems. The loading of the input latches is under the control of the CS and WR inputs. Logic low on these control inputs makes the input latches transparent, allowing direct unbuffered operation of the DAC. The device, which comes in a 20-pin DIP, operates from a single 5 to 15V supply and is available in commercial, industrial, and military grades. From $6.25 (100).

Harris Semiconductor, Box 883, Melbourne, FL 32902. Phone (407) 724-3800. Circle No. 375

Microwave Power Transistor

You can use the MZ0912B100Y npn power transistor in common-base, class C broadband amplifiers for Taean applications. A 50V supply provides the device with a maximum power output of 100W and a minimum power gain of 7 dB across the 960- to 1215-MHz frequency band. The device has an interdigitated structure with diffused emitter-ballasting resistors to enhance current sharing and gold metalization for stability. Internally matched input and output cells make circuit design easier. The transistor comes in a hermetic metal-ceramic flange package. $158 (1000).

Philips Components, Discrete Products Div, 45 George Washington Huy, Smithfield, RI 02917. Phone (401) 232-0500. Circle No. 377
1 µA OP AMP EXTENDS BATTERY LIFE 15X

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Maxim's new MAX406 op amp is the lowest power op amp on the market today, requiring a maximum supply current of only 1.2 µA — leakage current in most battery-powered applications. And, it consumes less than 3.6 µW of power enabling lithium or alkaline batteries to last years longer. A review of the specs below will show you that the new MAX406 is the ideal op amp for solar powered products, hearing aids, barcode readers, and many other micropower applications.

- 1.2 µA max Supply Current
- < 0.1 pA Input Bias Current
- 0.5 mV max Input Offset Voltage
- Input Voltage Range Includes Neg Supply Rail
- 40 kHz Gain Bandwidth
- Wide Supply Voltage Range: +2.4V to +10V or ±1.2V to ±5V

Rail-to-Rail Output Sources 2,000X Supply Current

The MAX406 maintains linearity under heavy load conditions and is capable of sourcing as much as 2 mA from a 9 V battery. The output swings rail-to-rail while the input voltage range extends to the negative supply rail. The new device operates from voltages as low as 2.4 V while maintaining widest input and output voltage ranges.

Lowest Bias Current, Highest Stability

Input bias current of the MAX406 is less than 0.1 pA — a 10X improvement over other low-power op amps. Input offset voltage is 0.5 mV maximum, eliminating the need for offset nulling in most applications. As a buffer, the MAX406 is extremely stable without any external compensation, even when driving capacitive loads as high as 1 µF.

Call your Maxim representative today for applications information, data sheets and samples. Or, write Maxim Integrated Products, 120 San Gabriel Dr., Sunnyvale, CA 94086, (408) 737-7600, FAX (408) 737-7194.

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Now, thanks to Fujitsu's MB89352, there's no need to compromise. Because it's a low-cost, high-performance SPC that meets the stringent cost and size requirements of PC applications.

Which makes your life a lot easier. Because instead of having to choose between slower products and higher prices, the only choice you have to make is Fujitsu.

And in contrast to other devices with pin counts of 68 to 150, the MB89352 provides you with a modest pin count of 48. All of which meets your need for smaller, lighter, more compact systems.

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All in a 48-pin quad plastic surface-mount package no larger than a dime. Or a conventional 48-pin DIP.

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Which is why Fujitsu provides a complete SCSI host adapter with all the hardware and software you need to convert any IBM® PC/XT,™ AT® or compatible into an MB89352 evaluation system.

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Integrated Circuits Division
3545 North First Street, San Jose, CA 95134-1804. 1-800/642-7616.

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We created the market… and we still lead the way.

Meet NCR’s SCSI development team. In 1983, they gave the computer industry its first SCSI device. By providing easy connectability and significantly reducing time to market, a new product era was born.

Since then needs have changed. By combining our system skills, high-performance standard cell methodology, and in-house manufacturing, NCR has maintained its leadership role with innovative new ideas like the 53C700 product family. And the joint development of LADDR — a new architecture aimed at cutting the development time of OS/2 device drivers by 90%.

Today SCSI is becoming the leading I/O standard — adopted by industry giants like Apple, IBM, HP, and DEC. And no one is selling more SCSI chip level products than NCR. In fact, no one even comes close.
Here's another.

The NCR 53C700 SCSI I/O Processor…
So good, Electronic Design named it the product of the year.

“You can’t tell a good SCSI chip just by looking at it…” and according to Electronic Design, NCR’s 53C700 is the best there is.

The only third generation SCSI device on the market today, it concentrates all the functions of an intelligent SCSI adapter board on a single, smart and extremely fast, chip… for about 15% of the cost.

As the first SCSI 110 processor on a chip, the 53C700 allows your CPU to work at maximum speed while initiating I/O operations up to thousands of times faster than any non-intelligent host adapter. DMA controllers can burst data at speeds of up to 50 Mbytes/s. This new chip cuts down system time hookup to a fraction of what it has been.

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When it comes to designing a system power network, you essentially have two ways to go: you can use a centralized power scheme or a distributed power scheme. In a centralized scheme, the bulk power supply (or supplies) develops the specific voltages and currents needed throughout the system. In the distributed power scheme, you again have a bulk supply. In this case, however, the supply develops an arbitrary voltage level, which is bused throughout the system. At appropriate points, dc/dc converters change this voltage to the levels needed for the circuitry involved.

While neither option will be the best choice in all cases, the distributed power scheme does offer a number of advantages in many applications. Such schemes can save space and lower weight, improve reliability, reduce the amount of redundant equipment, and ease the design of independent subsystems. Distributed power schemes can also improve the quality of the generated power.

One of the primary advantages of distributed power schemes is simplified power busing. Consider the following scenario: You must provide 500W of power for a system that involves 5V logic circuitry. In the centralized power scheme, your bulk supply must develop a 5V/100A output. Busing 100A throughout a system will require some pretty heavy gauge wire.

If you are using a distributed power scheme, your bulk supply can arbitrarily develop a 50V output voltage, which means the current requirement is only 10A. Your power bus can now use a much smaller gauge wire, which will reduce weight significantly.

There's another point to consider in this scenario—IR losses. In the centralized power scheme, there's very little you can do to correct for the significant losses that would occur when busing 100A of current. However, in a distributed power scheme, regulators residing at points of need won't have trouble with IR losses in the bus wiring. Each dc/dc converter will accept the reduced input voltage on the bus and still provide the specified output needed for the circuitry it is powering.

In the centralized vs distributed power debate, there is more to the cost- and weight-saving considera-
tions. A distributed power scheme partitions the system load into failure groups wherein each group has its own power source. As a result, the failure of one converter will affect only that portion of the system and, therefore, have a limited impact on overall system performance. Such is not the case in a centralizing powering scheme, where the loss of a single supply output will be felt throughout the entire system.

To avoid such problems, you would have to go with a redundant power scheme. For a centralized power design this could be very costly and exact significant weight penalties. In the case of distributed power, you need only provide redundant power sources for the most critical system functions—not the entire system. The result is that the distributed power concept develops into a compact, fault-tolerant system without the need to employ total redundancy.

In the centralized power scheme, the bulk supply must be capable of regulating its output (or outputs) to meet the needs of all system circuitry. Depending on how stringent these requirements are, you could be looking at a very expensive power supply. And even then, system performance is not going to be

Fully compliant with MIL-STD-883C, Method 5008, Interpoint's MHF/883 Series converters have output ratings ranging to 12W. The units have a 0.365-in.-high profile to support standard board-to-board spacing requirements. They are packaged in all-metal, hermetically sealed cases that require only 1.7 in.² of board area.

Operating with 36 to 72V inputs, MW005 Series converters from AT&T develop single outputs of 5, 12, or 15V. The units operate over a −40 to +85°C range and feature current limiting, overvoltage, and short-circuit protection.
The remote dc/dc converter provides all the necessary voltage regulation in a distributed power scheme.

Very reliable when you have fast changes in load requirements occurring at the end of a long power bus. In fact, the bulk supply in a centralized power scheme might not even see the rapid load change. In a distributed power scheme, the point-of-need dc/dc converters supply all the regulation, and each converter can handle very fast load changes without degrading system performance.

There's another point to consider when it comes to reliability—system protection. Table 1 lists some representative specifications for a number of dc/dc converters. As the numbers illustrate, today's converters perform quite well, operating efficiently and providing good power output capability. From the reliability standpoint, however, Table 1 doesn't tell the whole story. In just about every case, the converters listed offer short-circuit and overvoltage protection as standard features. In some cases, the units also offer thermal shutdown protection. Such features can lead to only one thing—better overall system reliability.

Satisfying system expansion needs is another area where distributed power schemes offer advantages over centralized power tech-

### Table 1—Representative dc/dc converter specifications

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Series</th>
<th>Output power (W)</th>
<th>Outputs</th>
<th>Output voltage (V)</th>
<th>Input voltage (V)</th>
<th>Efficiency (%)</th>
<th>Operating range (°C)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T</td>
<td>MW005</td>
<td>5</td>
<td>1</td>
<td>5, 12, 15</td>
<td>36 to 72</td>
<td>82</td>
<td>-40 to +85</td>
<td>$85.20</td>
</tr>
<tr>
<td>Abbott</td>
<td>M1/PAC</td>
<td>20, 35, 50</td>
<td>1, 2</td>
<td>5 to 28, ±12, ±15</td>
<td>14 to 31</td>
<td>70 to 80</td>
<td>-55 to +100</td>
<td>from $850</td>
</tr>
<tr>
<td>Astec America</td>
<td>AA9030</td>
<td>43</td>
<td>4</td>
<td>5, 12, -12, -26</td>
<td>11 to 17</td>
<td>80</td>
<td>NS</td>
<td>$114 to $129</td>
</tr>
<tr>
<td>Burr-Brown</td>
<td>PWR59X</td>
<td>0.5 to 1.3</td>
<td>1, 2</td>
<td>5, 9, 12, 15, ±5, ±12, ±15</td>
<td>5, 12, 15, 24</td>
<td>42 to 60</td>
<td>-25 to +85</td>
<td>$20.75 (100)</td>
</tr>
<tr>
<td>Calex</td>
<td>24S12.3500UW</td>
<td>45</td>
<td>1</td>
<td>12, 15</td>
<td>14 to 40</td>
<td>90</td>
<td>-25 to +80</td>
<td>$130</td>
</tr>
<tr>
<td>Computer Products</td>
<td>NFC25</td>
<td>25</td>
<td>3</td>
<td>5, ±12</td>
<td>36 to 72</td>
<td>82</td>
<td>-25 to +70</td>
<td>$77 (50)</td>
</tr>
<tr>
<td>Datei</td>
<td>wide range</td>
<td>15 to 30</td>
<td>1, 2, 3</td>
<td>±5, ±12, ±15</td>
<td>9 to 18, 18 to 36</td>
<td>75 to 84</td>
<td>-25 to +71</td>
<td>from $107</td>
</tr>
<tr>
<td>Interpoint</td>
<td>MHF883</td>
<td>12</td>
<td>1, 2</td>
<td>5, 12, 15, ±12, ±15</td>
<td>16 to 40</td>
<td>NS</td>
<td>-55 to +125</td>
<td>from $780 (100)</td>
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<tr>
<td>Lambda</td>
<td>UHD</td>
<td>210 to 233</td>
<td>1</td>
<td>5, 12, 15, 24, 28</td>
<td>38 to 72, 200 to 370</td>
<td>75 to 80</td>
<td>0 to 85</td>
<td>from $139 (250)</td>
</tr>
<tr>
<td>Powercube</td>
<td>28DC515-150</td>
<td>150</td>
<td>3</td>
<td>5, ±15</td>
<td>22 to 34</td>
<td>80</td>
<td>-55 to +85</td>
<td>from $1283 (100)</td>
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<tr>
<td>Power General</td>
<td>DCU1-5-WR</td>
<td>5 to 7.5</td>
<td>1</td>
<td>5, 12, 15</td>
<td>7 to 32</td>
<td>75</td>
<td>-25 to +70</td>
<td>$82</td>
</tr>
<tr>
<td>Reliability Inc</td>
<td>15A</td>
<td>15</td>
<td>2</td>
<td>±12, ±15</td>
<td>9 to 32</td>
<td>80</td>
<td>-25 to +71</td>
<td>$40 to $50</td>
</tr>
<tr>
<td>Shindengen</td>
<td>HDA/HDB</td>
<td>½</td>
<td>1, 2</td>
<td>5, ±12, ±15</td>
<td>5, 12, 24</td>
<td>NS</td>
<td>-10 to +70</td>
<td>$5.59 to $7.06 (1000) [5.59 to $7.06 (1000)]</td>
</tr>
<tr>
<td>Vicor</td>
<td>Minimod</td>
<td>25 to 100</td>
<td>1</td>
<td>5 to 48</td>
<td>12 to 300</td>
<td>80 to 90</td>
<td>-20 to +100</td>
<td>$134 (75W model)</td>
</tr>
</tbody>
</table>

Note: NS = not specified
niques. In the latter case, the bare-bones version of the system must include the power capability to accommodate any and all add-on features that users might employ. This power need is a must even if users never expand system capability beyond that afforded by the basic system. While the centralized power scheme works, it is certainly not a cost-effective way to satisfy expansion needs.

Distributed power techniques readily accommodate system expansion needs. Since each add-on subsystem card can have its own power source on board, there’s no problem when it comes to users increasing system capability. Best of all, you only have to provide the basic system design with enough power to satisfy its needs. Even in those cases where real estate restrictions make it impossible to mount the dc/dc converter right on the add-on card, distributed power schemes have minimal problems accommodating system expansion needs. You can simply design the basic system with a slot (or slots) that accepts a card containing multiple dc/dc converters. These con-

To accommodate ATE applications, Calex’s UW Series 45W converters feature an output that can be digitally programmed over a 2 ±10% range using a simple D/A converter. They include thermal shutdown circuitry for temperature protection and are housed in a 6-sided shielded case to minimize RFI.

For more information... 

For more information on the dc/dc-converter products discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN’s Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

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Reliability Inc Box 218970 Houston, TX 77218 (713) 492-0650 FAX (713) 492-0615 Circle No. 661

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POWER SOURCES

verters will provide the output needed to satisfy power requirements as expansion subsystem cards are added to the basic system configuration.

Keeping things clean

Distributed power schemes also provide better control over the quality of the system power—an important feature for many sensitive electronic applications. As noted earlier, dc/dc converters can maintain output at a constant voltage regardless of variations in input current and output load.

The dc/dc converters also isolate the subsystem by providing electrically separate power and ground planes. This scheme protects both the subsystem and the entire system from malfunction or damage due to failures or fluctuations in one part of a circuit. Single-chip power ICs can perform many of the conversion and regulation tasks provided by dc/dc converters, but they cannot provide the isolation. Even with the advances in recent power-IC device performance, dc/dc converters are still the devices that best satisfy the needs of distributed power schemes.

So what’s in the future? With the distributed power concept growing in popularity, many vendors see a strong market for dc/dc converters. Some also feel that the industrial and commercial markets will follow the aerospace/military demand for higher reliability, more durability, and smaller size. As they extend distributed power schemes to more industrial control, medical, and instrumentation applications, such benefits become inherent.

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EDN December 6, 1990
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Premium performance. MHF/883 converters offer up to 12-watts output power, 84% efficiency, a 16 to 40 Vdc input range, single and dual outputs, constant frequency switching, and 10 mV typical output regulation. And they're small enough (1.5 x 1.1 x 0.36 inches) to leave plenty of room for the rest of your design.

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CIRCLE NO. 132
Power Sources

Rechargeable, nickel-cadmium cells offer high capacity and high peak current

The Ultramax series of rechargeable nickel-cadmium batteries have ratings from 800 to 5000 mAh. The six sizes and their minimum capacities at a 5-hour discharge rate are: AA (800 mAh), ½Af (1000 mAh), ¾Af (1700 mAh), sub-C (2000 mAh), C (2800 mAh), and D (5000 mAh). (Af refers to a “fat” A cell with a maximum diameter of 16.5 mm versus 14.2 mm for a AA cell.) All have capacities at least equal to the highest in their size; some sizes’ capacities exceed by 50% to 70% the highest available in competitive units.

All batteries have a 1.2V nominal output voltage. Maximum output currents range from 18A for the AA cell to 110A for the D cell (1-sec ratings). Maximum internal resistance ranges from 38 mΩ for the AA cell to 13 mΩ for the D cell. With correct charge-termination techniques, you can fast-charge any of the batteries in as little as one hour.

Single-unit pricing for large OEM orders is as follows: AA, $1.25; ½Af, $1.56; ¾Af, $1.95; sub-C, $2.95; C, $3.50; and D, $6.

Gates Energy Products Inc, Box 667850, Charlotte, NC 28266. Phone (904) 462-3911.

