MARCH 17, 1982

A CAHNERS PUBLICATION

EDN

EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

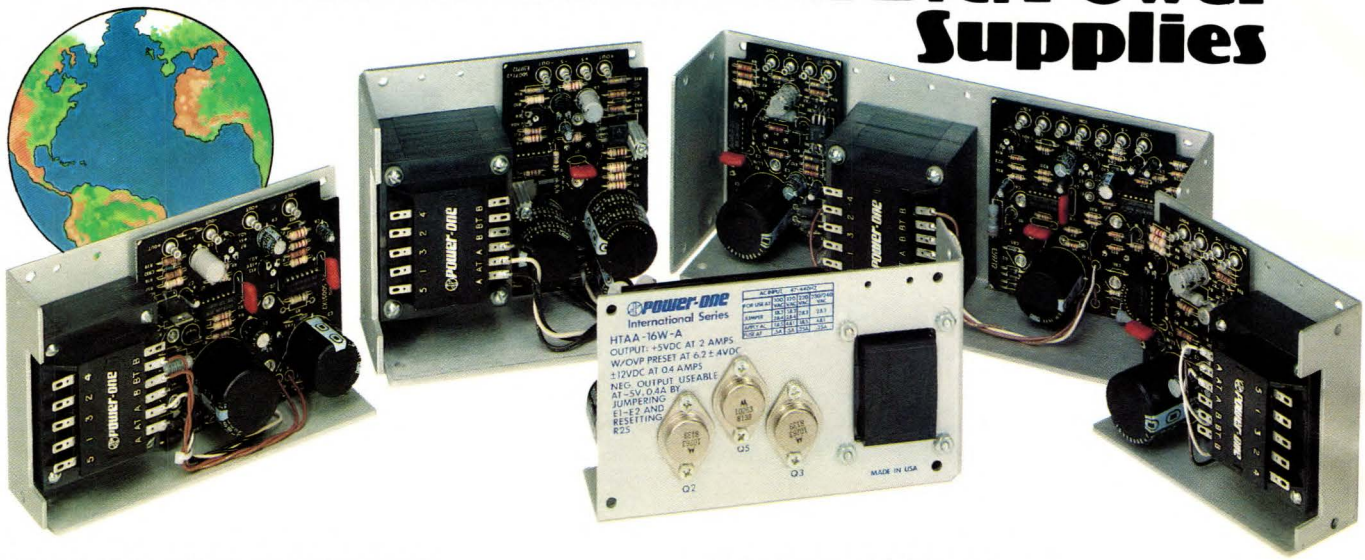
Use "hidden" counters in CMOS PLL ICs

Matrix-inversion program analyzes complex circuits

Integral connectors enhance power-line filters

Switching power supplies drive diverse and unusual systems

Power One's International Series-The New World Standard in D.C. Power Supplies



One Power Supply for the Whole World

At last... a world standard in high reliability open-frame power supplies. Designed specifically for products sold throughout the world to make your international marketing simpler. And more profitable.

Meets International Safety Requirements, Worldwide

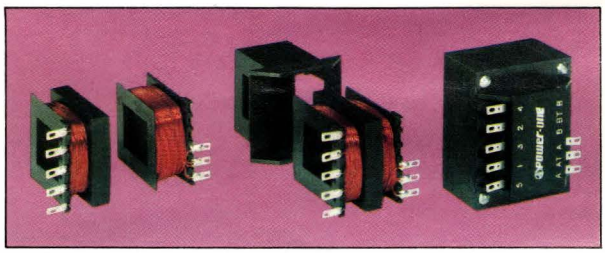
The International Series can be used anywhere, for almost any application. It's the only power supply available that meets the most important requirements of VDE, UL, CSA, BPO, IEC, CEE, and ECMA. This was achieved by using our new patented winding process featuring separate, fully enclosed primary and secondary windings. This unique construction complies with worldwide safety standards, including:

Leakage Current, Line to Ground: 5.0 μa
Spacings, Live Parts to Dead Metal: 9.0 mm
Other than Field Terminals: 5.25 mm

Dielectric Withstand Voltage,
Input to Ground: 3750 VAC
Input to Outputs: 3750 VAC
Outputs to Ground: 500 VAC

Wide Choice of AC Input Power

Each unit is rated at 100, 120, 220, 230, and 240 volts, 47 to 63 Hz. So wherever your products are headed, one standard off-the-shelf power supply will serve. No more costly stocking of different units for different destinations.



Power-One's patented International Series transformers feature separate, fully enclosed, primary and secondary coils. Meets safety requirements of VDE, UL, CSA, BPO, IEC, CEE, and ECMA.

SINGLE OUTPUT MODELS

MODEL	VOLTAGE/ CURRENT	PRICE (1-24)
5 VOLTS		
HB5-3/OVP-A	5V @ 3A	$ 32.95
HC5-6/OVP-A	5V @ 6A	$ 54.95
HN5-9/OVP-A	5V @ 9A	$ 74.95
HD5-12/OVP-A	5V @ 12A	$ 84.95
HE5-18/OVP-A	5V @ 18A	$119.95
12 VOLTS		
HB12-1.7-A	12V @ 1.7A	$ 32.95
HC12-3.4-A	12V @ 3.4A	$ 49.95
HN12-5.1-A	12V @ 5.1A	$ 69.95
HD12-6.8-A	12V @ 6.8A	$ 79.95
HE12-10.2-A	12V @ 10.2A	$109.95
15 VOLTS		
HB15-1.5-A	15V @ 1.5A	$ 32.95
HC15-3-A	15V @ 3A	$ 49.95
HN15-4.5-A	15V @ 4.5A	$ 69.95
HD15-6-A	15V @ 6A	$ 79.95
HE15-9-A	15V @ 9A	$109.95
24 VOLTS		
HB24-1.2-A	24V @ 1.2A	$ 32.95
HC24-2.4-A	24V @ 2.4A	$ 49.95
HN24-3.6-A	24V @ 3.6A	$ 69.95
HD24-4.8-A	24V @ 4.8A	$ 79.95
HE24-7.2-A	24V @ 7.2A	$109.95

DUAL OUTPUT MODELS

MODEL	OUTPUT #1	OUTPUT #2	PRICE (1-24)
±12 TO 15 VOLTS			
HAA15-0.8-A	12V @ 1A OR 15V @ 0.8A	-12V @ 1A OR -15V @ 0.8A OR -5V @ 0.4A	$ 42.95
HBB15-1.5-A	12V @ 1.7A OR 15V @ 1.5A	-12V @ 1.7A OR -15V @ 1.5A OR -5V @ 0.7A	$ 54.95
HCC15-3-A	12V @ 3.4A OR 15V @ 3A	-12V @ 3.4A OR -15V @ 3A	$ 87.95
HDD15-5-A	12 TO 15V @ 5A	(-) 12 TO 15V @ 5A	$129.95
5 VOLTS PLUS 9 TO 15 VOLTS			
HAA512-A	5V @ 2A	9 TO 15V @ 0.5A	$ 49.95
HBB512-A	5V @ 3A	9 TO 15V @ 1.25A	$ 59.95
HCC512-A	5V @ 6A	9 TO 15V @ 2.5A	$ 94.95

TRIPLE OUTPUT MODELS

MODEL	OUTPUT #1	OUTPUT #2	OUTPUT #3	PRICE (1-24)
HTAA-16W-A	5V @ 2A	9 TO 15V @ 0.4A	(-)9 TO 15V @ 0.4A OR -5V @ 0.4A	$ 54.95
HBAA-40W-A	5V @ 3A	12V @ 1A OR 15V @ 0.8A	-12V @ 1A OR -15V @ 0.8A OR -5V @ 0.4A	$ 75.95
HCAA-60W-A	5V @ 6A	12 TO 15V @ 1A	(-)12 TO 15V @ 1A OR -5V @ 0.4A	$ 89.95
HCBB-75W-A	5V @ 6A	12V @ 1.7A OR 15V @ 1.5A	-12V @ 1.7A OR -15V @ 1.5A OR -5V @ 0.7A	$ 99.95
CP131-A	5V @ 8A	12V @ 1.7A OR 15V @ 1.5A	-12V @ 1.7A OR -15V @ 1.5A OR -5V @ 0.7A	$119.95
HDBB-105W-A	5V @ 12A	12V @ 1.7A OR 15V @ 1.5A	-12V @ 1.7A OR -15V @ 1.5A OR -5V @ 0.7A	$134.95

SINGLE OUTPUT MODELS

MODEL	VOLTAGE/ CURRENT	PRICE (1-24)
28 VOLTS		
HB28-1-A	28V @ 1A	$ 32.95
HC28-2-A	28V @ 2A	$ 49.95
HN28-3-A	28V @ 3A	$ 69.95
HD28-4-A	28V @ 4A	$ 79.95
HE28-6-A	28V @ 6A	$109.95

New International Series Models

DISK DRIVE MODELS

MODEL	OUTPUT #1	OUTPUT #2	OUTPUT #3	PRICE (1-24)
CP205-A	5V @ 1A	-5V @ 0.5A	24V @ 1.5A/1.7A PK	$ 75.95
CP206-A	5V @ 2.5A	-5V @ 0.5A	24V @ 3A/3.4A PK	$ 99.95
CP162-A	5V @ 3A	-5V @ 0.6A	24V @ 5A/6A PK	$129.95
CP323-A	5V @ 2A	12V @ 4A		$ 79.95
CP379-A	5V @ 6A	-5V @ 1.2A OR -12V @ 1.2A	24V @ 3.5A/8A PK	$129.95
CP384-A	5V @ 9A	-5V @ 1.2A OR -12V @ 1.2A	24V @ 2A/8A PK	$129.95

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CIRCLE NO 1

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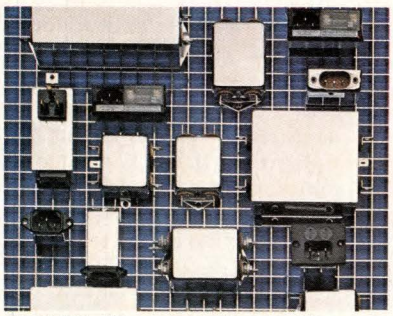
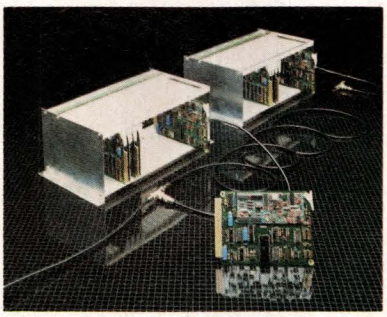
DESIGN FEATURES

TECHNOLOGY UPDATE

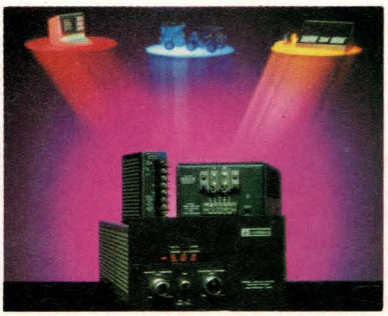
Contents continued on pg 7



RFI/EMI filters *with integral International Electrotechnical Commission connectors increase worldwide product marketability. And they're available in a variety of special-purpose configurations (pg 45).*



STD Bus-compatible modems *accommodate high-speed data transfers between μC systems connected via coaxial-cable links. They come in two versions: with or without a serial-interface port (pg 101).*



On the cover: *Switching power supplies now come in a variety of off-the-shelf versions and also in customizable modules and semicustom designs. Turn to pg 114. (Photo courtesy Lambda Electronics)*

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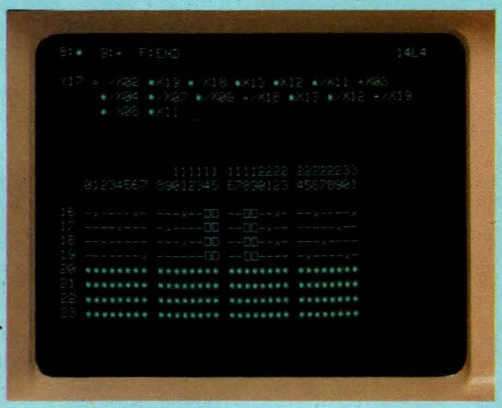
THE UP-803 INTERACTIVE
PROM & LOGIC PROGRAMMER

NOW WITH PAL™ ASSEMBLER/ DISASSEMBLER

Get to know the FAM™-51 module.
PAL™ assembly/disassembly and programming of 20/24 pin PALs: all done with the FAM-51 module! The resident assembler allows direct keyboard entry of either Boolean Equations or selected fuse to be blown in fuse matrix. Both are displayed on the CRT (see insert). The disassembly function displays the Boolean Equation corresponding to your PAL's fuse pattern.

Let the UP-803 be your easy-to-use PAL design center, while you profit from a shorter design cycle!



The FAM-12 module lets you **program hundreds of different PROMs with one software-selectable module.** The FAM-12 programs most MOS and Bipolar PROMs from all major manufacturers. Programming of new devices can be implemented by minor software updates, which we furnish.
The FAM-12 programs devices of all package types, including 40 pins and SKINNYDIP™ devices.

Enjoy the convenient use of the **Built-in CRT providing 20 lines** of data, control and status messages, all in plain language (no codes to decipher).
List blocks of data (72 bytes) in your favorite format (Decimal, Hex, Octal or Binary) and perform search, delete, insert, replace and complement on the battery backed up buffer memory.

The UP-803 communicates directly with your development system, computer and peripherals, in a variety of formats through serial and parallel ports.

Menu driven software guides you at each stage with an array of choices appropriate to that stage resulting in minimum operator error and reduced training time.
Parametric testing of devices: Post programming parametric and logic tests are performed on each device to assure ultimate reliability.

The UP-803 is ready for any future device, process or packaging development through its modular design, software control of all functions and its device adapter concept.

No calibration required at any time. Proven design and precision components assure that programming voltages and timing signals meet semiconductor manufacturers' specifications at all times, without periodical calibration

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EDITOR'S CHOICE

DESIGN IDEAS

μC DESIGN TECHNIQUES

FEATURE PRODUCTS

NEW PRODUCTS

A QUESTION OF LAW

Study your employment contract carefully to protect your rights.

LOOKING AHEAD

Converters need more production capacity . . . Retail hardware, software to total $22.5B by 1985.

DEPARTMENTS

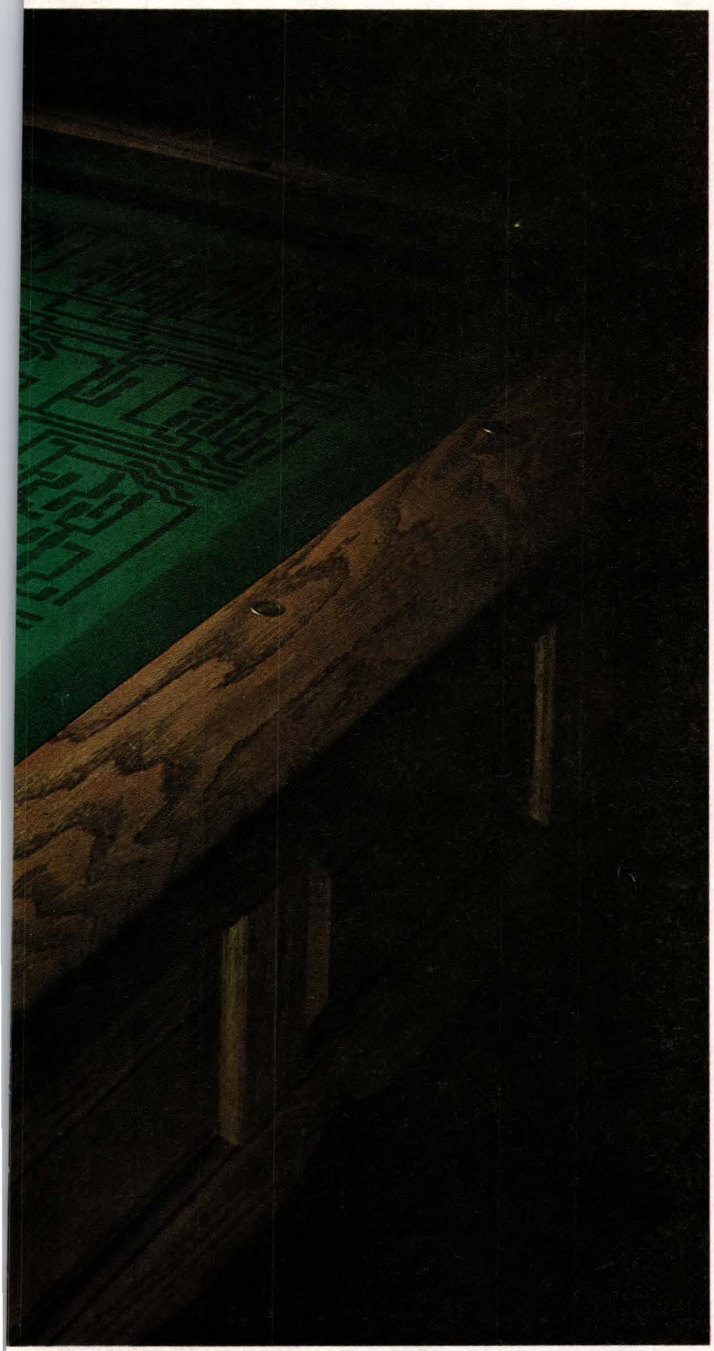
At Exar, you call the shots on custom IC development.

We bend our rules to meet your needs.

Some big custom IC houses lose interest if your custom requirements don't fit their rules. At Exar, we don't have rigid rules. You tell us what you need and we help you get it. Period.

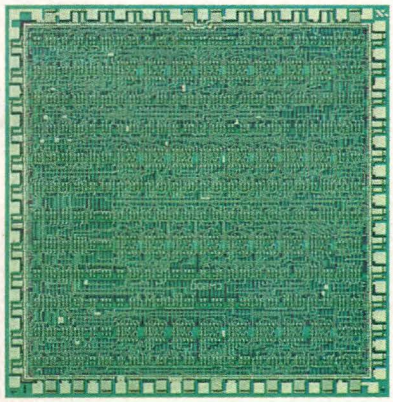
How many custom ICs do you need?

At Exar, there's no minimum volume requirement. Even if your current volume is too small to make full custom cost-effective right now, we'll help you get started with semi-custom ICs. When your product matures and the numbers get big, we'll help you convert to full custom.



How soon do you need prototypes?

We'll work out a schedule you can live with. At Exar, typical turnaround time is half that of most big custom houses.



How much do you want to do yourself?

We can do all or any part of the custom development cycle. We'll design and build your custom circuit from your specs. Or convert your semi-custom design to full custom to reduce unit cost. Or fabricate wafers from your design and tooling. We'll even second-source a custom circuit designed for you elsewhere. Any way you call it—CMOS, I^2L, or bipolar gate arrays—you'll get personal attention and guidance every step of the way from our custom IC experts.

What kind of packaging?

Choose from plastic or ceramic DIPs, molded flat packs, chip carriers, tab power packages, or your own custom packaging. Or specify delivery in wafer or dice form.

How about cost?

We're committed to providing the highest-quality custom ICs in the industry at a competitive price. We're even flexible about upfront money and contract agreements, because we know how important these can be to you.

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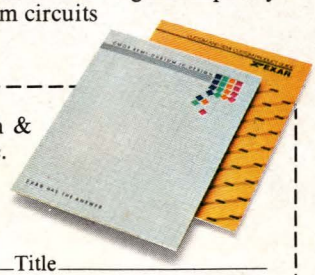

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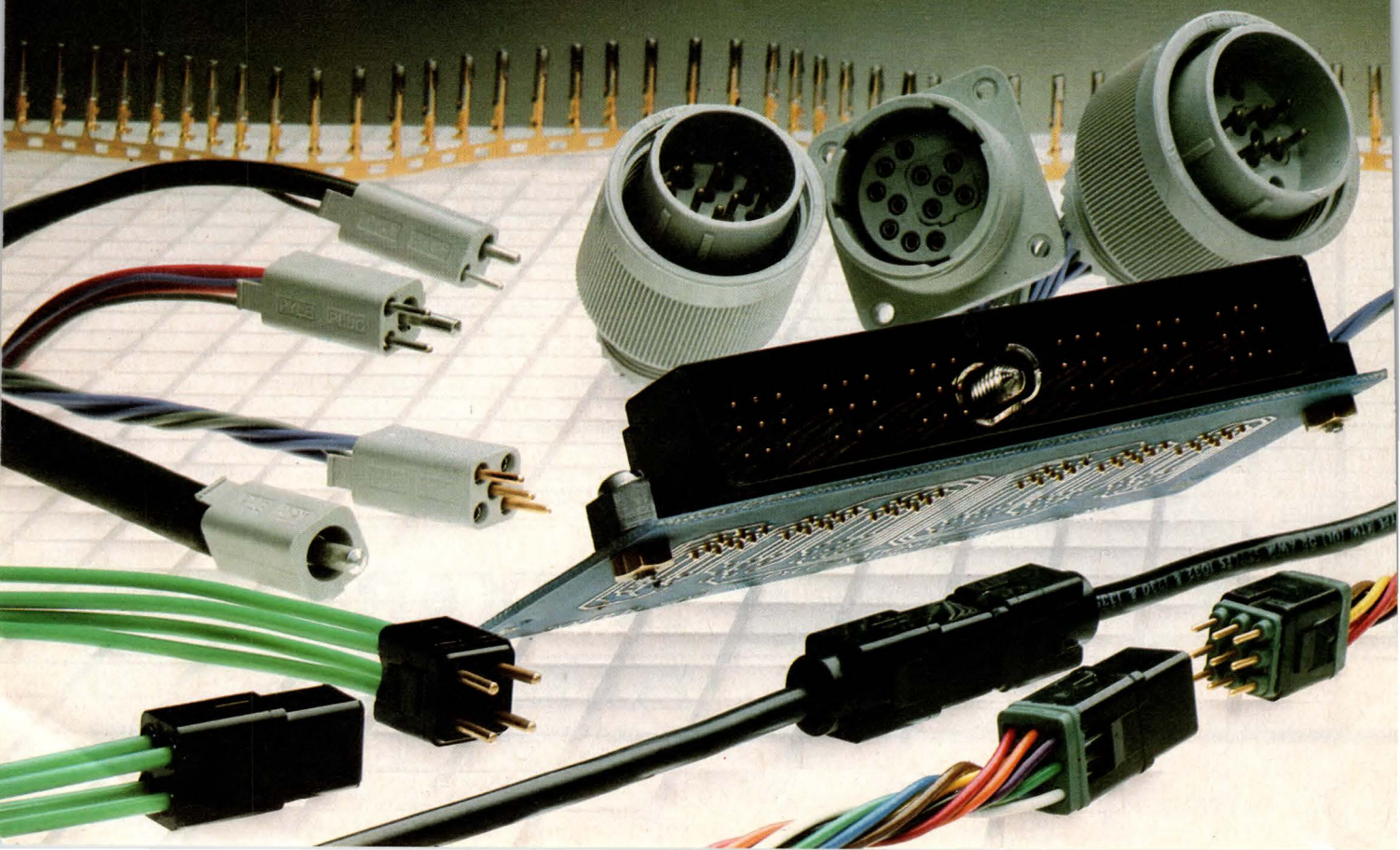
Now look at how you save. Modules can be prewired, thus allowing standardization of cable lengths. So, assembly time is kept to a minimum and applied cost savings are realized. You reduce the need for large inventories. And because, in most



different connectors assemblies you need?

cases, you'll have exactly what you need on hand, you eliminate time-consuming delays and the high costs of special connector orders. Finally, circuit upgrading and harness modification without replacing the entire connector assembly is fast and easy.

For more information about this unique and advanced line of modular connectors, drop us a note or give us a call.

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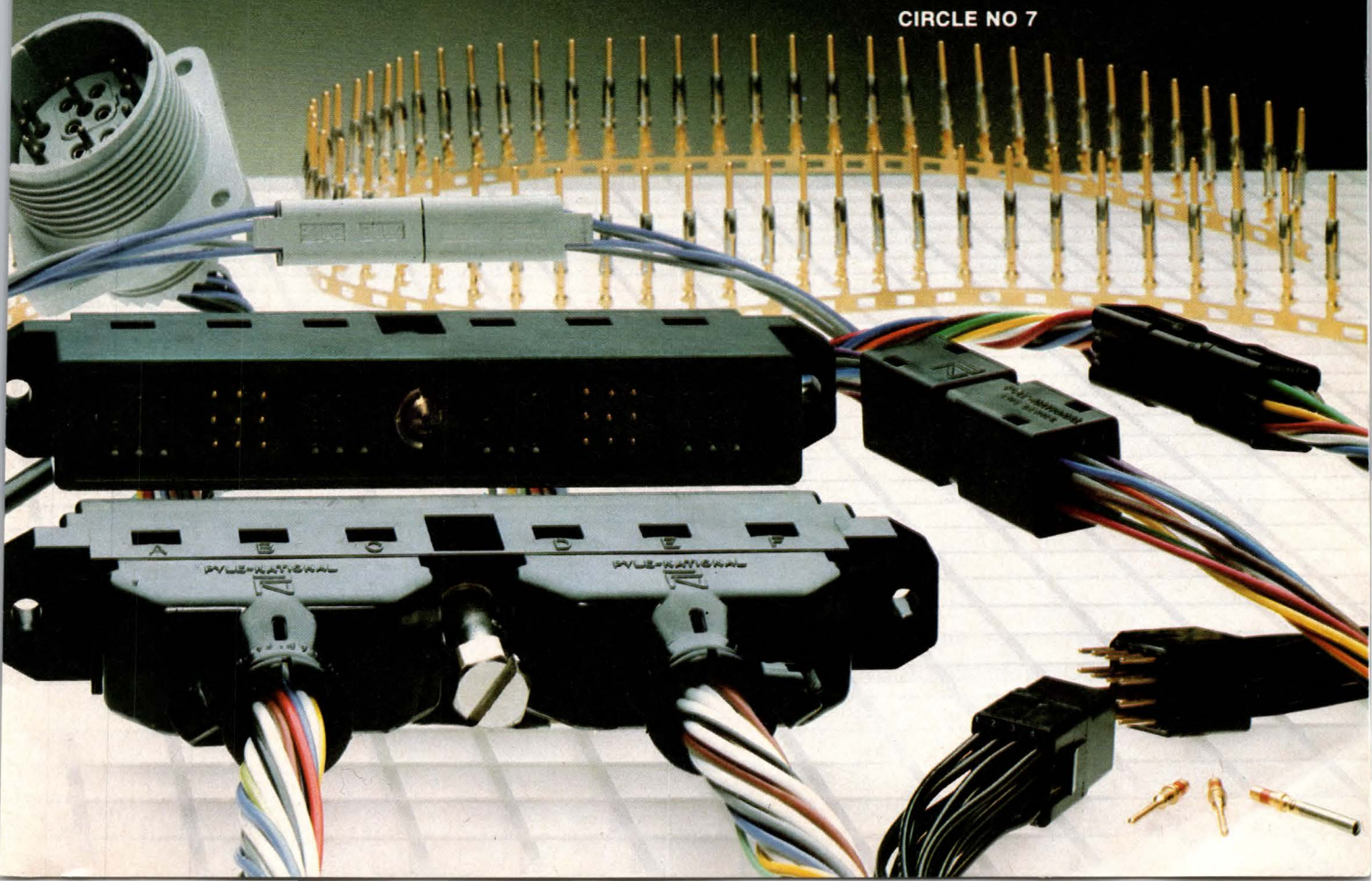
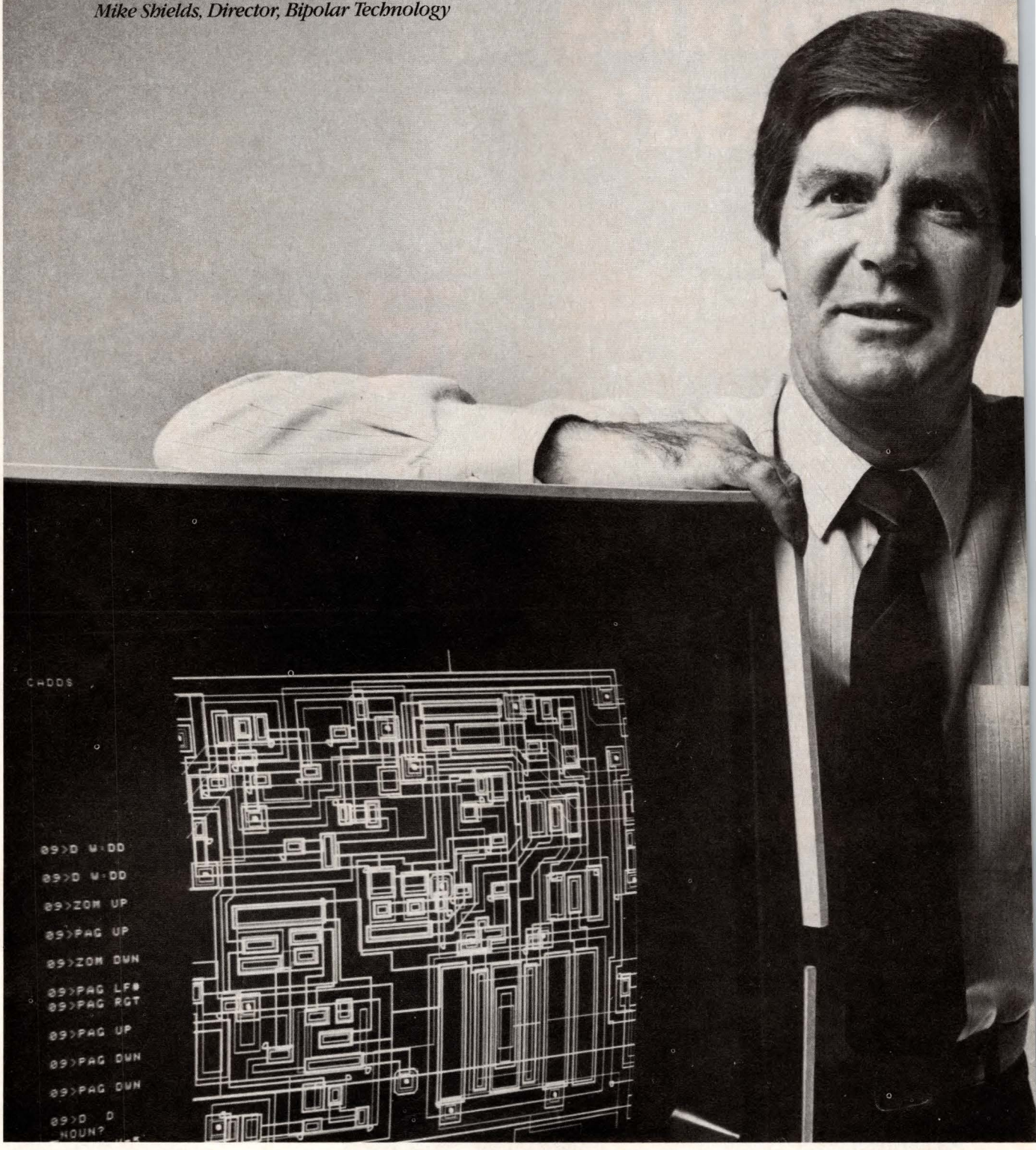


"Some people seem to think we're
Our commitment to the latest te

Mike Shields, Director, Bipolar Technology



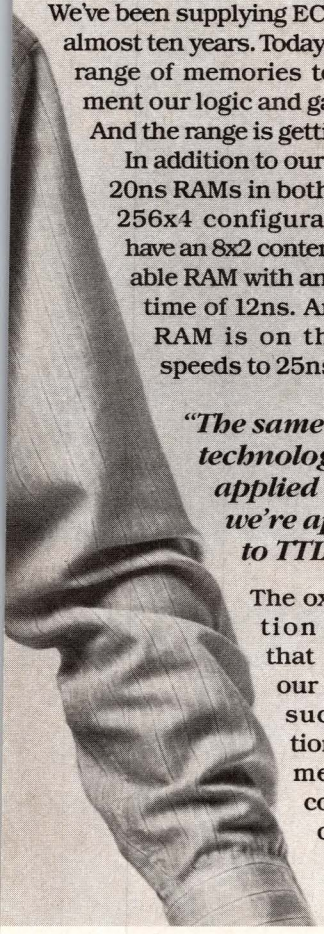
serious about bipolar RAMs.
ology says they're wrong."

We're producing bipolar RAMs to fit all kinds of applications. From large ECL memories for mainframe computers to small, byte-sized RAMs for peripheral products, we have the devices you want in the quantities you need.

"We're leading the way in ECL."

We've been supplying ECL parts for almost ten years. Today, we have a range of memories to complement our logic and gate arrays. And the range is getting bigger.

In addition to our 10, 15 and 20ns RAMs in both 1Kx1 and 256x4 configurations, we have an 8x2 content addressable RAM with an associate time of 12ns. And our 4K RAM is on the way at speeds to 25ns.



"The same process technology we applied to ECL, we're applying to TTL."

The oxide isolation process that has made our ECL parts such exceptional performers is becoming part of our TTL devices.

A quick look at our RAM family

	Size	Speed	Special Feature
SMALL TTL RAMs:			
82S112	8x4	40ns	Multiport
82S21	32x2	50ns	Read While Write
3101A	16x4	35/50ns	
82S25	16x4	35/50ns	
74S189	16x4	35/50ns	
82LS16/17	256x1	40ns	Low Power
74LS301	256x1	40ns	Low Power
BYTE ORGANIZED TTL RAMs:			
82S09/19	64x9	30ns	High Speed
82S210	256x9	50ns	Latched Addresses
82S212	256x9	45ns	High Speed
ECL RAMs:			
10155	8x2	12ns*	Content Addressable RAM
10/100415	1024x1	10/15ns	High Speed
10/100422	256x4	10/15ns	High Speed
10/100470**	4096x1	25ns	High Density

*Associate Time **Available soon

That means increased density, lower capacitance and higher speed. Which will in turn help us design special purpose memories, as well as the industry standards.

In TTL RAMs, we were the first with the byte-organized 64x9 part. At 30ns, it's still the leader. Our new 256x9 devices, one high-speed and the other with latched addresses, are two more examples of the way Signetics fills specific needs in TTL.

Our low power 256x1 memory, at 40ns, is another industry leader. And both our 8x4 and 32x2 TTL RAMs have unique characteristics for special uses. One is multiport while the other is a Read While Write design.

"You can get quality and quantity at the same time."

While investing millions of dollars in computerized design, layout and test equipment, we've also increased our production capabilities enough to supply your needs, as well as a major portion of the RAM market.

And we've instituted a tough quality control program aimed at lowering rejects to 250 parts per million in the next three years.

So, if you're as serious about high-quality bipolar RAMs as we are, contact your local Signetics distributor or sales office. Or send us the coupon. We'd like to prove that, with Signetics, you can't go wrong.

I'm serious about bipolar RAMs.
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TEXAS INSTRUMENTS

CIRCLE NO 9

Edited by Joan Morrow

News Breaks

ETHERNET NETWORK MANAGER EASES COMPLEX-PROGRAM DEVELOPMENT

Intel Corp (Santa Clara, CA) has announced a 3-phase product program to help you handle the complex programs that new μPs accept. The first phase consists of the $39,950 NDS-II, which includes a 5¼-in. floppy and a 35M-byte Winchester. It's an Ethernet-based network resource manager that ties eight Intellec workstations together for managing multiuser software-development projects. The second phase includes tools for existing workstation nodes, the first being the $2000 PSCOPE, a symbolic high-level program debugger with which you can debug at the PASCAL or PL/M level. Later this year, the third phase will provide enhanced workstation nodes; you can expect a high-performance compilation node that compiles 1500 to 2000 lines of code per min.—PGS

CONTROLLER BOARD COUPLES MULTIBUS-TYPE μCs TO ETHERNET

When connected to a coax-terminated transceiver unit, the $2990 Model NI3010 single-board communications controller from Interlan Inc (Chelmsford, MA) adds Ethernet-local-network transmission and reception capabilities to Multibus-based μCs. Plugged into one Multibus slot, the 12 × 6.75 × 0.48-in. card requires 5 and 12V dc power. It implements 10M-bps data transfers among as many as 1024 Ethernet-connected stations separated by as much as 2500m. The board complies fully with the Xerox/Intel/DEC Ethernet Version 1.0 specifications, providing the network's physical- and data-link-layer functions on a shared 50Ω coax cable.—GK

LOW-COST IN-CIRCUIT EMULATOR HANDLES 5-MHz 8085 μPs

The $1495 Model SBE-85 uses a dual-processor design that allows a target system to retain all of its memory and I/O space. From Huntsville Microsystems (Huntsville, AL), the single-board debugging tool incorporates an in-line assembler and a disassembler, has single-step and breakpoint capabilities and incorporates an RS-232C interface. The firm provides an easy-to-use command set that includes direct I/O operations plus instructions that fill, move, test and compare memory blocks. CP/M linking software on floppy disk is optional.—WP

DEVELOPMENT SYSTEM ADDS 8085 EMULATION

When installed in the 2302 emulator mainframe, a $2200 8085 slave emulator personality module from GenRad's FutureData Div (Culver City, CA) provides fully transparent emulation to 5 MHz. It supports the full 64k-byte address range, either within a prototype device or mapped into the emulator in 256-byte blocks. The module allows you to selectively activate all control lines on the prototype system, and you can force all 8085 interrupts from the 2302 keyboard.—ASR

KEY-OPERATED ROTARY SWITCH FEATURES NOVEL LOCKING PROCEDURE

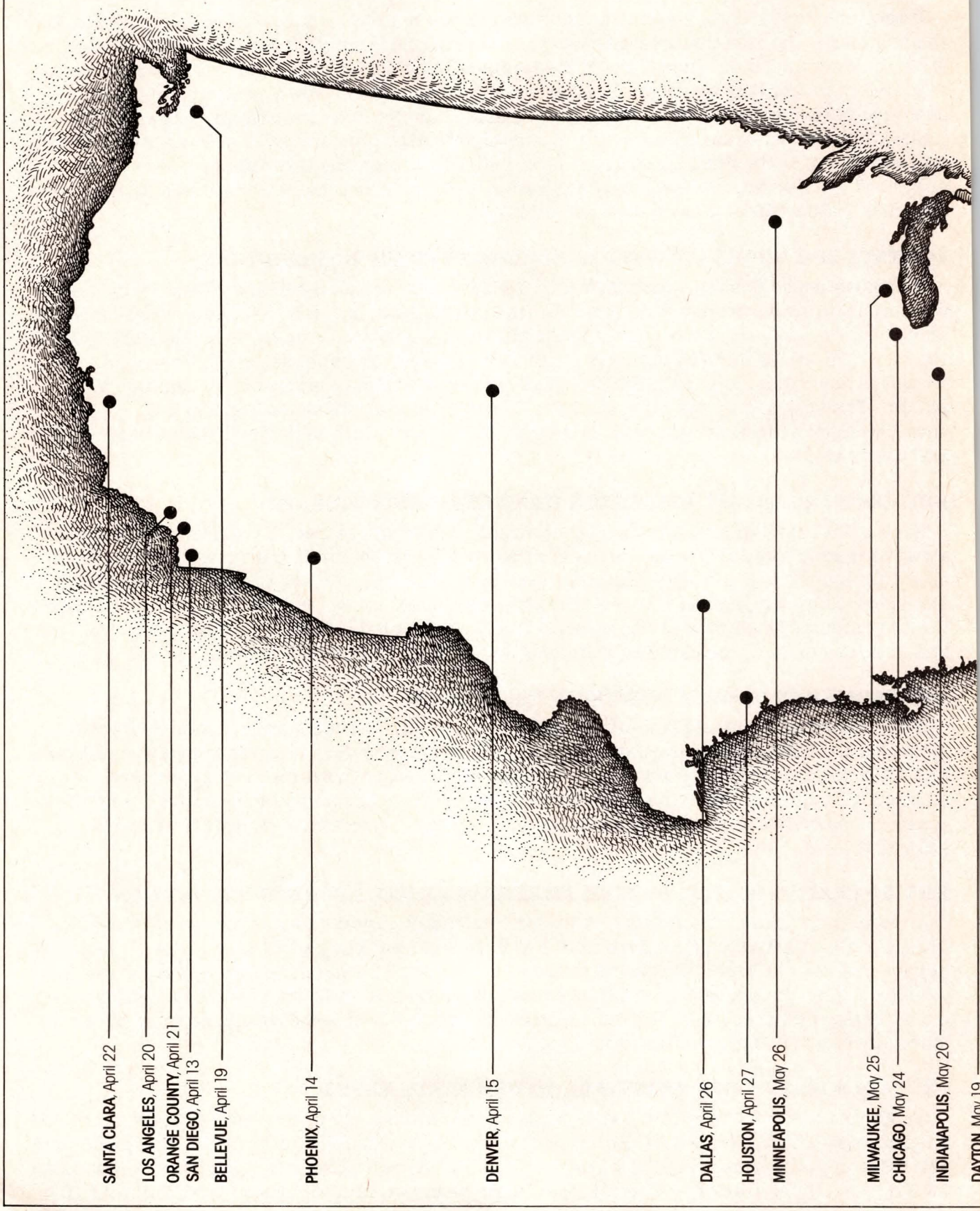
An explosion-proof key-operated multiposition rotary switch from Janco Corp (Burbank, CA) can only be activated by insertion of a key through the knob while in position 1. After the key is inserted, the knob rotates freely between positions 1 and 2. You can remove the key in position 2, and the keyless knob can then be turned back to position 1 where it automatically locks. The switch specs ¼A, 115V ac and 28V dc and meets MIL-S-3786. Turn to pg 65 for more information on keylock switches.—JM

PORTABLE HARD-COPY TERMINAL TO USE PLAIN PAPER

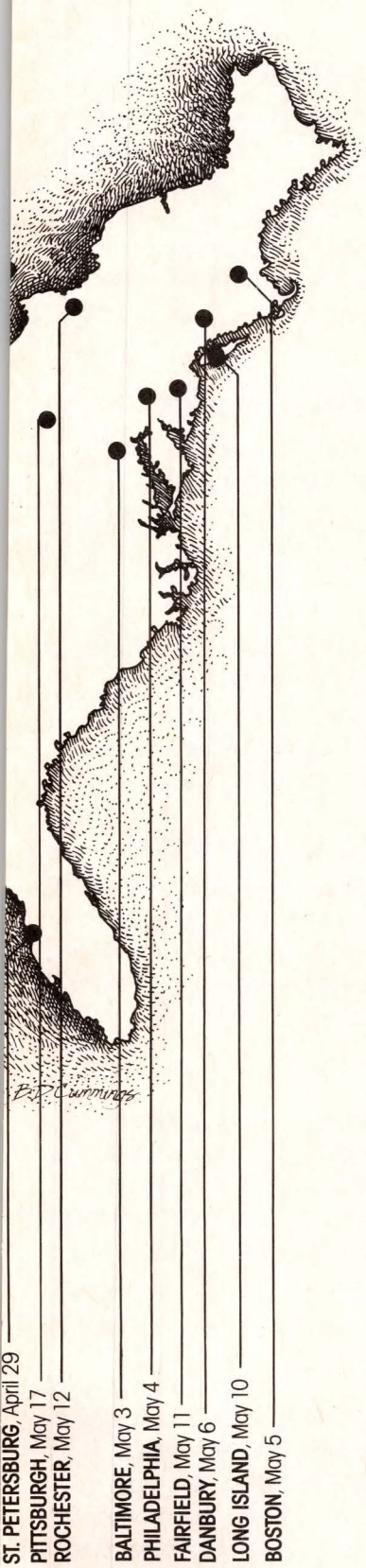
Weighing approximately 20 lbs and printing on ordinary paper, the Correspondent portable hard-copy terminal from Digital Equipment Corp (Maynard, MA) will provide 150-cps 80- and 132-column bidirectional printing under μP control. To be available this summer, it will print 9 × 9 dot-matrix characters—the full 128-character upper- and lower-case ASCII set and 10

Continued on pg 18

THE NATIONAL CMO



EMINAR CIRCUIT.



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EN EET EDN

CIRCLE NO 10

international character sets—and bit-map graphics with 132 × 72-dots/in. resolution. Keyboard-selectable features will include half- or full-duplex mode, 50- to 9600-baud operation, parity, keyclick and vertical and horizontal spacing. Four RS-232C terminal-interface configurations ($1995 to $3195), using acoustic coupler and direct-connect modem connections, will help meet host-communication needs.—GK

SIGNATURE-ANALYSIS TESTERS STIMULATE, MEASURE μP BOARDS

The $1500 Model 1310 signature verifier from Data I/O Corp (Redmond, WA) stores 4-hex-digit Hewlett-Packard-compatible signatures and transitions obtained from a known-good circuit in a PROM module. The module plugs into the instrument's front panel, eliminating the need for signature tables and annotated schematics. Thus, when you make engineering changes in your product, you can burn new PROMs instead of preparing a new set of documents. Additionally, the $2000 Model 1320A stimulus/control unit controls execution of unit-under-test software unrelated to the UUT's own software branches, although you can use the UUT's own self-test routines.—AS

NEW-GENERATION MICROCONTROLLERS ACHIEVE SPEED IMPROVEMENT

Signetics (Sunnyvale, CA) has introduced a series of bipolar controllers that extend its 8X300 family. Centered on the 8X305 controller, which furnishes a 25% speed improvement over the 8X300, the devices increase flexibility and support for microcontroller designs as well as provide increased throughput.—ET

FIBER-OPTIC MODULES HANDLE 32M BPS MAX

Hitachi America Ltd (San Jose, CA) now offers a line of digital fiber-optic transmitter and receiver modules that accommodate data rates to 32M bps. The modules employ various circuit technologies (CMOS, bipolar, hybrid) and feature LED sources and PIN-photodiode detectors. The DS2101 transmitter and DR2101 receiver, equipped with cable optimized for 890-nm operation, can accommodate dc to 2M-bps NRZ data transmissions over 2 km.—TO

RANGING MODULE MEASURES 30-FT DISTANCES WITH 0.5-IN. RESOLUTION

Consisting of a 26-kHz air transducer plus all necessary transmit/receive electronics, Model E-200 produces an output pulse width proportional to its distance from a target. Massa Products Corp (Hingham, MA) packages the $150 unit in a 3 × 1.5 × 1.8-in. module that operates from one 5 to 15V supply. You can narrow the sensor's 35° beam angle to 15° with a snap-on horn and trigger it externally or internally at 20 pulses/sec max.—WP

SWITCHING-POWER-SUPPLY PREVIEW

Three product introductions arrived too late for inclusion in this issue's Special Report on switching power supplies (pg 114). Sierracin/Power Systems (Chatsworth, CA) announced its 6EE200 supply, intended for computer systems incorporating Winchester-type disk drives. Pioneer Magnetics (Santa Monica, CA) introduced its PM2680 multiple-output 1500W supply. And Powertec (Chatsworth, CA) announced a Superswitcher line. Watch for more details on these products in the March 31 issue of EDN.—ET

ADD-IN BOARDS BOOST Z-89-μC-SYSTEM CAPABILITY

Employing 64k-bit dynamic RAMs, the Invisible Disk from Magnolia Microsystems (Seattle, WA) boosts the memory capacity of a Zenith Z-89 μC to 176k bytes. The $595 board replaces a Zenith-supplied 16k-byte RAM board and employs the bit-mapping feature of the system monitor to provide extended addressing. The firm has also developed a $79 external video board that plugs into the video board of the Z-89 μC or Z-19 terminal. This Video Out provides composite video and supports bandwidths to 6 MHz on an 80-character × 24-line display with a soft 25th line, as well as character graphics and inverse video.—CW

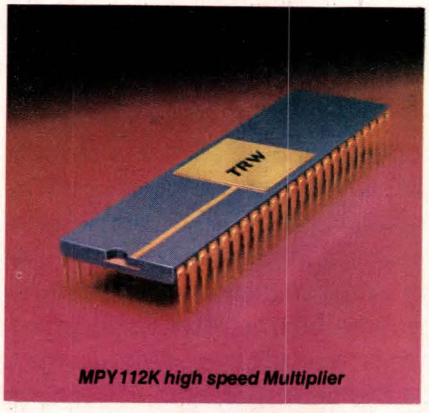
Introducing the first 50 nsec 12x12-bit multiplier.

TRW's OMICRON-B™* makes the MPY112K the fastest (20 MHz — video rate) 12x12-bit multiplier available.

The 48 pin DIP VLSI multiplier gives you a combination of more usable board space and higher speed multiplication than you've ever had before.

You can multiply in two's complement or unsigned magnitude format, and you get a 16-bit product, perfect for video systems where real time digital signal processing is required at very high data rates.

All inputs/outputs are registered and TTL compatible, of course. (After all, TRW invented TTL.) Three-state output drivers, single +5V supply, and the price is right: just $105 in 100s.



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CIRCLE NO 11

PROBABILISTIC/FUZZY LOGIC PROMISES REALLY SMART SYSTEMS

Expert systems—expert knowledge and power held in readily accessible form in a computer—will have the same impact on the world as books did, believes Systems Programming Ltd (London, UK). Packages such as its upcoming SAGE will allow construction of an expert-derived knowledge database (consisting of rules), and a navigating "inference engine" that uses probabilistic and fuzzy logic to provide answers in such applications as medical diagnosis. Because fault finding and prediction are natural applications for this technique, SPL believes it also holds much significance for electronics. One design possibility is to build an expert system for some complex test-and-measurement instrumentation or control problem, then run it and dump the code into ROM in static-knowledge-base form. Compared with the normal long sequential program, this system could provide much better structure with stronger linking of evidence, more alternative conclusions and a shorter program through control of complexity. The firm is also considering making a skeletal inference-engine interpreter available in ROM, to which designers can add databases and really smarten up their systems.—BN

FOIL-ETCHING ADVANCE YIELDS SMALLER ALUMINUM ELECTROLYTICS

The Elcoma Div of Philips (Eindhoven, The Netherlands) has developed a chemical-etching technique that yields a significant increase in the CV product of aluminum foil for production of smaller and ligher electrolytic capacitors. Foil-etching factors, or basic surface-area multiplication, of 100 or more are achieved with this process. That figure compares with typical currently available commercial values of 50 to 60. The firm's 021 Series, which will appear in May, will be one to two times smaller than conventional components and should cost less. Capacitors of 220 to 15,000 μF and mini electrolytic units with values as small as 1 μF are also planned. Initial working voltages will be as great as 63V, with 100V to follow. Axial and single-ended types with mounting rings and shock-resistant printing wiring pins will be available, and the series will conform to IEC384-4 and DIN 41316 specs.—BN

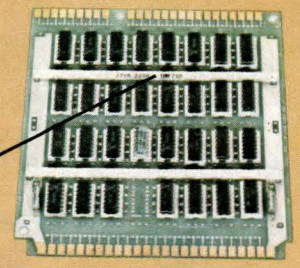
EUROCARD MICROCOMPUTER MODULES USE STD BUS

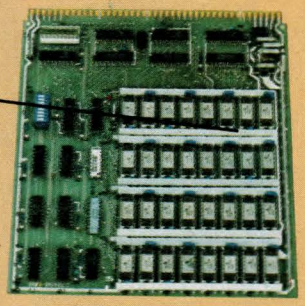
Microcomputer modules based on the 100 x 160-mm Eurocard and DIN 41612 connector but configured for use on the STD Bus, are being produced by GMT Electronic Systems (Wimbledon, UK). The firm claims that current Eurocard μC products' buses are not as general purpose as they might be for widespread standardization. Therefore, it has used the STD concept, with its high modularity and processor independence, on a Eurocard series to be launced next month. The bus spec has been slightly modified for mechanical considerations and to aid use of newer processors with higher performance interrupt structures. But the overall STD Bus concept is adhered to strongly, and other companies are encouraged to design boards. Only two rows (64 pins) of the connector are taken up by the 8-bit scheme, so the optional 32-pin third row provides a 16-bit-processor future-growth path. Initially, GMT will manufacture six card functions: 6802 or 6809 CPU, parallel or serial I/O and two memory modules.—BN

THYRISTOR/DIODE MODULES TO SUIT PHASE-CONTROL APPLICATIONS

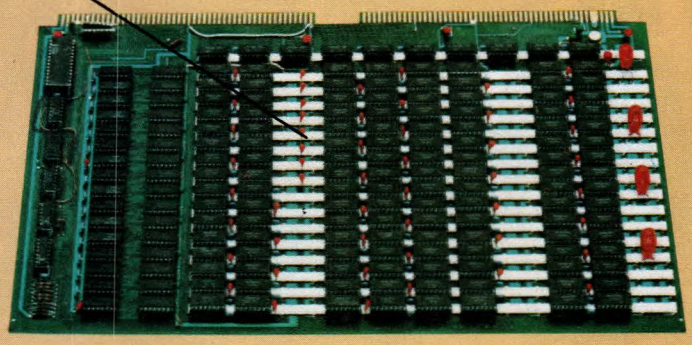
International Rectifier aims to expand its share of the power-device-subassembly market with its upcoming Add-A-Pak diode and thyristor modules. In packages suited particularly to European requirements, these glass-passivated device combinations, designed at the company's Turin, Italy facility, will simplify the building of phase-control circuitry. The series will cover 100 to 1200V, handling currents to 75A. First available parts will be dual thyristors, and all modules will come in packages with isolated bases to facilitate multiple mounting on a single heat sink.—BN

How the smart companies





distribute power



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CIRCLE NO 12

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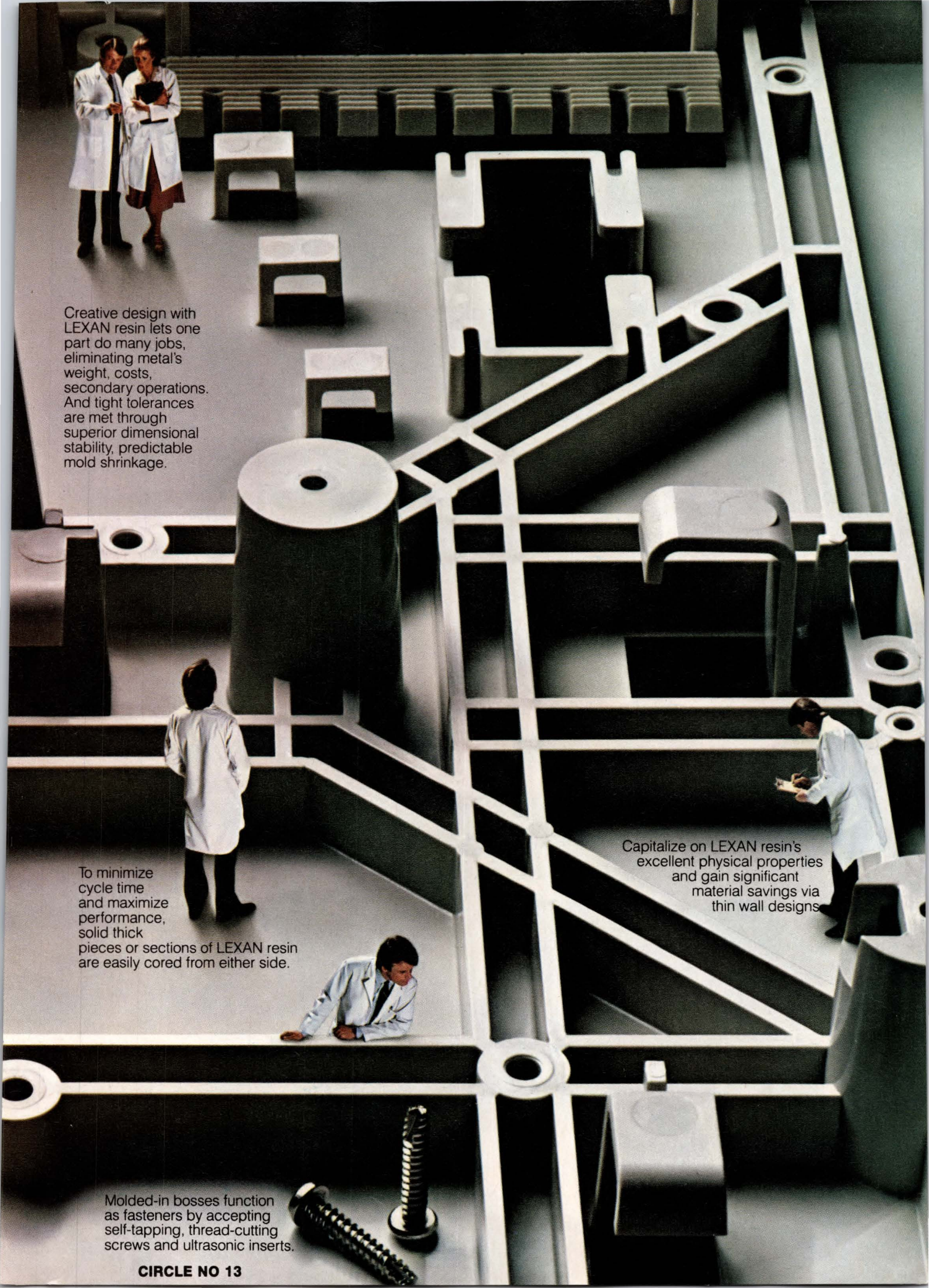
LEXAN resin's superb strength and durability mean slender snap-fit arms that resist snap-offs.

With LEXAN resin, parts that locate, align or hold components can be designed-in rather than added on.

By designing-in ribs, fillets and radiused corners, rigidity and strength are optimized while weight and costs are minimized.


Creative design with LEXAN resin lets one part do many jobs, eliminating metal's weight, costs, secondary operations. And tight tolerances are met through superior dimensional stability, predictable mold shrinkage.
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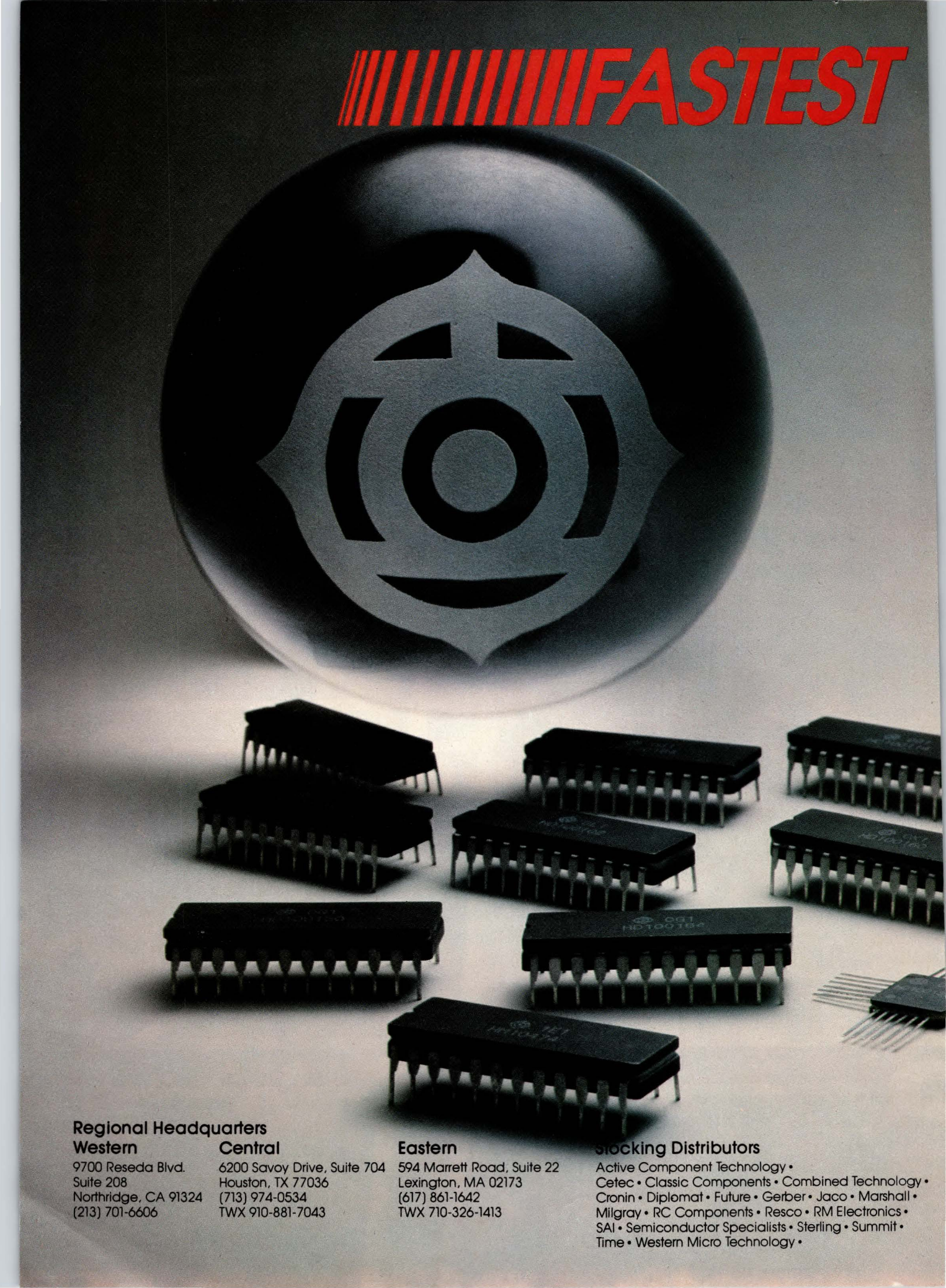
CIRCLE NO 13



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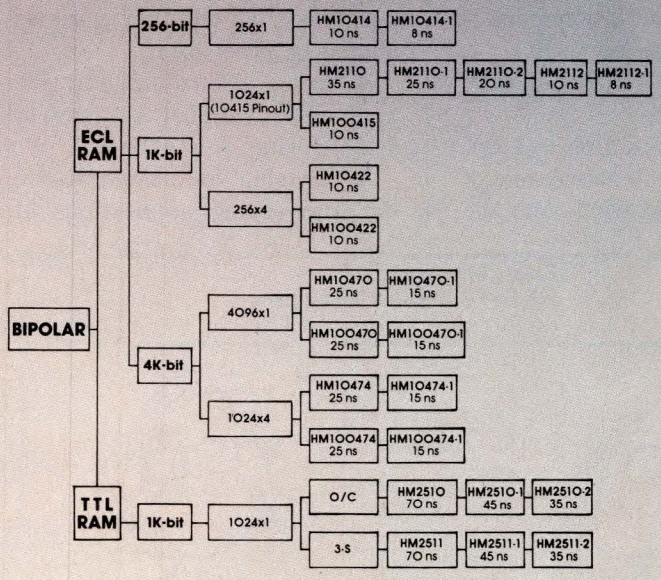
*Polyimide isoindroquinazoline-dione

BIPOLAR RAM FAMILY TREE



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Talk about speed: Hitachi's complete 35-device ECL logic family features subnanosecond performance (750 ps gate delays), as well as voltage and temperature compensation. This entire family of industry standard 100K ECL functions and pinouts is available in both ceramic DIP and flatpack.

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HD100118	HD100151	HD100180
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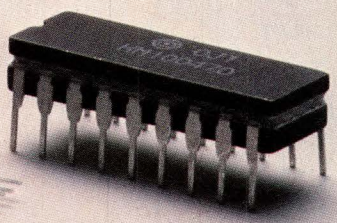

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NIE would support the physical sciences

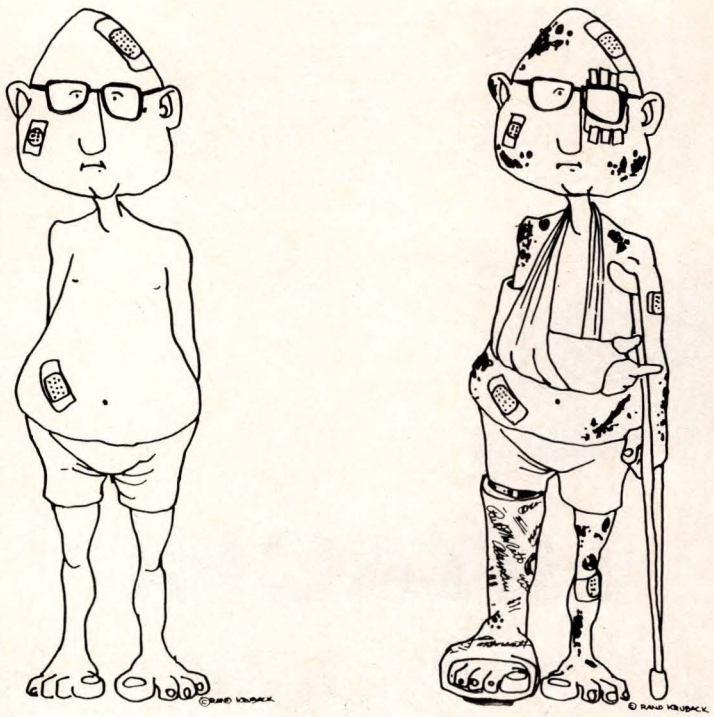
Dear Editor:

Increasing world population, depletion of high-quality mineral sources, escalation of energy consumption, the world food shortage and pollution are all complex problems that require technical solutions. For these and other problems, the cost of insufficient engineering can be (and often is) enormous. To avoid this waste and to better focus the limited engineering resources available in the US, I propose that the federal government establish a National Institutes of Engineering (NIE).

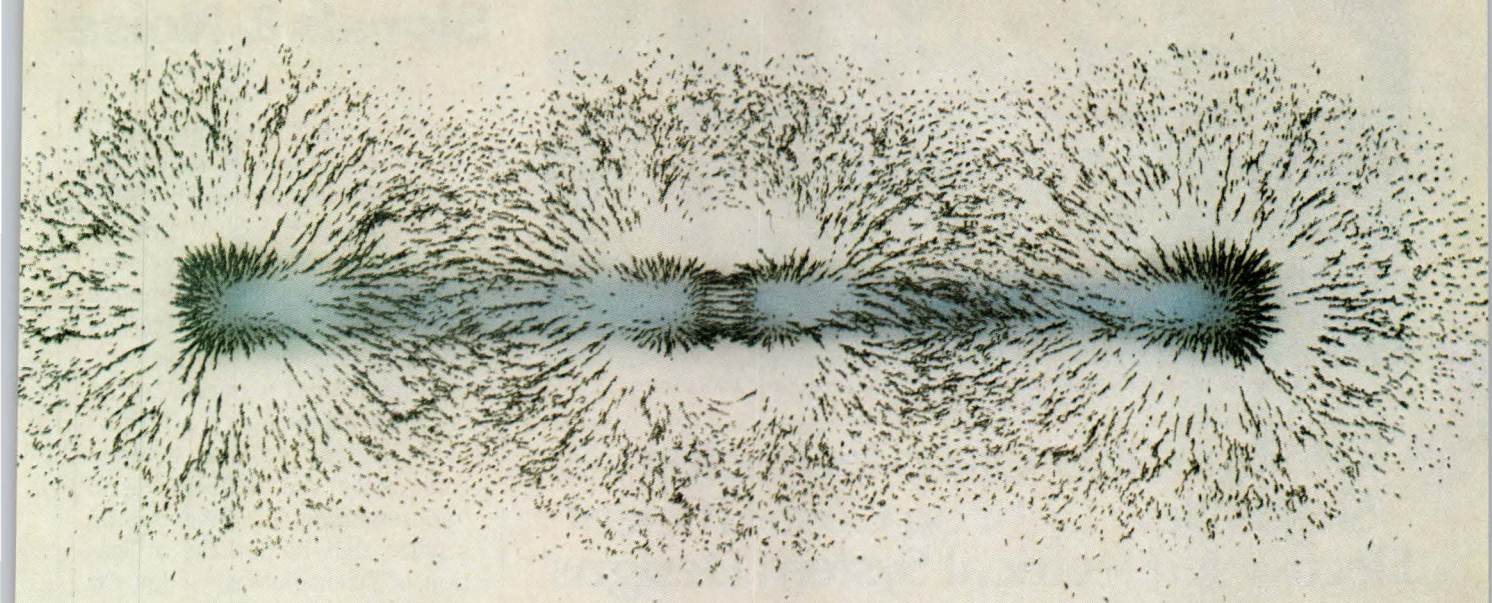
As I see it, NIE should have six main functions:

- Support research in engineering so that fundamentals of science can be used for the benefit of society.
- Enhance invention and creativity in applied science.
- Provide a forum for analysis of technological problems facing the nation—not to take political action, but to provide the nation with well-considered, objective analyses of technological applications of science, considering economy, probability of success, short- and long-term time requirements, probable effects on the quality of life, interrelationships of various systems, and the basic-science resource base. Where necessary, all conflicting views should be presented.
- Serve as an administrative arm of the National Academy of Engineering.
- Conduct in-house research on engineering applications of

Dictionary of Electronic Critters
Rand Kruback



MEGA HERTZ **GIGA HERTZ**



We've used an old principle of science to set a new standard for analog output sensors.

Magnets have been actuating our solid state digital output sensors for years. But now, this no-touch actuating principle triggers a new sensor with highly linear output. It's our Linear Output Hall Effect Transducer (LOHET™).

Sensitive to even slight changes in the magnetic field, but relatively insensitive to changes in temperature and supply voltage, the LOHET sensor couples accuracy with long life. So it's a cost-effective alternative to non-solid state position and current sensors, such as potentiometers and current transformers.

In current sensing, LOHET is isolated from the electrical transients that make transformers and shunts less reliable. And it has a higher frequency response than most other sensors.

Now, it's true that there are other magnetically actuated solid state sensors. But LOHET is more cost-effective than these, with greater linearity over a wider temperature range, and higher gain. It's more easily applied because precise chip placement gives you consistently accurate performance in relation to tight-tolerance actuating designs.

And you have a choice of three versions: ratiometric; a version independent of supply voltage that operates on 8-16 VDC; and another requiring a 5 VDC supply.

For more details about the LOHET sensor, write MICRO SWITCH, The Sensor Consultants, Freeport, IL 61032. Or call 815-235-6600.

(twice actual size)

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a Honeywell Division

CIRCLE NO 15

Signals & Noise

basic science to provide a reservoir of research excellence and scientific achievement. Such a program would give perspective to the evaluation and conduct of sponsored applied research and provide a staff of eminent engineers in the various capacities required by an organization such as the NIE.

- Report to the science community the deficiencies in understanding of fundamental science that hinder the utilization of scientific knowledge for the benefit of mankind.

I recommend that parallel to the National Institutes of Health, the engineering institutes be based on the immediate concerns of our society for technological progress. This division of responsibility could be modified by Congress as needed, and each institute could be funded separately. This approach would keep NIE responsive to the needs of society as seen by Congress.

Specific technological concerns of society would be addressed by individual institutes as follows:

1. The National Institute of Energy Engineering would incorporate the applied-research areas important to energy.

2. The National Institute for Space Engineering would be the applied-research portion of NASA.

3. The National Institute for Transportation would include all aspects of applied science relating to transportation, including rail, automotive, water and air (except outer space).

4. The National Institute for Environmental Engineering would address the problems of air and water pollution, waste disposal, conservation of natural resources and noise control.

5. The National Institute for Manufacturing Engineering

Continued on pg 33

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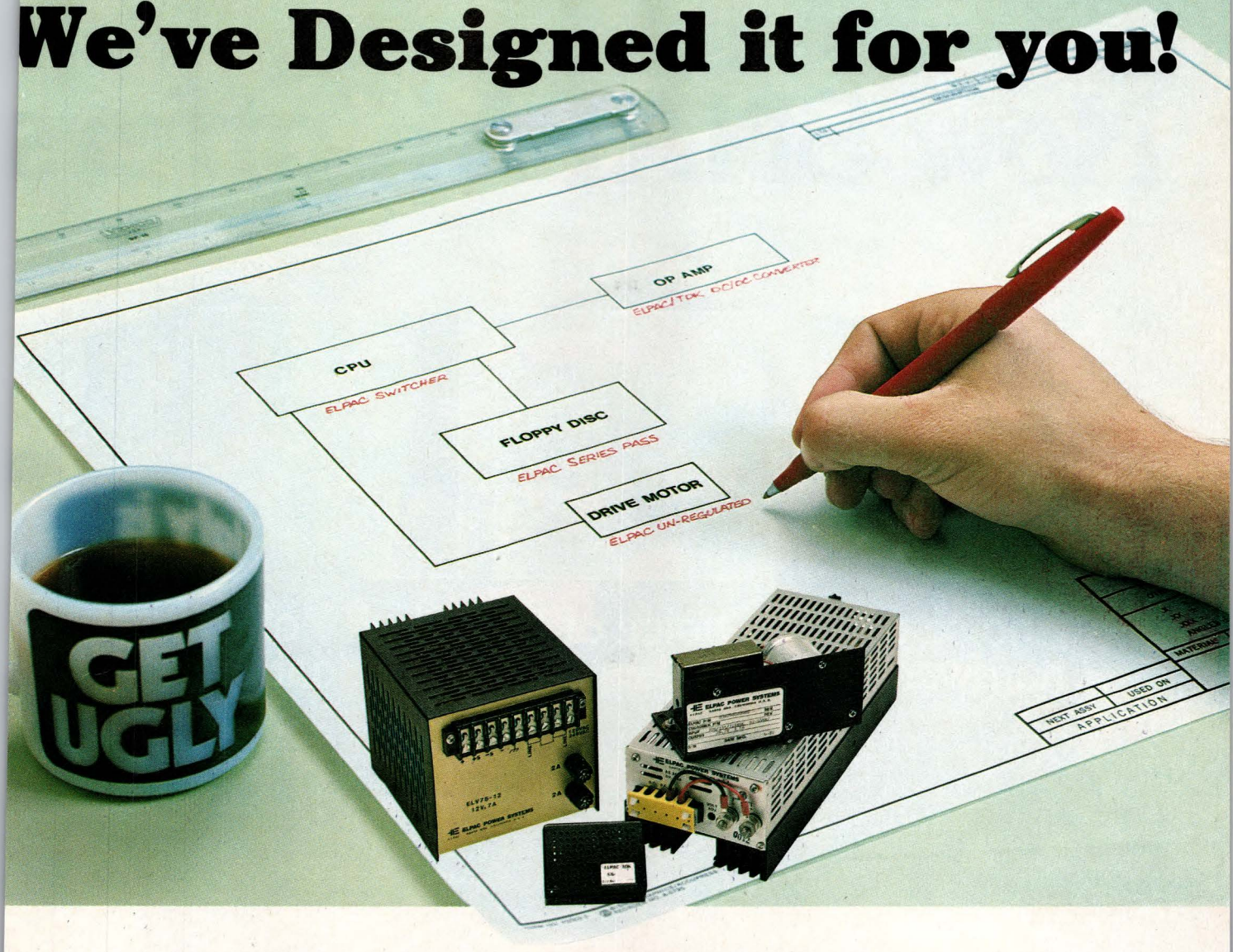

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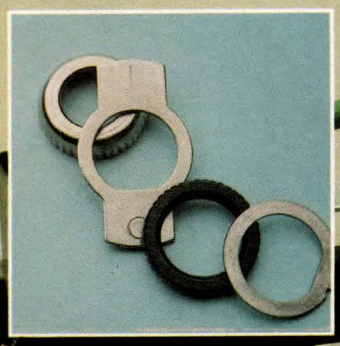
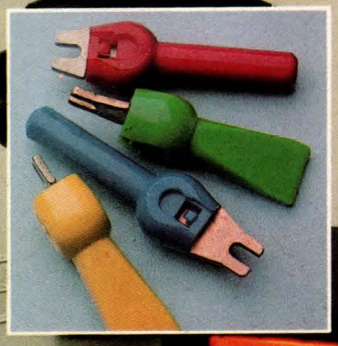
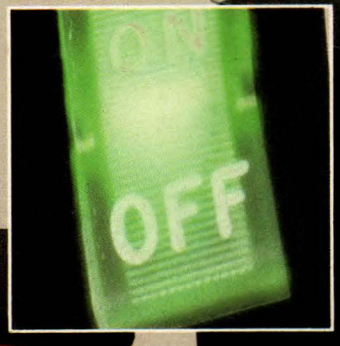


Choice of hardware



Choice of handles and colors

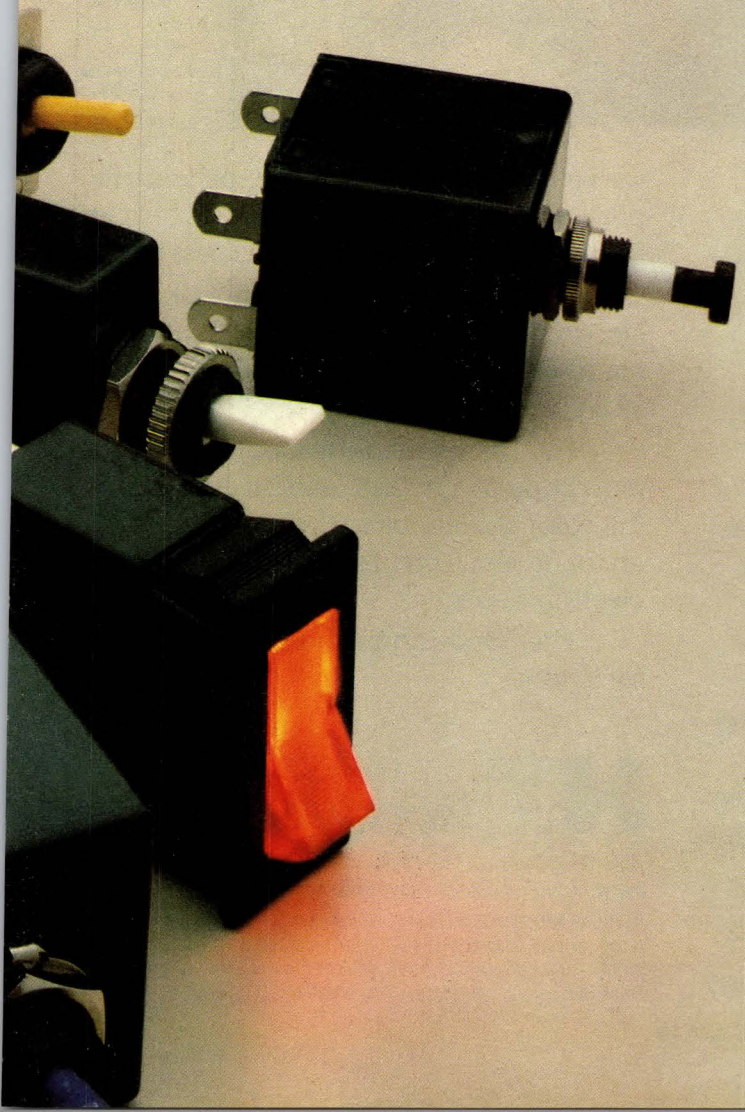


Choice of illumination

still more choices...