Circle No. 697

20 to 50W MIL-spec dc/dc converters offer MTBF to 1.4 million hours

The MIL/Pac line of dc/dc converters includes units that produce 20, 35, and 50W. Minimum efficiency is 65%. Input voltage range is 14 to 31V dc. You can get units that produce a single output of 5, 12, 15, 24, or 28V dc as well as triple-output units that furnish 5 and ±12 or ±15V. All units meet MIL-STD-810C for altitude, shock, acceleration, and vibration, and MIL-STD-901C for high-impact shock. Hermetically sealed units are available. At high line and full load, the MTBF of the converters comply with MIL-STD-2000, which is approximately $1.4 \times 10^6$ hours in a ground-benign environment and has a 50°C baseplate temperature.

Line regulation is the greater of 0.1% or 10 mV for an input change from 14 to 31V. No-load-to-full-load regulation is the greater of 0.1% or 10 mV. A 50% change in load current causes transient overshoot of no more than 0.5V; the units recover within regulation limits in less than 0.5 msec. Ripple and noise are less than 100 mV p-p in a 25-MHz bandwidth over the full -55 to +100°C temperature range. The units meet MIL-STD-461C for electromagnetic interference for class A1, A2, and A3 equipment. The converters start at $850 in small quantities. Delivery is 12 to 14 weeks ARO.

Abbott Transistor Labs Inc, 2727 S La Cienega Blvd, Los Angeles, CA 90034. Phone (213) 202-8820. FAX (213) 836-1027.

Circle No. 700

EDN December 6, 1990 141
When you need surface mount aluminum electrolytic capacitors, remember that all signs point to Nichicon. Because now there are seven surface mount electrolytic series ready to help your products meet their marketing window—on time and on budget.

Save time. Save space. Save money. Who isn't under pressure these days to reduce costs? Well now you can, without sacrificing performance, when you design your new products or replace comparable tantalum capacitors with Nichicon surface mount electrolytics.

More Nichicon advantages. Your real bottom line though is still capacitor performance. And with seven series with 1,000 to 5,000 load life ratings to choose from, your chances of finding your capacitor choice are better than ever.

Each series is carrier-taped and reeled and features Nichicon's anti-solvent design.
DC/DC Converters With 750V Isolation

The HPR1XX series of dc/dc converters have a power density of 10W per in.³ with efficiencies as high as 80% and a continuous input-to-output isolation rating of 750V dc. The converters’ load regulation is ±10% from a minimum load of 1 mA to full load. They do not provide line regulation.

The line includes single- and dual-output models; both produce 750 mW. All converters are packaged in single-in-line cases that occupy 0.78 x 0.25 in. on a pc board and are 0.41 in. high. Input voltages are 5, 12, 15, and 24 V dc. The 5V-input models include a unit with a single 5 V output rated at 150 mA and a ±5V-output unit with 75-mA outputs. At all input voltages, there are units with ±15 V, 25-mA outputs and at all input voltages, except 24 V, there are units with ±12 V, 30-mA outputs. All, except 24 V units, have a reflected ripple current of 5 mA p-p at their inputs. $6.85 (1000).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (800) 548-6132; in AZ, (602) 741-3978. FAX (602) 889-1510.

Circle No. 378

Power-Sources

Miniature DC/DC Converter

The NMH series of dc/dc converters produces dual outputs of ±5, ±9, ±12, or ±15 V from an input of 5 or 12 V. The devices deliver 1.8W over its 0 to 70°C operating range without heat sinks. Input-to-output isolation voltage is 500V dc. A choice of 5-pin packaging for pc boards exists; an SIP requires 0.23 in.², and the DIP requires 0.32 in.².

Newport Components Ltd, Tanners Dr, Blakelands N, Milton Keynes MK14 5NA, UK. Phone (908) 615232. FAX (908) 617545.

Circle No. 379

Power-Factor-Corrected 1000W Supplies

Series 31 supplies have from one to nine outputs. You can obtain them with integral power-factor correction. A power-factor-corrected unit with a 1000W output can operate from a 15A, 120V (nominal) ac line. A similarly rated supply without power-factor correction draws so much current at full load that it needs higher-current ac service.

The 120V-input models operate from 90 to 264V lines with no jumper change. The series also includes 2-kW, single-output and 1.5-kW, multiple-output models with a 240V (nominal) ac input as well as 48V dc input units. Without power-factor correction, the supplies are in the industry-standard 5 x 8 x 11-in. fan-cooled package; power-factor-corrected units measure 5 x 8 x 12.5 in. From $743. Delivery, 8 to 10 weeks ARO.

Qualidyne Systems Inc, 3055 Del Sol Blvd, San Diego, CA 92154. Phone (619) 575-1100. FAX (619) 429-1011.

Circle No. 380

Modules For Building Custom Switching Supplies

The MIM and MOP Series modules allow users to quickly assemble custom switching-regulated power supplies using single, dual, or triple outputs that produce a total power of 50, 100, or 200 W. The supplies can derive their inputs from 115/230V ac or from any dc source having a voltage from 12 to 130 V.

You can specify any output voltage from 5 to 130 V. The supplies meet their full specifications from 0 to 50°C. Interference meets the requirements of VDE 0871 class B. Units with ac inputs withstand 4250 V dc from input to outputs. Outputs withstand a continuous short circuit. Regulated outputs exhibit a maximum of 1% variation due to line and load changes. 50W unit, $75; 100W unit, $125; 200W unit, $165.

Absopulse Electronics Ltd, 110 Walgreen Rd, W Carleton Industrial Park, Carp, Ontario K0A 1L0, Canada. Phone (613) 836-3511. FAX (613) 836-7488. TLX 0533859.

Circle No. 381

12W, Single- And Dual-Output DC/DC Converters

The MHF/883 series of single- and dual-output dc/dc converters produce as much as 12 W. They comply with MIL-STD-883C, method 5008. The 0.365-in.-high units occupy 1.7 in.² on a pc board. They meet the requirements of MIL-STD-461 for reflected ripple current.

The units provide 5, 12, ±12, 15,
and ±15V outputs. Input voltage range is 16 to 40V dc. Maximum line and load regulation is 50 mV dc. Efficiency at full load typically exceeds 75%. Operating case-temperature range is −55 to +125°C. For units that produce 12 and 15V outputs, no derating is required. The vendor calculates a 1.3M-hour MTBF at a 45°C case temperature. From $780 (100).

Interpoint Corp, Box 97005, Redmond, WA 98073. Phone (206) 882-3100. FAX (206) 882-1990. Circle No. 382

Low-Profile DC/DC Converters

The FPD series of low-profile dc/dc converters includes units that produce 5, 10, 50, and 100W. The 5 and 10W units accept inputs from 12 to 24V. For the 50 and 100W models, input voltages are nominally 12, 24, 48, and 150V. The 5 and 10W units are 0.3 in. thick; the 50 and 100W units are 0.5 in. thick.

The 5W converters occupy 1.57 × 2 in. on a pc board; the 10W units require 2 × 2 in.; and both the 50 and 100W units take 2.28 × 4.53 in. All operate from 0 to 71°C, though you must reduce the output current when the baseplate temperature exceeds 50°C (5 and 10W units) or 85°C (50 and 100W units). 5W units, $45; 50W units, $120; 100W models, $175.

Kepco Inc, 131-38 Sanford Ave, Flushing, NY 11352. Phone (718) 461-7000. FAX (718) 767-1102. Circle No. 383

5¼-In.-High 75-kV, 1-kW Supplies

The WX Series of high-voltage supplies rack-mount in a 5¼-in.-high space and produce as much as 1 kW at voltages as great as 75 kV. The front panels have analog voltage and current meters. As an alternative, you can specify digital meters or a blank panel. The supplies use switching-regulator technology to achieve 83% efficiency. They automatically switch from constant-voltage to constant-current operation. Line regulation is 0.005% for input variations from 198 to 242V. Output resistance is <1Ω. At full

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Maxell Corporation of America, 22-06 Route 208, Fair Lawn, NJ 07410, 1-800-533-2836.
Power Sources

Load, ripple is <0.05% of rated output. You can program and monitor the output voltage and current. A TTL level enables and disables the output. $3900 to $7100. Delivery, six weeks ARO.

Glassman High Voltage Inc, Box 551, Whitehouse Station, NJ 08889. Phone (201) 534-9007. FAX (201) 534-5672. TWX 710-480-2839.

Circle No. 384

2.8V Lithium-Iodine Cells For CMOS Backup

The B-35 Powercell rechargeable lithium-iodine cell comes in a variety of shapes and sizes and provides continuous 2.8V power to CMOS circuits. The cell has true glass-to-metal hermetic seals. At temperatures below 37°C, the operational or shelf life is more than 20 years. The cell inherently limits its output current under short-circuit conditions, minimizing the likelihood of catastrophic failure.

Although operation of CMOS devices at voltages higher than 2.8V is common, CMOS RAMs retain data with a 2V supply. The vendor points out that because circuits use less power at lower voltages, a 2.8V battery will power a given set of ICs longer than a battery with the same capacity but a higher voltage. Axial-lead cell, $3; $1 (OEM qty).

Catalyst Research, 3706 Cron dall Lane, Owings Mills, MD 21117. Phone (301) 356-2400, ext 545. FAX (301) 581-0346.

Circle No. 385

2-kW Amplifier For Brushless DC Motors

The miniature, pulse-width-modulated amplifier of the SBA Series provides as much as 2 kW to drive 3-phase, brushless servo motors. The amplifier, which measures 5.1 x 3 x 1.2 in., operates from 20 to 330V and furnishes 10A continuously and 20A pk. An internal dc/dc converter lets you power the amplifier from a single unregulated supply. Standard models accept com-
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Power Sources

mutation signals directly from Hall-effect transducers, but the vendor can supply units that accept other types of commutation signals. The unit, whose efficiency exceeds 95%, shuts down automatically if it detects loss of commutation, excessive temperature, under- or overvoltage, or short circuits to a power supply or to ground. SBA-10-80 10A-pk, 80V unit, $495 (100).

Galil Motion Control Inc, 575 Maude Ct, Sunnyvale, CA 94086. Phone (408) 746-2300. FAX (408) 746-2315.

Circle No. 386

5-Output, 350W Open-Frame Supplies
The SMQ555 5-output, open-frame switching supply delivers 350W. The main output produces 5V at 30A. You can choose a first auxiliary output rated for 12 or 24V. You can pick 5, 12, or 24V for each of the other auxiliary outputs. You can strap the ac input to accept 90 to 132V or 180 to 264V from 47 to 440 Hz. The units include line filters that meet FCC level B and VDE 0871 level A requirements. Input-to-output spacing supports 3750V ac; the units conform to the CSA 22.2 and UL 478 standards. Overvoltage protection safeguards your load; overcurrent protection and thermal shutdown protect the supply. $261 (100).


Circle No. 387

7-To-32V-Input DC/DC Converter
The 12S5.1000WF dc/dc converter provides 5V dc at 1A from a 2×2×0.375-in. package. It can use any input voltage in the range of 7 to 32V. The wide input range allows the unit to operate from unregulated batteries with 12 or 24V nominal outputs.

The converter uses pot-core transformers to minimize radiation of magnetic fields and is shielded on all six sides as well. It incorporates both overcurrent and overvoltage protection. The overvoltage protection is set for 6.8V, hence it does not interfere with adjustment of the output voltage over a ±10% range. The converter operates from -25 to 80°C. Key specs include 20mV p-p noise, 0.05% line and load regulation, and 0.3%/1000 hour long-term stability. $43.40 (100).

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. FAX (415) 932-6017.

Circle No. 388

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The 1200DCS programmable dc power system lets you mount eight modules with a total output of 1200W in a 5½-in.-high, rack-mountable chassis. The chassis in-

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Model   VA
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7009/2   12/6
7009/3   15/5
7009/4   24/3.1
7009/5   28/2.65

INPUT: 18-36 VDC

SINGLE OUTPUT: UP TO 90W

SIZE: 4.24 x 2.13 x 0.67”

Model   VA
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7007/2   12/6.5
7007/3   15/6
7007/4   24/3.75

SINGLE OUTPUT: UP TO 200W

SIZE: 5.91 x 3.54 x 0.81”

7030/1   5/30
7030/2   12/16.5
7030/3   15/13
7030/4   24/8
7030/5   28/7

DUAL OUTPUT: UP TO 120W

SIZE: 5.91 x 2.81 x 0.81”

8001   ±5/8
8002   ±12/4.5
8003   ±15/4
8004   ±24/2.5

TRIPLE OUTPUT: UP TO 180W

SIZE: 5.51 x 4.49 x 0.81”

8506   5/12, ±12/4.5
8606   5/12, ±15/4

INPUT: 170-360 VDC

SINGLE OUTPUT: UP TO 150W

SIZE: 5.12 x 2.91 x 0.81”

7701/1   5/20
7701/2   12/12.5
7701/3   15/10
7701/4   24/6
7701/5   28/5.5

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California Instruments Corp, 5125 Convoy St, Suite 201, San Diego, CA 92111. Phone (800) 356-2244; in CA, (800) 821-1634; (619) 279-8620. FAX (619) 279-8139. Circle No. 389

Submodular 60W Supply

You can use PK 60 FKK submodular, 60W switch-mode power supply in 19-in.-wide card cages that comply with DIN 41494, part 5. The units, which are 100 mm high and 160 mm deep, produce their full rated output continuously at 70°C. A heat sink mounted on the front of the units conducts the heat dissipated within the modules outside the card cage. The units offer switch-selectable ac inputs of 110V and 220/240V. $275.

Bice-Vero Electronics, 1000 Sherman Ave, Hamden, CT 06514. Phone (203) 288-8001. FAX (203) 287-0062. Circle No. 390

125W, Dual-Output DC/DC Converters

If you maintain its case temperature below 100°C, the 0.98 x 3.4 x 4.85-in. RO48-D512 dc/dc converter can produce 125W. The unit has two floating outputs—5V at 10A max and 12V at 8A max. Input-to-output isolation is 5500V. You must limit the current you draw from one or both outputs to hold the total power to the rated maximum value. For operation without a heat sink, the thermal resistance from the case to ambient air is 2.5°C/W. Efficiency is approximately 80%. The converter can operate in an N+1 redundant configuration with true current sharing (no master and no slaves); it can withstand being plugged into or unplugged from live circuits. The unit complies with MIL-STD-810D as well as with UL, CSA, and IEC requirements. $325.

RO Associates Inc, Box 61419, Sunnyvale, CA 94088. Phone (408) 744-1450. FAX (408) 744-1521. Circle No. 391

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EDN December 6, 1990
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Circle No. 392

1-In.-Thick, 100W AC-Input Supplies
FS100 series supplies produce 100W from a 1 x 3.8 x 6.7-in. package. The units, which operate from 100V ac, produce 5, 12, 15, or 24V dc with efficiency of 78 to 82%. Overcurrent protection operates at 105% of full load. Recovery from overload is automatic. The units also include overvoltage protection. All models meet FCC class-A standards for electromagnetic interference. The vendor has applied for recognition under the UL478 and CSA A22.2 safety standards. From $228. Delivery, eight weeks ARO.

Toko America Inc, 1250 Feehanville Dr, Mount Prospect, IL 60056. Phone (708) 297-0070. FAX (708) 699-7864. Circle No. 393
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EDN December 6, 1990  CIRCLE NO. 135
2- And 3-Output, UL 544-Compliant Supplies
The MDU2-40 and MDU3-40 Series are double- and triple-output, 40W supplies that conform to the UL 544 safety standard for medical and dental equipment. All models have a 5V, 5A primary output. Secondary outputs produce 12, 15, 24, 28, and -5V. The units, which measure 3x5x1.5 in., have a universal, 85-to-265V input (100-to-380V optional) and incorporate a line filter that meets FCC class-B interference requirements. Unlike many multiple-output switching supplies, the units require no minimum load on any output to achieve regulation.

The vendor claims that the supplies’ MTBF exceeds 205,000 hours. $70 to $74 (100).

Power General, Box 189, Canton, MA 02021. Phone (617) 828-6216. Circle No. 394

Flash EPROM Supply
The NMF Series is a group of isolated dc/dc converters in single in-line packages. The modules provide supply voltages for programming flash EPROMs. The units occupy 0.18 in.² on your pc board. They accept a 5 or 12V input. The units withstand 500V between input and output, and they produce 5, 9, 12, 12.75, or 15V. By applying the proper voltage to a control pin, you can reduce a module’s output to approximately 1.2V. $12 (OEM qty).

International Power Sources Inc, 200 Butterfield Dr, Dept 8536, Ashland, MA 01721. Phone (508) 881-7434. FAX (508) 879-8669. Circle No. 395

100-To-2400V-Output DC/DC Converters
D series dc/dc converters are encapsulated, low-profile units that measure 1.5x1.5x0.63 in. They produce isolated high voltages at low power levels. The standard input is 10V, but the vendor can supply units that operate from supplies of 5 to 28V. Output voltages range from 100V at 250 μA to 2400V at 50 μA. Units rated to produce 500V or less can have regulated outputs. All units are short-circuit proof and have filters and shielding to limit electromagnetic interference. MTBF exceeds 100,000 hours. $31 (100).

Emco High Voltage Co, 11126 Ridge Rd, Sutter Creek, CA 95685. Phone (209) 223-3626. FAX (209) 223-2779. Circle No. 396

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Power Sources

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American Reliance Inc, 9241 E Valley Blvd, Rosemead, CA 91770. Phone (818) 287-8400. FAX (818) 287-8855. Circle No. 397

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Digital Power Corp, 686 E Gish Rd, San Jose, CA 95112. Phone (408) 288-5600. FAX (408) 288-9537. Circle No. 398

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EDN December 6, 1990

CIRCLE NO. 136 159
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CIRCLE NO. 137
HARDWARE AND INTERCONNECT

Methods converge to cool fast and dense circuits

Anne Watson Swager, Regional Editor

Manipulating the thermal characteristics of an IC to achieve optimum performance is a growing design philosophy. The alternative is designing the circuit from a purely electrical standpoint and then dealing with overheating just to maintain acceptable performance. Computer designers have used low-temperature design techniques for years to achieve superfast speeds. But the universally increasing density and speed of what were once low-power-producing ICs and circuits is forcing the philosophy to spread.

Fortunately, the increased recognition of heat-producing problems has led to some innovative uses of passive and forced-air systems as well as heat pipes and thermoelectric devices. Thermal-management companies, component suppliers, and enclosure manufacturers are all working to dissipate the heat today's circuits produce. The tools they're using—heat sinks, fans, heat pipes, thermoelectric devices, and liquid cold plates—are nothing new. What's new is the widespread and innovative application of these devices.

One new product epitomizes the philosophy of teaming thermal control with circuit performance, and shows what you can achieve by combining cooling techniques. The Icecap 486 (approximately $150 (OEM qty)), Velox Computer Technology's first product, combines heat-removal and -sensing techniques to cool Intel Corp's 80486 µP. The device doesn't cool the chip just to keep it from burning up; the cooling increases the chip's speed from 33 to 50 MHz. An integral sensor measures the device's temperature. On start-up, a control circuit lowers the µP's temperature from ambient to a constant 0°C. Using this device along with a dual clock-speed generator lets you increase the µP's clock speed once the device is cool. The device's designers plan to offer the dual clock generator and announce multipackage-IC and multichip-hybrid cooling modules.

This single-chip cooler combines a thermoelectric device and a heat sink—a heat pipe is optional. Heat from the thermoelectric cooler dissipates either through a finned heat sink attached to the cooler or through a heat pipe that terminates at a remote location, such as the external housing or fan-cooled power supply.

Thermoelectric devices operate...
on the same principle—the Peltier effect—as thermocouples, but in reverse. A thermocouple uses the voltage generated at the junction of two dissimilar metals to indicate temperature. A thermoelectric device externally applies a voltage to a pair of metal junctions causing one junction to heat up and the other to cool down. The device pumps the heat absorbed at the cold junction to the hot junction at a rate proportional to the current passing through the circuit.

Thermoelectric modules are available from Melcor and Marlow Industries in a variety of sizes, shapes, operating currents and voltages, and heat-pumping capacities. Melcor's modules cost $5 to $70, depending on type and quantity. Sizes vary from approximately 1 to 2 in. square. Most devices have an operating-temperature range of -150 to +80°C. Single-stage thermoelectric devices can produce temperature differentials of approximately 65°C. You can stack modules.
The increasing density and speed of what were once low-power-producing ICs and circuits are forcing designers to consider heat-removal methods up front.

Thermoelectric devices pump heat between two junctions based on the amount of current you supply. Typical units from such vendors as Melcor measure $1 \times 1 \times 0.25$ in.; subminiature devices are as small as $0.16 \times 0.16 \times 0.11$ in.

Heat pipes are simply that: heat conduits. In and of themselves they do not dissipate heat. Instead, they deliver heat away from your circuit to a point where the heat can more easily dissipate. Companies such as Thermacore and Noren Products often attach aluminum fins to the heat pipe. The heat pipe carries the heat to the fins where it dissipates to the air by natural or forced convection. One $1.25 \times 1.25$-in. model, the XHA6 ($\$10$ (OEM qty)) from Thermacore, can dissipate $60W$ with a temperature rise of $60^\circ C$ above ambient air temperature.

Heat pipes work on the principle of gas-phase changes. The pipe contains a liquid, which heats and then evaporates at the end of the pipe close to the semiconductor junction. The resultant gas travels quickly to the cool end of the pipe, where it condenses. One disadvantage of heat pipes is their weight. The copper and aluminum XHA6 weighs $68g$. Its typical operating temperature range is $25$ to $100^\circ C$.

Heat sinks vary

You might think you've heard all there is to know about heat sinks, but heat-sink manufacturers continue to develop new devices. They continue to design new styles and work with new materials. EG&G Wakefield Engineering recently announced a composite polymer heat sink. The Deltem heat sink is made from thermally conductive plastic and can remove heat from plastic surface-mount and high-lead-count IC packages.

These molded plastic heat sinks are extremely light and cheap. They reduce the thermal-coefficient-of-expansion mismatch that typically occurs when using aluminum heat sinks with plastic ICs.
packages. When attached with a thermally conductive adhesive to a package dissipating 0.75 to 3W, the heat sinks remove approximately 85 to 90% of the heat removed by same-size aluminum heat sinks at low airflows. However, the plastic Deltem heat sinks weigh 40% less and cost $0.30 (10,000).

Available from both EG&G Wakefield and Aavid Engineering, folded fin stock is another type of heat sink. A thin sheet of metal—typically an alloy of aluminum, stainless steel, or copper—folds back on itself to create the folded fins. The advantage of this design is the large surface area. The alloys are lightweight and can be folded with various heights and pitches.

Available for approximately two years (Ref 1), 3M’s liquid-filled heat-sink bags are an option for size-constrained systems. The bags contain fluorinert liquid—the same type of liquid used in many immersion-cooled systems. The liquid transports heat from the semiconductors it contacts to a cooler surface. NCR (West Columbia, SC) uses the liquid-filled bags in its Tower 32/200 supercomputer. The company estimates that forced-air methods fell short of the cooling objective by more than a factor of two. The liquid heat sinks reduced the temperature differences between components from 25°C for the forced-air version to about 8°C.

In addition to the advent of new heat-sink materials, more manufacturers of power components have started producing heat sinks for their devices. Apex Microtechnology, a power-amplifier manufacturer, early this year announced the HS11 heat sink ($48.40 (100)) for high-power amplifiers in TO-3 or PD-12 packages. Intended for power amplifiers in the 50 to 100W range, the heat sink contains pipes through which you can pump either air or water. You can also rely on natural convection. The heat sink’s natural-convection thermal resistance is 0.7°C/W. Using forced air drops this number to 0.2°C/W. The device’s water-cooled thermal resistance decreases to 0.1°C/W and

![Heat pipes conduct heat from one place to another. Heat-pipe vendors such as Thermacore often attach aluminum fins to the pipes to dissipate the heat by natural convection.](image)

...back pressure, and no net increase in air flow.

The company concluded that there are two critical aspects in cooling an enclosure. The first is how directed the air is. The second is the amount of room between the box’s inlet and the outside of the fan—in other words, the amount of back pressure on the fan. As a result, Electronic Solutions implemented a plenum—a gap in front of the fan where air can stabilize and pressurize—to direct the air flow more precisely and to avoid recirculating air inside the box. The gap ensures that the air flow into the card cage or power supply is uniform. The additional metal for the plenums has added a small cost to the Omega line of enclosures.

Mupac is also working to solve several heat problems. According to the company, many RISC-based systems are so power hungry that they’re exceeding VME specifications. As a result, the company has changed the size and placement of fans in its 539 series of enclosures.

These enclosure manufacturers work almost exclusively with...
Not all heat sinks are the same. Composite polymers and folded-fin stock are two examples of new heat-sink materials.

forced-air techniques. Although liquid-cooling techniques are common in high-end mainframe computers, you'd be surprised at what people are still doing with forced-air cooling. Digital Equipment Corp for instance, designed its VAX 9000 family of computers with forced-air cooling only. The company cooled the computers' internal multichip units with high-voltage dc fans and pin-fin heat sinks. DEC achieved thermal resistances of 0.14°C/W for a 4 x 4-in. aluminum heat sink when the impingement air flow rate was 31 cfm.

Although DEC managed to meet its requirements with forced-air cooling, many other mainframe manufacturers have implemented liquid-cooling systems. These methods range from cold plates to immersion cooling. Nothing provides as much heat-removal capacity as

Liquid-cooled systems handle extremely high heat fluxes. The elements to implement such systems include standard cold plates and this standard 4600 series cast bus-bar cooler ($22100) from Aavid Engineering. Note, however, that most liquid-cooled systems comprise custom parts.

For more information on the cooling methods and devices discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

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Thermal-management companies, component suppliers, and enclosure manufacturers are working to dissipate the heat today's circuits produce.

Not all heat sinks are created equal. Using a thermally-conductive polymer material, the light-weight Deltem heat sinks from EG&G Wakefield Engineering can cool plastic IC packages for a low cost ($0.30 (10,000)).

One distinct advantage of liquid cooling is the absence of acoustic noise that fans create. However, potential users of liquid cooling are more concerned with what they perceive to be liquid cooling's major disadvantages: cost and reliability. Liquid cooling adds cost, but just how much is difficult to quantify. Chris Soule, a senior engineer with Aavid Engineering, ventured some numbers. The cost of a heat sink for a PGA (pin-grid-array) package, including the forced air, is around $1.25. The average cost of a piece of copper tubing brazed to a copper cold plate, according to Soule, is $8 to $10. The cost increases if you need to add heat exchangers, a reservoir, and pumps.

Standard cold plates are available, but 80% of liquid-system designs are custom. You've got to provide drawings and specs to companies such as Aavid, EG&G Wakefield Engineering, and Lytron Inc for them to quote a price. On the positive side, companies with cold-plate-design experience, such as EG&G Wakefield, offer extensive design help which costs you—if anything—surprisingly little.

The reliability of liquid-cooling systems isn't as easy to quantify as their cost. All cold-plate and heat-exchanger manufacturers can claim no failures of their parts in the field, but elements other than the plates themselves can fail. The joints that connect the piping to the cold plate are one potential problem. Manufacturers recommend you use as few joints, and preferably straight ones, as possible. You have to keep the fluid running through the system at less than 8 ft/sec to avoid eroding the cold-plate material. Also, mixing dissimilar metals throughout a liquid-cooling system might cause problems.

If the extent of designing a liquid system is starting to sound a little beyond your area of expertise—more like that of a thermal or mechanical engineer—you're right. But gaining an appreciation for the potential hardware complexity will push you to do some power-density calculations. If the number starts pushing 10W/in.², start reviewing your options and get a thermal engineer involved—or consult with a thermal-management company or specialist—as early in the design cycle as possible.

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LEDs indicate the input status on both boards. Neon lamps display the output status on the ac board and the dc board uses LEDs for the same purpose. The ac relays have 140V ac µP, 3A max rating, and the dc relays have a 60V ac, 3A max rating. The input and output wiring terminations use the company's pressure-clamp connectors in a 45° wire-entry configuration, which eliminates sharp wire bends. The boards measure 2.7×6.0 in. and have corner holes for screw-mount installation. The ac output board is $145, and the ac output board is $95.

Vernitron Corp, Box 10, Laconia, NH 03247. Phone (603) 524-5101. FAX (603) 524-1627.

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The Series SSB3 are single-screw barrier strips with 0.325-in. center-to-center spacing. The series is available in strip lengths from 2 to 36 terminals. The units are resistant to wire pull-out and can accommodate #14 to #30 AWG wires. Backed-out recessed screws with interrupted threads prevent screws from falling out. Phil-slot screws accept both Phillips and straight screwdrivers. Additional features include elevated flat bases that allow flux and solvents to drain during soldering, polypropylene insulators, and molded-to-size strips that maintain circuit spacing when mounted end-to-end. Prices start at $0.43 for a 2-terminal strip and $5.76 for a 36-terminal strip.

Amerace Corp, Industrial Electrical Products, 530 W Mt Pleasant Ave, Livingston, NJ 07039. Phone (201) 992-8400.

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Fiber-Optic Connectors
The MST is a fiber-optic connector compatible with ITT's ST family of connectors. The connectors operate in single or multimode and feature a radial track design for the coupling ring. The radial track reduces the required rotation to mate with the connector.

The connectors accommodate tight and loose tube buffer cables that have jackets with outside dimensions as large as 4.4 mm. The multimode connectors are available with ceramic or polymeric alignment ferrules and have typical losses of 0.2 dB and 0.8 dB, respectively. The single mode connectors have ceramic alignment ferrules with a typical loss of 0.2 dB. Bulkhead and mating adapters and printed-circuit mount receptacles are also available. The plastic ferrule multimode connector is $6.15, and the ceramic ferrule multimode connector is $8.40 (100).

DIP Test Clips
A series of six DIP test clips penetrate oxides built up on DIP ICs. The product family operates the same as standard test clips, but feature a stainless-steel surface coating on their serrated contacts, which provides good electrical connections on contaminated surfaces.

The clips provide hands-free testing of standard ICs with 8 to 40 pins. Molded insulating barriers separate the 1.02-mm wide, serrated and rough-coated contacts. The construction allows you to make connections on live boards without accidentally shorting adjacent contacts. The upper contact pins on the clips, which accept wire wraps or miniature test clips, are 0.64 x 0.71 mm. You can use flat-ribbon cables with 8- through 40-pin sockets to connect the clips to an instrument. From $9.70 to $31.

Wire-Wrap Panels
Lo-Wrap Panels are low-profile, wire-wrap panels. Though the panels use a low-profile socket, the sockets do permit two full MIL-STD-1130B strips using #30 AWG wire. Available in 26 configurations, you can structure the panels for VME, Sun, VXI, MBII, Mupac Metric, or custom power commitments. $305. Delivery, four to six weeks ARO.

Terminal Strip
The Series 75H closed-side terminal strip features a captive, hinged cover. The 1-piece unit simplifies inventory and prevents loss of the cover. The cover features a snap closure to inhibit accidental opening. Probe holes in the cover aid testing. The terminal strips use a hardware-free mount that allows 1-sided mounting. The hinged cover, mounts, and insulating body of the terminal strip are made of a nonconductive, flame-retardant thermoplastic. Captive screw terminals are placed on 0.375-in. centers. The terminals accept a maximum #14 AWG wire and are voltage-rated to 250V rms for UL-recognized Class B equipment. 6-circuit strips, $1.25 (500).

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10-Layer VME Backplanes
A series of 10-layer VME backplanes handle fast VME signals with minimum distortion and crosstalk. The backplanes feature four signal planes, four power planes, two pads-only planes, an embedded microstrip design, evenly distributed power entry, onboard decoupling capacitors, three types of power connector options, Schottky-diode clamping of critical signals, and wire-wrap connector.
Hardware and Interconnect Devices

pins on J1 and J2. The backplanes are available in sizes from 2 to 21 slots. The backplanes also come in 6U heights, which include J2 connectors with VME extended addressing. Six versions have a choice of power and I/O connections. The 3-slot version costs $297; the 21-slot version sells for $1375.

Electronic Solutions, 6790 Flanders Dr, San Diego, CA. Phone (800) 854-7086; in CA, (619) 452-9333. TWX 910-335-1169.

Circle No. 423

Power Supply For The PS/2
The FS200-40 is a 200W power supply for the IBM PS/2 computer. The supply provides 5, 12, -12, and -5V dc at maximum current ratings of 20, 8, 0.5, and 0.5A, respectively. You can switch the supply to operate with an input voltage from 90 to 130V ac or from 180 to 250V ac at input currents of 4.2 and 2.4A, respectively. The input frequency can range from 47 to 63 Hz.

Other specifications include a minimum efficiency of 65% at 200W output; a holdup time of 16 msec; a line regulation of 0.5% max at full load; an inrush current of 50A at 115V ac or 100A at 230V ac at 25°C; operating temperature of 0 to 50°C; and an MTBF of 40,000 hours min. The supply measures 5.9 x 5.5 x 3.4 in. and costs $34 (100).

Fortune/Source Corp, 6818-G Patterson Pass Rd, Livermore, CA 94550. Phone (415) 373-1008. FAX (415) 373-1168. TLX 559291.