Four new models join "The Leadership Line" of magnetic circuit breakers

Fast, reliable, precise magnetic circuit protection – in the smallest package and at the smallest price – that's SNAPAK. These miniature circuit breakers replace three conventional components: power switch, fuse holder and fuse.



SNAPAKs, with toggle or pushbutton actuation, are established favorites in instrumentation, appliance, power supply, and data processing applications. Now we've added a double pole push-pull, push-to-reset, and a double pole rocker version with neon or LED illumination and auxiliary switch. The new rocker models aid in solving anti-static problems, and feature human factored "dead front" matte finish. On-off or international handle identification is available. All have the patented snap-action mechanism which increases operational life by as much as five times. Operator "teasing" of the contacts has been eliminated and arcing is minimized.

VDE/IEC Spacing Requirements

SNAPAK circuit breakers conform to the spacing requirements of VDE 0730, IEC 380 and IEC 435, so they can be used in equipment for export. You now have the benefits of precision magnetic "stand alone" protection – with choices of handle actuation, colors, illumination, terminals and hardware.

Send today for the new SNAPAK catalog or call our "Hotline" (301) 228-4600 for fast prototype service. AIRPAX/North American Philips Controls Corp., Cambridge Division, Woods Road, Cambridge, MD 21613.

The Intelligent Choice.

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NORTH AMERICAN PHILIPS CONTROLS CORP.

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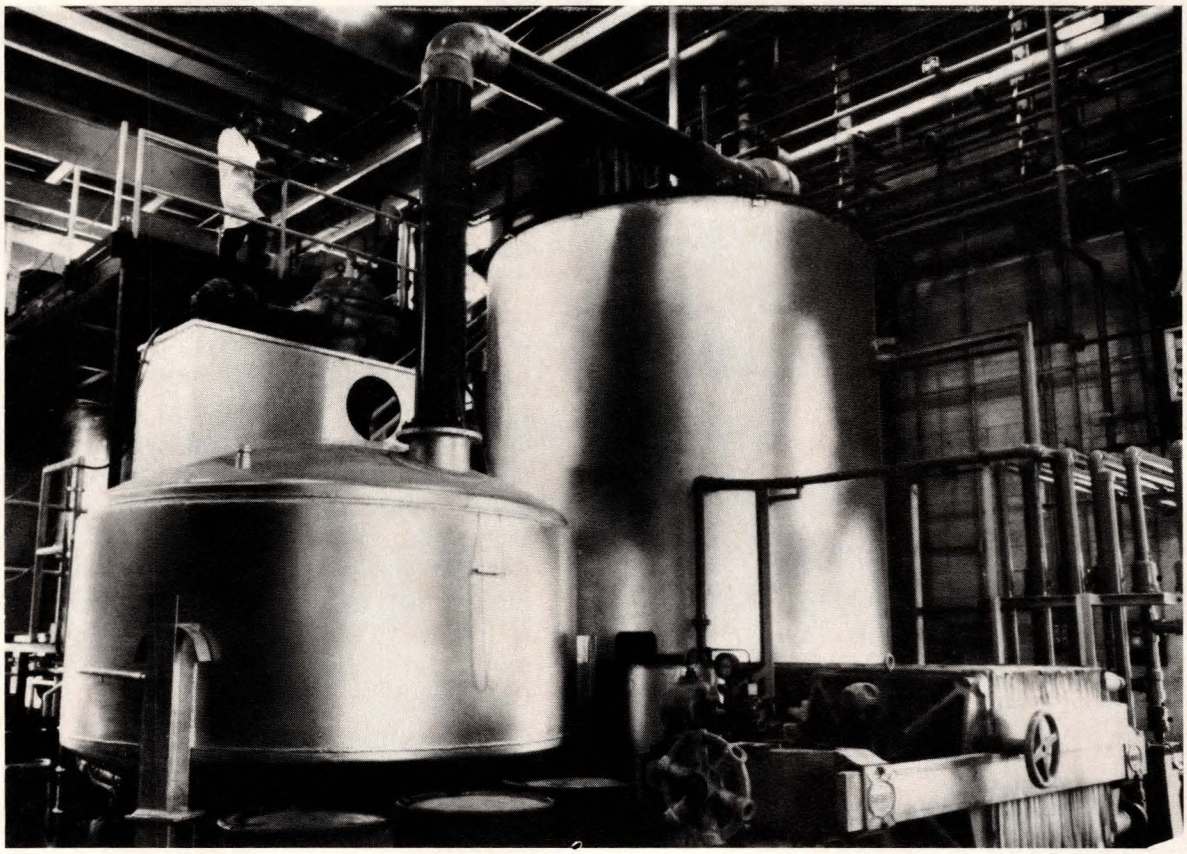
We're the most modern refiner of electronic precious metal scrap in the business.



Leaching tanks in Handy & Harman's Attleboro, Mass. refinery—part of a new process for efficient refining of electronic precious metal scrap.

Efficiency and stability. It's a valuable combination in a precious metals refiner.

And it's especially important in recovering the maximum value from electronic precious metal scrap.

Electronic scrap presents special problems in refining. Typically, small but highly valuable quantities of gold, silver and platinum are buried in huge masses of plastics, ceramics and base metals. It takes a well-equipped and experienced refiner to extract the full value of those precious metals from your scrap.

Handy & Harman can do the job.

Our four modern refineries (including the world's most advanced electrolytic refining plant) contain the very latest equipment and processes. Their refining efficiency enables us to deliver the top return for your scrap.

And we're the most experienced company in the business. Founded in 1867, we've had over a century of experience in precious metal refining. And we've built an unsurpassed reputation for business integrity.

To get the best possible return for your electronic precious metal scrap, consider Handy & Harman—the modern refiner with 115 years of experience.

You can learn more about us by requesting a copy of our "Book about Trash," the full-color guidebook to the profitable recovery of precious metals from industrial and electronic scrap.

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CIRCLE NO 18

would include the engineering systems involved in industrial manufacturing processes.

6. The National Institute for Communications Engineering would include all types of communications systems.

For this proposal to be practical, the federal government would not only have to create the agency, but also staff it and provide it with a starting laboratory. This could be done effectively by utilizing the one engineering institute that already exists: NASA.

NASA is now essentially an Engineering Institute for Space Exploration. It has already accomplished remarkable engineering feats—sent the Apollo spacecrafts to the moon and beyond and developed the Space Shuttle, for example. Thus, this organization could be identified as one of the national institutes.

About half of NASA's employees are engineers. Their experience could be readily adapted to the needs of a National Institute for Space Engineering. The management of NASA would be a logical source for the eminent engineering scientists needed for the NIE. NASA facilities, plus some from agencies such as the Bureau of Mines, could serve as the nucleus from which the program of the institutes could be developed. Ultimately, however, a central research and administration facility would be needed.

Sincerely,
Thomas D McGee
Professor
Dept of Materials Science & Engineering
Iowa State University

(Ed Note: This letter is based on an article that appeared in the December 1981 issue of the NSPE's Professional Engineer *magazine.)*

Signals & Noise

For your calendar

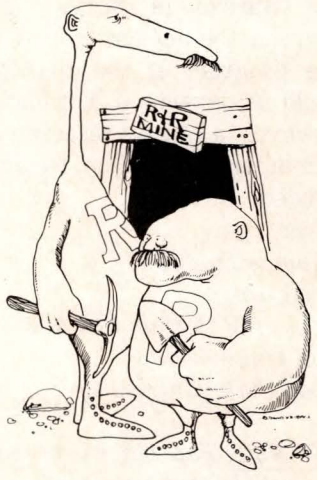
Please make two corrections in EDN's Calendar of Electronic Industry Events (January 6):

- The Interface '82 conference in Dallas will run from March 22 to 25, not February 22 to 25.
- The National Computer Conference on June 7 to 10 will be held in Houston, TX, not New York.

Additions are also required:

- The International Invitational Computer Conference will be held in Frankfurt, West Germany on March 23. For more information, contact B J Johnson and Associates at (714) 644-6037.
- The PCI Motorcon Conference & Exhibition will be held at the Moscone Convention Center in San Francisco on March 29 to 31. For more information, phone (805) 985-1595 or (805) 985-2289.

Dictionary of Electronic Critters
Rand Kruback



ROM & RAM

COST REDUCE TTL-INTENSIVE BOARDS DOWN TO SIZE.

CMOS Logic Arrays Now Replace Low-Power Schottky TTL Designs

LSI Logic Corporation's LC 3100 series silicon gate CMOS macrocell arrays replace complete boards of medium speed logic, like standard TTL, low power Schottky TTL and CMOS 4000B series. You benefit immediately with reduced size, power, cost, and increased reliability. Call us to review your low power Schottky and TTL designs. You could be evaluating prototype parts in twelve weeks.

Part Number	Gate Complexity	Maximum Pins	LS Output Buffers	TTL Output Buffers	Gate Speed (nsec) Typical	Gate Speed (nsec) Maximum	Supported by LDS 1™
LC 3100	300	40	17	20	6	12	Yes
LC 4100	400	46	23	20	6	12	Yes
LC 5400	540	52	25	24	6	12	Yes
LC 7700	770	62	31	28	6	12	Yes
LC 10000	1000	70	35	32	6	12	Yes
LC 12600	1260	78	39	36	6	12	Yes

CMOS Logic Arrays For New Designs

The LC 3100 series is ideal for new designs. Our advanced LDS 1™ CAD (computer-aided design) tools let you design your logic and run a full performance analysis before you commit to production. Or we'll do the entire job for you. Either way, you have the flexibility of using our 7400 SSI/MSI macro function library as your design basis for faster turnaround.

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LSI Logic can build an array for your application in any standard package of your choice. Call or return the coupon today and we'll send you comprehensive specifications on our LC 3100 series of CMOS arrays. Other arrays in ECL or advanced HCMOS are also available.

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CIRCLE NO 21

YES ☐ I want to move up into array design now. Call me.
YES ☐ Send me your LC 3100 CMOS array data sheet.
YES ☐ Send me your data pack on ECL ☐ or HCMOS ☐ arrays.

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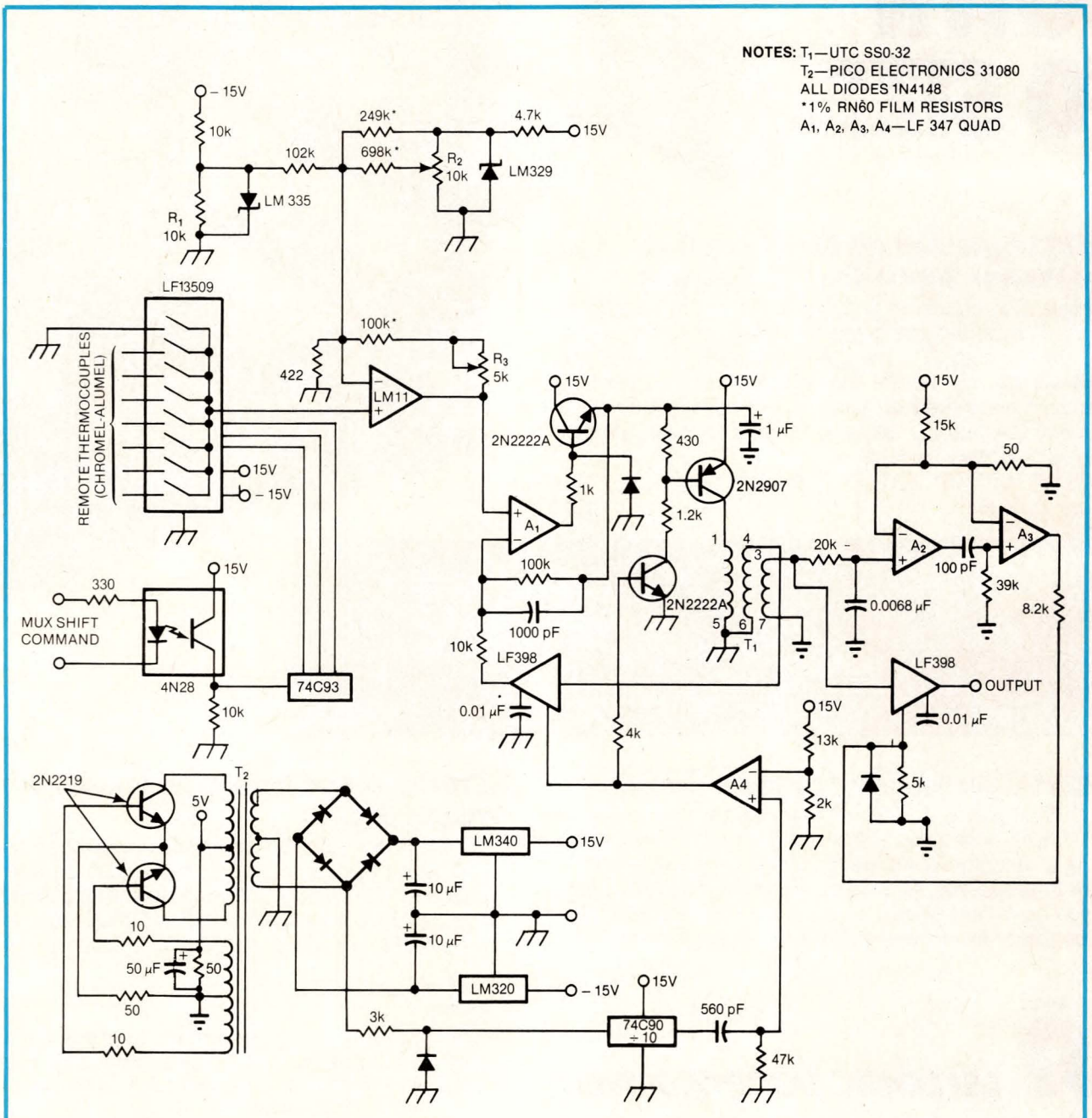
EDN282

The designs work better this way

Several bugs crept into the schematics of Jim Williams's article "Transformers and opto-couplers implement isolation techniques" (EDN, January 6, pgs 115-122).

The gain-adjustment potentiometer in **Fig 1**'s op-amp stage should be 10 kΩ; not the indicated 100k value.

Fig 6 contains several errors and is reproduced correctly nearby: First, the LM335 circuit (upper left in the drawing) should be hooked up as shown. Next, the dc/dc converter (lower left) does indeed require an input voltage and a ground; make the 5V and ground connections indicated here. Other corrections appear in the drawing.



Revised Fig 6.

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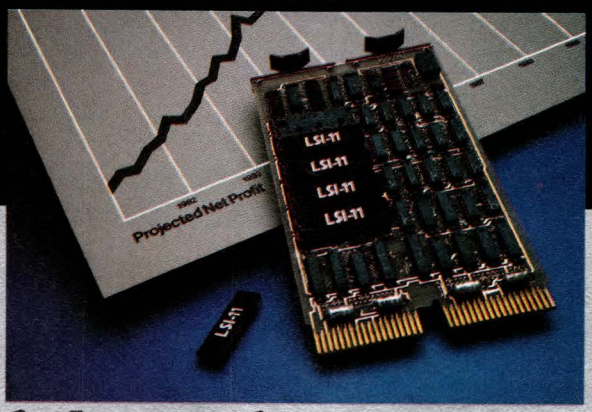

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When you measure the performance of a microcomputer, you've got to go beyond what it can do for your product. You have to look at it in terms of your profit picture, too.

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For instance, we've given considerable thought to helping you get your product to market faster. We've developed multi-user software that lets several programmers work on a project simultaneously, cutting way down on your development time. And our broad line of micro products—from LSI-11 boards all the way up to PDP-11 micro systems—gives you more to choose from. So you get the right balance of price and performance at the outset. Without compromises that cost you extra development time and extra money.

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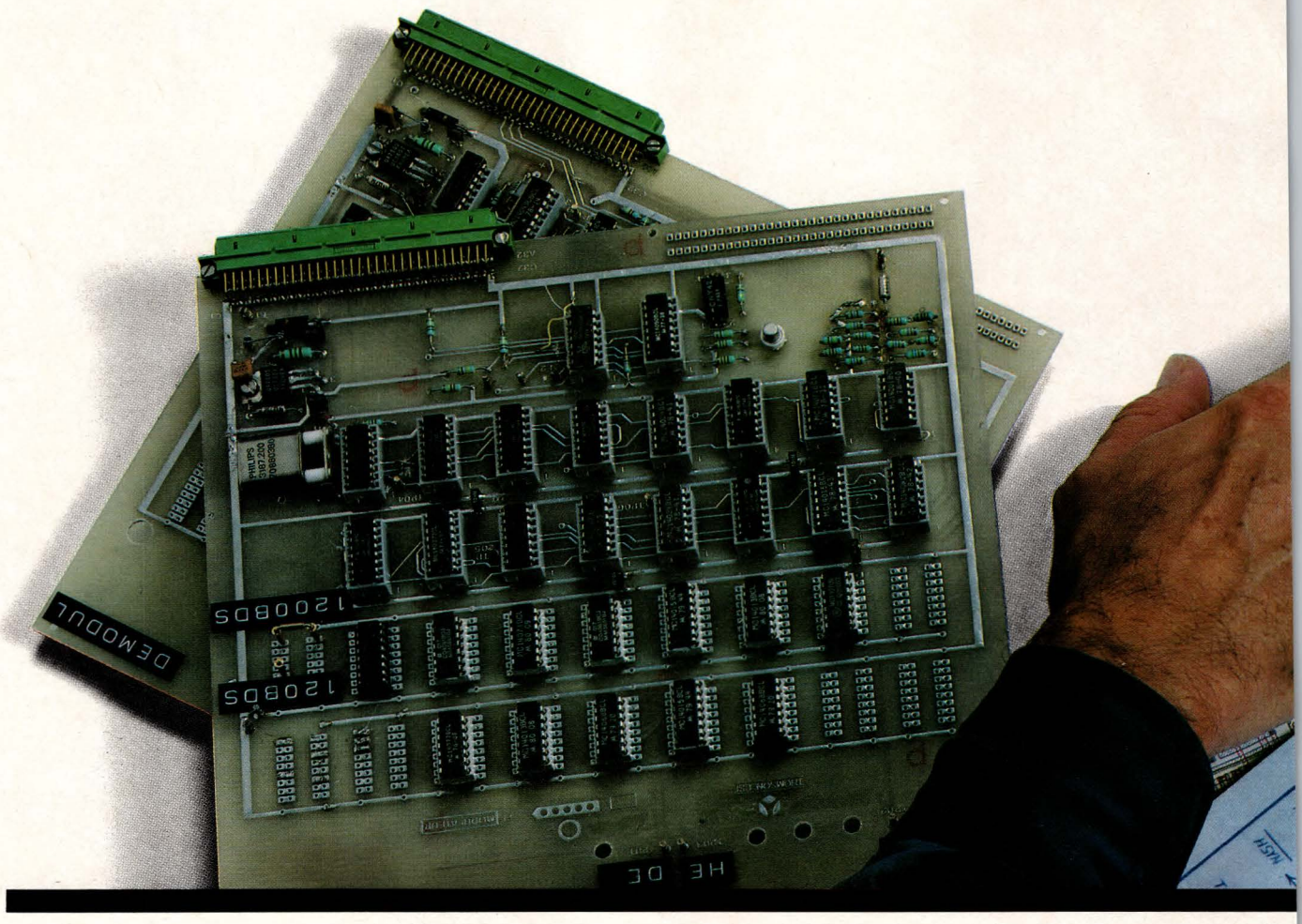

Let an SSi custom IC shrink

There's a custom IC in your future.
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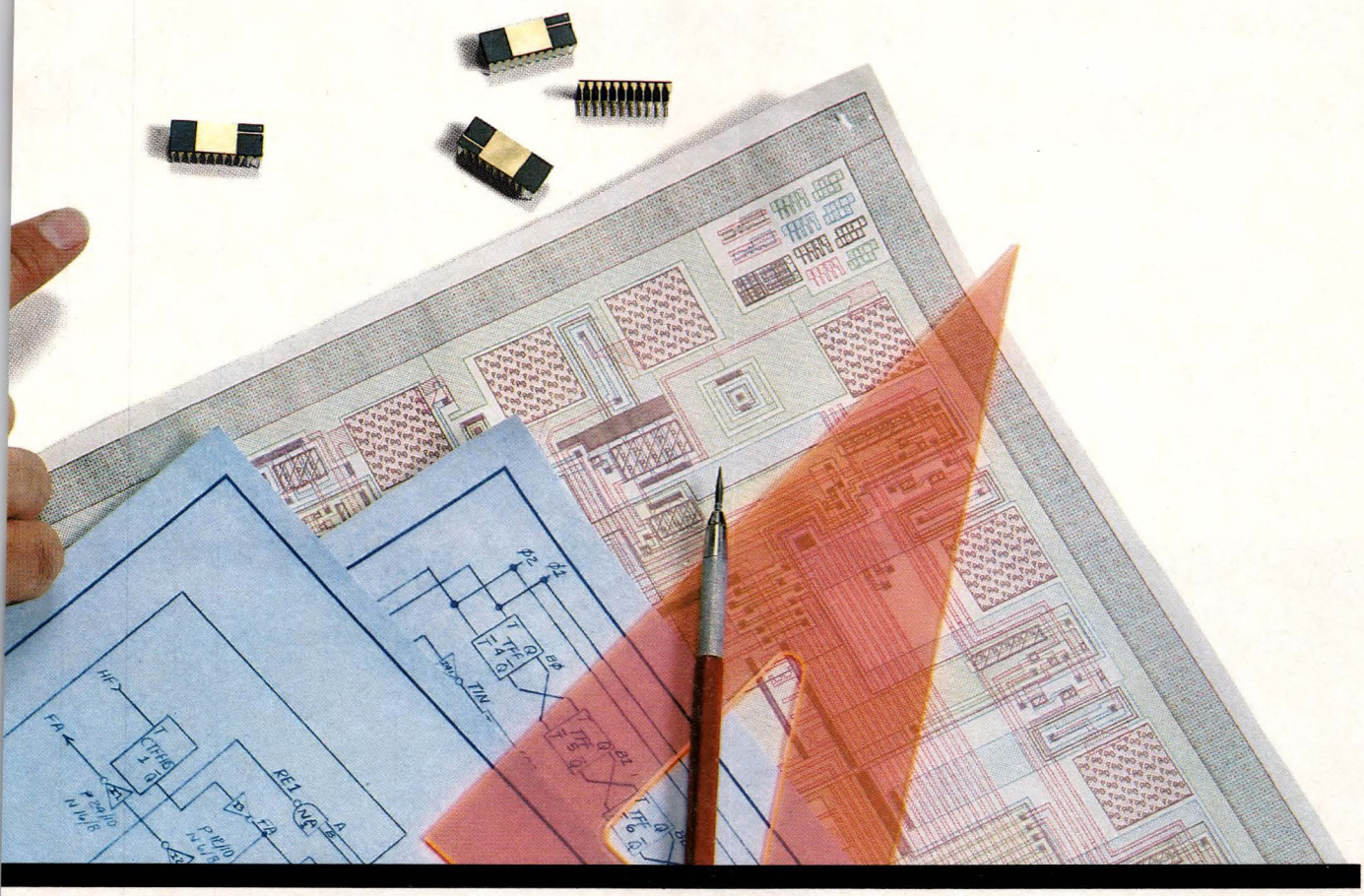

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From computers to chess games, SSi custom IC users are getting the jump on their competitors. An SSi custom MOS speech synthesis chip enabled one customer to introduce the world's first talking calculator. The same chip technology is also being used in a talking chess game. Another family of SSi custom-developed bipolar chips is providing the competitive edge for the leading Winchester technology disc-drive manufacturers. It's the same story with our advanced CMOS switched-capacitor filter technology which allowed us to produce the first monolithic Touch-Tone® receiver. We have since used switched-capacitor filters in other custom IC's for products in many diverse fields. What we have done for others, we are ready to do for you.

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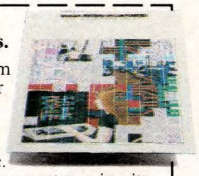

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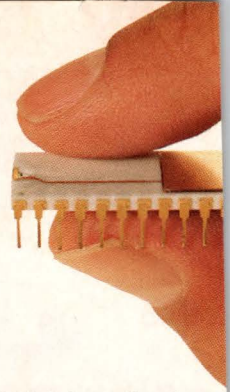
CIRCLE NO 22

Why more and more people have come to prefer RCA for High-Rel ICs.



People who use High-Rel ICs have special needs. And they want suppliers who understand that. That's why so many of them come to RCA.

To start, we offer CD4000-series CMOS digital logic circuits; CDP1800-series CMOS microprocessor, memory and I/O circuits; CA3000-series linear circuits; and our newly announced EPIC (Emulation & Programmable IC) CMOS 8-bit slice series.

We also offer rad-hard versions of most parts.

And produce custom circuits to High-Rel standards.

But our customers want more than a broad product line. They want a supplier who is committed to the most demanding needs of the military, aerospace and industrial applications.

Here are some examples of our commitment:

- First supplier of Mil-M-38510 to attain Class A certification
- First Class S, Part-1 supplier of CMOS rad-hard devices

So if you're looking for High-Rel parts (and High-Rel support), talk to us. We understand your needs.

RCA Solid State headquarters: Somerville, NJ. Brussels. Sao Paulo. Hong Kong.

"First-class reliability."

Marvin Bero, Spar Aerospace Ltd.

"We can't afford product failures on our NASA projects. That's why we've been using 4000-series High-Rel ICs from RCA.

"Their Class S devices save us a lot of testing time. The flat-pack is a big advantage. And the paperwork package is the best I've ever seen."

"Outstanding support."

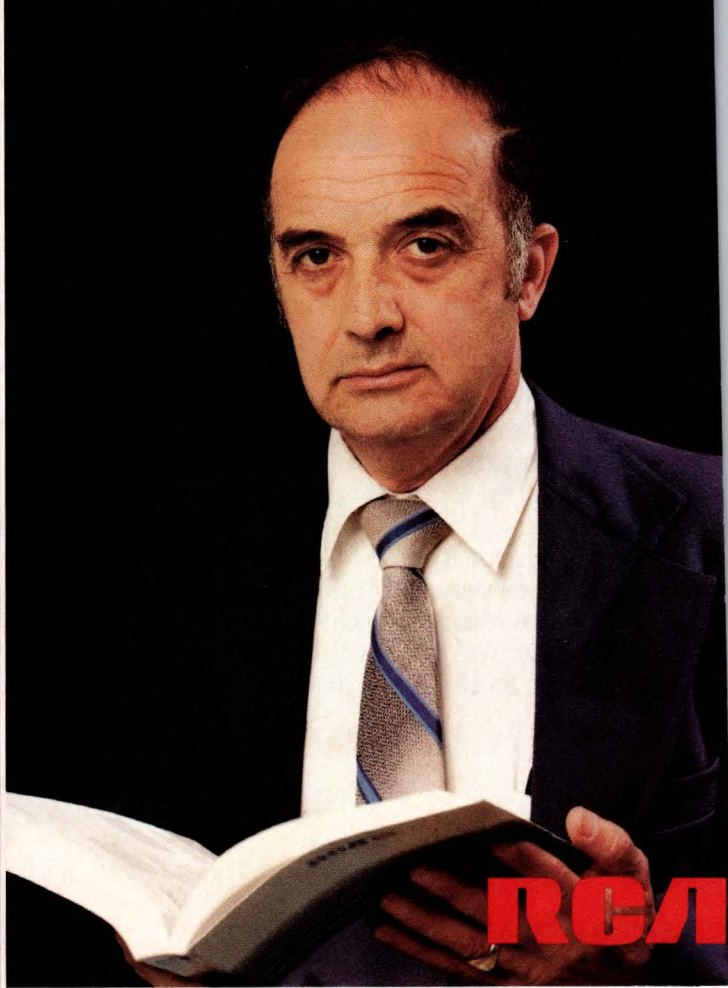
Armin F. Mohr, Westinghouse

"In our business, we need suppliers we can rely on.

"That's one big reason we've been buying our High-Rel ICs from RCA.

"They've been able to provide us with applications support whenever we've needed it, and the product reliability is excellent.

"But what impresses us most is the support we get from the people at RCA. We've been working with them since 1972, and they've never let us down."



Editorial

Competitive pressures demand new investment strategy

Many factors affect the US electronics industry's ability to compete worldwide. Some are artificially generated, as we noted in last month's editorial on import tariffs. Others arise from the increasing complexity of the electronic products themselves. For example, the semiconductor industry has become more and more capital intensive: The cost of a facility to manufacture and test today's VLSI circuits has skyrocketed compared with the cost of an equivalent facility just five years ago, and tomorrow's products and processes will demand even greater investments.

Can such investments be financed in the traditional manner, out of retained earnings? Quite unlikely, says Dr Lester Thurow, an economist at the Massachusetts Institute of Technology. In testimony before the House Budget Committee, which is investigating the US's lack of net productivity growth, he noted that the Japanese utilize massive amounts of debt capital from the Bank of Japan to finance the equipment that will allow them to outproduce the rest of the world in VLSI semiconductor circuits. Japan's current success could become self limiting, though: Many experts speculate that as Japanese bankers become more reluctant to provide such massive amounts of capital at low rates of return, Japanese companies will have to turn to other sources. And when those sources gain significant equity, they'll force the companies to think in terms of short-term profits—much like US companies do now.

Given these considerations, Dr Thurow maintained that a major shift in US investment strategy is required to allow US companies to remain competitive. He suggested a national investment policy that focuses on aid to what he calls "sunrise" industries such as semiconductors. He specifically proposed a "national corporate investment committee" that should have the power not only to offer debt capital at attractive rates, but also to effect changes in antitrust or environmental regulations if necessary and justified.

Dr Thurow's proposal is interesting and challenging—one that deserves serious consideration. It should neither be denounced as a new form of federalism nor embraced without full investigation of its implications. The problems he describes are real and require concrete action. The federal government now aids declining industries under "sunset" legislation; should it not invest in and encourage growing businesses instead?

Roy W. Forsberg

Roy Forsberg
Editorial Director

An Award-Winning Magazine
1981 *Subject Analysis:
Electronic Technology—The Next 25 Years
1981 *Editorials
1981 **ASBPE Excellence in Writing (3rd place):
Seventh Annual μP/μC Chip Directory
1978 *Staff-Written Series:
System Design Project
1978 *Contributed Series:
Designer's Guide to Fiber Optics
1977 *Contributed Series
Software Design Course
1976 *Special Issue:
Microprocessor Reference Issue
1975 *Staff-Written Series:
Microprocessor Design Series

**Jesse H Neal Editorial Achievement Awards are the business-press Pulitzer Prize equivalent, awarded by the American Business Press (ABP).*
***American Society of Business Press Editors*

PS: I am proud to report that EDN's editors have won two additional awards. One is a First Place Jesse H Neal Editorial Achievement Award for the supplement, "Electronic Technology —The Next 25 Years," which appeared in our October 14, 1981 Silver Anniversary issue. The other is a Jesse H Neal Certificate of Merit for editorials that appeared in the March 4 and September 16, 1981 issues. We are doubly proud because no other electronics publication was so honored.

Unitrode linear ICs let you design to the same old standards.

REGULATING PULSE WIDTH MODULATORS

Unitrode Part No.	Max. Output Voltage	Output Current	Operating Temp. Range	Package Type (TO-116)	Features
UC1524	40V	100mA	−55°C to +125°C	16 Pin Ceramic	Uncommitted dual alternating outputs.
UC2524	40V	100mA	−25°C to + 85°C	16 Pin Ceramic/Plastic	
UC3524	40V	100mA	0°C to + 70°C	16 Pin Ceramic/Plastic	
UC1525A	40V	500mA	−55°C to +125°C	16 Pin Ceramic	Dual source/sink outputs (NOR logic).
UC2525A	40V	500mA	−25°C to + 85°C	16 Pin Ceramic/Plastic	
UC3525A	40V	500mA	0°C to + 70°C	16 Pin Ceramic/Plastic	
UC1527A	40V	500mA	−55°C to +125°C	16 Pin Ceramic	Dual source/sink outputs (OR logic).
UC2527A	40V	500mA	−25°C to + 85°C	16 Pin Ceramic/Plastic	
UC3527A	40V	500mA	0°C to + 70°C	16 Pin Ceramic/Plastic	
UC1524A	60V	200mA	−55°C to +125°C	16 Pin Ceramic	Improved performance over UC1524/2524/3524.
UC2524A	60V	200mA	−25°C to + 85°C	16 Pin Ceramic/Plastic	
UC3524A	60V	200mA	0°C to + 70°C	16 Pin Ceramic/Plastic	

THREE TERMINAL FIXED VOLTAGE REGULATORS

Unitrode Part No.	Output Polarity	Output Current	Operating Temp. Range	Nom. Reg. Output Volt.	Present Output Volt. Tolerance	Package Types
UC7800	Positive	1.0A	−55°C to +150°C	5, 12, 15V	±4%	TO-3,
UC7800C	Positive	1.0A	0°C to +125°C	5, 12, 15V	±4%	TO-3, TO-220
UC7800A	Positive	1.0A	−55°C to +150°C	5, 12, 15V	±1%	TO-3
UC7800AC	Positive	1.0A	0°C to +125°C	5, 12, 15V	±1%	TO-3, TO-220
UC7900	Negative	1.0A	−55°C to +150°C	−5, −12, −15V	±4%	TO-3
UC7900C	Negative	1.0A	0°C to +125°C	−5, −12, −15V	±4%	TO-3, TO-220
UC7900A	Negative	1.0A	−55°C to +150°C	−5, −12, −15V	±1%	TO-3
UC7900AC	Negative	1.0A	0°C to +125°C	−5, −12, −15V	±1%	TO-3, TO-220

THREE TERMINAL ADJUSTABLE VOLTAGE REGULATORS

Unitrode Part No.	Output Polarity	Output Current	Operating Temp. Range	Output Volt. Range	Line Regulation	Package Types
UC150	Positive	3.0A	−55°C to +150°C	1.2 to 33V	0.005%/V	TO-3
UC250	Positive	3.0A	−25°C to +150°C	1.2 to 33V	0.005%/V	TO-3
UC350	Positive	3.0A	0°C to +125°C	1.2 to 33V	0.005%/V	TO-3
UC117	Positive	1.5A	−55°C to +150°C	1.2 to 37V	0.01%/V	TO-3
UC217	Positive	1.5A	−25°C to +150°C	1.2 to 37V	0.01%/V	TO-3
UC317	Positive	1.5A	0°C to +125°C	1.2 to 37V	0.01%/V	TO-3, TO-220
UC137	Negative	1.5A	−55°C to +150°C	−1.2 to −37V	0.01%/V	TO-3
UC237	Negative	1.5A	−25°C to +150°C	−1.2 to −37V	0.01%/V	TO-3
UC337	Negative	1.5A	0°C to +125°C	−1.2 to −37V	0.01%/V	TO-3, TO-220

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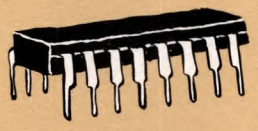
Or set new ones.

~~3524~~

3524A



REGULATING PULSE WIDTH MODULATORS

Unitrode Part No.	UC3524A	UC2524A	UC1524A
Max. Output Voltage	60V	60V	60V
Output Current	200mA	200mA	200mA
Operating Temp. Range	0°C to +70°C	−25°C to 85°C	−55°C to 125°C
Package Type (TO-116)	16 Pin Ceramic/Plastic	16 Pin Ceramic/Plastic	16 Pin Ceramic

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CIRCLE NO 24

Technology Update

Power-line filters with IEC connectors reduce equipment cost, enhance marketability

Paul G Schreier,
Assistant Managing Editor

Power-line filters with integral International Electrotechnical Commission (IEC) male connectors are far outstripping the growth of other types. Why? Users have found that if they must add a filter to their designs—as most must to reduce equipment noise susceptibility or to meet new regulations (**Refs 2** through **7**)—they can do so with a connector filter and thereby reduce internal wiring, design time and cost. The IEC-connector filters also enhance product marketability, especially outside the US.

The IEC connector provides a CEE 22 Type VI receptacle with three blade-shaped prongs. This device, used primarily for single-phase line power at 120/250V ac with currents less than 10A, is becoming the worldwide standard. It appears in appliances, instruments, personal computers, desktop calculators—virtually any line-powered commercial equipment.

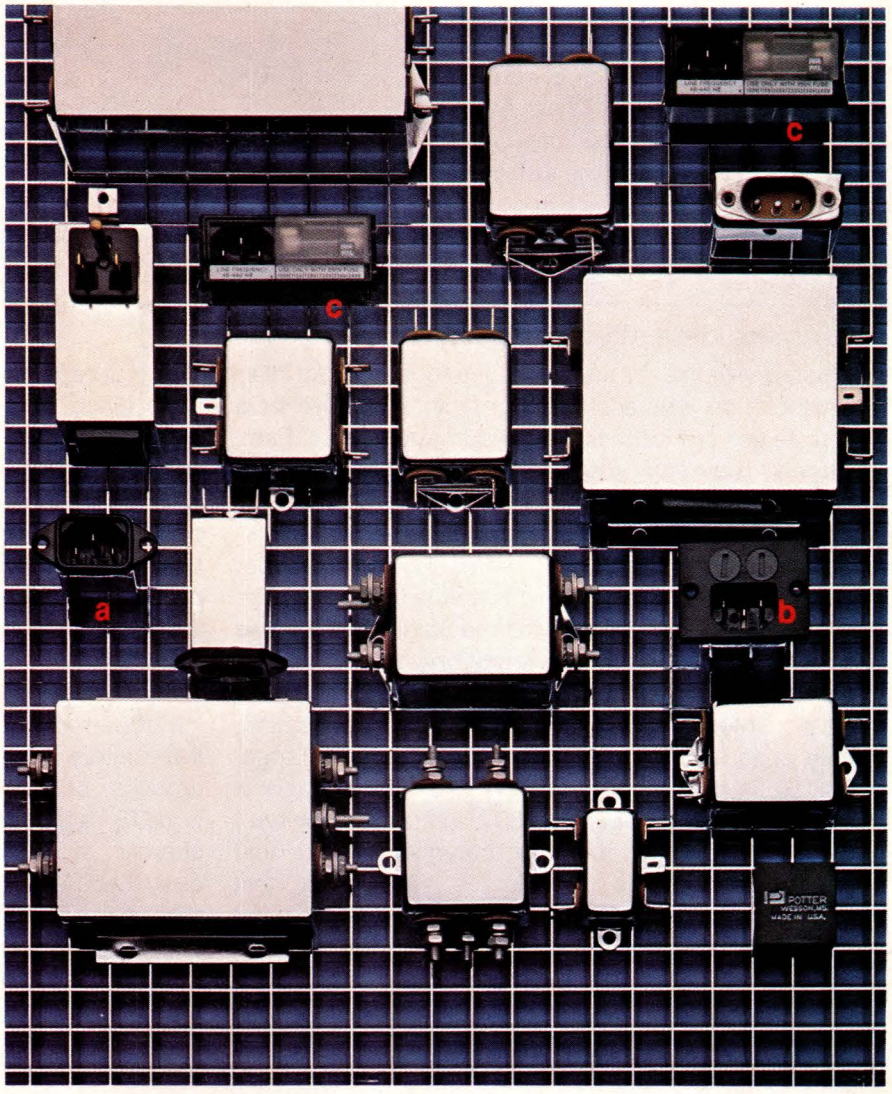
The connector accepts detachable line cords, so users can supply a cord with the appropriate power-line plug: US plugs differ from European plugs, for example, and the latter also vary from country to country. Thus, with an IEC connector, equipment manufacturers can build one unit for sale anywhere. A refinement of this concept, the fused multivoltage connector (see **box,** "Multivoltage power modules sell convenience"), makes equipment even more transportable.

Adding a filter to the IEC connector doesn't increase the connector's size appreciably—you can obtain connector filters not much larger than the connector housing itself. General-purpose and medical-equipment versions with basic filter components measure less than 2×2×1 in. and sell for less than $5 in quantity.

Size and price increase with filtering or current-handling capability, though: More capable units can measure 4.5×2.25×1.75 or larger and cost nearly $20 in quantity. Few such connector filters handle more than 10A, though; at that current level, they become too large and heavy for bulkhead mounting—one of their major mechanical advantages. Most connector-filter families also include a variety of termination styles, including loose leads, solder lugs or quick-connect terminals.

You'll find a wide selection of commercial power-line connector filters in four major categories:

- **General-purpose filters**—Although designed to provide

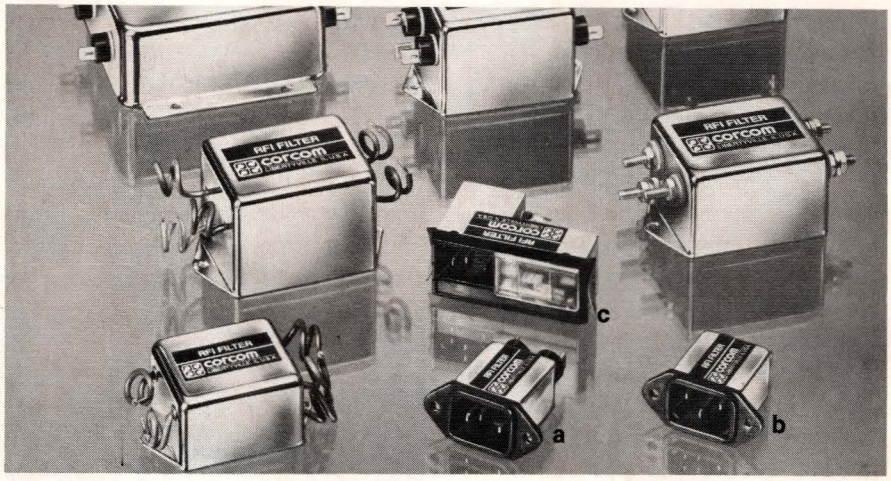


In its family of power-line-filter products, *Potter offers several with IEC connectors. Among them are 610 Series international filters* ***(a),*** *which house the connector and filter in a small package. 612 Series units* ***(b)*** *add fuses for the hot and neutral wires, and Series 7100 power modules* ***(c)*** *add a multivoltage selector card.*

noise-susceptibility protection, these filters often suffice to meet FCC emission regulations in equipment such as digital systems using linear power supplies. They generally provide higher line-to-ground (common mode) than line-to-line (differential mode) insertion loss. (Most noise conducted on power lines is common mode.)

- **High-performance filters**—These devices achieve better susceptibility protection in noisy environments and also provide differential-mode filtering at levels much higher than general-purpose filters to meet stringent emission standards (Most emitted noise is differential mode.)
- **Low-leakage-current filters**—Used in medical and dental equipment, these devices generally spec leakage at 5 μA. Their filter sections uaually handle common-mode noise better than the differential-mode variety.
- **Filters for switching power supplies**—With both high common-mode and high differential-mode filtering to reduce the noise emitted by switching transistors and triacs, these filters also handle the high peak currents associated with switching power supplies (see pg 114 in this issue).

Many vendors supply filters in the first two application groups. One of your shopping stops might be at Corcom, which manufactures only power-line filters and claims nearly 50% of the US market for these devices. Its smallest units (1.55×1.16×0.83 in. without mounting flange), the EF Series filters, are UL recognized, CSA certified and VDE and SEV approved and



From large to small *and with any desired amount of filtering capability, Corcom's power-line filters cover virtually any base. Shown are just a few of the firm's IEC-connector filters: EF1* ***(a)*** *and EF2* ***(b)*** *Series units provide low-cost common-mode-noise reduction; the 6J4 power module* ***(c)*** *makes connecting power a cinch in any country.*

Examine data sheets closely

When reviewing the specifications for connector-filter products, be aware of several factors that will help you select the best unit for your application. First, filters in the same series with larger current ratings generally have lower filtering capability, spec'd by insertion loss (see **box,** "A spec that means little").

Second, line-to-ground (common-mode) leakage-current specs are quoted in this article at 250V/50 Hz. Many filters spec 0.5-mA max leakage under these conditions, meeting most international safety requirements; you can assume this value unless otherwise stated. (Medical-equipment filters are an exception; they spec leakage currents in the microamp range. For all filters, though, you can estimate leakage at 125V/60 Hz by dividing the 250V/50 Hz value by two.)

Not cited here are high-potential (hipot) and insulation-resistance test levels. The hipot test stresses filter insulation at a high voltage, and insulation resistance then measures the resulting condition. With few exceptions, the filters described in this article undergo a 2550V ac hipot test and spec insulation resistance equal to 6 MΩ at 100V dc (if at all); the recently issued draft of UL 1283 for electromagnetic interference filters addresses these specs.

The foregoing spec considerations illustrate the importance of agency approvals. If you intend to market a design outside the US, make sure that the connector filter you use has the necessary agency approvals and certification. Watch out for data sheets or salesmen touting filters that "comply to," "are designed in accordance with" or "meet the standards of" various agencies—such devices don't yet have the respective agency certification or approval. The most meaninful phrases are "is listed as certified with," "is agency approved" or "is registered with."

Furthermore, although most suppliers claim that their filters have pending approvals, the review process can take many months, especially for non-US agencies. The status of a product can change at any time, so the agency approvals described here are those in effect as of this writing. To determine a filter's latest approvals, contact the manufacturer directly.

Finally, several agency abbreviations appear in this survey: UL (Underwriters' Laboratories, USA), CSA (Canadian Standards Association), VDE (Verband deutscher Elektrotechniker, West Germany) and SEV (Schweizerishcher Elektro-Techniker Verein, Switzerland).

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CIRCLE NO 25

cost approximately $7 (100). Insertion loss for these 1, 3 and 6A units measures 12 to 55 dB typ.

For more filtering capability, consider Corcom's 3, 5 and 10A K7 Series filters, which sell for approximately $10 (100). They control line-to-line as well as line-to-ground RFI/EMI interference and spec typical insertion loss of 20 to 55 dB (3A) and 10 to 50 dB (5 and 10A). The devices are UL recognized and CSA certified and spec 1.25-mA max leakage currents.

If you need still higher performance, $13 to $17 (100) buys the UL-recognized Super K filters. The largest Corcom IEC connector filters, these 3, 6 and 10A SK Series devices measure 4.21×2.19×1.75 in. and contain components that achieve insertion loss between 30 and 45 dB typ with leakage of 1.25 mA max (VSK Series) or 0.4 mA max (ESK Series).

Another manufacturer with a wide range of IEC connector filters

A spec that means little

One power-line-filter spec—common-mode insertion loss—proves ambiguous and confusing when you're comparing EMI filters. Some manufacturers even feel it's necessary to footnote a warning.* To understand how to properly use this spec, you must know a few facts about applying filters.

RFI power-line filters act as mismatching networks for high-frequency interference; they provide high-impedance series barriers and low-impedance ground shunts in the stopband. Thus, it's necessary to maximize the mismatch for optimal filtering.

On the filter's input side, power lines present a low impedance, so the device generally uses a high-Z series inductor. The situation gets more complicated on the load side, however: For high-Z equipment (such as linear power supplies), the filter must present a low impedance, generally with a shunt capacitor; for low-Z loads (such as switching supplies, shunt regulators or synchronous motors), the filter must present a high impedance, usually with a series inductor.

However, most loads change their impedance greatly over the frequencies of concern to regulating agencies. Thus, you must find a filter that best suits the load's spectral signature. This task isn't trivial because two filters with identical attenuation specs can operate totally differently with a given load. That's why you'll find such a wide range of standard filter products; the best selection technique is merely to try various configurations until you find one with adequate performance.

Filter manufacturers can't predict the load impedances that their devices will have to work with. Thus, they use constant 50Ω source and load impedances to determine line-to-ground (common-mode) noise reduction, spec'd in terms of insertion loss—a ratio of input-to-output signal reduction specified in decibels. These measurements are generally made from 0.15 to 20 MHz to match various agency requirements and are performed according to MIL-STD-220.

Unfortunately, this MIL standard's test methods aren't adequately defined and can lead to incompatible results. For instance, to measure a filter's true common-mode 50Ω/50Ω response, the line and neutral terminals should be connected together on both the line and load sides. But all manufacturers don't follow this procedure.

The insertion-loss data for filters described here are unaccompanied by frequency-response charts for obvious reasons. Listed, however, are high and low values within the spec'd frequency range. Unless otherwise stated, you can assume that values are given for 0.15 to 20 MHz; they generally are smallest at low frequencies and increase gradually to reach a maximum between 1 and 10 MHz.

What about line-to-line (differential-mode) noise? Only a few manufacturers supply specs for this parameter—and only for selected models. Note, however, that differential-mode insertion-loss values generally run lower than common-mode values, except in high-performance and switching-power-supply filters designed to handle this noise.

Given this situation, what good are insertion-loss specs? Once you've matched the load characteristics of a specific piece of equipment to available filter configurations and made a rough selection, insertion loss takes on some meaning. This 50Ω data roughly characterizes a filter—high insertion-loss values indicate greater filtering and give you some idea of how many "goodies" a device contains. The values also allow you to compare the relative performance of filters with similar configurations.

Additionally, once you've selected a particular filter for your design, insertion-loss values serve as a good incoming-parts-inspection aid to ensure product uniformity. And with this data, you can also verify filter-performance consistency over time.

(Ed Note: Special thanks to Corcom's Bill Wallace (marketing specialist), Al Toppeto (manager of application engineering) and Lon Schneider (manager of R&D engineering) for their assistance in preparing this box.)

*For example: "CAUTION: The values of measured insertion loss (although adequate for incoming inspection of product uniformity) are not generally acceptable for the evaluation and prediction of system performance in the actual operating environment."

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CIRCLE NO 26

is Potter. For general-purpose applications, it offers fused and unfused versions. Series 610 devices, without fuses and costing roughly $6 (100), come rated for 1, 3 or 6A. Their typical insertion-loss values vary from 15 to 50 dB (1A) to 10 to 50 dB (6A). The series is UL recognized.

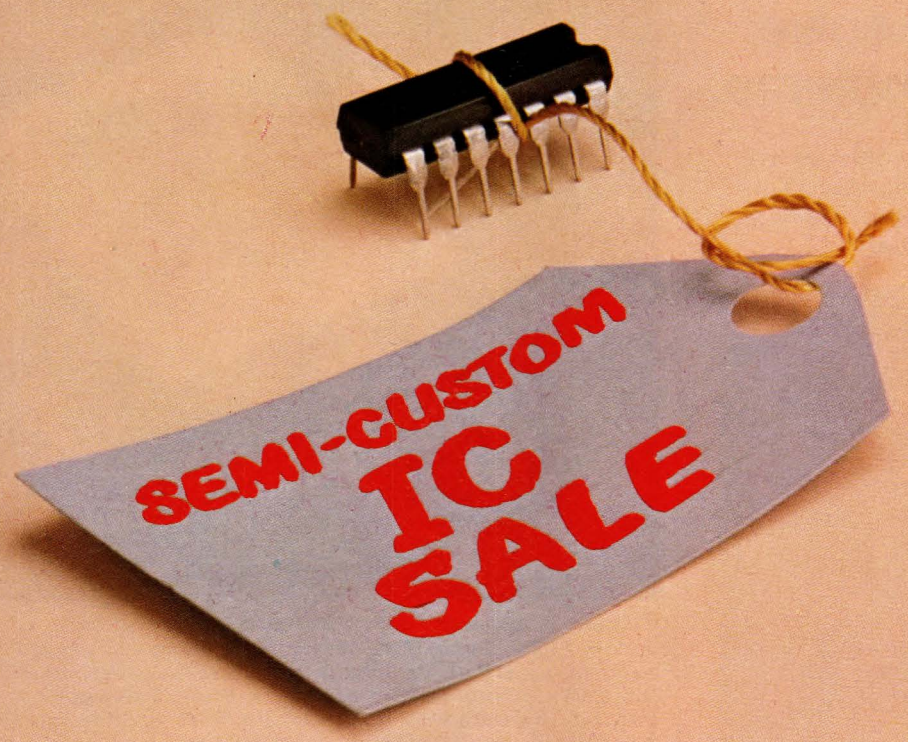
The fused Series 611/612 filters (approximately $10 to $15 (100)), differ in that the 611 units have one fuse on the hot line while the 612 devices fuse the neutral line as well. They measure 1.74×2.16×1.3 in. and 1.96×2.25×1.45 in., respectively. Both come in 1, 3.15 and 6.3A versions with insertion losses of 25 to 40 dB typ.

Potter's 620 Series will also soon be available with IEC connectors and will come with either leads or quick-connect terminals. Expected to sell for roughly $13 (100), they will suit low-impedance loads and spec leakage of 1.25 mA and typical insertion loss of 45 to 70 dB (1 and 3A units) or 20 to 70 dB (2, 5, 10 and 20A versions).

In the same general price/performance range as Potter's products are filters from Stanford Applied Engineering. The firm's $5.46 (100) CA and CB Series devices differ only in the location of their quick-connect terminals—on the side or rear. The 1.55×1.17×0.81-in. units come in 1, 3 and 6A versions, spec leakage of 0.65 mA max (0.5 mA optional) and feature minimum insertion loss of 22 to 50, 15 to 50 and 9 to 45 dB, respectively.

SAE's new high-performance HPCA units cost nearly $0.25 more than the mechanically equivalent CA and CB units and provide insertion loss of 40 to 65 dB min in 1, 2, 3 and 5A versions. And the firm's ER Series extended-range units, priced at approximately $9.50 (100), come rated at 1, 3 or 6A and feature insertion loss of at least 40 dB from 1 to 200 MHz.

Cornell-Dubilier's general-purpose IEC-connector filters, the



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CIRCLE NO 28

Technology Update

With an IEC connector on the line side *and quick-connect terminals on the load side, Curtis's F1600 Series filters save chassis space and reduce wiring time. Priced at approximately $15.50 (100), the UL-recognized 3A devices measure 1.5×2.0×2.5 in. and spec common-mode insertion loss of 55 to 65 dB. Their high-performance dual-coil design also holds down differential-mode noise and handles six times rated current for 8 sec, making them ideal for use with switching power supplies.*

APF Series, cost approximately $4 (100) and are UL recognized, VDE approved and CSA certified. They come in 1, 3 and 6A versions with typical insertion-loss specs of 20 to 55, 12 to 55 and 10 to 55 dB, respectively.

F1500 Series devices from Curtis sell for roughly $11.50 (100) and belong in the high-performance category. These UL-recognized units provide minimum insertion loss of 35 to 50 dB (3A devices) and 35 to 45 dB (6 and 10A units). They also spec leakage at 0.4 mA max.

Several circuit styles

Siemens supplies its B84104K family of 6A IEC-connector filters in three circuit configurations. Circuit 1, for approximately $6 (100), specs leakage at less than 0.3 mA max and insertion loss at 10 to 50 dB typ. With the same leakage current, the approximately $7 (100) Circuit 2 filters increase insertion loss to 20 to 60 dB typ. Finally, Circuit 3 filters, priced at roughly $10 (100), allow 0.6-mA max leakage current but up insertion loss to 20 to 70 dB typ. All three versions are UL recognized, and Circuits 2 and 3 are VDE approved.

You'll also find several circuit styles in Sprague's JX5400 Series. General-purpose Circuit 1 filters, priced at less than $7 (100), spec leakage current of 1 mA max and come in current ratings of 1, 3, 6, 10 and 15A. Typical insertion loss ranges from 25 to 57 dB for 1A units to 5 to 58 dB for 15A versions.

Recommended for applications where differential-mode RFI/EMI predominates, Sprague's Circuit 4 filters carry 1, 3 and 6A, also spec leakage at 1 mA max and cost $8 (100) or less. Insertion losses range from 1 to 64 dB (1A) to 0 to 57 dB (6A) typ. Both circuit styles are UL recognized.

Other vendors of such filters include Hopkins and Genisco. Hopkins's F85100 universal filters, UL recognized and CSA certified, cost approximately $7 (100). They come in 1, 3 and 6A versions, spec leakage at 1.5 mA max and feature insertion loss of 12 to 55 dB typ. Genisco's N Series units, priced at roughly $5 (100), also come in 1, 3 and 6A versions with respective typical

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insertion-loss figures of 24 to 55, 18 to 55 and 12 to 55 dB.

Most of the aforementioned units spec leakage current near 0.5-mA—too close for comfort to the limits of UL 544. This safety standard contains two sections: for patient-connected medical and dental units with a 100-μA leakage-current limit, and for nonpatient-connected units (which nevertheless might come in contact with a patient and upset weak life-support systems) with a 500-μA limit.

Medical-equipment filters are generally designed to meet the 100-μA limit, and the majority spec leakage at 5 μA. To achieve this low leakage current, most manufacturers merely eliminate line-to-ground capacitors. But because these components achieve high common-mode filtering, the medical-application filters also exhibit low insertion-loss values.

For example, Cornell-Dubilier sells APFM units with 5-μA leakage current for roughly $4 (100). UL recognized and CSA certified, these 1, 3 and 6A units offer typical

Multivoltage power modules sell convenience

Adding an IEC-connector filter to your design won't allow any user to merely attach a line cord and operate the product; varying line voltages and frequencies must also be accommodated. Connector-filter suppliers, however, also produce a device that allows users to plug in their products virtually anywhere: the multivoltage power module.

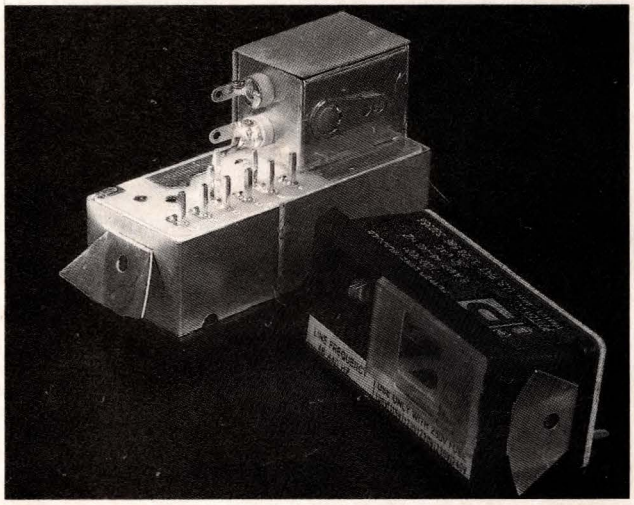
To understand the features found in most such modules, consider Hopkins's $11.80 (100) Model F65003. It measures 2.75×1.15×1.53 in. and contains an EMI power-line filter with 10-μA leakage and insertion-loss values of 30 to 60 dB typ in the 0.5- to 5-MHz range; a voltage-selector card that lets you choose 100, 115, 120, 220, 230 or 240V ac from 48 to 440 Hz merely by inserting it in the proper orientation; a fuse holder and ejector; and an IEC power-line male connector.

On its load side, the UL-recognized and CSA-certified device connects to appropriate taps on the equipment's transformer primary. The 6A unit is also easy to install in one panel cutout because of its snap-in construction. Furthermore, a plastic window slides across the device's front to provide access to either the line-cord receptacle or the fuse/voltage-card compartment. (You must disconnect power to change settings.)

With the same mechanical construction, agency approvals and input-voltage ranges, Hopkins's F65004 provides interference filtering across 0.1 to 100 MHz with typical insertion loss of 10 to 40 dB and 0.5-mA leakage. Also rated for 6A, this unit costs $12.71 (100).

Rounding out Hopkins's devices, the similarly operating 6A Model F65005 sells for $12.34 (100), provides insertion loss of 16 to 24 dB typ from 0.5 to 20 MHz and specs leakage current at 0.5 mA max.

Another manufacturer that piggybacks an RFI/EMI filter on line-voltage selector modules, Potter offers two models: the 7100-0002 and -0003, priced a approximately $10.20 (100). Both are 6A UL-recognized units that measure 2.6×1.06×1.56 in. and accept 100, 115/120, 220 or 230/240V ac from 48 to 440 Hz. Mechanically, they function in a manner similar to the Hopkins units but feature maximum leakage currents of 0.5 mA (-0002) and 2 μA (-0003), with respective insertion-loss figures of 10 to 38 dB across 0.1 to 100 MHz and 13 to 28 dB across 0.1 to 10 MHz.



With or without filters, *power-line modules from Potter accommodate the wide variety of voltages and frequencies in use today. In the foreground is Model 7100-0001 (unfiltered), and behind it you can see how a filter rides piggyback on Models 7100-0002 and -0003.*

Corcom's new 6J4 power module, priced at approximately $12 (100), handles 100, 120, 220, and 240V ac at 50 to 400 Hz. The 6A device's insertion loss specs at 12 to 55 dB with leakage at 0.5 mA; the device measures 1.82×2.65×1.15 in. and is UL recognized and CSA certified.

Other new introductions in this product area include forthcoming modules from Stanford Applied Engineering and Sprague. SAE's FCA Series units, expected to sell for between $12 and $13 (100), will use filters equivalent to the firm's HP Series high-performance devices. They will include an IEC connector and fuse holder, but voltage-switching capability will be an external option.

Sprague's 200JM6, which should enter the market momentarily, will sell in the $6 to $8 (100) range and will have specs roughly equivalent to those of products already on the market.

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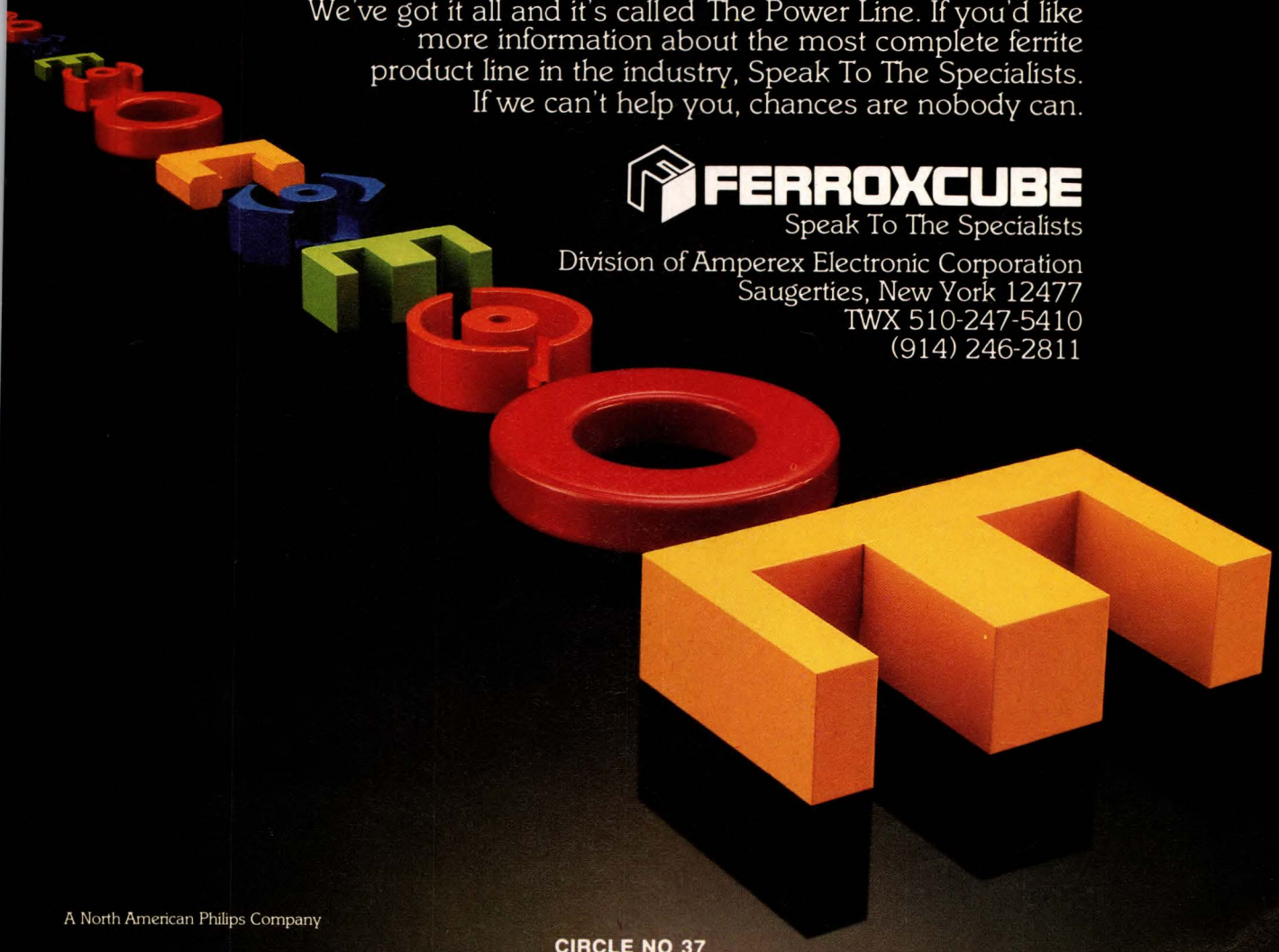

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insertion losses of 20 to 40, 15 to 30 and 12 to 28 dB, respectively. Hopkins's F11935 and F12034, priced at $7.33 (100), come with the same approvals and in the same current ranges with insertion loss of 12 to 28 dB typ. With 5-μA leakage, the two differ only in solder-lug location—rear or top.

Corcom's EH Series devices also spec 5-μA leakage. The UL-recognized and VDE-approved 6A units, priced at roughly $8 (100), achieve the same insertion loss as the firm's EF Series. Another choice, the $6 (100), 6A Potter 615 Series, specs leakage at 5 μA and insertion loss at 15 to 30 dB typ. These devices are UL recognized.

Sprague's JX5400 Series Circuit Style 2 devices also suit low-leakage medical applications with their 5-μA max leakage. They sell for less than $7 (100), come with current ratings of 1, 3, 6, 10 and 15A and feature typical insertion losses ranging from 26 to 40 dB (1A) to 5 to 21 dB (15A). Finally, Stanford Applied Engineering's $6.65 (100) M6 Series devices offer 5-μA leakage. The 6A devices, UL recognized and CSA certified, spec insertion loss of 9 to 25 dB min.

When designed to meet the stringent needs of switching power supplies, IEC-connector filters generally contain large series inductors and line-to-line capacitors to handle high differential-mode emissions and high peak currents (which can exceed rms current by a factor of three or four). Thus, these filters, supplied by Corcom, Curtis and Potter, are among the physically largest connector filters.

Corcom's 3EP7 is a 3A device that handles 10A pk; the necessary filter components, here achieving an insertion loss of 55 to 65 dB typ, would make higher current units too large and heavy for easy mounting. The $18 (100) UL-approved unit specs leakage of 0.4 mA max and measures 3.15×2.19×75 in.

In a 2-in.-wide case, Curtis's 3A F1600 costs roughly $15.50 (100). It,

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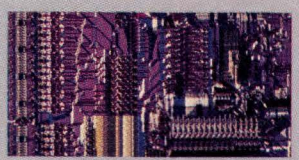

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too, specs leakage of 0.4 mA max but handles six times rated current for 8 sec and features insertion loss of 55 to 65 dB typ. UL approved, it measures 1.5×2.0×2.5 in.

Finally, Potter recommends its 622 Series units for switching-supply applications. UL recognized, CSA certified and VDE and SEV approved, they cost $15 to $30 (100), come in 3, 6 and 10A versions and spec typical insertion loss of 50 to 65 dB. **EDN**

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References

1. McDermott, Jim, "Special Report: EMI shielding and protective components," *EDN,* September 5, 1979, pgs 164-176.

2. Santoni, Andy, "FCC's computing-equipment EMI standards pose threat to other products' shipments," *EDN,* March 5, 1980, pgs 47-54.

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5. Straus, Isidor, "Testing products correctly ensures EMI-spec compliance," *EDN,* November 25, 1981, pgs 121-130.

6. *Corcom Tech Tips,* No 101-109, 1980 through 1981, Corcom Inc, Libertyville, IL. (*A collection of useful notes that clarify FCC and international regulations and provide application hints.*)

7. *Interpretation of the FCC Rules for Computing Devices (Part 15, Subpart J),* Bulletin OST 52, June 1981, FCC Office of Science and Technology, Washington, DC. (*This 13-pg bulletin, in question-and-answer format, presents a representative sampling of questions received by the FCC Computing Device Board. It can be obtained from the Downtown Copy Center, 1114 21st St NW, Washington, DC 20037*).

8. *ITEM* (Interference Technology Engineers Master). R&B Enterprises, Plymouth Meeting, PA. (*This annual directory, distributed free to qualified applicants, contains application articles and regulatory news on all aspects of electromagnetic compatibility. It also provides extensive listings of manufacturers, distributors and consultants in this area.*)

For more information...

For more information on the power-line-filter products described in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

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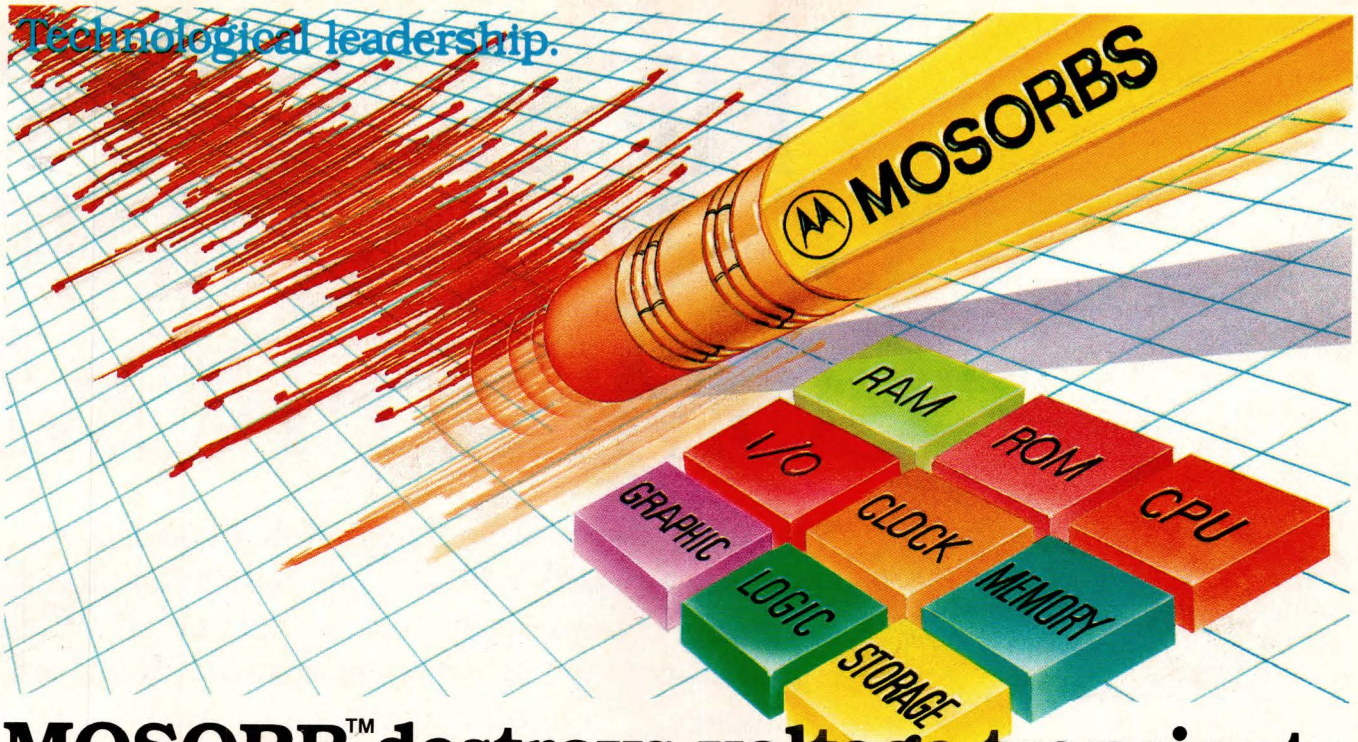

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CIRCLE NO 39

The Great Precision OP Amp Trial

In Which the Jury Finds in Favor of PMI's No-Fault OP-05, 06 and 07

In "Alice's Adventures in Wonderland," the Knave of Hearts went on trial for stealing the Queen's tarts, with her husband, the King, as a very partial judge. There was so little evidence that no verdict could be reached, but that didn't deter the Queen.

"Let the jury consider their verdict," the King said.

"No, no!" said the Queen, not caring to wait for all the evidence. "Sentence first—verdict afterwards."

Alice argued that no decision could be made based on evidence with no meaning to it.

"If there's no meaning in it," said the King, "that saves a world of trouble, as we needn't try to find any."

There is a great parallel here in the way precision operational amplifier buying decisions are made in Linear Wonderland. The evidence presented by many manufacturers has little meaning for the engineers who use op amps. As a result, they reach the sentence (read: "buying decision") first and reach a verdict later (read: "This doesn't really do the job") based on the only evidence that counts, performance.

Precision Monolithics likes its products to be judged on the evidence before the verdict is reached. Consider the case of our precision operational amplifiers, the OP-05, 06 and 07.

Our OP-05 already is well known to many industry users, as well as to the many competitors who have tried to compete with it in the last couple of years. It is, simply stated, a superlative instrumentation op amp for low signal level applications, with an ultra low TCV_{os}. One feature that has helped many juries find in its favor is its long term stability and nulled temperature drift, which is about the lowest anyone can buy. This comes from the clever thermally balanced chip topography plus PMI's famous process technology.

Our OP-07 series also has been tried, and found faultless, by engineers who need even greater improvement in input offset voltage than is available in the OP-05. PMI's "zener zapping" technique is used (instead of laser trimming, which can cause long-range stability problems) to permanently null V_{os} at the wafer probe stage of manufacturing. This provides V_{os} as low as 25 μV at the full military temperature range. That's lower than most test systems can test.

Between the two we have now added the OP-06 series, and as you will see from the performance specifications, it is ideal for applications where ultra stability, high gain, and super speed (particularly at gains over 100) are called for. Just look at the testimony in its favor, including an impressive 120 dB minimum A_{vo} and CMRR of 110 dB. That kind of performance allows the OP-06 to resolve and process microvolt level signals with accuracy, stability and speed.