Circle No. 424

Test Points
The TP-105 series are color-coded printed-circuit test points that directly replace header posts. The test points are available in ten colors and offer from one to ten positions with 100 mil hole spacing. The 0.035-mil-hole-diameter loops provide a positive anchor for probes and spring-loaded test clips. The test-point's collars are made from an Underwriters Lab-recognized, glass-filled nylon insulator. A break-away strip format, similar to header connectors, let you use as many or as few test points as you need. Depending on quantity, $0.05 to $0.08 each.

Components Corp, 6 Kinsey Pl, Denville, NJ 07834. Phone (201) 627-0290. FAX (201) 361-5801.

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ITT Cannon Components Div.,
1851 E Deere Ave, Santa Ana, CA 92705. Phone (714) 757-8337. FAX (714) 757-8301. Circle No. 426

RS-422 Multiplexer
A fiber-optic RS-422 multiplexer connects peripheral equipment to CPUs via fiber-optic cables. The multiplexer eliminates ground loops and attenuates voltage spikes and EMI/RFI. You can power the multiplexer through a DB25-pin connector or through an optional power supply. The multiplexer, which can be purchased with either male or female contacts, accommodates 125- and 140-µm glass fibers and handles data rates, low-speed data rates as high as 19.2k baud/sec, and high-speed data rates as high as 1.5M baud/sec. $90 in low volume. Delivery, six weeks ARO.

Thomas and Betts Corp, 1001 Frontier Rd, Bridgewater, NJ 08807. Phone (201) 685-1600. Circle No. 427

AC Outlet Strips
RAC ac outlet strips are available with either five or nine receptacles. Built from heavy-gauge steel in a textured black-enamel finish, the outlet strips feature 15A grounded

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EDN December 6, 1990
Mini-DIN Sockets

Mini-DIN sockets are available in connector sizes of 3 to 8 positions. These small DIN sockets are 69% smaller than standard DIN sockets. Among the features of the mini-DIN sockets are shielding for protection from EMI, RFI, and ESD. Right-angle solderable tails simplify pc-board mounting. Solderable grounding tabs help maintain conductivity between the cable shield and the pc board. Boardlocks provide mechanical hold-down during soldering. The mating area uses phosphor-bronze contacts post-plated with gold over nickel. The tail area is tin/lead over nickel. 6-position socket, $0.60 (10,000).

Cinch Connector Div, 1500 Morse Ave, Elk Grove Village, IL 60007. Phone (708) 981-6000. Circle No. 429

Mass-Terminated Connector

The Selective Integral Ground (SIG) transmission-line cable/connector series is a mass-terminated, insulation-displacement connector. The connector utilizes a ground-signal-ground configuration to reduce crosstalk via an internal bus bar at rise times faster than 1.5 nsec. The connector, with conductors on .050-in. centers, terminates two flat or twisted-pair ribbon cables. The bus bar grounds all common wires. The series offers con-
This guide only skims the surface of the HP 48SX's breakthrough features. With over 2100 built-in functions, for starters, what could you expect?

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Hardware and Interconnect Devices

Connectors with 13 positions in a single row to 64 positions in a dual row. Additional series members offer 40-pin DIP plug and 64-position DIN connectors. $15 to $20.

Augat Interconnection Products Div, 33 Perry Ave, Attleboro, MA 02703. Phone (508) 222-2202. Circle No. 430

Cable Markers
FM321 is an irradiated, polyolefin, heat-shrinkable tubing that accepts lettering so you can use it as a marker. The tubing is mounted on pin-feed carriers to aid computer printing. After customizing with a typewriter, ink-jet printer, or computer printer and heat shrinking, the lettering is permanent. The yellow FM321 markers are available in reels of 125 or 250. In small quantities, $0.26 to $0.95/marker.

Cole-Flex, 91 Cabot St, West Babylon, NY 11704. Phone (516) 249-6150. Circle No. 431

Thermal Epoxy
EP30AN is a 2-part epoxy resin system. The epoxy uses a ceramic filler to provide thermal conductivity as high as 25 BTU/hr/ft²/°F/in. at 75°F. The epoxy uses a non-critical 10:1 mix ratio and offers a working life of 30 minutes after mixing for a 450g mass. The epoxy cures at room temperature to 90% strength within 24 hours; at 200°F, the epoxy cures to 85% strength within 30 minutes. Additional features of the epoxy include volume resistivity of 7 x 10¹⁴Ω-cm and a dielectric constant of 6.9 at 60 Hz and 77°F. $12 to $20/lb.

Master Bond Inc, 154 Hobart St, Hackensack, NJ 07601. Phone (201) 343-8983. FAX (201) 343-2132. Circle No. 432

Board-Mount Sockets
The 5100 Series right-angle board-mount sockets use centerbump polarization to guide the connector, reduce mismatch, and eliminate circuit damage. They use gold-plated wiping contacts to ensure connections. The body of the sockets is...
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Thomas & Betts Corporation, Electronics Division, 1001 Frontier Road, Bridgewater, NJ 08807, 201-685-1600

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Hardware and Interconnect Devices

made of glass-reinforced polyester; the sockets are available in eight sizes: 20, 26, 30, 34, 40, 50, 60, and 64. The sockets' size is 0.1 x 0.1 in. with standard headers and plug connectors. $3.59 to $6.71 (500).

3M Electronic Products Div, Box 2963, Austin, TX 78769. Phone (800) 225-5373. Circle No. 433

PLCC Sockets
A family of PLCC (plastic-lead-chip-carrier) sockets is available with 28, 32, 44, 52, 68, and 84 leads. The sockets, made from a liquid crystal polymer, withstand high-temperature soldering. Stamped solder tails have a small slot which aids adhesion of the solder paste and provides mechanical strength after reflow. Downward pressure exerted by the contacts on the PLCC ensure that it remains in the socket. The sockets have openings that allow full visual inspection of the solder fillets. From $1.50 (1000).

Samtec Inc, Box 1147, New Albany, IN 47151. Phone (812) 944-6733. FAX (812) 948-5047. Circle No. 434

Connector Series
A series of 13 1-piece, plug-in connectors and headers accept wire from #12 to #30 AWG. Some connector models offer easy access to test points. All connectors are UL/CSA certified. 2-circuit connectors, from $0.67.

Amerace Corp, Industrial Electrical Products, 530 W Mt Pleasant Ave, Livingston, NJ 07039. Phone (201) 992-8400. Circle No. 435

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also come in four depths, ranging from 17 to 36 in.; their three available panel widths are 19, 24, and 30 in. The enclosures are all tested to the Zone 4 seismic test. Gaskets can provide additional protection from dust and moisture. EMI/RFI protection is also available. From $1000.

Equipto Electronics Corp, 351 Woodlawn Ave, Aurora, IL 60506. Phone (708) 897-4691. FAX (708) 897-5314. Circle No. 436

Pressert Flush Nuts
Pressert flush nuts are stainless-steel nuts that provide a smooth, flush finish. To install the nuts, you press the nut into a punched or drilled hole. The nuts are available in hex sizes from 3/16 to 7/16 in. and thread sizes from 2-56 to 1/4-28 as well as metric sizes from M2 to M6. You can use the nuts with panels from 0.04 to 0.312 in. thick. Free samples are available. $0.04/piece.

Precision Metal Products Co, Box 6026, Peabody, MA 01961. Phone (617) 532-5500. Circle No. 437

DIP Switches
You can insert the EAM100 Series of surface-mount DIP switches using automatic equipment. The switches are available with 2 to 10 switches. Switching contact ratings are 100 mA, 5V dc. Contact resistance is 100 mΩ. The switch's top is tape sealed to withstand wave soldering and board washing. The contacts are gold-plated, and the body is UL 94V-0 rated. 8-position switch, $1.05 (1000).

Kycon Cable & Connector Inc, 1772 Little Orchard St, San Jose, CA 95125. Phone (408) 295-1110. FAX (408) 295-8054. Circle No. 438

DC Cooling Fan
Smartfan is a dc cooling fan that uses a closed-loop temperature-regulating system to control cooling air flow. The regulating sensor is built into the fan. At full speed, the fan noise level is 45 dB. At idle speed, the fan's noise level is 31 dB. The fan is available in four sizes: 3.1×1.0, 3.6×1.0, 4.7×1.0, and 4.7×1.5 in. 4.7×1.5 in. fan, $15 (5000).

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Working with a variety of mechanical requirements, plus strict electrical parameters, we custom-design and produce complete interconnect systems. Micro-miniature cables, usually using 38 AWG and smaller conductors, can be terminated to standard or micro connectors and protected with flex-strain reliefs. Custom overmolds and sealing designs have been developed to protect interconnect systems in harsh environments. These cable assemblies provide the critical link in hand-held applications on diagnostic instruments, sensors, and medical and surgical devices.

Our expertise, increasing with each unique problem we solve, ensures that reliability is designed in, built in, and tested. So we can keep our balance. And assure a great performance every time.
Filter Module

The EMI Filter Module has male and female DB-9-type connectors and plugs between an RS-232A cable and an input or output port. The module attenuates EMI as much as 19 dB over the 30- to 300-MHz range, using common-mode magnetics. $25.95.

Coilcraft, 1102 Silver Lake Rd, Cary, IL 60013. Phone (708) 639-6400. Circle No. 440

Memory-Card Connectors

The ICM-B connectors are 0.050-in. pitch, 60-circuit memory-card connectors. Independent split-beam contacts ensure at least 5000 mating cycles. The connectors feature 0.126-in. and 0.157-in. tails for surface mounting. Rated at 0.5A, the connector's contacts are copper alloy with nickel plating overall and selective gold plating. $0.05/mated position. Delivery, 8 to 10 weeks ARO.

JST Corp, 1200 Business Center Dr, Suite 400, Mount Prospect, IL 60056. Phone (800) 292-4243; in IL, (708) 803-3300. Circle No. 441

Card-Edge Connector

The FCN228 is a card-edge connector for low-profile designs, which is available in 26- and 60-pin configurations. Standing 0.283-in. high, the connector features two rows of gull-wing surface-mount contacts on its back. When mated to a 0.063-in. pc
Meeting FCC/VDE requirements is quick and simple with Chomerics' low-cost clip-on EMI gaskets. Each combines Chomerics quality and technology with labor-saving attachment mechanisms. All are available off-the-shelf.*

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Our METALKLIP™ gaskets offer a choice of wire mesh-over-elastomer, or hollow carbon-filled silicone.

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3. Stainless Steel Clip. Series 302/304 SS clip has sharp tines which bite through paint or oxide for electrical contact. Closure force as low as 1 lb/in. Available mitered.


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6. Mesh-Over-Elastomer. Choice of monel or Ferrex® wire mesh over sponge or hollow elastomer core. Up to 90dB shielding from 10MHz to 1GHz. Sharp tines in SS clip bite through paint or oxide.

7. Carbon-Filled Silicone. UL94V-0 rated hollow gasket in the same series 302/304 SS clip. Lowest cost, for lower shielding requirements with low closure force.
Hardware and Interconnect Devices

board, the connector extends only 0.110 in. above the board's surface. The connector's body is polyphenylene sulfide plastic to ensure its momentary withstanding the 240°C temperatures of infrared reflow soldering. Electrical specifications include a dc current rating of 24A and a voltage rating of 250V ac. The connector provides a 0.1A contact resistance, 2 kg maximum insertion force, and 250g minimum withdrawal force. 26-pin connector, $5.21 (1000).

Fujitsu Component of America Inc, 3330 Scott Blvd, Santa Clara, CA 95054. Phone (408) 562-1000. Circle No. 442

Nature equipped the armadillo with a shielding system designed for reliable protection.

General Devices' shielded enclosures employ that same principle.

Spring Contact Probe

The Rotator is a 0.1-in. center, 0.25-in. stroke-spring contact probe. The probe, available with springs of 4-, 5.5-, 6.7-, 8-, and 10-oz springs, rotates 90° at 0.167-in. travel. Rated at 3A continuous current, the probe offers a contact resistance of 50 mΩs max. The plunger is beryllium copper, rhodium plated over nickel. The rotation of the contact allows the heads to penetrate fluxes or residues on test pads or plated-through holes. $1.50 to $2 (10,000).

Interconnect Devices Inc, 5101 Richland Ave, Kansas City, KS 66106. Phone (913) 342-5544. FAX (913) 342-7043. Circle No. 443

Twisted-Pair Cables

The 1455A, 1456A, 1457A, and 1458A are twisted-pair cables for data transmission. The cables carry data at speeds of 16M to 100M bps. The cables meet or exceed the IEEE 10-Base-T standard and the proposed EIA/TIA SP1907 standard. The cables contain 4-pair, #24 AWG insulated copper wire. Shielded versions use an overall foil shield with a drain wire. 1455A, 1000-ft lengths, from $140.

Belden Wire and Cable, Box 1980, Richmond, IN 47375. Phone (800) 235-3364. Circle No. 444
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Type MD, miniature, circular DIN connector has EMI shielding. Low profile...only 19.4 mm (H) x 13.0 mm (W). Spring mounting lock prevents movement during PCB soldering.

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These unshrouded breakaway headers have .100" pitch, 36 (single row) and 72 (double row) positions, and .025" square pins suitable for wire wrap. Also .200" pitch, 18 (single row) and 36 (double row) position types. Straight & rt. angle styles.

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Motorola Discrete

High gain power modules for mobile cellular radios.

From the industry leader in power modules comes a new high gain improvement. The industry standard, the MHW806A, now comes in a 0-dBm version as the MHW807 Series. Instead of the previous power requirement of 30 mW, the new series requires only 1 mW to obtain 6W of output power, thanks to two new gain stages.

The MHW807 Series is perfect for all cellular radio applications. They offer controllable, stable performance over more than the 35 dB range in Po that’s needed. Two different frequency models are available: 820 to 850 MHz and 870 to 905 MHz.

Long pulse microwave power transistor.

Motorola continues to expand its long pulse microwave power transistor portfolio with the introduction of its new 120 watt L-Band transistor, the MRF10120. This output device completes the lineup consisting of the pre-driver MRF10005 and the MRF10030 driver.

The MRF10120 operates on a power supply of 36 volts and delivers 120 watts of peak power for typically less than 15 watts of peak RF input power. It's designed for common base amplifier applications such as JTIDS (military) and Mode S (commercial) transmitters. The frequency of operation extends from 960 to 1215 MHz.

Satellite microwave power transistors.

Three new microwave power transistors are available for large-signal output and driver amplifier stages for satellite up/down links. The MRA1600-2, MRA1600-13 and MRA1600-30 are designed for Class C, common base amplifiers that operate in the 1600-1660 MHz frequency range. They provide 2.2, 12.7 and 30 watts of minimum power respectively.

These devices offer the highest in reliability and performance. They feature gold metallization, diffused ballast resistors and internal compensation for impedance matching control. All this is offered in a low-cost microwave package for cost efficiency.

Special TRIACS offer high noise immunity.

The MAC219 series of TRIACS is designed specifically for applications in industrial areas where high noise immunity is required. These TRIACS have voltage ratings from 200 to 800 volts and current ratings of 8, 12, 15 and 20 amps.

All of the devices in the MAC219 series have a noise immunity of 500 volt/microsecond minimum value. This critical rate of rise of off-state voltage is five times that of standard devices with equivalent specifications.

They're perfect for exceptionally demanding applications in AC power control where noise immunity is essential to successful operation of the TRIAC. Use them in appliance controls, industrial controls and AC power circuits involving motors and other inductive loads.

Make a splash in high resolution CRTs.

The SCANSWITCH™ family of semiconductors offer simple answers to horizontal deflection and video amplification problems in high resolution and ultra high resolution CRT applications. The SCANSWITCH family consists of application specific horizontal output transistors, damper diodes and video amplifiers.

Single-chip control ICs are also available for personal computer monitors to reduce design complexity and overall system cost.

All the devices are designed to improve performance in monochrome and color CRT monitors with horizontal scan frequencies of 50 kHz or greater. They offer reduced power dissipation and the ability to work over a wide range of frequencies.

For horizontal output, video amplifiers and multimode horizontal, vertical and video processors, the SCANSWITCH family of semiconductors is the answer.

New high-voltage EFETs.

There's some new additions to Motorola’s advanced line of Bulletproof™ EFETs. The new devices have gate voltage ratings of 40 volts and have avalanche energy capability specified. These two characteristics make them essentially indestructible from transients on the gate or drain when used within their specified ratings.

These high voltage EFETs offer breakdown ratings from 400 volts to 1000 volts in the industry's standard TO-218 and TO-200 plastic package. They allow the design of line operated circuits such as motor controls, power supplies and lamp ballasts and other high voltage circuits with a higher degree of reliability.

Many other EFETs are available with smaller size die housed in both metal and plastic packages, including isolated Full Paks.
Low pressure transducer for critical applications.
This new low pressure, temperature compensated, fully calibrated sensor provides a very accurate and very linear voltage output directly proportional to pressure differentials. Its accurate range is from 0 to 1.5 PSI.
The MPX2010D pressure sensor is calibrated for a full-scale span of 25 mV, with a linearity error of less than 1.0 percent, due to laser trimming of critical on-chip components. Even with temperature variations from 0 to 85 °C, typical span error is only ±1.0 percent.
A variety of package options make it perfect for applications in automotive, industrial, medical, and many more.

Switchmode power rectifier with dual Schottky barrier.
These new high current, dual Schottky rectifiers are available in an electrically-isolated low profile package. Less hardware and tooling is required for mounting than with conventional stud-mounted rectifiers. Both reverse avalanche energy and dv/dt are specified.
Their low inductive package is of obvious advantage in high frequency switching applications. And the platinum barrier metal technology creates optimum forward voltage drop and low reverse leakage current.
The MBR16035CT, MBR16055CT and MBR16050CT Schottky barrier rectifiers are rated at 160 amps continuous, with a non-repetitive peak surge current of 1200 amps. VFM is rated at 35, 45 and 50 volts minimum respectively.

A new breed of workhorse.
Now you can have the same rugged workhorse you've enjoyed for your high-power applications in a medium-power, broadband amplifier. The PAA series of broadband amplifiers are bred to outwork and outlast the competition.
They're ruggedly built with the same power components as our high-power PAA Series including MIL-STD capacitors and resistors, gold-plated connectors, MIL-SPEC plating and painting, EMI/RFI input filter, heavy-duty machined housings with stainless steel hardware, and teflon-coated wire.
For high-reliability performance you can depend on in a medium-power amplifier, Motorola's PAA Series is the answer.

They're here. High volume, small-footed Optoisolators.
There's a new, reliable, UL-recognized optoisolator for designers who need the time and space savings of opto coupling in small outline, surface mount packages—the MOC200 Series.
Motorola supplies all MOC200 devices in the industry-standard SOIC-8, eight pin packages. And, they're available in tape-and-reel option, conforming to EIA standard RS481A. These devices offer a variety of output configurations:
- 30 & 70 volt transistors @ 1F=10mA
- 30 volt transistors @ 1F=1mA
- PhotoDarlington detectors
Each of the 12 small-footprint types in the series is packaged with a stable, long-life infrared emitting diode, and features high input-output isolation of 2500 vac(rms), minimum.

ICePAK™ TMOS Power Modules for brushless motor control.
Just one ICePAK™ power module replaces 6 power MOSFETS in brushless motor applications. Motorola's MPM3003 power module can handle high surge of up to 25 amps at motor startup. It's a complete three-phase bridge with three N-channel MOSFETS in the lower legs and P-channel MOSFETS in the three upper legs.
This power module is rated at 60 volts to 100 volts at 8 to 10 amps. It offers high dissipation capability and a mechanically rugged, isolated, space-saving package.

Get more information.
To get more information on any of the Motorola products shown here, contact your local Motorola sales office, complete and return the coupon below to Motorola Semiconductor Products, Literature Distribution Center, P.O. Box 20912, Phoenix, AZ 85036. Or call toll-free any weekday, 8:00 a.m. to 4:30 p.m. (MST) 1-800-521-6274.

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SW O RT H E W A

DSP software handles varied applications

Richard A Quinnell, Regional Editor

If the 80s were the decade of the personal computer, the 90s may well be the decade of digital signal processing (DSP). The proof will lie in how large a range of applications DSP software can service. Examining some of DSP’s novel uses may help inspire your own creativity.

Perhaps the first application you think of when considering DSP technology is signal filtering. Most DSP boards and development tools have filter development aids as part of their standard software package. DSP-based filtering is commonplace in telecommunications. Virtually every modem and most cellular telephones use a digital filter to increase their S/N ratios. Almost any electronic system can do the same.

DSP improves S/N ratios

Improving S/N ratios is a major goal of the engineers at Metrologix (Santa Clara, CA). Their design of an electron-beam-based wafer-inspection system is a good example. The system scans the wafer with a narrow high-energy electron beam, then measures the scattered secondary electrons to create an image of the wafer surface. The secondary-electron signal is both noisy and weak. “We have an S/N ratio of about one to one,” says company president Guillermo Toro-Lira. “We only get one and a half electrons per pixel.”

To pull their signal out of the noise, the Metrologix engineers turned to DSP technology. Using a National Instruments DSP2300 board running in a Macintosh, they developed proprietary signal-enhancement algorithms in C. They were able to develop their complex algorithms quickly, says Toro-Lira, because of the development tool kit and many useful software routines that came with the board. Once the engineers had developed and tested their algorithms, they compiled the code into machine language for the Texas Instruments 32030 DSP chip. They then optimized the code for speed.

Ironically, one challenge the engineers faced was not a lack of capability but an excess. The wafer-inspection system needed the DSP chip’s speed, but didn’t always use the chip’s 32-bit word width. The word width became a liability when the system needed to use 8-bit arithmetic. Toro-Lira says, “To do the 8-bit operations, we had to use..."
software tricks like shifting and masking."

Improving S/N ratios is only one use of DSP filtering. Filters can also simulate the effect a physical system will have on your signal's propagation. Sam Berkow, an associate with the Joiner-Rose Group (Dallas, TX), uses DSP filtering to check concert-hall acoustics while his design is still on the drawing board.

Berkow uses computer simulation to evaluate the propagation of sound within his planned concert halls. He also employs empirical methods. Because acoustic effects scale linearly, Berkow can build a scale model of a hall and measure its frequency response directly. But simulations and measurements provide only numbers, and the audio community is more concerned with aesthetic quality than numbers. "What looks good on paper," says Berkow, "may not sound right."

What DSP technology allows Berkow to do that a calculation doesn't is check the quality of the sound. By using an Ariel Corp DSP56 analog board, an Ariel Corp TMS320C30 DSP board, and Hyperception software, Berkow can literally listen to his designs.

To ensure the fidelity of his signal, Berkow starts with music digitally recorded in an anechoic chamber. Then he uses the DSP board to convolve the music signal with the measured or calculated impulse response of his design. The result is music as it would sound if he were sitting in the completed hall.

Audio has its own needs

DSP technology has a variety of other uses in audio applications, including music synthesis, soundtrack editors, and virtually noise-free digital recording and playback of music. People using current DSP software products for sound analysis, however, have a problem.

"The way acoustic people represent signals is different from that of the general DSP community," says Berkow. He points out that

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Spectral analysis need not be an end in itself. You can embed the analysis in test tools that make simple go/no-go decisions.

Acoustic filters are specified in decibels per octave instead of decibels per decade, frequency scales are logarithmic instead of linear, and noise spectrums are measured in one-third- and one-sixth-octave instead of 1-kHz bands.

Spectrum analysis is another well-known application of DSP technology. With the addition of a plug-in board and some software, any personal computer can become a spectrum analyzer. You're not limited to only using that analysis capability as a lab tool, however. You can also use it to create tools for other disciplines, as the engineers at Titan Engineering in Racine, WI did.

Titan's general manager, Greg Petro, says the tool they created tests the transmissions of motorized agricultural equipment. It comprises an IBM PC/AT with data-acquisition and DSP boards from Burr-Brown. By using DSP techniques to analyze a transmission's vibration at a variety of drive speeds, the tool helps the manufacturer's production engineers test 50 transmissions per day. Previously, says Petro, they would have used stand-alone analog filters and a spectrum analyzer, but only for spot testing. Now they can test every transmission they make.

According to the project's systems engineer, Kevin Sholly, Titan's engineers wrote the system software in a high-level language that calls machine-coded DSP routines. The routines came from Burr-Brown's DSP library and were supplied with the board. The system software gives the user a simple go/no-go test that compares the energy in various bands of the spectrum against preset limits.

Order-tracking eases analysis

Because spectrum analysis only provides absolute frequencies, the Titan software does more than merely compute the frequency spectrum of the vibrations. "We can measure the spectrum and get all of these numbers," says Petro, "but what do they mean? The real key to vibration analysis is to make the correlation between the data you've collected and the physical entity you're looking at. We need to know that when we see a given signal it means that the bearing on the third shaft down in the clutch is cracked."

To help make correlating easier, the Titan software provides order-tracking eases analysis

Not all signals can be sampled with an A/D converter. For Drs Zeller and Laird of the University of Kansas, the "signal" is the occurrence of nitrates in snowfall.
tracking—it normalizes the computed vibration spectrum to the transmission's drive rate. As the drive rate changes, gear meshes shift in frequency. With a conventional spectrum analyzer someone would have to keep track of those shifts manually. Order tracking accounts for them automatically.

Other cross-disciplinary tools that use DSP-based spectral analysis are safety monitors for power generators. If a monitor detects vibration frequencies that herald a mechanical breakdown, power-plant engineers can shut down equipment before any damage occurs.

**Synthesis: reversing analysis**

Spectral analysis and signal filtering aren't the only capabilities that DSP software offers. You can also reverse the analysis process by using spectral information to regenerate signals. You can even synthesize signals that never existed.

Dr Charles S Henry of the University of Connecticut (Storrs, CT) is combining DSP-based analysis and signal generation in his studies of the family *Chrysopidae*, or green lacewing insects. They are important to biological pest-control programs because, in their larval form, lacewings prey voraciously on aphids, scale, mealybugs, and other insects that damage crops.

Dr Henry is studying the insects' mating songs. Each species of lacewing, even those very closely related, produces a distinctly different mating song. They avoid cross-species mating because they respond only to the song of their species. By introducing controlled variations into the mating songs and observing the insects' reactions, Dr Henry can determine which features of the songs are important.

First, Dr Henry records and digitizes an individual lacewing's song using a CED-1401 Intelligent Laboratory Interface board from Cambridge Electronics Design Ltd (Cambridge, England) in an IBM PC/AT. Next, he manipulates the recorded signal with a DADiSP 1.05 signal-processing spreadsheet from DSP Development Corp. He changes such characteristics as amplitude, repetition rate, and frequency content. Then he plays the resulting synthetic signal back through the CED board and observes how it affects other lacewings.

One key to unlocking the power of DSP technology is to expand your concept of what constitutes a signal. Signals don't come from A/D converters alone. A signal can be any series of data points acquired by any means. Consider the solar flare studies being conducted by Dr Ed Zeller, Professor of Physics and Geology at the University of Kansas (Lawrence, KS). His signal is atmospheric nitrates embedded in Antarctic snow.

Nitrates form when a solar flare...
Filtering not only removes noise, it can also simulate the transmission mechanism’s effects on signal propagation.

reaches Earth’s upper atmosphere and ionizes oxygen and nitrogen. Precipitation then washes the nitrates out of the air and brings them to earth. In the Antarctic, they remain trapped in snow that never melts.

Dr Zeller acquires his data by first taking a coring from the Antarctic snow mass. Individual snow falls are visible as layers in the coring, much like growth rings in a tree. You can determine the age of a sample by counting the layers above it. It’s even possible to determine the season during which the snow fell. Dr Zeller separates the layers in the coring, melts them, and measures their nitrate concentrations.

Dr Zeller uses the DSP Development Corp’s DADISP software to analyze his data. In order to prove he could date his samples accurately, he correlated his data with the snowfall records of nearby weather stations. He then correlated his data with solar-flare records. He proved that the nitrate concentrations in the layers of snow accurately reflected flare activity.

For example, spectral analysis showed 11- and 22-year solar-activity cycles, just as he expected. Dr Zeller’s long-term goal is to study the occurrence of solar flares over the last 3000 years.

One drawback that Dr Zeller faces in using DSP techniques on his data is that he has to assume a uniform sampling rate. However, because the sampling times depend on the whim of the weather, they are far from uniform. “Nature isn’t very convenient,” notes Dr Zeller. He uses interpolation routines to generate uniformly spaced data from the randomly spaced samples.

Another example of an unconventional signal comes from ESI Communications (Tallahassee, FL). The signal is a periodic measurement of memory utilization and I/O activity in a mainframe computer. ESI engineers use DSP techniques to study system utilization patterns and trends, which enable them to plan system capacity more effectively.

Performance metrics, chemical concentrations, sound, vibration, and electron voltages are only a few of the possible sources of signals that can be analyzed with DSP software. Regardless of the nature of your signal, there are ICs, boards, and software development tools (Refs 1 to 3) to help you turn it into useful information. The limits on what you can handle with DSP technology will be set only by your imagination.

References

Article Interest Quotient
(Circle One)
High 515 Medium 516 Low 517
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Emulation and development tools run on Sun-4

Validate/Xel and Validate/Unison are integrated-emulation and software-development tools that work with either the company's EL 3200 or its ES 1800 emulators. These tools are now available for cross-development using a Sun-4 workstation as the host. The EL 3200 emulates Motorola's 68020 and 68030 µPs; The Sun-4 host can run as a node on an Ethernet network using TCP/IP protocols so that you can access the emulator from any node on the network.

The ES 1800 can emulate the major Intel, Motorola, and Zilog µPs, including Intel's 80C186 and 80C188, and Motorola's 68302. This emulator includes an event monitor that provides hardware triggering. Therefore, you can maintain full control of the software trace and find deeply nested bugs. The ES 1800 comes with a built-in SCSI interface.

Validate/Xel gives you extensive tracing capability, source- and assembly-level debugging features, instruction simulation, a window-oriented display, a command history, and the ability to use macros that make full use of the Sun-4 features. The package includes an ANSI-C compiler, an assembler, a disassembler, a simulator, and a source-level debugger. Validate/Unison includes a C source-level cross-debugger, an optimizing cross-compiler, a cross-assembler, and a variety of other debugging tools. The Unison also has a real-time C-level trace, data breakpoints for tracking variables, and simultaneous display of as many as four I/O ports.

Pricing for the EL 3200 with control software starts at $30,000, and the ES 1600 at $12,500. Validate/Xel costs $10,300, and Validate/Unison costs $7050.

Applied Microsystems Corp, Box 97002, Redmond, WA 98073. Phone (206) 882-2000. FAX (206) 883-3049.

Circle No. 701

Database system integrates a variety of workstations

Objectivity/DB database management system (DBMS) provides a common repository for a variety of data types on networked workstations from multiple vendors. It allows a team of engineers to use data created and manipulated by tools and application programs from many sources.

The distribution model is a superset of the client/server model. It permits databases having separate administrative control by individual engineers, departments, or groups to be located anywhere on the network. The system automatically provides the data conversion that is required when you access the database from multiple, heterogeneous workstations.

Currently supporting mixed networks of Sun-3, Sun-4, and Deestations, the system provides multiple levels of caching, clustering, page swapping, and pinning. It also offers local working sets, which you can access with almost no DBMS overhead, and efficient recovery mechanisms. For operations such as locking, version control, recovery, deletion, and data creation, you can specify the appropriate granularity for each type of operation. This feature lets you lock fine-grained objects to obtain a high level of concurrency. Alternatively, if you want higher performance, you can apply the locks to larger pieces of the design. A development system costs $30,000.

Objectivity Inc, 800 El Camino Real, 4th Floor, Menlo Park, CA 94025. Phone (415) 688-8000.

Circle No. 702
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Task-Management Tool
Mind's Eye is an application-development tool that lets you interactively create a database relating to almost any system engineering project. Although this tool does not adhere to the strict definition of an object-oriented database management system, it does let you define your project by means of objects and their relationships. An object may, at different levels, be the whole system, a subsystem, a component, a subcomponent, or a piece part. At each level, an object may require values or actions from other objects, and in turn be the target of requirements from still other objects. Further, each object may be represented by any of three kinds of data: attributes, text, or images.

The proprietary user interface is as easy to use as Windows 3.0, but is faster because it is fully integrated with all of the tool's functions. Color coding helps you identify the status of objects.

To run Mind's Eye you need an IBM PC/AT-class computer with 640k bytes of memory (2M bytes recommended), an expanded memory manager, a VGA graphics card and monitor, a mouse, and DOS 3.3 or later version. A preconfigured version with templates to get you started is $995; a professional version for large applications is $3000.

Earle-Briggs Inc/Mind's Eye Inc, 36 Commerce Way, Woburn, MA 01801. Phone (301) 862-1944. FAX (301) 862-2121.

Circle No. 399

Real-Time Multimedia Interface For PCs
RAVE (Real-Time Audio/Video Environment) is a set of tools that helps you build multimedia software for industrial process control, instrumentation, and similar applications. The tools run on 80386/486-based computers under the OS-9000 real-time operating system. The package includes a graphics editor and a library of graphics primitives, with which you can create images of control panels as well as virtual instruments. You can also use a video camera to capture images of actual equipment control panels, and then modify the images with the graphics editor. You can also capture sound from external audio equipment such as microphones or cassettes, or load digitized sound segments from a disk.

The tools work with ATI's VGA Wonder graphics board, as well as with Vigra's VME-MMI-100 board for the VMEbus. Both boards yield 640×480-pixel resolution with 256 colors; thus you can move an application from a PC-based OS-9000 system to a VMEbus OS-9 system (or vice versa) just by recompiling the application on the target system. $750.