Of course, no jury bases an opinion strictly on the testimony of a partial witness, and we would be in comtempt of court if we said we were totally impartial. That's why we submit the following exhibits for the plaintiff:

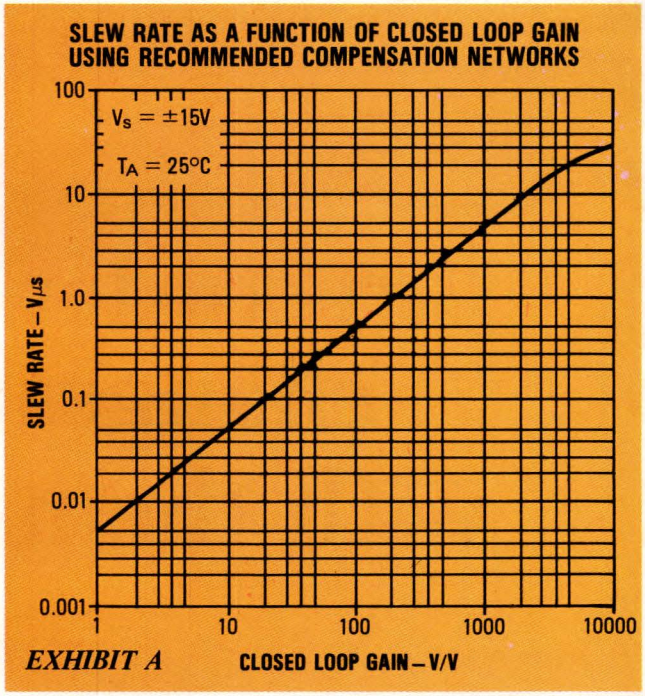

EXHIBIT A

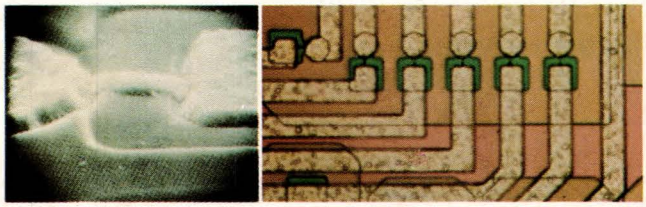

EXHIBIT B *S.E.M. photo of PMI Zener Zap showing no surface damage.*

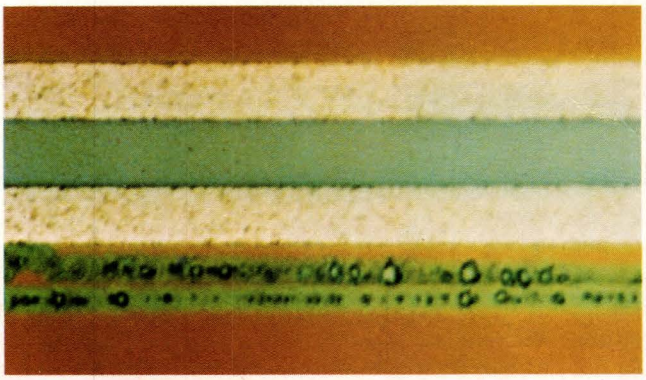

EXHIBIT C *S.E.M. photo of laser trim showing surface dislocation.*

PART NUMBER	TEMP RANGE	V_{os}, MAX μV	GAIN, MIN V/mV	CMRR, MIN dB	TCV_{os}, MAX μV/°C
OP-05A	MIL	150	300	114	0.5
OP-05	MIL	500	200	114	1.0
OP-05E	COM	500	200	110	0.6
OP-05C	COM	1300	120	100	1.5
OP-06A	MIL	100	1000	120	0.6
OP-06B	MIL	500	1000	120	1.0
OP-06F	COM	500	1000	120	2.0
OP-06G	COM	1300	500	100	4.5
OP-07A	MIL	25	300	110	0.6
OP-07	MIL	75	200	110	1.3
OP-07E	COM	75	200	100	1.3
OP-07C	COM	150	120	100	1.8
OP-07D	COM	150	120	94	2.5

EXHIBIT D **ALL SPECIFICATIONS AT 25°C**

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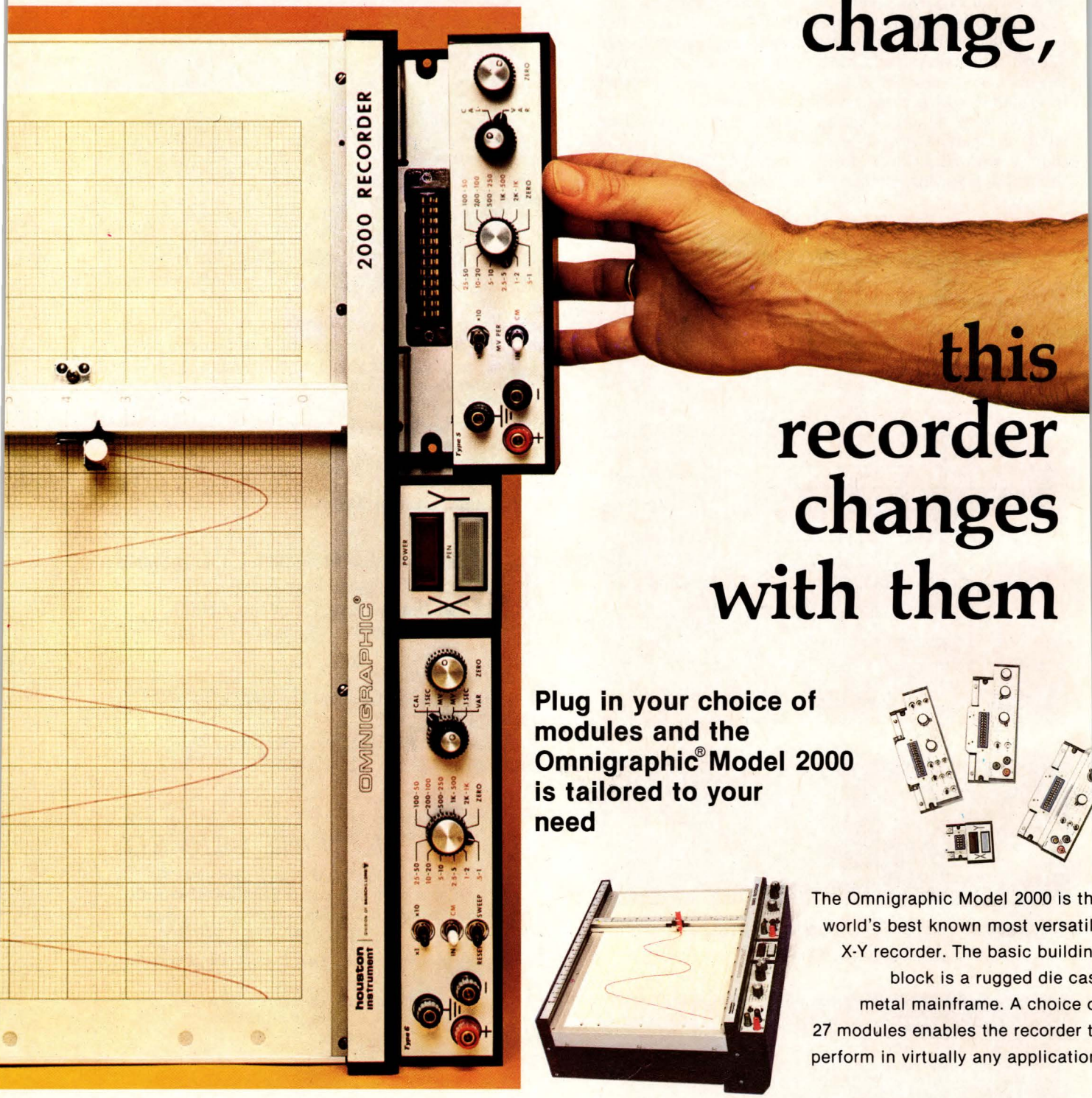

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Keylock-switch manufacturers broaden lines as system security grows more critical

John Tsantes, Eastern Editor

Keylock security switches are enjoying a renaissance of designer interest as white-collar crime, the unwelcome byproduct of the electronics industry's growing sophistication, continues to pace technology.

Indeed, the same developments that have made computers "friendlier" have given unscrupulous users new tools with which to surreptitiously obtain confidential information, funds and hardware through clandestine remote and direct access to electronic equipment (EDN, February 17, 1982, pg 39). And although incorporating a high-security keylock switch in such computer-based designs might not prevent a crime perpetrated by an individual accessing data through a communications link, it does minimize on-site tampering.

No startling developments

Although no startling new developments are occurring in keylock security switches, several clear trends are becoming evident.

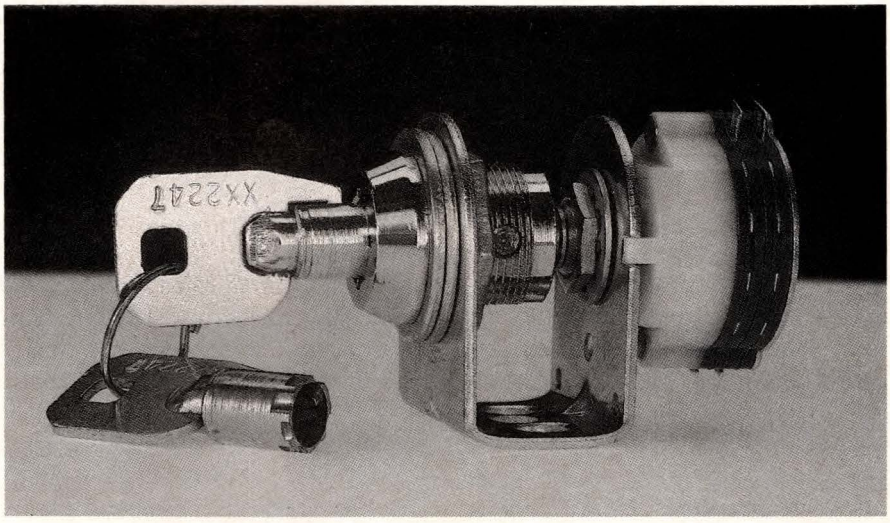
For example, recognizing the need for various levels of security, manufacturers are expanding their lines to span low- to high-security devices (see **box,** "Picking the right keylock switch"). In addition, because these keylock switches must work with electronic circuitry of varying complexity, contact options are expanding to include most arrangements found on conventional switches. You can, for example, order a simple On/Off power switch or opt for one that incorporates BCD or custom-coded outputs for direct IC-level interfacing.

Illustrating another trend, many keylock security switches now incorporate an antistatic mechanism —a form of nonmetallic sleeve installed between lock and switch that prevents static built up on the key from discharging through the keylock and damaging sensitive circuits.

Probably the most noticeable trend, though, is that keylock security switches are becoming standard catalog items at both independent lock makers and switch manufacturers. Therefore, you need no longer select a good lock and then worry about whether its manufacturer can marry a good switch to it, and vice-versa.

For instance, the Illinois Lock Company's Lectro-Quip (LQ) Series medium- and high-security keylock switches will by midyear include low-security devices as well. The LQ7 antistatic switch will come in an 8-tumbler double-bitted-key version as well as a single-bitted, 5-tumbler style.

The LQ Series now consists of six keylock-switch devices, each available with tumbler arrangements embodying various degrees of



High-quality locks can mate with high-quality switches, *as in Stackpole's Series 100.*

Some key keylock-switch terms

Circular key—A unit with a cylindrical section intended for insertion into a circular keyhole (see photograph this page).

Double-bitted key—A flat (as opposed to circular) key with indentations cut on both edges.

Key pull—On multiposition keylock switches, a position that permits key removal.

Sidebar locking mechanism—A lock element that prevents tumbler movement (and hence lock picking) without insertion of the proper key.

Single-bitted key—A flat key with indentations cut on one edge.

Triple-bitted key—Similar to a double-bitted key but additionally containing indentations on one surface as well as each edge.

Tumbler—An obstruction within a lock that prevents unlocking until it's displaced to a predetermined position. Tumblers take the form of pins or blades; depending on their shape, the tumbler elements are often termed disks or wafers.

security and with various contact arrangements, key pulls and electrical ratings. All these switches can be equipped with the company's Illinois or Duo mechanisms.

Steel deters drilling

The Duo mechanism consists of 14 brass tumblers with a hardened stainless-steel head guide that deters drilling of the tumbler mechanism. A triple-bitted key activates the tumblers, and you can choose among 13,950 primary key changes as well as master keying.

The Illinois mechanism uses eight tumblers and is operated by a double-bitted key. Its brass-tumbler version (type D) allows 250 primary key changes and master keying. The type E version incorporates aluminum tumblers and, although not as rugged as the type D, offers multiple key-pull configurations (as many as 10) for designers who need this capability.

The switch mechanisms run the gamut from integral On/Off types to rotary wafer types mated to the lock using a mounting bracket. The contacts can range from spst to dp5t; you can choose momentary-position and sp8t configurations in a few models. Power-handling capability ranges from 12A at 125V ac down to dry-circuit ratings; gold and silver plating are available.

An antistatic high-security member of the line, the LQ5, offers protection to 20 kV. Engineered for use in computer equipment, POS terminals and medical applications where static buildup is a problem, it includes a nylon housing to isolate the switch contacts from the lock.

Other features include AMP-type solderable Faston terminals and optional multipole/multiposition and momentary contact styles. Silver-plated contacts furnish high power ratings (4A at 125V ac, 2A at 28V dc); 0.4-VA devices employ gold/nickel plating. Prices for a 1-pole, 2-position switch range from about $12 (1) or $4.60 (100) for the LQ5 using the Duo mechanism to $8.80 (1) or $3.50 (1000) for a unit using Illinois tumblers.

Prices for other LQ Series models range from roughly $8 to $16 for single quantities depending on lock, switch and contact configurations. 1000-piece discounts range to 40%.

A 20-tumbler design

The Chicago Lock Co also offers an extensive line of keylock switches, classified as either medium- or high-security devices. The company's familiar cylindrical-key design comes on its high-security Ace locks.

The 4900 Series switch locks, termed UL Ace, incorporate a 20-tumbler locking mechanism mounted in a brass cylinder. The 4902 employs an spdt microswitch, while the 4903 uses a wafer-type switch that provides one or two poles and eight positions. Voltage ratings range from 6 to 250V with current ranges to 5A for both types of switches.

A 7-pin-tumbler Ace lock is also available in several switching configurations. Mounted to a wafer switch, Model 4188 offers as many as eight switching positions. And Model 4235, with an integral spdt switch, is an On/Off power keylock that has received widespread usage.

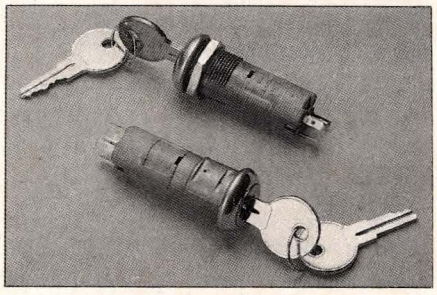
Chicago Lock also offers its high-security double-bitted 11-blade-tumbler lock mechanism on several keylock designs incorporating both integral microswitches and wafer switches.

Pricing varies with lock style and switch mechanism; a unit such as the 4235 sells for approximately $12.50 (1) or $6.50 (2500). The company's Model 4073, widely used in vending machines and available in both spst and momentary-contact arrangements, sells for roughly $6 (1) or $4 (OEM qty).

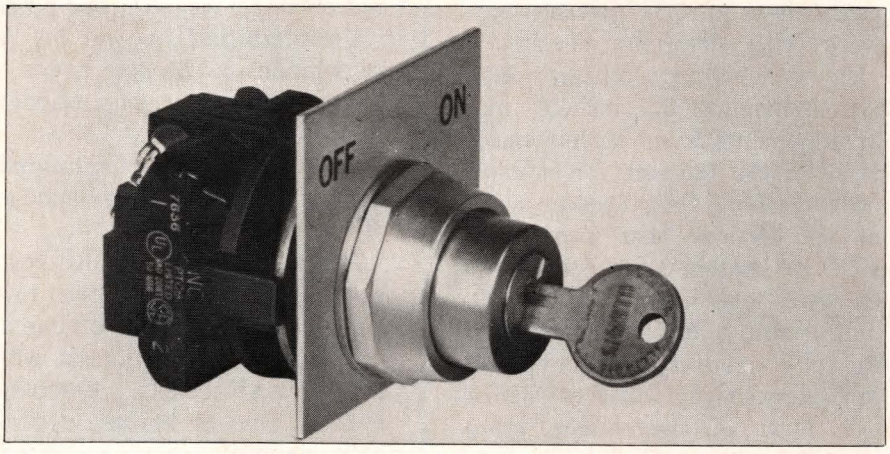
Chicago Lock's high-security keylocks are already available with thousands of key changes, and the company will this year introduce a new patented mechanism providing 5½ million combinations. Few details are available, but the company claims that in 1½ yrs of trying, it has been unable to defeat the switch, which employs a new key type in a radical new design aimed at applications currently using 4073- and 4235-type keylocks.

Depressions are the key

Although the Series 14 high-security keylock switch from EAO Switch Corp is not being touted as a

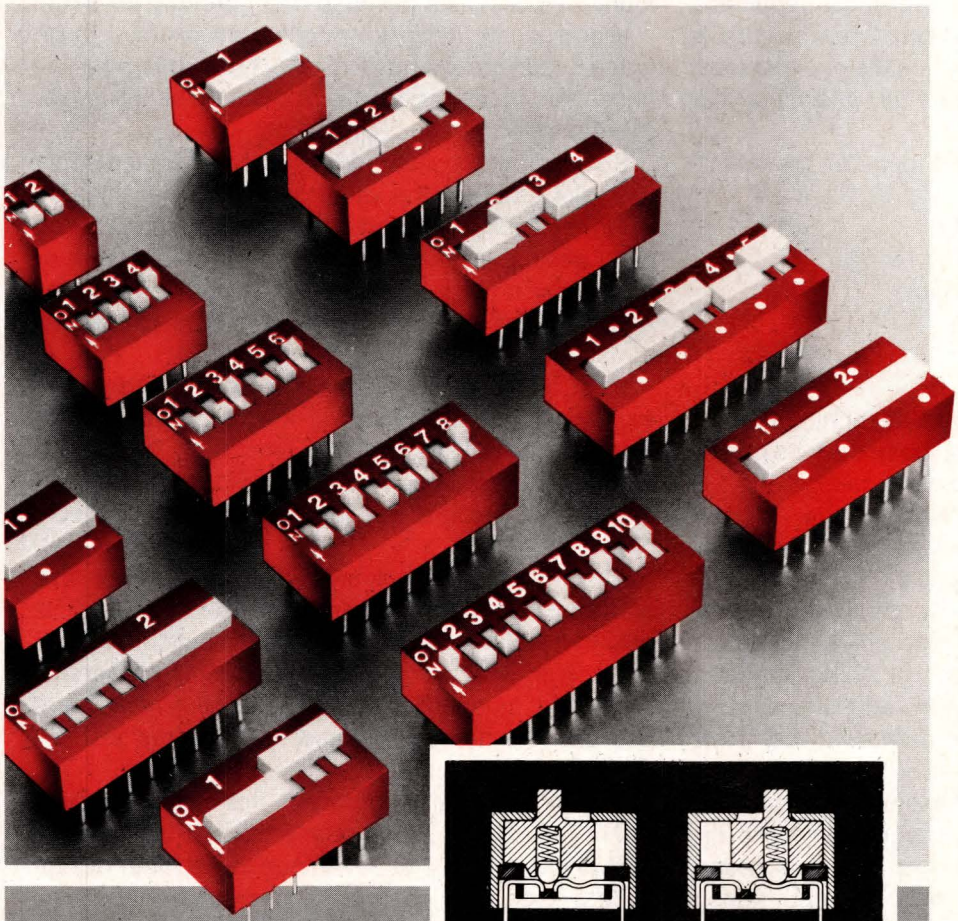


Antistatic keylock switches *such as this Oak Switch device can protect equipment from 20-kV static discharges.*



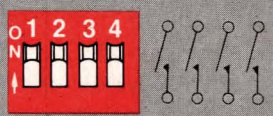
Oiltight construction *highlights this Model PTK keylock switch from Micro Switch.*

NEW GRAYHILL SLIDE DIP SWITCHES: VISIBLY BETTER!

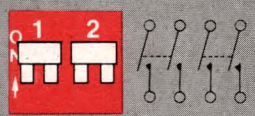


Available Circuitry

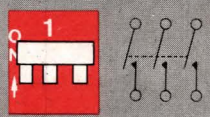
SINGLE THROW—
All "On" Positions Inline



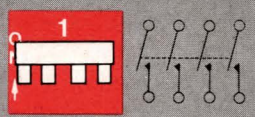
SPST, 2 - 10 stations;



2PST, 1- 5 stations;

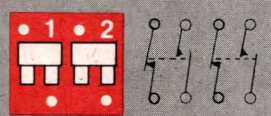


3PST, 1 - 3 stations;

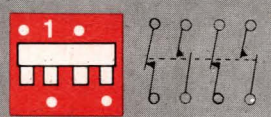


4PST, 1 or 2 stations.

DOUBLE THROW—
Alternating Side "On" Positions



SPDT, 1 - 5 stations;



DPDT, 1 or 2 stations.

Other combinations and specials available. Call Grayhill for more information.

Visible position identification is one big plus the slide format DIP switch offers; the red color indicates a second visible advantage —it tells you it's a *Grayhill* slide DIP switch.

The new Grayhill 78 Series is not just another DIP switch variation. It is a completely new family of DIP switch products built on automated equipment (and at automated prices). Multi-pole and multi-throw switching is accomplished by means of an external snap-on plastic strap. The switches are "ganged" after completion, providing maximum flexibility in inventory management and allowing for many "non-standard" ganging arrangements.

The BIG PLUS features of the Grayhill Series 78 Slide DIP come along with all the other BIG PLUS features that have long made Grayhill's Different DIP Switch the favorite of engineers and buyers world-wide.

- **High contact pressure**
  The famous Grayhill spring-and-ball contact system outperforms cantilever contacts, and provides an exceptional 30,000 cycle life.
- **Epoxy sealed base— as a standard feature**
- **100% electrical inspection— as a standard feature**
- **100% pin straightening**
- **Off-the-shelf distributor availability**
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CIRCLE NO 43

Picking the right keylock switch

Once you've decided that your application requires a keylock security switch (see **box,** "How secure is secure?"), the next step is selecting the one that most closely meets your needs by carefully analyzing your application and requirements.

The selection process should focus on the following points:

- Lock-mechanism integrity
- Contact arrangements and ratings
- Size and space requirements
- Environmental conditions
- UL listing
- Cost.

Although no industry-standard security classification exists for keylock switches, these devices can be broadly classified as low-, medium- and high-security units. Keep in mind, though, that one manufacturer's high-security keylock might be considered a medium-security device by another supplier.

A low-security keylock switch usually employs a single-bitted key (cuts on one side only) and usually only a few (three to five) blade or wafer tumblers. Typically, these devices are all keyed identically, but some designs permit several hundred key combinations, depending on the number of tumblers.

The lock consists of a metal alloy such as zinc and has aluminum tumblers. Low-security keylocks are easily picked and cannot take much physical abuse. Thus, they should be used only to keep honest people honest.

Most medium-security keylocks use a double-bitted key with six to 11 wafer or pin tumblers. They typically have brass or zinc housings; tumblers are aluminum or brass, depending on the manufacturer. This level of security permits as many as 1000 key changes, and the lock is not easily picked or damaged from physical abuse.

High-security keylock switches engender the most confusion from a buyer's standpoint. Some manufacturers claim that wafer tumblers are not as secure as pin tumblers; others dispute this statement. And some experts maintain that a highly secure lock can incorporate either mechanism type.

High-security mechanisms usually include more than 10 tumblers and sometimes as many as 20. They feature all-brass construction; hardened-steel inserts, guides and pins deter drilling of the tumbler mechanisms. Some pin-tumbler designs incorporate a rotational feature for double-action locking or additional locking and tamper-proof mechanisms. Double-bitted, triple-bitted (cuts on top, bottom and face) and circular keys are typical, and the number of key changes can exceed ½ million. Additionally, the keys can't be easily duplicated. (Key blanks are rarely found at locksmiths because of proprietary keying.)

High-security keylock switches are claimed to be virtually pickproof and can take enormous physical abuse. In most cases, the mounting panel is destroyed before the lock gives out.

Selecting the switch portion of a keylock presents no major problem; the same considerations you use when selecting conventional switches apply. You must decide whether you need ac or dc and high or low power ratings and choose the number of poles and positions, contact material and type of external terminal connections.

Most manufacturers can't handle all conceivable variations, so don't select a keylock switch for its locking mechanism and find later that the contact requirements you need are not available. (Of course, custom devices are possible, but at a considerable cost penalty.)

According to keylock-switch manufacturers, size and space requirements are among the key points designers should consider when selecting devices. Keylock switches come in all panel-cutout, length, width and mounting configurations. But make sure you examine the entire assembly and not just the unit's lock or switch portion.

Some keylocks incorporate the switch section within the barrel; others use a bracket to mate the lock to the switch. The advantage to the latter design is that it can be changed if damaged—integrated devices requiring repair must be completely discarded or returned to the manufacturer. These integrated devices, however, are usually smaller.

Because some keylock switches find use in harsh environments, many manufacturers offer units that feature sealed oiltight, waterproof and pressure-tight lock and switch mechanisms. In addition, if a switch will find use in an area where static can build up, you might want to consider the antistatic keylocks available from several manufacturers. Although their lock and switch configurations are usually limited, these devices can protect sensitive circuitry from static discharge as high as 20 kV.

All keylock switches are not UL listed. Most manufacturers offer such devices, but the UL rating does not usually span the entire line. In addition, consider the entire assembly, not just the lock or switch portion, when looking for the UL rating. If you ask a manufacturer to modify its standard UL-rated unit, it might not retain the rating.

Cost is perhaps the most important consideration in selecting a keylock switch. The major part of the keylock's cost is the lock itself. So how much security can you afford?

radical new design, it certainly incorporates an unusual key mechanism. Rather than the common bitted or circular keys, it employs a flat key on which depressions are formed.

Inserting this key into the keylock switch causes spring-loaded tumblers to align themselves, enabling the lock mechanism. As many as 1000 combinations can be configured, depending on the key depressions' depth and position.

Series 14 keylocks combine standard snap-acting, low-level or solid-state Hall-effect switch elements in a case-hardened steel lock mechanism. Snap-action units include one double-break snap-acting mechanism per element and silver contacts with 10 μm of gold laminate. They furnish momentary or maintained action and a minimum life of one million operations. Contact blocks are diallyl phthalate, providing dimensional stability at extreme temperatures.

EAO's low-level switch elements, on the other hand, have two contacts and a minimum life of two million operations. And the solid-state Hall-effect units achieve a minimum life of five million operations. The low-level and Hall-effect units feature universal pc-board, wire-soldering or quick-connect terminals. Pricing begins at $19 in sample quantities.

EAO employs the same mechanism in its Series 31 switch line, which has just been expanded to include both high-security and low-cost keylock switches. The high-security devices, like the standard keylocks in the line, come with round, square or rectangular fronts and mount from the front of a panel. Switch elements and contact arrangements are identical to those of Series 14 models.

The high-security keylocks, using new locking mechanisms, start at $18. Standard versions employing cut keys sell for $14, and the low-cost models furnishing only two key combinations will be priced from $8.

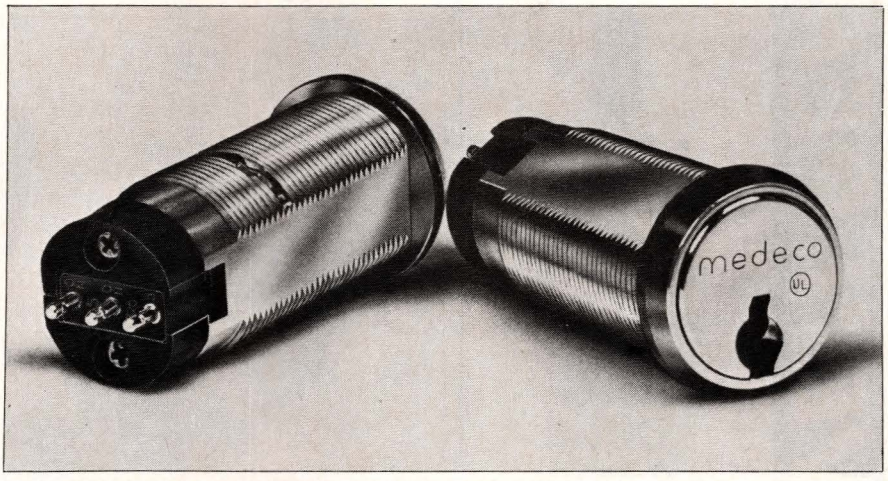
Employing a similar design concept but using a conventional double-bitted key, Alco Electronic Products's new programmable switches feature a BCD output. You program these SKC Series devices by inserting the custom key into the switch; no turning is necessary. The key action opens or closes appropriate gold-plated contacts and completes the circuit. The devices come with as many as 31 different codes and sell for $4.95 (1) or $3.61 (250).

Although this keycode program switch provides some level of security from the standpoint of key combinations, its mounting method (it's held in place by external screws) allows a determined person to easily remove and circumvent it. Thus, for a higher level of security, consider Alco's SWK and SKF panel-mounting keylock switches.

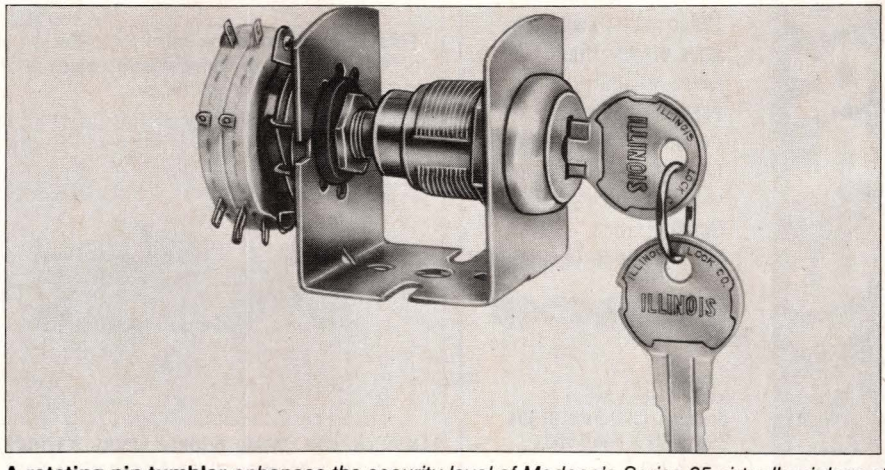
Both have a single-bitted key mechanism. The SWK comes only in spst contact arrangements; SKF Designer Series models use a square-flange design and allow a variety of operating configurations —including rotaries and reed switches. All switches in the series feature as many as 10 standard key changes. Prices start at $4.75.

Rotating tumblers

Although an antistatic-type keylock will be coming from Alco eventually, the firm has no plans to introduce higher security devices. In contrast, Medeco Security Locks's keylock line includes only high-security devices. The Medeco ¾-in.-diameter switch locks feature



The 14 brass tumblers *in this Illinois Lock Duo mechanism, coupled with a triple-bitted key, furnish a high level of security.*



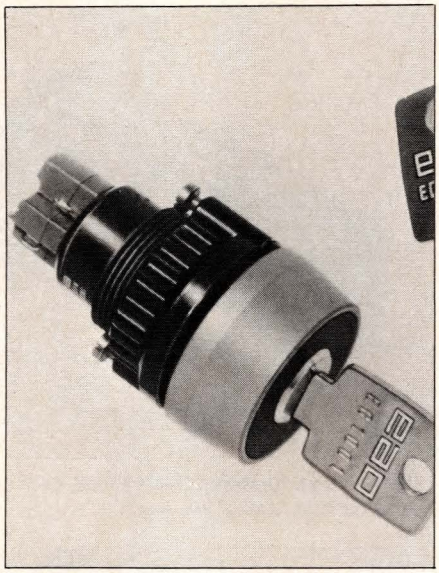
A rotating pin tumbler *enhances the security level of Medeco's Series 65 virtually pickproof keylock switches.*

a patented sidebar locking mechanism as well as rotating pin tumblers for double-action locking.

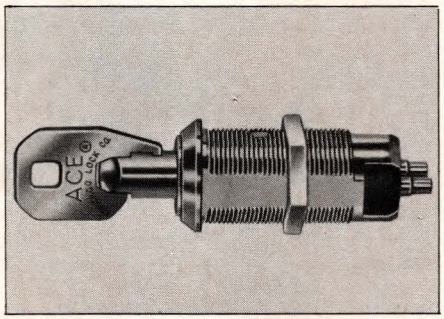
Touted as being virtually pick-proof—picking the lock without rotating the tumblers doesn't compromise the device—the Series 65 features more than 500,000 noninterchangeable key combinations.

Medeco provides only a few switch combinations. A single-switch type offers spst or spdt actions and momentary contacts; a double-switch version has dpdt contacts. Silver and gold contacts are available for all configurations, and terminals accept quick-connect leads. Prices begin at $22 (1) and decline to $15 for large volumes.

Sharing the same reputation for locking integrity but providing significantly more switch variations is Fort Lock Corp. It offers more than 40 different switch configurations, ranging from low- to high-security units.



This unusual keylock *from EAO Switch is activated only after spring-loaded pins match the key indentations perfectly.*



One of the most widely used keylock switches, *Chicago Lock's Model 4073 finds use in vending machines and comes in spst and momentary-contact configurations.*

For high-security applications, the Fort Lock Gem mechanism employs a 7-pin tumbler with a tubular-type circular keyway. A chrome-plated brass cylinder is standard; nickel-plated hardened-steel plugs are optional. The locks feature more than 100,000 key combinations and various levels of mastering.

Keylock switches employing the Gem locking mechanism include the SW2, SW20, SW93 and 3SW devices. The first two feature integral spst switches; the SW20 has momentary contact arrangements. The SW93 furnishes a 3p4t configuration and fully enclosed self-wiping contacts, and the 3SW is an spdt UL-listed 3-wire switch.

Lock uses multiple switches

Fort Lock also offers snap-action switches. Its SW11 Series models include one to three switches for multicircuit applications.

Other Fort Lock devices employ a double-bitted, 6-disk-tumbler lock mechanism for medium security rather than the high security of the Gem locks. Switches similar to those found in Gem models are available, as are wafer switches for multipole, multiposition contact arrangements. The wafer keylock carries an SW5 part number.

For low-security uses, Fort Lock employs a single-bitted keylock mechanism. 5- and 6-disk tumblers are standard, but a 3-tumbler device, the SW3, serves as a lower cost, less secure option. It provides only 20 key changes—Fort Lock's standard normal single- and double-bitted locks provide more than 1000.

Most of these Fort Lock switches carry fairly high power ratings. If you need low-voltage operation, you can select one of the firm's wafer-type keylock models with optional switch/contacts.

Pricing varies considerably de-

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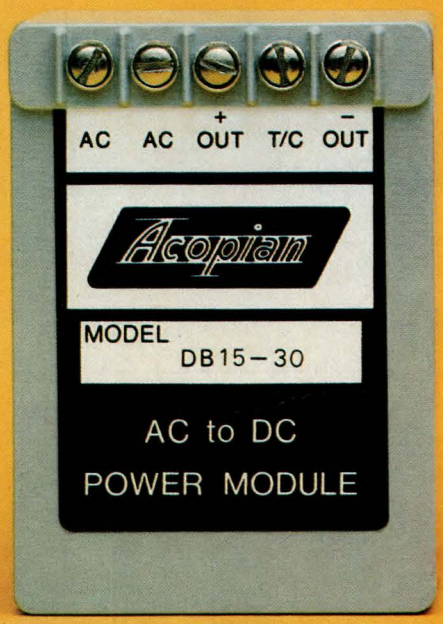
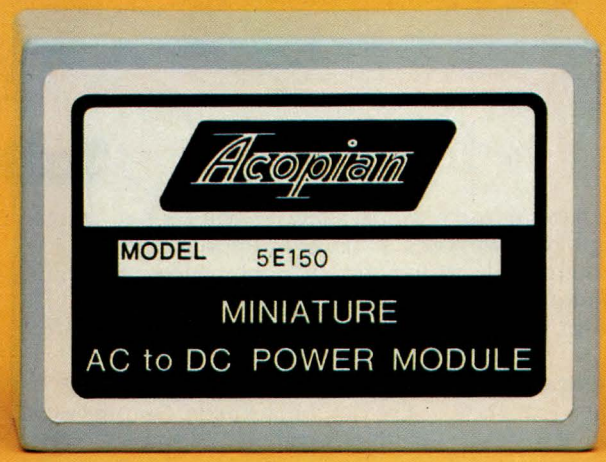
Nominal Output Voltage	Output Current Amps.	Regulation Load ±%	Regulation Line ±%	Ripple mv RMS	Price	Model	Case Size
5	.500	.15	.05	1	$ 69	5EB50	EB-10
5	1.0	.25	.05	1	79	5EB100	EB-13
5	1.5	.35	.1	1	105	5EB150	EB-13
5	2.0	.25	.05	1	115	5EB200	EB-20
5	2.5	.25	.05	1	130	5EB250	EB-20
±12	.100	.05	.05	1	69	DB12-10	EB-10
±12	.150	.05	.05	1	79	DB12-15	EB-10
±12	.200	.05	.05	1	89	DB12-20	EB-10
±12	.300	.05	.05	1	109	DB12-30	EB-13
±12	.350	.05	.05	1	119	DB12-35	EB-13
±12	.500	.1	.05	1	139	DB12-50	EB-20
±15	.100	.05	.05	1	69	DB15-10	EB-10
±15	.150	.05	.05	1	79	DB15-15	EB-10
±15	.200	.05	.05	1	89	DB15-20	EB-10
±15	.300	.05	.05	1	109	DB15-30	EB-13
±15	.350	.05	.05	1	119	DB15-35	EB-13
±15	.500	.1	.05	1	139	DB15-50	EB-20



For PCB Mounting

Nominal Output Voltage	Output Current Amps.	Regulation Load ±%	Regulation Line ±%	Ripple mv RMS	Price	Model	Case Size
5	.250	.05	.05	0.5	$ 49	5E25	ES-10
5	.500	.1	.05	1	59	5E50A	EL-10
5	1.0	.2	.05	1	75	5E100	EL-13
5	1.5	.3	.1	1	98	5E150	EL-13
5	2.0	.15	.05	1	110	5E200	EL-20
5	2.5	.15	.05	1	125	5E250	EL-20
±12	.025	.1	.05	1	35	D12-03	ES-10
±12	.050	.1	.05	1	49	D12-05	ES-10
±12	.100	.05	.05	1	59	D12-10A	EL-10
±12	.150	.05	.05	1	69	D12-15A	EL-10
±12	.200	.05	.05	1	79	D12-20	EL-10
±12	.300	.05	.05	1	98	D12-30	EL-13
±12	.350	.05	.05	1	105	D12-35	EL-13
±12	.500	.1	.05	1	130	D12-50	EL-20
±15	.025	.1	.05	1	35	D15-03	ES-10
±15	.050	.1	.05	1	49	D15-05	ES-10
±15	.100	.05	.05	1	59	D15-10A	EL-10
±15	.150	.05	.05	1	69	D15-15A	EL-10
±15	.200	.05	.05	1	79	D15-20	EL-10
±15	.300	.05	.05	1	98	D15-30	EL-13
±15	.350	.05	.05	1	105	D15-35	EL-13
±15	.500	.1	.05	1	130	D15-50	EL-20



Input Voltage: 105-125 Vac, 47 to 420 Hz, single phase.

Output Voltage Setting: Single output models are factory preset to within ±2% of nominal output voltage, and may be more precisely trimmed to the nominal voltage rating with an external trim resistor. Dual models are set to within ±1% of their nominal ratings, and are not trimable.

Polarity: Either positive or negative terminal of a single output module may be grounded. Dual output modules have a positive/common/negative output terminal configuration.

Ambient Operating Temperature: −20 to +71°C. (Model 5E150 and 5EB150, 0 to +71°C.) No derating required.

Optional 230 Volt Input: To order, add suffix "-230" to model number and $10.00 to price.

Case Sizes and Weight:
EB-10: 3.5″ × 2.5″ × 1.375″ (15 oz)
EB-13: 3.5″ × 2.5″ × 1.625″ (1 lb 4 oz)
EB-20: 3.5″ × 2.5″ × 2.375″ (2 lb 1 oz)
EL-10: 3.5″ × 2.5″ × 1″ (13 oz)
EL-13: 3.5″ × 2.5″ × 1.25″ (1 lb 3 oz)
EL-20: 3.5″ × 2.5″ × 2″ (1 lb 15 oz)
ES-10: 2.3″ × 1.8″ × 1″ (7 oz)

Other models available from 1 to 75 volts. Send for complete information.

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CIRCLE NO 45

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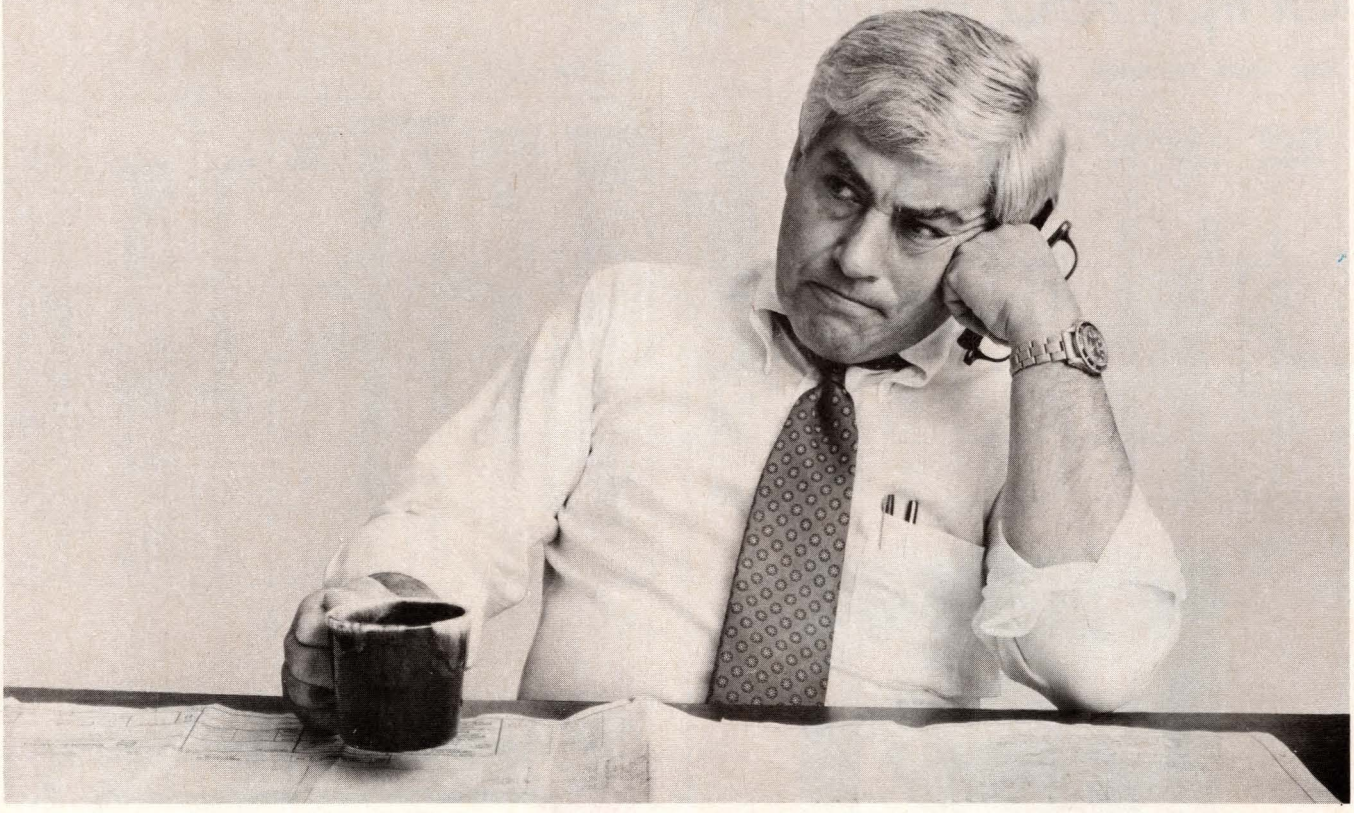

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We have industry standard mechanical configurations combined with over 30 standard options. Your choice of output voltage and current combinations. An almost infinite selection of unique high-power switching power supplies.

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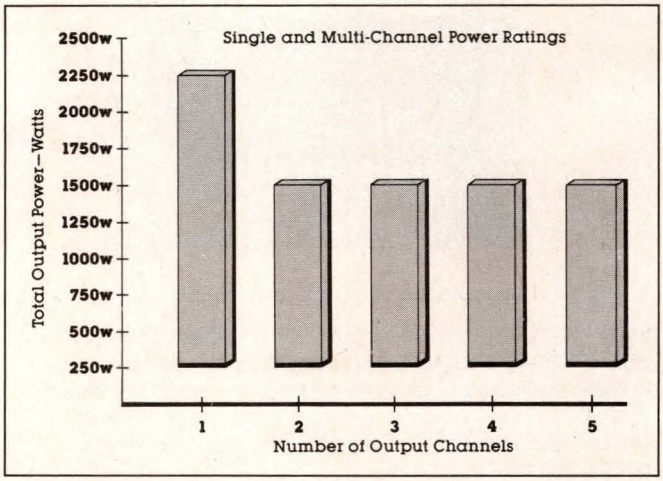
Have a unique need? Power fail signal? Digitally programmed output? Line clock? Over/Undervoltage detection? Four different inhibits? DEC interface? Out of tolerance shutdown? These are just some of the many options available to customize your unit.

So if you think you need a custom high power switcher, look at our power rating chart which shows the total power delivered from our one through five output units. If your needs are within those ranges, Pioneer can give you a standard design product that does the job.

For details, talk to us...today!



Pioneer Magnetics

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CIRCLE NO 46

pending on type of lock and switch. The SW2, for instance, sells for $8.39 (1) or $3.40 (1000). The SW93 lists for roughly $20.55. The double- and single-bitted versions cost less.

Keylock mounts on pc board

Stackpole uses both Fort Lock and Chicago lock mechanisms in its new Series 100 rotary keylock switch. In a fully enclosed configuration, the device can handle 15A with a maximum contact make-and-break rating of 0.5A at 125V ac and 1A at 28V dc.

Each switch deck consists of an input and an output module with contact and terminals molded into a glass-filled thermoset material to provide ruggedness and good electrical characteristics. Contact and terminal jumpering and deck interconnects can provide any switch configuration or encoding.

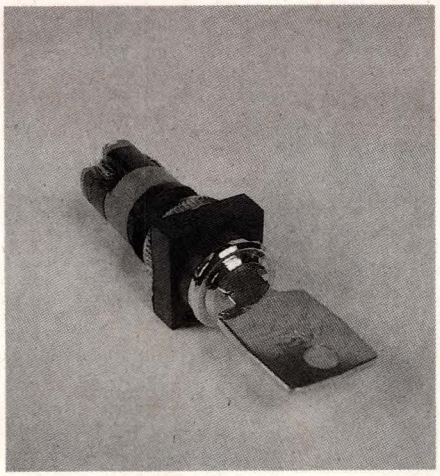
Contacts are silver-plated brass; silver-alloy or gold plating and other finishes are optional. Terminal options are for vertical pc-board in-line mounting or rear pc-board mounting with circular pin patterns. Switching configurations include shorting, nonshorting, mixed, BCD or special. Prices range from $15 (small qty) to $6.50 (1000).

Similar rotary keylock switches are offered by Oak Switch Systems Inc. The type F (cylindrical) and type A (flat key) low-power rotaries, however, employ open-frame wafer switches rather than the Stackpole equivalents' sealed units.

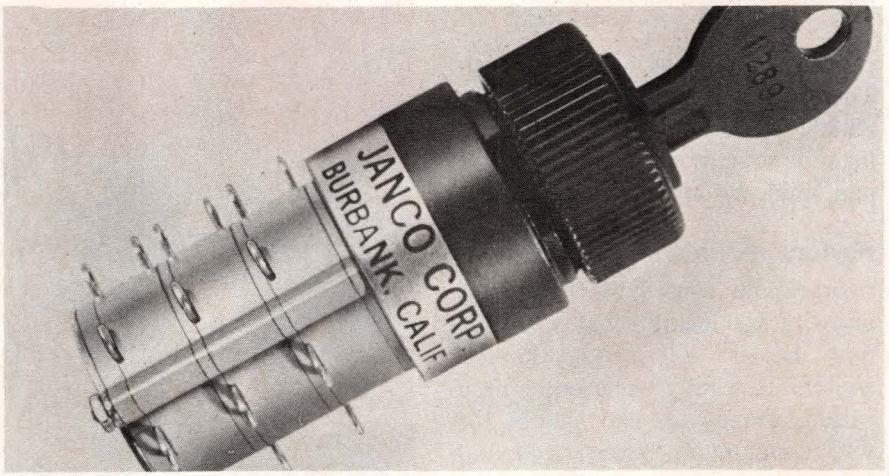
The type A unit specs electrical ratings of 0.5A at 28V dc and 0.25A at 110V ac; type F ratings are 1A and 0.5A, respectively. Silver-plated brass or silver-alloy self-cleaning, double-wiping contacts are available for both types, as are multiple-section switches.

Oak's newest offering in keylock switches is its antistatic 6-disk- and 5-disk-tumbler device, designed to protect sensitive electronic circuitry from static discharge. This switch provides 20-kV protection and is ideal for dry-circuit applications;

Technology Update



A mechanical life greater than one million actuations *highlights Series TH65/66 switches from Unimax.*



If you need an explosion-proof keylock rotary switch *that meets MIL-S-3786 requirements, consider this Janco KB Series device.*

operating voltages range from 5V ac/dc at 100 mA to 120V ac at 4A.

Enclosed contacts in spst, spdt, sp3t and sp4t versions are available; silver-plated copper alloy is used for the contact material. Typical pricing for the sp3t arrangement is $5.80 (1000).

Oiltight keylock

If enclosed contacts aren't adequate for your application, an oiltight keylock switch might suit your needs. Consider, for example, Micro Switch's PT and PW Series devices, which use Illinois Lock mechanisms incorporating Micro Switch's own switch designs—a modular approach that permits use of a variety of contact blocks. Solid-state and mechanical contacting are available; electrical ratings span 3V dc to 125V dc and 3 mA dc to 10A dc, resistive. AC currents range from 1A to 30A. Prices begin at $39 (1) or $16 (1000).

Keylock switches that meet stringent environmental requirements such as those imposed by the MIL-S-3786 standard, Janco Corp's new KB Series use rotary switch mechanisms that permit switching configurations such as multipole, shorting, nonshorting and bridging. Electrical ratings range from 250 mA to 5A, 115V ac and 28V dc. You can also order lower level switching.

Contacts employ a solid-silver alloy, and the collector rings are

How secure is secure?

If a manufacturer tells you a keylock switch is pickproof, don't believe it. The best lock in the world is at best highly pick-resistant.

One leading security consultant with more than 40 yrs of experience maintains that a high-security device should be able to withstand both surreptitious tampering and considerable abuse. He says that a lock that he requires more than 30 min to pick can be considered a highly secure device and virtually unpickable by a common thief.

A low-security lock can be picked in as little as 10 sec, and medium-security devices take somewhat longer, the expert maintains. He adds that taking a hammer to an inexpensive lock can compromise it in one blow, while high-quality locks can withstand hours of such abuse and still not be defeated.

These considerations raise the question of how much security even the best keylock switch affords in a particular application. Indeed, mounting the same device in different ways can produce radically different security levels.

For instance, consider mounting the most secure keylock switch available on a computer terminal to prevent unauthorized access to confidential information. If someone wants to gain access badly enough, this keylock will not stop him—he can cut the molded cabinet, make appropriate switch connections and get on with the business at hand. Of course, if the enclosure is made out of hardened steel, his task is more difficult.

Note that keylock security switches employed in nonremote applications function more as visual crime stoppers than actual ones. In most cases, this is all that's needed. For example, if the physical abuse necessary to defeat a switch can't go undetected at your facility, you have probably secured the equipment properly. In such an environment, a less secure keylock switch will most likely also do the job. But watch out—if the keylock has too low a security level, an employee can defeat it rather quickly, with even a paper clip, and the illegal access will go unnoticed. And even a high-security keylock is useless if the key is "hidden" in a nearby desk drawer.

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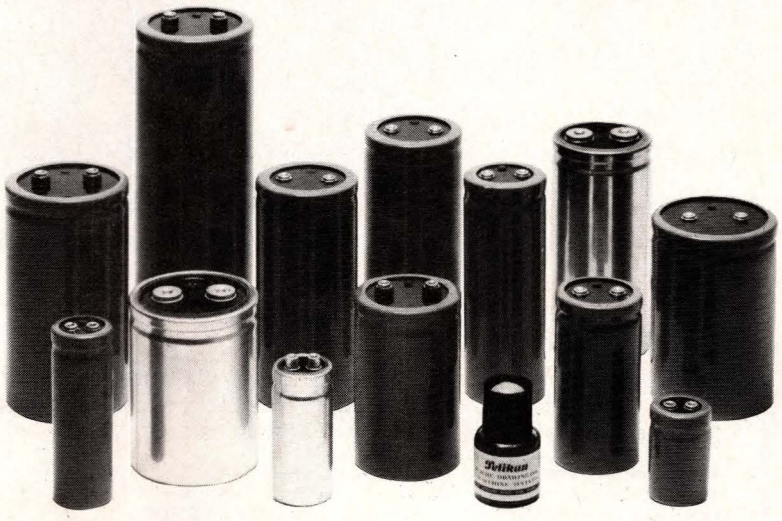

KEY SPECS	TYPE 623D* Extralytic® ALUMINUM ELECTROLYTICS 20 Standard Ratings	TYPE 602DX Extralytic® ALUMINUM ELECTROLYTICS 150 Standard Ratings	TYPE 32DR Compulytic® ALUMINUM ELECTROLYTICS 132 Standard Ratings	TYPE 32DX Compulytic® ALUMINUM ELECTROLYTICS 132 Standard Ratings	TYPE 36DX Powerlytic® ALUMINUM ELECTROLYTICS 132 Standard Ratings
Case Size Range (D. x L.)	1.375″ x 2.125″ to 3.000″ x 5.625″	1.375″ x 2.125″ to 3.000″ x 5.625″	1.375″ x 2.125″ to 3.000″ x 8.625″	1.375″ x 2.125″ to 3.000″ x 8.625″	1.375″ x 2.125″ to 3.000″ x 8.625″
Operating Temperature Range	−55°C to +85°C	−55°C to +85°C	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
WVDC Range	200 and 250	5 to 250	7.5 to 150	10 to 200	10 to 450
Capacitance Range (μF)	7400 to 260*	270,000 to 150	310,000 to 410	320,000 to 180	390,000 to 80
Max. ESR (ohms) at 120 Hz	7400 μF at 200 WVDC: 0.020	270,000 μF at 5 WVDC: 0.0062	310,000 μF at 7.5 WVDC: 0.010	320,000 μF at 10 WVDC: 0.017	390,000 μF at 10 WVDC: 0.012
Max. RMS Ripple Current (Amperes) at 120 Hz and 85°C	20.0	36.0	23.9	18.3	15.3
Terminal Styles	Low Screw-Insert	Low or High Screw-Insert, or High Current	Low or High Screw-Insert, or Solder Lug	Low or High Screw-Insert, or Solder Lug	Low or High Screw-Insert, or Solder Lug

*Designed specifically for off-line switched-mode power supplies.

4SE-1107

For complete technical data, write for Engineering Bulletins 3461A, 3457B, 3441E and 3431D to Technical Literature Service, Sprague Electric Co., 491 Marshall St., North Adams, Mass. 01247.

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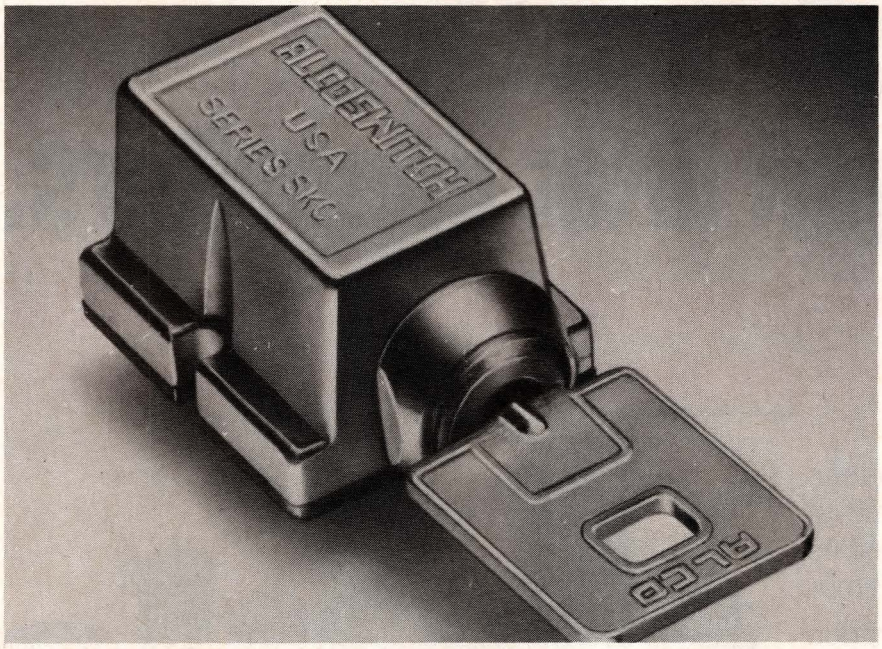

Merely inserting the key *into Alco's SKC switches produces a programmable BCD output.*

gold plated. Prices vary with options and tend to be high, reflecting the devices' high-performance military and commercial-aircraft applications.

Keylock switches from Electro Switch Corp are closer in pricing to Micro Switch devices than Janco units. The Series 31 keylock switches, for instance, cost $25 to $50, depending on quantity, number of rotary wafer stages and contacting. They feature a cylindrical-type lock mechanism and a selection of different keycodes, although identical-keycode devices are standard.

Depending on the switch selected, you can configure as many as six poles and six decks. Voltage ratings range from 125V to 600V ac and 24V to 12V dc at 0.5 to 10A.

Other manufacturers offering keylock security switches include Crouse-Hinds and Unimax Switch. The Crouse-Hinds line ranges from the low-security Canopy Series to what the company terms a high-security tumbler-type series (employing a single-bitted key mechanism). Ratings range from 1 to 6A at 125 to 250V ac/dc.

Additionally, Unimax offers a new family of 2-position keylock switches, designated the TH65/66. The TH65 and TH66 both use single-bitted keylock mechanisms; the TH65 provides a 2-position, 1- to 4-pole momentary action, while the TH66 features identical contacting but in a maintained action with key removable in the On or Off position.

The TH65/66 switches are rated at 5A ac; dc ratings vary from 5A at 12V to 0.3A at 250V. **EDN**

For more information...

For more information on the keylock security switches discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Alco Electronic Products Inc
1551 Osgood St
North Andover, MA 01845
(617) 685-4371
Circle No 728

Chicago Lock Co
4311 Belmont Ave
Chicago, IL 60641
(312) 282-7177
Circle No 729

Crouse-Hinds Co
103 Hawthorn St
Hartford, CT 06101
(203) 249-8471
Circle No 730

EAO Switch Corp
255 Cherry St
Milford, CT 06460
(203) 877-4577
Circle No 731

Electro Switch Corp
King Ave
Weymouth, MA 02188
(617) 335-5200
Circle No 732

Fort Lock Corp
3000 N River Rd
River Grove, IL 60171
(312) 456-1100
Circle No 733

Illinois Lock Co
301 W Hintz Rd
Wheeling, IL 60090
(312) 537-1800
Circle No 734

Janco Corp
3111 Winona Ave
Burbank, CA 91504
(213) 846-1800
Circle No 735

Medeco Security Locks Inc
Box 1075
Salem, VA 24153
(703) 387-0481
Circle No 736

Micro Switch
11 W Spring St
Freeport, IL 61032
(815) 235-5500
Circle No 737

Oak Switch Systems Inc
Box 517
Crystal Lake, IL 60014
(815) 459-5000
Circle No 738

Stackpole Components Co
Box M
Farmville, VA 23901
(804) 392-4111
Circle No 739

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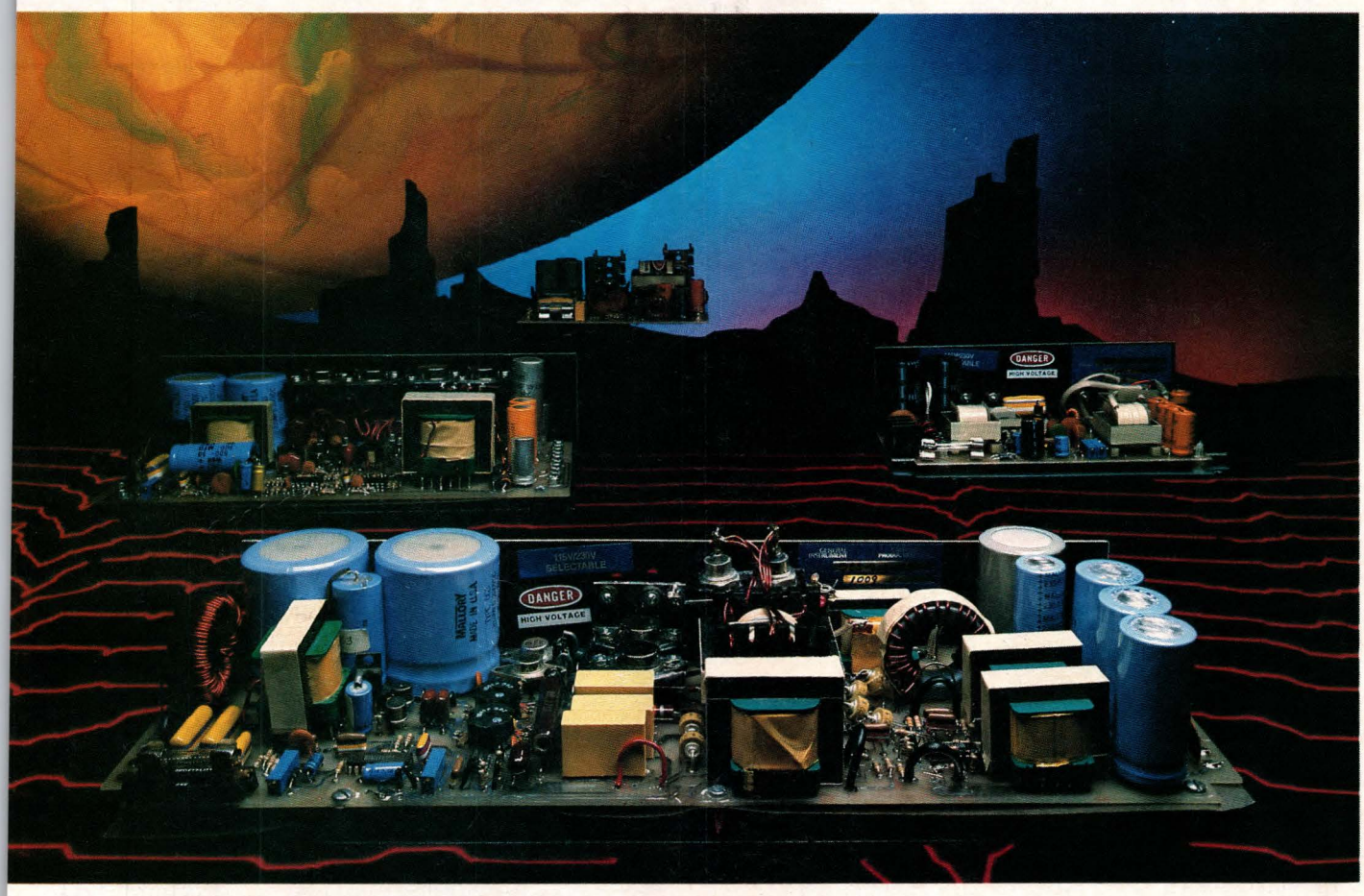

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CIRCLE NO 49

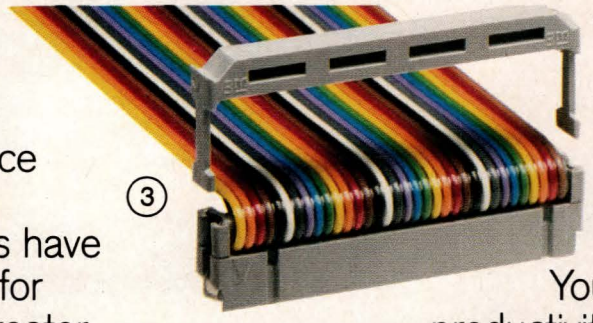
CLICK A

Scotchflex® interfaces with a positive

"Click" is the sound of decisive socket-to-header interface in Scotchflex® Brand connectors from 3M, The Source for premium mass termination systems. Sockets and headers have important design features for easier assembly and greater mechanical dependability than ever before.

First, Scotchflex headers (.100" x .100" grid series) now have built-in retainer/ejector latches (1). ② They snap up to lock sockets firmly in place. They snap down to disconnect sockets quickly and easily . . . good news where density makes access tough.

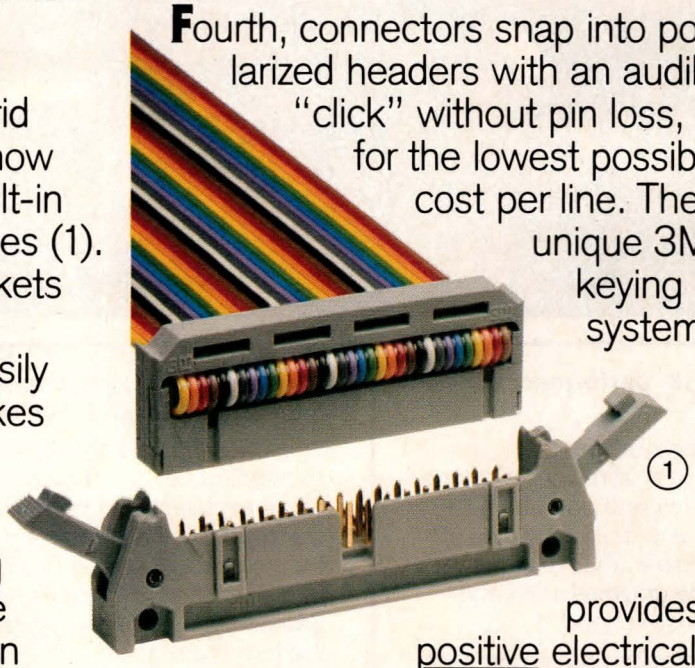
Second, mating socket connectors have designed-in metal spring clips (2) that lock the covers to the bodies for maximum cover retention The clips double cover retention strength, and let the connector be disassembled and reused if necessary.



③

Third, one-piece strain relief clips (3) take fewer steps to assemble. You get higher productivity and lower inventory costs since you need only one type of socket and a supply of efficient, inexpensive clips.

Fourth, connectors snap into polarized headers with an audible "click" without pin loss, for the lowest possible cost per line. The unique 3M keying system (4)



① provides positive electrical polarization, prevents even a partial mismatch, and helps reduce equipment damage and field maintenance.

ID EASY.

sound for 6-way better assembly.

Fifth, 3M's patented U-contact is ultra-simple. But it's superbly functional, proven reliable in thousands of applications.

Sixth, Scotchflex Brand sockets and headers in this grid range include 10, 14, 16, 20, 26, 34, 40, 50, and 60-pin sizes. They give you the same dependable mechanical and electrical performance as other 3M components.

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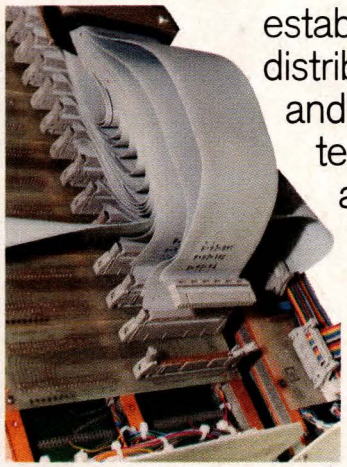

established national distributor network) and superlative technical assistance, and you can see why 3M is The Source for the very best mass termination has to offer the electronic designer. And there's one more thing.

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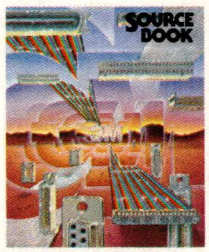
All the technical data you'll need for Scotchflex Brand mass termination products is in our complete Scotchflex catalog. It's yours free. Ask your 3M Scotchflex distributor, or write Electronic Products Division/3M, Building 225-4S, 3M Center, St. Paul, MN 55144.



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CIRCLE NO 50

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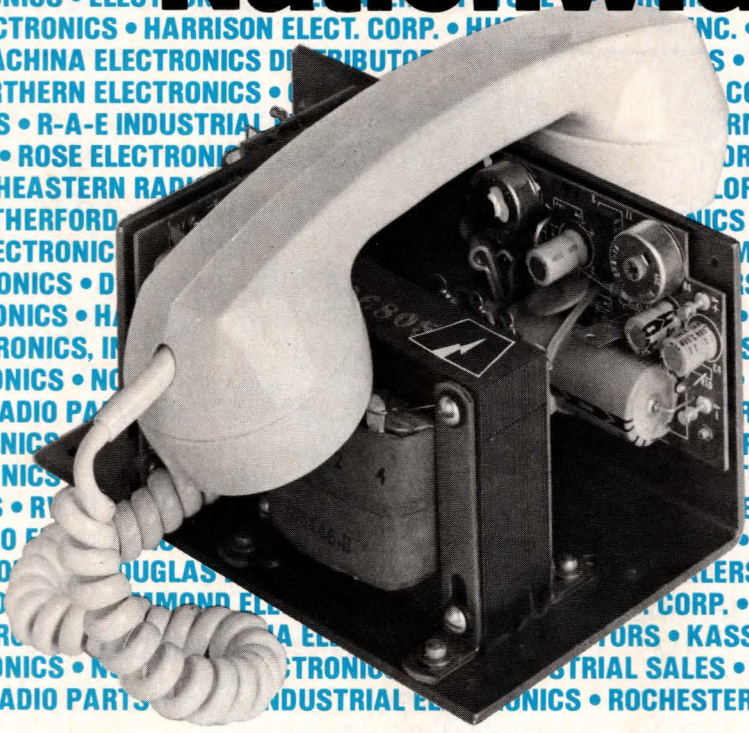

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CIRCLE NO 51

Independents jump on the IBM bus with Personal Computer add-ons

Carl Warren, Western Editor

Six months after the IBM Personal Computer's introduction, independent system designers have already developed or plan a host of add-ons for the machine. Spurred by the promise of a very large potential market, these independents have produced everything from 256k-byte memory boards to expansion chassis for the IBM system.

Their efforts have been aided by IBM's uncharacteristic support. The company has laid out the Personal Computer's bus structure in a straightforward manner, and it has documented the structure with a very detailed manual (see **box**, "IBM's bus basics"). Additionally, it is making available personnel who can answer questions and provide applications support for designers producing equipment to interface with the machine.

Peripheral-equipment manufacturers view the IBM machine as an ideal vehicle for new products. GTCO Corp, for example, provides a digitizing option designated the Graphic Analysis Package 1. It consists of a digitizer pad with 0.001-in. resolution (active area varies from 11×11 to 42×60 in.), a digitizing stylus, a power supply, a communications-interface cable and an operator's manual. The necessary software is available on diskette. Prices range from $1419 to $3025.

The option's software embodies IBM's philosophy of using user-oriented menu systems; it displays 22 predefined functions and also accommodates 11 user-defined functions. It makes generous use of the Personal Computer's graphics and computational capabilities, allowing you to create such complex graphics functions as defining and calculating the areas of irregular polygons.

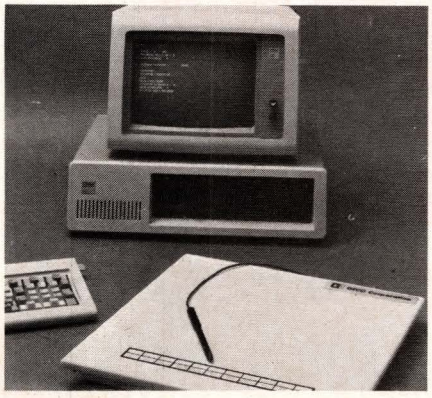
GTCO's product, like most of the add-ons, is designed to tie directly to the Personal Computer's backplane. In some cases, such as Tecmar's $945 PCMate expansion chassis, the products extend the bus's working capacity.

The Tecmar expansion chassis is designed to interface to any one of the bus's five expansion slots via a host adapter and extension cables. The adapter handles all bus-signal translation and provides buffering and the drivers required to ensure proper operation of both the primary bus and the expansion bus. Once connected, the expansion chassis furnishes seven additional slots for memory and controllers.

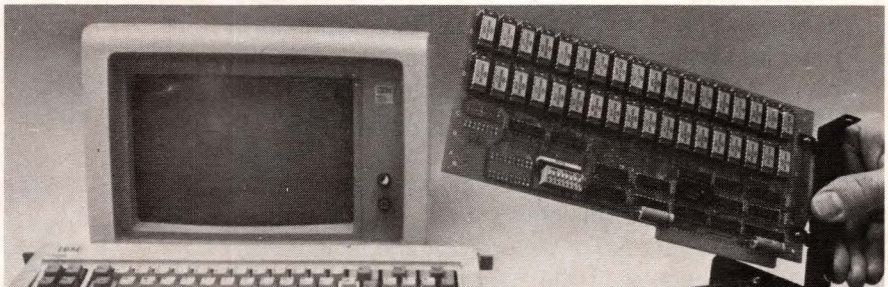
The chassis comes with a heavy-duty power supply capable of handling a 5¼-in. Winchester disk drive. Additionally, it provides convenience power outlets for printers or monitors.

Tecmar also offers a variety of other IBM-bus-compatible products —20 in all. This TecMate Series includes RAM ranging from a $495 64k-byte unit to a $1295 256k-byte board, a $395 EEPROM card that allows you to convert the computer system into a development station, a $395 IEEE-488-bus adapter that permits interfacing to a host of test equipment and a $395 Lab Tender that provides 16-channel 8-bit A/D and D/A conversion plus five timer/counters and three parallel ports.

The series also includes the $395 Speech Master, which contains a vocabulary of 143 words, letters and word sounds. (Additional personality modules to increase the vocabulary will be available by midyear.) And you can purchase the $345 Video Digitizer, which converts standard NTSC video signals to digital patterns, as well as the $495 Stepper Motor Controller to handle



Equipped with an 11×11-in. digitizer pad and menu-driven software, *the Graphic Analysis Package 1 from GTCO Corp costs $1419 and takes advantage of the processing and graphics of IBM's Personal Computer.*



Priced from $499, *Data Mac Computer Systems's 64k RAM-expansion system for the IBM Personal Computer comes with parity capability. You can expand it to 256k in 64k increments.*

IBM's bus basics

The IBM Personal Computer is an 8088-μP-based system that operates at 4.7 MHz (derived from a 14.31818-MHz crystal, divided by three for the processor clock and by four to obtain the 3.58-MHz color-burst signal required for color TVs). Its major elements are arranged on an 8½×11-in. system board **(Fig 1)** that fits horizontally in the base of the μC's system unit.

This multilayer single-land-per-channel board incorporates internal ground and power planes. DC power and a signal from the power supply enter the board through two 6-pin connectors; other connectors include those for a keyboard, audio cassette drive and speaker.

Additionally, five 62-pin card-edge sockets mount on the system board; the system-I/O channel is bused across these slots. These five expansion slots accommodate memory and/or other specialized cards, such as those described in this article.

The basic system is software compatible with the 16-bit 8086 μP and supports 20 address lines (permitting 1M bytes of storage). Additionally, the 8088 is implemented in Maximum mode to permit addition of a coprocessor such as the Intel 80130 software-system processor.

The 8088 bus cycles in 840 nsec; fully demultiplexed I/O takes 1.05 msec. Further support consists of a set of on-board high-function devices that provide four channels of 20-bit direct memory access (DMA), three 16-bit timer/counter channels and eight prioritized interrupt levels.

These last-named functions are implemented as follows: Three of the four DMA channels are available on the I/O bus, eliminating the need to implement them in add-on cards; the fourth refreshes the system's dynamic memory.

Although the IBM system is essentially a single-board computer with a local bus, you can expand it in a manner similar to that used for the Apple, via the five I/O-channel slots. Each I/O channel is demultiplexed, repowered and enhanced by the addition of interrupts and DMA functions. As shown in **Fig 2,** a channel contains an 8-bit bidirectional data bus, 20 address lines, six levels of interrupts, control lines for memory and I/O read or write, clock and timing lines, three channels of DMA control lines, memory-refresh-timing control lines, a channel-check line, and power and ground. Power consists of ±5 and ±12V dc. All signals are arranged in a 62-pin connector on 100-mil card-tab spacing.

As in the Apple μC, I/O channels are addressed through mapped memory space; 512 addresses are available.

To avoid problems with RFI and EMI, the computer contains a fully filtered switching power supply and is configured as a closed system. In this concept, each card for the I/O channels comes with an attached metal mounting bracket that fits in slots in the system unit's rear apron. This arrangement not only provides mechanical stability, it also shields the system.

To assist you in understanding the Personal Computer's functions and its bus's charcteristics, consider purchasing the machine's *Technical Reference.* This $37.50 manual contains full technical details on the system, including its software, and is available from most Computerland and Sears stores or directly from IBM.