Microware Systems Corp, 1900 NW 114th St, Des Moines, IA 50322. Phone (515) 224-1929. FAX (515) 224-1352. Circle No. 401

Optimizing C Compiler For 80386-Based Computers
Watcom C8.0/386 is an optimizing ANSI-C compiler that generates 32-bit, 80386 or 80486 protected-mode code, and can make use of all the hardware features of the 80386 µP. The package includes a video debugger (with mouse support), a C runtime library and graphics library, an editor, a linker, an object librarian, a make recompilation utility, a disassembler, and a source-level debugger.

Applications compiled with C8.0/386 can make use of a DOS extender. The compiler can generate re-entrant code, and the library contains many re-entrant functions, so that you can generate ROMable code for embedded systems. The compiler has a built-in syntax checker that validates the syntax of your program before attempting to generate code; it produces warnings for type mismatches, uninitialized variables, unreferenced variables, questionable operations, and potentially incorrect statements. The register allocator accommodates user variable declarations as well as the instruction selector's requirements, thereby reducing code size and improving execution speed. $1295 (US); $1595 (Canadian).

Watcom, 415 Phillip St, Waterloo, Ontario N2L 3X2, Canada. Phone (519) 886-3700. FAX (519) 747-4971. Circle No. 402
Developer's Kit For CAD/CAM Software

The CAD/CAM Developer's Kit (CCDK) is a toolbox of C functions that can help you write third-party CAD/CAM applications. The tool kit uses object hierarchies and data encapsulation to minimize the number of public routines needed to support all of the operations provided. DXF functions let you read and write ASCII and binary files in AutoCAD's DXF format and create layers, blocks, and exploded inserts. Display functions let you create 3-D images that are adaptable to many popular graphics libraries. Geometric functions let you perform 2-D and 3-D operations such as translation, rotation, scaling, mirroring, intersection, offset, trimming, and selection. List-management functions support list construction, traversal, sorting, and iteration. CCDK is compatible with the AutoCAD Development System and with ANSI-C compilers that run under DOS, Unix, and VAX/VMS, as well as with Metaware and Watcom compilers that provide extended-DOS facilities. $1295.

Building Block Software, Box 1373, Somerville, MA 02144. Phone (617) 628-5217.
Circle No. 403

Tool Set For IC-Library Development

New tools that the vendor added to the GDT Designer module-generation system automatically characterize cell libraries and let you adapt these libraries to different manufacturing processes. In addition, you can capture handcrafted layouts in a reusable form.

The object-oriented database and a new procedural design interface allow you to access both geometric and connectivity data in chip designs, thereby shortening the time required to adapt libraries to different manufacturing processes. The tool set includes Explorer Lsim, a mixed-signal, multilevel simulator that provides detailed circuit-level simulation of the layouts created by the module generators.

Using the timing data produced by Lsim, you can automatically calibrate gate-level and logic-synthesis models and create data sheets. GDT Designer runs on Sun and HP/Apollo computers and includes tools for schematic capture, rule-checking, placement and routing, simulation, and cell-library development. $90,000.

Mentor Graphics Corp, Silicon Design Div, 2045 Hamilton Ave, San Jose, CA 95125. Phone (408) 371-2900. FAX (408) 559-4916.
Circle No. 404

Cross-Debugger For The Motorola 68332 µP

RMXDB 5.0 is a C source-level debugging system for Motorola's 68332 µP. The package consists of a ROM-based monitor resident on the target system, and a window-based version of the vendor's XDB debugger hosted on an IBM PC or other computer. You can configure RMXDB for almost any target system that has a serial port; the installation kit includes driver programs and configuration examples for a wide variety of single-board computers and serial-interface boards.

The debugging system is compatible with Motorola's 68332 development system (the 68332 EVS and Business Card Computer), as well as with the vendor's Intertools line of C cross-compilers, cross-assemblers, and programming utilities for writing ROMable, reentrant code for the 68332. From $2500 for RMXDB 5.0 hosted on an IBM PC; a full tool kit of compilers, assemblers, utilities, and RMXDB, $4250 for a single PC host. The tools for the 8086 and 68000 µP families are available at the same prices.

Intermetrics Microsystems Software Inc, 733 Concord Ave, Cambridge, MA 02138. Phone (617) 661-1840.
Circle No. 405

Neural-Network Application Development System

Brainmaker Professional version 2.0 is a development tool that lets you simulate in software a neural network that can recognize patterns, analyze trends, and learn from any set of data. Applications include stock, sales, and inventory forecasting; assistance in medical diagnoses; filtering noise from communications links; and accurate conversion of optically scanned printed characters to ASCII codes, regardless of font style and size.

Netmaker Professional, which is the network-generation and data-manipulation program, displays data in spread-sheet style, makes possible complex arithmetic operations on data, and automatically builds network-description and training files. This program optimizes the number of hidden neurons so you can identify the data that has the most influence on your network. The program can handle chaotic systems, and can work with In-
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The development system also supports both expanded and extended memory for as many as 8000 neurons per layer. To run the programs, you’ll need an IBM PC or compatible equipped with at least 512k bytes of memory, monochrome or color display, a hard disk, and DOS 3.0 or later version. An 8087 or equivalent math coprocessor is recommended but is not mandatory. The documentation includes an Introduction to Neural Networks and the BrainMaker Professional User’s Guide and Reference Manual. $795.

California Scientific Software, 10141 Evening Star Dr #6, Grass Valley, CA 95945. Phone (916) 477-7481. FAX (916) 477-8656.

Circle No. 406

Software-Analysis Tool For Ada
AC 100 Task View allows software engineers who use Ada to design embedded systems to analyze target-system performance at the system-state and task levels. This performance analyzer runs on IBM PCs and compatibles in conjunction with the vendor’s Software Analysis Workstation (SAW) and the Veridex Ada Development System (VADS).

The SAW is a real-time, nonintrusive software measurement tool that monitors the execution of the software under test. It monitors the execution using state-analysis boards resident in the µAnalyst chassis and a probe that connects to the target processors address, data, and control lines. Task View accumulates information on the time spent in the kernel, in application tasks, in interrupt handlers, in select library routines, and in the idle state. At the end of the test run, each accumulated time is displayed as a percentage of the total time. This display helps to determine which areas of the software will best repay refinement and optimization efforts.

The program can also generate a high-level trace, providing a view of target-system state transitions. This trace information includes identification of each application task entered, identification of interrupt handlers entered and of system calls to the kernel, Ada exception occurrences, memory-allocation routines, and semaphores. In

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addition, you define specific measurement points in the application code, and you can elect to track specific procedures in detail. Task View, $4500; SAW, from $10,500, depending on the target version and the options selected.

**Cadre Technologies Inc, 222 Richmond St, Providence, RI 02903. Phone (401) 351-2273. Circle No. 407**

**Ada Development System**

FirstAda is a development system for Ada software that runs on IBM PC/ATs, PS/2s, and compatibles under DOS 3.0 or later version. The compilation system (officially validated by the Ada Joint Program Office) includes the compiler, with high- and low-level optimizers and binder; multiple library managers; the Ada runtime executive; the Adaworld user interface; and all standard Ada packages. In addition, you get a source-level symbolic debugger, a cross-reference generator, an automatic recompilation tool, a source-code standardization tool, and an Ada syntax checker. The package is menu driven and includes a full-screen text editor; however, you can add your preferred text editor to the menu.

A set of packages provides an Ada interface to all DOS functions, and interrupt-entry handling makes it easy to create special device drivers. You can generate either 8086 or 80286 code, and you can call existing routines that you've written in assembly language or Microsoft C. Floating-point code that you write will use an 80287 or 80387 math coprocessor if one is present in your system; otherwise, the system will emulate the floating-point instructions in software. The package incorporates an ISO-standard elementary math function library (this library requires a math coprocessor). Documentation includes a Beginner's Guide, User's Guides, a Project Development Guide that explains the multilib library features, and the ANSI/ISO standard for the Ada language. $1815.

**Alsys Inc, 67 S Bedford St, Burlington, MA 01803. Phone (617) 270-0030. FAX (617) 270-6882. Circle No. 408**

**Object-Oriented Development System**

Objectvision is an integrated development system for creating object-oriented software. The program lets you draw objects on the screen by using the built-in graphics editor. Once you've named an object, you can attach properties to it to specify the information it contains.
You can also attach procedures to an object to specify how the object works. You can establish the relationships between two or more objects merely by drawing lines between them.

The program supports inheritance. For example, you can specify a "class" object and then attach other objects, which share the same properties and procedures, to it. These objects have additional properties and/or procedures that distinguish them from each other and from the class object.

When you've completed your design, you can run it interactively from within the development system, or ask the system to generate commented and ready-to-compile code in Zortech C++, Glockenspiel C++, or Borland's Turbo C++ or Borland's Turbo Pascal 5.5 (you specify the compiler type when you order). To run the program, you'll need an IBM PC or compatible that has at least 640k bytes of memory, a VGA or EGA monitor, and a mouse. $399.

Objectvision, 2124 Kittredge St, Suite 118, Berkeley, CA 94704. Phone (415) 540-4889.

Circle No. 409

Cross-Development System For VMEbus

Uniflex.wks is a cross-development system for designers of real-time, embedded systems based on Motorola 68000 µPs and the VMEbus. The tools run under the real-time Uniflex operating system on Sun 68000-based and SPARC-based workstations. The package includes the GNU ANSI-C compiler and GDB (the GNU symbolic debugger). Other tools provide network services such as TCP/IP and NFS, and file-system creation for the target system. The tools fully support remote procedure calls.

The system provides real-time features such as priority task assignment, interprocess communications, and contiguous files. In addition, you can configure the target system to use standard Uniflex features such as networking, virtual memory, multiprocessing, and X Windows with the Motif user interface.

The output of the cross-development system is a pseudo-disk that you can download to PROM on the...
Software

target system; this pseudo-disk contains the Uniflex kernel and the application programs. To improve performance, the target system should copy the programs into RAM before executing them. From $13,600.

UniFLEX Computing Ltd, 111 Providence Rd, Chapel Hill, NC 27514. Phone (919) 493-1451. FAX (919) 490-2903. Circle No. 410

Data-Protection Software

The Immunity software data-protection package runs under PC/MS-DOS 3.2 or higher on IBM PCs, PS/2s, and compatibles. The program requires that the computer be equipped with two identical hard disks; it can work with most standard disk controllers and coding schemes such as MFM, RLL, ESDI, and SCSI. The software intercepts all disk-write operations and writes the data in duplicate to the same physical sectors on both drives. If the primary drive fails, the program notifies you and automatically switches over to the secondary drive (or vice versa).

Read operations are performed by whichever drive has its heads closer to the required data; the decreased seek time more than compensates for the extra time needed for writing to the second disk. The program sends all details of disk errors to an error log and includes disk-repair utilities to aid in troubleshooting and resynchronizing the disks after an error. Immunity version 2.41 uses only 5k bytes of main memory and is compatible with a number of DOS-based LAN operating systems. $345.

Unitrol Data Protection Systems Inc, 815 Hornby St, Suite 604, Vancouver, BC V6Z 2E6, Canada. Phone (604) 681-3611. FAX (604) 687-0814. Circle No. 411

and out.

Graphics Tool For Double-Buffering On X Windows

Figaro+ is a graphics application builder for personal workstations that run the X Window System. It is an enhanced implementation of the PHIGS (Programmer's Hierarchical Interactive Graphic System) standard, and provides features previously unavailable on X servers. In particular, you can use double buffering to make an image

But all you really need to know is that they're made by NEC, a 24-billion-dollar company, and the fourth largest manufacturer of disk drives in the world. For more information, call 1-800-NEC-INFO.
move smoothly across the screen, and you can remove hidden surfaces from an image. The tool gives you two methods of double buffering. Using a hidden pixmap as a buffer allows full color and also works on monochrome displays.

Alternatively, you can use colormap manipulation, which is not limited by the X server's pixmap-copy speed, but does limit the available colors. The hidden-surface-removal feature improves the quality of the image by removing all polygon facets that in real life would be hidden by other surfaces closer to the eye of the viewer. The tool runs on 80386/486-based computers running Unix and the X Window graphics system. $1595.

Template Graphics Software Inc, 3510 Dunhill St, San Diego, CA 92121. Phone (619) 457-5359. FAX (619) 452-2547.

Circle No. 412

Branch-Analysis Tool
HP Branch Validator simplifies and improves your software-validation testing by providing accurate information about the execution of branches in the program under test. Histogram summary information lets you apply validation criteria to a complete file or to individual functions. You can select branches to be excluded from your test criteria with the aid of a mouse, and you can insert comments to explain why a branch was ignored.

When you run the tool, its default report provides a global view of program coverage; it can also generate a report that identifies all unexecuted branches. You can then determine what conditions would execute those branches and expand your test file to make sure that those branches are executed during testing. The tool works with the vendor's Softbench suite of debugging tools. Branch Validator and Softbench run on the vendor's HP 9000 Series 300 and Series 800 computers; separate versions are available for HP-UX C (native) and for AxLS C (embedded). Softbench, from $1500; Branch Validator, from $2000.

Hewlett-Packard Co, Logic Systems Div, Box 617, Colorado Springs, CO 80901. Phone local office.

Circle No. 413

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Detector ensures safe Christmas

Alan Rich
Linear Technology Corp, Haverhill, MA

The Christmas season is here, and the tree is decorated, the stockings are hung by the fireplace, and the kids are nestled in their beds. But wait, worrying about the water level in the Christmas tree stand (yes, real Christmas trees do still exist) spoils the joyful mood. You must check the water level daily—or else, fire and smoke!

The circuit in Fig 1 takes that worry away so you can enjoy the festive season with eggnog, carols, and visions of sugar plums. In the figure, the detector energizes a musical Christmas card to signal a low water level. You can adapt the circuit to other alarms.

One half of the dual comparator, IC1, senses the water level via a simple probe. The probe consists of two 1-in. pieces of wire. When the water level is high, the conductivity of the water biases one comparator input, pin 7, below the threshold of the other input, pin 6. The two 47-kΩ resistors bias pin 6. The two 0.1-μF capacitors minimize errors arising from the probe’s high source resistance and provide necessary noise filtering for the sampling comparator.

When the water level drops, the comparator changes state, which turns on transistor Q1. Q1, in turn, powers the alarm—in this case, the music.

The 2.2-MΩ resistor fixes the sampling time constant of the comparator to 20 sec. Because the comparator operates only once every 20 sec, the circuit will run for months on a pair of dry cells. The comparator’s Vp output powers the sensor and triggers the indicator LEDs during the sampling interval. Note that capacitor C1 powers the indicator LEDs; the 220-kΩ resistor recharges C1 slowly between sampling periods.

To Vote For This Design, Circle No. 746

**Fig 1**—This water-level detector will ensure that your Christmas-season festivities do not go up in smoke.
Tube amp isolates high voltages

Dave Cuthbert
Tektronix, Beaverton, OR

The isolation amplifier in Fig 1 employs a vacuum-tube, shunt-regulator triode (designed for TVs) and two op amps to transfer dc-to-5-MHz signals across a potential difference of 25,000V. The circuit is a gain-of-1 inverting amplifier that has a ±1V input range. The circuit’s 60-Hz rejection ratio is −100 dB.

This isolation amplifier can send signals only from a negative to a positive potential, and the system must support a 1.6-mA current flow between input and output. At potentials greater than 15 kV, the tube produces X-rays.

WARNING: You MUST shield the tube with sheet metal at least 0.1-in. thick to block the X-rays.

The circuit’s op amps determine its dc accuracy. For example, the LM381 op amps shown yield wide bandwidth; precision op amps would give better dc performance.

In operation, op-amp IC1 controls the tube’s cathode current via the tube’s grid to hold the inverting input equal to $V_{IN}$. The cathode current, $I_k$, is

$$I_k = \frac{V_{IN}}{(R_1 R_4)/(R_1 + R_4)} - \frac{V_{REF1}}{R_2}.$$

If $V_{IN}$ is 0V, then the cathode current is 1 mA. An input signal varying between ±1V will vary the cathode current from 433 to 1567 µA. For a tube-anode potential of 25 kV, the grid’s voltage must vary from −10.5 to −6.5V to produce this range of cathode current. Because no grid current flows, the anode and cathode currents are equal.

Output op-amp IC2 converts the anode current to an output voltage, $V_{OUT}$, which equals

$$V_{OUT} = \left(\frac{V_{REF2}}{R_4} - I_k\right) \times \frac{(R_3 R_4)/(R_3 + R_4)}{}.$$

You zero the output circuit by adjusting $V_{REF2}$.