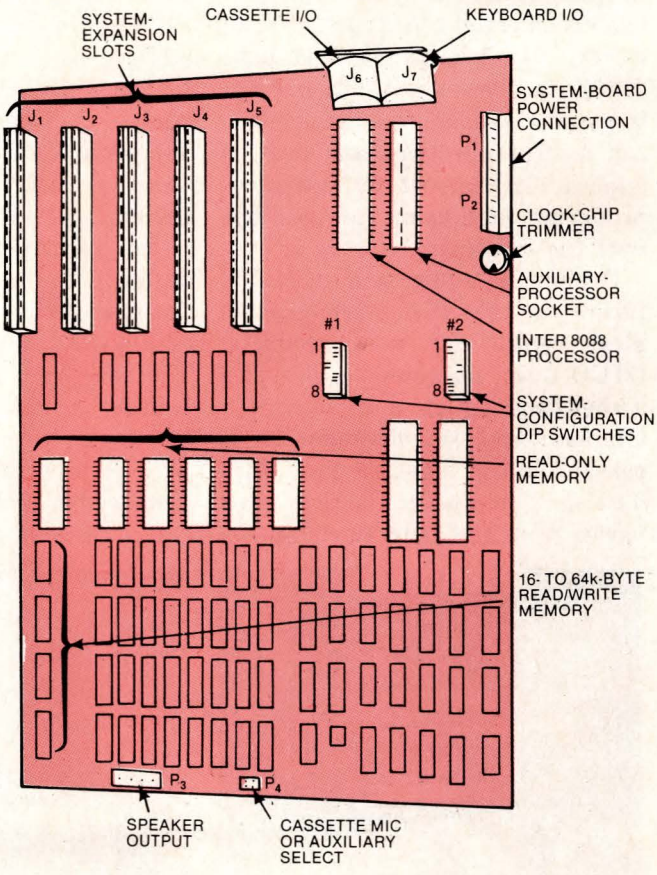
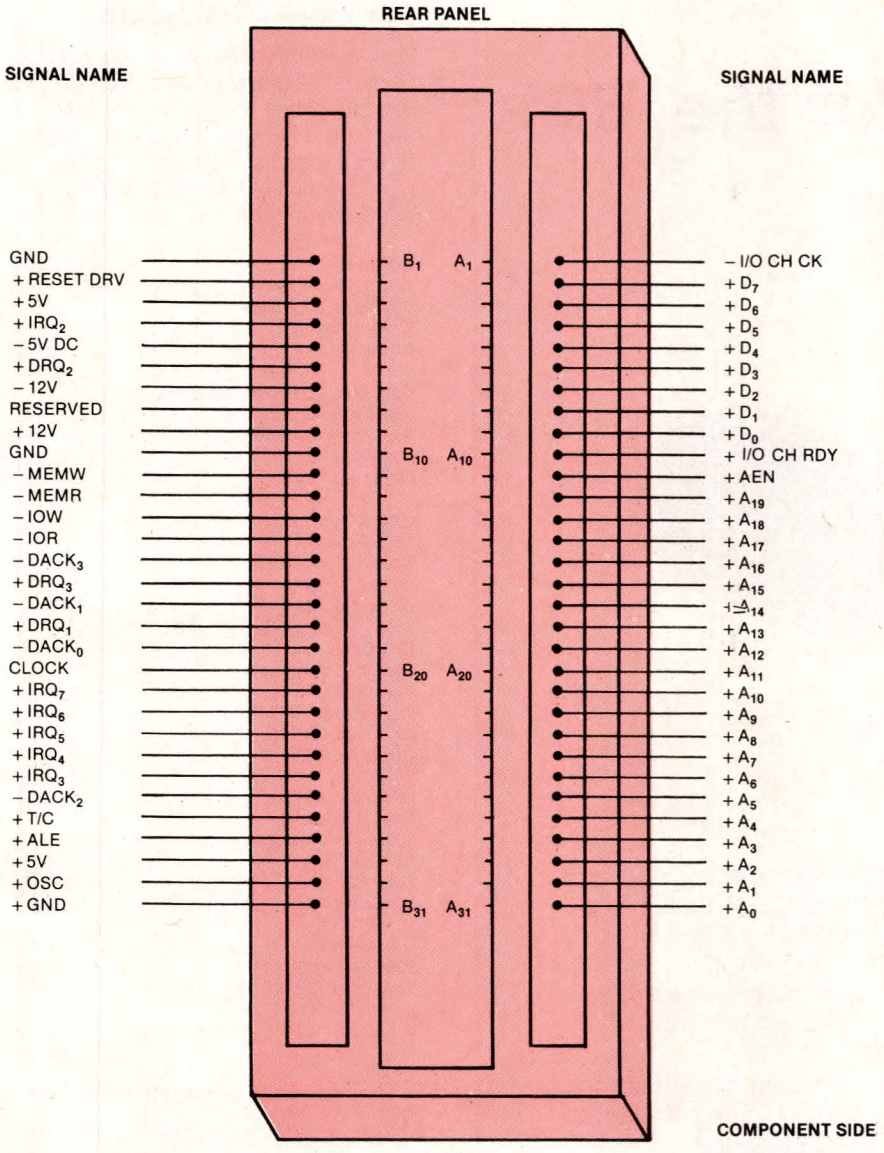


Fig 1—Essentially a single-board unit, *IBM's Personal Computer employs a local bus and expands via five I/O channels mapped into memory space.*



SIGNAL	DESCRIPTION
+ OSC	OSCILLATOR (14.3181 MHz)
CLOCK	CLOCK (4.77 MHz)
+ RESET DRV	RESET DRIVER: RESETS SYSTEM
+ A_0-A_{19}	ADDRESS BITS 0 TO 19
+ D_0-D_7	DATA BITS 0 TO 7
+ ALE	ADDRESS LATCH ENABLE: LATCH VALID ADDRESSES
– I/O CH CK	I/O CHANNEL CHECK: PROVIDES PARITY INFORMATION
+ I/O CH RDY	I/O CHANNEL READY: NORMALLY HIGH
+ IRQ_2-IRQ_7	INTERRUPT REQUEST 2 TO 7
– IOR	I/O READ: LETS I/O DEVICE READ DATA ON TO DATA BUS
– IOW	I/O WRITE: LETS I/O DEVICE WRITE DATA ON TO DATA BUS
– MEMR	MEMORY READ: ACTIVE LOW; USED TO LET MEMORY DRIVE DATA ON TO DATA BUS
– MEMW	MEMORY WRITE: ACTIVE LOW; INSTRUCTS MEMORY TO STORE DATA CURRENTLY ON DATA BUS
+ DRQ_1-DRQ_3	DMA REQUEST 1 TO 3: ANSYNCHRONOUS LINES WITH DRQ_1 HAVING THE HIGHEST PRIORITY
– $DACK_0$-$DACK_3$	DMA ACKNOWLEDGE 0 TO 3: USED TO ACKNOWLEDGE DMA REQUESTS; ACTIVE LOW
+ AEN	ADDRESS ENABLE: WHEN HIGH GIVES DMA CONTROLLER CONTROL OF THE I/O CHANNEL BUS
+ T/C	TERMINAL COUNT: ACTIVE HIGH; USED TO INDICATE WHEN TERMINAL COUNT FOR DMA CHANNEL IS REACHED

Fig 2—Each of five 62-pin I/O channels *provides expansion in the IBM Personal Computer. They're designed for edge-connector cards with 100-mil tab spacing and provide 20 bits of addressing, an 8-bit bidirectional data bus and DMA.*

Increase the IBM bus's 5-slot capacity *with the $945 PCMate expansion chassis from Tecmar (unit immediately above keyboard). The chassis furnishes seven additional channels.*

the movement of robotic arms. Thus, you'll be able to use the Personal Computer to develop an artificial-intelligence system that not only performs tasks, but also recognizes images.

Tecmar VP for marketing David Wertman asserts that buyers of IBM's new system will be searching for precisely this type of broad-based application capability. He contends that the μC's architecture and basic computing power make it an ideal laboratory tool; it should therefore find as much use in the lab as it does in business settings.

More than 50,000 Personal Computers have reportedly been ordered, and IBM expects to install 200,000 by year's end. However, most independent design houses have committed a smaller amount of resources to add-on designs than Tecmar. Typically, most are planning to jump into the market with one or two products.

Data Mac Computer Systems, for example, offers a $499 64k-byte memory board, which expands (on board) to 256k bytes for approximately $1200. Additionally, the Microsoft Consumer Products Div plans a 256k-byte memory add-on (designed by Burtronix), also for roughly $1200. This RAMCard employs 64k×1 devices; as with the Data Mac card, you can enable or disable its parity.

Finally, even though Burtronix is best known as an R&D house that develops products for others to

For more information...

For more information on the IBM Personal Computer and its add-ons described in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Burtronix
18472 Jocotal Lane
Villa Park, CA 92667
(714) 974-6171
Circle No 722

Data Mac Computer Systems
680 Alamanor Ave
Sunnyvale, CA 94086
(408) 735-0323
Circle No 723

GTCO Corp
1055 First St
Rockville, MD 20850
(301) 279-9550
Circle No 724

IBM Corp
Information Systems Div
Box 1328
Boca Raton, FL 33432
(305) 998-6007
Circle No 725

Microsoft Consumer Products Inc
10700 Northrup Way
Bellevue, WA 98004
(206) 828-8080
Circle No 726

Tecmar Inc
23600 Mercantile Rd
Cleveland, OH 44122
(216) 464-7410
Circle No 727

market, it, too, plans to climb on the IBM bus. An $80 prototyping card and an as-yet-unpriced extender card will be its first offerings.

Additional Personal Computer add-ons are on the way. Many observers, such as San Francisco consultant Jim Edlin, foresee at least 100 companies supplying such devices. Interestingly, though, no supplier has yet developed communications capability in the form of a network server. But industry analysts expect one soon to appear. IBM itself could also be working on such a product. **EDN**

Article Interest Quotient
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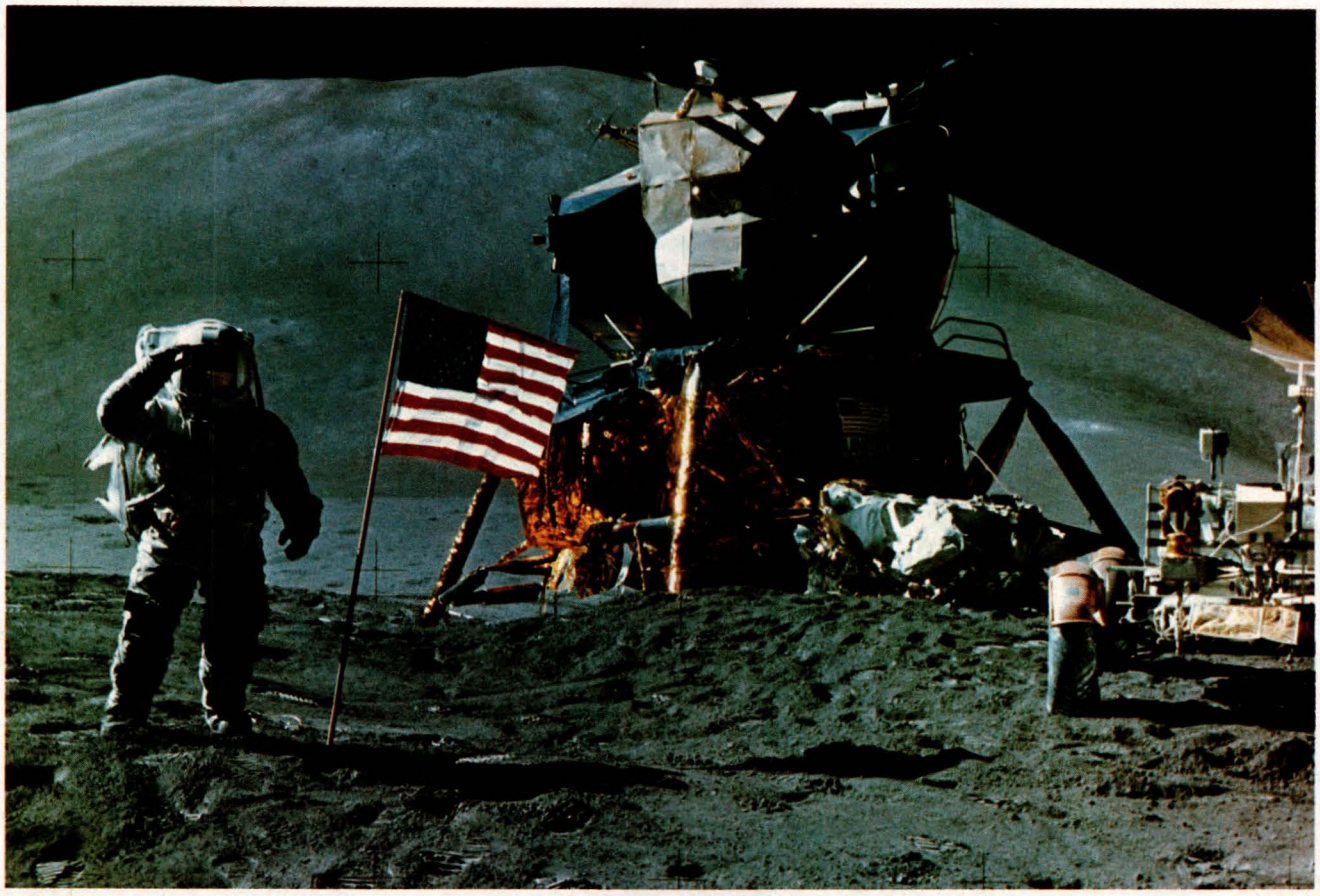
When reliability is imperative.



Abbott Military Power Supplies have performed successfully during the past 20 years in the most demanding environments known, including such diverse applications as Apollo, F-111 and Trident programs.

At Abbott, reliability is the prime consideration. Quality assurance begins with the basic design. Each military power supply is inspected or tested no less than 41 times during assembly to ensure that its performance exceeds published specifications before it is encapsulated and hermetically sealed.

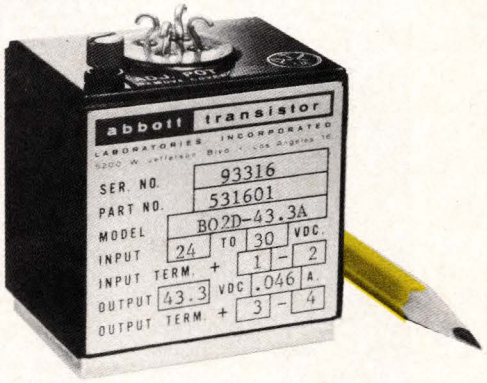
Abbott offers four models of DC to DC converters for your specific military application. The high performance Model C provides exceptional line and load regulation of 0.1% and peak to peak ripple of less than 50 millivolts. The CC dual output version is available in 20 output voltage ranges with tracking accuracy of better than 1%. Model B provides high reliability at less cost than the Model C. Single output BN and dual output BBN high efficiency switchers have a wide input range of 20 to 32 VDC. All units perform over the full military temperature range of −55°C to 100°C. For full information, write or call: Abbott Transistor Laboratories, Inc., Power Supply Div. Western offices: 5200 W. Jefferson Blvd., Los Angeles, CA 90016. 213/936-8185. Eastern offices: 1224 Anderson Ave., Fort Lee, NJ 07024. 201/224-6900. New England: (617) 272-5676

Send for Full Line Catalog. 1,355 Models

DC to DC CONVERTERS

MODEL	TYPICAL MTBF*	OUTPUT VOLTAGE RANGE	OUTPUT POWER RANGE (WATTS)
C	277,000	5-100	10-100
CC	176,000	±3-±30	3-210
B	626,000	5-500	2-170
BN	112,000	5-48	25-100

*Ground benign 50°C baseplate temperature per MIL-HDBK-217C

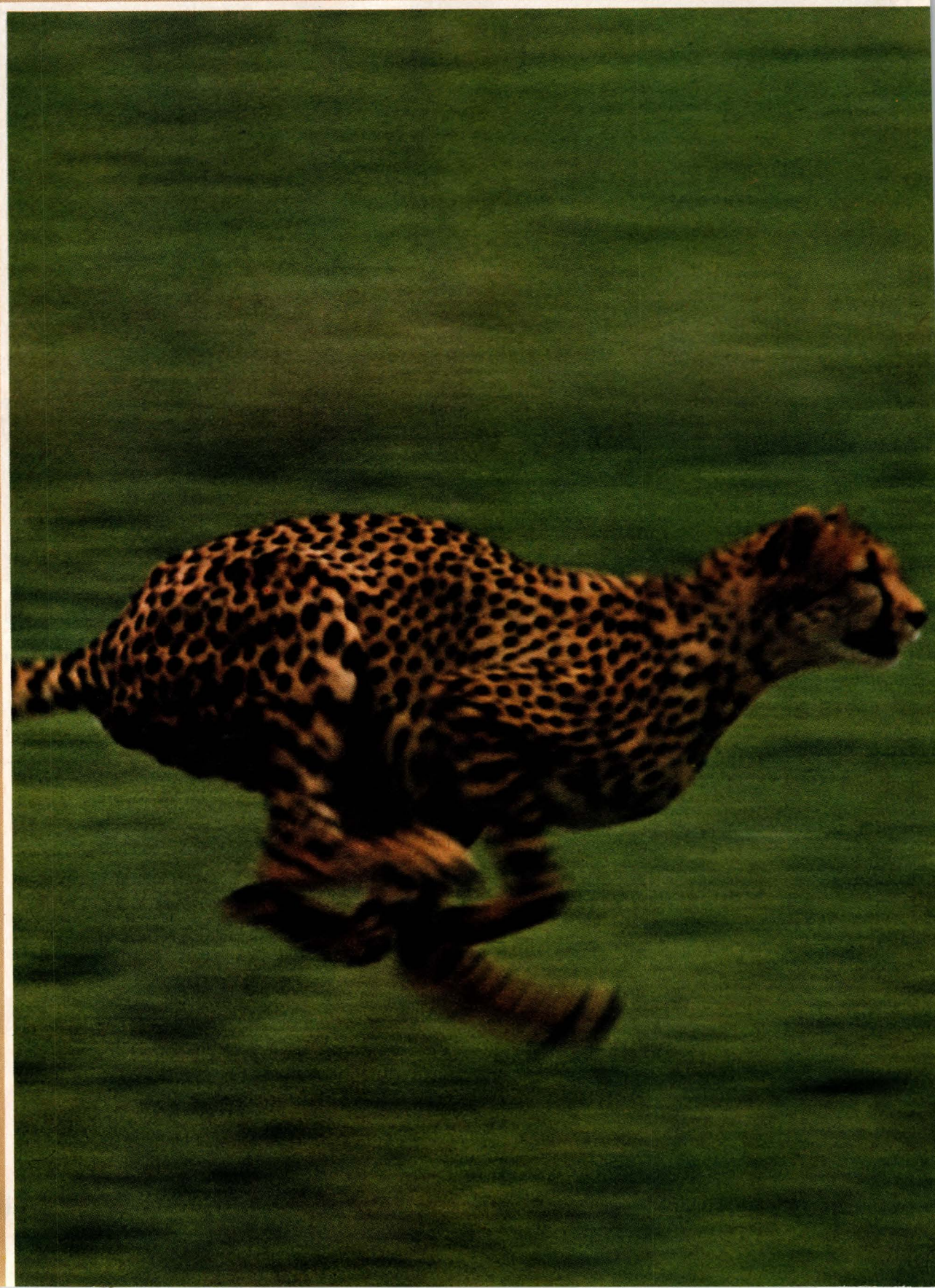


abbott

MILITARY POWER SUPPLIES

CIRCLE NO 53

AMI gets you into production



before your market slips away.

You know the advantages of custom circuits. Superior performance. Reduced component count. Less power consumption. Proprietary protection. And lower costs in production. But you're concerned about development time.

Well, don't be.

AMI delivers more custom approaches than anyone else. And one of them is just right for getting you to market quickly.

The right solution. AMI has a full spectrum of custom solutions. Like semi-custom logic arrays. Computer drawn standard cells. Computer-aided designs. Hand drawn design. Or we can teach you how to design your own circuits and fabricate for you.

One of these options is the right one to replace your standard logic and get you to market at the lowest possible cost, in the shortest possible time. No matter what stage your project is in—masks, design, or blue sky.

Solutions on time. What's more, AMI has more experience than any other company in delivering these custom solutions. More experience in evaluation. Specification. Logic design. Layout. Prototype. Production. And our process technologies—NMOS, CMOS, or PMOS—are ready when you are, whether your designs are digital or analog.

Quality you can depend on. With over 15 years experience in MOS/LSI technology, with more custom circuit designs in use than anyone else, with more expertise, technology, and facilities at our disposal, no one can offer you more than AMI. Proven, reliable circuits, inspected and tested to our 0.1% AQL or your custom specifications.

And no one can deliver them more quickly.

Outpace your competition. To find out more about what we do and how fast we can do it for you, just call Custom Marketing at (408) 554-2150. Or send in the coupon below.

After all, if you're going to put some distance between yourself and the rest of the pack, don't wait any longer.

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American Microsystems, Inc.

The most natural solutions in MOS.

I want to know more. And I want to know it fast!

___ Send me your capabilities brochure, "The AMI Spectrum of Custom Solutions."

___ Send me your most amazing custom circuits' case histories.

___ Have a field engineer call me.

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Company _____ Phone ( ) _____

Address _____ M/S _____

City _____ State _____ Zip _____

Send to: AMI Custom, 3800 Homestead Road, Santa Clara, CA 95051

EDN 3-17

COTO SETS THE PACE IN RELAY TECHNOLOGY.

HIGH PERFORMANCE RELAYS: Coto relays are built for endurance. So, only the highest quality materials are used. From low-moisture absorbent materials to state-of-the-art reed switch contact plating materials.

UNBEATABLE QUALITY: Every reed switch and completed Coto relay undergo an extensive series of cycling and dynamic testing to monitor their quality throughout the manufacturing process. Coto relays assure designed-in performance especially in critical low-level or dry-circuit conditions.

ALL-AROUND PERFORMANCE: Whatever the application, you'll find Coto quality-engineered relays making the rounds. In fact, you'll find them in a variety of markets that include: Computers and Computer Peripheral Equipment, Data Acquisition Devices, Automatic Test Equipment , Test Instrumentation, Medical Electronics Equipment and Telecommunications, to name just a few.

RUN WITH COTO: No matter how unique your relay requirements, Coto design engineers are ready to meet them. With specialty relays that not only conform to your individual specifications but hold up under Coto "High Reliability Testing Procedures."

Next time you're looking for relays that go the distance, run with Coto. For more information, contact: Coto Corporation, 65 Pavilion Avenue, Providence, R.I. 02905. (401) 467-4777.

COTO CORPORATION

CIRCLE NO 54

Firms from throughout Europe to introduce products at Paris show

Barrie Nicholson,
European Editor

France's premier electronics exhibition, Salon International des Composants Electroniques, gets underway in Paris on April 1 for a 1-wk run. Now in its 25th year, the event shares the distinction, with West Germany's Electronica, of being a primary showcase for the European electronics industry.

The show's title is somewhat misleading—the exhibition has outgrown its original concentration on components and now covers the entire spectrum of electronics. Thus, although components account for the majority of exhibits, you'll also find many exhibitors in test-and-measurement instrumentation, packaging and production.

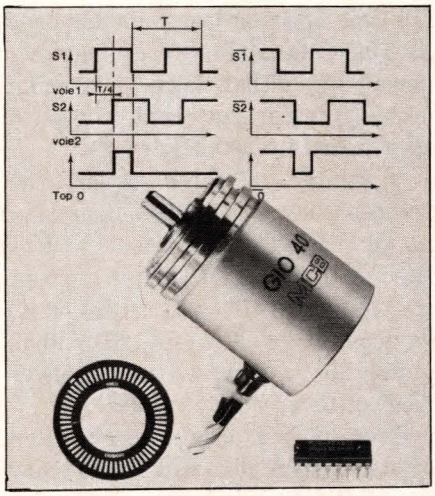
And if your energy level runs low after visiting some of these exhibits, you can sit in on several informal free technical sessions reviewing new products and technology.

Composants is a truly international show—more than 1000 of last year's 1745 exhibitors came from 34 countries outside France. The US, West Germany and the UK accounted for 678 of them. Attendance is international as well: Of last year's 95,000 attendees, more than 10,000 crossed the French border to visit the show's 77,000-m^2 of exhibits. They found that language constituted only a small barrier—the show guide is in three languages (English, German and French).

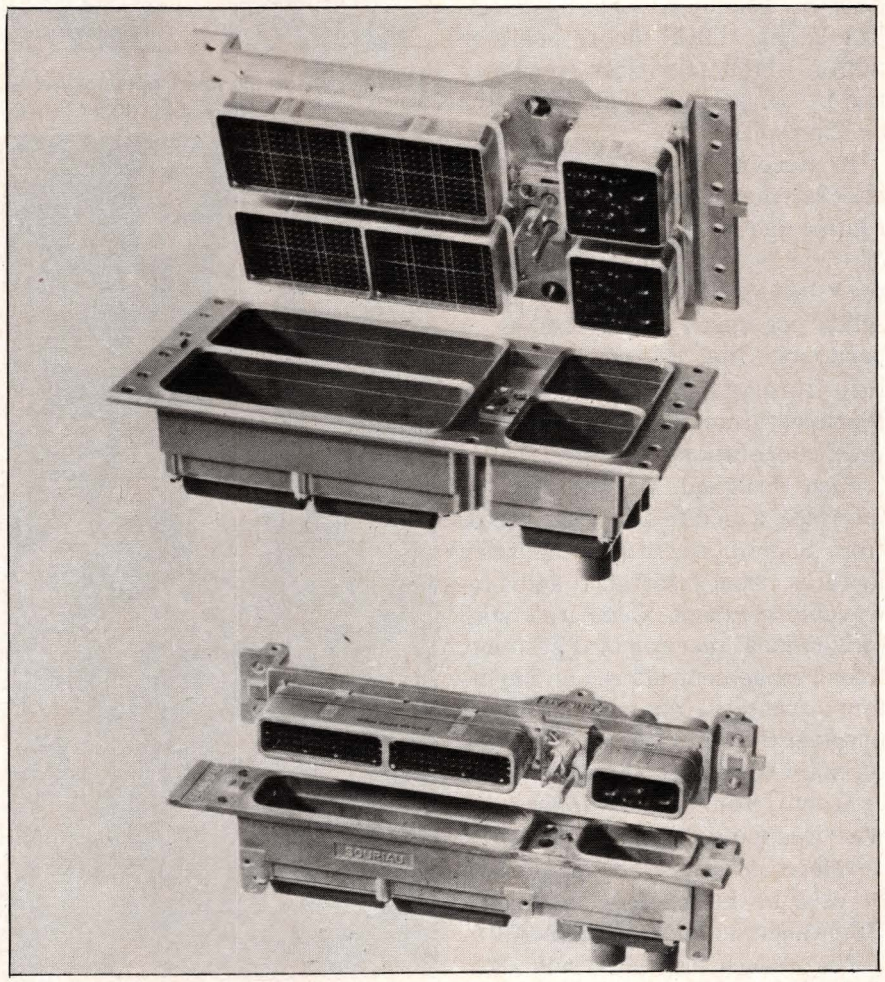
Salon des Composants's position in the marketing calendar ensures that visitors will find many product introductions. Companies from the host will set an example.

For instance, the LETI laboratories of the French Atomic Energy Commission (Grenoble) will display solid-state keyboards capable of operation in harsh environments. They differ from standard capacitive keyboards, which reduce susceptibility to electrical interference by decreasing key sensitivity, preventing actuation with gloved hands. To overcome this problem, one LETI keyboard uses a framework that boosts sensitivity by increasing the ratio of active to parasitic capacitance. It also eliminates interference affecting all keys by making a differential measurement between a depressed key and unactivated ones.

Another French firm, Thomson CSF, will show a new series of fast bipolar power transistors. These Superswitch II BUV Series devices



Custom LSI *helps the GIO40 incremental encoder from MCB achieve an MTBF of 100,000 hrs.*



Front-insertable and -removable contacts *make contact replacement a snap on Souriau's S600 connector.*

feature voltage drops of less than 0.9V at $I_{C\ SAT}$, cutting ON-state power losses by 25 to 40% compared with equivalent BUX Series devices. Furthermore, output-current fall time specs at less than 300 nsec at 100°C junction temperature, permitting either lower switching losses or faster switching speeds (to approximately 200 kHz max).

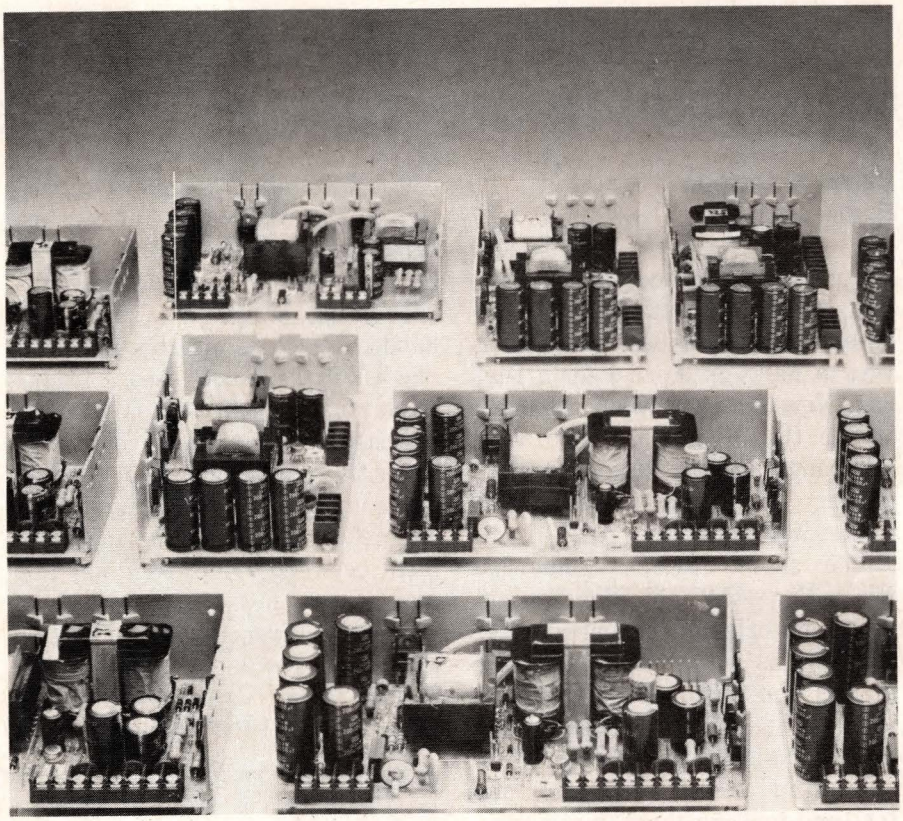
Organized in three series, the devices cover a 90 to 250V operating range: BUV39-42 Series devices spec an operating collector current ($I_{C\ SAT}$) of 6 to 20A; BUV50-52 devices, 10 to 20A; and BUV60-62 units, 20 to 50A, allowing power dissipation as high as 250W.

Thomson will also be represented by its EFCIS Div, which will show the EFA4440 full-duplex transceiver IC for interfacing 6800-based μCs to an ARINC 429 channel (the serial interface used in airborne systems). The 28-pin NMOS device operates with a 1-MHz max clock frequency and in two possible modes: Receive or Transmit.

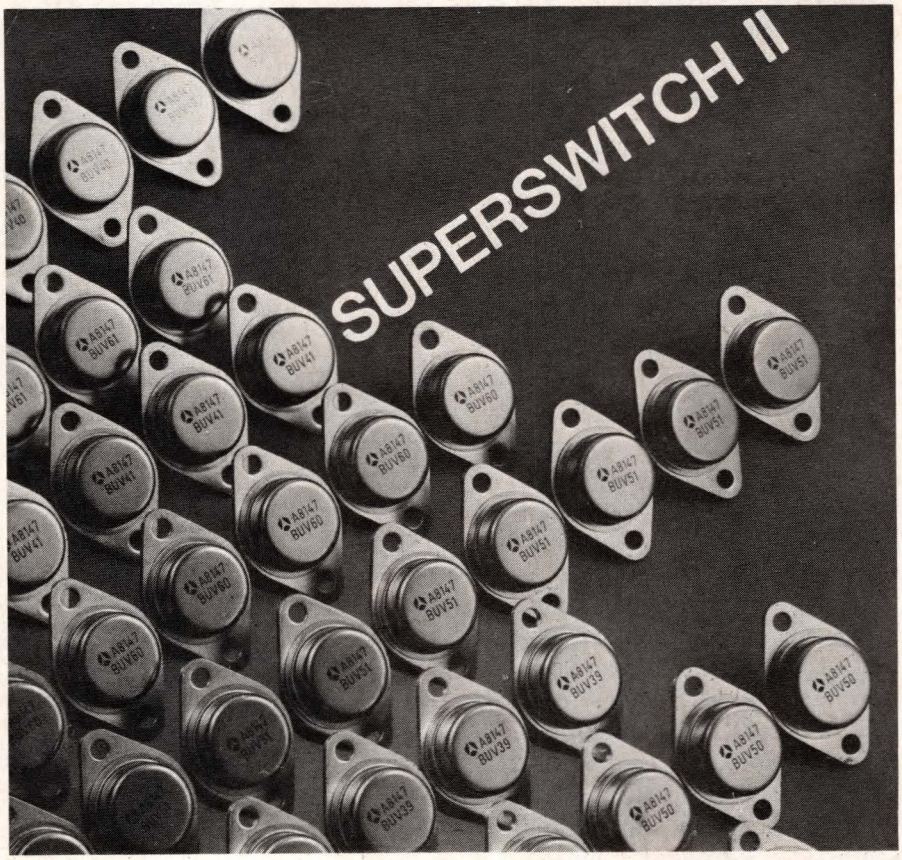
In Receive mode, the EFA4440 checks messages via a parity, routine and stores as many as eight of them in locations dependent on their labels. When transmitting, it sends messages (after adding a parity bit) that the μC introduces into internal memory. It also features simultaneous transmit/receive operation.

Also designed for the ARINC interface, a modified S600 connector from Souriau slated for exhibition features front-insertable and -removable contacts. Compared with conventional rear-removal systems, this arrangement affords an important advantage: You no longer must unsolder the entire connector from a pc board to remove and replace one contact. Similar versions with wire-wrapping contacts are also in development. These connectors will be used in the forthcoming Boeing 767 jetliner and Aerospatiale's A310.

The French firm MCB will show two additions to its Series 40 encoders for positioning and ta-



Eliminating the standard optoisolated feedback loop *reduces component count by an estimated 30% in Gould's Econoflex Series low-power switchers.*



Low ON-state power losses and fast switching *are features of Superswitch II power transistors from Thomson CSF.*

ECONO/SWITCH
THE SWITCHER COST BREAKTHROUGH YOU'VE BEEN WAITING FOR!

Thanks to a new monolithic chip that contains all regulation, modulation and a protective circuitry, Power/Mate now offers top quality switching regulated power supplies at a fraction of the cost of conventional switchers. In many cases even less than the cost of quality linear supplies.

Typical parts count is reduced 20% for a much higher MTBF...well over 50,000 hours... with a one year warranty to back it up. Reliability is greatly improved by use of computer-aided "worst-case analysis," individual testing of every IC and semiconductor, and a comprehensive burn-in program.

The new ES Series boasts well over one watt output per cubic inch, 70-80% efficiency and a 16ms holdup time.

But the big news is dollars per watt, a breakthrough achieved through advanced design and manufacturing techniques. Power/Mate's ES Series switchers set the new standards for value and performance in switching power supplies for years to come.

Features.

- Dual AC inputs
- Brownout protection
- Overvoltage protection
- Overload protection
- Short circuit protection
- Reverse polarity protection
- Soft start protection
- Advanced EMI filtering
- Convection cooled
- Convenient 3-surface mounting
- UL and CSA recognized
- Transient suppressor
- Remote sensing
- Logic Inhibit
- Cover

Specifications.

AC Input. 85-132 and 170-264 VAC, 47-440Hz.
DC Output. See charts.
DC Output Adjustability. ± 10%.
Regulation. Line ±0.1% + 1mV within AC limits specified above. Load ±0.1% + 1mV from no load to full load.
Noise and Ripple. 50mV peak-to-peak max., 20Hz to 200KHz.
Efficiency. 70 to 80%.
Transient Response. Recovery to 1% in 300 microseconds for a 50 to 100% load change.
Remote or Local Sensing. Provision included for improved overall regulation.
Overload and Short Circuit Protection. Solid state short circuit protection. Automatic electronic current limiting circuit limits output current adjustable between 105% and 125% of unit rating, thereby providing protection for the load as well as the supply. Units cannot be damaged by prolonged short circuits.
Overshoot. No voltage spikes on turn-on, turn-off or power failure.
Logic Inhibit Function. A command signal between 4.5 and 5.5V referenced to (–) negative sense terminal will inhibit the DC output. May be used for control, sequencing or maintenance.
Overvoltage Protection. Built-in, fixed.
Energy Storage Time. The output voltage will remain within regulation for a minimum of 16 milliseconds after loss of AC input power (from nominal line voltage).
Polarity. May be either positive, negative or floating up to 300 volts DC.
Soft Start. Provides input current limiting at turn-on.
Parallel Operation. Units may be paralleled for increased output current. Consult factory.
Long-Term Stability. 0.1% for 8 hours after 20 minute warm-up.
Ambient Operating Temperature. Continuous duty from 0°C to 71°C. Full rating from 0°C to 50°C, derate linearly to 60% of rating at 71°C.
Storage Temperature. – 20°C to + 85°C.
Quality Control. In accordance with MIL-I-45208

ES-C Series $85.

MODEL	VOLTS	AMPS
ES-5C	5	3
ES-12C	12	1.5
ES-15C	15	1.2
ES-24C	24	0.75
ES-28C	28	0.65
ES-36C	36	0.5

ES-D Series $89.

MODEL	VOLTS	AMPS
ES-5D	5	6
ES-12D	12	3
ES-15D	15	2.4
ES-24D	24	1.5
ES-28D	28	1.3
ES-36D	36	1.0

ES-E Series $99.

MODEL	VOLTS	AMPS
ES-5E	5	10
ES-12E	12	5
ES-15E	15	4
ES-24E	24	2.5
ES-28E	28	2
ES-36E	36	1.5

ES-F Series $149.

MODEL	VOLTS	AMPS
ES-5F	5	20
ES-12F	12	10
ES-15F	15	8
ES-24F	24	5
ES-28F	28	4
ES-36F	36	3

ES-G Series $189.

MODEL	VOLTS	AMPS
ES-5G	5	30
ES-12G	12	15
ES-15G	15	12
ES-24G	24	8
ES-28G	28	7
ES-36G	36	5

ES-H Series $229.

MODEL	VOLTS	AMPS
ES-5H	5	45
ES-12H	12	22
ES-15H	15	18
ES-24H	24	12
ES-28H	28	10
ES-36H	36	8

ES-J Series $269.

MODEL	VOLTS	AMPS
ES-5J	5	60
ES-12J	12	30
ES-15J	15	25
ES-24J	24	16
ES-28J	28	14
ES-36J	36	10

Case Sizes

ES-C	4.13"x3.25"x1.68"
ES-D	6.12"x3.24"x1.75"
ES-E	4.62"x4.88"x2.00"
ES-F	7.10"x4.88"x2.75"
ES-G	8.60"x4.88"x2.75"
ES-H	10.60"x4.88"x2.98"
ES-J	12.00"x4.88"x3.13"

POWER/MATE. THE SWITCHER COMPANY.

514 S. River St./Hackensack, New Jersey 07601/(201) 440-3100/TWX (710) 990-5023
1400 Coleman Ave., Suite H17/Santa Clara, CA 95050/(408)727-8118/TWX(910)338-0553

The world's largest supplier of quality switching power supplies.
See us at Southcon booth No. 2119-2121

CIRCLE NO 55

Technology Update

chometer applications. The GIO40 incremental encoder reads frequencies as high as 100 kHz and produces as many as 2048 pulses per turn. Its custom LSI circuit reduces the unit to 40 mm in diameter and 55 mm in length and increases MTBF to 100,000 hrs. It also provides two square-wave outputs offset by ¼ period, a square-wave-calibrated zero index and the complement of those signals for accurate data transmission in noisy environments.

MCB's second introduction, the bus-interface-equipped Model CO40A absolute optical encoder, also uses custom LSI for high performance. Its TTL-compatible strobe simplifies the task of connecting multiple encoders to a 9-bit bus.

Many non-French companies will also take advantage of Salon des Composants to introduce their products. For example, two UK power-supply manufacturers will display their open-frame switchers for the first time.

Coutant Electronics claims several cost-saving features for its ML Series. These multioutput supplies use MOSFETs switching at 75 kHz for simplified drive requirements and increased efficiency. Coutant believes that the units provide a cost-effective alternative to custom supplies in quantities as low as 200 units; they use various magnetic amplifiers and a forward-converter technique to form modular circuit

Visit Paris in April

Salon International des Composants Electroniques 1982 will be held at the Parc des Expositions de la Porte de Versailles in Paris from April 1 to 7. For detailed information, contact the show's organizers: Societe pour la Diffusion des Sciences et des Arts, 20 Rue Hamelin, 75116 Paris, France. Phone 505 13 17. Telex 630400F.

For more information...

For more information on the products described in this article, contact the following manufacturers directly.

Centre d'Etudes Nucleires de Grenoble
LETI
Avenue Des Martyrs, 85X
38041 Grenoble Cedex
France
Phone (76) 97 41 11

Coutant Electronics Ltd
Kingsley Ave
Ilfracombe
Devon EX34 8ES
UK
Phone (0271) 63781

Exacta Circuits Ltd
Selkirk, TD7 5EJ
Scotland
Phone (0750) 21601

Gould Power Conversion Division
Raynham Rd
Bishop's Stortford
Herts CM23 5PF
UK
Phone (0279) 55155

MB Electronique
606 Rue Fourny
ZI Centre
78530 Buc
France
Phone 956 81 31

Societe MCB
11 Rue Pierre l'Homme
92400 Courbevoie
France
Phone (1) 788 51 20

Souriau
13 Rue Gallieni, BP410
92103 Boulogne-Billancourt Cedex
France
Phone (1) 609 92 00

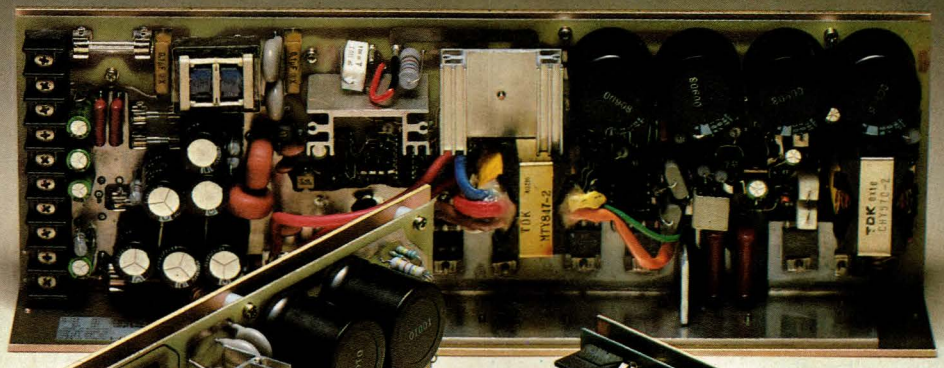
Thomson CSF
Division Semiconducteurs
50 Rue J P Timbaud
92403 Courbevoie
France
Phone 788 50 01

Thomson EFCIS
BP217
38019 Grenoble Cedex
France
Phone (76) 97 41 11

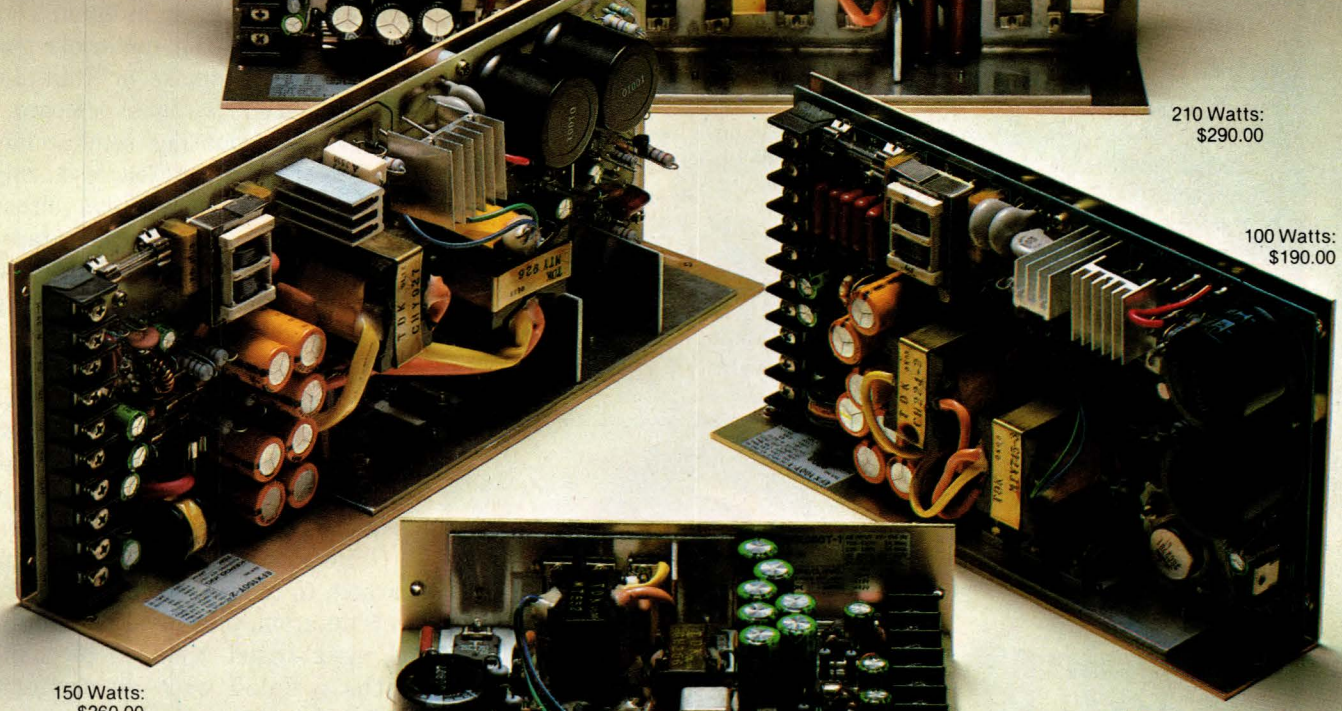
HIGH QUALITY

open frame SWITCHING POWER SUPPLIES

. . . at a very attractive price



210 Watts:
$290.00



100 Watts:
$190.00

150 Watts:
$260.00

50 Watts:
$120.00

Single board, multiple-output, open frame switch-mode power supplies offer you high efficiency, well regulated power at a very attractive price.
The listed prices are for single unit quantities. Please contact us for quantity pricing and a demonstration.

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CIRCLE NO 57

blocks on a CAD database for fast connection. The devices come in 75, 150 or 300W versions with a choice of outputs.

You'll find Gould Power Conversion's Econoflex Series at MB Electronique's booth. These switchers, which provide as many as three output voltages, spec 50 to 100W ratings. They reduce typical component count by approximately 30% by eliminating the optoisolated feedback loop often found in switchers. Instead, they employ a transformer technique whereby the core's regular magnetic excursions influence dwell time and provide control.

Another UK innovation to get its first exposure at the show will be Exacta Circuits's Chipstrate, a family of multiplanar interconnects designed to fill the materials gap between small thick- or thin-film hybrids and conventional pc boards. Capable of mounting semiconductors in leaded or leadless chip carriers or as bare chips either wire-bonded or with spider/tape-automated bonds, the material accommodates the high wiring densities of VLSI circuitry.

Dielectric constants spec from 3 to 5 at 1 MHz, so propagation delays and degradation of high-speed edges are reduced compared with comparable thick-film circuits on ceramic or glazed-steel substrates.

Chipstrate's applications are comparable to those of pc boards. This consideration, plus its incorporation of metal-based conduction-cooling paths coupled with elastomeric dielectrics that reduce mechanical stress on reflow soldered joints, opens up a new area of electronics packaging. Manufacturers can implement large circuits on one substrate without intermediate joints, such as those used when thick/thin-film hybrids are mounted on boards or plugged into sockets. **EDN**

Article Interest Quotient
(Circle One)
***High* 509 *Medium* 510 *Low* 511**

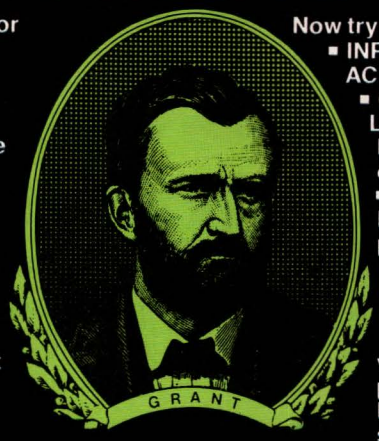
At a buck a watt,

A 50-watt switching power supply for 50 bucks? What a value! Especially when you realize it's a Panasonic. Simple, compact, lightweight construction... and famous Panasonic quality control, for dependable, stable operation, hour after hour, day after day.

Our J Series 50-watt switchers are designed for high efficiency and high frequency operation (50 KHz).

All components are modularized in one printed circuit board.

And we'll even make the switcher available without a case, if that's what your design requires.

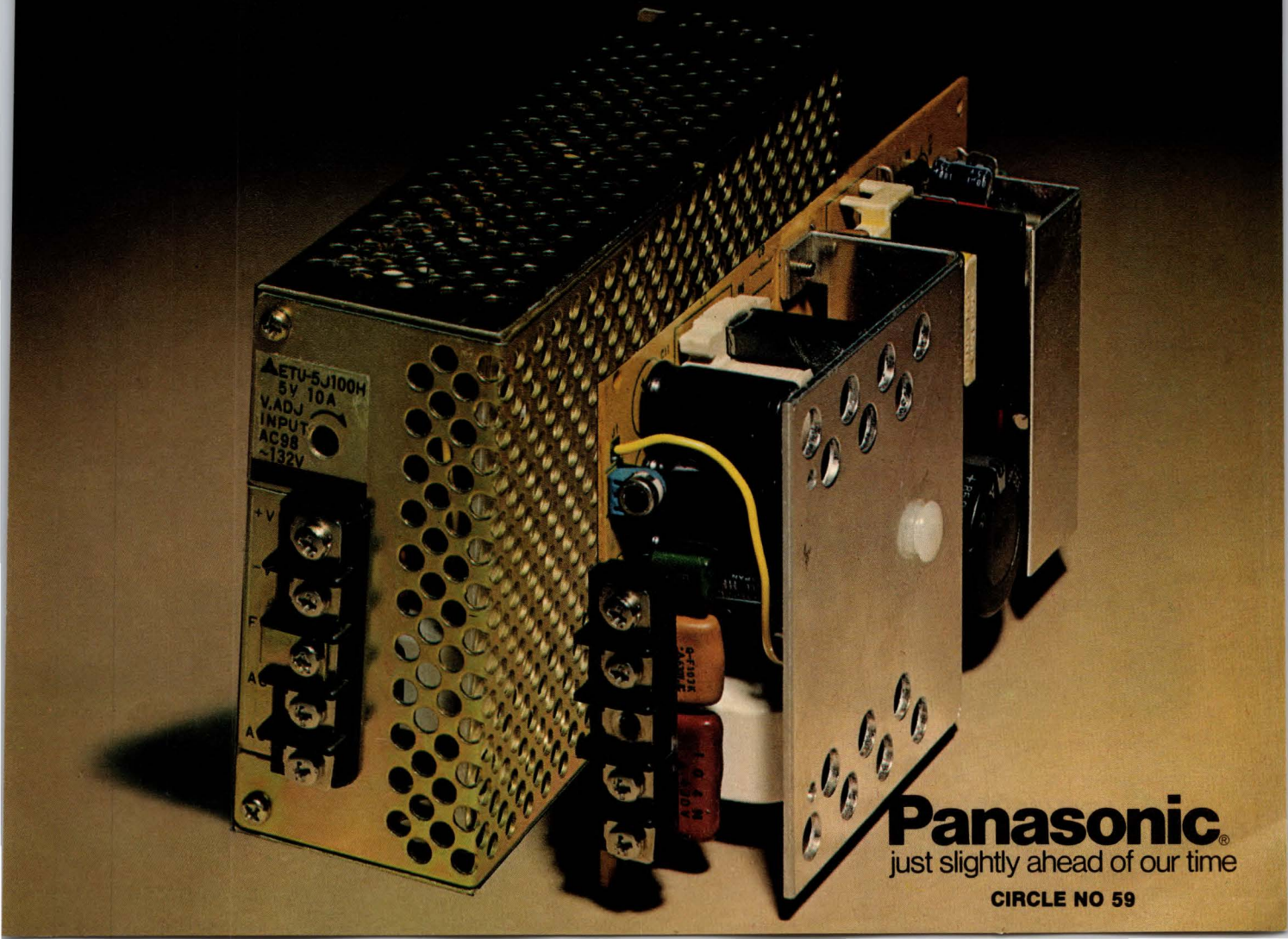


Now try finding these specs at a buck a watt elsewhere:

- INPUT VOLTAGE:
  AC 98-132 Vrms, 1Φ or DC 140-180V
- OUTPUT VOLTAGE REGULATION:
  Line: within 0.5% for full input voltage range
  Load: less than 0.5% from 0-100% of rated output current
- DIFFERENTIAL RIPPLE & NOISE:
  Less than 0.5% plus 75 mV of output voltage peak to peak value
- TEMPERATURE DRIFT: Within 0.5%
- ADJUSTABLE RANGE OF OUTPUT VOLTAGE:
  ±10% or over

To find out more about the "buck a watt" value of our J Series switching power supplies, write or call today: Panasonic Company Electronic Components Division, One Panasonic Way, Secaucus, NJ 07094; (201) 348-5283.

Panasonic dares you to find a better 50W switching power supply value.



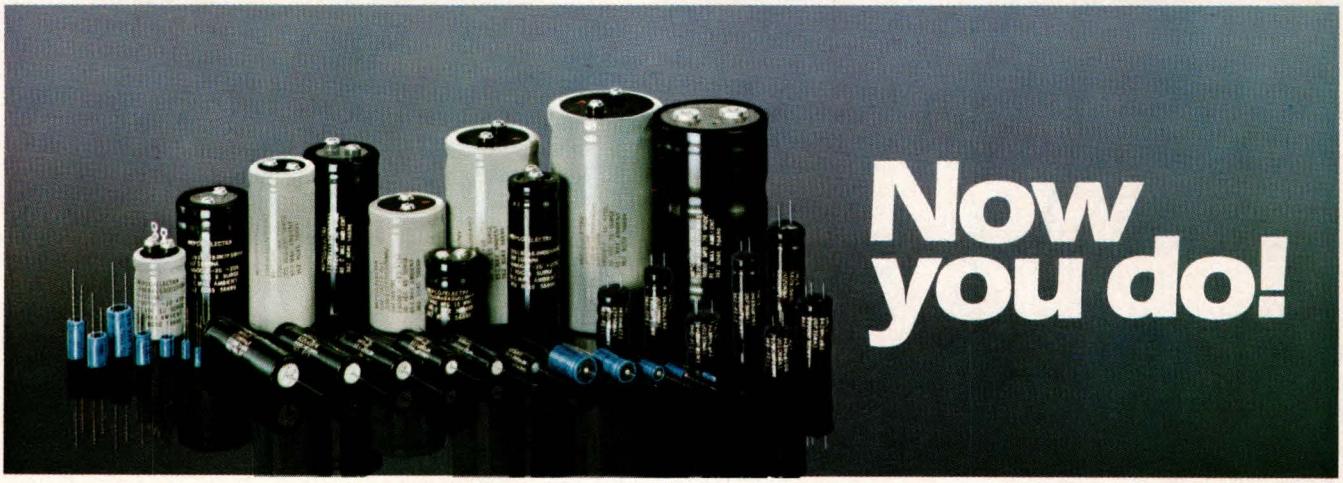
Panasonic®
just slightly ahead of our time

CIRCLE NO 59

Did you know the other "one-stop source" for power supply 'lytics (Mepco/Electra!) gives you more design options?

Look what Mepco/Electra, "The preferred source" has available for you...

Product Series			3050	3070	3120	3186	3187	3188	3191	3428	3475
Power Supply Rating	<100W	Input	✓	✓			✓				✓
		Output	✓	✓						✓	✓
	250W to 500W	Input				✓		✓			
		Output	✓							✓	
	>1000W	Input				✓		✓			
		Output			✓				✓		
Mounting Style Options	Direct P.C. Board		✓	✓			✓		✓	✓	✓
	Buss Bar				✓	✓		✓	✓		
Capacitance Range (μF's)			3-28,000	.33-4,700	110-700,000	75-1,000,000	30-73,000	80-600,000	2800-200,000	19-17,000	.47-4,700
Voltage Range (WVDC)			6-450	6.3-100	6-300	5-450	6-450	5-450	5-55	6.3-250	6.3-100
Case Size (inches)			.500x1.125 thru 1.000x3.625	.177x.433 thru .728x1.201	1.375x2.125 thru 3.000x8.625	1.375x2.125 thru 3.000x8.625	1.000x1.500 thru 1.375x5.000	1.375x2.125 thru 3.000x8.625	1.375x2.125 thru 2.000x5.625	.750x1.125 thru 1.000x3.625	.217x.472 thru .650x1.260
Operating Temp. Range			−40 to +85°C	−40 to +85°C	−55 to +105°C	−40 to +85°C	−40 to +85°C	−40 to +85°C	−55 to +85°C	−55 to +105°C	−40 to +85°C



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CIRCLE NO 60

Leadtime Index

ACTIVE COMPONENTS

PRODUCT	LEADTIME IN WEEKS Min.	Max.	Trend
DISCRETE SEMICONDUCTORS			
Diode, switching	2	6	=
Diode, zener	3	8	⬦
Rectifier, low-power	2	6	▼
Rectifier, power	1	6	▼
Thyristor, low-power	1	8	=
Thyristor, power	2	8	=
Transistor, bipolar power	2	9	▼
Transistor, bipolar signal	2	8	▼
FET, power	2	6	▼
FET, signal	2	6	▼
Transistor, RF power	4	9	▼
DISPLAYS			
Fluorescent	2	9	=
Gas-discharge	2	10	=
Incandescent	4	9	=
LED	5	11	⬦
Liquid crystal	2	12	=
Plasma panel	6	15	=
ELECTRON TUBES			
CRT, black and white TV	10	22	=
CRT, color TV	10	18	⬦
CRT, industrial	4	18	=
Industrial power	5	15	=
Light and image sensing	2	10	=
Microwave power	7	12	=
INTEGRATED CIRCUITS, DIGITAL			
CMOS	4	8	=
Diode transistor logic (DTL)	4	6	=
Emitter-coupled logic (ECL)	5	13	=
Low power Schottky TTL	4	17	=
Standard Schottky TTL	6	18	=
Standard TTL	4	6	▼
INTEGRATED CIRCUITS, LINEAR			
Communications circuit	6	14	=
Data converter	6	10	▼
Interface circuit	7	13	=
Operational amplifier	2	7	=
Voltage regulator	1	6	=

PRODUCT	LEADTIME IN WEEKS Min.	Max.	Trend
MEMORY CIRCUITS			
EPROM	2	4	=
PROM, bipolar	2	4	=
RAM, bipolar	4	8	▼
RAM, CMOS	2	10	▼
RAM, 4k MOS dynamic	2	10	⬦
RAM, 16k MOS dynamic	2	10	⬦
RAM, 1k MOS static	2	8	⬦
RAM, 4k MOS static	2	10	▼
ROM, masked MOS	2	10	▼
MICROCOMPUTER/MEMORY SYSTEMS			
Core memory board	3	7	=
IC memory board	5	11	▼
Interface board	2	8	=
Microcomputer board	6	12	▼
MICROPROCESSOR IC'S			
CPU, bipolar bit slice	4	15	⬦
CPU, 4-bit MOS	4	10	=
CPU, 8-bit MOS	3	10	=
CPU, 16-bit MOS	4	10	=
Peripheral chip	4	12	=
OPTOELECTRONIC DEVICES			
Coupler and isolator	5	8	=
Discrete light-emitting diode	2	8	=
PACKAGED FUNCTIONS			
Amplifier, instrumentation	4	10	=
Amplifier, operational	1	6	=
Amplifier, sample/hold	3	10	=
Converter, analog/digital	6	10	⬦
Converter, digital/analog	6	11	=
PANEL METERS			
Analog	9	17	=
Digital	5	10	=
POWER SUPPLIES			
Custom	9	20	=
Enclosed modular	8	15	⬦
Open-frame module	12	16	=
Printed circuit	10	15	▼

Leadtimes are based on recent figures supplied to *Electronic Business* magazine by a composite group of major manufacturers and OEMs. They represent the typical times necessary to allocate manufacturing capacity to build and ship a medium-sized order for a moderately popular item. Trends represent changes expected for next month.

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CIRCLE NO 61

High-speed coaxial modems feature STD Bus compatibility

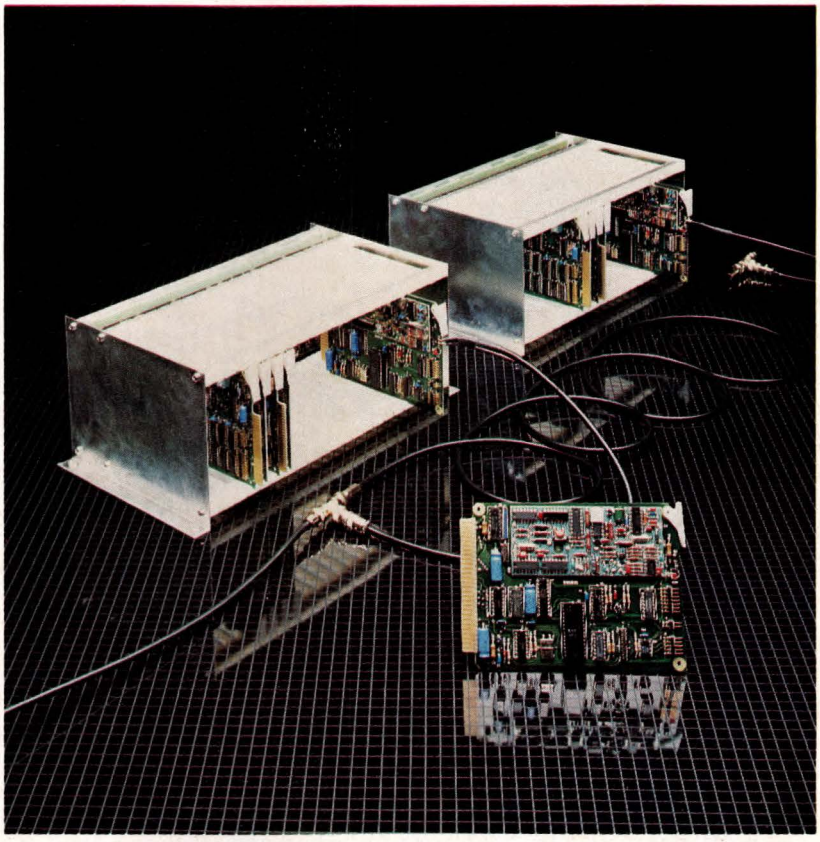
Satisfying all mechanical and electrical STD Bus requirements, SB8601/SB8602 modems accommodate high-speed data transfers between μC systems on dedicated coaxial-cable links.

The SB8601 includes an asynchronous/synchronous serial-interface port that drives an on-board modem at 19.2k baud max to accommodate local-area-network or gateway operation. The SB8602, providing only a modem, is designed to work with the manufacturer's SB8451 synchronous data-link controller —a combination that supports high-level data-block exchanges (complete with error checking) at 1 MHz.

Both units operate in half-duplex mode in point-to-point or multidrop party-line configurations. You connect to the system with a BNC T connector.

Because of their wide dyanmic range, you can connect the 8601/8602 to any point on the system cable without gain adjustment or adjacent-modem overload. FSK modulation with a 3-MHz carrier and additional filtering provide EMI/RFI noise immunity.

Typical modem features include 1V p-p output and transmission lengths to 5000 and 12,000 ft for RG-59 and RG-11 coax, respectively. The devices exhibit a 2-μsec carrier-on-to-transmit data delay and a 12-μsec carrier-off-to-carrier-on delay. Receiver input impedance (single ended) equals 50 kΩ min; receiver dynamic range measures 30 dB with normal-mode rejection of 10V at 60 Hz.



Simplify dissimilar-μC-system coupling *by employing the STD Bus-compatible SB8601/SB8602 coaxial modems and SB8451 SDLC controller in a stand-alone network-server configuration.*

Error rate specs at less than 10^{-12} typ for a 20-dB signal-to-noise ratio.

Stand-alone network server

By combining an SB8601 or SB8602 in an STD card cage with a μP board and SB8451 controller, you can create a powerful network server for handling one or several nodes at the same time, depending on the basic server architecture. To satisfy specialized needs, such as a file server, you can add a disk-controller card.

In gateway operation, the modem combination furnishes the necessary system-to-telephone line connections. Moreover, the SB8451 permits full emulation of IBM synchronous protocols, includes 16-bit CRC with each data frame and is compatible with RS-422 interface levels.

Model SB8601, $540; Model SB8602, $510; Model SB8451, $350 (10).

Micro/Sys, 1367 Foothill Blvd, La Canada, CA 91011. Phone (213) 790-7267.

Circle No 452

BOONTON'S NEW RF MICROWATTMETER

Simple, But Not Simple-Minded

Most instruments with microprocessors work like a charm under controller command — but they can be a real puzzle when you try to operate them manually. Boonton's new 4210 is microprocessor-based, but with a difference: It is designed to simplify **manual** r.f. power measurements.*

- Zeroing is automatic: one button stores and corrects for zero offsets.
- Ranging is automatic: select either Power or dBm mode and the 3½ digit display and annunciators show the value.
- Ratios are automatic: any reading may be used as a reference, and later readings displayed in dB relative to that reference.

The 4210 may be ordered with a variety of Boonton power sensors. Diode sensors, featuring high sensitivity, low drift, and a 70 dB dynamic range, are available for power levels from 1 nW (-60 dBm) to 100 mW (+20 dBm) and frequencies from 200 kHz to 18 GHz. Thermocouple sensors, with true r.m.s. indication, cover 1 μW (-30 dBm) to 10 mW (+10 dBm), 10 MHz to 18 GHz.

For more information, or a convincing demonstration, call Boonton Electronics or your local representative ....keep the puzzlement out of measurement!

*For **programmable** applications, ask about the Model 4200. It offers full bus compatibility, and is available with dual input channels for direct measurement of reflection coefficients.

BOONTON ELECTRONICS CORP.
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(201) 887-5110

SEE US AT SOUTHCON BOOTH 4327

CIRCLE NO 62

High-reliability open-frame supplies serve domestic/foreign applications

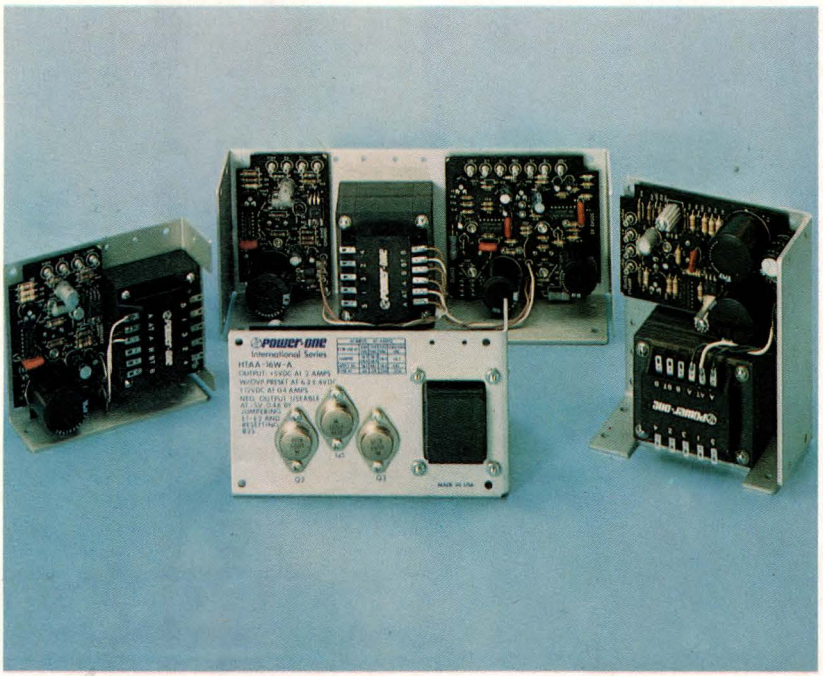
The International Series, a high-reliability line of open-frame linear power supplies, operates from the wide range of ac power sources used worldwide. This feature greatly simplifies inventory and service considerations by letting you use one standard power supply regardless of end-product destination. The supplies also satisfy many VDE, UL, CSA, IEC, CEE and ECMA safety and electrical requirements.

You can jumper-select input voltages of 100, 120, 220 or 230/240V ac (+10%/−13%) over 47 to 440 Hz. The supplies come in single-, dual- and triple-output versions. Single-output models have output voltages of 5, 12, 15, 24 and 28V with 3 to 18A current capability. Dual-output units provide ±5, ±12 or ±15V outputs at 800 mA to 6A; triple-output models deliver the same levels at 400 mA to 12A.

All supplies spec ±0.05% line regulation (10% change) and ±0.05% load regulation (50% change). For a 50% load change, transient response equals 50 μsec. Typical efficiency ranges from 45% for 5V units to 60% for 24V models. Output ripple specs at 5 mV max for 5,12 and 15V.

Extensive protection

All supplies feature automatic current-limit short-circuit protection and foldback overload protection. Overvoltage protection (set at 6.2±0.4V) comes standard on all 5V outputs but is optional on others. Most versions have remote sensing with open-sense-lead protection.



To simplify inventory and service considerations, *International Series open-frame supplies are designed to operate from ac power used in various parts of the world.*

The supplies operate over 0 to 50°C at full rated output; they derate linearly to 40% at 70°C. TC equals ±0.03%/°C max, and stability (after 1-hr warmup) specs at ±0.3% for a 24-hr period. $32.95 (15W single output) to $129.95 (105W triple output).

Power-One Inc, Power One Dr, Camarillo, CA 93010. Phone (805) 484-2806.

Circle No 453

The Best In ROMs From Synertek.

That's no idle boast. And there's one word that tells why. Versatility. It's the key to our unmatched success in manufacturing ROMs. And essential to your needs.

To give you that versatility, we offer two basic options: our Low Cost Option and our Quick Turn Option.

When Cost Is Key. For high volume needs, our Low Cost Option is your answer. By taking advantage of normal lead time requirements, this economical option starts at the very beginning and utilizes the diffusion programming technique common to the entire line of Synertek ROMs. And, because we start at the beginning, we can take advantage of all cost saving opportunities available along the way.

When Time Tells All. For small volume and prototype requirements when time is all important, Synertek's Quick Turn Option is your answer. Within a matter of weeks, you can have Synertek ROMs at work for you.

That's because – even before you call on Synertek – we've already begun the manufacturing process. So that when you do call, we've got wafers at advanced stages in the manufacturing flow thanks to our constantly maintained strategic inventory of partially completed generic wafers. Determined by your exact needs, we can start manufacturing your ROMs at either the implant, contact or metal-mask programming stages.

	Organization	Access Time (Max)	Operating Current (Max)	Standby Current (Max)	No. of Pins	Compatible EPROM
SY2316B	2048x8	450ns	98mA	–	24	2716
SY2316B-2	2048x8	200ns	98mA	–	24	2716
SY2316B-3	2048x8	300ns	98mA	–	24	2716
SY2332	4096x8	450ns	100mA	–	24	TMS2532
SY2332-3	4096x8	300ns	100mA	–	24	TMS2532
SY2333	4096x8	450ns	100mA	–	24	2732
SY2333-3	4096x8	300ns	100mA	–	24	2732
SY2364	8192x8	450ns	100mA	–	24	TMS2564
SY2364-2	8192x8	200ns	100mA	–	24	TMS2564
SY2364-3	8192x8	300ns	100mA	–	24	TMS2564
SY2364A	8192x8	450ns	100mA	12mA	24	TMS2564
SY2364A-2	8192x8	200ns	100mA	12mA	24	TMS2564
SY2364A-3	8192x8	300ns	100mA	12mA	24	TMS2564
SY2365	8192x8	450ns	100mA	–	28	2764
SY2365-2	8192x8	200ns	100mA	–	28	2764
SY2365-3	8192x8	300ns	100mA	–	28	2764
SY2365A	8192x8	450ns	100mA	12mA	28	2764
SY2365A-2	8192x8	200ns	100mA	12mA	28	2764
SY2365A-3	8192x8	300ns	100mA	12mA	28	2764
SY23128	16384x8	*Future Availability*				
SY23256	32768x8	*Future Availability*				

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CIRCLE NO 63

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EDN-3

CIRCLE NO 64

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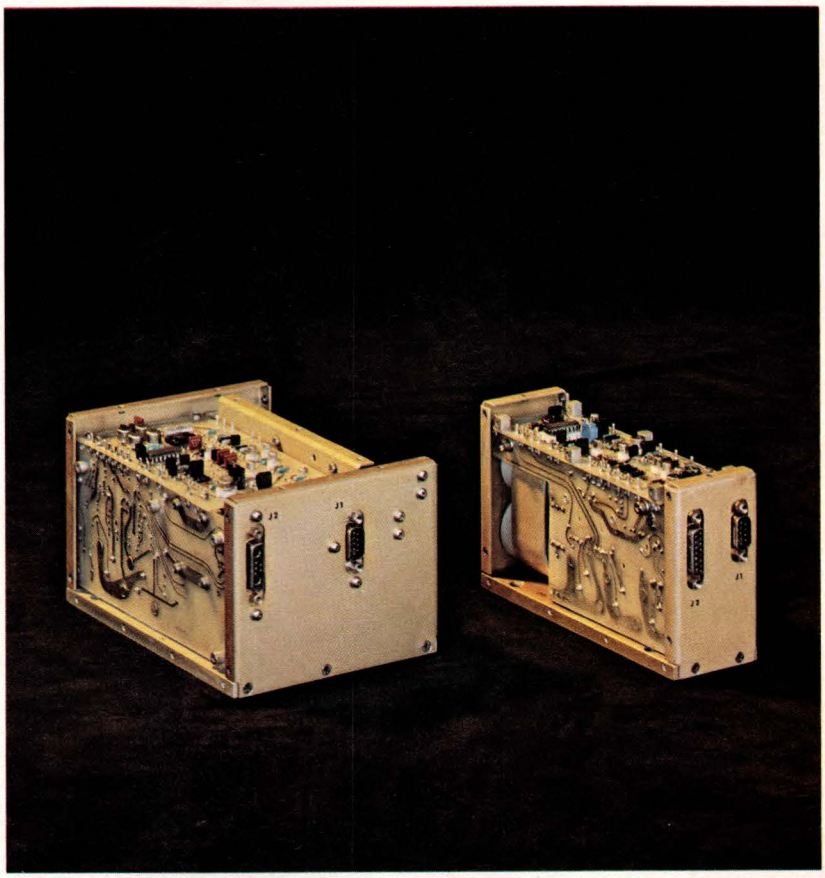
Standard switching power supplies meet tri-service MIL specs

Series 1000 switching power supplies are designed to meet the demands of tri-service military qualification, including shipboard-shock and airframe-vibration requirements. They feature a single-base-drive transformer with current feedback that virtually eliminates cross conduction. Thus, as one switching transistor turns on, the other is forced off, eliminating simultaneous conduction through both transistors and thereby minimizing currents and component destruction.

Features include ±1% max line and load regulation (typically 0.1%), inrush surge protection and soft start, remote sense and foldback current limiting (110%±10% with foldback to 25% of rated current).



Cross-conduction problems are eliminated *by the single-base-drive transformer design employed in Series 1000 switching supplies.*

The supplies spec a power density of 1.2 to 2.5W/in.^{3} (depending on the voltages selected) and weigh 20 to 40 lbs. Remote-on and -off (TTL) capability turns the 100% conduction-cooled units on in 10 msec max (5 msec typ).

Pick what you need

The series delivers 75 to 750W with output voltages of 5, 12, 15, 24 and 28V. You can get dual- or triple-output versions with ±15V (or ±12V) outputs that meet exceptionally tight ripple and noise specs.

To adapt the units to your application, a strappable input lets them accept 115V or 230V ac (single phase) at 47 to 400 Hz. Units in the series operate over −55 to +85°C with a ±0.02%/°C max voltage-drift TC.

Rantec Div, Emerson Electric Co, 9401 Oso Ave, Chatsworth, CA 91311. Phone (213) 885-8223. **Circle No 454**

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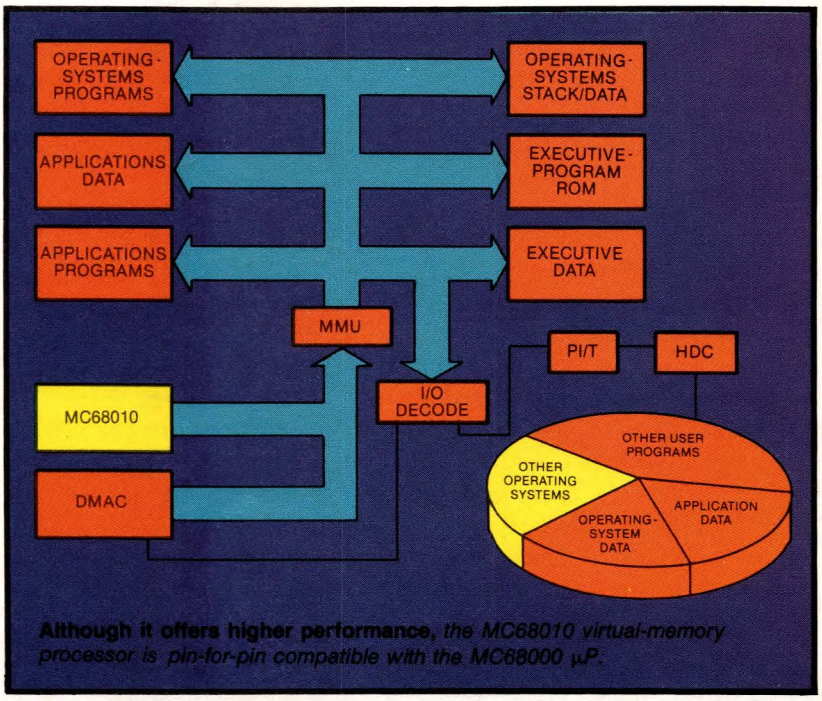
CIRCLE NO 65

MC68000-family virtual-memory processor adds performance, retains compatibility

With the addition of the MC68010, the basic MC68000 16/32-bit μP series acquires the ability to operate in virtual-memory systems or as a true virtual machine. Enhancing 68000 capabilities, it features:

- Complete, automatic instruction continuation after a memory fault
- Support for multiple-operating-system processing
- Improved operating-system support through relocatable exception vectors, data accessibility in alternate address spaces, new system-control registers and generic exception handlers
- Faster operations
- No execution penalty for error-detection circuitry.



Although it offers higher performance, *the MC68010 virtual-memory processor is pin-for-pin compatible with the MC68000 μP.*

Virtual-memory support

Although the 68000 has a direct addressing capability of 16M bytes, actual physical memory size will be less than 1M bytes (even with inexpensive 64k RAMs). Additional memory from sources such as disk and tape must be switched into physical memory when called on without faulting the processor or greatly slowing it.

In the 68010, when a possible fault is detected (attempted access of nonexistent, nonresident, unauthorized or invalid memory or other bus error), execution of the current instruction is suspended and the processor's entire internal state, including temporary internal-register contents and progress information, is saved on the Supervisor stack.

A Bus Error service routine attempts to correct the fault, and if it's successful, the information saved is sufficient for the same or even another 68010 to return to the μP's exact state when the fault occurred, rerun the previously faulted cycle and continue the program as if nothing had happened.

Virtual machine

The User/Supervisor privilege levels in the 68000 set up the protected environment needed for a virtual machine (in which one operating system—OS—controls the management of many other operating systems, which don't know they're being controlled). But the privilege level of the MOVE FROM SR instruction prevents implementation of such an environment. In the 68010, however, the governing operating system executes at the Supervisor level while the rest of the OSs execute at the User level. They operate, though, as if they were in the Supervisor level.

This feature also makes virtual I/O possible—one set of software I/O drivers controlled by the managing OS can service all the other OSs through automatic traps.

Operating-system support

Several improvements in the 68010 directly enhance its software operations. A facility is included for the software relocation of the 1k exception-vector table to provide different vectors for different routines or operating systems.

By removing some extraneous read cycles and improving the processing efficiency of some instructions, the 68010 speeds execution of several 68000 instructions. Some new instruc-

tions have also been added, as well as several control registers.

Two of the new instructions allow the supervisor to move data to or from an address space other than the Supervisor Data space. This feature allows the supervisor to move data between two users or to pick up operands from a user call.

Error detection

To facilitate error detection and correction and loosen some of the memory constraints of current systems, the 68010 relaxes the bus timing for acceptance of a bus error (BERR) signal. Even though the μP has accepted data from memory with a DTACK signal, a BERR input can occur as much as one-half clock period later and activate a Bus Error trap.

This capability gives the error-detection system an extra half clock cycle to determine whether the processor is receiving valid data. It also means your error-detecting system can use memory chips that are no faster than those used in a system not detecting and correcting errors.

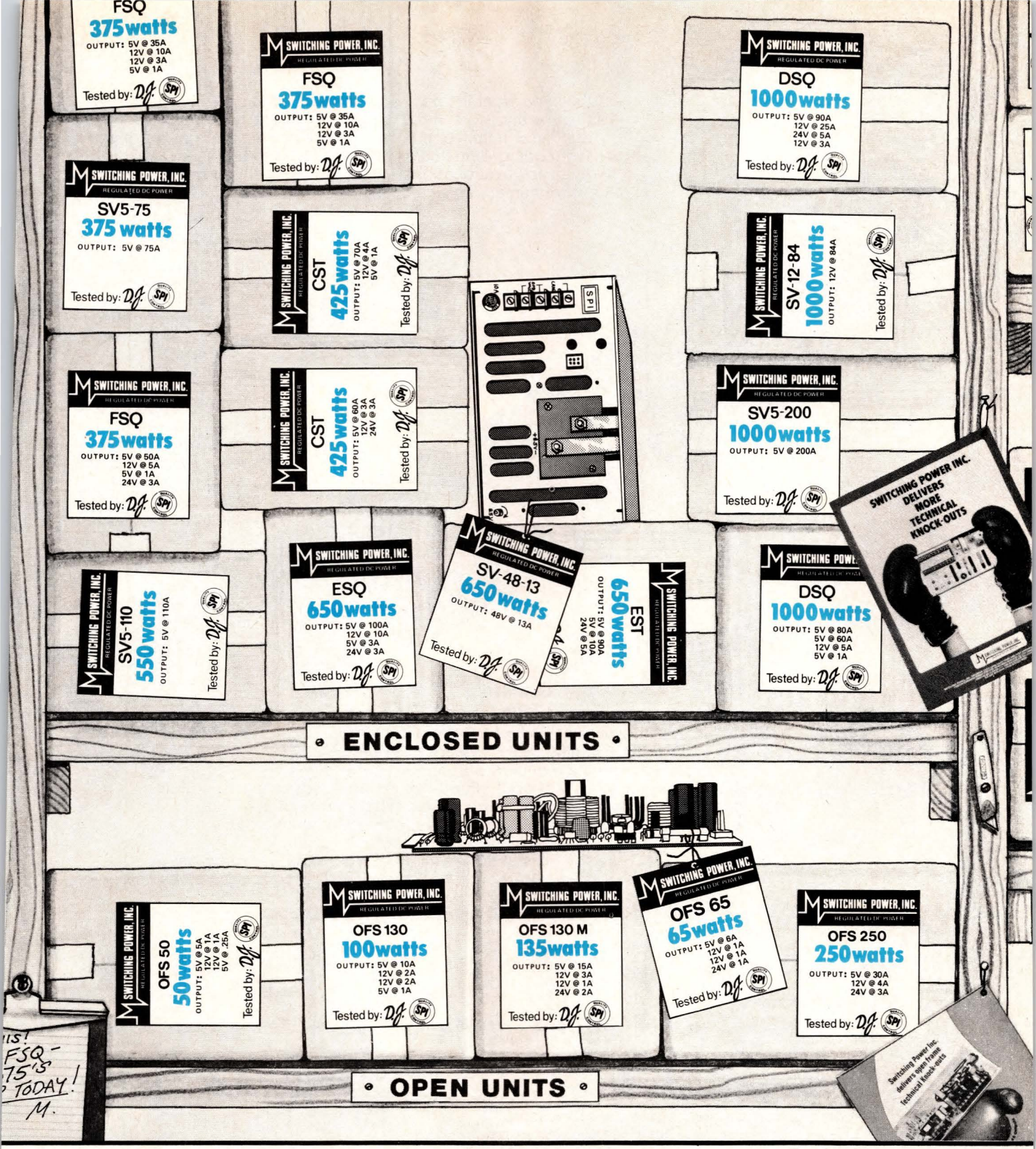
The 68010 is pin-for-pin compatible with the 68000 and is upwardly software compatible. All subsequent μPs in the 68000 line will also be upwardly compatible, preserving your software investment.

The 68010 retains the 68000's programming model and resources, including 32-bit data and address registers, a 16M-byte direct-addressing range, five main data types, 14 addressing modes and memory-mapped I/O. Considering all instruction types, data types and addressing modes, you get more than 1000 instructions, including signed and unsigned multiply and divide, BCD arithmetic and expanded (trap) operations.

The 68010 operates from a 5V±5% supply over 0 to 70°C. A single-phase 8-MHz clock drives the current version; other speeds will be available. Power dissipation for an 8-MHz part is 1W typ. $249 (100). Available third quarter.

Motorola Semiconductor Products Inc, 3501 Ed Bluestein Blvd, Austin, TX 78721. Phone (512) 928-6000.

Circle No 455



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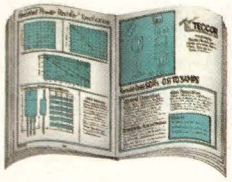
When you want the best, you go to a "specialist"...and when selecting thyristors, that's Teccor, with over 18 years in the business.

But even in the confines of one area of technology, there are never ending refinements and variations to be discovered. That's why specialization makes sense. At Teccor, the process of change and refinement never stops.

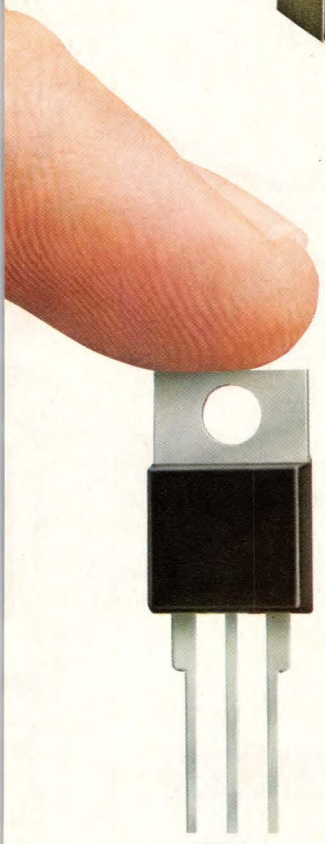
THYRISTOR

Catalog



Teccor's full line catalog contains complete electrical specifications on over 700 thyristor devices with application notes and an industry wide cross reference guide.

For a copy of the new 1982 catalog, letterhead requests should be mailed to: Teccor Electronics, Inc., "Literature department", P.O. Box 61447, Dallas, Texas 75261.



SCR's & Triacs That Won't Shock You

When isolation is required for SCR's and Triacs, you've probably been shocked to learn that as many as 10 extra insulating parts are necessary to isolate the device from the mounting surface. Teccor offers 9 package configurations that are "internally" isolated requiring no additional parts for isolation purposes. What's more, there are no complicated mounting procedures that can cost you time and money on the assembly line, or at the test and rework station.

2,500 Volt (RMS) isolation is standard with 4,000 volt (RMS) isolation on special order in TO-220 AB packaging. All isolated parts are recognized by Underwriters Laboratory.

Current ratings from 800 mA to 40 Amps and voltage ratings up to 800 volts are available.

U.L. Recognized

TO-92 | TO-220 AB | Swedge | Swedge TO-3 | Hex Stud | Fastpak | Press-fit | Press-fit TO-3 | Press-Fit Stud

And Some That Will...

Teccor also offers non-isolated SCR's and Triacs in 5 basic package configurations. These economical parts work well in a wide variety of applications where internal isolation is inappropriate. Functional features include a lower thermal resistance and a common electrical connection point.

Teccor's TO-220 AB package is available in both isolated and non-isolated configurations.

TO-220 AB | TO-202 AB | Metal Can TO-5 | Press-Fit | Press-fit Stud

Standard & Custom Lead Forming

The TO-202 AB, TO-220 AB and TO-92 package configurations, because of their unique design, are capable of being mounted in a variety of methods. A variety of typical lead forming options are available as standard parts direct from the factory. The DO-35 diac package also is available with a standard lead form. Other lead forming is available on a "special order basis."

Sidac's

The Teccor SIDAC is a unique type of two terminal thyristor switch. It is a voltage triggered, bilateral switch capable of fast turn-on with a surge rating of 20 amperes. When the breakover voltage is exceeded, the SIDAC switches on through a negative resistance region in less than one μsec to a low on-state voltage of 1.5 volts with peak di/dt of 30 A/μs. It is capable of conducting 1 ampere RMS until the current is interrupted or drops below a holding current level of 50 mA.

TO-92

The SIDAC device has been used in a variety of high energy pulse applications. Since there is no external gate connection, SIDACS eliminate the need for high voltage zeners or other expensive voltage sensing schemes required to do the same job, and fewer components mean increased reliability.

The SIDAC is packaged in a standard TO-92 package with two common leads and is currently available with seven voltage breakover ranges from 95 to 250 volts.

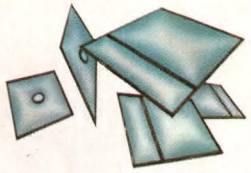
Quadrac™

The Quadrac, developed by Teccor, is a triac with a diac trigger mounted inside the same package. This breakthrough in package technology has been economically applied in many applications where space and costs are major considerations. By eliminating the need for a discrete diac, users save expense and assembly time of buying a diac and mounting in conjunction with a gated triac. Teccor also offers discrete diacs in a DO-35 package.

Specials

Teccor considers an aggressive specials program one of the best sources for the creation of new "standard" parts. Special high volume product requests are continually produced where manufacturing capability exists.

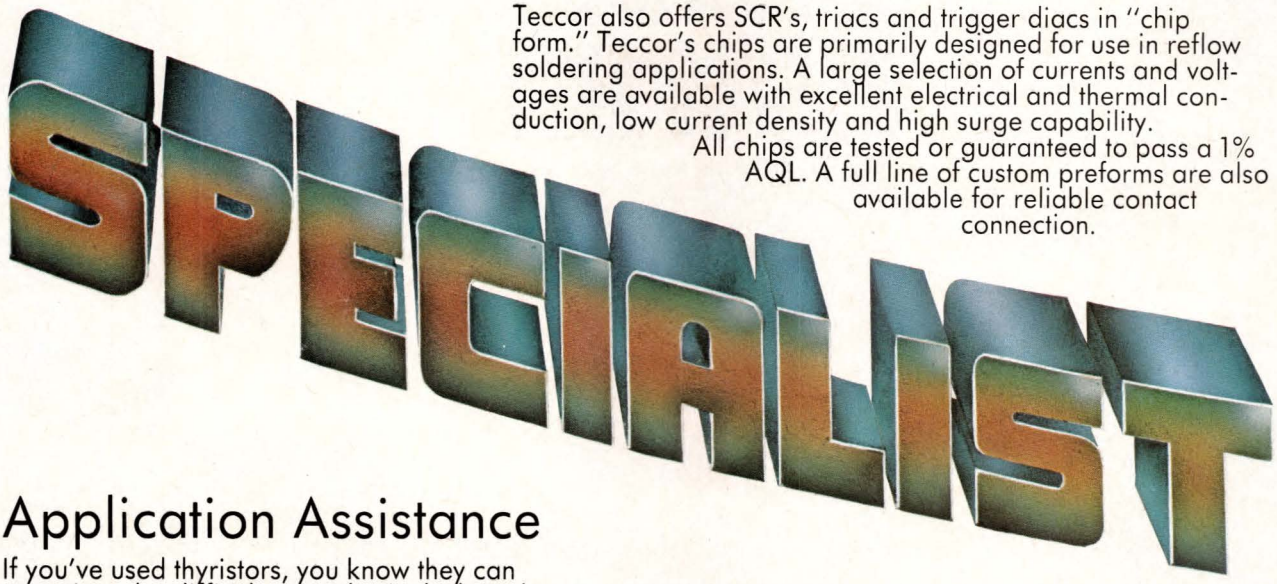
If you don't find the part you need, contact our "Marketing Department" (214-252-7651) for a special product evaluation.



Chips

Teccor also offers SCR's, triacs and trigger diacs in "chip form." Teccor's chips are primarily designed for use in reflow soldering applications. A large selection of currents and voltages are available with excellent electrical and thermal conduction, low current density and high surge capability.

All chips are tested or guaranteed to pass a 1% AQL. A full line of custom preforms are also available for reliable contact connection.



Application Assistance

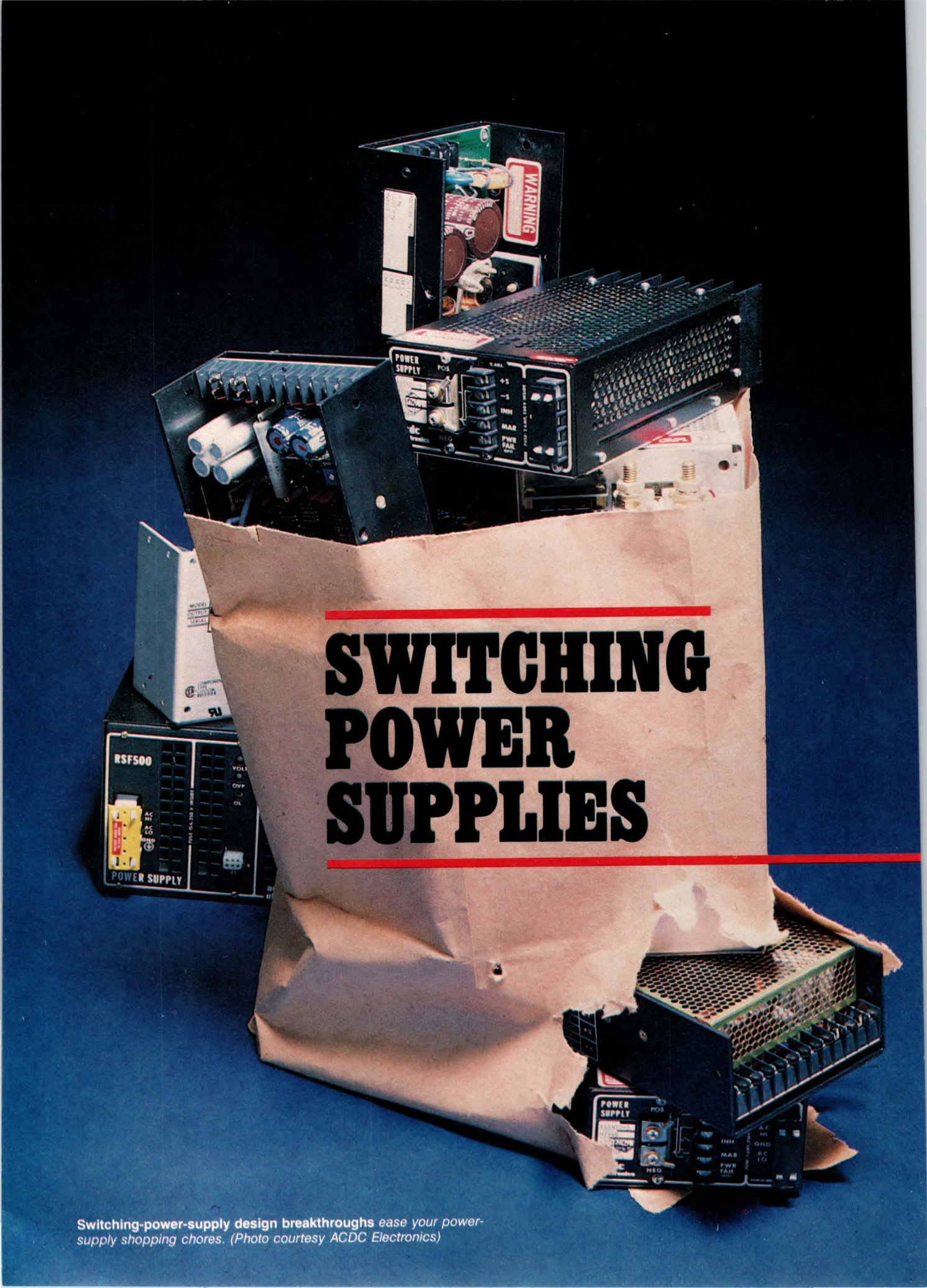
If you've used thyristors, you know they can sometimes be difficult to apply. And when choosing a supplier, you know that it's important to find one that will stand ready to assist in any application problems that may occur.

The Teccor "specialists" have accumulated 18 years worth of application solutions and stand ready to analyze virtually any circuit design. We're ready and willing to help ... we're specialists!

TECCOR ELECTRONICS, INC.

Semiconductor Division
P.O. Box 61447
Dallas, Texas 75261
214-252-7651

CIRCLE NO 67



Switching-power-supply design breakthroughs *ease your power-supply shopping chores. (Photo courtesy ACDC Electronics)*

To capture your order in a maturing industry, switching-supply manufacturers are adapting to your needs via customization, tailoring or a wide selection of off-the-shelf models. And they're meeting international standards.

Edward R Teja, Western Editor

As their market grows, switching-power-supply manufacturers are finding their product niches as each concentrates on what it does best. Thus, when selecting a switcher, you must look for the supplier subset that furnishes the power rating, input/output configuration and package style you need.

But don't just settle for any firm whose product line's specs bracket your electrical and mechanical requirements. Look for a vendor that can zero in on your needs within a product category—by offering a wide selection of off-the-shelf supplies, by configuring standard models with catalogued options or by designing custom units.

Indeed, you'll find firms specializing in certain manufacturing and marketing approaches as well as in various product types. As you evaluate these companies, you'll find them touting capabilities in such product areas as low-cost open-frame switchers, high-power enclosed models or dc/dc converters. Additionally, they might employ marketing approaches ranging

Tailored standard products fit some custom applications

from distributor sales of a wide variety of off-the-shelf products to custom-only orders.

Although such specialization areas aren't mutually exclusive, many companies can and do choose to concentrate on one or two categories. Endicott Research Group, for example, makes only dc/dc converters, originally designed for gas-discharge-display activation and capable of delivering 5 to 1000V outputs from 5 to 48V inputs. The modules use switching technology for ratings to 25W and 85% efficiencies.

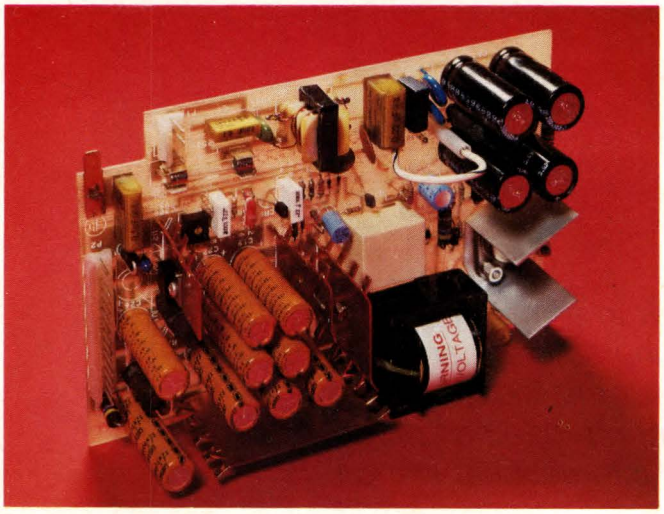
CEAG Electric, on the other hand, concentrates on high-reliability and high-power-density supplies for military applications. For example, its enclosed 750W Model SP7911 achieves a 4W/in.^{3} power density, compared with the 1.7W/in.^{3} typical of 750W enclosed commercial units.

LH Research also specializes, but in a marketing approach rather than a product category; indeed, its product lines range from low-power open-frame models to high-power boxes or enclosed switchers. It specializes in offering configurable standard products, an approach that affords about 2.5 million different models. Using the company's catalog, you specify the supply you want as you generate its model number.

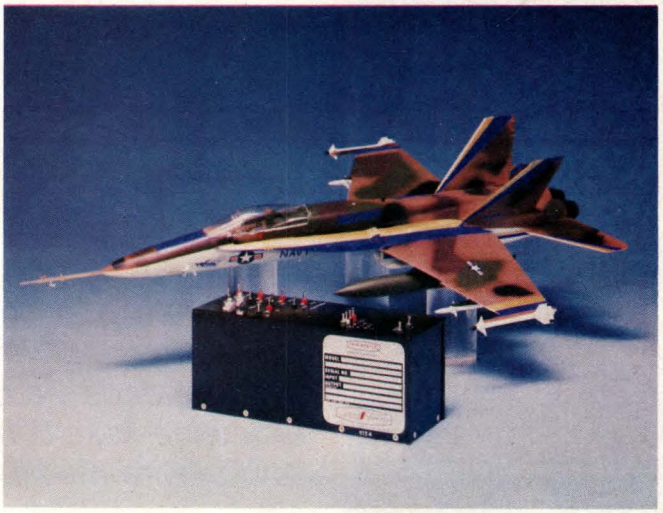
For example, DM34-XXXX/48 specifies a 350W, 4-output model in LH Research's Dyna-Mite Series of convection-cooled, dc-input units, and DM41-X/48 indicates a 500W, 1-output model in the same line. In both model numbers, you replace each X with an output-voltage rating.

Citing the advantages of its configurable-standard-product approach, LH points out that the system allows customers flexibility in supply selection while reducing the custom-supply design load on the company's engineers. It thus frees those engineers to apply their combined 200 man-yrs of switcher design experience to such state-of-the-art considerations as meeting demands for more power in less space.

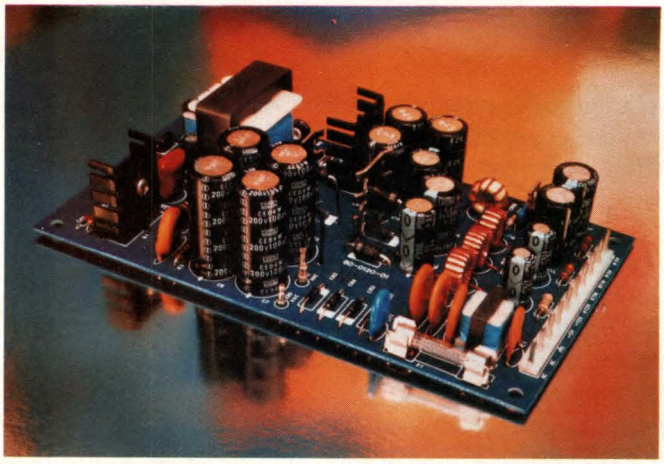
A popular buzzword for such configurable standard products is "tailored." And you'll find a definite trend toward tailored supplies. Whether a company makes



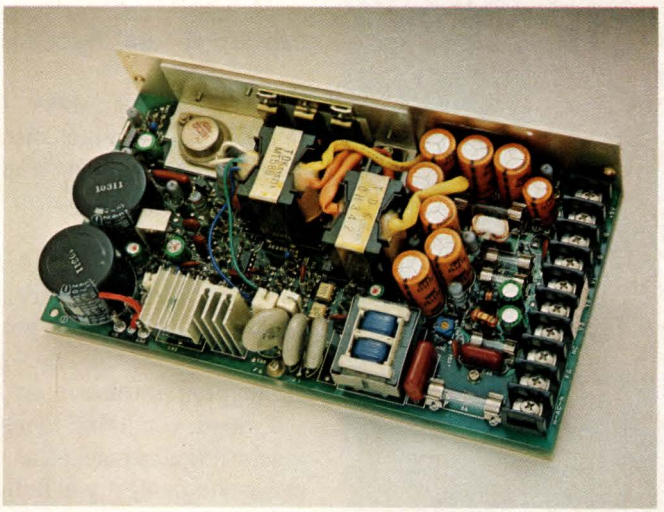
Providing as many as three dc outputs *at a 65W total continuous power rating (90W pk), Power/Mate Corp's EVS-65 supply meets the demands of CRT applications.*



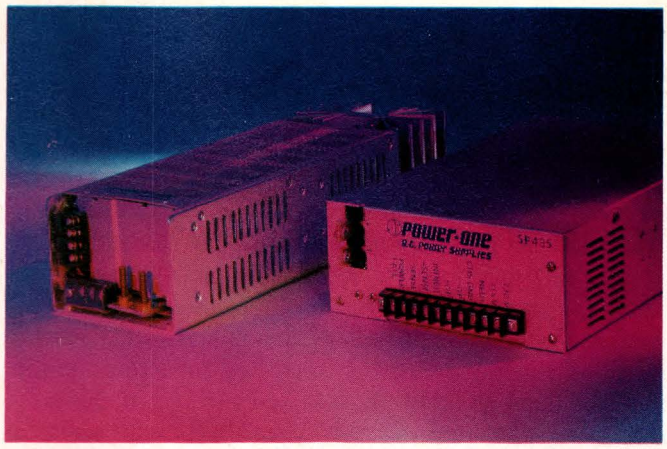
High reliability and compact packaging *are provided by the miniaturized and encapsulated switchers from Arnold Magnetics. This 240W, 7-output TW-7 Series model costs $1735 (100).*



Serving a broad range *of terminal, peripheral and small-computer applications, this representative supply from California DC's LR5100, LR5300 and LR6500 Series produces as much as 65W at less than a dollar per watt.*



On-board EMI filtering *and four power ratings (50, 100, 150 and 210W) suit the Kepco/TDK EFX switchers to OEM applications.*



Delivering as much as 400W, *Power-One's SM Series supply (left) costs $450; the 600W SN Series unit costs $595. Both work in a convection-cooled environment and come with one 5, 12, 15, 24 or 28V output.*

Fig 1—Comprising of 16 power supplies *ranging from 250 to 600W, LH Research's Dyna-Mite Series employs a proprietary control IC to furnish a low component count.*

open-frame switchers or enclosed units, the approach is attractive to both manufacturers and users. By stocking interchangeable modules from which it builds all its supplies, a manufacturer can easily put together a nonstandard supply that still isn't a custom device. Although you have fewer choices with this approach, you benefit from lower prices and faster delivery than you'd typically get from a custom house. Indeed, some vendors can deliver tailored standard products at reasonable cost within a few weeks. The first unit you receive isn't a prototype, either, but an actual production model. Furthermore, you aren't paying a premium for special tooling or engineering.

National Power Technology, for example, serves the 65 to 400W switcher market with a line of tailored supplies. When it reconfigures one of its standard modules according to your needs, its engineers determine which basic unit to use and which output modules to add.

Thus, full production can begin not long after you receive the first "samples" that you use to test out the supply in your system. And you can still make changes between the arrival of the demonstrators and the production run. If, for example, you decide that a particular secondary output needs regulation after all, the firm can add that feature for a small charge.

In fact, post-regulation is one of the more common features that you can add or delete from a standard supply. Although more manufacturers are choosing to regulate all outputs, many still offer quasiregulated secondaries with post-regulators as an option, allowing you to buy only what you need. Another option that you might ask for is some form of logic-signal output such as power-failure-detection indication, although firms such as Sierracin suggest that you build your own power-failure-detection circuit (see **box,** "Build your own power- failure-detection circuit").

Pioneer Magnetics adds such features as power-failure detection, output-turn-on sequencing and alternative input voltages (ac or dc) by plugging option cards into a supply's main pc board. In fact, Pioneer marketing VP Arnold Hagiwara claims that although the firm is rigid about the sheet metal it employs, it's quite flexible with bells, whistles and monitoring so long as you need an enclosed unit in the 275W to 3-kW range. Pioneer employs a computer to generate designs and test specifications.

Not all firms use the tailoring approach, however. Manufacturers such as Lambda offer a large number of off-the-shelf products at low prices. Such supplies are a cost-effective choice if you find you need no tailoring to fit one of them into your product.

The do-it-yourself option

At the other extreme, you can build your own power supply. However, designers familiar with the subtleties of switcher design are few and far between. To help you, some manufacturers offer switching submodules (EDN, January 20, pg 125) that you can incorporate in your power-supply system.

For example, Stevens-Arnold's 7W/in.^{3} PS-4348 dc/dc-converter modules are flexible building blocks that furnish as much as 20W in a 0.375×2.56×3-in. package. The 84%-efficient design operates at slightly more than 200 kHz, taking advantage of a new power controller.

Additionally, Powercube uses its own mass-produced Cirkitblock dc/dc converters to produce custom switchers; a unit such as the XDD-499 **(Fig 3)** includes five modules in a Block-Pac II enclosure and provides three outputs at a combined 55W rating. The prewired, assembled and tested unit costs $995.

And now General Electric has introduced a new twist in the game. Rather than following Powercube's technique of putting the modules together for you, GE furnishes a set of SwitchMod modules **(Fig 4)** that you put together yourself to configure a 100-kHz switching power supply. You can thus build a switcher without knowing anything about its internal design. GE repre-

Bringing in a custom supplier might help reduce system costs

sentatives use a small computer (currently an HP-85, but the software will soon be available for Radio Shack, IBM and Apple personal computers) to select the appropriate building blocks for a specific application. You tell the vendor your requirements, and the computer generates a bill of materials—a list of the modules you need to piece together a custom supply with as many as eight outputs and ratings to 250W.

Toward the end of the year, GE will have a CAD/CAM (computer-aided design/computer-aided manufacturing) system on line. In addition to generating a bill of materials, it will design a complete supply for you, including the pc board and sheet metal.

To ensure a continuity of supply to OEMs and thus inspire more customer confidence, GE is also investigating the cross licensing of other companies to second-source its modules. It feels its modular approach will be especially attractive to firms needing a custom supply for a 100- to 250-piece order—the size that many large manufacturers typically don't bid on.

If you don't want to design or manufacture your own supply and tailored models can't meet your requirements, the custom builder is the only route. Such a supplier can even sometimes help reduce design costs if brought into the design cycle sufficiently early; indeed, companies such as Deltron, which makes both standard and custom products, can help you decide if a standard product might be adequate after all.

But some vendors feel that sticking to custom work alone gives them an edge. Acme Electric Corp, for example, with the exception of its dc/dc-converter line, has abandoned its standard products (which will

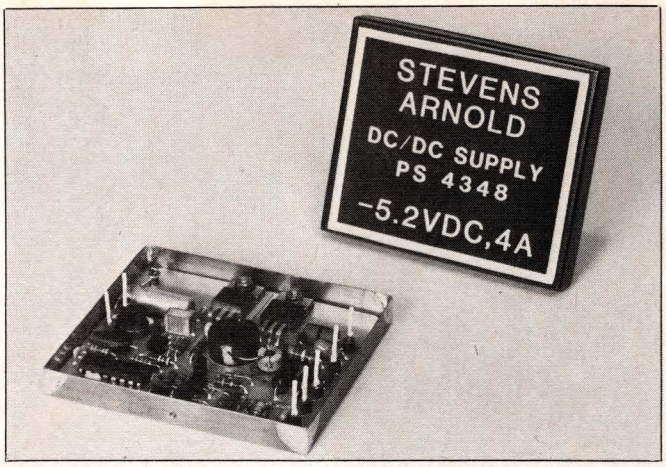
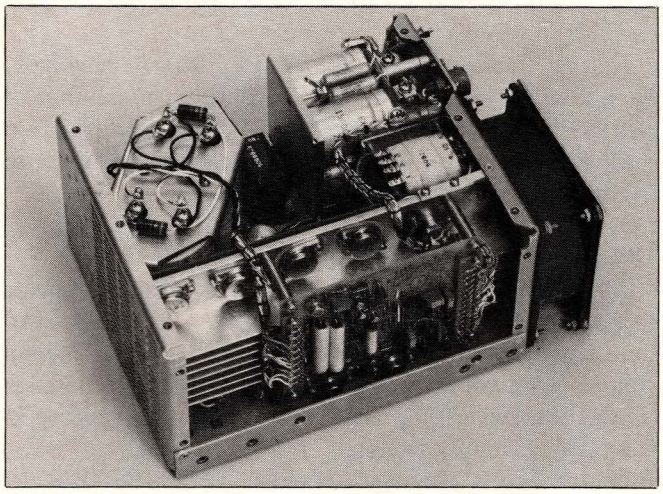


Fig 2—Utilizing dc/dc converters *from Stevens-Arnold Inc simplifies the use of switching power supplies in your designs.*



Providing 5V at 120A, *Trio Laboratories's fan-cooled switcher meets military specifications.*

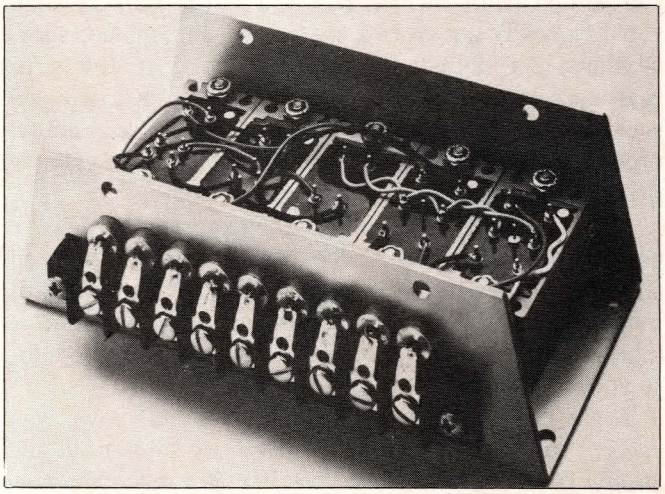
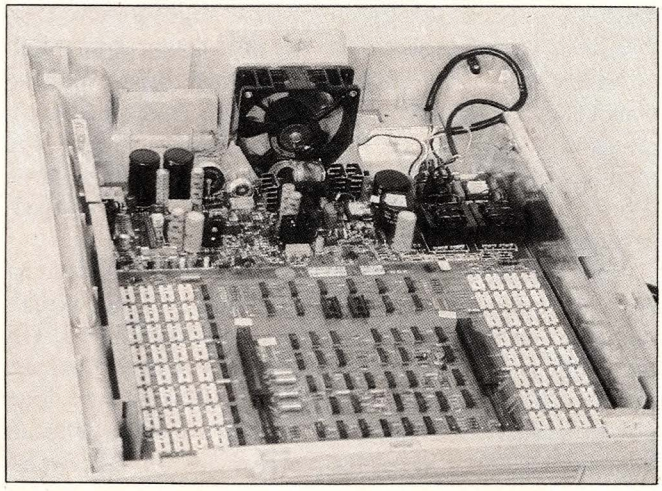


Fig 3—Combining five *Cirkitblock modules in a Block-Pac II enclosure, Powercube's XDD-499 supply produces 55W.*



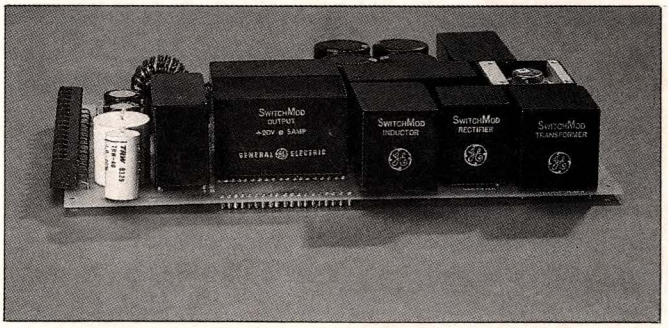
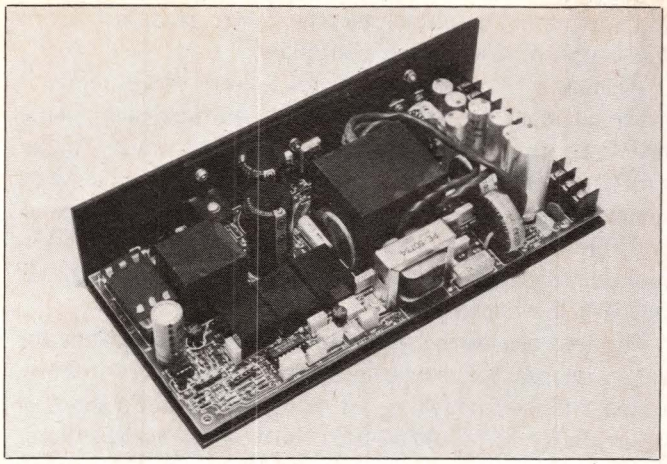
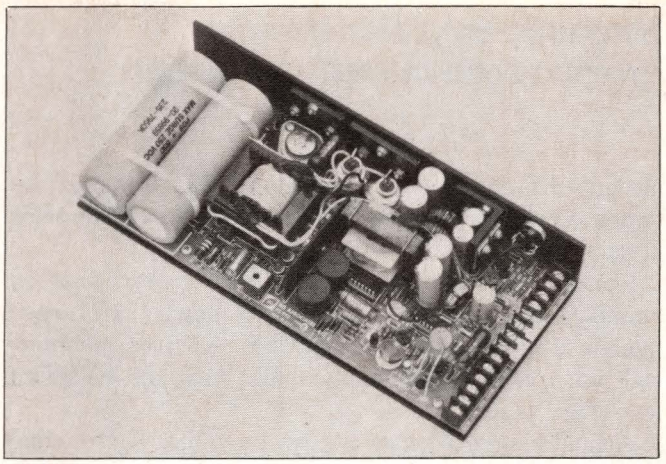


Fig 4—Building your own switching power supply *has gotten easier with the introduction of General Electric's SwitchMod modules. A prototype kit costs $495.*

Custom switchers *such as this Sola Electric 150W 5-output supply cut design costs and occupy less space than standard supplies.*



Encapsulated magnetics *help National Power Technology's $237 (100) 130W switchers meet requirements of VDE 0730 and IEC 435.*



Power-failure-detection circuitry *furnishes a warning 2 msec before the output begins to drop on RO Associates's Model 910.*

continue to be manufactured by Standard Power) in favor of handling custom orders. It wants to be able to give these jobs its full engineering attention without worrying about modifying its on-the-shelf units.

To handle the one exception to its custom-only rule—its AMC Series dc/dc converter line (39 models in six package sizes from 100 to 640W)—Acme has established a toll-free number that you can call to get a quote or delivery information: (800) 828-2946.

Babcock Electro-Mechanical Inc also has established a narrow focus; it specializes in such custom lines as militarized shipboard units and can concentrate on design skills that involve understanding packaging considerations such as vibration and stress.

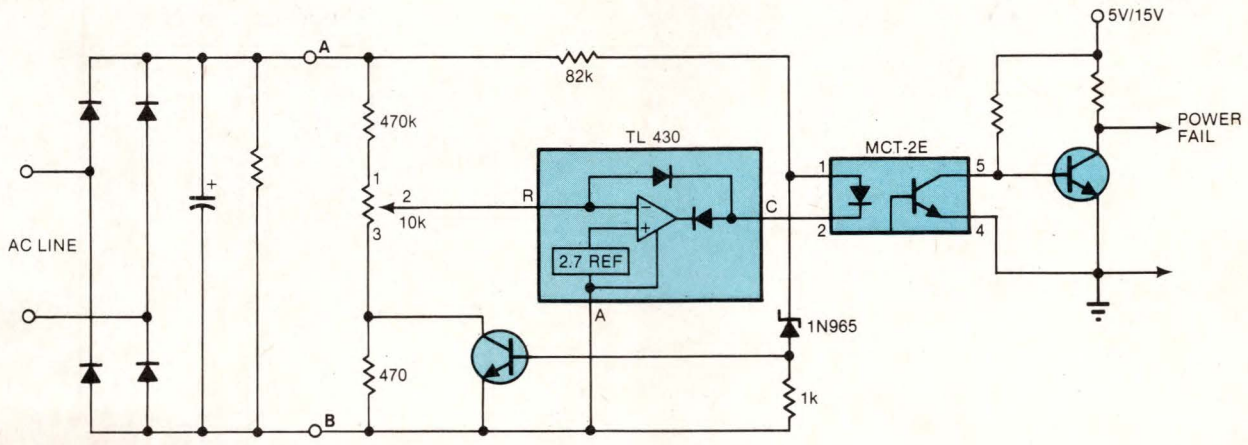
Rantek similarly concentrates on military supplies; its parent company Emerson Electric delegates commercial orders to ACDC Electronics. Why this division between the military and commercial markets? Primarily because they exhibit more differences than similarities. To the military mind, for example, MTBF is

Build your own power-failure-detection circuit

Not every switching power supply comes with power-failure-detection circuitry, and not every manufacturer offers it as an option. Building your own circuit isn't too difficult, however. Sierracin/Power Systems applications engineer Jim Coombs suggests the circuit shown in the **figure.**

A power-failure-detection circuit warns your circuitry, via a logic signal, that dc-power loss is imminent, thus giving the supply time to terminate I/O operations or initiate cleanup functions necessary for a graceful shutdown.

The circuit shown can connect directly to a supply's high-voltage circuitry through points A and B. It senses the energy-reservoir capacitor's voltage, looking for a drop below the potentiometer-set reference point. This reference voltage should lie somewhere between the minimum voltage required for normal operation and the normal ripple-valley voltage at nominal line input. The amount of warning you'll receive before you lose dc power depends on the reference point you select, the capacitance—and thus hold-up time—and the dc-output load.



This power-failure selection circuit *can ensure graceful shutdown of your switching supply.*

Magnetic-amplifier circuits provide high-current regulation

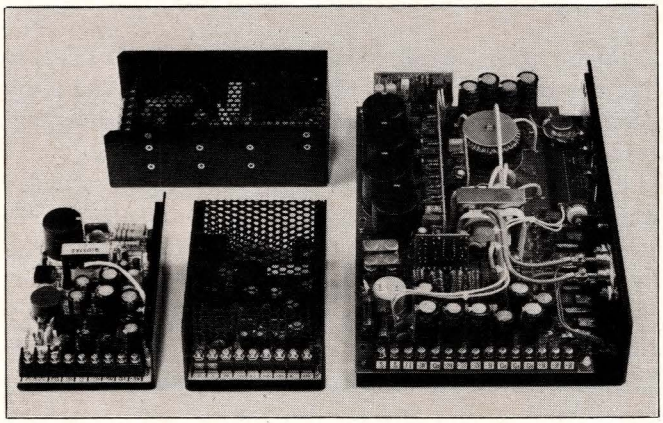
measured in hundreds of thousands of hours. And the military has traditionally been willing to pay the price of such reliability.

Rantek, for example, boasts a 0.25% return rate on standard products and specifies its newest MIL-spec models at nearly 200,000 hrs MTBF. A typical commercial unit, on the other hand, might have an MTBF of less than 100,000 hrs.

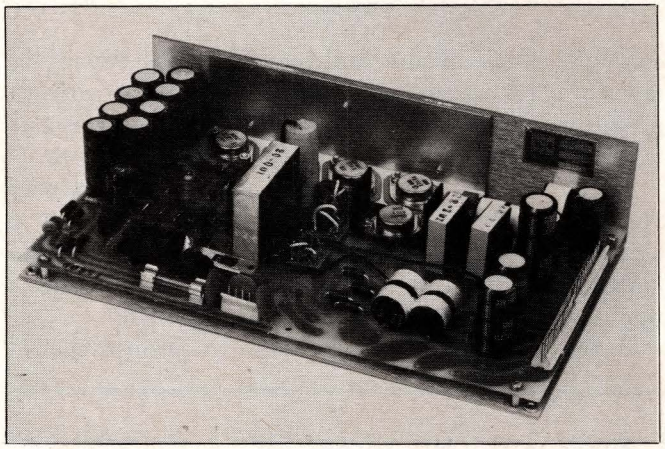
Arnold Magnetics also serves the military, providing supplies that furnish power for avionic and other high-reliability applications (the Space Shuttle *Columbia* uses two of the firm's supplies).

Although the military market follows design considerations alien to the commercial marketplace, some problems (and some solutions) are the same. Using switcher technology, manufacturers try to squeeze as much performance as possible into as small a space as possible. To accomplish this task, they employ techniques ranging from magnetic amplification to 200-kHz MOSFET switching.

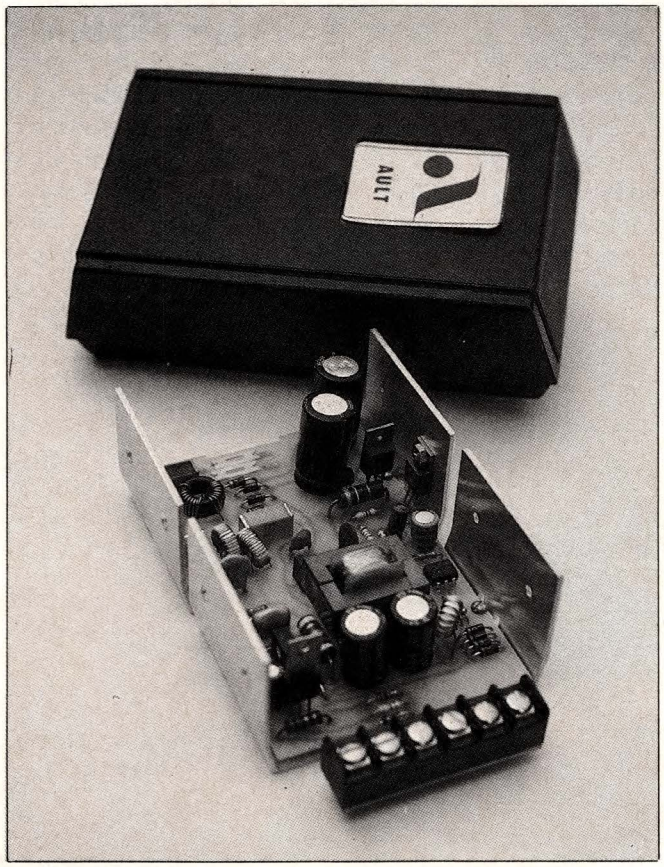
Indeed, use of the venerable magnetic amplifier (or saturable reactor) represents a trend in new switchers, at least those furnishing 4A or more. Xentec's soon-to-be-available XOM-130 50-kHz 130W open-frame switcher will employ the technique, and Powertec uses it in



Serving a variety of applications, *KEC's low-power, compact SCFL Series supplies (left) start at $95 for a 15W model. The 300W SCB Series switcher (right) costs $119.*



Furnishing four standard or tailored outputs, *this 200W Series QS-250 supply from Optimal Systems features a 2.3-in. profile.*



A flyback design *allows Ault Inc's 14-oz wall-plug-in switcher to pack 25W into a 2×4×6-in. case.*

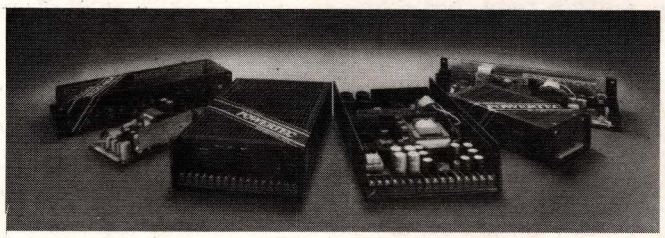
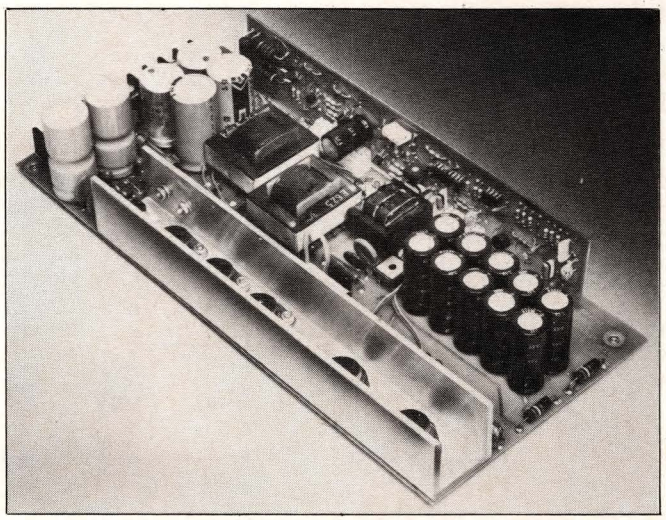


Fig 5—Featuring a fully regulated main output *and optional regulation on the secondaries, Powertec's Series 19 ValuSwitcher line furnishes 50 to 300W and includes an optional EMI filter that meets VDE 0871 specifications.*



Furnishing six outputs that total 250W, *Datapower's first off-the-shelf product costs $255.*

each of its ValuSwitcher models (**Fig 5**) with 4A and higher ratings. Arnold Magnetics has been using the technique for nearly 20 yrs to meet military packaging requirements for supplies rated at 6A or more.

The mag amp's main advantage is its ability to furnish regulation without the thermal losses of equivalent series regulation. According to Powertec's engineering VP, Philip Koetsch, a typical series regulator needs about 40W of headroom (power available from the supply in excess of that nominally present at the output). This power is normally dissipated as heat. And in a small package, that can be deadly.

Other methods of enhancing supply performance include use of switching frequencies higher than 20 kHz. In theory, such higher switching frequencies can yield smaller supplies. The introduction of high-frequency components such as MOSFETs (see **box,** "MOSFETs shrink power supplies") has stirred a great deal of interest in high-frequency switchers, although available products are lagging behind; few companies make switchers that operate at more than 25 kHz.

One exception, Hewlett-Packard, manufactures a series of 50W modular supplies (HP 65000A) that use MOSFETs to operate at 165 to 200 kHz. A typical 50W triple-output unit in the 65000 Series costs $225 (100). The same technology gives the firm's 6024A and 6012A switchers laboratory performance, featuring efficiencies of 80%.

Macpower offers a triple-output high-frequency switcher (**Fig 6**) that operates at 100 kHz. Edward

MOSFETs shrink power supplies

Steve Clemente and **Brian Pelly,** International Rectifier

You can't always tell a switcher by its block diagram. The **figure** illustrates the basics of an off-line switcher, but the switching element could be either a bipolar transistor or MOSFET device. Using a MOSFET, though, will make a difference in the final package. Indeed, power MOSFETs (EDN, November 25, 1981, pg 91) can make the newest generation of switching power supplies 20 to 50% smaller and lighter than their predecessors.

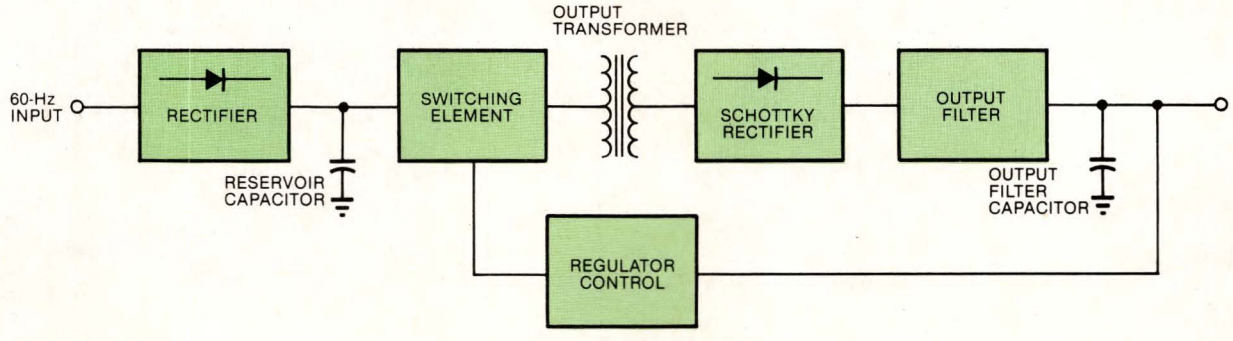
Although replacing bipolar switching transistors with power-MOSFET devices results in higher switching losses, these losses are compensated by the higher ON-state efficiency of the MOSFET switch. Therefore, the efficiency of an 80- to 100-kHz MOSFET switcher equals or exceeds that of a 20-kHz bipolar switcher.

For supplies with equivalent ratings, you'll find a significant reduction in the size and weight of the MOSFET-based units because their higher operating frequencies permit use of lighter weight magnetic components. In addition, high-frequency circuit techniques reduce energy-storage requirements, allowing you to use smaller reservoir capacitors. Furthermore, a high operating frequency lets you use a smaller (typically 50% smaller) output-filter capacitor than in lower frequency bipolar supplies, although the capacitor must have a lower equivalent series resistance (ESR). The MOSFET switcher, additionally, provides faster response to changes in output voltage.

The MOSFET device also has a higher input impedance than bipolar switching transistors, thus reducing drive-power requirements. And you don't need a negative voltage to ensure that the MOSFET turns off; because it's a majority-carrier device, it has zero storage time. You can also forget about shaping the dynamic load line. The MOSFET doesn't experience secondary breakdown. As a result of these characteristics, a switcher using power MOSFETs can have a lower parts count than an equivalent bipolar circuit.

To date, the major argument against using power MOSFETs has been their price. But falling prices will open up many more applications for these devices.

***Steve Clemente** and **Brian Pelly** are, respectively, the senior applications engineer and the VP of worldwide marketing at the El Segundo, CA firm.)*



An off-line switcher *converts a 60-Hz input to high-voltage dc, which in turn is inverted, rectified and filtered to provide a dc output.*

Not all supplies designed to VDE will meet the specifications

Joyner, the firm's marketing VP, suggests that this feature suits use in supplies that must work near a CRT: The 100-kHz switching frequency won't interfere with the tube's operation.

Performance features aren't the only switcher aspects receiving attention. Manufacturers are also concentrating on meeting international safety and emission requirements. And you, too, should be aware of these specs if you're specifying supplies for use in equipment for sale outside the US. To get you started, ACDC Electronics has published a useful booklet: the *International Safety and Emissions Handbook* ($5). It describes the players, such as the International Electrotechnical Commission (IEC) and the Verband deutscher Electrotechniker (VDE), and outlines some of the relevant regulations.

West Germany's VDE specifications, for example, are grouped into two major categories (and many classes): One category (Class 0730) deals primarily with operator safety; another (Classes 0871, 0875 and 0876) covers emissions. You needn't necessarily know the specs in detail, but you should know how they affect your product.

Indeed, the onus of VDE compliance lies not on components and subassemblies such as power supplies but rather on your final system. Some power-supply manufacturers take this as a sign that they shouldn't get involved in the approval process. Others, however, are designing new supplies to comply with regulatory specs and are willing to work with you to speed your qualifying process.

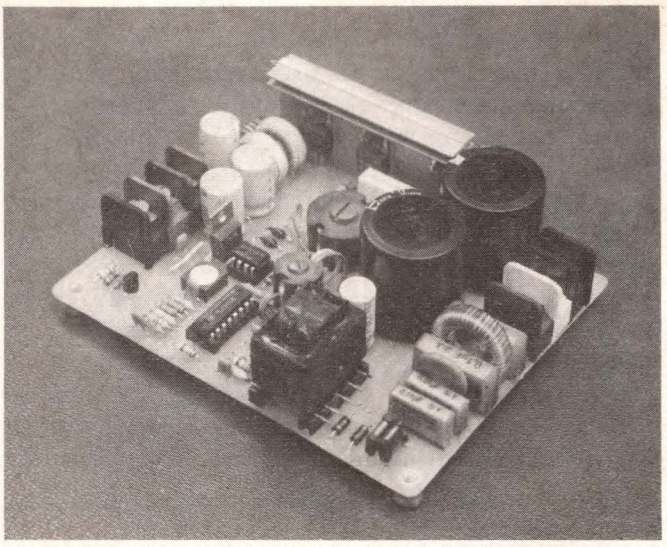
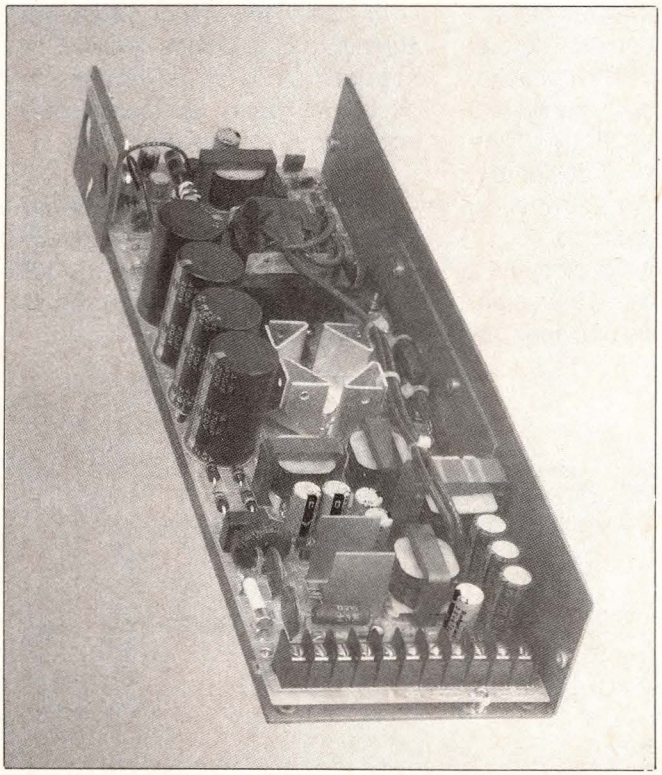


Fig 6—Operating at 100 kHz, *Macpower's configurable standard supplies provide dual, triple and quad outputs at 60 and 75W.*

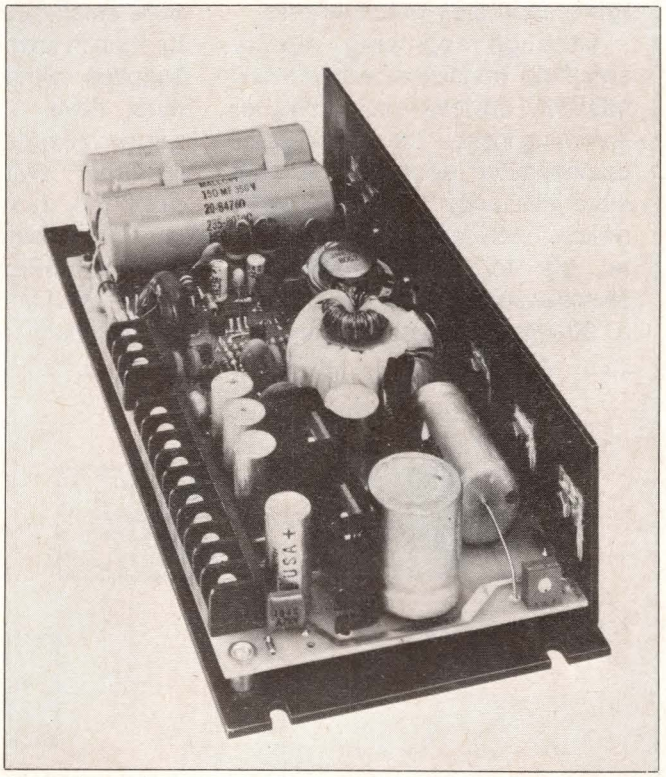
As you look at supply data sheets, you can expect one of three situations with respect to VDE compliance:

- No mention of VDE
- The statement, "Designed to VDE specifications"
- The statement, "VDE approved."

Each of these responses represents a completely different set of advantages and problems for you. If the manufacturer ignores VDE and your system must comply with its regulations, you'll have to determine for yourself if the supply will pass. On the other hand,



This open-frame modular switcher, *formerly manufactured by Acme Electric, is now part of Standard Power's line of off-the-shelf products.*



Accepting ac inputs *that range from 90 to 250V ac and 44 to 440 Hz, this VLSI Series supply from Converter Concepts Inc comes in 30, 65 and 100W versions and costs $98.25 to $196.25 (100).*

Limiting a switcher's inrush current

Roger Christenson and **Frank Colver,** LH Research Inc

The circuit configuration that gives off-line switchers the ability to continue uninterrupted operation through ac-line dropouts—typically to 16 msec—also gives them significantly different turn-on characteristics than those of linear supplies. In a typical linear device, the ac voltage is applied to a 60-Hz power transformer whose impedance limits any current surges when the supply is turned on, unless the transformer saturates during the first half cycle.

In an off-line switcher, which has no input transformer, the ac-line voltage is rectified and applied directly across large, high-voltage capacitors. When the switcher is turned on, the charging capacitors act as an almost perfect short circuit for the first few ac cycles, resulting in a very high peak inrush current, which trails off rapidly as the capacitors reach full charge.

Switcher inrush current is represented as the average rms value over a specific period directly following turn-on. For example, the inrush-current specifications for a typical switching power supply might read, "The ac input current is 42A when averaged over one cycle." This current drops to nominal line current within three to four cycles. The instantaneous peak current, however, can exceed 100A, but its duration is short. In fact, many 1000W switchers use line fuses rated at 25A because the duration of the current spike is only a few milliseconds.

Two primary techniques limit switcher inrush current. Most switchers use thermistors; the alternative employs SCRs.

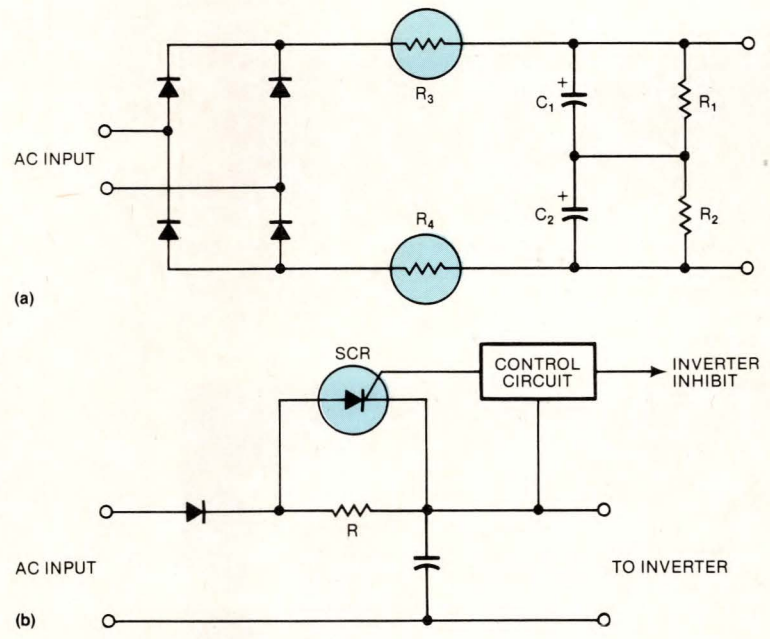
A thermistor has a relatively high resistance when cool and a very low resistance (almost zero) when hot. The resistance change is highly nonlinear, declining rapidly at first and more slowly near the operating temperature. The thermistor therefore suits switcher applications because their need for inrush current limiting declines in proportion to the thermistor's decreasing resistance. You merely place the thermistors (R_3 and R_4) in series between an off-line switcher's input bridge and input capacitors, as shown in part **(a)** of the **figure.**

If you cycle the supply on and off rapidly, the scenario changes, however. The thermistors won't have sufficient time—they typically need about 60 sec—to regain their high resistance. If a partial charge remains on the capacitors, however, the thermistors won't have to do the whole job: Bleeder resistors such as R_1 and R_2 eventually drain off the charge.

In the SCR approach, you put a resistor and an SCR in parallel between the bridge and input capacitors, as shown in part **(b)** of the **figure.** Resistor R_3 then limits the inrush current while the capacitors charge. The switching circuitry is inhibited at this time—a control circuit monitors the voltage across the capacitors, and when that voltage reaches a predetermined level, the circuit fires the SCR, shorting out the resistor and allowing the switching to start.

The SCR approach is more expensive than using thermistors. You must use high-current devices, and the power-supply control circuitry must include an SCR-control function. The thermistor is more efficient, too. At the operating temperature, its resistance is less than 1Ω, furnishing typical continuous power dissipation of 3 to 6W. The forward voltage drop across a fired SCR, by contrast, averages about 1V. For medium- to high-power switchers, this means a typical power dissipation of 12 to 18W.

***Roger Christenson** and **Frank Colver** are, respectively, a senior design engineer and a principal engineer at the Tustin, CA firm.*



You can limit switcher inrush current *while the input capacitors charge by employing either thermistors* ***(a)*** *or a resistor teamed with an SCR* ***(b).***

No size standardization in open-frame switchers

you won't have to pay the switcher manufacturer for VDE design and testing in this case.

However, if the manufacturer contends that its units are VDE approved, at least one unit did undergo and pass the approval process. Conver Corp, for example, has announced that its AC65 supply (**Fig 7**) is the first 65W supply to receive VDE 0730 approval.

Todd Products Corp has just introduced a new line (five models) of 200W open-frame switchers designed to meet or exceed VDE specifications, although the units haven't undergone VDE evaluation. The supplies provide the voltages most widely requested for small computer systems. This MOX-200 Series (**Fig 8**) costs $224 to $239 (100).

Sierracin's Fred Heath contends that eventually all of his firm's switchers will be VDE approved. And most other commercial manufacturers state that they are redesigning their products to meet VDE specs.

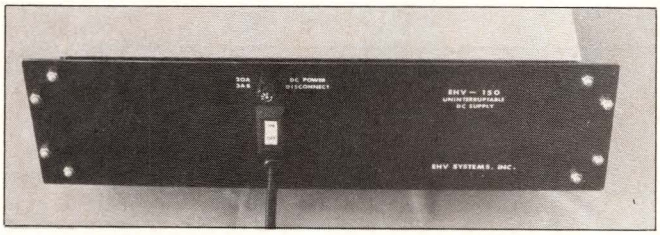
As manufacturers learn more about the approval process and gain experience in designing to the regulations, more supplies will become type approved. But smaller firms will have much more difficulty gaining approval. The process is expensive and time consuming, and engineering time is precious enough without spending a lot of it making trips to Germany.

What size fits all?

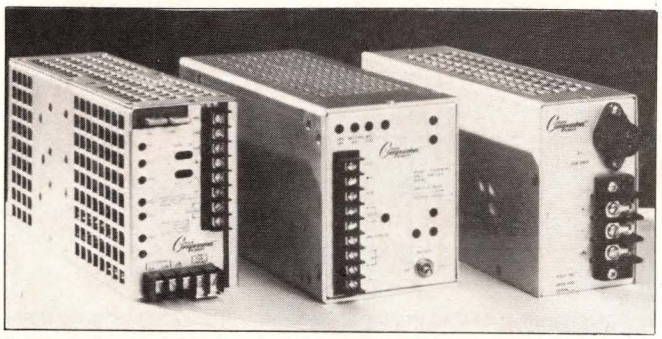
After dealing with electrical performance and standards compliance, you still must consider the mechanical switcher configuration you need. Although most electronic products boast some kind of form-factor standardization, the only widely used switcher mechanical standard is the 5×8-in. footprint typical of enclosed models in the 500 to 1500W range. At least 10 manufacturers now furnish such supplies.

But you won't even find this limited level of standardization in open-frame switchers. For example,

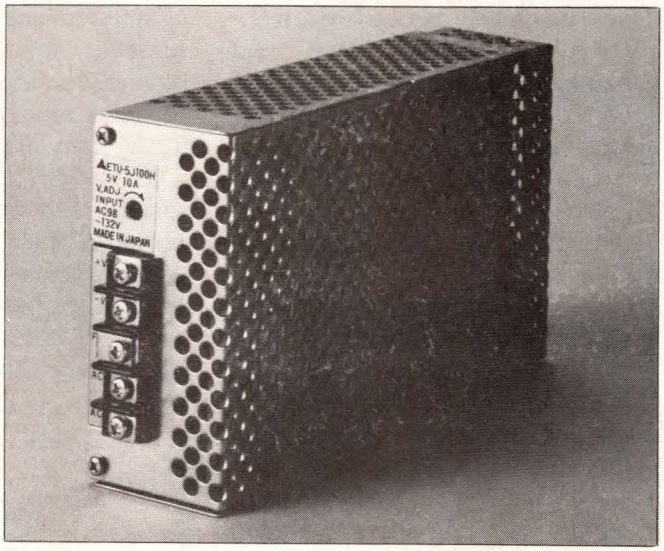
Monolithic switching regulators *employ a push/pull pulse-width-modulation technique operating at 20 kHz min to ensure silent operation of Datel-Intersil's 5V, 3A Model USM-5/3. The unit accepts line voltages of 90 to 130V ac at 47 to 450 Hz and costs $119.*



A fully shielded and integrated package *suits EHV Systems's $960 (100) EHV-100 to computer applications, where noise can be a problem. In case of a line failure, the unit's internal battery supports orderly shutdown by furnishing backup power for 30 sec to 1.5 min after main power loss.*



Comprising both a switch-mode ac/dc supply and a 24V, 2.5-Ahr sealed lead-acid battery, *the Companion Series from Lorain Products (from $800 (OEM qty)) can furnish 5V at 30A for 8 min.*

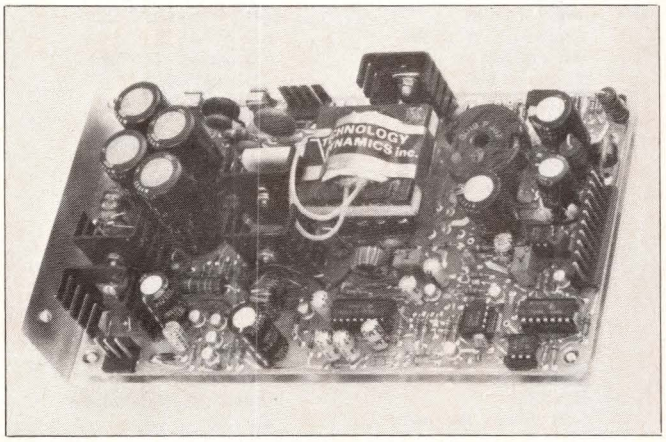


Providing switching power *at about $1 per watt, this Panasonic J Series model operates at 50 kHz and boasts a 3-yr warranty.*

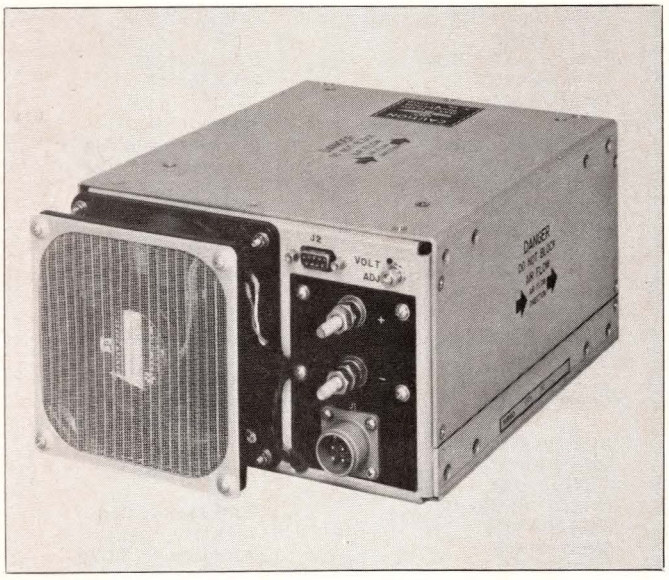
Available in 85 and 135V ac input versions, *$89 Series 325 25W switching power supplies from Power General furnish 1500V ac isolation between input and output.*

POWER-SUPPLY OUTPUT SPECIFICATIONS

PARAMETER	OUTPUT 1	OUTPUT 2	OUTPUT 3	OUTPUT 4	OUTPUT 5	OUTPUT 6	UNITS
OUTPUT VOLTAGE							V DC
OUTPUT CURRENT							A
OUTPUT-VOLTAGE ADJUSTMENT RANGE							+
LINE REGULATION							+
LOAD REGULATION							+
RIPPLE AND NOISE (DC TO Hz)							mV P-P
RECOVERY TIME (ΔL = TO)							mSEC
REMOTE SENSE (TOTAL, BOTH LINES)							V
REMOTE PROGRAMMING							
TURN-ON/OFF OVERSHOOT							+
OVERVOLTAGE PROTECTION (TRIP)							V DC
UNDERVOLTAGE PROTECTION (TRIP)							
OVERLOAD PROTECTION (I_0 MAX)							A
MAXIMUM SURGE LOAD CURRENT							A/DURATION
SEQUENCING, TURN-ON (ORDER 1, 2...)							
SEQUENCING, TURN-OFF (ORDER 1, 2...)							
TEMP COEFFICIENT (OPERATING TEMP)							%/°C
SPECIAL REQUIREMENTS							



Able to deliver 5V at 2.5A and 12V at 2A, *this TDI-168 supply from Technology Dynamics Inc costs $145 (100).*



High reliability and military-style modular packaging *characterize this single-output 1500W switcher from CEAG Electric Corp.*

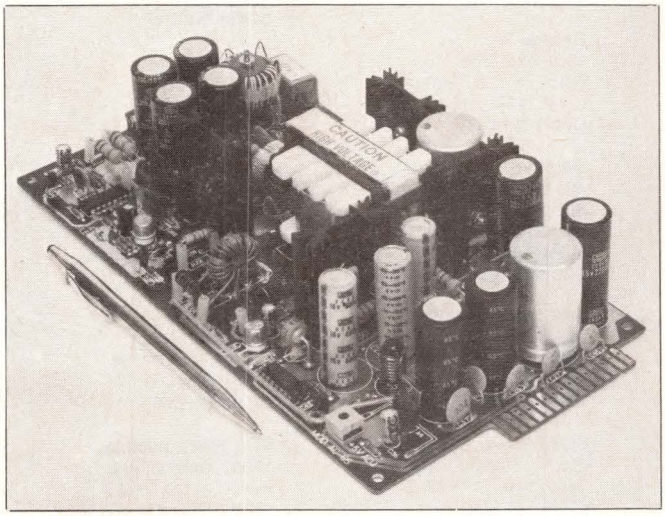


Fig 7—VDE approval *enhances use of the $178 (100) AC65 supply from Conver Corp in office products intended for sale in Europe.*

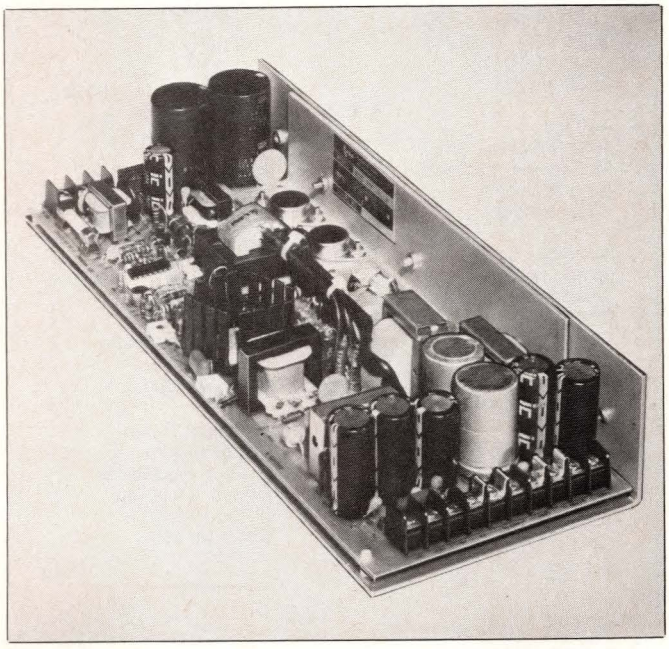


Fig 8—Regulated, adjustable multiple outputs *highlight the MOX-200 line of switchers from Todd Products.*

Many suppliers offer forms of customer support

Boschert, the largest open-frame-switcher manufacturer, developed a number of custom multioutput units, sold later as off-the-shelf products, that some firms copied as a de-facto standard. However, Boschert made many of them obsolete as fast as competitors could produce interchangeable models.