You can obtain the tube from Newark Electronics (phone local office). (EDN BBS DI #914)

To Vote For This Design, Circle No. 747

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Fig 1—Because a vacuum physically separates this tube’s current-carrying elements, the tube can function safely (if you block the resulting X-rays) as an isolation amplifier across a 25,000V potential difference.
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It's a smart move.
Programmable resistor shifts phase

Ajoy Raman and K Radhakrishna Rao
Indian Institute of Technology, Madras, India

You can replace the fixed RC network commonly used for phase shifting sinusoidal signals with a digitally programmable circuit. The circuit in Fig 1 replaces the traditional circuit's resistor with a discrete, multiplying D/A converter (MDAC), which functions as a programmable resistor.

With the MDAC in a magnitude-comparison loop, the resulting circuit is a digitally programmable, frequency-independent phase shifter. For the values

Fig 1—This digitally programmable phase shifter can replace a fixed RC network.
specified in Fig 1, the circuit achieves a phase-shifting range of 50 to 179°, with an accuracy better than 1.5° over the 400-Hz to 4-kHz range. The input to the phase shifter must be sinusoidal and have no dc bias. The circuit's operation is independent of input amplitude.

The array of resistors and AD7512 CMOS switches forms a programmable resistor between circuit nodes A and B. Its resistance is

$$R_{AB} = \frac{V_{AB}}{I} = \left( R_{LADDER} \times 1024 \right) / \left( 2^Q_1 + 2^Q_2 + \ldots + Q_6 \right),$$

where $Q_6$ through $Q_0$ are either 0 or 1, depending on
the state of the 10 CMOS switches in the AD7512 array.

An MDAC IC’s output must be close to analog ground. The MDAC made from discrete devices removes that restriction. Buffer op amp IC₁ maintains outputs B and B’ at the same potential.

An RC network’s phase shift, φ, depends on the network’s attenuation factor, α:

\[ \phi = -\arctan(\sqrt{1 - \alpha^2}) \]

The digitally variable resistance, together with capacitor C₁, form an RC phase-shift network. An MDAC, IC₅, attenuates the input to op amp IC₂ by the factor α. IC₅’s setphi input determines α.

The circuit’s magnitude-comparison loop bridges the input and output of the programmable RC network. Op-amp IC₂ is a half-wave rectifier, as is buffer op-amp IC₃. Comparator IC₆ compares the outputs of IC₂ and IC₃.

Depending on the state of IC₆’s output, the comparator clocks the counter comprising IC₇, IC₈, and IC₉ up or down. Consequently, the magnitude-comparison loop servos the programmable resistance’s value so that the phase-shift network shifts phase by an amount proportional to α. When the phase shift is proportional to α, the average-value outputs of IC₂ and IC₃ are equal. At that point, the total phase shift equals \(2\times\phi\).

The output filter, IC₄, restores the circuit’s output to the same level as its input. The filter allows the voltage across C₂ to settle to within a small ac-hysteresis band during each clock period.

**EDN BBS DI #913**

To Vote For This Design, Circle No. 748

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Loop-through amp rejects common-mode noise

Barry L Siegel
Elantec, Milpitas, CA

The video-bandwidth amplifier in Fig 1 (a “loop-through” amplifier) rejects common-mode noise such as 60-Hz hum. Usually, such circuits consume three video amps. The circuit in Fig 1 uses only two video amplifiers, yet it achieves a differential bandwidth of 60 MHz \(A_{\text{DIFF}} = 2\) and an ac CMRR in excess of 45 dB at frequencies as high as 100 kHz. The circuit will also work well for \(A_{\text{DIFF}}>1\).

The video amps are current-feedback units, and \(R_2\) and \(R_4\) yield an optimized 3-dB bandwidth. You can improve both the ac and dc CMRR by varying \(R_1\). The circuit’s design equations are

\[ A_{\text{DIFF}} \geq 1, \]
\[ R_1 = R_2 (A_{\text{DIFF}} - 1), \]
\[ R_3 = R_4 (A_{\text{DIFF}} - 1). \]

With a ±5V power supply, the circuit has a ±1.5V dc common-mode range. **(EDN BBS DI #915)**

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Analog voltage tracks camera images

Thomas J Dahlin
3M, St Paul, MN

Fig 1 uses a low-cost, RS-170-output video camera to track the vertical position of an object within the camera's field of view (FOV). The circuit produces an analog voltage which varies with the distance from the top of the object to the top of the camera's FOV. For example, if the object is near the top of the FOV, the output is around zero volts. As the object moves toward the bottom of the FOV, the voltage increases.

The operation of this circuit relies on a lighting setup that silhouettes the object against a white background, which assures sufficient detection contrast. The object is detected by the presence of a near-black video level occurring in the middle of a scan line. The circuit updates its output at 60 Hz once per video field.

The circuit feeds the RS-170 video signal into IC1, a LM1881 sync stripper. The two one-shots in IC2 form a valid-video gate. As Fig 2's timing diagram indicates, the output of IC2B is high only during active-video scan lines and is low during vertical-retrace and blanking times. This signal holds IC3 in reset to prevent the circuit from interpreting the black levels present in the video blanking interval as an object.

The LM139 comparator, IC4, detects black level in the video signal. The potentiometer RT sets the black threshold. The output from the comparator is high when a black video level is present. The circuit tests the presence of a black object in the middle of each

Fig 1—By detecting the presence of a black object in the active-video area, this circuit generates an analog voltage, which corresponds to an object's location in the camera's field of view.
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EDN December 6, 1990
CIRCLE NO. 161
valid video line. IC5A latches the comparator’s output upon receiving a clock edge from IC5B. IC5B produces a 60-Hz rectangular waveform, whose duty cycle varies as a function of where a black level is detected in the video field. The signal VS resets IC5A at the start of each field. The output of comparator latch IC5A sets IC5B. R1 and C1 integrate the analog output voltage. IC6 buffers the output. Although not shown, adding a dc clamp to the video input may be required in some applications. You can use the clamp burst output from the LM1881 to turn on a FET or transistor that momentarily grounds the video input.

To Vote For This Design, Circle No. 801

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**FET-input amplifier settles fast**

Barry L Siegel
_Elantec, Milpitas, CA_

The FET-input amplifier in Fig 1 slews at 700V/µsec and settles to within 0.01% in under 200 nsec. You can maintain low-offset drift by running both J1 and J2 at the same drain current. Thus, R1 and R2 should match to within 1% resistors. The EL2028 exhibits inherently low offset (250 µV) and drift (3 µV/C). A 10-kΩ, 10-turn potentiometer enables you to null the offset of both the FET source followers and the op amp. The dual FET must have an I_DSS in excess of 6 mA in order to preserve the high slew rate. If your application requires the op amp to drive a high capacitive load—greater than 25 pF—a snubber of 100Ω in series with a 100-pF capacitor is recommended. (EDN BBS DI #909)

To Vote For This Design, Circle No. 802

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Fig 1—To maintain the low-offset drift of this FET-input amplifier, R1/R2 should be less than 1%.

---

Fig 2—The video-tracking timing diagram illustrates the signals at various points in Fig 1’s circuit.
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Conditional skip manipulates clock

Stan Mircea-Raducu  
Research Institute for Computers  
Bucharest, Romania

By manipulating the clock inputs to the Am2910 microsequencer, you can implement a conditional skip, which is not part of the 16 standard sequence-control instructions of the Am2910. The advantage of the conditional skip instruction is that it leaves the data/address microinstruction field free while still providing a means of conditional branching. The conditional skip instruction provides a technique for skipping the next microinstruction depending upon the test condition inputs. For example, at location 51, if the test on the condition input passes, the next executable instruction is number 53. If the test fails, it will go to 52.

You can implement either the usual continue or the new conditional skip by using the standard Am2910 continue instruction (code 14) in conjunction with another microinstruction field (the skip field). Depending on the test input, you generate either one or two clock pulses on the Am2910 clock input. For this particular design, the normal clock for the Am2910 and the pipeline register has a 250-nsec period: 150 nsec high, 100 nsec low (Fig 1a). When you execute the conditional skip and the test passes, the clock for the Am2910 corresponds to Fig 1b, and the pipeline microinstruction clock's period is 300 nsec. Because of the two low pulses, the microsequencer advances with two steps through the microprogram and executes the skip. The instruction on the Am2910 inputs I0 through I3 is the continue instruction.

However, when the test fails, both clocks have the normal 250-nsec period just as in (Fig 1a), and the microsequencer advances only one step. In this example, manipulating the clock in 50-nsec multiples simplified the hardware design because the available clock on the controller board was 20 MHz. The state machine for microclock generation was also easily modified to generate the extra low pulse when switching to the 300-nsec clock period. You can tune this idea to work with faster clock rates. (EDN BBS D1 #911)

Sensor and logic form digital compass

Brian Grenoble  
Maxim Integrated Products, Sunnyvale, CA

Combining a Hall-effect sensor with a few ICs provides an 8-point digital compass. Four open-collector outputs on the sensor correspond to the four cardinal points of the compass. The sensor's Hall-sensing action activates one output for each of the principal directions: N, S, E, and W. Aligning the sensor with an intermediate direction, such as NW, grounds both of the associated outputs.

By detecting whether the sensor is selecting single
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or dual outputs, the NOR-gate scheme resolves the four sensor signals into eight distinct compass readings. Following the NOR gates, eight inverters enable the system to drive medium-power LEDs.

The circuit's power supply (Fig 2) operates from an unregulated input voltage that can vary between 5.25V and 18V. The supply includes a linear regulator, IC1, that provides 5V for the LEDs, logic, and low-power step-up converter (IC2). The converter generates a clean, stable 10V for the sensors, which, if necessary, allows the sensor and control/display unit to be located yards apart in a noisy automotive environment. The sensor operates from 8 to 12V.

Inductor L1 determines the actual voltage supplied to the sensor. An inexpensive barrel (bobbin) inductor, though noisy, suits this application because the control section includes no RF-sensitive components. If higher efficiency is required, toroidal-core inductors are recommended. The sensor, like any device that responds to the earth's magnetic field, should be located away from metal structures and electric motors. In most vehicles, the windshield area meets this requirement. (EDN BBS DI #910)

To Vote For This Design, Circle No. 804

Fig 1—Based on the operation of a Hall-effect sensor, this digital compass illuminates one LED for each of eight directions.

Fig 2—The compass' power-supply circuit converts a 5.25 to 18V, unregulated input to 5V for the LEDs and logic, and provides 10V for the Hall-effect sensor.
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C++ "class" generates bit manipulators

Eric Horner
Sundstrand, Rockford, IL

Posted on the EDN bulletin-board service (BBS) is a C++ "class" and related programs for generating and testing routines that set groups of bits. The class produces a variety of bit-setting routines. You need such routines to interface high-level languages to memory-mapped hardware.

The concept of the C++ class is similar to that of Ada's "generic" and Forth's "<BUILDS DOES>" constructs. These three constructs let programmers devise their own defining words. Formulating defining words is a cornerstone of object-oriented programming. With older high-level languages, programmers are stuck with only the defining words, such as Fortran's and Basic's DIM statement, that the language's designer deigned to include.

Each time you invoke a C++ class with a set of applicable parameters, the class will produce a customized example, or "instantiation," of a certain generalized program. Note the functional similarity of C++ classes to DIM. Each time you invoke DIM in Fortran or Basic, the statement produces a unique, named data structure according to your specifications. DIM also attaches to the data structure the routines needed to manipulate the new structure, thereby producing an "object." (EDN BBS DI #916)

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The *Engineer's Guide To MIL-STD-1553 Modular Bus Testers* tells you how to use the 1553 Bus Tester, which tests and evaluates 1553A/B terminals and systems. The 6-pg foldout brochure describes the Tester's capabilities and shows you how to economically match testing requirements with the proper Bus Tester model.

*Test Systems Inc, 217 W Palmaire, Phoenix, AZ 85021.*  
Circle No. 716

**Digital Multimeters Brochure Released**

This 32-pg brochure provides specs and descriptions of bench and system DMMs. A selector guide enclosed in the booklet allows easy comparison of various models, from battery-powered portables to IEEE units. User profiles and applications describe the features of comparable products.

*Keithley Instruments Inc, 28775 Aurora Rd, Cleveland, OH 44139.*  
Circle No. 718

**Test-Measurement-Control Instruments**

This 546-pg catalog features more than 12,000 instruments including air velocity, flow, temperature, humidity, laboratory, gas sound, vibration, light, data-logging, and recording meters. In the spotlight are a 4-color hot-product section and an introduction to a wide range of instruments.

*Davis Instrument Mfg Co Inc, Seton Business Center, 4701 Mount Hope Dr, Baltimore, MD 21215.*  
Circle No. 719

**Temperature-Measurement Reference Encyclopedia**

Volume 27 of the hardbound Complete Temperature Measurement Handbook and Encyclopedia offers more than 1000 pages of comprehensive technical and temperature-measurement information. A few technical areas discussed in this book include custom engineering case histories; computer interfaces and data loggers; relative-humidity measurement devices; and analog meters and amplifiers. This reference book also highlights a technical-books library with price listings and delivery information.

*Omega Engineering Inc, Box 4047, Stamford, CT 06907.*  
Circle No. 717

**Quick-Reference Foldout Features Waveform Digitizer**

A 6-pg foldout describes the Model 6400 waveform digitizer. This pamphlet lists specific features of the device, as well as details of waveform processing, analysis, and storage. The foldout offers a quick-reference index, which divides applications into transient-, power-, and vibration- and structural-analysis categories. This list also includes medical, seismological, geophysical, and sonar applications of the waveform digitizer.

*Analogic Corp, 8 Centennial Dr, Peabody, MA 01960.*  
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**VXIbus Time-Interval Analyzer Highlighted**

A 6-pg pamphlet describes magnetic media, radar, frequency standards, and agile radio test applications of a time-interval analyzer. The brochure also provides photos and detailed color illustrations to depict the device's graphics output formats. A table located at the end of the pamphlet summarizes product specs.

*Racal-Dana Instruments Inc, Box C-19541, Irvine, CA 92713.*  
Circle No. 720

**Catalog Offers Efficient Guide to Products**

This 13-pg catalog discusses applications of test and measurement and video graphics devices and transcoders. A combined format of tables, photos, and specification lists provides a straightforward look at waveform monitors, vectorscopes, and test-signal generators. A business-reply section allows you to request additional information on products, listings, and applications presented in the catalog.

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Military/Aerospace Relays Listed
The 32-pg catalog spotlights a range of relay lines for military and aerospace applications. The catalog covers time-delay, dry-reed, mercury-wetted, magnetic-polarized, and general-purpose relays. It also presents a line of relays that includes minigrid, TO-5 case, crystal-can, solid-state, RF and time-delay devices, power monitors, and voltage sensors. An index arranged according to military specifications and a cross reference to military part numbers help you select parts.

Struthers-Dunn Inc/Hi-G Co, Lambs Rd, Pitman, NJ 08071.
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Catalogs Offer SMDs, Capacitors, And Resistors
The 1990-91 Resistor/Capacitor Data Book lists a complete line of capacitors and resistors. Containing more than 700 pages, the book describes aluminum electrolytic, ceramic, tantalum, film and variable capacitors, fixed resistors, trimmers, and nonlinear resistors. Each section provides a reference index, and the book features a cross-reference index of competitors. The Surface Mount Device Catalog contains a full listing of surface-mount resistors, capacitors, and semiconductors. The 140-pg publication provides design, performance, and specifying data for numerous devices: tantalum and monolithic ceramic capacitors, aluminum electrolytic capacitors, thick-film and precision metal-film resistors, high-performance trimmers, miniature selector switches, and discrete semiconductors. The latest addition to the catalog is the section on surface-mount semiconductors, containing a cross-reference index.

Philips Components, 2001 W Blue Heron Blvd, Riviera Beach, FL 33404. Circle No. 712

Publication Highlights Flush-Mounting Switches
The 8-pg technical catalog of switches includes the flush-mounting Series 61 bezel version of modular oil and watertight indicators, lighted pushbuttons, and 2- and 3-position keylock switches. Other presentations are the membrane Series 96, a high-reliability switch system, and the all-plastic mounting flange for the Series 04. Also included are mounting dimensions, types of illumination, accessories, lens shapes, and colors.

EAO Switch Corp, 198 Pepe's Farm Rd, Milford, CT 06460. Circle No. 713

Brochure Features Circuit-Protection Devices
The 12-pg Circuit Protection Devices Catalog presents an overview of general operating principles and application of thermal breakers. It describes automatic-reset and manual-reset circuit breakers and high-amp automatic- and manual-reset circuit breakers in both panel-mount and firewall-mount packages. Other devices listed include enclosed diodes and short-stop automatic and modified reset 12 and 24V circuit protectors. Specifications and illustrations complete the publication.