You might see a trend toward open-frame mechanical standards, though. Sierracin/Power Systems, for example, has introduced a full line of off-the-shelf open-frame

Manufacturers of switching power supplies

For more information on switching power supplies, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

AAK
11 Villa St
Haverhill, MA 01830
(617) 373-3769
Circle No 635

Abbott Transistor Laboratories Inc
639 S Glenwood Pl
Burbank, CA 91506
(213) 842-7150
Circle No 636

ACDC Electronics
401 Jones Rd
Oceanside, CA 92054
(714) 757-1880
Circle No 637

Acme Electric Corp
49 Water St
Cuba, NY 14727
(716) 968-2400
or (800) 828-2946
Circle No 638

Adtech
Box 6064C
Anaheim, CA 92806
(714) 634-9211
or (800) 854-8288
Circle No 639

Analytyx Electronic Systems Inc
1 Executive Dr
Hudson, NH 03051
(603) 880-3600
Circle No 640

Arnold Magnetics Corp
11520 W Jefferson Blvd
Culver City, CA 90230
(213) 870-7014
Circle No 641

Ault Inc
1600 H Freeway Blvd
Minneapolis, MN 55430
(612) 560-9300
Circle No 642

Autronics Corp
314 E Live Oak
Arcadia, CA 98006
(213) 445-5470
Circle No 643

Babcock Electro-Mechanical Inc
3501 Harbor Blvd
Costa Mesa, CA 92626
(714) 540-1234
Circle No 644

Berkleonics Inc
1 Aerovista Park
San Luis Obispo, CA 93401
(805) 544-5454
Circle No 645

Bertan Associates Inc
3 Aerial Way
Syosset, NY 11791
(516) 433-3110
Circle No 646

Bikor Corp
1504 W 228th St
Torrance, CA 90501
(213) 539-6320
Circle No 647

Boschert Inc
384 Santa Trinita Ave
Sunnyvale, CA 94086
(408) 732-2440
Circle No 648

Calex Mfg Co Inc
3355 Vincent Rd
Pleasant Hill, CA 94523
(415) 932-3911
Circle No 649

California DC
2150 Anchor Ct
Newbury Park, CA 91320
(805) 499-3621
Circle No 650

CEAG Electric Corp
1324 Motor Parkway
Hauppauge, NY 11788
(516) 582-4422
Circle No 651

CEI Corp
Box 501
Londonderry, NH 03053
(603) 623-8888
Circle No 652

Century Electronics
5965 Washington Blvd
Culver City, CA 90230
(213) 870-1083
Circle No 653

Compower
548 Div St
Campbell, CA 95008
(408) 866-8141
Circle No 654

Computer Power Systems Corp
18150 S Figueroa St
Carson, CA 90749
(213) 515-6566
Circle No 655

Condor Inc
4880 Adohr Lane
Camarillo, CA 93010
(805) 484-2851
Circle No 656

Conver Corp
10629 Bandley Dr
Cupertino, CA 95014
(408) 255-0151
Circle No 657

Converter Concepts Inc
435 S Main St
Pardeeville, WI 53954
(608) 429-2144
Circle No 658

Data Power Inc
3328 First St
Santa Ana, CA 93009
(714) 775-2000
Circle No 659

Datel-Intersil
11 Cabot Blvd
Mansfield, MA 02048
(617) 339-9341
Circle No 660

Deltron Inc
Box 1369
North Wales, PA 19454
(215) 699-9261
Circle No 661

Digital Power Corp
686 E Gish Rd
San Jose, CA 95112
(408) 288-5600
Circle No 662

Dynage Inc
1331 Blue Hills Ave
Bloomfield, CT 06002
(203) 243-0315
Circle No 663

Efflo Inc
455 Los Gatos Blvd
Suite 103
Los Gatos, CA 95030
(408) 356-2325
Circle No 664

EHV Systems Inc
226 Terminal Rd
Setauket, NY 11733
(516) 751-6066
Circle No 665

Elpac Power Systems
3131 S Standard Ave
Santa Ana, CA 92705
(714) 979-4440
Circle No 666

Emco High Voltage Co
556 Weddell Dr
Sunnyvale, CA 94086
(408) 734-9123
Circle No 667

Endicott Research Group Inc
Box 269
Endicott, NY 13760
(607) 754-9187
Circle No 668

ERA Transpac Group
311 E Park St
Moonachie, NJ 07074
(201) 641-3650
Circle No 669

General Electric Co
Box 1701
Ft Wayne, IN 46801
(800) 348-1770
Circle No 670

General Instrument
1401 Lomaland Dr
El Paso, TX 79935
(915) 592-5700
Circle No 671

Glassman High Voltage
Box 551
Whitehouse Stn, NJ 08889
(201) 534-2226
Circle No 672

GMR Inc
1048 E Burgrove
Carson, CA 90746
(213) 639-4663
Circle No 673

Gould Inc
2525 Campus Dr
Irvine, CA 92715
(714) 955-2710
Circle No 674

Hewlett-Packard Co
1507 Page Mill Rd
Palo Alto, CA 94304
Phone local office
Circle No 675

Intronics
57 Chapel St
Newton, MA 02158
(617) 964-4000
Circle No 676

KEC Electronics Inc
19300 Vermont Ave
Gardena, CA 90248
(213) 515-2561
Circle No 677

switchers designed to meet UL, FCC and VDE specifications and aimed at distributor sales.

It seems that in the short run, however, all you can count on is an ever-increasing variety of multioutput switchers. At Calex, which manufactures a variety of supplies targeted at the computer market, engineering and marketing manager Ron Krepps expects to see a vendor shakeout. He predicts that by 1985, only one-fourth of today's switcher companies will still be in the switcher business. And the majority of sales, according to Krepps, will be in special OEM supplies.

Faced with the lack of mechanical, regulation, performance or price standards, how can you deal with the myriad choices that switcher selection entails?

Keltec Florida
Drawer 2917
Ft Walton Beach, FL 32549
(904) 862-3107
Circle No 678

Kepco Inc
131-38 Sanford Ave
Flushing, NY 11352
(212) 461-7000
Circle No 679

Lambda Electronics
515 Broad Hollow Rd
Melville, NY 11747
(516) 694-4200
Circle No 680

LH Research Inc
14402 Franklin Ave
Tustin, CA 92680
(714) 730-0162
Circle No 681

Lorain Products
1122 F St
Lorain, OH 44052
(216) 288-1122
Circle No 682

Macpower
9115 26th Ave
Kenosha, WI 53140
(414) 694-8866
Circle No 683

Microsource Corp
1806 Greenleaf
Chicago, IL 60626
(312) 465-8419
Circle No 684

MIL Electronics Inc
176 Walker St
Lowell, MA 01854
(617) 458-4535
Circle No 685

Modular Power Systems Inc
8900 Shoal Creek Blvd
Suite 127
Austin, TX 78758
(512) 452-8151
Circle No 686

National Power Technology
2111 Howell Ave
Anaheim, CA 92806
(714) 937-1301
Circle No 687

NJE
Box 50
Dayton, NJ 08810
(201) 329-4611
Circle No 688

Nortel Ltd
31149 Via Colinas
Bldg 608
Westlake Village, CA 91361
(213) 707-0120
Circle No 689

Novatronics
500 SW 12th Ave
Pompano Beach, FL 33061
(305) 942-5200
Circle No 690

Optimal Systems Corp
3333 Yale Way
Fremont, CA 94538
(415) 657-9256
Circle No 691

Panasonic Co
1 Panasonic Way
Secaucus, NJ 07094
(201) 348-7276
Circle No 692

Philips
TQ III-4
Eindhoven, The Netherlands
Circle No 693

Pioneer Magnetics
1745 Berkeley St
Santa Monica, CA 90404
(213) 829-6751
Circle No 694

Power-One
Power One Dr
Camarillo, CA 93010
(805) 484-2806
Circle No 695

Power Design
1700 Shames Dr
Westbury, NY 11590
(516) 333-6200
Circle No 696

Power General
152 Will Dr
Canton, MA 02021
(617) 828-6216
Circle No 697

Power/Mate
514 S River St
Hackensack, NJ 07601
(201) 440-3100
Circle No 698

Power Products
Div of Computer Products Inc
2801 Gateway Dr
Pompano Beach, FL 33060
(305) 974-2442
Circle No 699

Power Systems Inc
12 Tobey Rd
Bloomfield, CT 06002
(203) 243-0357
Circle No 700

Powercube Corp
8 Suburban Park Dr
Billerica, MA 01821
(617) 667-9500
Circle No 701

Powertec Inc
20550 Nordhoff St
Chatsworth, CA 91311
(213) 882-0004
Circle No 702

Qualidyne Systems
2256 Main St, Suite 5
Chula Vista, CA 92011
(714) 429-7440
Circle No 703

Rantek Div
Emerson Electric Co
9401 Oso Ave
Chatsworth, CA 91311
(213) 885-8223
Circle No 704

Reliability Inc
Box 37049
Houston, TX 77036
(713) 492-0550
Circle No 705

RO Associates Inc
246 Caspian Dr
Sunnyvale, CA 94088
(408) 744-1450
Circle No 706

Semiconductor Circuits Inc
49 Range Rd
Windham, NH 03087
(603) 893-2330
Circle No 707

Sierracin/Power Systems
20500 Plummer St
Chatsworth, CA 91311
(213) 998-9873
Circle No 708

Sola Electric
1717 Busse Rd
Elk Grove Village, IL 60007
(312) 439-2800
Circle No 709

Sorensen Co
676 Island Pond Rd
Manchester, NH 03103
(603) 668-4500
Circle No 710

Stevens-Arnold Inc
7 Elkins St
South Boston, MA 02127
(617) 268-1170
Circle No 711

Switching Power Inc
4835 Veterans Hwy
Holbrook, NY 11741
(516) 981-5353
Circle No 712

Systron Donner
2700 Systron Dr
Concord, CA 94518
(415) 676-5000
Circle No 713

Technipower
Box 222
Commerce Park
Danbury, CT 06810
(203) 748-7001
Circle No 714

Technology Dynamics Inc
91 Carver Ave
Westwood, NJ 07675
(201) 664-7636
Circle No 715

Tecnetics Inc
Box 910
Boulder, CO 80306
(303) 442-3837
Circle No 716

Todd Products Group
50 Emjay Blvd
Brentwood, NY 11717
(516) 231-3366
Circle No 717

Trio Laboratories Inc
80 Dupont St
Plainview, NY 11803
(516) 349-0400
Circle No 718

US Astek Electronics
1101 Space Park Dr
Santa Clara, CA 95050
(408) 727-3350
Circle No 719

Wall Industries Inc
2 Franklin St
Lawrence, MA 01846
(617) 688-1287
Circle No 720

Xentek
279 S Pacific St
San Marcos, CA
(714) 744-3346
Circle No 721

Communication with the vendor prevents overspecification

There is, unfortunately, no shortcut. Making the right decision requires a thorough knowledge of your application as well as familiarity with potential suppliers.

Each supplier offers not only specific product types but specific customer-support services. You might, additionally, deal directly with the manufacturer or work through a representative or distributor. Regardless of the person or institution you deal with, though, all the same problems will prevail.

To help you think through the purchasing decision, The Powerhouse, a California rep firm that handles several switching manufacturers, has developed a set of specification guidelines that provides you with answers to questions you might otherwise not think to ask.

The **table** summarizes switcher parameters you should be familiar with before talking to a vendor. According to vendors surveyed by EDN, the most common mistake engineers make is overspecification. Thus, after you've thought through your requirements, discuss them with some power-supply manufacturers.

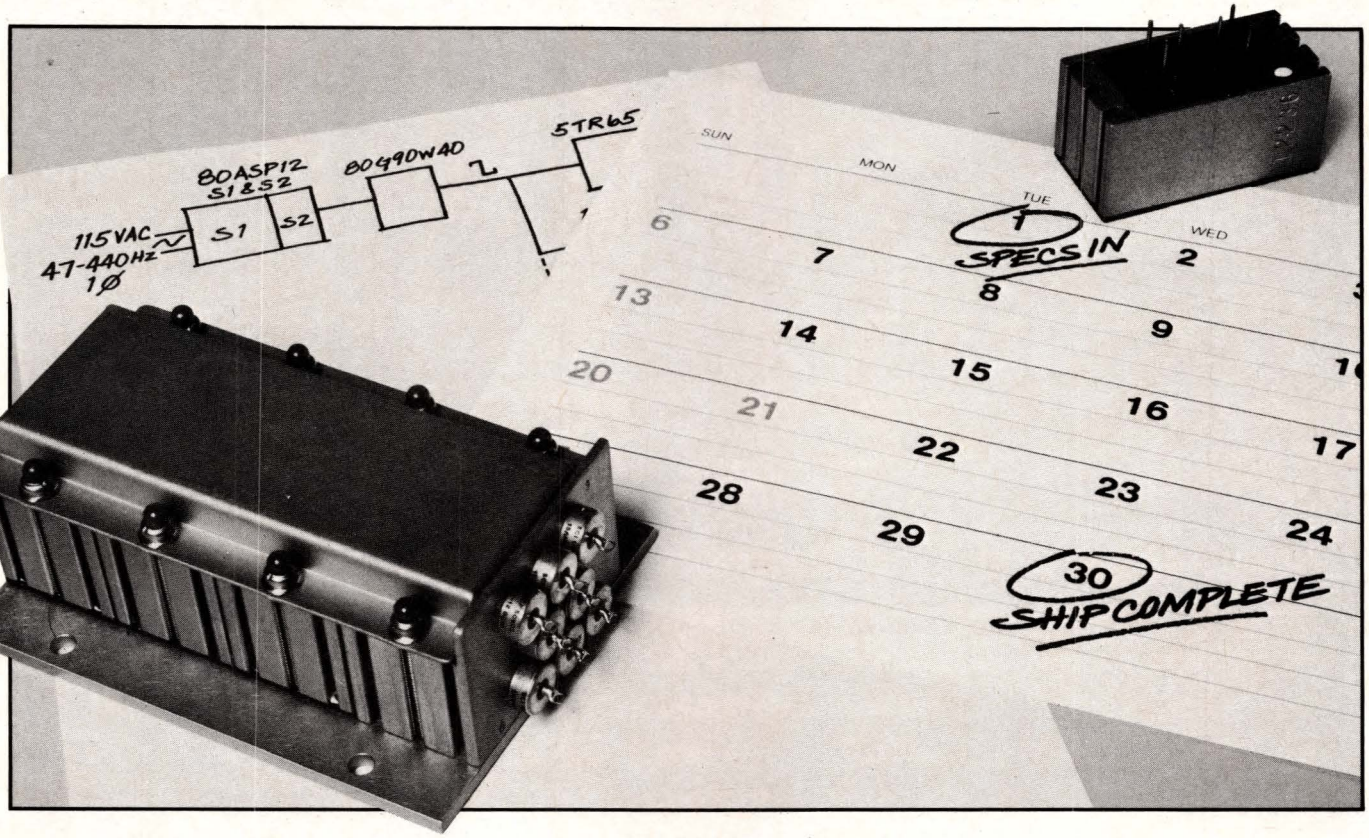
If you are building a computer that uses Winchester disks, for example, you might think you need a supply that can deliver 8 or 9A to get the disk spinning. You do, but some supplies are specifically designed to handle this high-current, low-duty-cycle service yet have lower continuous-current ratings. Some supplies are even designed to meet the specifications of a particular disk drive. Using one of these rather than specifying a 9A supply can save you money. The bottom line? Communicating with your switcher supplier can save you time and money. **EDN**

Acknowledgement

Special thanks to Larry Gilbert of The Powerhouse, 2098 S Grand Ave, Suite D, Santa Ana, CA 92705 for his help in preparing this report.

Article Interest Quotient (Circle One)
High **470** ***Medium*** **471** ***Low*** **472**

RAPID DEPLOYMENT



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With power densities running as high as 50 watts per cubic inch, Cirkitblock modules can pack more power into limited space. For over a decade, these rugged modules have met or exceeded stringent specifications for size, weight, performance and tough environmental considerations whether your equipment operates from below the sea, on the ground or in outer space.

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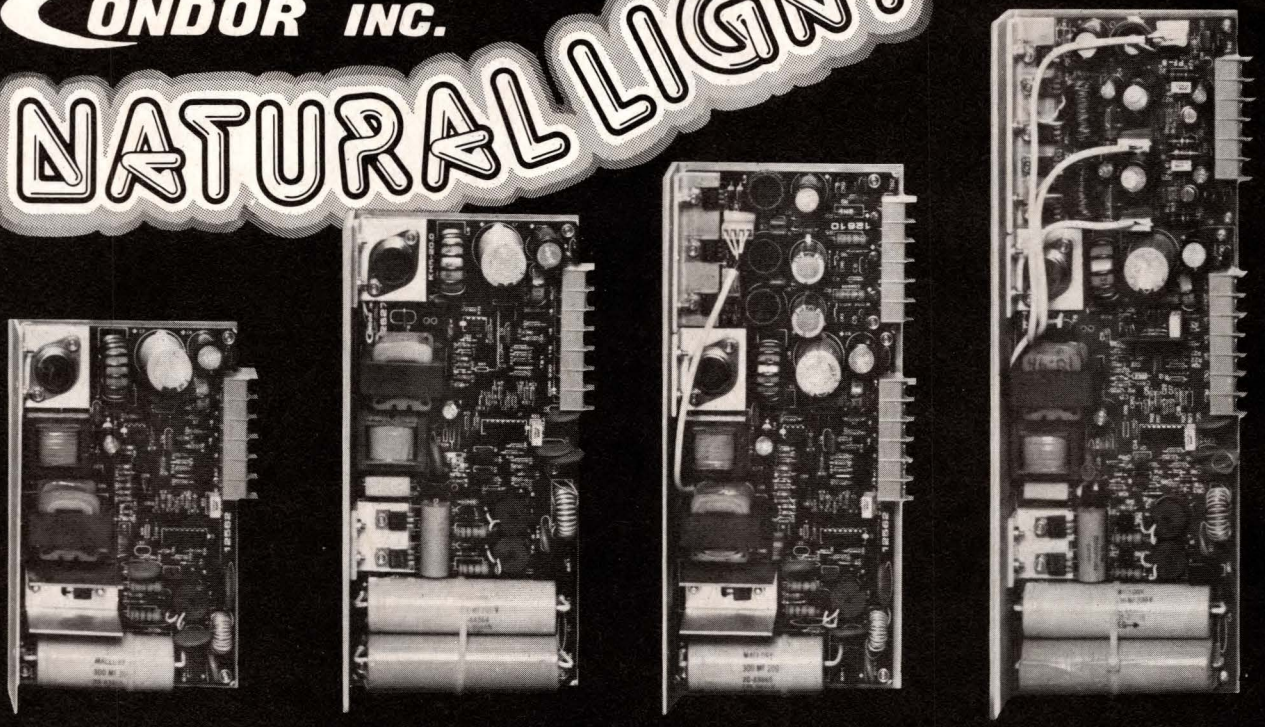

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MODEL	INPUT	OUT #1	OUT #2	OUT #3	OUT #4	PRICE 1-9
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KE12-6.5	115 VAC	12V@6.5A				$145.00
KE15-5	115 VAC	15V@5A				$145.00
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KFT302	115 VAC	5V@15A	15V@1A	15V@1A		$186.00
KFT303	115 VAC	5V@15A	5V@1A	15V@1A		$186.00
KFT304	115 VAC	5V@15A	5V@1A	15V@1A		$186.00
KGM401	115 VAC	5V@15A	5V@1A	12V@1A	12V@1A	$200.00
KGM402	115 VAC	5V@15A	5V@1A	15V@1A	15V@1A	$200.00
KH5-20	115/230VAC	5V@20A				$167.00
KH12-12.5	115/230VAC	12V@12.5A				$167.00
KH15-10	115/230VAC	15V@10A				$167.00
KJT301	115/230VAC	5V@20A	12V@3A	12V@3A		$290.00
KJT302	115/230VAC	5V@20A	15V@2,4A	15V@2.4A		$290.00
KJT303	115/230VAC	5V@20A	5V@3A	12V@3A		$290.00
KJT304	115/230VAC	5V@20A	5V@3A	15V@2.4A		$290.00
KJT305	115/230VAC	5V@20A	5V@3A	24V@1.7A		$290.00
KLT305	115/230VAC	5V@20A	5V@1A	24V@1.7A		$260.00
KPM401	115/230VAC	5V@20A	5V@1A	12V@3A	12V@3A	$300.00
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CIRCLE NO 71

Analyze complex circuits with a matrix-inversion program

Once the domain of mainframes, circuit-analysis tasks yield to a calculator program that inverts 5×5 complex-element matrices.

William N Waggener, Sangamo Weston

You don't need an elaborate computer facility to perform steady-state analysis of linear circuits: This article's matrix-inversion program for the TI59 calculator can invert matrices containing as many as 5×5 complex elements, allowing you to solve the sets of linear equations that describe such circuits.

Consider, for example, the analysis of the frequency-domain response of a linear network based on solving the simultaneous linear equations defining the network's node currents (**references**). This procedure results in a set of complex-coefficient linear equations that relate node currents to node voltages:

$$\left.\begin{aligned} Y_{11}V_1 + Y_{12}V_2 + \cdots + Y_{1N}V_N &= J_1 \\ Y_{21}V_1 + Y_{22}V_2 + \cdots + Y_{2N}V_N &= J_2 \\ \cdot \quad\quad \cdot \quad\quad\quad\quad \cdot & \\ \cdot \quad\quad \cdot \quad\quad\quad\quad \cdot & \\ \cdot \quad\quad \cdot \quad\quad\quad\quad \cdot & \\ Y_{N1}V_1 + Y_{N2}V_2 + \cdots + Y_{NN}V_N &= J_N. \end{aligned}\right\} \quad (1)$$

You can also represent these in matrix notation:

$$\mathbf{Y}\cdot\mathbf{V} = \mathbf{J}, \quad (2)$$

where V_K is the k*th* node voltage and J_K is the current into the k*th* node.

In this form, the nodal admittance matrix **Y** relates the node-current vector **J** to the node-voltage vector **V**. The elements in the nodal admittance matrix in turn are related both to the individual-component admittances and any dependent-current-source transconductance. For a network composed of resistors, capacitors and inductors, the nodal admittance elements are complex values that depend on the steady-state frequency. Inverting the complex nodal admittance matrix to solve for the node voltages in terms of the independent node currents then yields a complete description of a linear circuit at a particular frequency.

Review nodal-equation setup

Before looking at the program's details, review the method of setting up the nodal equations. The direct method involves converting all network voltage sources to equivalent current sources and then setting the sum of all currents entering a given network node to zero. Expressing dependent current sources in terms of node voltages and simplifying the resulting simultaneous equations yields the form of **Eq 1.** To set up the nodal admittance matrix for a general network containing both dependent and independent current sources, you can follow a step-by-step procedure:

- Convert all voltage sources in the network to equivalent current sources, using the Norton transformation.
- Label the nodes in the equivalent circuit, starting with a reference node (typically ground) as Node 0 and continuing through the remaining nodes as Nodes 1 through N. The voltage at Node 1 is represented by V_1, the voltage at Node 2 by V_2, and so forth.
- Construct the nodal admittance matrix as follows. First, set up the matrix without regard for independent current sources. For example, the admittance component Y_{11} equals the sum of all admittances connected to Node 1, and similarly, the admittance component Y_{22} is the sum of all admittances connected to Node 2. In general, the diagonal elements of the admittance matrix represent the sum of the admittances connected to the respective nodes. Note that no component represents the reference nodes. Next, put in the matrix's off-diagonal elements. Y_{12}, for example, is the negative of the admittance connected between Node 1 and Node 2, and in general, Y_{ij} is

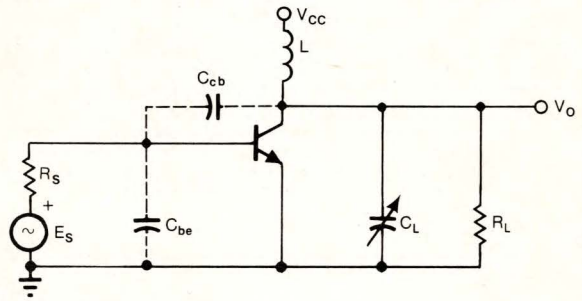

Fig 1—An example *based on this tuned amplifier illustrates how a calculator program can help you analyze complex linear networks.*

Convert transistors to hybrid-π equivalents

the negative of the admittance connected between nodes i and j. Note that in a linear circuit, Y_{ij} equals Y_{ji}, resulting in a symmetric matrix.

- Add the effects of dependent current sources—expressed in terms of a transconductance and a node voltage. For a dependent current source connected to Node i and controlled by voltages V_j and V_k, you must modify the nodal admittance components in row i, columns j and k by subtracting the transconductance from the terms Y_{ij} and Y_{ik}. (The typical sign convention requires subtracting the transconductance term from the admittance term if the current flows into the node, and adding it if the current flows out of the node.) You then add or subtract the transconductance for each dependent source to the appropriate terms in the preliminary nodal admittance matrix to produce the final nodal admittance matrix. Note that dependent current sources destroy the admittance matrix's symmetry.
- Construct the node-current vector, which is composed of all independent current sources. The current-vector component J_1, for example, is the sum of all independent current sources entering Node 1. Similarly, component J_i is the sum of all independent current sources entering Node i.
- Determine the complex node voltages for a given frequency by numerically evaluating the nodal admittance matrix at that frequency, inverting the matrix and multiplying the inverted matrix by the node-current vector:

$$\mathbf{V} = \mathbf{Y}^{-1} \cdot \mathbf{J}. \qquad (3)$$

Form amplifier's equivalent circuit

Now consider an example: a simple tuned amplifier (**Fig 1**) composed of an npn-transistor-driven LC network and including a 50Ω input-voltage-source impedance. You need a frequency-domain analysis of this amplifier at several frequencies, taking into account the stray capacitances from collector to base and base to emitter. (Assume that the stray capacitance from collector to emitter is lumped into the equivalent tuning capacitor.)

First, form an equivalent circuit of the amplifier (**Fig 2a**) that represents the transistor as its hybrid-π equivalent circuit. Additionally, **Fig 2a** represents the input voltage source converted to an equivalent Norton current source, satisfying the matrix-setup procedure's first step. Next, label the circuit nodes. In **Fig 2a**, ground is Node 0, Node 1 is the input point to the transistor and Node 3 is the circuit output.

Next, construct the nodal admittance matrix from the equivalent circuit. Excluding the reference node, the equivalent circuit has three nodes; thus, you obtain three simultaneous equations, yielding a 3×3 nodal admittance matrix.

Form the matrix's diagonal element first. Note that Y_{11} is the sum of all admittances connected to Node 1; for this circuit, the total admittance equals the sum of the conductances connected to Node 1 plus the admittance arising from the base-to-collector and base-to-emitter capacitances.

Fig 2b shows the components of the nodal admittance matrix. The diagonal elements are the sums of the admittances connected to the individual nodes; the off-diagonal elements are the admittances from node to node with the signs changed.

After forming the elements of the nodal admittance matrix whose sources are the components connected from node to node, take into account any dependent

TABLE 1—CIRCUIT VALUES

$g_X = 3.3 \times 10^{-3}$S	$C_{bc} = 1.7$ pF
$g_\pi = 3.5 \times 10^{-4}$S	$C_L = 200$ pF
$g_m = 3.6 \times 10^{-2}$S	$R_L = 300\Omega = 1/G_L$
$C_u = 2.3$ pF	$L = 1.2665\ \mu$H
$C_\pi = 33$ pF	$R_S = 50\Omega = 1/Y_S$
$C_{be} = 1.5$ pF	

(a)

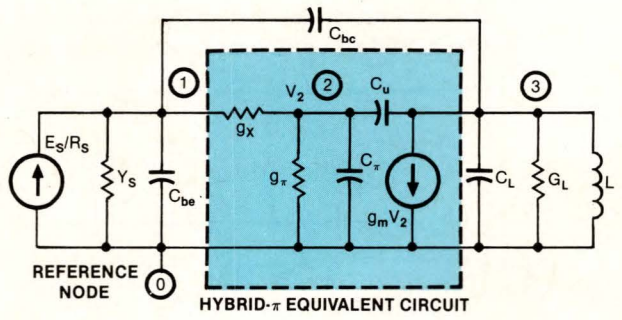

Fig 2—The first step *in the analysis of* ***Fig 1****'s circuit involves converting the voltage source to a current source, representing the transistor by its equivalent-π circuit and labeling nodes and voltages* ***(a)****. Then you generate the corresponding nodal admittance matrix* ***(b)****, which relates the node-current and -voltage vectors (****J*** *and* ***V****, respectively) according to the equation* ***Y*** *×* ***V*** *=* ***J****.*

(b)

$$\mathbf{Y} = \begin{pmatrix} (Y_S + g_X) + j\omega(C_{bc} + C_{be}) & -g_X & -j\omega C_{bc} \\ -g_X & (g_X + g_\pi) + j\omega(C_u + C_\pi) & -j\omega C_u \\ -j\omega C_{bc} & g_m - j\omega C_u & G_L + j\left[\omega(C_L + C_{bc} + C_u) - \frac{1}{\omega L}\right] \end{pmatrix}$$

$$\mathbf{J} = \begin{pmatrix} E_S/R_S \\ 0 \\ 0 \end{pmatrix} \qquad \mathbf{V} = \begin{pmatrix} V_1 \\ V_2 \\ V_3 \end{pmatrix}$$

```
000  76 LBL     057  01  1      114  42 STO     171  01  01     228  43 RCL     285  54  )      342  86 STF
001  16 A'      058  02  2      115  01  01     172  79  √x     229  07  07     286  99 PRT     343  02  02
002  19 D'      059  54  )      116  00  0      173  43 RCL     230  32 X:T     287  18 C'      344  61 GTO
003  42 STO     060  42 STO     117  42 STO     174  09  09     231  43 RCL     288  87 IFF     345  94 +/-
004  03  03     061  00  00     118  02  02     175  32 X:T     232  10  10     289  02  02     346  76 LBL
005  32 X:T     062  92 RTN     119  36 PGM     176  43 RCL     233  77  GE     290  65  ×      347  13  C
006  76 LBL     063  76 LBL     120  04  04     177  07  07     234  88 DMS     291  19 D'      348  42 STO
007  17 B'      064  19 D'      121  18 C'      178  19 D'      235  87 IFF     292  94 +/-     349  07  07
008  42 STO     065  71 SBR     122  94 +/-     179  42 STO     236  01  01     293  42 STO     350  99 PRT
009  04  04     066  98 ADV     123  42 STO     180  01  01     237  68 NOP     294  01  01     351  98 ADV
010  36 PGM     067  73 RC*     124  05  05     181  32 X:T     238  69 OP      295  99 PRT     352  01  1
011  04  04     068  00  00     125  42 STO     182  42 STO     239  29  29     296  32 X:T     353  42 STO
012  13  C      069  32 X:T     126  01  01     183  02  02     240  43 RCL     297  94 +/-     354  08  08
013  92 RTN     070  69 OP      127  32 X:T     184  18 C'      241  09  09     298  42 STO     355  36 PGM
014  76 LBL     071  20  20     128  94 +/-     185  43 RCL     242  32 X:T     299  02  02     356  01  01
015  18 C'      072  73 RC*     129  42 STO     186  09  09     243  43 RCL     300  99 PRT     357  71 SBR
016  43 RCL     073  00  00     130  06  06     187  16 A'      244  10  10     301  18 C'      358  25 CLR
017  08  08     074  32 X:T     131  42 STO     188  71 SBR     245  77  GE     302  61 GTO     359  43 RCL
018  32 X:T     075  69 OP      132  02  02     189  33 X²      246  87 IFF     303  55  ÷      360  10  10
019  43 RCL     076  20  20     133  43 RCL     190  19 D'      247  22 INV     304  76 LBL     361  42 STO
020  07  07     077  92 RTN     134  09  09     191  44 SUM     248  86 STF     305  65  ×      362  09  09
021  92 RTN     078  76 LBL     135  32 X:T     192  01  01     249  02  02     306  42 STO     363  76 LBL
022  76 LBL     079  10 E'      136  43 RCL     193  32 X:T     250  61 GTO     307  01  01     364  95  =
023  33 X²      080  71 SBR     137  09  09     194  44 SUM     251  94 +/-     308  32 X:T     365  43 RCL
024  43 RCL     081  98 ADV     138  10 E'      195  02  02     252  76 LBL     309  42 STO     366  08  08
025  05  05     082  43 RCL     139  86 STF     196  18 C'      253  68 NOP     310  02  02     367  91 R/S
026  42 STO     083  01  01     140  01  01     197  10 E'      254  22 INV     311  91 R/S     368  42 STO
027  03  03     084  72 ST*     141  76 LBL     198  61 GTO     255  86 STF     312  99 PRT     369  01  01
028  43 RCL     085  00  00     142  69 OP      199  79  √x     256  01  01     313  48 EXC     370  91 R/S
029  06  06     086  69 OP      143  01  1      200  76 LBL     257  61 GTO     314  01  01     371  42 STO
030  17 B'      087  20  20     144  42 STO     201  77  GE     258  69 OP      315  32 X:T     372  02  02
031  18 C'      088  43 RCL     145  07  07     202  87 IFF     259  76 LBL     316  91 R/S     373  18 C'
032  92 RTN     089  02  02     146  76 LBL     203  01  01     260  94 +/-     317  99 PRT     374  16 A'
033  76 LBL     090  72 ST*     147  88 DMS     204  79  √x     261  43 RCL     318  48 EXC     375  43 RCL
034  98 ADV     091  00  00     148  01  1      205  18 C'      262  10  10     319  02  02     376  01  01
035  53  (      092  69 OP      149  42 STO     206  32 X:T     263  42 STO     320  32 X:T     377  44 SUM
036  53  (      093  20  20     150  08  08     207  67  EQ     264  09  09     321  76 LBL     378  05  05
037  24 CE      094  92 RTN     151  43 RCL     208  79  √x     265  01  1      322  55  ÷      379  43 RCL
038  75  -      095  76 LBL     152  10  10     209  18 C'      266  42 STO     323  10 E'      380  02  02
039  01  1      096  11  A      153  42 STO     210  19 D'      267  07  07     324  69 OP      381  44 SUM
040  54  )      097  01  1      154  11  11     211  42 STO     268  76 LBL     325  28  28     382  06  06
041  65  ×      098  42 STO     155  76 LBL     212  01  01     269  85  +      326  18 C'      383  69 OP
042  02  2      099  09  09     156  89  π      213  32 X:T     270  01  1      327  43 RCL     384  28  28
043  65  ×      100  76 LBL     157  43 RCL     214  42 STO     271  42 STO     328  10  10     385  97 DSZ
044  43 RCL     101  87 IFF     158  07  07     215  02  02     272  08  08     329  77  GE     386  09  09
045  10  10     102  43 RCL     159  32 X:T     216  71 SBR     273  76 LBL     330  75  -      387  95  =
046  85  +      103  09  09     160  43 RCL     217  33 X²      274  75  -      331  69 OP      388  43 RCL
047  53  (      104  32 X:T     161  09  09     218  10 E'      275  98 ADV     332  27  27     389  05  05
048  02  2      105  43 RCL     162  67  EQ     219  76 LBL     276  53  (      333  97 DSZ     390  99 PRT
049  65  ×      106  09  09     163  77  GE     220  79  √x     277  43 RCL     334  09  09     391  32 X:T
050  53  (      107  19 D'      164  32 X:T     221  69 OP      278  07  07     335  85  +      392  43 RCL
051  32 X:T     108  42 STO     165  43 RCL     222  28  28     279  65  ×      336  91 R/S     393  06  06
052  75  -      109  03  03     166  08  08     223  97 DSZ     280  01  1      337  76 LBL     394  99 PRT
053  01  1      110  32 X:T     167  67  EQ     224  11  11     281  00  0      338  12  B      395  32 X:T
054  54  )      111  42 STO     168  77  GE     225  89  π      282  85  +      339  42 STO     396  98 ADV
055  54  )      112  04  04     169  22 INV     226  69 OP      283  43 RCL     340  10  10     397  91 R/S
056  85  +      113  01  1      170  87 IFF     227  27  27     284  08  08     341  99 PRT
```

Fig 3—Following Table 2's instructions *allows you to use this TI59 program to analyze networks described by 5×5 matrices.*

TABLE 2—OPERATING PROCEDURE

STEP	PROCEDURE	ENTER	DISPLAY/COMMENTS
1	LOAD PROGRAM.		
2	FOR 5 × 5 MATRICES, REPARTITION CALCULATOR.	7 [OP] 17	399.69
3	ENTER MATRIX SIZE n.	n [B]	"11"
4	ENTER MATRIX ELEMENTS ROW BY ROW, STARTING WITH THE REAL (Re) PART OF THE ROW 1, COLUMN 1 ELEMENT, THEN ITS IMAGINARY (Im) PART, AND CONTINUING UNTIL ALL ELEMENTS ARE ENTERED.	Y_{11}(Re) [R/S] Y_{11}(Im) [R/S] Y_{12}(Re) [R/S] • • • Y_{nn}(Im) [R/S]	"Y_{11}(Re)" "Y_{11}(Im)" "12" "Y_{12}(Re)" "Y_{nn}(Im)"
5	INVERT MATRIX	[A]	"11" "Y_{11}^{-1}(Re)" "Y_{11}^{-1}(Im)" "12" "Y_{12}^{-1}(Re)"•••"Y_{nn}^{-1}(Im)
6	MULTIPLY THE INVERTED MATRIX BY A COLUMN VECTOR: FIRST ENTER THE NUMBER OF THE MATRIX ROW TO BE MULTIPLIED; THEN ENTER THE COLUMN VECTOR, STARTING WITH THE REAL PART OF THE FIRST ELEMENT.	i [C] J_1(Re) [R/S] J_1(Im) [R/S] J_2(Re) [R/S] • • • J_i(Im) [R/S]	1 "3" "V_i"

NOTES:

1. THE PROGRAM USES MASTER LIBRARY PROGRAM PGM 04 AND DATA REGISTERS 00 THROUGH 11. ADDITIONALLY, MATRIX ELEMENTS ARE STORED SEQUENTIALLY BEGINNING AT REGISTER 12, WITH Y_{11}(Re) IN 12, Y_{12}(Im) IN 13, Y_{12}(Re) IN 14 AND CONTINUING WITH REAL PARTS IN EVEN REGISTERS AND IMAGINARY PARTS IN ODD REGISTERS. AFTER STEP 5, INVERTED-MATRIX VALUES REPLACE ORIGINAL VALUES IN THESE REGISTERS.
2. PRINTER OUTPUT IS INDICATED IN QUOTES IN THE DISPLAY/COMMENTS COLUMN. THE PRINTER IS NOT REQUIRED; YOU CAN RECALL INVERTED-MATRIX VALUES FROM THE MEMORY REGISTERS DESCRIBED IN NOTE 1. AFTER STEP 6, THE REAL PART OF THE VECTOR-MULTIPLICATION RESULT REMAINS IN THE DISPLAY; THE IMAGINARY PART IN THE t REGISTER.
3. THE MATRIX INVERSION ALWAYS STARTS WITH THE ROW 1, COLUMN 1 ELEMENT, WHICH MUST BE NONZERO. IF A ZERO ELEMENT IS ENCOUNTERED AS A PIVOT VALUE, THE PROGRAM HALTS WITH A FLASHING DISPLAY. IF THE MATRIX IS NOT SINGULAR, PERMUTATING THE ROWS OF THE MATRIX AND RERUNNING THE PROGRAM MIGHT ELIMINATE THE ERROR CONDITION.

Calculator program inverts nodal admittance matrix

current sources in the network. In this example, the one dependent source is the transistor connected to Node 3, which has a transconductance of g_m and which therefore affects an admittance component in row 3. The current source depends on the voltage at Node 2; thus, the specific component affected is Y_{32}. Because the current is directed out of Node 3, you must add the transconductance to the admittance component Y_{32}.

Next, form the node-current vector, composed of all independent current sources in the network. In this example, the equivalent current input to the amplifier represents the one independent current source, which enters at Node 1, yielding a value for node-current-vector component J_1. Note that J_2 and J_3 equal zero because no independent current sources enter or leave Nodes 2 and 3.

After obtaining the nodal admittance matrix and the node-current vector, use the calculator program to solve for the complex node voltages V_1, V_2 and V_3. **Table 1** shows some typical numerical values for the transistor equivalent circuit (**Fig 2a**) and the circuit components. These values represent a tuned amplifier with peak response at about 10 MHz. To find the amplifier's frequency response at 5, 10 and 15 MHz, first compute the numerical values of the nodal-admittance-matrix components. Then load the program into the TI59 calculator, using the standard 479.59 calculator-memory partition. (After loading, the calculator must be repartitioned to 399.69 if the matrix has dimension 5.)

Next, enter the nodal-admittance-matrix values, using the **Table 2** steps. After entering the values corresponding to the first frequency, invert the matrix and find the node voltages by multiplying the inverted matrix by the node-current vector, using function key C. The program takes approximately 2 min to invert a complex 2×2 matrix, about 6½ min for a 3×3, about 16 min for a 4×4 and 30 min for a 5×5 matrix. After computing the node voltages for the first frequency, change the values of the admittance matrix for the next frequency and repeat the process. **Table 3** shows the 5-MHz values obtained for the **Fig 1** amplifier, using a 1V 50Ω input source. Because Node 3 is the output of the tuned amplifier, you can easily compute the circuit gain and express the values in decibels for each of the three frequencies.

With this 3-node circuit, the calculator can evaluate approximately four to six frequency points per hour. Although this time might seem excessive, only about 20% is devoted to interfacing with the calculator; thus, you can work on other projects while the calculator grinds out the results. **EDN**

TABLE 3—PROGRAM OUTPUT (5 MHz)

Y	Y^{-1}	DESCRIPTION
3		MATRIX ORDER
11.	11.	ROW 1, COLUMN 1
0.0233	48.85686718	REAL PART
0.00010053	− 2.508010836	IMAGINARY PART
12.	12.	ROW 1, COLUMN 2
− 0.0033	42.00712886	
0.	− 16.21518356	
13.	13	
0.	− .2802227887	
− 0.000053407	.1196397575	
21.	21.	
− 0.0033	40.8579383	
0.	− 15.52737167	
22.	22.	
0.00365	288.9655244	
0.0011089	− 108.3699406	
23.	23.	
0.	− 1.114226533	
− 0.000072256	.6609882516	
31.	31.	
0.	− 42.77988075	
− 0.000053407	− 70.88844612	
32.	32.	
0.036	− 299.0244046	
− 0.000072256	− 501.9938274	
33.	33.	
0.0033333	10.82581538	
− 0.01872	53.63099972	
NODE VOLTAGES		
1		V_1
0.9771373436		REAL PART
− 0.501602167		IMAGINARY PART
2		V_2
0.8171587661		
− 0.3105474335		
3		V_3
− 0.8555976149		
− 1.417768922		
4.380858222		OUTPUT LEVEL (dB)
238.8897869		ANGLE (DEGREES)

References

1. Wing, Omar, *Circuit Theory with Computer Methods,* McGraw-Hill, New York, 1978.
2. Chua, L O and Line, Pen-Min, *Computer-Aided Analysis of Electronic Circuits,* Prentice-Hall, Englewood Cliffs, NJ, 1975.

Author's biography

William Waggener serves as technical adviser to the division general manager and is a senior staff engineer at Sangamo Weston's Data Systems Div (Sarasota, FL). Employed for 20 yrs at Sangamo Weston, he previously worked for the Mitre Corp and Bendix. Bill earned a BSEE degree from Rose Hulman Institute of Technology and an MEE from the University of Florida. He holds seven patents and is a member of IEEE, NSPE and the Florida Engineering Society. In his spare time, he enjoys Laser- and Sunfish-class sailboat racing.

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CIRCLE NO 73

Use flash ADCs carefully to handle high-frequency signals

Flash ADCs help solve high-speed-digitizing problems. Successfully applying these converters, though, mandates a thorough understanding of their operating principles.

Trevor Emmens and **Mark Lonsborough,**
Ferranti Electronics Ltd

The use of digital techniques in wide-band applications such as video, X-ray tomography and radar requires analog-to-digital converters capable of digitizing signals at sample rates greater than 10 MHz—a task best suited to flash ADCs. Neither the classical servo (counter) nor integrating ADC types can operate at such high speeds: The latter demand sufficient time to perform their integration; the former need several clock pulses to execute their feedback iteration.

Additionally, although several successive-approximation ADC types do spec conversion times less than 100 nsec, to digitize high-slew-rate signals they require a sample/hold circuit—which can cost more than the converter itself. The ideal solution, therefore, is an n-bit ADC that can simultaneously generate 2^n quantization levels in response to an analog input applied under the control of a strobing signal—in other words, a device that combines a digital sample/hold function with ultrafast A/D conversion, precisely what a flash ADC accomplishes. But you can't merely plug this device into your high-speed application (see **box,** "System-design considerations in flash-ADC applications"). You have to master its intricate subtleties.

Start with the basics

Fig 1's block diagram illustrates a typical 6-bit flash ADC's performance fundamentals. A reference voltage applied across a chain of identical resistors defines the converter's analog span ($V_{REF\ HI}-V_{REF\ LO}$). The chain divides the analog range into 2^n quantization levels at 1-LSB (least significant bit) intervals. Note that 1 LSB equals $(V_{REF\ HI}-V_{REF\ LO})/2^n$.

Each resistor-chain tap connects to a separate voltage comparator's input; the other input of each comparator ties to the analog input. The comparator array thus compares the analog input simultaneously with every one of the 2^n quantization levels within the ADC's analog span.

Should a comparator's reference level total less than the analog input voltage, the comparator changes state to ONE. Conversely, the outputs of comparators whose reference voltages lie above the analog input level remain at ZERO. Consequently, depending on the analog-input-voltage value, zero to 63 comparators can have ONE outputs.

Clearly, this 63-bit-wide digital representation proves cumbersome to process. You must, therefore, re-encode the logic outputs into a more compact, binary format. The process calls for logic gating to detect the highest output level (ie, the point in the comparator chain at which the comparator outputs change from ONE to ZERO). Unlike the comparator outputs, only one line of the highest-level-detection logic goes to ONE at any time (ie, it performs an n-of-63 to 1-of-63 decoding). Additionally, the 63 lines go to a 1-of-63-to-binary encoder or ROM.

Now consider the bandwidth and sampling aspects of flash converters. If you assume that the comparators' bandwidth is large enough to respond to rapidly varying signals but that the converter incorporates no sampling, the comparators would merely produce noise at the digital outputs as the output code continuously changes. Furthermore, note that to digitize ac signals accurately, you must sample at precise intervals.

Orderly flash-converter input-signal sampling and data extraction result from strobing the comparators and the output data latches. When this Strobe signal goes HIGH, the comparators track the analog input signal. Data from the previous sample remains unaffected in the data latches and available at the digital outputs. When Strobe goes LOW, the comparator

Flash ADCs outshine other types in high-speed applications

outputs don't change, but the data latches become transparent, and new data from the comparators propagates through the encoding logic to the outputs.

Establishing the analog span

Three factors determine a flash ADC's input range:

- Comparator offset voltage
- Comparator common-mode range
- Maximum voltage applied across the reference-resistor chain.

The input range varies from $V_{REF\ LO}$ to $V_{REF\ HI}$. If the reference voltage across the resistor chain decreases, the LSB's value eventually becomes comparable with the comparators' offset-voltage value, yielding increasing linearity errors. This deficiency places a lower limit on the ADC's analog span.

The reference-resistor chain often consists of low-value aluminum resistors in order to present a low source impedance to the comparators and to avoid errors arising from comparator bias currents. Therefore, the maximum voltage across this resistor chain is limited by current-density and power considerations. And these constraints determine the analog span's upper limit.

The comparators' common-mode range determines the maximum $V_{REF\ HI}$ value and the minimum $V_{REF\ LO}$ value. However, because of the reference-resistor chain's current and power limitations, you can't apply these maximum and minimum voltages simultaneously. In the ZN440 flash ADC, for example, the comparators' common-mode range spans −4 to +0.5V, but the

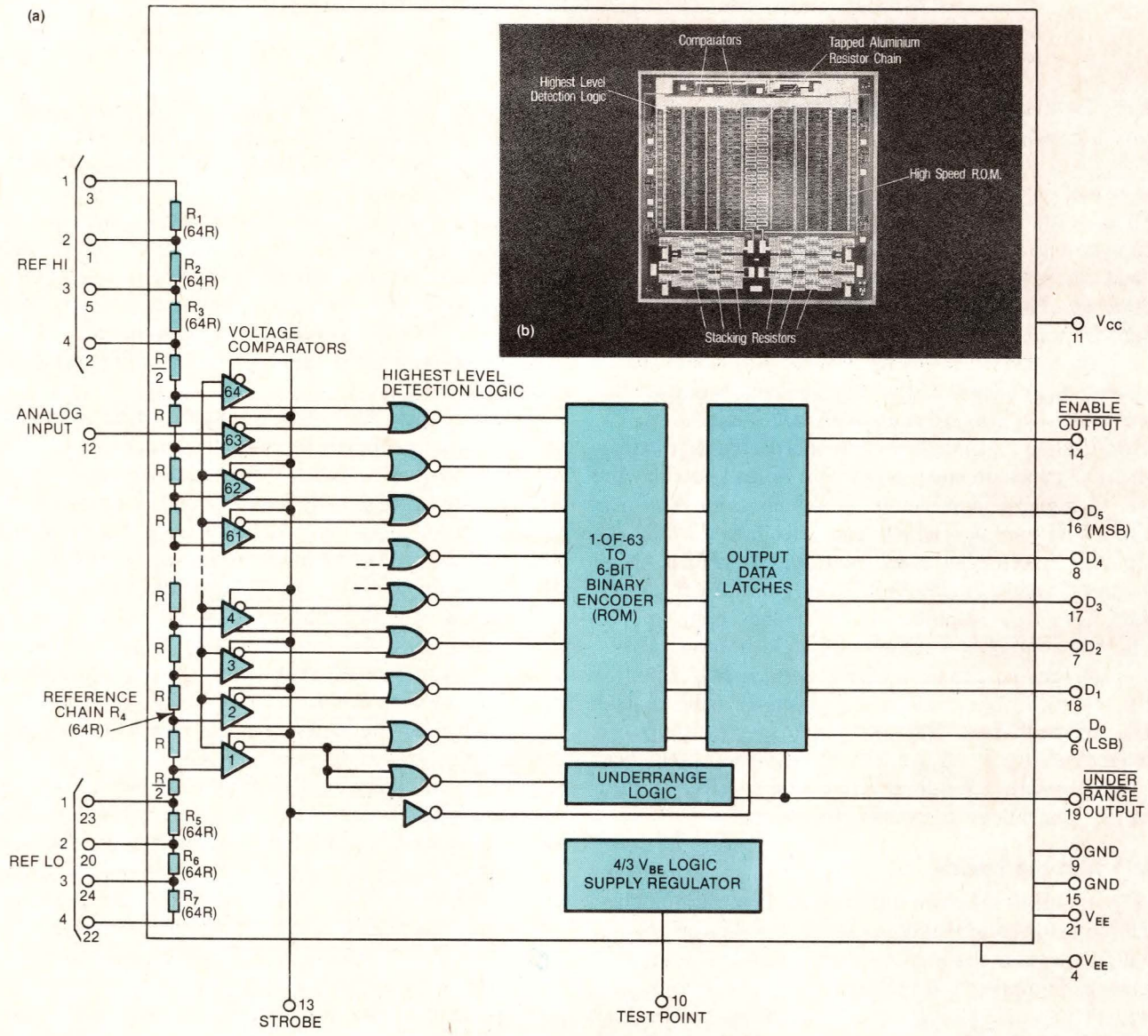


Fig 1—A typical 6-bit flash ADC, *the ZN440 performs at an 18-MHz max sampling rate* ***(a).*** *It provides an aluminum reference-resistor chain down its centerline, with voltage comparators, detection logic, stacking resistors and high-speed ROM located along both sides* ***(b).***

System-design considerations in flash-ADC applications

A common problem encountered in high-speed systems is noise. It proves particularly troublesome in A/D conversion, where noise amplitude radically changes an analog input waveform when its level reaches that of the least significant bit (LSB).

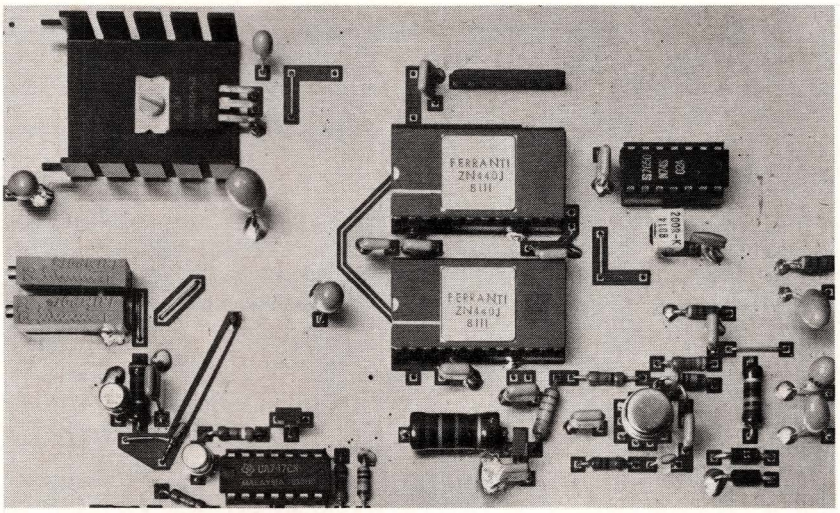
To minimize such effects, consider these precautions:

- A video-speed converter's digital inputs and outputs often carry frequency components exceeding 100 MHz. At this frequency, wire more than a few inches long becomes an efficient RF antenna. Use coaxial cable, therefore, for carrying analog signals, and keep it away from noisy digital environments.
- Switching-current spikes associated with TTL circuits can couple into an analog front end via the power-supply and ground lines. Because these input circuits have an inherently wide bandwidth, little high-frequency filtering occurs. You can reduce these current spikes in two ways: First, decouple each power supply with a parallel combination of a 0.1-μF ceramic and 10-μF tantalum capacitor joined to the converter's ground pin. Second, use a low-impedance ground system such as a pc board's ground plane, which also provides electrostatic shielding.
- Cautiously choose a power supply. Switching-regulator types usually exhibit peak noise spikes of several hundred millivolts with a considerable high-frequency content. Therefore, use linear power supplies where possible.
- When designing board-to-board interconnections, note that terminated coaxial cables for clock and analog input lines minimize signal distortion and line reflections. For systems requiring a large number of board-to-board interconnections, install multiple-conductor ribbon cable for digital signals. Both cable types produce a defined characteristic impedance and reduce the amount of digital crosstalk.

Bipolar flash converters possess a large input capacitance and a dc input bias current. For example, a 64-comparator array presents an 80-pF junction capacitance that varies with voltage.

The dc input bias also varies each time the input voltage crosses a comparator's threshold value. In the ZN440, for instance, a 1V full-scale reference voltage produces a 15.6-mV least significant bit. A 1-μA incremental change in the input bias current thus occurs for each LSB. You can approximate this change with a 15.6-kΩ input resistance. These input characteristics therefore indicate a 10Ω max source impedance for optimum performance.

Finally, one method of avoiding design pitfalls when applying flash ADCs is to buy an evaluation board rather than build a prototype from scratch. The **photo** shows a complete fast A/D subsystem installed on a standard Eurocard. The board contains the components needed to perform 6- or 7-bit A/D conversion at sample rates from dc to 16 MHz. The analog input range typically covers 1V p-p driven from a 75Ω source impedance. Simple resistor substitutions permit selection of other input ranges and impedances, and an offset adjustment establishes a unipolar or bipolar input range.



When applying flash ADCs, *consider purchasing a standard-size Eurocard evaluation circuit board instead of building a development model from scratch. This ZN440-based board contains all the components necessary to perform 6- or 7-bit A/D conversions at dc- to 16-MHz sampling. It processes 1V p-p inputs driven by a 75Ω source impedance.*

maximum voltage across the resistor chain limits at 1V. The analog span is thus limited to 1V within the range of −4 to +5V (eg, −4 to −3V, ±5V, etc).

Input loading can present problems

If you employ a bipolar flash ADC like the ZN440, be alert to some performance idiosyncrasies. The comparator input stages, for example, present a nonlinear input resistance. Specifically, each comparator doesn't draw input current until its analog input voltage exceeds the reference voltage; after that point, its input current remains relatively constant. Therefore, as the analog input voltage increases, the input current increases in a series of small steps as the comparators turn on one after another.

Note also that each comparator has an associated nonlinear junction capacitance. For a 6-bit flash converter, the sum of these capacitances can equal 80 pF. Therefore, you should drive a flash ADC from a low-impedance source.

Considering a typical flash ADC's logic timing (**Fig 2**), observe that when the Strobe signal changes to

Digitizing ac inputs calls for well-defined sampling intervals

ONE, the comparators become free to change state in response to the analog input. When Strobe falls to ZERO, the comparators latch the information present just before the transition. You need careful on-chip propagation-delay matching, however, to ensure that each comparator samples the analog input signal with precision timing. After the comparator outputs pass thorough the decoding logic, the appropriate 6-bit binary word gets selected from the high-speed ROM. This data transfers to the output latches during Strobe's ZERO period and is held during its ONE period. The timing logic thus guarantees that valid data always exists at the digital outputs.

Internal propagation delays between the comparators and the output latches largely determine the

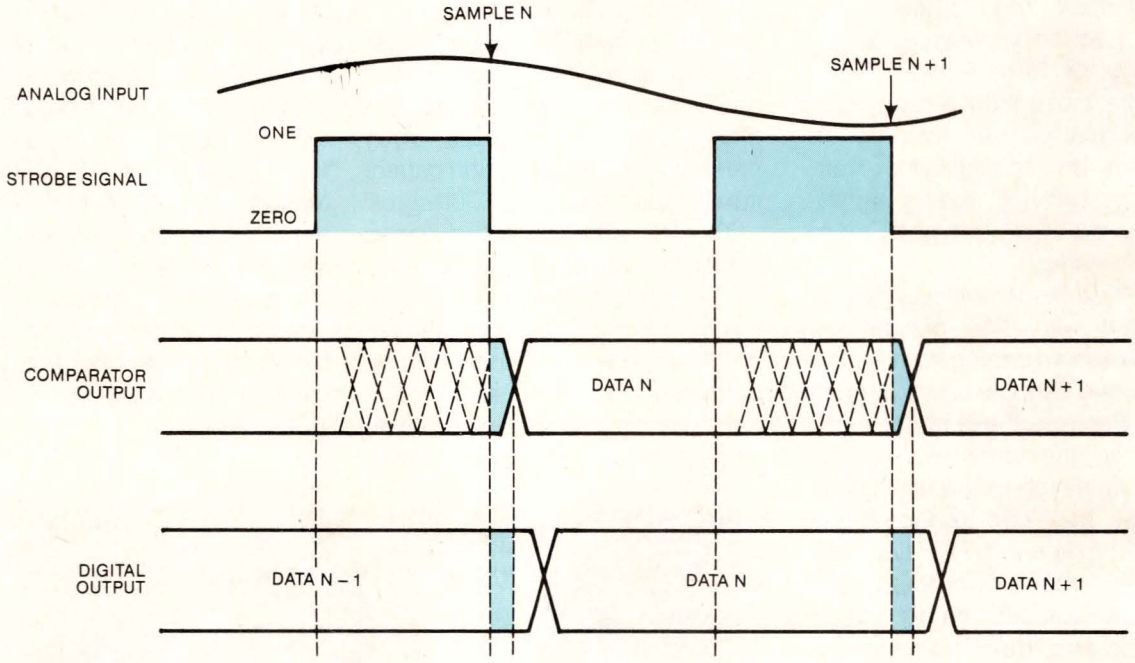


Fig 2—When its Strobe signal rises to ONE, *a flash converter's voltage comparators change output state depending on the analog input's value. When Strobe falls to ZERO, the comparators latch the data available just prior to the transition. Digital data transfers to the converter's output latches during Strobe's ZERO period and remains latched during its ONE period.*

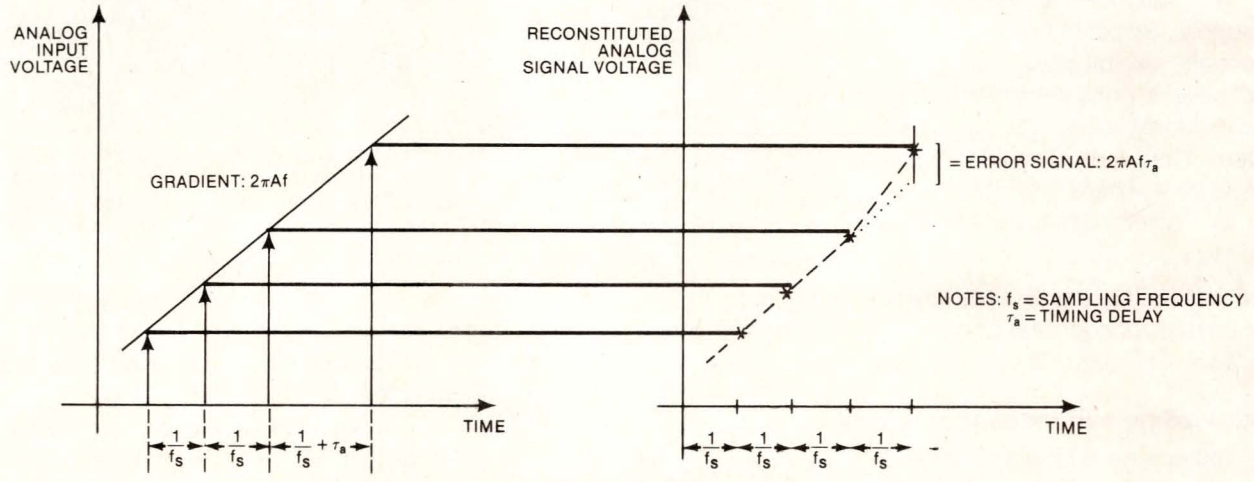


Fig 3—An extra time delay (τ_a) *added to voltage-comparator processing can cause variations in the flash converter's sampling frequency* (f_s). *Because an ideally reconstituted analog input waveform assumes equal sampling intervals, an error voltage commonly evolves, imposing a boundary on the maximum input frequency.*

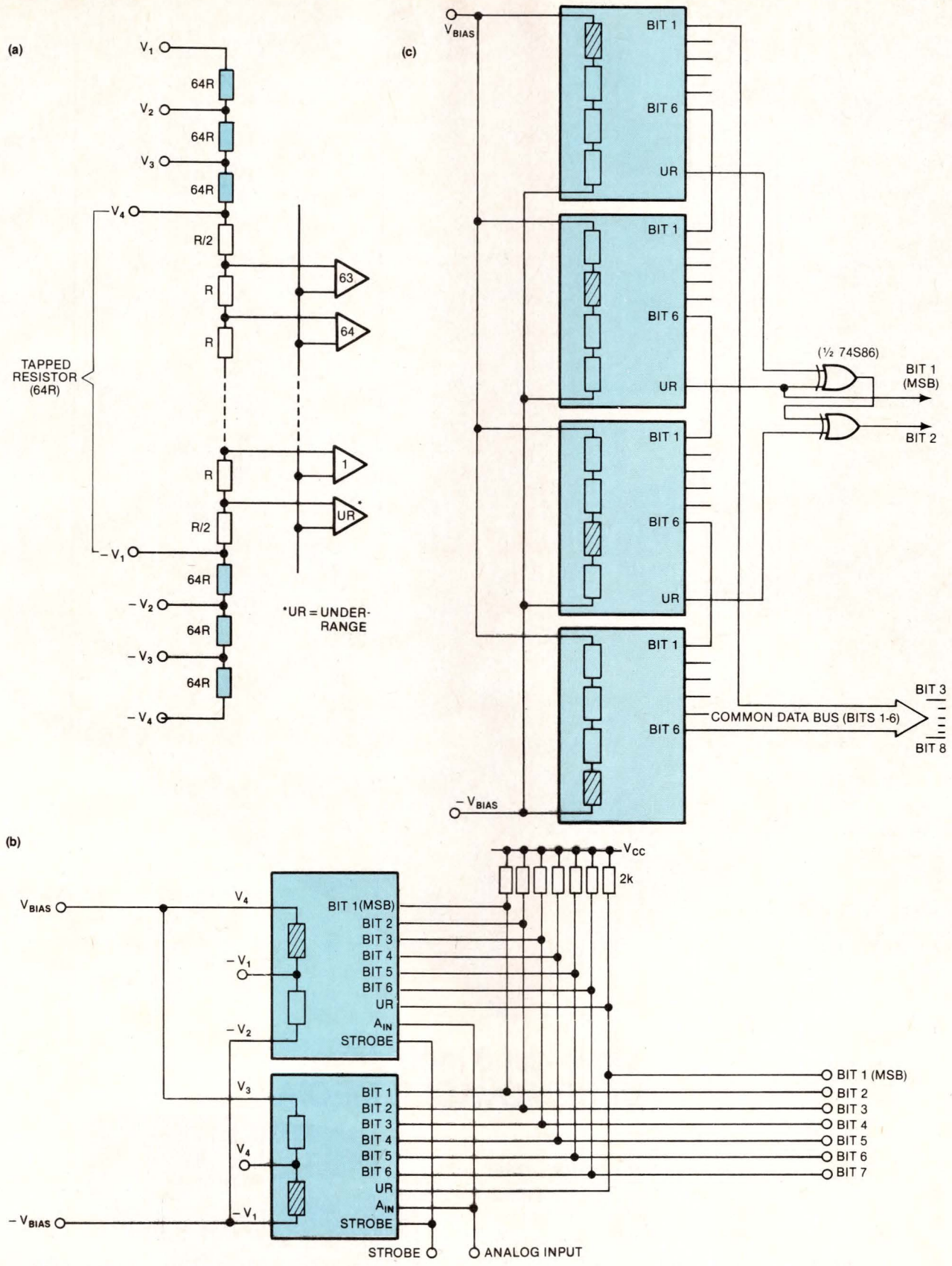


Fig 4—This flash converter *incorporates extra resistors at the end of each reference chain* **(a).** *Suitable connections to these resistors allow the converter (a ZN440) to operate over half the total reference-voltage range for 7-bit stacking* **(b)** *or over one-quarter of the total reference-voltage range for 8-bit stacking* **(c).** *In 7-bit stacking, the six least significant bits (LSBs) result from busing bits 1 to 6 together from two converters. The most significant bit serves as the upper converter's underrange (UR) output because the UR comparator's threshold value is exactly 1 LSB higher than the lower converter's comparator-63 threshold. In 8-bit stacking, decoding the logic outputs using two exclusive-OR gates produces bits 1 and 2. You can feed all eight outputs into a latch to eliminate the additional propagation-delay effects introduced in bits 1 and 2.*

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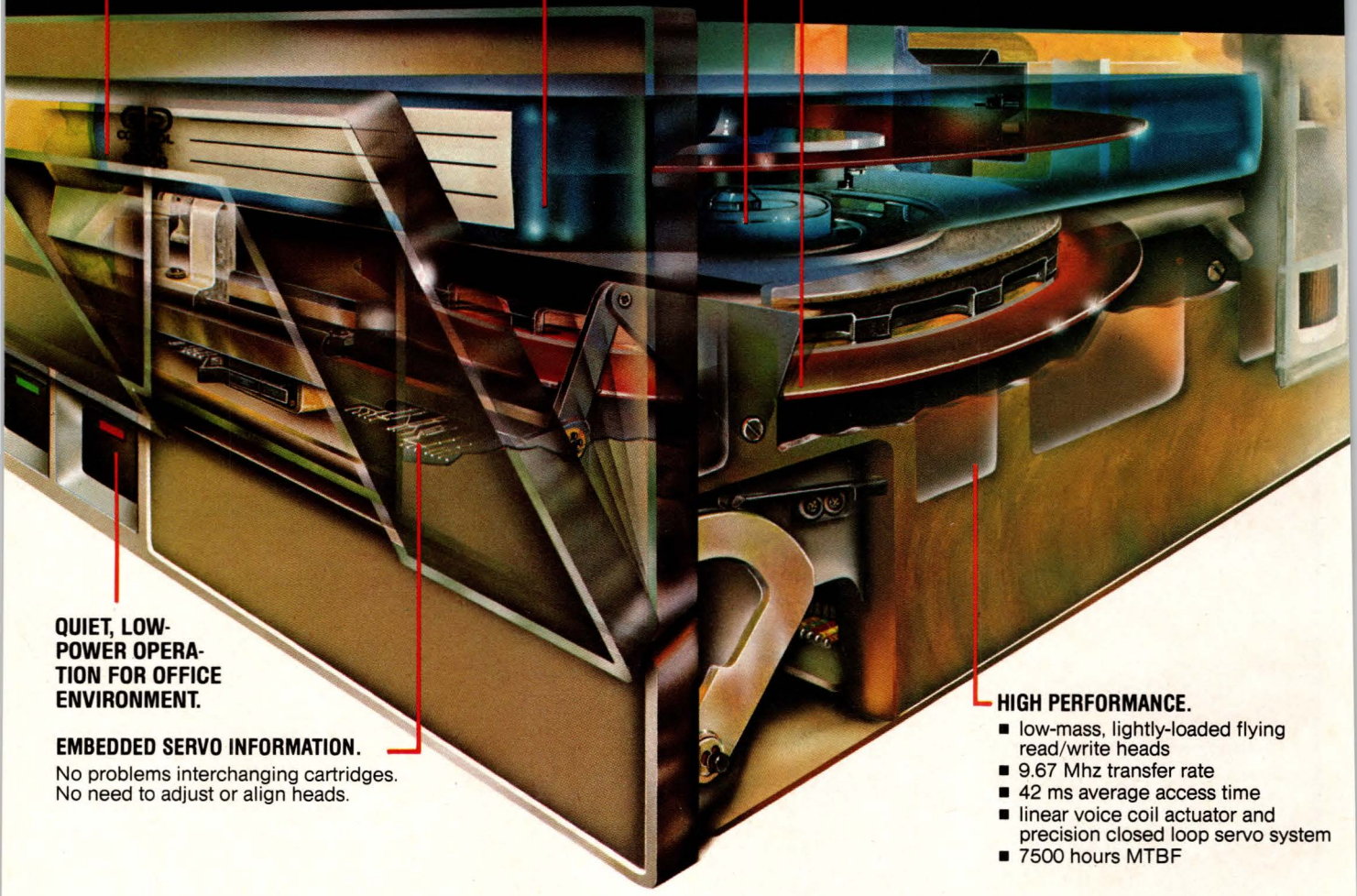

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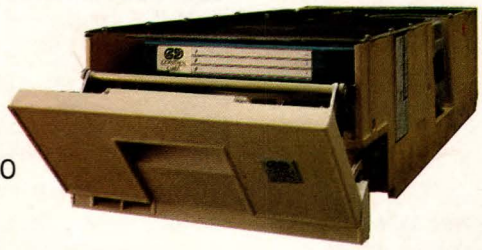

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Meticulous timing-logic design assures valid digital data

maximum conversion frequency. Fast flash ADCs therefore have designs that minimize internal RC delays and avoid the use of saturating transistors.

Aperture delay produces timing errors

In an ideal flash ADC, the input signal samples at the instant Strobe changes from ONE to ZERO. However, because of propagation delays in the strobe-driver circuits, an aperture delay on the order of tens of nanoseconds usually occurs between these two events.

Aperture delay can thus cause timing problems when you're digitizing fast aperiodic pulses such as radar echoes. If the flash ADC strobes at the instant of pulse detection, the pulse might expire before Strobe reaches the comparators. An often-used solution places a delay equal to the aperture delay in the analog signal path to the ADC. This setup detects the pulse and strobes the ADC before pulse arrival. In most applications this solution proves impractical, however, because aperture delay varies widely among different devices of the same type as well as with temperature.

Aperture jitter bounds input frequency

In an ideal flash ADC, sampling occurs instantaneously. Each comparator therefore processes the same point on the analog input waveform. Obviously, these conditions prove impossible to achieve in practice because differential delays exist in the Strobe and analog-input paths that feed each comparator. These timing errors cause sampling to take a finite time interval—a duration termed aperture jitter, τ_a.

Consider the analog waveform

$$y = A \sin 2\pi ft,$$

where A is a signal amplitude equal to half the reference voltage across the tapped resistor and f is the input signal frequency. The waveform's maximum slew rate therefore becomes

$$\frac{dy}{dt}(\max) = 2\pi Af \quad V/sec.$$

Fig 3 shows how an extra delay τ_a to one comparator can cause apparent variations in the sampling frequency (f_s). Because a reconstituted analog input waveform assumes equal sampling intervals, an error voltage ($2\pi Af\tau_a$) develops. For given values of aperture jitter and conversion accuracy, a corresponding limitation confines the maximum input frequency. For example, the ZN440 specs jitter at approximately 300 psec; therefore, this chip can accurately sample input signals containing frequency components greater than 8 MHz.

Improve resolution with stacking

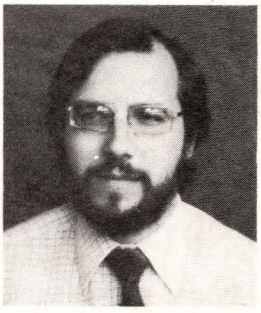
In theory, you can double a flash ADC's resolution (eg, from six to seven bits) by connecting or stacking the reference-resistor chains of two converters in series—or even quadruple it by connecting four chains in series. Because this stacking arrangement can increase the analog input range while keeping the LSB size the same, the system's linearity should remain unaffected. However, problems inevitably arise:

- No guarantee exists that the converters' reference-resistor chains will exactly match so that each converter will operate over exactly a half or a quarter of the analog span.
- The converters must operate with increased values of V_{REF} and analog input.
- A converter's logic outputs in the chain must activate only when the analog input lies within that converter's range, allowing you to bus the data outputs together.

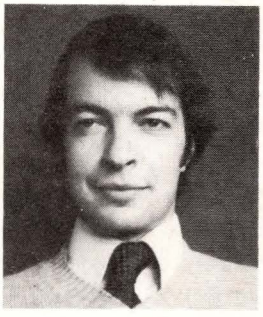
Some flash ADCs have additional on-chip circuits to facilitate expansion, but others do not (**Fig 4**).

Because the stacking process involves placing converters in parallel, no reduction results in the maximum sampling frequency. However, differences in Strobe propagation delays among converters do affect aperture jitter. Accordingly, the maximum analog input frequency is 500 kHz for 7-bit accuracy and 250 kHz for 8-bit accuracy. You can compensate for these timing errors, though, by introducing a variable delay in each converter's Strobe signal. However, different converters' Strobe-propagation delays don't necessarily track with temperature. To overcome this problem, you must use a sample/hold circuit to achieve the ADC's full bandwidth. **EDN**

Authors' biographies



Trevor Emmens serves as a senior product marketing engineer for data converters at Ferranti Electronics Ltd, Oldham, UK. Before joining the firm 3 yrs ago, he worked for 8 yrs as a designer and technical author. Trevor earned a BSC in electronic engineering at the University of Leeds. His hobbies include music, photography and collecting old clocks and scientific instruments.



Mark Lonsborough, a linear design engineer at Ferranti Electronics Ltd, designs and develops monolithic-IC data converters. He holds a BA (Honors) in physics and electronics from Keele University. Among his hobbies, Mark lists music, squash and photography.

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CIRCLE NO 77

Ask the key questions when buying a custom IC

Go through a series of critical questions to evaluate the services that various vendors offer and the level of user involvement they afford. Then review the responses and choose the company that can best serve your needs.

Paul Brown, Exar Integrated Systems Inc

As the availability of custom ICs increases and their cost comes down, a spectrum of custom fabrication services broader than that available only a few years ago will emerge. Therefore, assuming you've decided on one of the various "buy" options in the make-vs-buy analysis for these devices (EDN, March 3, pg 127), you'll still face a large number of alternatives.

Although in the past you might have thought that buying custom ICs was too expensive or troublesome, you'll probably want to reconsider that course soon. Technological advances have made custom ICs a viable choice for many applications. The increased availability of computers for design and layout, for instance, has substantially reduced the engineering effort necessary for IC design. And the state of the art of semiconductor manufacturing has improved to the point where manufacturing processes once considered difficult are now common.

Narrow your choices

The custom integrated circuits you can choose among divide into two groups: full custom and semicustom. All of the mask layers used to manufacture a full-custom IC are unique to that particular circuit. Semicustom ICs, on the other hand, consist of standard layers except for the last one or two, which are used to interconnect the components. Development charges for a semicustom IC are usually significantly lower than those for a full-custom circuit because fewer custom masks and processing steps are involved.

Semicustom ICs further divide into digital types (commonly termed gate arrays because they consist of collections of uncommitted logic gates) and linear semicustom units. The latter consist of arrays of transistors and resistors of various types and values that you can interconnect to yield a wide variety of custom circuits.

The increased availability of *all* types of custom ICs opens up many possibilities for new, improved and less expensive products—each with extensive market appeal. The major problem today, therefore, is not finding a custom-IC vendor but choosing the *best* one. You can solve this dilemma by asking yourself some key questions about each vendor under consideration.

How long has the vendor been in the custom-IC business?

The answer to this question provides a general picture of the company. A firm that has been in business for several years is likely to have acquired the necessary experience, talented people and effective methods, techniques and procedures to successfully complete a project. You can easily check out such a company by asking for and contacting references. You can also verify its credit standing. Avoid working with a company just starting out in custom-IC design and/or manufacturing; you could provide its experience at your product's expense.

How many and what type of products does the vendor offer?

Are the vendor's custom products specialized? For example, does it offer only CMOS arrays, or does it also make linear, bipolar I^2L and other types? The more diversified a vendor's products, the better it can serve you. For example, you might evaluate your custom-IC needs and determine that you need a CMOS gate array. I^2L, however, might be the better choice of technologies. A vendor that only offers CMOS might agree to provide CMOS, while a vendor offering both technolo-

The vendor's turnaround time affects your production cycle

gies will encourage you to choose the best one for you.

Some companies providing custom products also have a line of standard products. This consideration can be valuable. First, a company with a broad product line is more likely to be able to ride out market fluctuations; the last thing you need is a custom-IC vendor that's trimming its staff just when you need service. Second, such a vendor might also be able to supply you with the standard ICs you need and offer you combination pricing for these standard products plus your custom IC. The most significant consideration, however, is that a vendor offering a broad line has a lot of experience designing, manufacturing and supporting products.

One word of caution: Be careful when you approach large semiconductor companies that also design and manufacture custom circuits. They sometimes use custom jobs to fill in when their standard-product business is slow. When the market turns up, you could have trouble obtaining service from these companies.

Does the vendor process its own wafers?

A custom-IC vendor that processes its own wafers is clearly responsible for the quality of its products. It can usually offer lower unit prices than a vendor that farms out its wafer processing because no middleman profit is involved—and there's no delay of deliveries.

A vendor that processes its own wafers can also offer special processing—special diffusions, for example. Such a vendor can therefore offer wafer-foundry services—it can process wafers from masks that you design or from masks that another vendor has designed for you. (If you're contemplating designing your own masks, though, you'd best choose a vendor beforehand to assure that your layout rules are acceptable. This simple step can help you avoid many hours of reworking a layout.)

Does the vendor offer an adequate technology?

Are the processes your potential vendor uses to produce its custom ICs sufficiently fast? Are propagation delays and toggle rates (for digital gate arrays) or storage time and beta cutoff frequency (for linear circuits) adequate for your needs? If you're considering a semicustom circuit, do the vendor's products offer sufficient functional density? Will the power consumption of the resulting circuit be acceptable?

Finally, can the vendor expect a reasonable production yield on your device? This last point is an extremely important consideration. If the vendor can't manufacture your device in sufficient quantities to meet your needs or can't manufacture them at a profit, you'll experience delivery problems.

Is the vendor's production capability adequate?

Is the expected volume of your custom IC too large for the vendor to handle comfortably? Too small? If you answer "yes" to either of these conditions, delivery problems could result.

What is the vendor's turnaround time?

How long is the the vendor's normal production cycle? How much notice is required to increase or decrease order size? If you have an abnormally large order, can the vendor rapidly deliver the goods? And is there an extra cost for fast turnaround? If a vendor responds quickly to irregular or unexpected product demand, you can reduce your inventory.

Does the vendor offer the packaging you need?

Custom ICs come in three forms: wafers (tested or untested), dice (usually tested) and fully packaged and tested devices. You can choose among a wide variety of packages, including DIP, SIP, flatpack and chip carriers. All come in plastic and ceramic form. You can also choose the new plastic SO (small outline) option. Don't put off the packaging decision; treat packaging as an integral part of your design.

Does the vendor offer the engineering services you require?

Is the vendor capable and willing to perform circuit design? Does it require a discrete implementation of your circuit? Will it work from a block diagram and specifications that you supply and construct a breadboard or perform computer simulation to verify the performance of the custom unit before it's committed to silicon? Will the vendor do the layout, digitizing (tape-up) and edits, if necessary? Will it provide the information and materials that you need to do your own mask design? Will it assist in having masks made?

What is involved if an iteration proves necessary?

Will the vendor make the necessary design iteration in a reasonable amount of time and at a reasonable cost? Iterative costs should be included as a part of your total budget; if they prove unnecessary, you just might come in under the budget.

Does the vendor offer the special screening, inspections or AQL sampling plans you require?

A company that does its own screening ships you only screened parts. The rejects generated by this screening process therefore become the manufacturer's problem. If you must purchase unscreened parts, however, and arrange for your own screening independently through an outside testing lab (EDN, January 6, pg 47), you could end up paying a high price for rejects. Why?


In the world of flat cable, new Vari-Twist™ cable really stands out.
Belden's new Vari-Twist™ twisted pair cable combines the excellent electrical characteristics of paired conductors with the fast termination of flat cable.
The 18 inch twisted portions feature opposite direction lays on each adjacent pair of conductors. This minimizes cross-talk and provides a cleaner, more reliable signal. Each two inch straight section has precise 50 mil centers to fit standard IDC connectors. And because Vari-Twist is laminated on one side only, an easier, more reliable termination can be achieved.
Best of all, you can count on Vari-Twist cable's high quality because it's made by Belden. And backed by our strong commitment to service. For more information on Vari-Twist cable or any other cables, connectors or value-added products in Belden's flat cable world, contact: Belden Corporation, Electronic Division, Central Regional Sales Office in Richmond, IN; 317-983-5200. Western Regional Sales Office in Irvine, CA; 714-833-7700. Eastern Regional Sales Office in Framingham, MA; 617-872-7846.
8-1-1
BELDEN
Coming through...
with new ideas for moving electrical energy
CIRCLE NO 78
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Packaging type: an integral design decision

Unless the fault of the device that fails in an outside lab can be clearly traced to a manufacturing defect (frequently difficult to prove), vendors generally won't accept these failed devices as returns.

Is it reasonably easy to interface with the vendor's engineering, marketing and sales departments?

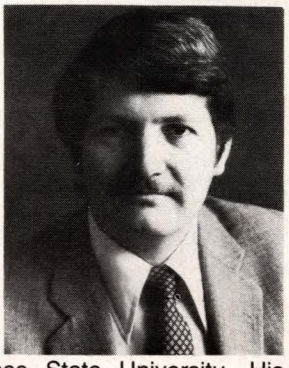
Are people from each department assigned to your account? Your dealings with the vendor will proceed more smoothly when a person familiar with your project is available to answer questions and tackle problems that arise. If the vendor isn't located nearby, find out whether local representatives can work with you. Such representatives want your custom program to run smoothly because they receive a commission based on its success.

Is a second source available?

This question is vitally important if you're considering using a state-of-the-art process, if your usage projections indicate very high volume or if you're contemplating a special package type. Many custom vendors second-source each other's semicustom products, such as gate arrays. Full-custom circuits are difficult to second-source, though, because they require specialized tooling. Usually, a 1-time fee is charged to tool up a second source; this fee can range from a few thousand dollars for a gate array to several tens of thousands of dollars plus a volume-purchase agreement for a full-custom circuit.

Some vendors avoid the expense of tooling up a completely independent second source—usually by furnishing a second source through an independent but affiliated company. In such cases, both companies have equivalent processes and can interchange masks. **EDN**

Author's biography



Paul Brown, manager of custom products at Exar Integrated Systems Inc (Sunnyvale, CA), is responsible for designing, marketing and selling custom ICs. A holder of two patents and a member of Tau Beta Pi, Eta Kappa Nu and the IEEE, he worked at National Semiconductor and Precision Monolithics before he joined Exar 2½ yrs ago. Paul earned a BSEE degree at San Jose State University. His leisure-time activities include woodworking, swimming, hiking and writing.

"Of course it's a Lambda. I wouldn't have a switching power supply that wasn't independently regulated on all three outputs!"

LYT-W triple output switching power supply
5V @ 14 amps, ±12V @ 1.2 amps, or 5V @ 14 amps, ±15V @ 1.2 amps, $197.*
One day delivery. One year guarantee.

LAMBDA ELECTRONICS

*Quantity 1000

LY series switching power supplies solve design problems of size, heat and power.

Lambda's low-cost, open-frame switching power supplies are ideal for such OEM applications as computer peripherals, business machines and medical instrumentation where heat and size are critical. Compared to equivalent linear power supplies, they are typically one-quarter the size, have one-half the heat dissipation and have twice the output power.

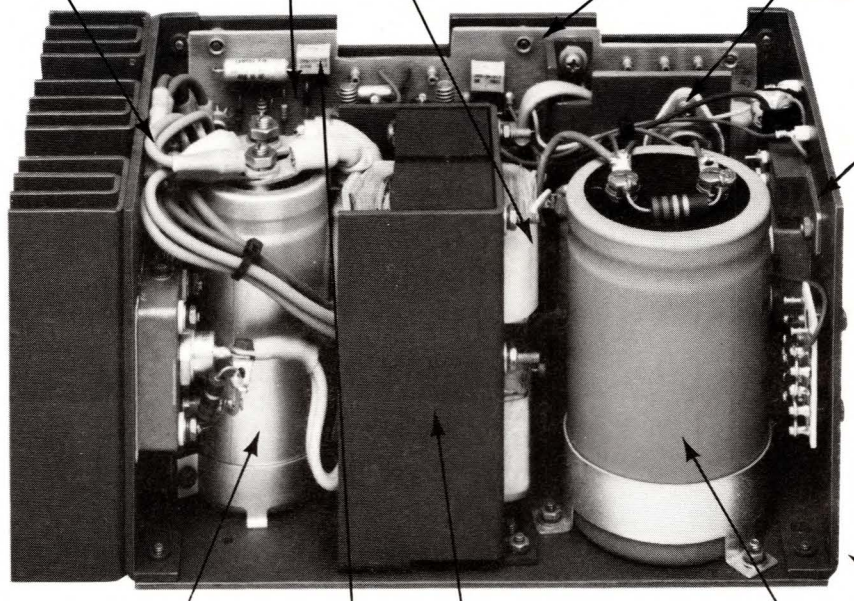
All of these LY Series, one-year-guaranteed power supplies are convection cooled. The new LYS-D models, which measure 7½" x 9½" x 4 13/16" with outputs up to 28 volts, currents up to 120 amps, are the only power supplies of their size and power that do not require fans or blowers for cooling.

Forty-two single output, four dual output and eight triple output models are available. The triple output models feature regulation on all three outputs.

EMI suppression covers are available as accessories for all models. The covers provide additional filtering sufficient for compliance with FCC Docket 20780, CLASS A conducted. (See page 7.)

LY units are Underwriters Laboratories recognized components and are CSA certified. (LYS-D presently under test.)

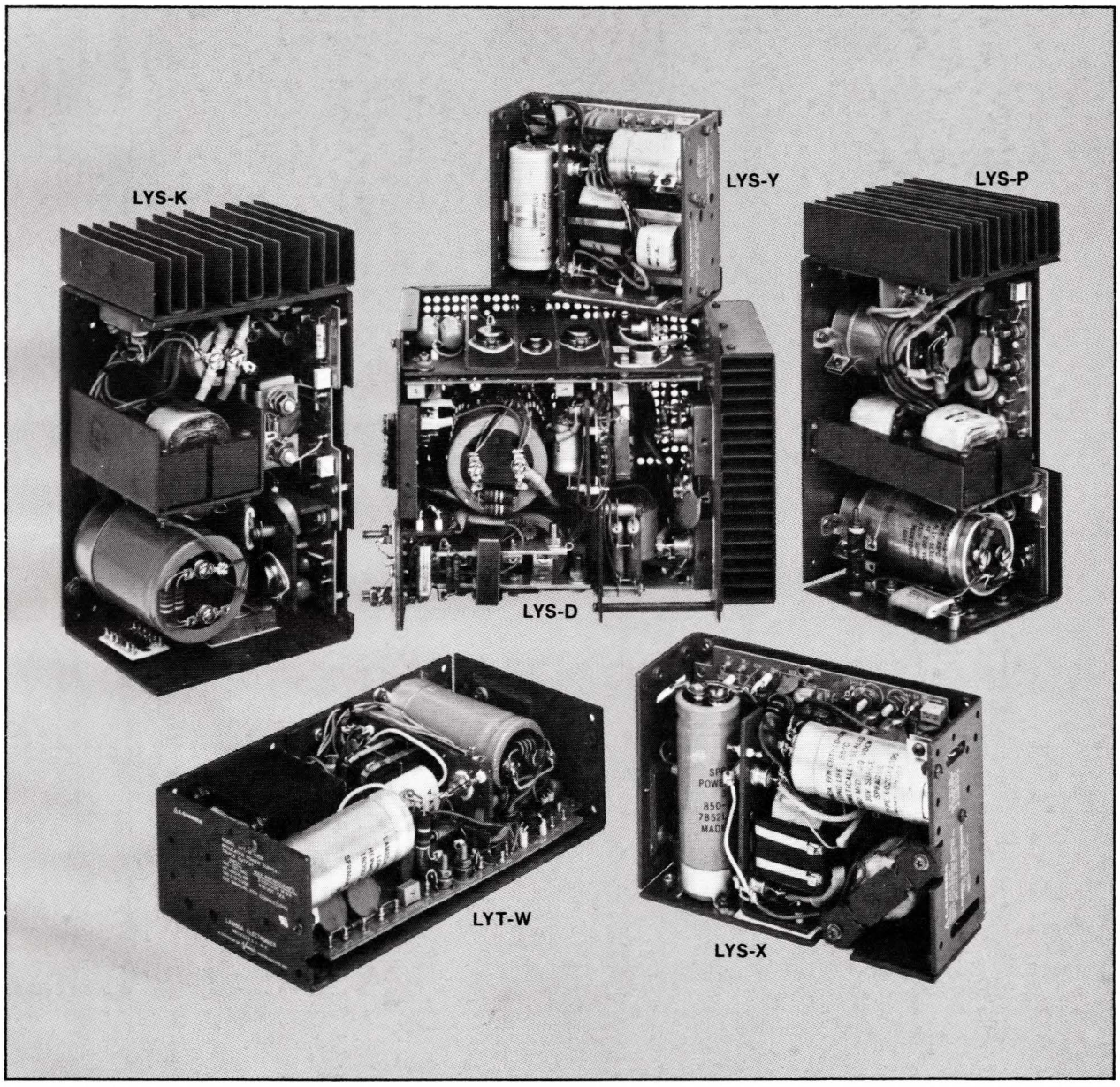
Lambda is its own distributor and all LY Series power supplies are available for one-day delivery from stock.



*Licensee of Photocircuits Inc.

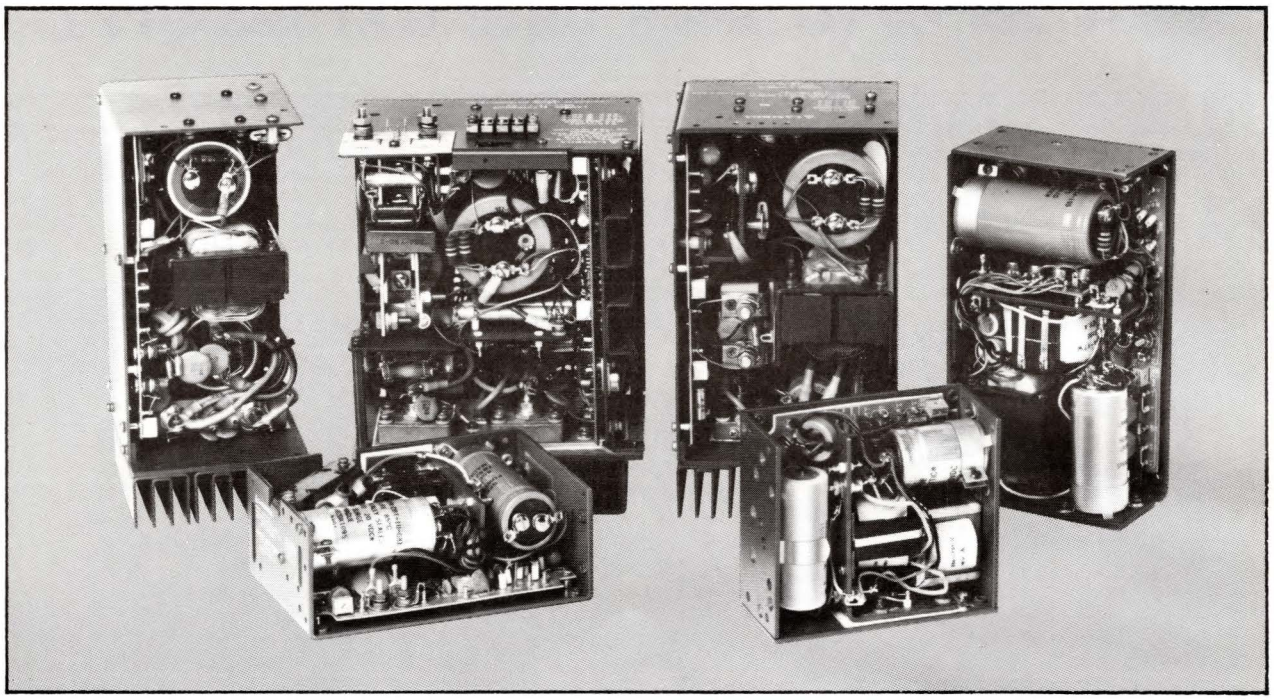
The LY series

6 PACKAGES, 42 SINGLES, 4 DUALS, 8 TRIPLES, UP TO 28V, UP TO 120A, STARTING AT $163. QTY 1.



1. ¼ the size (volumetric) of equivalent linear.
2. Twice the output power of equivalent linear.
3. ½ the heat dissipation of equivalent linear.
4. Priced from $163 for Qty 1 and $122 for Qty 1,000.
5. Convection cooled, no fans or blowers needed.
6. One day delivery.
7. Efficiency greater than 60%. Single output models.
8. Overvoltage protection available as accessory.
9. EMI suppression covers available as accessory.
10. ᖰU recognized and CSA certified.
11. 20 KHz switching.

Lambda LY series



Commercial switching selector guide

Model LY. Triple and dual outputs.

MODEL	VOLT Vo	REGULATION (LINE, LOAD)	RIPPLE (mV RMS)	MAX CURRENT (AMPS AT) 40° C	50° C	60° C	PKG. SIZE	DIMENSIONS (Inches)	PRICE QTY. 1	QTY. 250	QTY. 1000
5 ±5% ADJ. ±12V[3]											
LYT-X-5122	5	0.1%, 0.1%	10	7.5	6.6	5.7	X	7 x 4-7/8 x 2-3/4	**$210**	**$168**	**$158**
	±12[3]	0.1%, 100 mV	15	0.9	0.8	0.7					
LYT-W-5122	5	0.1%, 0.1%	10	14.0	12.7	11.0	W	9 x 4-7/8 x 2-3/4	**263**	**210**	**197**
	±12[3]	0.1%, 100 mV	15	1.2	1.1	0.9					
LYT-P-5122	5	0.1%, 0.1%	10	28.0	24.5	20.0	P	10 x 4-7/8 x 4-7/16	**375**	**300**	**281**
	±12[3]	0.1%, 100 mV	15	3.0	2.6	2.2					
LYT-K-5122	5	0.1%, 0.1%	10	40.0	36.0	29.0	K	10 x 4-7/8 x 5-1/2	**525**	**446**	**420**
	±12[3]	0.1%, 100 mV	15	4.0	3.5	2.9					
5 ±5% ADJ. ±15V[3]											
LYT-X-5152	5	0.1%, 0.1%	10	7.5	6.6	5.7	X	7 x 4-7/8 x 2-3/4	**210**	**168**	**158**
	±15[3]	0.1%, 100 mV	15	0.8	0.7	0.6					
LYT-W-5152	5	0.1%, 0.1%	10	14.0	12.7	11.0	W	9 x 4-7/8 x 2-3/4	**263**	**210**	**197**
	±15[3]	0.1%, 100 mV	15	1.2	1.1	.09					
LYT-P-5152	5	0.1%, 0.1%	10	25.0	22.0	18.0	P	10 x 4-7/8 x 4-7/16	**375**	**300**	**281**
	±15[3]	0.1%, 100 mV	15	3.0	2.6	2.2					
LYT-K-5152	5	0.1%, 0.1%	10	37.0	33.0	27.0	K	10 x 4-7/8 x 5-1/2	**525**	**446**	**420**
	±15[3]	0.1%, 100 mV	15	4.0	3.5	2.9					
±12V[3]				**DUAL OUTPUT**							
LYD-Y-122		0.1%, 100 mV	15	1.8	1.5	1.2	Y	5-5/8 x 4-7/8 x 2-1/2	**$194**	**$155**	**$146**
LYD-X-122		0.1%, 100 mV	15	3.0	2.5	2.0	X	7 x 4-7/8 x 2-3/4	**236**	**189**	**177**
±15V[3]											
LYD-Y-152		0.1%, 100 mV	15	1.8	1.5	1.2	Y	5-5/8 x 4-7/8 x 2-1/2	**194**	**155**	**146**
LYD-X-152		0.1%, 100 mV	15	3.0	2.5	2.0	X	7 x 4-7/8 x 2-3/4	**236**	**189**	**177**

Commercial switching selector guide

Model LY. Single output.

MODEL	VOLT Vo	REGULATION (LINE, LOAD)	RIPPLE (mV RMS)	MAX CURRENT (AMPS AT) 40° C	50° C	60° C	PKG. SIZE	DIMENSIONS (Inches)	PRICE QTY. 1	QTY. 250	QTY. 1000
5 VOLTS ±5% ADJ.					**SINGLE OUTPUT**						
LYS-Y-5		0.1%, 0.1%	10	11.0	11.0	9.5	Y	5-5/8 x 4-7/8 x 2-1/2	163	130	122
LYS-X-5		0.1%, 0.1%	10	20.0	17.7	15.0	X	7 x 4-7/8 x 2-3/4	194	155	146
LYS-W-5		0.1%, 0.1%	10	35.0	31.5	27.5	W	9 x 4-7/8 x 2-3/4	236	189	177
LYS-P-5		0.1%, 0.1%	10	50.0	46.0	40.0	P	10 x 4-7/8 x 4-7/16	299	239	224
LYS-K-5-OV		0.1%, 0.1%	10	70.0	61.0	50.0	K	10 x 4-7/8 x 5-1/2	420	336	315
LYS-D-5-OV		0.1%, 0.1%	10	120.0	104.0	86.0	D	7-1/2 x 9-1/2 x 4-13/16	630	504	473
6 VOLTS ±5% ADJ.											
LYS-Y-6		0.1%, 0.1%	10	9.4	9.4	8.2	Y	5-5/8 x 4-7/8 x 2-1/2	163	130	122
LYS-X-6		0.1%, 0.1%	10	17.0	15.0	12.7	X	7 x 4-7/8 x 2-3/4	194	155	146
LYS-W-6		0.1%, 0.1%	10	30.0	27.5	24.0	W	9 x 4-7/8 x 2-3/4	236	189	177
LYS-P-6		0.1%, 0.1%	10	43.0	40.0	35.0	P	10 x 4-7/8 x 4-7/16	299	239	224
LYS-K-6-OV		0.1%, 0.1%	10	60.0	53.0	43.0	K	10 x 4-7/8 x 5-1/2	420	336	315
LYS-D-6-OV		0.1%, 0.1%	10	104.0	90.0	74.0	D	7-1/2 x 9-1/2 x 4-13/16	630	504	473
12 VOLTS ±5% ADJ.											
LYS-Y-12		0.1%, 0.1%	15	6.0	6.0	5.1	Y	5-5/8 x 4-7/8 x 2-1/2	163	130	122
LYS-X-12		0.1%, 0.1%	15	10.4	9.3	7.8	X	7 x 4-7/8 x 2-3/4	194	155	146
LYS-W-12		0.1%, 0.1%	15	20.0	18.0	15.0	W	9 x 4-7/8 x 2-3/4	236	189	177
LYS-P-12		0.1%, 0.1%	15	29.0	27.0	23.0	P	10 x 4-7/8 x 4-7/16	299	239	224
LYS-K-12		0.1%, 0.1%	15	40.0	35.0	29.0	K	10 x 4-7/8 x 5-1/2	394	315	296
LYS-D-12-OV		0.1%, 0.1%	15	57.0	50.0	41.0	D	7-1/2 x 9-1/2 x 4-13/16	630	504	473
15 VOLTS ±5% ADJ.											
LYS-Y-15		0.1%, 0.1%	15	5.0	5.0	4.3	Y	5-5/8 x 4-7/8 x 2-1/2	163	130	122
LYS-X-15		0.1%, 0.1%	15	8.5	7.5	6.3	X	7 x 4-7/8 x 2-3/4	194	155	146
LYS-W-15		0.1%, 0.1%	15	16.5	14.5	12.0	W	9 x 4-7/8 x 2-3/4	236	189	177
LYS-P-15		0.1%, 0.1%	15	24.0	22.0	19.0	P	10 x 4-7/8 x 4-7/16	299	239	224
LYS-K-15		0.1%, 0.1%	15	32.0	28.0	23.0	K	10 x 4-7/8 x 5-1/2	394	315	296
LYS-D-15-OV		0.1%, 0.1%	15	48.0	42.0	34.0	D	7-1/2 x 9-1/2 x 4-13/16	630	504	473
20 VOLTS ±5% ADJ.											
LYS-Y-20		0.1%, 0.1%	15	3.9	3.9	3.1	Y	5-5/8 x 4-7/8 x 2-1/2	163	130	122
LYS-X-20		0.1%, 0.1%	15	6.7	5.9	4.7	X	7 x 4-7/8 x 2-3/4	194	155	146
LYS-W-20		0.1%, 0.1%	15	12.5	11.5	9.5	W	9 x 4-7/8 x 2-3/4	236	189	177
LYS-P-20		0.1%, 0.1%	15	18.5	16.5	14.5	P	10 x 4-7/8 x 4-7/16	299	239	224
LYS-K-20		0.1%, 0.1%	15	25.0	21.5	18.0	K	10 x 4-7/8 x 5-1/2	394	315	296
LYS-D-20-OV		0.1%, 0.1%	15	36.0	31.5	26.0	D	7-1/2 x 9-1/2 x 4-13/16	630	504	473
24 VOLTS ±5% ADJ.											
LYS-Y-24		0.1%, 0.1%	15	3.3	3.3	2.6	Y	5-5/8 x 4-7/8 x 2-1/2	163	130	122
LYS-X-24		0.1%, 0.1%	15	5.7	4.9	4.0	X	7 x 4-7/8 x 2-3/4	194	155	146
LYS-W-24		0.1%, 0.1%	15	10.5	9.5	8.0	W	9 x 4-7/8 x 2-3/4	236	189	177
LYS-P-24		0.1%, 0.1%	15	15.5	14.0	12.0	P	10 x 4-7/8 x 4-7/16	299	239	224
LYS-K-24		0.1%, 0.1%	15	21.0	18.0	15.0	K	10 x 4-7/8 x 5-1/2	394	315	296
LYS-D-24-OV		0.1%, 0.1%	15	32.0	28.0	23.0	D	7-1/2 x 9-1/2 x 4-13/16	630	504	473
28 VOLTS ±5% ADJ.											
LYS-Y-28		0.1%, 0.1%	15	2.8	2.8	2.2	Y	5-5/8x 4-7/8 x 2-1/2	163	130	122
LYS-X-28		0.1%, 0.1%	15	5.0	4.3	3.5	X	7 x 4-7/8 x 2-3/4	194	155	146
LYS-W-28		0.1%, 0.1%	15	9.5	8.5	7.0	W	9 x 4-7/8 x 2-3/4	236	189	177
LYS-P-28		0.1%, 0.1%	15	13.5	12.5	10.5	P	10 x 4-7/8 x 4-7/16	299	239	224
LYS-K-28		0.1%, 0.1%	15	18.0	15.5	13.0	K	10 x 4-7/8 x 5-1/2	394	315	296
LYS-D-28-OV		0.1%, 0.1%	15	27.5	24.0	19.5	D	7-1/2 x 9-1/2 x 4-13/16	630	504	473

NOTES: 1. Ratings are for LY series when cover not used. When cover is used derate by 10%.
2. Dimensions are without cover.
3. ± outputs are fixed and preset at factory to be within 100 mV of nominal and within 100 mV of each other at no load, 25° C ambient.

Specifications of LY series

DC Output
Voltage range shown in tables.

Regulated Voltage
regulation, line 0.1%
regulation, load .....0.1% for single output models, and 5V output of LYT, 100mV from 0 to full load for dual output models and dual outputs of LYT
ripple and noise .....10mV RMS, 75mV p-p for 5V and 6V models, and 5V output of LYT, 15mV RMS, 150mV p-p for 12V through 28V models, 15mV RMS, 150mV p-p for dual output models, and dual output of LYT
temperature
coefficient .....0.03%/° C

remote programming
resistance .....200 Ω/V (Not applicable to dual output models or dual output of LYT)
remote programming
voltage .....volt per volt (not applicable to dual output models or dual output of LYT)

AC Input
line .....105 to 132 VAC, 47-440 Hz
power .....105 to 132 VAC, 47-440 Hz
130 watts max for LYS-Y models, 200 watts max for LYS-X models, 380 watts max for LYS-W models, 510 watts max for LYS-P models, 700 watts for LYS-K models, 1150 watts for LYS-D models, 105 watts max for LYD-Y models, 160 watts max for LYD-X models, 125 watts max for LYT-X models, 190 watts max for LYT-W models, 420 watts max for LYT-P models, and 580 watts for LYT-K models
efficiency .....60% min for LYS-Y models, 64% min LYS-X models, 64% min for LYS-W models, 67% min for LYS-P models, 65% min for LYS-K&D models, 57% min for LYD-Y and LYT-W models, 60% min for LYD-X models, 50% min for LYT-X models, 52% min for LYT-P models and 55% min for LYT-K models
power failure
hold up time .....5V and 6V models and the LYT & LYS-D models will remain within regulation limits for at least 16.67 msec after loss of AC power when operating at full load, V_{OUT} max and minimum input at 60 Hz
DC Input .....145VDC ±10%

Overshoot
No overshoot at turn-on, turn-off, or power failure.

Ambient Operating Temperature
Continuous duty 0° to 60° with suitable derating shown in tables.

Storage Temperature Range
−55° C to +85° C

Overload Protection
Electrical
External overload protection, automatic electronic current limiting circuit limits the output current (short circuit output current LYT only) to a preset value, thereby providing protection for the load as well as the power supply.

Cooling
Convection cooled, no fans or blowers needed.

Soft Start
LYS-D models only, limits inrush current at turn on.

EMI
EMI suppression cover available as an accessory. Provides additional filtering sufficient for compliance to FCC Docket #20780, Class A conducted; perforated cover minimizes-radiated emissions. Customer input and output connections via barrier strips mounted on cover (LYT-X, LYT-W, LYS-Y, LYS-X, LYS-W, LYD-Y, LYD-X models), and terminal board mounted on cover of LYS-P, LYS-D, LYS-K, LYT-P and LYS-K models. Output current must be derated 10% with cover, 15% for LYS-D with cover. Ripple and noise when cover is used is 10mV RMS, 35mV p-p for 5 and 6V units, 15mV RMS, 100mV p-p for 12 thru 28V units and duals. See page 7 for cover model and price for each LY series.

DC Output Controls
Simple screwdriver voltage adjustment over the entire voltage range. (Not applicable to dual output models or dual output of LYT.)

Mounting
Three mounting surfaces and three mounting positions. (One mountng surface and one mounting position for LYS-P, LYS-K, LYS-D, LYT-P, and LYT-K models.

Input and Output Connections
Solder terminals located on printed circuit boards, (studs for LYS-X, W, P, K and 5V output of LYT-W and LYT-P and LYT-K and heavy duty studs for LYS-D). When EMI suppression cover is used connections through barrier strips or terminal board mounted on cover.

Remote Sensing
Provision is made for remote sensing to eliminate the effects of power output lead resistance on DC regulation. (Sum of dual outputs can be remotely sensed on dual and triple models.)

PHYSICAL DATA

Package Model	Weight (without cover) Lbs. Net	Lbs. Ship	Size Inches
LYS-Y	2-3/4	3	5-5/8 x 4-7/8 x 2-1/2 (w/o cover)
	—	—	5-5/8 x 4-7/8 x 3-5/16 (w cover)
LYS-YV	2-3/4	3	6.5 x 4.33 x 2.5 (w/o cover)
LYD-Y	3-1/4	3-1/2	5-5/8 x 4-7/8 x 2-1/2 (w/o cover)
	—	—	5-5/8 x 4-7/8 x 3-5/16 (w cover)
LYS-X, XV	4	4-1/2	7 x 4-7/8 x 2-3/4 (w/o cover)
	—	—	7 x 4-7/8 x 3-5/16 (w cover)
LYD-X	4-1/4	4-3/4	7 x 4-7/8 x 2-3/4 (w/o cover)
	—	—	7 x 4-7/8 x 3-5/16 (w cover)
LYT-X	4-1/4	4-3/4	7 x 4-7/8 x 2-3/4 (w/o cover)
	—	—	7 x 4-7/8 x 3-5/32 (w cover)
LYS-W	5-1/2	6	9 x 4-7/8 x 2-3/4 (w/o cover)
	—	—	9 x 4-7/8 x 3-3/4 (w cover)
LYT-W, WV	6	6-1/2	9 x 4-7/8 x 2-3/4 (w/o cover)
	—	—	9 x 4-7/8 x 4-5/32 (w cover)
LYS-P	8-1/2	10-1/2	10 x 4-7/8 x 4-7/16 (w/o cover)
	—	—	10 x 4-7/8 x 5-9/16 (w cover)
LYT-P, PV	9-3/4	12-1/2	10 x 4-7/8 x 4-7/16 (w/o cover)
	—	—	10 x 4-7/8 x 5-5/8 (w cover)
LYS-K	11	13-1/2	10 x 4-7/8 x 5-1/2 (w/o cover)
	—	—	10 x 4-7/8 x 7-1/2 (w cover)
LYS-D	12-1/2	15-1/2	7-1/2 x 9-1/2 x 4-13/16 (w/o cover)
	—	—	7-1/2 x 11 x 4-13/16 (w cover)
LYT-K	11	13-1/2	10 x 4-7/8 x 5-1/2 (w/o cover)
	—	—	10 x 4-7/8 x 7-21/32 (w cover)

Options
AC Input
(LYS-Y, X, W, P and K models only)

Add[1] Suffix	For Operation at:	Price[2]
−V	187-265 VAC 47-440 Hz	12% or $30†

†Whichever is greater.
[1] Add V after package number. (LYS-YV-5)
[2] Consult factory for voltage and current ratings and quantity prices.

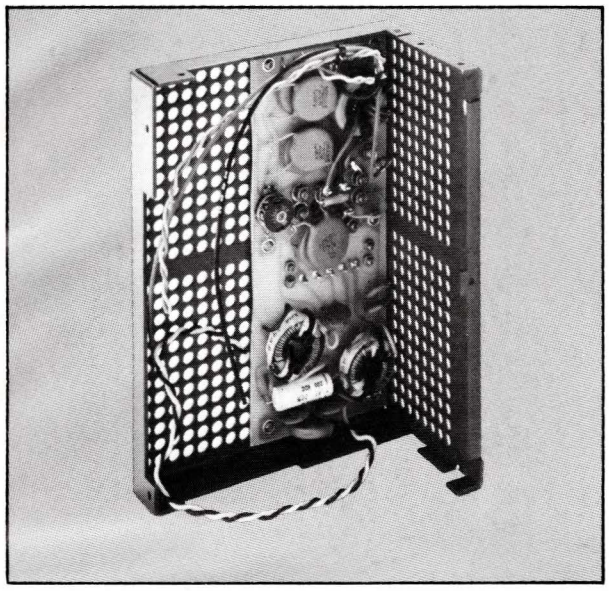
Finish
Gray, Fed. Std. 595, No. 26081.

UL/CSA
UL recognized and CSA certified except LYS-D presently under test.

Accessories
Overvoltage protection built in on LYS-D and LYS-K, 5V and 6V models, LYT-K 5V output only. Available as accessory on other models — see catalog. Rack adapaters available; LRA-14 through LRA-17. Not all models fit in LRA-14 and LRA-16, see catalog.
EMI suppression cover — see page 7.

Guarantee for 1 Year
One year guarantee includes labor as well as parts.

EMI suppressor accessory



EMI suppression cover available as an accessory. Provides additional filtering sufficient for compliance with FCC Docket 20780, Class A conducted; perforated cover minimizes radiated emissions. Customer input and output connections via barrier strips mounted on cover. (LYS-Y, LYS-X, LYS-W, LYD-Y, LYD-X, LYT-P, LYT-W, LYT-X models), and terminal board mounted on cover for LYS-P, LYS-D, LYT-K and LYS-K models. Ripple and noise when cover is used is 10mV RMS, 35mV p-p for 5 and 6V units. 15mV RMS, 100mV p-p for 12 thru 28V units and duals.

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M-YSK-2	LYS-K models	3-3/4	5	100
M-YSP-2	LYS-P models	2-1/8	3-1/4	74
M-YSW-2	LYS-W models	2	2-1/4	68
M-YSX-2	LYS-X models	1-3/4	2	53
M-YSY-2	LYS-Y models	1-1/2	1-3/4	53
M-YTK-2	LYT-K models	3	4	125
M-YTP-2	LYT-P models	2-7/8	3-1/2	95
M-YTW-2	LYT-W models	2	2-1/4	65
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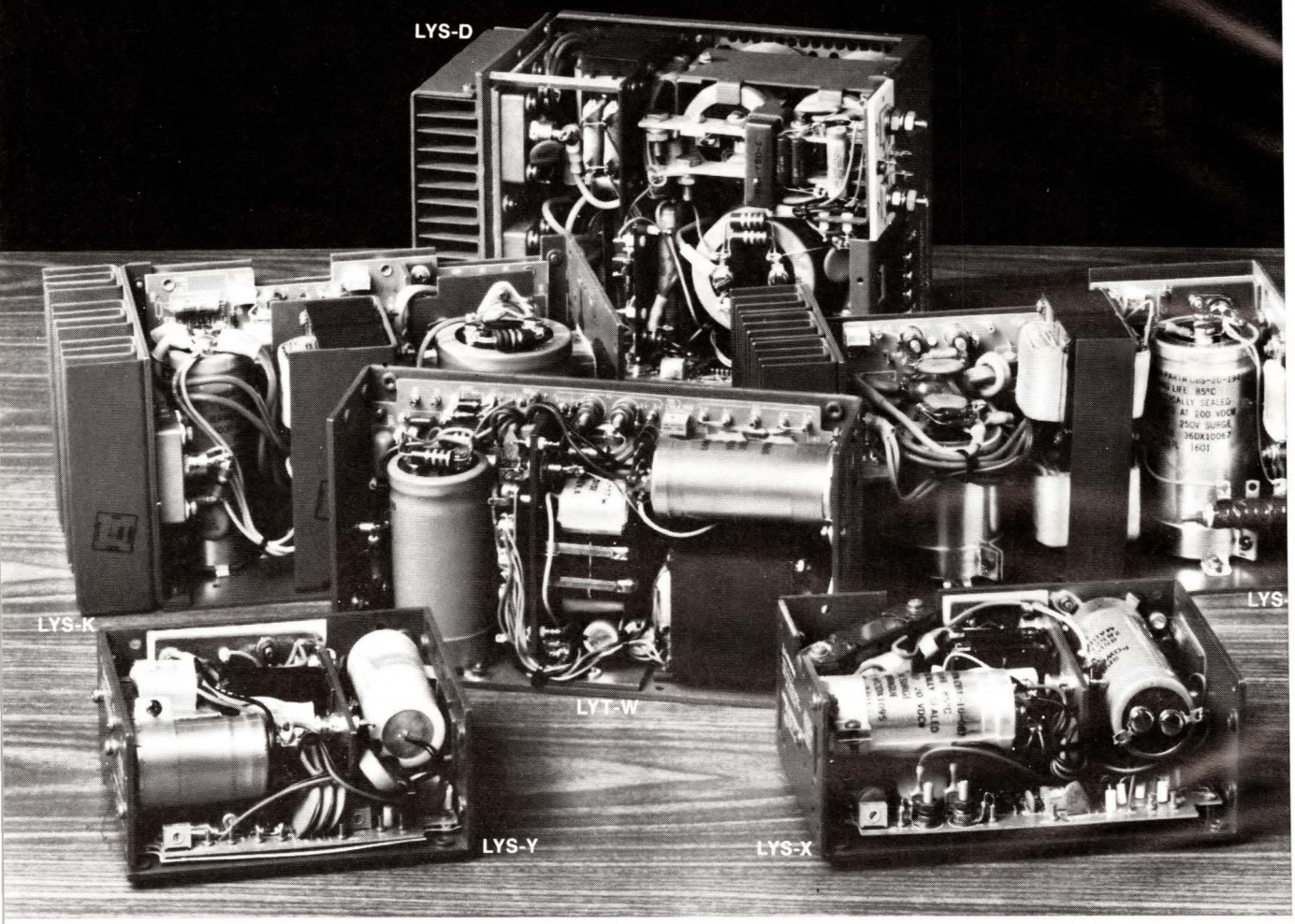

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CIRCLE NO 81

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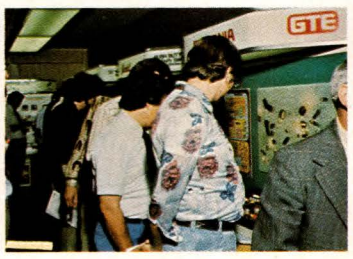

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March 22 to April 26 (last half)

DATE	TIME	SITE
3/22 Monday	8:30-9:30 AM	BENDIX CORPORATION, TEST SYSTEMS DIVISION Rt. 46, Teterboro, NJ
3/22 Monday	10-12 AM	BENDIX CORPORATION, GUIDANCE SYSTEMS DIVISION Rt. 46, Teterboro, NJ
3/22 Monday	1:30-4:30 PM	BELL LABORATORIES Whippany Road, Whippany, NJ
3/23 Tuesday	8:30-10 AM	HAZELTINE CORPORATION Cuba Hill Rd., Greenlawn, NY
3/23 Tuesday	10:30-12 AM	HAZELTINE CORPORATION Pulaski Rd., Greenlawn, NY
3/23 Tuesday	1:30-2:15 PM	APPLIED DIGITAL DATA SYSTEMS 100 Marcus Blvd, Hauppauge, NY
3/23 Tuesday	3:15-4 PM	BURROUGHS CORPORATION 95 Horseblock Rd., Yaphank, NY
3/24 Wednesday	9-11 AM	IBM CORPORATION Rt. 134, Yorktown, NY
3/24 Wednesday	2-4:30 PM	IBM CORPORATION Rt. 52, E. Fishkill, NY
3/25 Thursday	8:30-11 AM	IBM COPRORATION Neighborhood Rd., Kingston, NY
3/25 Thursday	1-2:30 PM	IBM CORPORATION South Rd., Poughkeepsie, NY
3/25 Thursday	3-4:30 PM	IBM CORPORATION Boardman Rd., Poughkeepsie, NY
3/26 Friday	8:30-9:15 AM	PERKIN ELMER CORPORATION Rt. 7, Richfield, CT
3/26 Friday	10-12 AM	PERKIN ELMER CORPORATION 100 Wooster Hts. Rd., Danbury, CT
3/26 Friday	1:30-3:30 PM	GENERAL DATACOMM INDUSTRIES 1 Kennedy Ave., Danbury, CT
3/29 Monday	9-10 AM	PERKIN ELMER CORPORATION 50 Danbury Rd., Wilton, CT
3/29 Monday	10:30-12 AM	PERKIN ELMER CORPORATION Main Ave., Norwalk, CT
3/29 Monday	1:30-3:30 PM	PITNEY BOWES 380 Main Ave., Norwalk, CT
3/30 Tuesday	8:30-9:45 AM	ITT ADVANCED TECHNOLOGY CENTER 1 Research Dr., Shelton, CT
3/30 Tuesday	10:45-12 AM	DATA PRODUCTS NEW ENGLAND 50 Barnes Park Rd., North, Wallingford, CT
3/30 Tuesday	2-4 PM	HAMILTON STANDARD DIV., UTC Bradley Field Rd., Windsor Locks, CT
3/31 Wednesday	9-11:30 AM	RAYTHEON COMPANY W. Main Rd., Portsmouth, RI
3/31 Wednesday	1-2:30 PM	CODEX CORPORATION 20 Cabot Blvd., Mansfield, MA
3/31 Wednesday	3-4:30 PM	FOXBORO COMPANY 28 Neponset Ave., Foxboro, MA
4/1 Thursday	9-11:30 AM	GTE SYLVANIA 77 A Street, Needham Hts, MA
4/1 Thursday	1-2:30 PM	PRIME COMPUTER 500 Old Connecticut Path, Framingham, MA
4/1 Thursday	3:15-4:30 PM	DIGITAL EQUIPMENT CORPORATION 200 Forest St., Marlboro, MA
4/2 Friday	9-11:30 AM	DATA GENERAL Rt.. 9, Westboro, MA
4/2 Friday	1:30-4 PM	RAYTHEON COMPANY Hartwell Rd., Bedford, MA
4/5 Monday	9-12 AM	SANDERS ASSOCIATES, INC. 95 Canal St., Nashua, NH
4/5 Monday	1:30-2:30 PM	DIGITAL EQUIPMENT CORPORATION 55 Northeastern Blvd., Nashua, NH
4/5 Monday	3:15-4:30 PM	SANDERS ASSOCIATES, INC. Daniel Webster Hwy., Nashua, NH
4/6 Tuesday	9-11:30 AM	WESTERN ELECTRIC CO./BELL LABORATORIES 1600 Osgood St., North Andover, MA
4/6 Tuesday	1-2:30 PM	RAYTHEON COMPANY 350 Lowell St., Andover, MA
4/6 Tuesday	3:15-4:30 PM	DIGITAL EQUIPMENT CORPORATION 1925 Andover St., Tewksbury, MA
4/7 Wednesday	9-12 AM	WANG LABORATORIES 1 Industrial Ave., Lowell, MA
4/7 Wednesday	2-4 PM	HONEYWELL INC. 300 Concord Rd., Billerica, MA
4/8 Thursday	8:30-11:30 AM	DIGITAL EQUIPMENT CORPORATION 146 Main St., Maynard, MA
4/8 Thursday	1-2:30 PM	GENRAD CORPORATION 300 Baker Ave., Concord, MA
4/8 Thursday	3:15-4:30 PM	HONEYWELL INC. 2 Forbes Rd., Lexington, MA
4/9 Friday	8:30-10 AM	RAYTHEON COMPANY Boston Post Rd., Sudbury, MA
4/9 Friday	10:45-12 AM	RAYTHEON COMPANY Boston Post Rd., Wayland, MA
4/12 Monday	8:30-10:30 AM	GENERAL ELECTRIC COMPANY R&D Electronics Center, Schenectady, NY
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4/12 Monday	3-4:30 PM	GENERAL ELECTRIC COMPANY French Rd., Utica, NY
4/13 Tuesday	8:30-10 AM	GENERAL ELECTRIC COMPANY Court St., Syracuse, NY
4/13 Tuesday	10:30-12 AM	GENERAL ELECTRIC COMPANY Farrell Rd., Syracuse, NY
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4/14 Wednesday	9-11:30 AM	IBM CORPORATION Rt. 17C Glendale Dr., Endicott, NY
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4/20 Tuesday	1-3:30 PM	WESTINGHOUSE ELECTRIC COMPANY 1310 Beulah Rd., Pittsburgh, PA
4/21 Wednesday	9-10 AM	TACTEC SYSTEMS/RCA CORPORATION Meadowlands, PA
4/21 Wednesday	2-4 PM	NCR CORPORATION Cochran Ave., Cambridge, OH
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CIRCLE NO 82

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CIRCLE NO 83

ICs' hidden features enhance counter-based designs

ICs designed expressly for counter applications appear in most digital-device data books but might not offer the features you need. Chips dedicated to other applications, however, often include counter functions that you can access.

John Hatchett and **William Morgan,**
Motorola Semiconductor Products Sector

When looking for a digital counter, don't limit your search to dedicated ICs, which might require the "wrong" supply voltage, take too much power, operate too slowly or perhaps not be readily available. The function you need might be hidden within other devices aimed at different applications.

For example, frequency-synthesizer/phase-locked-loop ICs generally contain on-chip counters—often more than one. And CMOS-based versions of these devices tolerate wide supply-voltage variations, operate at low current levels and function at input frequencies in the tens-of-megahertz range.

Three devices provide the options

Three devices that meet these requirements, the MC145146, -151 and -157, each contain at least one 10-, 12- or 14-bit counter **(Table 1)** and operate over a 3 to 9V supply range. The counters' programming methods differ, suiting them to a variety of applications.

Table 2 shows the devices' counting ranges and counter-programming requirements: The 14-bit MC145151 accepts parallel counter loading; a 4-bit data bus programs the 10- and 12-bit -146 counters; and the -157's dual 14-bit counter loads via a clocked, serial data stream.

You parallel-load **Fig 1a**'s MC145151 via inputs N_0 through N_{13} using **Table 2**'s code sequence. (Note that all three devices achieve full count value for an all-ZERO input and are nonresponsive for inputs of 00...01 and 00...10.) By comparision, the -146's 10- and 12-bit counters require three 4-bit inputs at D_0 through D_3 **(Fig 1b).** Address bits A_0 through A_2 direct these 4-bit nibbles to the appropriate counter locations. The indicated strobe/chip-select signal (ST) allows the data and address lines to share a common bus with other system functions because they achieve an inactive high-impedance state when ST is LOW.

The MC145157's dual 14-bit counters employ only three programming interface controls: the Data, Clock and Enable functions **(Fig 1c).** You accomplish a count-loading operation by clocking the data into the on-chip shift registers, then transfering the information into the latches by taking Enable HIGH. (Conversely, keeping Enable LOW allows you to enter new data into the registers without disturbing what's already in the counters.) The first 14 bits are the count value; the 15th bit selects which counter gets loaded—a ONE loads ÷R, a ZERO loads ÷N.

Other than these programming differences, the counters are sufficiently similar to permit one functional description, and an example application demonstrates their advantages.

A CMOS counter's current consumption generally depends on its supply voltage and the input's frequency

TABLE 1—COUNTER CHARACTERISTICS

OPERATING VOLTAGE	3 TO 9V DC
OPERATING TEMPERATURE	−40 TO +85 °C
COUNTERS AVAILABLE: MC145146 MC145151 MC145157	 ONE 12-BIT, ONE 10-BIT ONE 14-BIT TWO 14-BIT
TYPICAL CURRENT DRAIN AT 25 °C FOR f_{IN} = 10 MHz, V_{DD} = 5V V_{IN} = 2V p-p V_{IN} = 0.5V p-p	 2.0 mA DC 2.4 mA DC
MAXIMUM F_{IN} WITH 500 mV P-P SINE-WAVE INPUT AND V_{DD} = 5V	15 MHz MIN
PACKAGE SIZE (DUAL IN-LINE): MC145146 MC145151 MC145157	 20 PIN, 0.3-IN. WIDE 28 PIN, 0.6-IN. WIDE 16 PIN, 0.3-IN. WIDE

Programmable counters hide in chip block diagrams

and amplitude. **Figs 2** and **3** show this relationship for the -151's 14-bit counter operating at 3 and 5V supply levels; they depict the results of using an external signal source, grounding the OSC_{IN} pin and leaving all other unused pins open. (Although you'll note slight

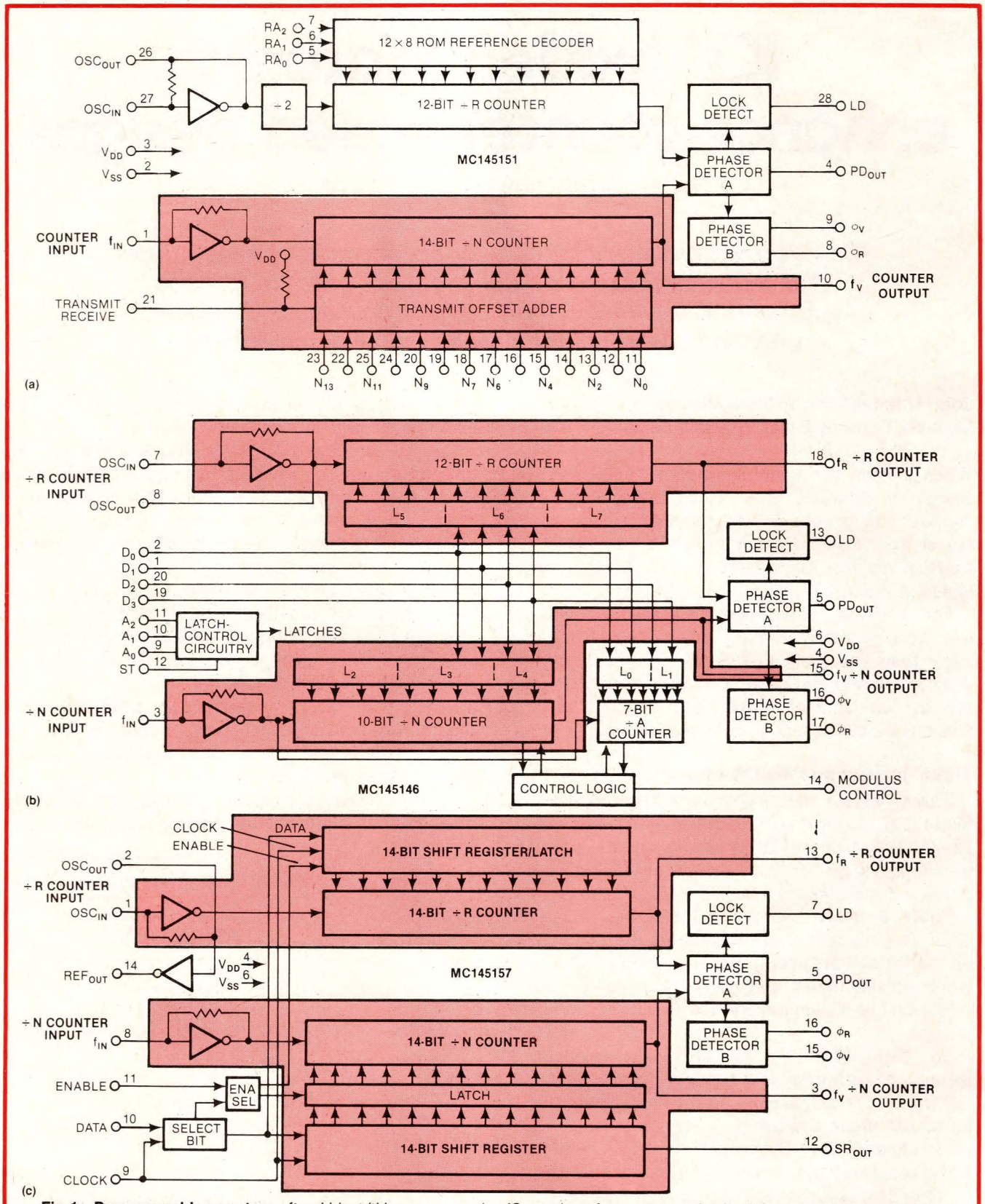

Fig 1—Programmable counters *often hide within more complex ICs such as frequency-synthesizer/phase-locked-loop devices. For example, the MC145151* ***(a)*** *includes a parallel-programmed 14-bit counter. The MC145146 chip* ***(b)*** employs two counters—12- and 10-bit—driven by a 4-bit data bus, and the -157 ***(c)*** *has dual counters programmed by 14-bit shift registers.*

current differences for different divider ratios, these changes are insignificant above approximately ÷32.)

You can supply a low-level (500 mV p-p) input signal in conjunction with the chip's built-in buffers and ac coupling; however, as **Figs 2** and **3** indicate, a large input amplitude requires less supply current, especially at higher supply voltages. If your application operates at standard CMOS logic levels, use direct coupling; if you employ ac coupling, be sure the waveform is symmetrical to avoid upsetting the on-chip bias levels, thus degrading the counter's sensitivity.

Fig 4 shows a counter's typical frequency capability over a −40 to +85°C span as a function of supply voltage and input-signal amplitude. Guaranteed maxi-

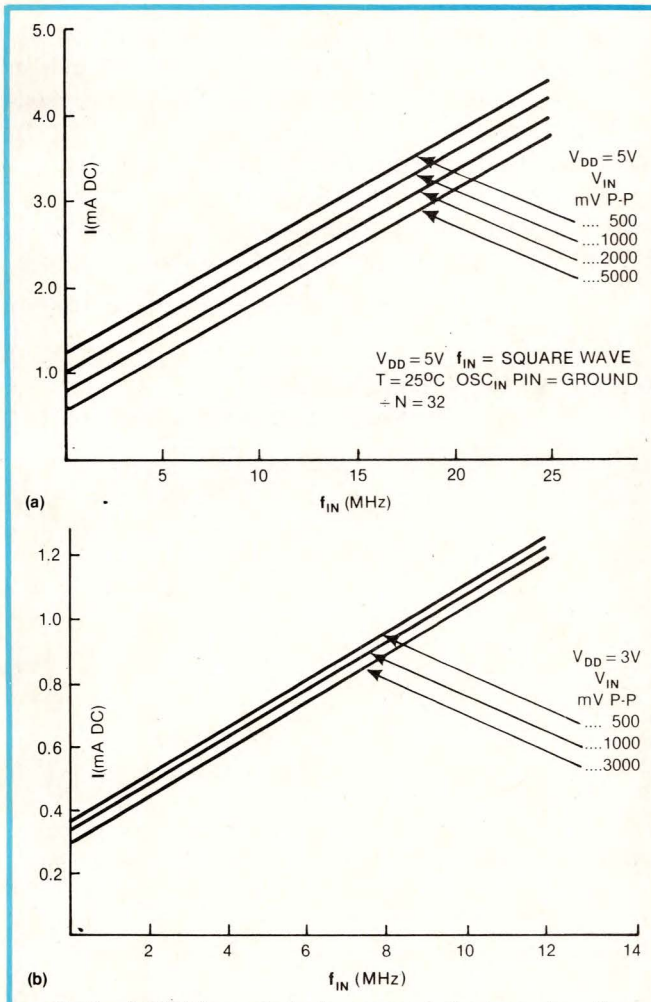

Fig 2—A CMOS counter's dc current drain *depends on the supply voltage and the input signal's frequency and amplitude. Although a higher voltage does permit higher operating frequencies* ***(a),*** *it also causes higher currents at lower frequencies. For example, a 500-mV, 10-MHz input draws 2.4 mA at 5V* ***(a)*** *but only 1.1 mA at 3V* ***(b).***

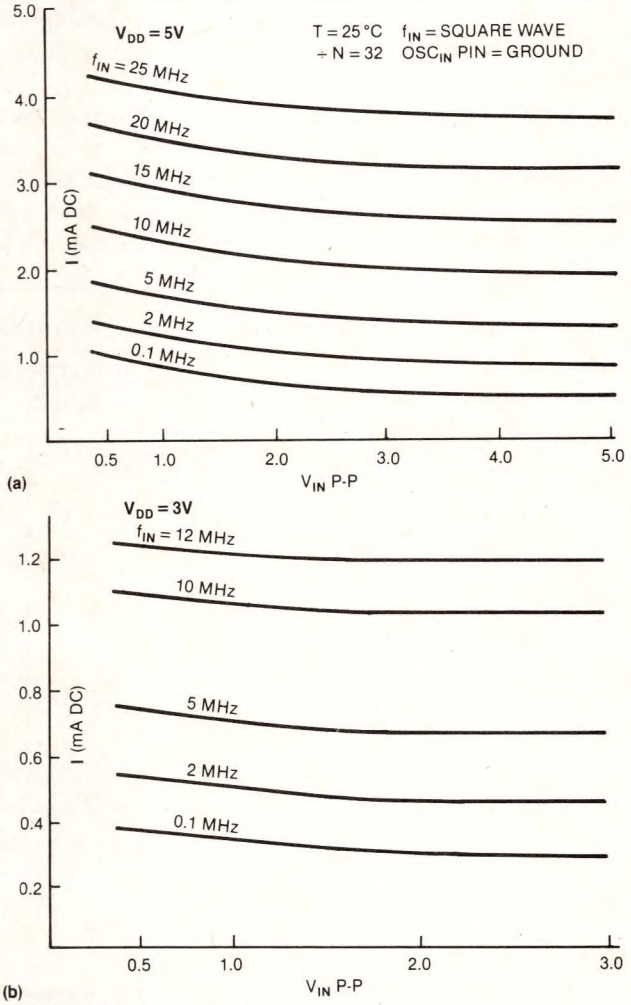

Fig 3—Varying a CMOS counter's input frequency *has more of an effect on its supply current than does an input-amplitude change at a constant frequency. At divider values less than 32, the device's current requirements vary with its count requirements.*

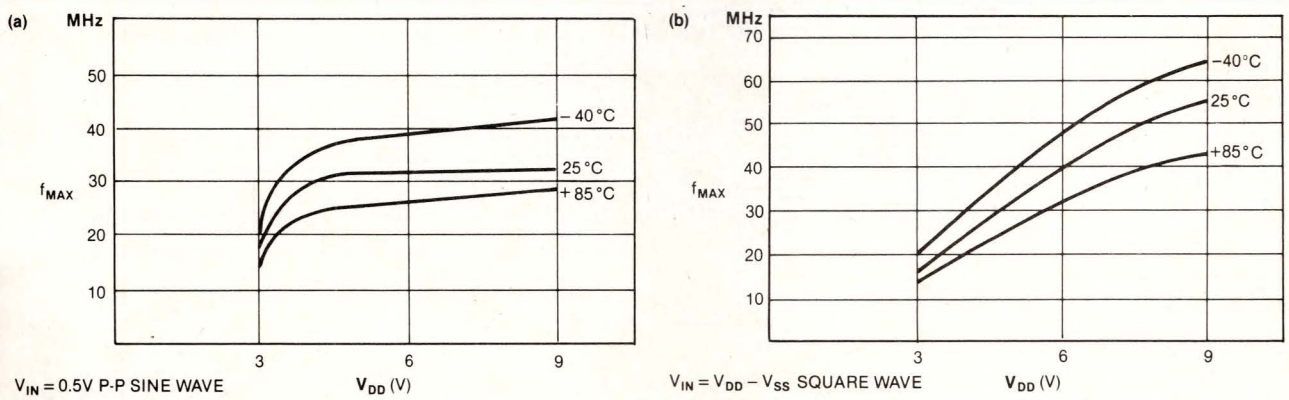

Fig 4—A counter's maximum operating frequency *depends on its supply voltage, temperature and input signal amplitude. A 500-mV p-p sine-wave input* ***(a)*** *limits performance at the higher supply-voltage levels. A rail-to-rail square wave* ***(b),*** *however, provides impressive response at all supply levels.*

CMOS counters reach 12 MHz drawing 1.2 mA from a 3V supply

mum frequency for a 500-mV p-p input level is 15 MHz min at V_{DD}=5V and 6 MHz min at 3V.

You can employ any of these "hidden" counters in many applications requiring a low- to medium-speed count function; they're especially useful in low-power μC-controlled designs.

Before looking at specific applications, however, note two MC145151 characteristics. First, for use in its intended application as a frequency synthesizer, the IC provides a frequency offset between a transmitter and receiver—driving pin 21 LOW adds 856 to the ÷N's value. Second, the device has on-chip pull-up resistors of approximately 360 kΩ on pins 21, 5, 6 and 7 and the count-controlling inputs N_0 through N_{13}. Thus, when operating at V_{DD}=5V, each pin that's held LOW consumes 14 μA. The current drains shown in **Figs 2** and 3 reflect this situation—the ÷32 input code (all but one input is LOW) pulls 180 μA from a 5V supply and 110 μA from a 3V unit.

A low-power-drain, variable-time-base-generator design (**Fig 5**) demonstrates how to use the -151's hidden counter. You can use either the IC's on-chip crystal-oscillator circuits or an external source for f_{REF}. In either case, determine the output signal's interval:

$$T=N/f_{REF},$$

where N is the divide value, entered via switches S_0 through S_{13} according to **Table 2**'s coding sequence.

TABLE 2—COUNTER DIVIDE RANGES AND PROGRAMMING METHODS

BINARY PROGRAMMING CODE RANGE (SHOWN IN DECIMAL)	AVAILABLE COUNTERS AND THEIR DIVISION VALUES			
	PARALLEL PROGRAMMING MC145151 14-BIT COUNTER	4-BIT DATA-BUS PROGRAMMING MC145146 12-BIT COUNTER	10-BIT COUNTER	SERIAL PROGRAMMING MC145157 TWO 14-BIT COUNTERS
0	16,384	4096	1024	16,384
1	*	*	*	*
2	*	*	*	*
3	3	3	3	3
1023			1023	
4095		4095		
16,383	16,383			16,383

*COUNTER NOT SPECIFIED FOR DIVIDE VALUES LESS THAN 3

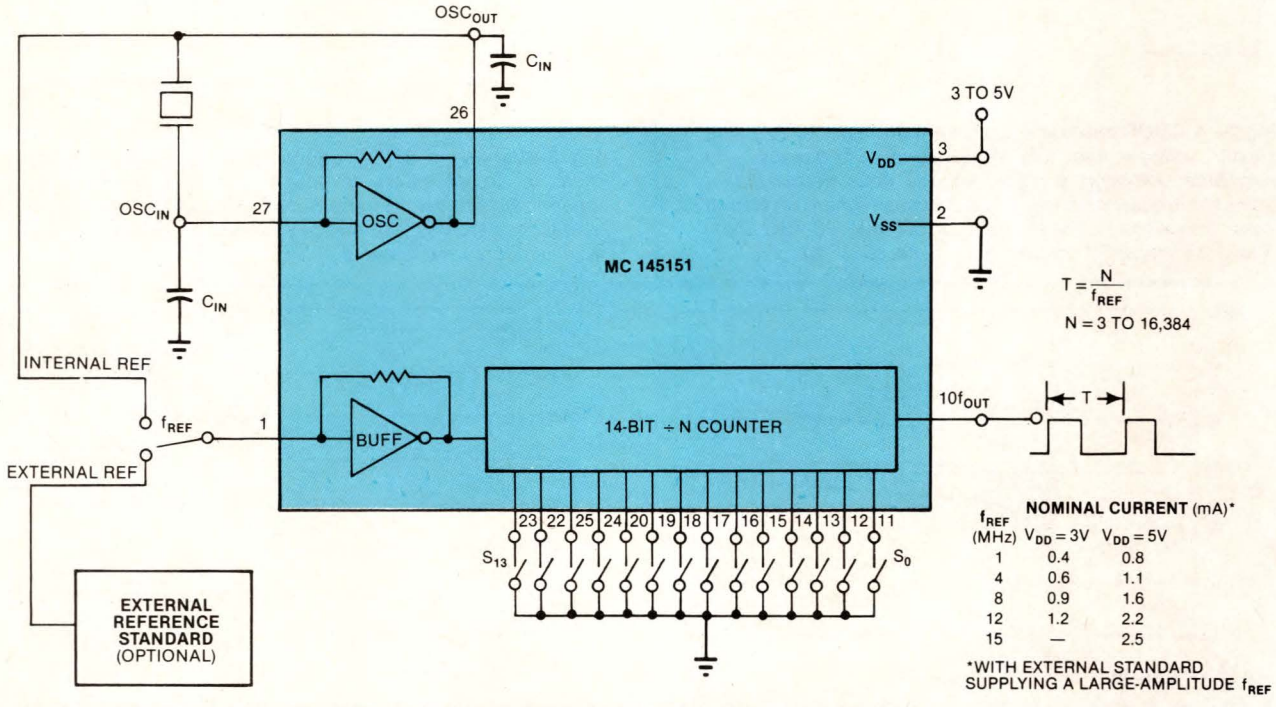

Fig 5—A variable-time-base-generator design *employs the 14-bit counter section of a frequency-synthesizer/phase-locked-loop IC. By combining the chip's programmable 3 to 16,384 divide ratio with a reference-frequency range of 1 to 15 MHz, you can vary the output's interval from 16.384 msec to 0.2 μsec.*

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			Convection	Fan		
TTM	100	2-5	X		115/230AC	8
TM	100-200	1-4	X		115/230AC 48VDC	5
LM	250-600	1-4	X		115/230AC	16
DM	250-600	1-4	X		48VDC	16
MM	375-750	1-7		X	115/230AC	21
SM	750-1500	1-4		X	115/230AC	7

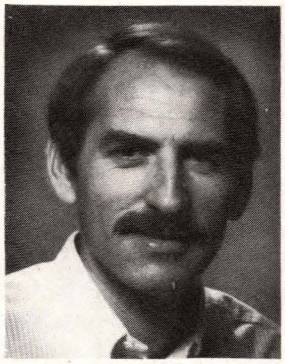
CIRCLE NO 84

Large input amplitudes reduce supply currents

And because N can equal any integer value from 3 to 16,384, you can vary T from 16.384 msec to 0.2 μsec using common f_{REF} frequencies between 1 and 15 MHz.

To use the on-chip oscillator, connect a parallel resonant, fundamental-mode crystal between the OSC_{IN} and OSC_{OUT} pins. $C_{IN(TOT)}$ and $C_{OUT(TOT)}$—the crystal's loading capacitances—are functions of the operating frequency, f_{REF}. The crystal's total loading, C_L, equals $C_{IN(TOT)}$ in series with $C_{OUT(TOT)}$ and shouldn't exceed 32 pF for frequencies to approximately 8 MHz, 20 pF for the 8- to 15-MHz range and 10 pF for frequencies higher than 15 MHz. $C_{IN(TOT)}$, for example, equals the IC's input capacitance, $C_{IN(IC)}$, plus that of circuit strays, $C_{IN(STRAY)}$, plus **Fig 5**'s indicated C_{IN}. Add this last component value to properly load the crystal. Although $C_{IN(TOT)}$ and $C_{OUT(TOT)}$ are usually approximately equal, you can frequency-trim the crystal by making C_{IN} variable. **EDN**

Authors' biographies



John Hatchett, principal staff engineer with Motorola's Semiconductor Products Sector, is responsible for the systems engineering that leads to the definition, development and application of semiconductors in entertainment and radio-communication equipment. A member of the Society of Professional Engineers, John received his BSEE degree from the University of Illinois and his MSEE from the Illinois Institute of Technology; he has two patents pending. Besides attending Phoenix Suns basketball games, he enjoys camping and golfing.

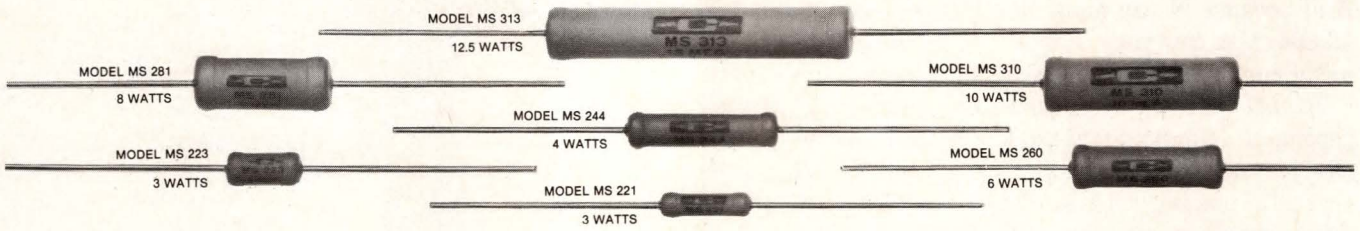
William Morgan, a senior technician with Motorola for 16 yrs, provides technical support for new semiconductor-product developments. He studied electrical engineering for 2½ yrs at the University of New Mexico and lists camping, hiking and gardening among his outside activities.

A deeper look

This article considers only one aspect of the MC145146, -151 and -157 chips. For more information and a data sheet, **Circle No 741.**

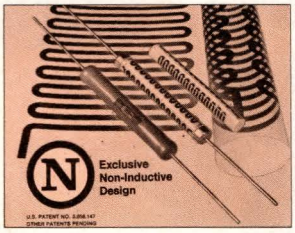
Article Interest Quotient (Circle One)
***High* 473 *Medium* 474 *Low* 475**

Type MS Non-Inductive Power Film Resistors from CADDOCK optimize high-speed power switching:



1. Caddock's "Non-Inductive Design" can improve rise and fall times to minimize losses in power switching circuits.

To keep the inductance to an absolute minimum, the special serpentine pattern provides for neighboring lines to carry the current in opposite directions to achieve maximum cancellation of flux fields over the entire length of the resistor.

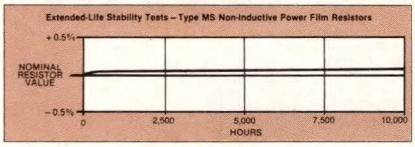


The result is a truly non-inductive resistor that is about as inductive as a straight piece of wire the length of the resistor body.

This makes it possible for engineers to design new circuit configurations with superior non-inductive performance.

2. Extended-life stability that is typically better than 0.05% per 1000 hours.

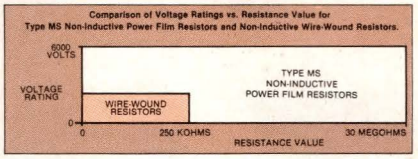
Extended load-life tests at full power have demonstrated typical stability better than 0.05% per 1000 hours.



Detailed stability data is included in the "Reliability Test Summary – Caddock Report #1" which is available on request.

3. Higher voltage and power ratings extend the maximum 'critical' resistance value.

Caddock's Micronox® film resistor technology permits single-resistor voltage ratings as high as 6000 volts to be combined with power ratings of 12.5 watts at +25°C. This combination of power and voltage provides a 'critical' resistance value of 2.88 Megohms - more than 10 times higher than can be achieved with wire-wound construction.



The higher voltage rating of Type MS resistors also overcomes the resistance value limits imposed on wire-wounds by the minimum wire size and spacing.

4. The special construction of Micronox® resistors assures high performance through harsh environments.

Type MS Power Film Resistors are produced by firing high-stability Micronox® resistance films directly onto a solid ceramic core - in air - at +1400°F to achieve a structure with these special performance advantages:

- Operating temperatures as high as +275°C.
- Repeatable temperature characteristics that include a TC of only 50 PPM/°C.
- Verified reliability through environmental extremes encountered in both 'down-hole' oil exploration and deep-space instrumentation equipment.

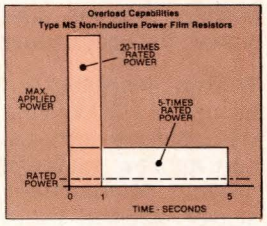
5. The family of Type MS Power Film Resistors includes 14 models with single-resistor values to 30 Megohms.

To overcome the construction *and* cost limitations inherent in wire-wound resistors, Caddock Micronox® film resistor technology gives circuit designers a *practical* balance between performance, value, size and cost, as the specifications for the Model MS 313 demonstrate:

- Non-inductive performance.
- 12.5 watt power rating.
- Resistance values from 50 ohms to 30 Megohms.
- Resistance tolerances from ±1.0% to ±0.1%.
- Maximum operating voltage of 6000 volts.
- Unit prices below $2.50 on 1000-lot orders for any value between 100 ohms and 200 Kohms.

6. Overloads of 5-times rated power for 5 seconds and 20-times rated power momentary are standard on all models.

After repeated power overload tests that apply 5-times rated power for 5 seconds, Type MS resistors have demonstrated stability typically better than 0.1%



For even higher overload situations, Type MS resistors can be subjected to 20-times the rated power for one second.

Caddock's advanced film resistor technology is the source of these outstanding advantages - advantages that are matched by a 20-year record of outstanding 'in-circuit' reliability.

Discover how easily these problem-solving resistors can improve the performance and reliability of your equipment, too. For your copy of the 20th Edition of the Caddock General Catalog, and specific technical data on any of the more than 150 models of the 13 standard types of Caddock High Performance Film Resistors, just call or write to -

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CADDOCK

HIGH PERFORMANCE FILM RESISTORS

CIRCLE NO 87

Combine DACs and power amps to digitally control large loads

By using the designs presented here, you can build power DACs that interface μP controllers to large analog loads. Learn how to build digitally controlled power supplies and use them in motor-control applications.

Gary Grandbois and **Wes Freeman,**
Precision Monolithics Inc

When you add the appropriate interface circuitry to low-power precision DACs, you can provide them with power drive to create power DACs. These converters prove useful in applications such as servo-control systems (for instance, in X-Y plotters), linear and rotary actuators, transducer drives, signal-reconstruction and digital-audio systems, and test and instrumentation systems—anywhere you need control of precision, high-current voltage outputs.

Your particular power-output application dictates the proper precision DAC to build your system around. Current-output DACs with high speed, high compliance and complementary outputs, for example, provide the easiest interface to voltage-regulator circuits and the highest speed when used in power DACs.