USD Products, 7300 W Wilson Ave, Chicago, IL 60656. Circle No. 714

Guides To Bondings And Encapsulation Compounds
These four application selector guides deal with adhesives, sealants, coatings, and potting and encapsulation compounds. One chart has a listing of more than 30 different 1-component curable compositions. The 2-pg guide on thermally conductive, electrically insulating epoxy systems provides viscosity, gel and cure times, service operating temperature ranges, thermal conductivity, and application recommendations for 15 grades. It describes both 2- and 1-component systems. The 2-pg chart for potting and encapsulation compounds lists the above specifications as well as room-temperature and heat curing, and UV curing grades. In addition to the standard specs, the guide to microelectronic resin systems includes sections for adhesives and sealants, impregnants, coatings, potting, and encapsulation compounds. The guide for compounds presents a wide range of products to meet the varied requirements of the electronics industry.

Master Bond Inc, 154 Hobart St, Hackensack, NJ 07601. Circle No. 715
Catalog Presents Computer And Bus Products
This 92-pg catalog divides products into the following categories: PC data acquisition; VME data acquisition; signal conditioning; and Multibus and Unibus data acquisition. Six application notes discuss gain and resolution, plug-in I/O boards vs I/O subsystems, and the Picobus—a flexible I/O Bus. Recent additions to the product line include Direct Connect for laptop-compatible data acquisition and EZ-Lab temperature-, pressure-, and current-measurement systems. A glossary of terms and an index of model numbers round out the publication.
Adac Corp, 70 Tower Office Park, Woburn, MA 01801.
Circle No. 445

Brochure Presents System Solutions
This 6-pg Systems Overview brochure describes on-line data-collection system solutions. It details how the company's integrated systems architecture has provided solutions for many Fortune 1000 companies. The publication describes uses of the system for quality control/inspection, material handling, machine monitoring, labor reporting/tracking, inventory control, plant equipment maintenance, and statistical process control. The brochure also discusses the company’s Strategic Alliance and VAR Partnership Programs.
Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Circle No. 446

Note Deals With STD Bus Programming Solution
Interrupt Handling with STD Bus Systems focuses on the programming aspects of interrupt handling in an STD DOS environment, with special reference to the shared interrupt and cascaded interrupts. This 8-pg application note defines and discusses interrupts, interrupt configurations, multiple interrupt controllers, and many other issues related to the Intel 80 Series of µPs and the STD Bus.
Ziatech Corp, 3433 Roberto Ct, San Luis Obispo, CA 93401.
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Catalog Presents VMEMbus Board-Level Items
This 4-color, 8-pg catalog lists a range of board-level, software, and development-system products. Processor boards described include 68030- and 68020-based multiprocessor boards, as well as 68010-based single-board computers and 68000-based general-purpose processors. The publication details memory boards for commercial, ruggedized, and MIL-spec applications as well as a selection of SCSI and disk-controller boards. The catalog describes a variety of development software for systems integrators such as Unix, VRTX32, OS-9, VXWorks, and Ada.
Radstone Technology Corp, 20 Craig Rd, Montvale, NJ 07645.
Circle No. 448

Charting Your Way To Data-Bus Products
This data-bus product-selection chart provides an at-a-glance guide to more than 30 characteristics of data-bus products for MIL-STD-1553 applications. Color-coded tabulations highlight the 2-sided chart, which lists single and dual transceivers, bit processors, remote terminal units, interfaces, card assemblies, and testers.
ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716.
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Booklet Offers Services For VXIbus
This 8-pg brochure delineates the vendor's flexible VXIbus integration services. After stating the benefits, the 4-color publication identifies the optimal instruments for users' applications; subsystem and system configurations (including end-to-end specification); and development of customized modules and application software.
Racal-Dana Instruments Inc, 4 Goodyear St, Irvine, CA 92718.
Circle No. 450

Volume Concentrates On Data Acquisition
The Data-Acquisition Handbook, Vol 27 (No. 2 of a 6-volume set) presents a plethora of state-of-the-art equipment. The book, which
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features more than 600 pages, covers data-acquisition and engineering software; communications-based acquisition systems; data-logging systems; an expanded line of recorders, printers, and plotters; industrial-process controls; and signal conditioners. It also covers communications products and accessories with an enlarged selection of IEEE products. A library of technical books is also listed.

Omega Engineering Inc, Box 4047, Stamford, CT 06907.
Circle No. 451

Booklet Describes Pen Plotters

This 6-pg brochure features the Artisan Plus 1020 Series of pen plotters. The booklet is divided into sections that describe the plotters’ cost efficiency, performance and throughput, quality output, plotting flexibility, computer and software compatibility, and reliability, as well as the company’s service and support. It examines the three 8-pen models, including the E-size model with roll-feed capability. Several 4-color reproductions of drawings illustrate applications ranging from architecture and mechanical engineering to mapping and circuit-board design.

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<thead>
<tr>
<th></th>
<th>FRANKLIN SOFTWARE</th>
<th>MCC51 v1.2</th>
<th>Archimedes ICC51 v2.20A</th>
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</thead>
<tbody>
<tr>
<td>Linkage time</td>
<td>6 sec</td>
<td>9</td>
<td>29</td>
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<tr>
<td>Execution time</td>
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<td>9.00</td>
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<td>Total code size</td>
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<tr>
<td>Compilation time</td>
<td>17 sec</td>
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<tr>
<td>Sieve module size</td>
<td>541 bytes</td>
<td>1021</td>
<td>726</td>
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</tbody>
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CIRCLE NO. 150

EDN December 6, 1990
Lotus Development Corp vs Paperback Software International

Judge rules software's look and feel can be copyrighted

Joseph S Iandiorio, Attorney at Law

The software industry has regarded the "look-and-feel" doctrine of copyright protection for software with mixed emotions. Simply stated, the doctrine says that if someone creates a software program that looks and feels like an existing, copyrighted program then that person has infringed on the copyright, whether or not the codings of the two programs are similar.

Some people were in favor of such strong protection because they believed it would do away with the need for licensing every piece of software to every customer. They thought the software industry would be able to rely solely on the protection a copyright affords to prevent unauthorized copying, the same way the recording and film industries do.

Other people felt that such broad protection would stifle the creation and development of new software products. They feared that copyrights would prevent software developers from borrowing the ideas behind new products to use in their own programs, which has long been a common practice.

The first case to deal with an infringement of copyright based on a software program's look and feel was Lotus Development Corp vs Paperback Software International.

The two computer programs at issue were Lotus 1-2-3 and Paperback's VP-Planner. Lotus brought the lawsuit against Paperback because it claimed that VP-Planner imitated 1-2-3's menus and keystrokes—in other words, its user interface. The case was recently decided by the federal district court in Boston, MA, and the court's ruling didn't endorse either of these extreme positions.

Lotus 1-2-3, VP-Planner, and the other programs considered during the course of the trial—Visicalc, Multiplan,
Supercode 4, and Excel—are all expressions of the same idea. They are all electronic spreadsheets. It was clear from the beginning that the idea of an electronic spreadsheet cannot be protected by copyright because it is both functional and obvious. But each of these programs, with the exception of VP-Planner, develops that core idea in a different way. Each program is different in its structure, appearance, and method of operation, and each of these different ways of expressing the same idea may be copyrighted.

A magic blackboard
The electronic spreadsheet was invented by Daniel Bricklin, a student at the Harvard Business School (Cambridge, MA). He envisioned a magic blackboard that would recalculate numbers throughout itself whenever the user made a change in one part. He eventually transformed his idea into Visicalc, which was the first electronic spreadsheet to reach the market.

Bricklin’s idea was revolutionary, and Visicalc was a commercial success. However, the software’s scope wasn’t very extensive because it was written for the Apple II computer, which has limited hardware capabilities. A later conversion of Visicalc for the IBM PC was less than successful because it failed to take full advantage of that computer’s capabilities.

Mitchell Kapor and Jonathan Sacks, two young computer programmers, saw an opportunity. They adopted Bricklin’s basic idea for an electronic spreadsheet but expressed it in a different, more powerful way. They took full advantage of the IBM PC’s expansive memory and versatile screen display and keyboard. They called their program 1-2-3, and after it was introduced in 1983 it rapidly became a bestseller.

No one denied that these two programs were based on the same idea, but each expressed that idea in a different way. A central feature of copyright law is that the form of the expression is protectable, but the underlying idea is not. When Paperback Software introduced VP-Planner, the company believed it was introducing another variation of the basic idea of an electronic spreadsheet. Lotus, however, saw too many similarities to 1-2-3 and in 1987 decided to sue.

The fundamental issue addressed in Lotus vs Paperback Software was whether the nonliteral as well as the literal components of a software program can be protected by a copyright. The nonliteral components include the overall organization of a program, the structure of a program’s command system, and the presentation of information on the screen. Courts have ruled in the past that the copyrights on musical compositions, plays, motion pictures, and works of literature can be infringed on even if their literal aspects are not copied. For example, even if the exact words of a book aren’t copied, its copyright is infringed upon if someone copies the setting, characters, or plot with a resulting substantial similarity.

The literal aspects of a software program—the source code and the object code—are copyrightable. There is no dispute about that. Flowcharts, too, are copyrightable. It would be an infringement to take a detailed description such as a flowchart and convert it into a computer language. It has already been held a violation of the copyright of a book to take a detailed description of a program in prose and program it in source code.

The court said that creating a suitable user interface is a more difficult intellectual task, requiring greater creativity, originality, and insight, than converting the user interface design into instructions for the machine. In the case of Lotus vs Paperback Software, therefore, the court held that the nonliteral components of a program are protectable by copyright and that Paperback Software had infringed upon Lotus’s copyright.

At the same time, the court rejected the notion that computer programs couldn’t be copyrighted because they were not works of an author but rather useful articles. (Useful articles are specific physical expressions of a general idea and are protectable under patent law.)

The court went on to explain that the conventional applica-
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tion of the look and feel doctrine was not helpful in analyzing this case because it didn't deal with the fundamental issue of whether a particular nonliteral portion of a software program is protectable. In earlier cases, the look and feel doctrine had been applied, not to determine the copyrightability of nonliteral aspects but to judge similarities between the nonliteral aspects of a copyrighted program and those of an infringing program.

A new 3-part test
For the case of Lotus vs Paperback Software, the court developed its own 3-part test for software copyright infringement. The test consists of

- Determining the underlying idea of the program so the idea can be distinguished from the expression of the program
- Determining whether the particular expression of the underlying idea is essentially the only way to express the idea or if there are other ways
- Determining whether or not the elements of the expression have been substantially copied.

Paperback's VP-Planner evolved in a way similar to Lotus 1-2-3. Dr James Stephenson, the originator of VP-Planner, recognized—like Kapor and Sacks—that Visicalc wasn't sufficient to meet the financial planning needs of some companies and didn't take advantage of recent advances in computer hardware. In January 1982, he began creating his own electronic spreadsheet. By the following January, he had developed much of the user interface for his program, including the menu command hierarchy. In April 1983, he installed an operational version of his electronic spreadsheet at one of his client's businesses. It had substantially the same menu hierarchy as the January 1983 version. That hierarchy was expressed differently from the hierarchy of both Visicalc and Lotus 1-2-3.

Paperback Software bought out Stephenson and VP-Planner and continued to improve the spreadsheet program. Then they made the decision that eventually brought the litigation against them. They decided that to be a commercial success, VP-Planner would have to be compatible with 1-2-3.

The court found that the defendants believed that the only way to make the two programs compatible was to ensure that the arrangement and names of commands and menus in VP-Planner conformed to that of Lotus 1-2-3. Such compatibility would let users transfer spreadsheets created in 1-2-3 to VP-Planner without losing functionality for any macros. In addition, such compatibility would let users switch from 1-2-3 to VP-Planner without having to learn new commands.

The intent of VP-Planner was clearly set forth in its users' manual:

"VP-Planner is designed to work like Lotus 1-2-3, keystroke for keystroke... VP-Planner's worksheet is a feature-for-feature work alike for 1-2-3. It does macros. It has the same command tree. It allows the same kind of calculations, the same kind of numerical information. Everything 1-2-3 does, VP-Planner does."

"It has the same command tree" as 1-2-3 means that Paperback Software deliberately copied the expression embodied in the 1-2-3 menu hierarchy.

The court found that Lotus's L-shaped menu screen and the particular key chosen to call up the menu were not copyrightable because they were not essential to the expression of the spreadsheet idea. But the court ruled that other elements of the menu, such as the precise structure, sequence, and organization of the menu command system, were distinctive details of expression and therefore could be copyrighted.

Lotus's particular expression of a menu structure is not essential to the idea of an electronic spreadsheet, nor is it essential to the somewhat less abstract idea of a menu structure for an electronic spreadsheet. The idea of a menu structure can be expressed in a great many ways: through the overall
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EDN December 6, 1990
It has already been held a violation of the copyright of a book to take a detailed description of a program in prose and program it in source code.

structure; the order of commands in each line; the choice of letters, words, or symbolic tokens to represent each command; the presentation of these symbolic tokens on the screen (first letter only, abbreviations, full words, full words with one or more letters capitalized or underlined); the type of menu system used (1-, 2-, or 3-line moving-cursor menus, pull-down menus, or command-driven interfaces); and the length of the prompts.

The fact that some of these command terms are quite obvious or overlap with another company's particular command terms doesn't mean that the command structure taken as a whole can't be copyrighted. If particular characteristics that are not distinctive individually have been brought together in a way that makes the whole a distinctive expression of an idea, then the whole is copyrightable.

Copying was a nonissue in the case of Lotus vs Paperback Software. The court found the copying to be overwhelming and pervasive, and Paperback freely admitted it copied the essential elements.

The new test for software copyright infringement worked well:
• The Lotus user interface was an expression of an idea, not the idea itself.
• A number of other ways to express the idea exist.
• Paperback Software had copied a substantial portion of Lotus's expression.
Lotus wins 1-2-3.

Although this ruling was the decision of a federal trial court and is not binding on other federal courts (as it would be if it were the decision of a US appeals court or the US Supreme Court), it nevertheless establishes a major, definitive, and persuasive authority for two reasons. First, the decision was reached through a thoughtful and thorough analysis of the issues by a well-respected judge. Second, because the issues involved were fully litigated by major competitors, there was ample opportunity for all the facts and arguments to be presented.

What the decision means to the average programmer is that he or she can build on and improve existing ideas embodied in copyrighted software without fear of infringing on that copyright as long as the final product doesn't use the same form of expression—the user interface, screens, or symbols—in the same flow and organization. You can design a new spreadsheet. You just can't make it look like Lotus's.
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  Circuit Development and Acoustics
- DEFLECTION DEVELOPMENT
- CAD/CAE
  Software Development
- MICROCOMPUTER DEVELOPMENT
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**Systems Engineers & Analysts**
- Top-level systems design and requirements definition
- Segment design

**Resource Management**
- Operations research
- Man-machine interfaces
- Software lifecycle

**AI Information Systems Analysts**
- Natural language processing
- Image understanding
- Tactical data fusion
- ART, CLIP, KEE, Lisp and C++ languages

**Computer Security Engineers**
- Orange and Red Book Standards
- Network security
- Accreditation of trusted systems
- DoD 50200.28 criteria

**Software Engineers/Software Analysts**
- Software development for vast information processing systems and applications
- Hands-on experience with SUN/UNIX, VAX/VMS, IBM MVS/XA, C, Ada, Fortran, Pascal

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- System configuration maintenance & installation
- Maintaining a tuned operating environment

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- 3+ years Wang analytical support experience

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- LAN/WAN operations experience
- BSCS or 3 years experience in systems administration

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- 3+ years experience with IBM and Macintosh, DB2 and IDMS

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Will design and develop enhancements to the UNIX-based operating systems of high performance workstations and file servers. Experience in kernel development, SCSI device drivers, file systems in BSD or System V, and optical mass storage routines is required. Experience with NFS/ Yellow Pages porting and implementation, B1/C2 security features, performance enhancements for multi-user systems and AT&T UNIX 5.3 is highly desired. Positions require a BS/MS in Computer Science or equivalent and a minimum of 2 years industrial experience.

COMMUNICATIONS SOFTWARE DESIGN ENGINEERS
Will be responsible for the development and maintenance of system software supporting LAN protocols in UNIX environments. Positions require a BS/MS in Computer Science or equivalent and a minimum of 2 years industry experience in LAN protocols (TCP/IP, ISO/OSI, SNA, XNS). A good knowledge of UNIX/C is highly desired.

MANAGER, OPERATING SYSTEM DESIGN
Will be responsible for administering the activities of software engineers developing enhancements to UNIX-based operating systems. Candidates should be very knowledgeable of the UNIX OS, especially the functions listed in the above position, and should have a minimum of 2 years experience in developing UNIX enhancements. Additionally, candidates should have at least 2 years of functional management experience and should be familiar with budgeting, manpower planning, and performance and salary reviews. The position requires a BS/MS in Computer Science or a related field.

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Responsible for development and maintenance of reference user and product description documentation for UNIX-based workstations and servers and their supporting operating systems software. Requires a BS in a related field and 2 or more years industrial experience developing documentation for UNIX-based operating systems, systems enhancements, and related software in C.

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