Another option is a complete DAC, which includes a voltage reference and output amplifier and can thus reduce components count, especially in systems that time-share the DAC for D/A- and A/D-conversion functions. Additionally, complete DACs offer sign-magnitude coding format, a feature advantageous in motor-control and audio-driver applications. Specifically, the advantages for bipolar outputs include:

- Minimum zero drift
- No zero adjustments and thus no interaction between zero and full-scale adjustments
- No major-carry error at zero
- Symmetrical positive and negative outputs
- An extra bit of resolution.

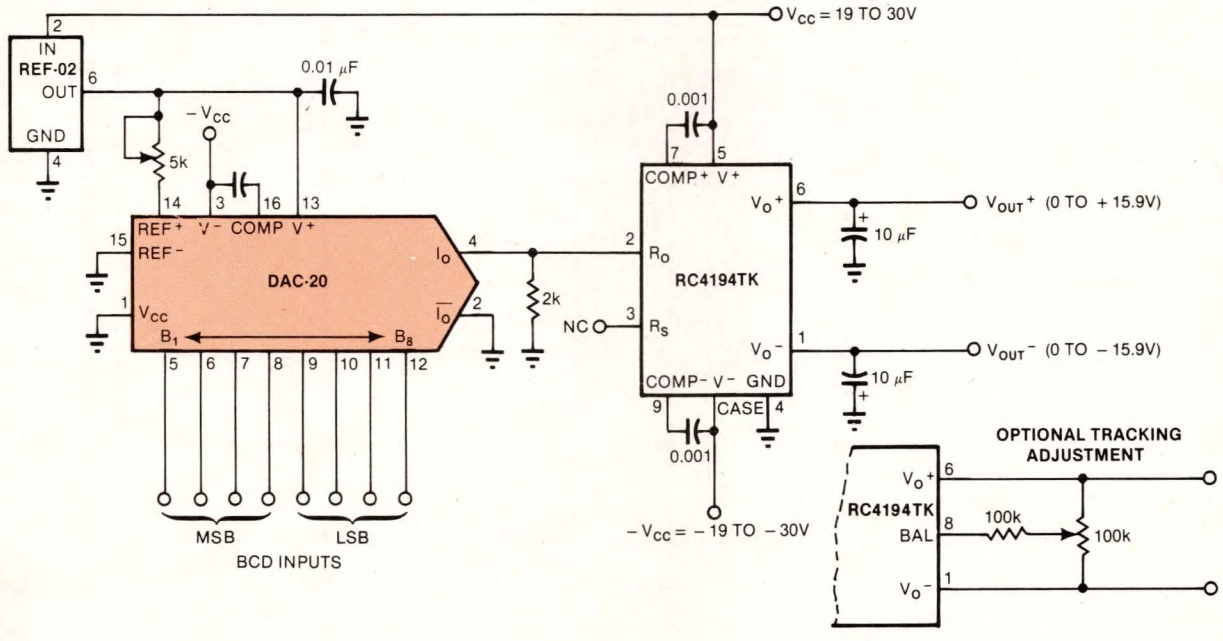


Fig 1—BCD inputs control this power supply *in 0.1V increments. This design uses three ICs and thus costs little to implement, requires just one adjustment (with the 5-kΩ pot) and provides steady operation because the REF-02 stabilizes the DAC and the voltage regulator. The RC4194TK limits both outputs to 200 mA. You can achieve closer regulator tracking with the optional adjustments shown.*

Sign-magnitude coding suits motor-control designs

As for inputs, binary coded decimal (BCD) is preferable for any system with an operator interface. An example of BCD inputs appears in the DAC-based power supply shown in **Fig 1.** Such digitally controlled supplies find use in two primary applications: bench supplies (with operator adjustment) and test equipment (with logic or software control). BCD DACs such as the 2-digit DAC-20 prove ideal for a thumbwheel-programmed bench supply because you can expand their output to "2½ digits," equivalent to 159 states.

Fig 1's simple 2-digit-BCD, dual-tracking regulator limits both outputs to 200 mA. The input word can come from either thumbwheel switches or logic. Although the design uses the DAC-20, that converter's most significant digit (MSD) is not restricted to BCD limits and accepts 16 states to 1111_2 for an output range of 0.0 to ±15.9V in 0.1V increments. Furthermore, you can increase the RC4194TK dual linear voltage regulator's ±2% tracking by a factor of four or five with the adjustment circuit shown.

To increase the DAC-20's outputs to 1.5A for a dual-tracking supply, use the design shown in **Fig 2.** It achieves the higher power of the two, using two discrete voltage regulators (LM317 and LM337) and a voltage-inverter circuit. The adjustable regulator ICs establish the output voltage by maintaining a 1.25V difference between their output and adjustment pins.

This feature proves useful for two reasons: First, the regulators' "reference voltage" can also serve as the DAC-20 reference and thereby provide drift compensation for the LM317; this capability eliminates the need for a separate DAC reference. Second, the DAC-20 can establish the output voltage by changing the voltage between the regulators' adjustment pin and ground.

Given these features, you can determine values for the output-adjustment resistors. Start with the equation

$$V_O = 1.25\left(1 + \frac{R_S}{R_A} - \left(\frac{159 - x}{100}\right)\frac{R_S}{R_R}\right),$$

where R_D serves as the full-range DAC-output-setting resistor, R_A sets full-range current, R_R acts as the DAC full-scale current-setting resistor and X is the digital input word.

Next, set R_A=1k to establish the necessary 1.25V across the LM317. Note also that the minimum voltage occurs when X=0, so

$$V_{MIN} = 1.25\left(1 + \frac{R_S}{R_A} - \left(\frac{159}{100}\right)\frac{R_S}{R_A}\right).$$

The maximum voltage occurs when X=159, leading to

$$V_{MAX} = 1.25\left(1 + \frac{R_S}{R_A}\right).$$

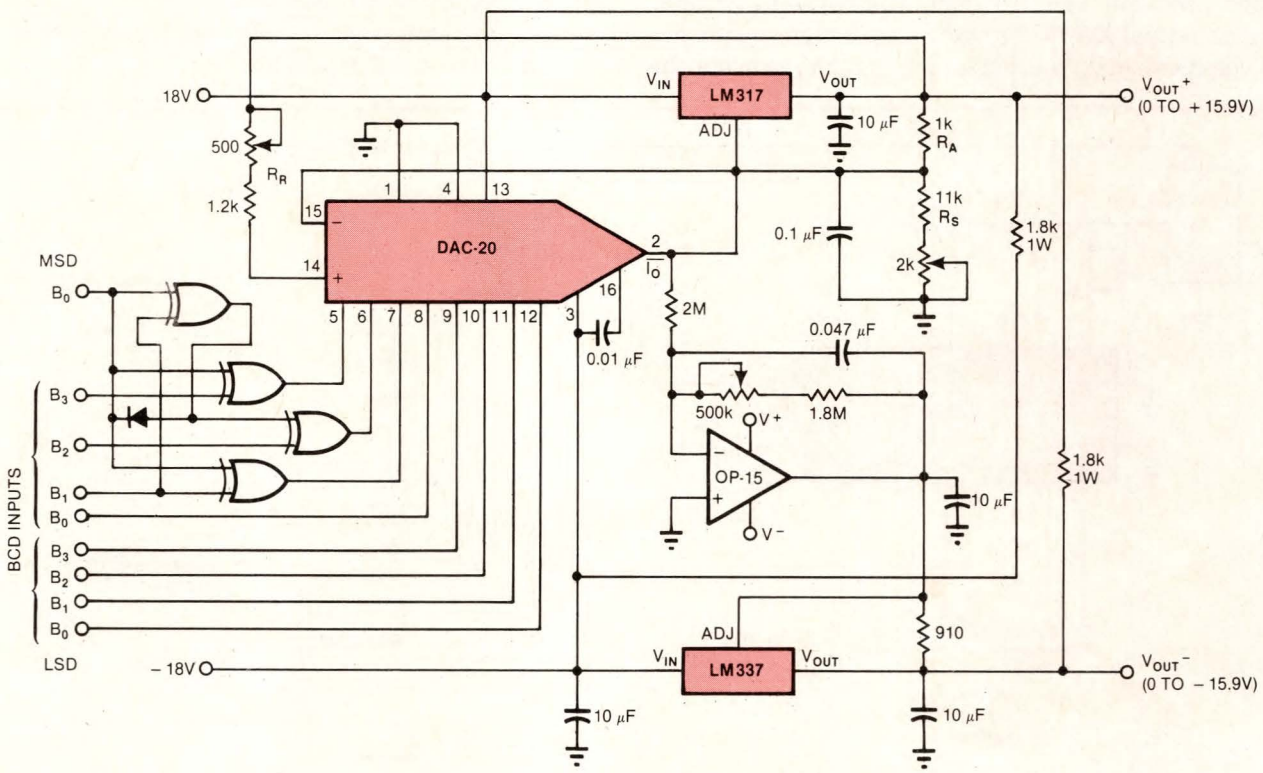


Fig 2—With two voltage regulators, *this modification of* ***Fig 1****'s design increases output capability from 200 mA to 1.5A per line. The circuit also uses an XOR gate to convert 3-digit BCD inputs to a 2-digit BCD word suitable for the DAC-20.*

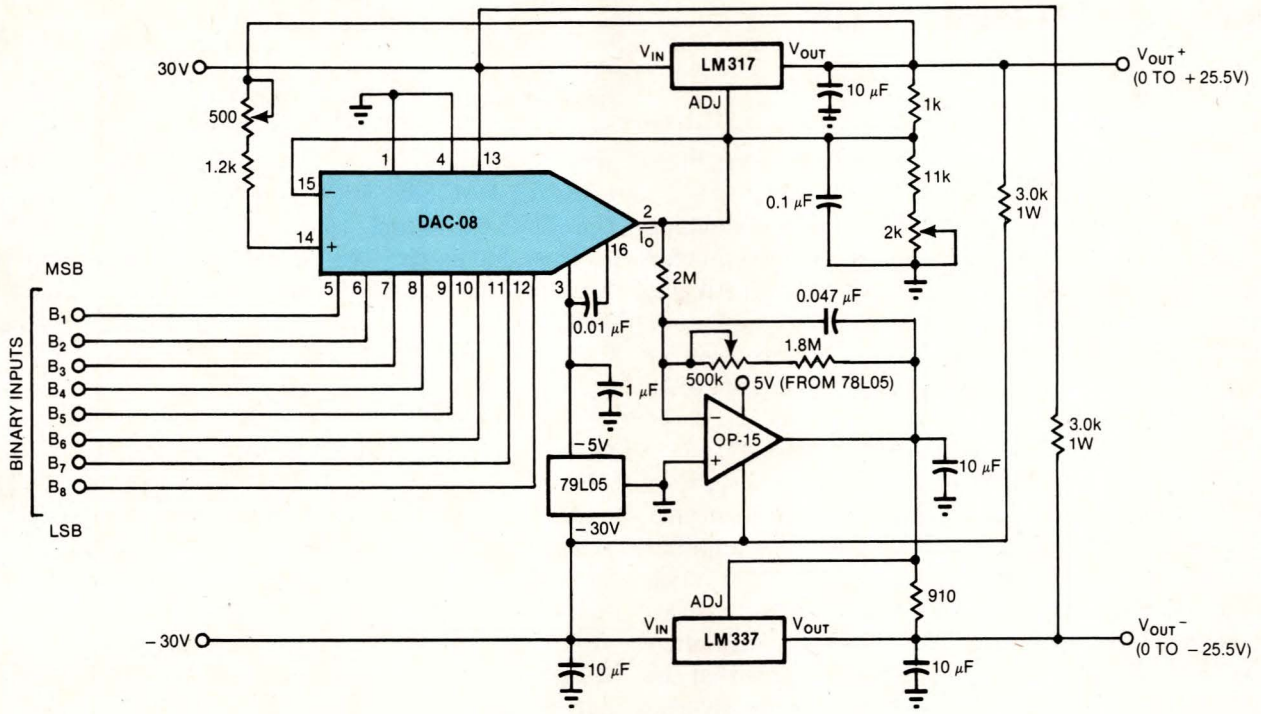


Fig 3—For binary inputs instead of BCD, *replace* ***Fig 2****'s DAC-20 with a DAC-08. Note the modifications in the converter's voltage supply (connected to pin 3).*

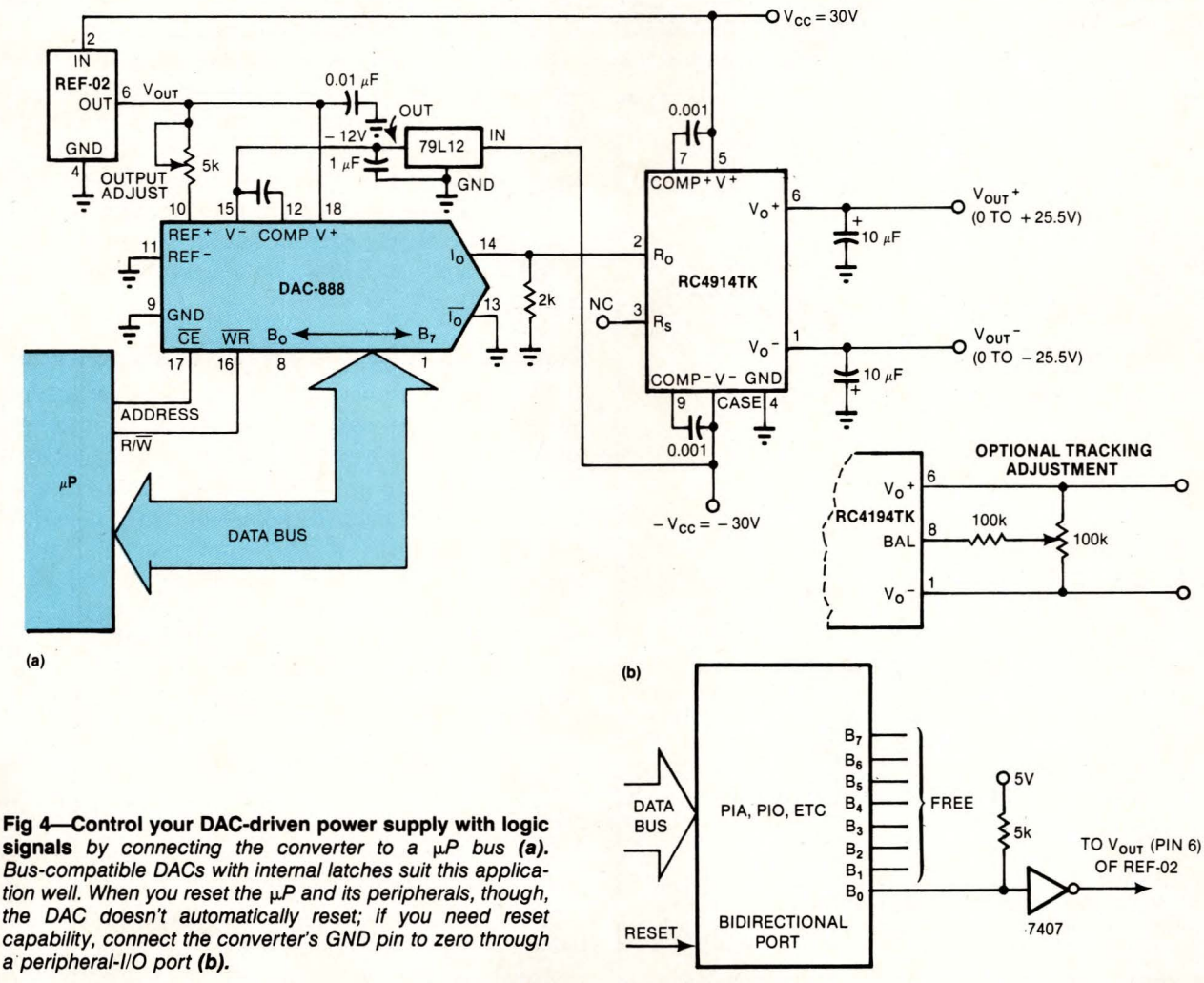


Fig 4—Control your DAC-driven power supply with logic signals *by connecting the converter to a μP bus* ***(a).*** *Bus-compatible DACs with internal latches suit this application well. When you reset the μP and its peripherals, though, the DAC doesn't automatically reset; if you need reset capability, connect the converter's GND pin to zero through a peripheral-I/O port* ***(b).***

Resetting your μP to zero doesn't always reset the DAC

Substituting V_{MAX}=15.9 (for 159 increments of 0.1V) and V_{MIN}=0, you can solve for the two remaining unknowns: R_S=11.7k and R_R=1.45k.

The design illustrated in **Fig 2** uses trimming resistors to obtain these values in its positive voltage adjustment. To set the negative voltage adjustment, merely invert the voltage at the positive regulator's (LM317) adjustment pin and apply it to the negative regulator's (LM337) adjustment pin. Then calibrate the supply in three steps:

- Adjust R_1 for 15.9V output (input code=159).
- Adjust R_2 for −15.9V output (input code=159).
- Set input code to 000, adjust R_3 for zero output.

Note that an unregulated supply feeds the amplifier and DAC; if its voltage exceeds ±18V, you must regulate the DAC voltage below the maximum operating voltage for these devices. Another difference between the designs depicted in **Figs 1** and **2** is that the higher output circuit uses a quad XOR gate to convert a 3-digit BCD word (as high as 159) to a 2-digit hexadecimal word (as high as $F9_H$) for the DAC-20.

Both digitally programmed supplies, however, allow you to change their input coding to 8-bit binary (256 states and outputs to ±25.5V) by replacing the DAC-20 with the pin-equivalent DAC-08. When making this replacement, though, you must also alter the DAC voltage supply as shown in **Fig 3.**

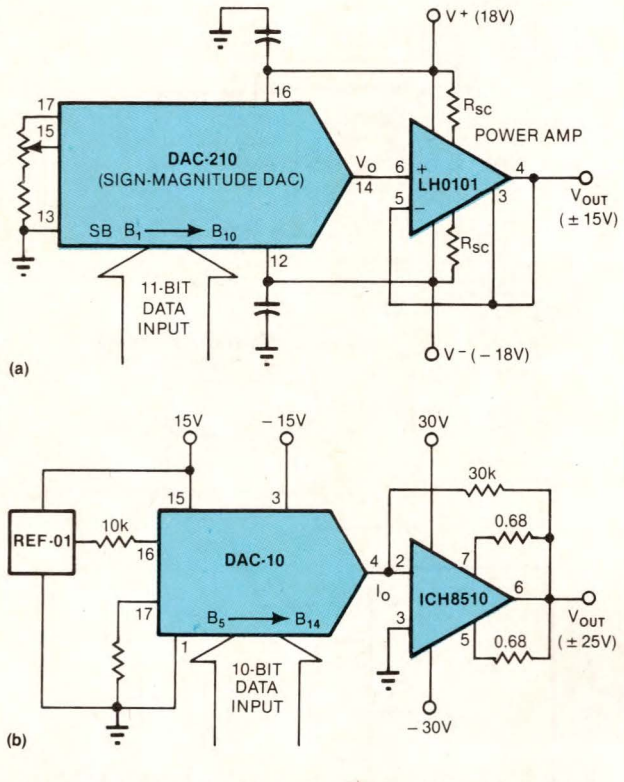


Fig 5—For high precision, *combine a DAC with a hybrid power amplifier. In* **(a),** *the converter and amp use the same voltage, limiting circuit output voltage; in* **(b),** *the hybrid amp alone limits output voltage.*

The designs just discussed readily accept operator inputs, but if you want to connect your supply to a μP, bus-compatible DACs prove helpful. Such devices can reside on a system data bus, and they get addressed as write-only memory devices. The circuit shown in **Fig 4a** uses the DAC-888, an 8-bit converter that resembles the DAC-08 except that it also includes an 8-bit addressable latch. The device's data-bit and control lines interface easily to most 8-bit μPs: Connect the $\overline{WR}$ line to the processor's R/$\overline{W}$ or $\overline{MEMW}$ line, send data bits over the μP's data lines and $\overline{CE}$ to an active-LOW memory-decoder device.

This DAC-888-based supply produces an output corresponding to a digital input, but note that when the μP and peripherals get reset to zero, the DAC-888 doesn't automatically latch these new inputs. Thus, the voltage output doesn't go to zero. If you need reset capability, connect the REF-02's output (pin 6) to an unused bidirectional port on a peripheral device **(Fig 4b).** This port should be able to enter a third state so the pull-up resistor can deactivate the DAC. To regain normal output operation, write a ZERO into the port.

For μP-controlled supplies requiring higher precision, such as those for power references and precision transducer drives, you can use a hybrid power amplifier in conjunction with a DAC. **Fig 5** shows the interfacing of two popular power amps.

Instead of buying such a power amp, however, you can design one with standard op amps and power transistors. **Fig 6a**'s circuit implements a fast power DAC using the OP-17, a wide-bandwidth BiFET op amp; **Figs 6b** and **6c** illustrate its dynamic performance with a 50Ω load. You can obtain even higher power by substituting higher current output transistors such as MJE170s and MJE180s, but these devices degrade response time.

Closed-loop controller uses one data converter

Now that you know how to design several types of power DACs, review how to use them in a typical application—motor control. Digital controllers often find use in linear systems with dc servo motors and linear control signals. To implement such a controller, you can use both a D/A converter and an A/D converter: The controller feeds digital control words to the DAC, which then drives the motor, and the ADC accepts small-signal feedback such as motor position and digitizes it for evaluation by the controller. You can't use typical DACs in the drive circuit because they provide current or voltage outputs in the milliwatt range, and these outputs require significant power amplification to be useful. Instead, you can use a configuration similar to that depicted in **Figs 5** or **6.**

You can eliminate the ADC in controllers similar to those just described by choosing either a voltage-output DAC or a current-output version with complementary currents and then time-sharing the DAC between A/D- and D/A-conversion functions. For

example, the circuit shown in **Fig 7** uses a multiplying DAC with a high-compliance current output (I_O), which a terminating resistor converts to a voltage. A sample/hold amplifier freezes the DAC's output while the converter performs a successive-approximation A/D conversion. To perform an A/D conversion, the circuit compares the DAC's complementary current output ($\overline{I_O}$) with the current from the servo motor's tachometer. (You might have to filter this signal, which typically appears as ac ripple on dc.) By placing the controller within this closed-loop velocity-control system, you can modify the system transfer function with software as required.

This simple application becomes more complex if your motor controller must account for several dynamic parameters such as torque, position, velocity or acceleration. In such a case, you need a multiple-input A/D-conversion system. To implement it, consider a voltage-output "complete" DAC that interfaces multi-

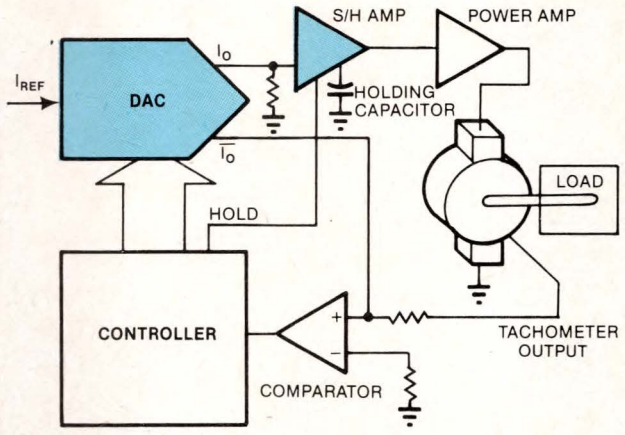
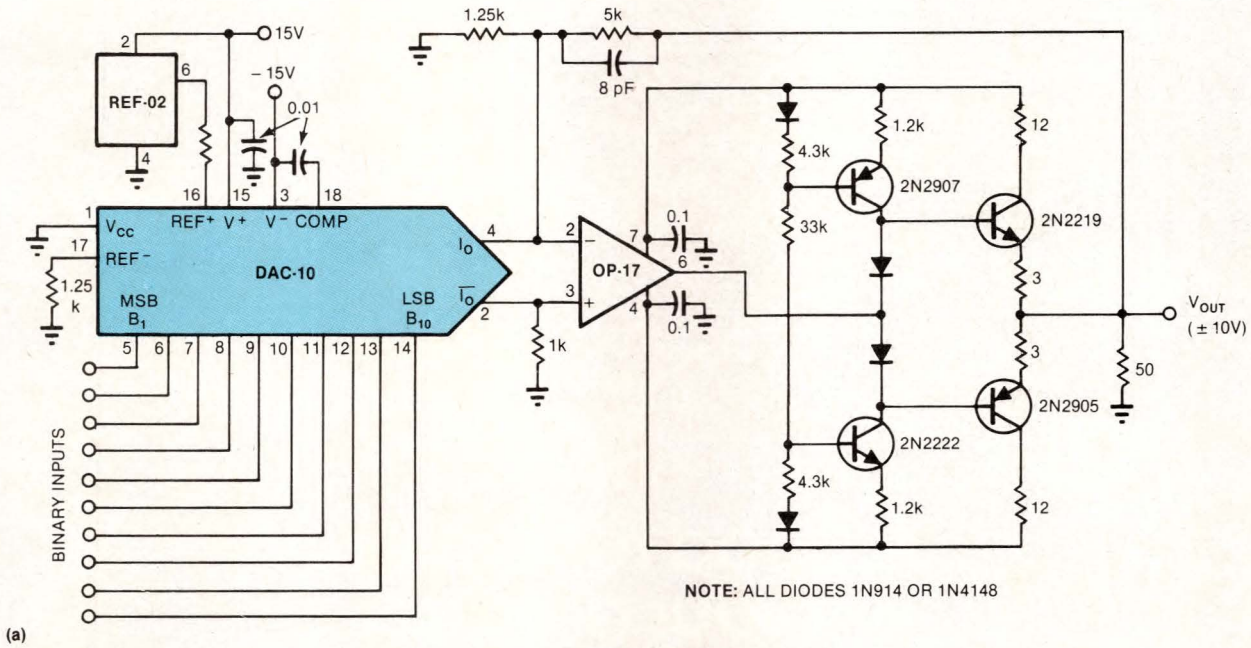
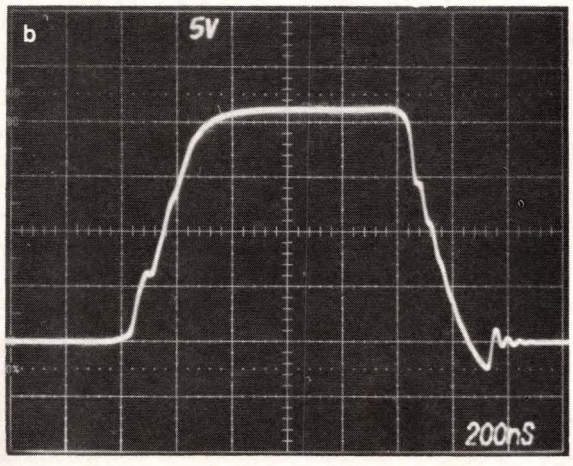


Fig 7—Time-share a DAC *in closed-loop controllers for both D/A- and A/D-conversion functions. A sample/hold amp allows the converter to perform other tasks while the S/H controls driver signals.*





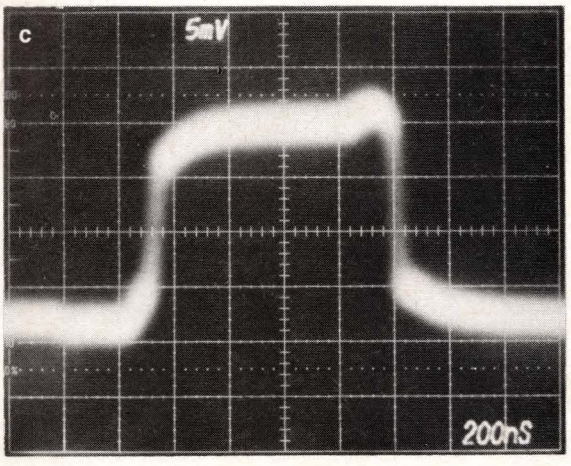


Fig 6—Build your own fast power DAC *with discrete components and three ICs* ***(a).*** *As the traces show, the circuit operates in the nanosecond range for full-scale outputs of ±10V when all input bits are driven* ***(b)*** *and for small-signal outputs from 0 to 20 mV when only the LSB is driven* ***(c).***

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CIRCLE NO 88

Reduce controller parts count by using DAC for ADC functions

ple-signal A/D and D/A conversions—such as the 10-bit-plus-sign DAC-210. This device's sign-magnitude coding format simplifies the controller algorithm because you can write the routine for magnitude-only control, ignoring motor direction.

The DAC-210 multi-input implementation shown in **Fig 8** uses as many voltage comparators as necessary to digitize the required analog inputs. This design needs no analog multiplexing and performs comparator selection and successive-approximation conversions through software. (The **reference** details the controller, including hardware and software routines for many μPs.)

This 3-parameter servo system uses torque, speed and position as its control inputs. It obtains the analog signal for torque by converting armature current (which is proportional to torque) to a voltage. Although this system uses a single S/H amplifier to freeze the DAC output while the controller is performing A/D conversion, it doesn't limit you to one S/H. You can time-share the DAC function by adding more S/H amplifiers and power drivers to drive several motors from one DAC. EDN

Reference

"Complete DACs simplify μP-based data-acquisition and data-distribution systems," Application Note AN-51, Precision Monolithics Inc, 1982.

Authors' biographies

Gary Grandbois was a product marketing manager at Precision Monolithics Inc (Santa Clara, CA) when he coauthored this article; he's now manager of product marketing at Teledyne Semiconductor (Mt View, CA). Gary earned his BSEE degree at the University of Minnesota and his MSEE at San Jose State University. When asked about spare-time activities, he responded, "With four children, who has time for hobbies?"

Wes Freeman worked as a marketing applications engineer for Precision Monolithics Inc (Santa Clara, CA) at the time he helped prepare this article; he's since moved to Teledyne Semiconductor (Mt View, CA) in the same capacity. Wes earned a BS degree in psychology at the University of Illinois and has also studied at Foothill College (Los Altos Hills, CA). Among his hobbies, he lists competition rifle shooting, photography and home computers.

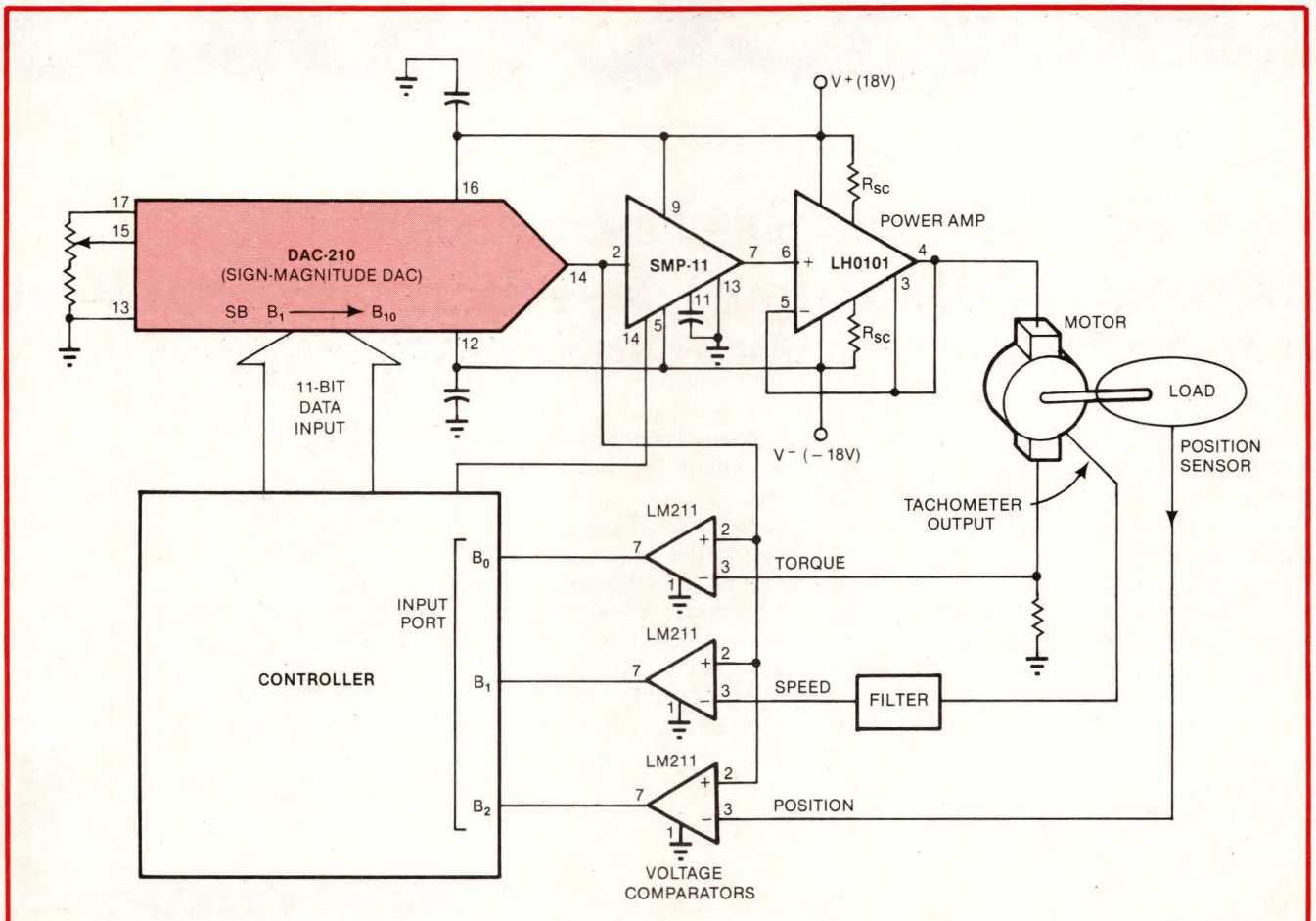

Fig 8—Digitize multiple dynamic feedback signals *with software in the controller. By adding more S/H amplifiers, you can also control several loads.*

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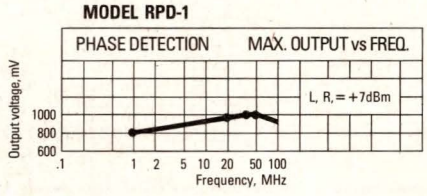

RPD-1 SPECIFICATIONS

FREQUENCY RANGE:	
L and R ports	1-100 MHz
Output ports	DC-50 MHz
SCALE FACTOR	.8 mV/Degree
IMPEDANCE	
L and R ports	50 ohms
I port	500 ohms
L and R SIGNAL LEVELS	+7 dBm
ISOLATION, L-R	40 dB min
MAXIMUM DC OUTPUT, mV	1000 mV typ 750 mV min
DC OUTPUT POLARITY	
(L and R in-phase)	Negative
DC OUTPUT OFFSET	
VOLTAGE	0.2 mV typ 1 mV max
FIGURE-OF-MERIT, M	143 Typical

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CIRCLE NO 89

Design Ideas

Decoder forms mutually exclusive latch

Stephen Cannon
Seymour, CT

The next time you need to latch a signal from one of four pushbuttons, consider using a BCD-to-decimal decoder such as **Fig 1**'s design, employing a CD4028 CMOS device. This circuit maintains a HIGH level at the output corresponding to the last button pressed.

When you close one of the design's switches, the appropriate output line goes HIGH, and its 10-kΩ feedback resistor latches the input. Because an active output holds its corresponding input HIGH, the circuit tolerates infinite switch bounce.

When a second switch closes, the decoder's outputs change state, resetting the previous input. The output selected by the new keystroke then latches HIGH. If multiple pushbuttons close simultaneously, the last button released determines the circuit's latched output condition.

You can also apply **Fig 1**'s latched decoder to TTL: **Fig 2** shows a circuit based on a 7442 chip. The 7404 buffers provide the input inversion necessary to allow positive feedback around the inverted-logic decoder. Unlike **Fig 1**'s design, this circuit possesses active-LOW inputs and outputs. **EDN**

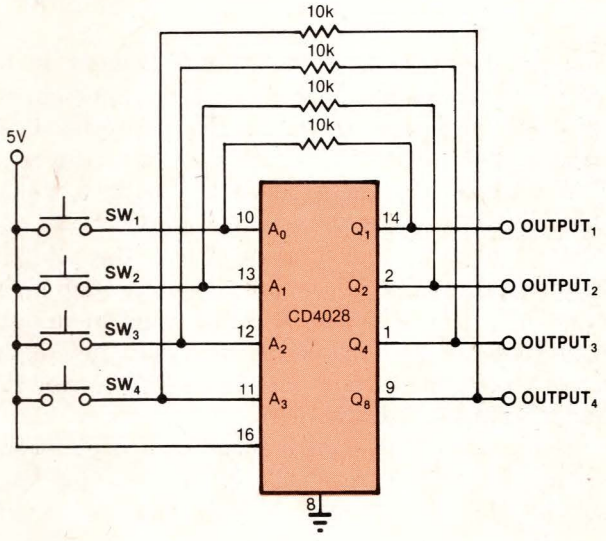


Fig 1—Positive feedback *around a BCD-to-decimal decoder results in a quad mutually exclusive latch. The circuit's output holds the state corresponding to the last input-switch closure.*

To Vote For This Design, Circle No 456

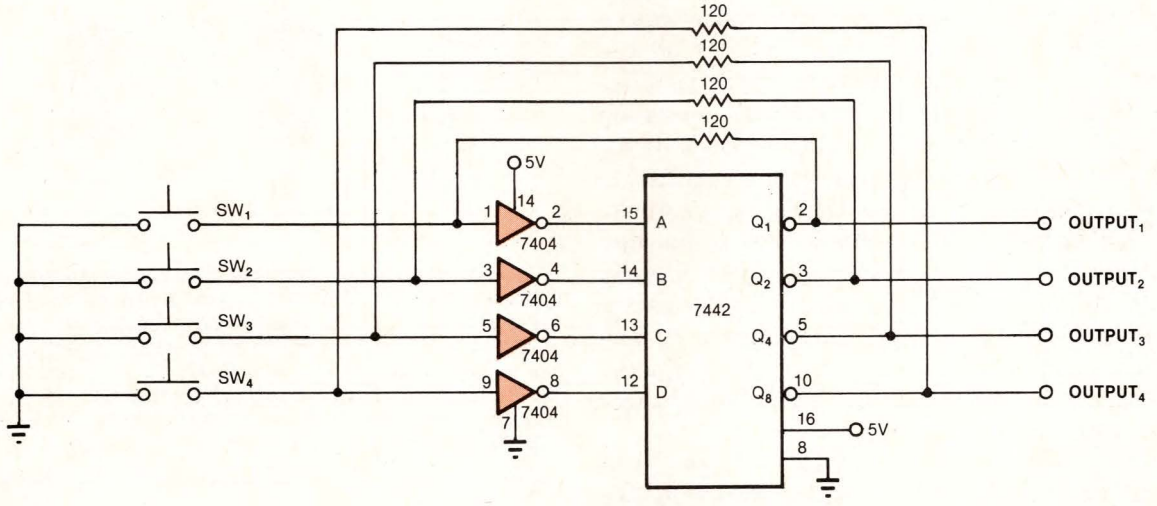


Fig 2—By adding a 7404 buffer, *you can apply* ***Fig 1****'s technique to TTL. This circuit, based on a 7442, provides active-LOW inputs and outputs.*

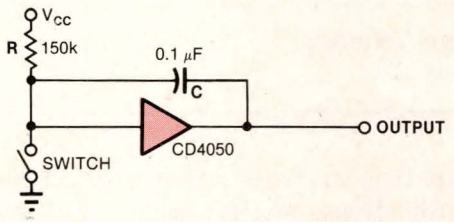
One IC debounces six switches

Victor Regener
VHR Systems, Albuquerque, NM

You can debounce six switches with a single IC by properly exploiting CMOS logic's high input impedance. In this design **(figure)**, an RC network around each section of a CD4050 filters contact bounce.

Closing the switch grounds the buffer's input, immediately driving the circuit's output LOW. As contact bounce momentarily opens the switch, feedback capacitor C charges slowly through input resistor R. But so long as no bounce component lasts longer than approximately 0.7RC, the gate's input never reaches its turn-on threshold of $\frac{1}{2}V_{CC}$, and the buffer's output remains LOW.

When you hold the switch open long enough for the voltage across C to reach the gate's switching level (roughly 10 msec for the values shown), the circuit's output goes HIGH. Hysteresis through the feedback capacitor ensures sharp output transitions. **EDN**



An RC network around a CMOS buffer *debounces a switch. Feedback capacitor C allows LOW-to-HIGH output transitions only when the switch contacts remain open longer than 0.7RC (approximately 10 msec for the values shown).*

To Vote For This Design, Circle No 457

Bias Hall sensors for minimum drift

Yishay Netzer
Honeywell Inc, Lexington, MA

A Hall-effect magnetic sensor generates an output voltage that varies linearly with the product of the device's bias current and the strength of the surrounding magnetic field. Unfortunately, its absolute sensitivity depends heavily on its operating temperature. Although early indium-arsenide devices possessed unpredictable temperature coefficients that prevented their use in critical applications, recent advances in silicon-based Hall technology permit the production of devices that drift linearly and repeatably. By understanding and anticipating such a Hall sensor's temperature-dependent performance characteristics, you can create magnetic-detection circuits that maintain high stability over broad operating ranges.

When biased from a low-impedance voltage source **(Fig 1a)**, a silicon Hall-effect sensor suffers from two drift mechanisms. First, the device's bias current varies because of the positive temperature coefficient of the sensor's internal resistance (R_0). A typical high-performance silicon Hall sensor, the Micro Switch 632SS2, undergoes an internal resistance change of 0.6%/°C, resulting in a bias-current drift—and thus a sensitivity variation (α)—of −0.6%/°C.

Continued on pg 185

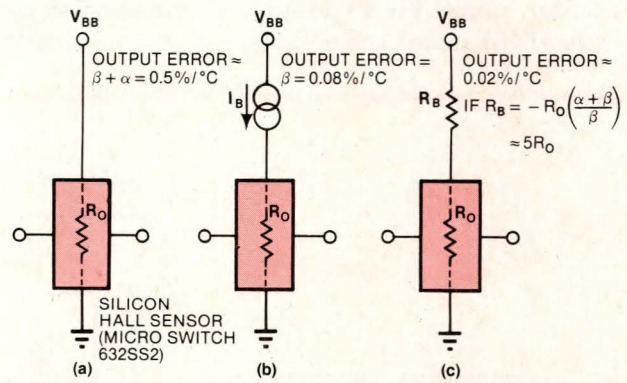
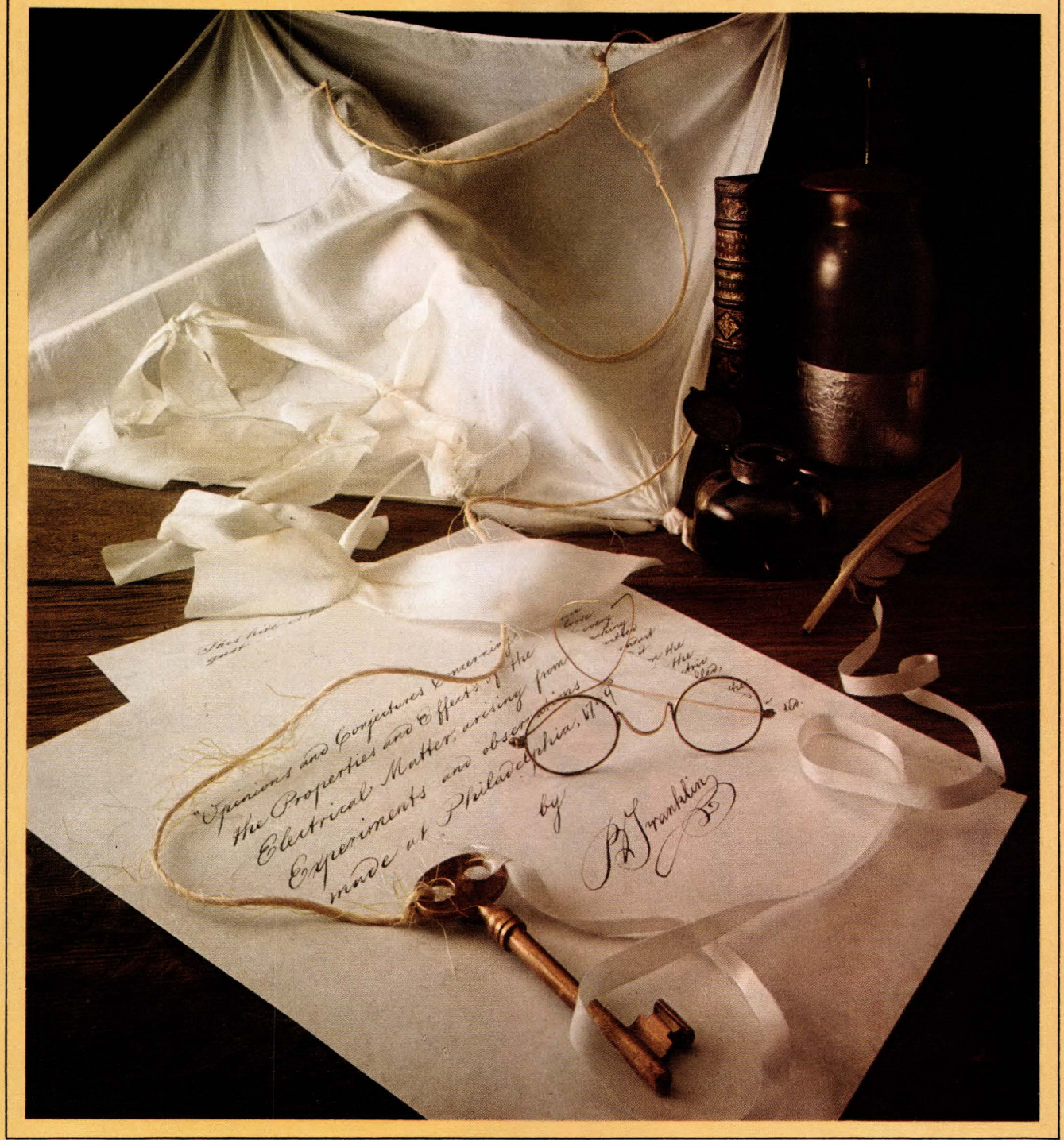
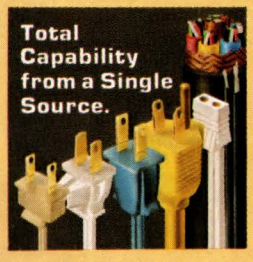


Fig 1—A silicon Hall-effect sensor's bias arrangement *determines overall drift. When the sensor operates from a constant-voltage source* ***(a)****, bias-current changes arising from internal resistance variations (α) add to the device's inherent temperature sensitivity (β). Constant-current biasing* ***(b)*** *eliminates the effects of R_0, but the sensor's temperature coefficient is still too high for critical applications. A series resistor* ***(c)*** *allows the naturally opposing characteristics of α and β to stabilize the sensor.*



Some pretty big achievements started out as just an idea.



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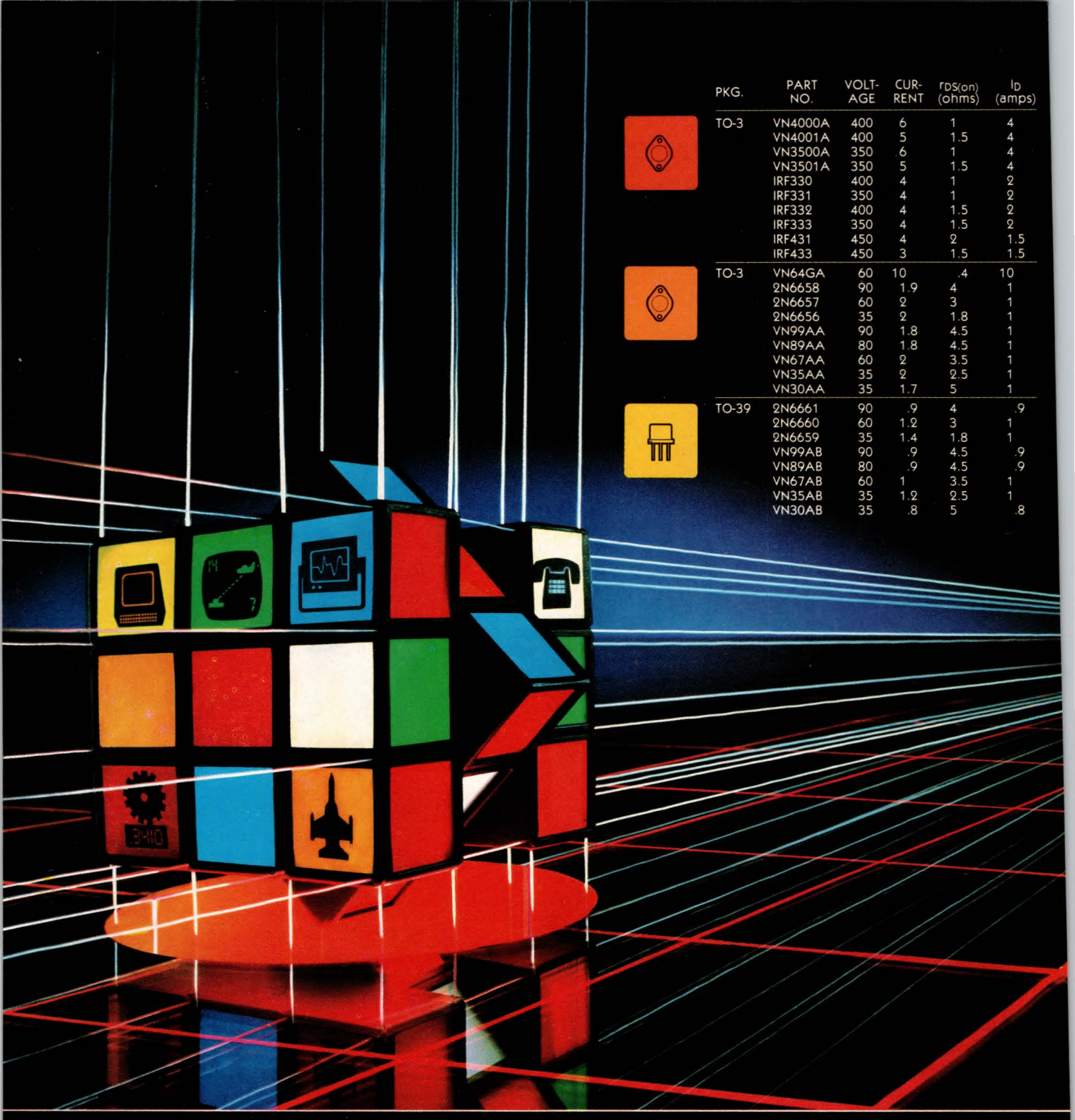
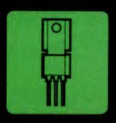


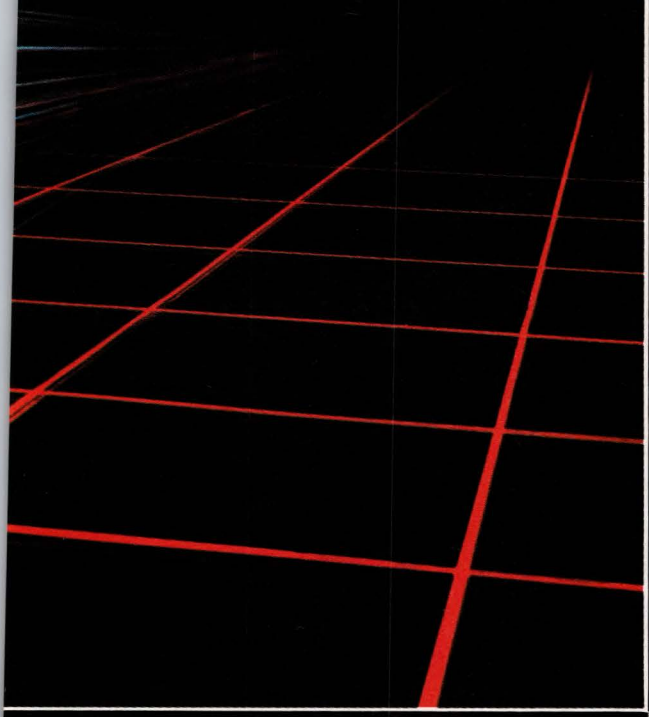
PKG.	PART NO.	VOLT-AGE	CUR-RENT	$r_{DS(on)}$ (ohms)	I_D (amps)
TO-3	VN4000A	400	6	1	4
	VN4001A	400	5	1.5	4
	VN3500A	350	6	1	4
	VN3501A	350	5	1.5	4
	IRF330	400	4	1	2
	IRF331	350	4	1	2
	IRF332	400	4	1.5	2
	IRF333	350	4	1.5	2
	IRF431	450	4	2	1.5
	IRF433	450	3	1.5	1.5
TO-3	VN64GA	60	10	.4	10
	2N6658	90	1.9	4	1
	2N6657	60	2	3	1
	2N6656	35	2	1.8	1
	VN99AA	90	1.8	4.5	1
	VN89AA	80	1.8	4.5	1
	VN67AA	60	2	3.5	1
	VN35AA	35	2	2.5	1
	VN30AA	35	1.7	5	1
TO-39	2N6661	90	.9	4	.9
	2N6660	60	1.2	3	1
	2N6659	35	1.4	1.8	1
	VN99AB	90	.9	4.5	.9
	VN89AB	80	.9	4.5	.9
	VN67AB	60	1	3.5	1
	VN35AB	35	1.2	2.5	1
	VN30AB	35	.8	5	.8

When It Comes to Winning Combinations, We Invented



PKG.	PART NO.	VOLT-AGE	CUR-RENT	$r_{DS(on)}$ (ohms)	I_D (amps)
DIP	VQ1000	60	.3	6.5	.3
QUAD	VQ1001	30	.85	1	1
14-PIN	VQ2001	30	.6	2	1
	VQ3001	30	.6	3*	1
	VQ7254	20	.6	3*	1
TO-202	VN88AF	80	1.5	4	1
	VN89AF	80	1.4	4.5	1
	VN66AF	60	1.7	3	1
	VN67AF	60	1.6	3.5	1
	VN46AF	40	1.7	3	1
	VN40AF	40	1.3	5	1
TO-52	VN10KE	60	.2	5	.5
TO-92	VN2222	40	.2	7.5	.1
TO-237	VN10KM	60	.3	5	.5

* Sum of N & P $r_{DS(on)}$



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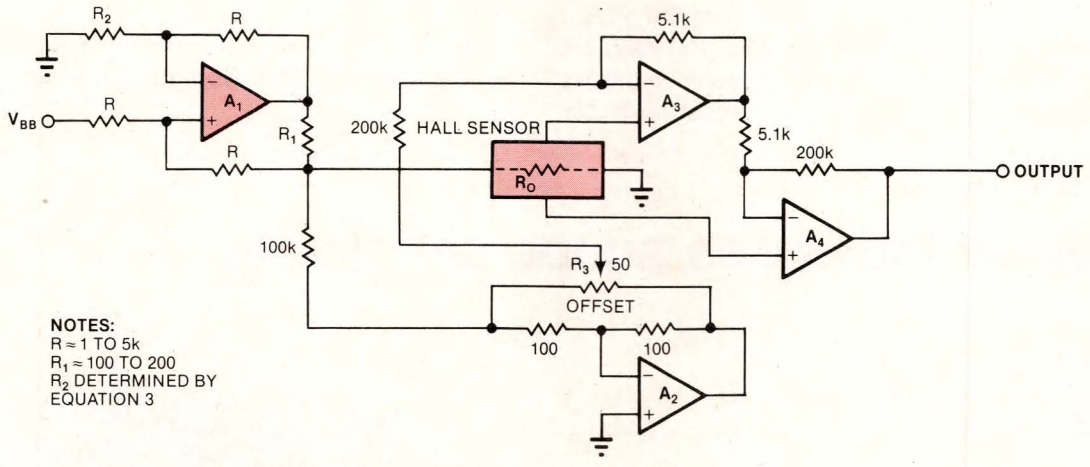


Fig 2—Separate current and voltage feedback paths *around op amp A_1 create a controlled-impedance bias source for the Hall sensor. Op amp A_2 and offset pot R_3 feed a correction voltage to the output circuit (A_3 and A_4) to compensate for offset drift arising from the sensor's varying bias voltage.*

The second drift source results from a silicon sensor's inherently temperature-dependent sensitivity. The Micro Switch device possesses a sensitivity temperature coefficient (β) of 0.08%/°C. Thus, approximated to the first order, a device operating from a fixed bias voltage experiences drift equal to α+β, or approximately −0.5%/°C for the Micro Switch device. Constant-current biasing (**Fig 1b**) eliminates the α term from the drift equation, but even the β value alone causes too much drift in critical applications.

You can greatly reduce a Hall-effect sensor's thermally induced output variations by exploiting the naturally opposing characteristics of the device's two drift mechanisms. If a properly selected series resistor (R_B) limits the extent to which the device's internal resistance sets the unit's operating current (**Fig 1c**), the bias reduction arising from R_0 variations cancels the absolute sensitivity increases resulting from the β coefficient.

In **Fig 1c**'s circuit, the Hall Sensor generates an output voltage proportional to

$$\underbrace{\frac{V_B}{R_O + R_B}}_{\text{NOMINAL BIAS CURRENT}} \times \underbrace{\frac{1 + \beta T}{1 + \dfrac{R_O}{R_O + R_B}\alpha T}}_{\text{CORRECTION FACTOR}}, \qquad (1)$$

Where T equals the ambient-temperature change. To find the bias resistor's ideal value, set this equation's correction term equal to one and solve for R_B. Thus,

$$R_B = -R_O\left(\frac{\alpha + \beta}{\beta}\right). \qquad (2)$$

The Micro Switch sensor exhibits a typical internal resistance of 700Ω, so it performs best when connected in series with approximately 4.2 kΩ.

Unfortunately, **Fig 1c**'s solution presents a major drawback: Because R_B is six times greater than R_0, the bias resistor reduces the voltage across the Hall sensor to $V_{BB}/7$. To provide adequate sensitivity, the Micro Switch unit requires a bias level of 5 to 10V, so when $R_B=6R_0$, V_{BB} must equal 35 to 70V.

Fig 2 illustrates a circuit that provides a Hall sensor with a high-impedance bias without requiring high-voltage power supplies. In this scheme, separate voltage and current feedback paths around op amp A_1 control the sensor's bias impedance. This circuit's equivalent R_B value equals

$$R_B = \frac{2R_1R_2}{R_2 - R}. \qquad (3)$$

So long as you maintain the proper relationship between R, R_1 and R_2, their absolute values aren't critical. To use the circuit, first determine the bias resistance your design requires. Then select convenient values for R (1 to 5 kΩ) and R_1 (100 to 200Ω) and solve **Eq 3** for R_2.

Because the Hall element connects to a high-impedance source, the sensor's bias voltage varies with R_0. Although this effect helps cancel sensitivity errors, it results in temperature-dependent offset drift at the sensor's output terminals. To compensate

for this effect, op amp A_2 derives a correction voltage from the bias circuit's output, and the offset pot (R_3) feeds this signal to the first output amplifier (A_3). Trimming R_3 for zero offset reduces the circuit's output drift to 1 μV/°C, but you can achieve output variations as small as 0.3 μV/°C by adjusting R_3 for least output change while using a heat gun to thermally cycle the Hall sensor. **EDN**

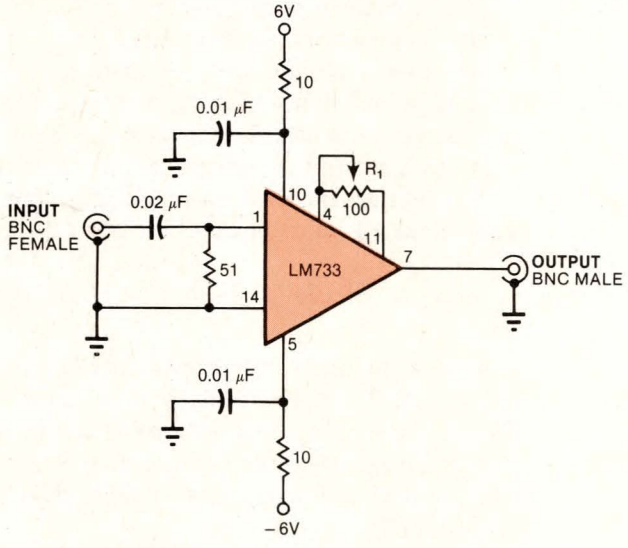
To Vote For This Design, Circle No 458

Amplifier increases scope sensitivity

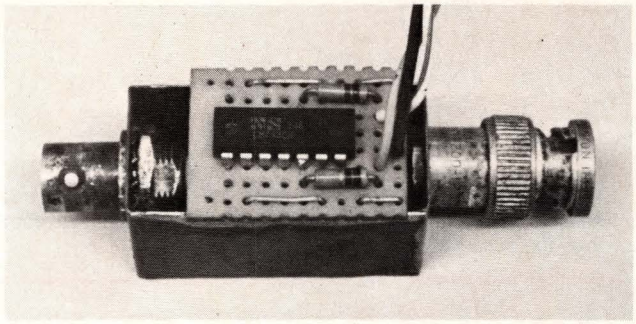
M J Salvati
Flushing Communications, Flushing, NY

With an unusual packaging technique, you can turn $5 worth of common components into a wide-band preamp. Ideal for use with older, low-sensitivity oscilloscopes and frequency counters, this circuit (**figure**) provides 20±0.1-dB voltage gain from 0.5 to 25 MHz (±3 dB, 70 kHz to 55 MHz).

This design's only active component, an LM733 video amplifier, furnishes a low input-noise spec (10 μV typ, measured over a 15.7-MHz bandwidth). You can preserve the scale factor of the instrument you connect to the preamp's output by exploiting the 733's gain-control inputs. Use R_1, a cermet trimmer or selected precision resistor, to set the circuit's voltage gain to exactly 100.



A video amp *(LM733) constitutes all of this preamp's active circuitry. Increasing the sensitivity of older oscilloscopes and frequency counters, this design boosts signals spanning 0.5 to 25 MHz by 20±0.1 dB.*



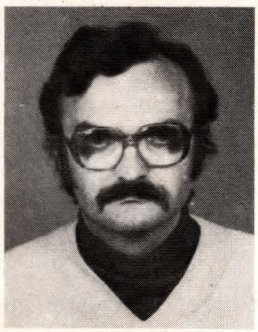
A 0.75-in. copper strip, *bent into an open rectangle, serves as the preamp's chassis. The metal frame forms a low-inductance ground system that extends high-frequency response.*

To form the preamp's chassis (**photo**), bend a 0.75-in.-wide sheet-copper strip into an open rectangle and lap-solder the seam. Be sure to drill the input- and output-connector mounting holes before bending the copper. Soldering all of the circuit's ground connections directly to the metal frame creates a low-inductance ground system that results in the design's high-frequency performance.

(Ed Note: You can extend the preamp's low-frequency response by shunting the 0.02-μF input capacitor with a larger unit.) **EDN**

To Vote For This Design, Circle No 459

Readers have voted:
Florin Nestor Mugioiu winner of the June 10, 1981 issue's $75 award for best design. His design is "Stand-alone TTL tester indicates Go/No Go." Mr Mugioiu is with the Institute for Electronic Research, Bucharest, Romania.



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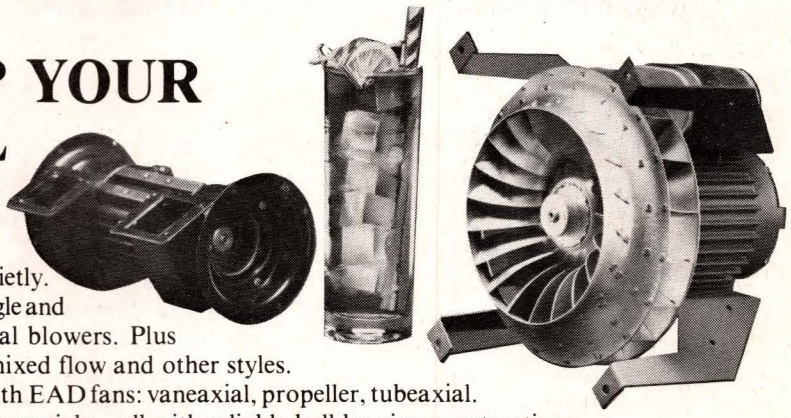

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μC Design Techniques

EDN Software Note #82

Generate symbol lists for the Aim-65

John C Grebe Jr
Smithkline Geometric Data Div, Wayne, PA

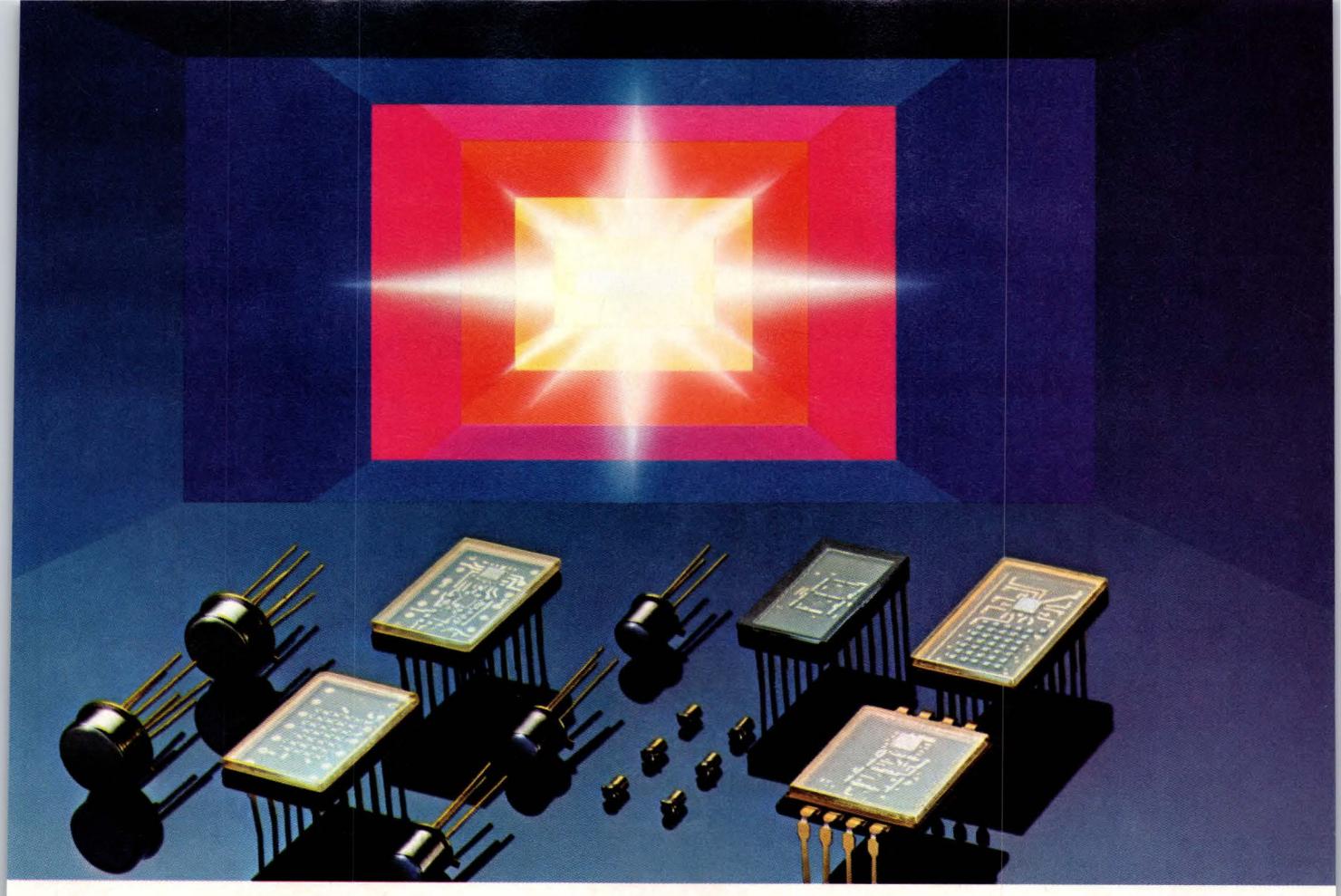
Rockwell's assembly option for the Aim-65 μC does not generate a symbol table while assembling—a potentially serious problem in debugging larger programs. To eliminate this deficiency and facilitate debugging, the program shown in the **figure** finds and prints the Aim-65's internal symbol table after the assembler completes pass two.

The generating code starts at location 200_H; to access it upon completing assembly, press the F_1 key on the Aim-65 keyboard or the "[" key on an external terminal. After completing the symbol table, the program returns to the Aim-65's monitor program.

Keep this program resident in memory while you edit or assemble by starting the editor or assembler memory space above location 270_H. Exemplifying program execution, the listing at the end of the code shows the result of running the program against itself: the program's own symbol table. **EDN**

```
N>
ASSEMBLER
FROM=400 TO=1000
IN=T F=TABLE T=1

LIST?Y
LIST-OUT=

OBJ?N
PASS 1

PASS 2


SYMBOL LIST GENERATOR


==0000
;THE PROGRAM  ENTERED  AT LOCATION 200 HEX AFTER
;AN ASSEMBLY HAS BEEN RUN ON AN AIM 65 WILL GENERATE
;A SYMBOL TABLE OUTPUT TO THE ON BOARD PRINTER OR TTY OUTPUT
;THE PROGRAM IS EXECUTED BY PRESSING THE F1 KEY ON THE AIM 6
;OR THE "[" KEY ON A TERMINAL

==0000 NUMA=$EA46
==0000 OUTPUT=$E97A
==0000 CHAR=$0020
==0000 CRLF=$E9F0
==0000 MONTOR=$E182

==0000
       *=$10C
==010C
4C0002 JMP START F1 KEY VECTORS TO START OF PROGRAM

==010F
       *=$200
==0200 START
A53A   LDA $003A SYMBOL TABLE STARTING ADDRESS POINTER
8520   STA CHAR
A53B   LDA $003B
8521   STA CHAR+1
A50C   LDA $000C NUMBER OF SYMBOLS IN SYMBOL TABLE
8D4802 STA COUNT
A50B   LDA $000B
8D4902 STA COUNT+1
==0212
20F0E9 JSR CRLF CR AND LF TO START TABLE ON NEW LINE
==0215 NXTSYM
204C02 JSR SYMOUT OUTPUT SYMBOL POINTED TO BY CHAR
AD4802 LDA COUNT SUBTRACT ONE FROM COUNT, BRANCH TO END ON ZERO
F006   BEQ HIBYT
CE4802 DEC COUNT
4C2902 JMP CONT
==0223 HIBYT
CE4802 DEC COUNT
CE4902 DEC COUNT+1
==0229 CONT
AD4802 LDA COUNT
D005   BNE INPT
AD4902 LDA COUNT+1
F010   BEQ END
==0233 INPT
18     CLC ADD EIGHT TO THE SYMBOL POINTER LOCATION
A520   LDA CHAR
6908   ADC #08
8520   STA CHAR
A521   LDA CHAR+1
6900   ADC #00
8521   STA CHAR+1
4C1502 JMP NXTSYM GO BACK TO OUTPUT NEXT SYMBOL
==0243 END
4C82E1 JMP MONTOR RETURN TO AIM 65 MONITOR
EA     NOP
EA     NOP
==0248 COUNT
       *=*+2
EA     NOP
EA     NOP
==024C SYMOUT
A000   LDY #00 OUTPUT 6 CHAR SYMBOL AND 2 DIGIT HEX VALUE
==024E NEXT
B120   LDA (CHAR),Y
207AE9 JSR OUTPUT
C8     INY
C006   CPY #06
D0F6   BNE NEXT
A920   LDA #$20
207AE9 JSR OUTPUT
B120   LDA (CHAR),Y
==025F
2046EA JSR NUMA
C8     INY
B120   LDA (CHAR),Y
2046EA JSR NUMA
20F0E9 JSR CRLF
60     RTS
       .END
 ERROPS= 0000

<D>
NUMA   EA46
OUTPUT E97A
CHAR   0020
CRLF   E9F0
MONTOR E182
START  0200
NXTSYM 0215
HIBYT  0223
CONT   0229
INPT   0233
END    0243
COUNT  0248
SYMOUT 024C
NEXT   024E
```

Create a symbol table for Aim-65 assemblies *by running this routine after completing pass two of the μC's assembler. Running the program against itself produces the program's own table, which appears at the end of the listing.*



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CIRCLE NO 92

Link CMOS logic to a 6809 μP

Ralph Tenny
George Goode and Associates Inc, Dallas, TX

Changes in bus timing from older 6800-family μPs make the 6809 processor easy to interface with ordinary CMOS devices. By contrast, the older devices (and all 6500-family μPs) use a standard 2-phase nonoverlapping clock signal with its two elements 180° out of phase; this clock scheme prohibits CMOS-device interfacing, even with a processor frequency of only 1 MHz. The reason? Data from the processor stays available for too short a time during writes to permit device connection.

The 6809 features a clock signal with its second phase in quadrature (90° out of phase) with phase E (**Fig 1**). In addition to this skewed clock time, the μP makes data available much earlier in a write cycle than do the older processors. As a result, the 6809 allows CMOS interfacing even when you use worst-case design techniques.

Fig 2 shows a CMOS output interface for capturing data from the 6809. The CD40174 hex D latch serves as a 6-bit output port. One-third of a CD4025 gate performs a NOR operation on the 6809 quadrature clock (Q), the Decode-port-location definer and the processor's Read/Write signal.

Fig 1's worst-case timing diagram for this device combination, computed for a 1-MHz processor clock, shows that the timing margins are good enough to ensure reliable operation. Indeed, CMOS devices usually tolerate even wider timing margins than the ones resulting from this interface.

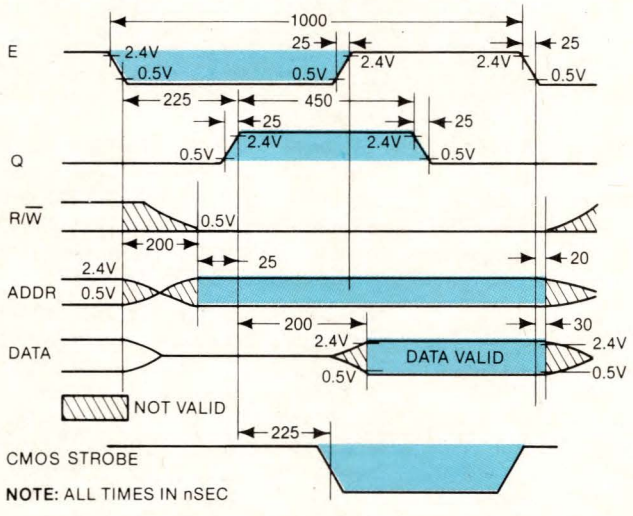

Fig 1—A timing diagram *for a CMOS-to-6809 interface shows timing margins adequate for such a link.*

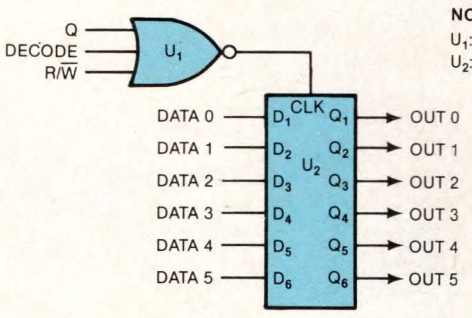

Fig 2—A simple CMOS interface *captures output data from the processor, thanks to the relaxed timing margins shown in* ***Fig 1.***

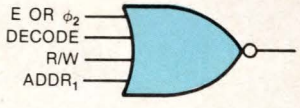

Fig 3—For additional output ports, *include a low-order address line in the decoding scheme.*

For multiple output ports, substitute a CD4002 for the CD4025 (**Fig 3**) to include lower order address lines in the decoding. For example, using only the four low-order address lines (A_0 to A_3) provides four 6-bit output ports. These address lines must be HIGH to inhibit data transfer, so if the port base address equals $A000_H$, the new output ports appear at the following addresses:

Port 1 $AD0E_H$
Port 2 $A00D_H$
Port 3 $A00B_H$
Port 4 $A007_H$.

Although you can use this technique to further expand the interface, additional address-line decoding should employ low-power Schottky logic because a second level of CMOS propagation delay would create prohibitive timing margins.

Additionally, some CMOS devices require negative-going Strobe/Enable signals; for these, substitute CD4072 or CD4075 devices for the strobe decoding. To implement input functions, use latches with 3-state outputs, such as the CD4076. With them, the decoded signal becomes the bus enable. Latch input signals with the μP's E clock phase to prevent the signal from changing as the μP reads the port. **EDN**

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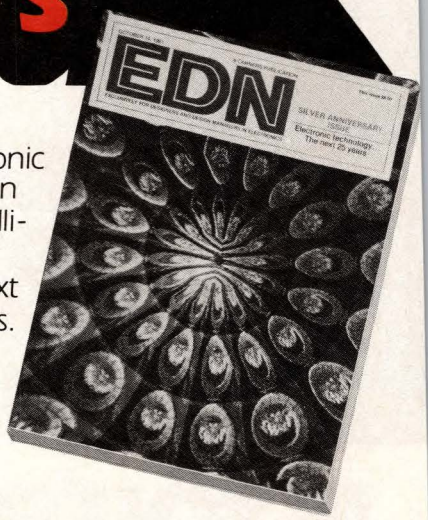

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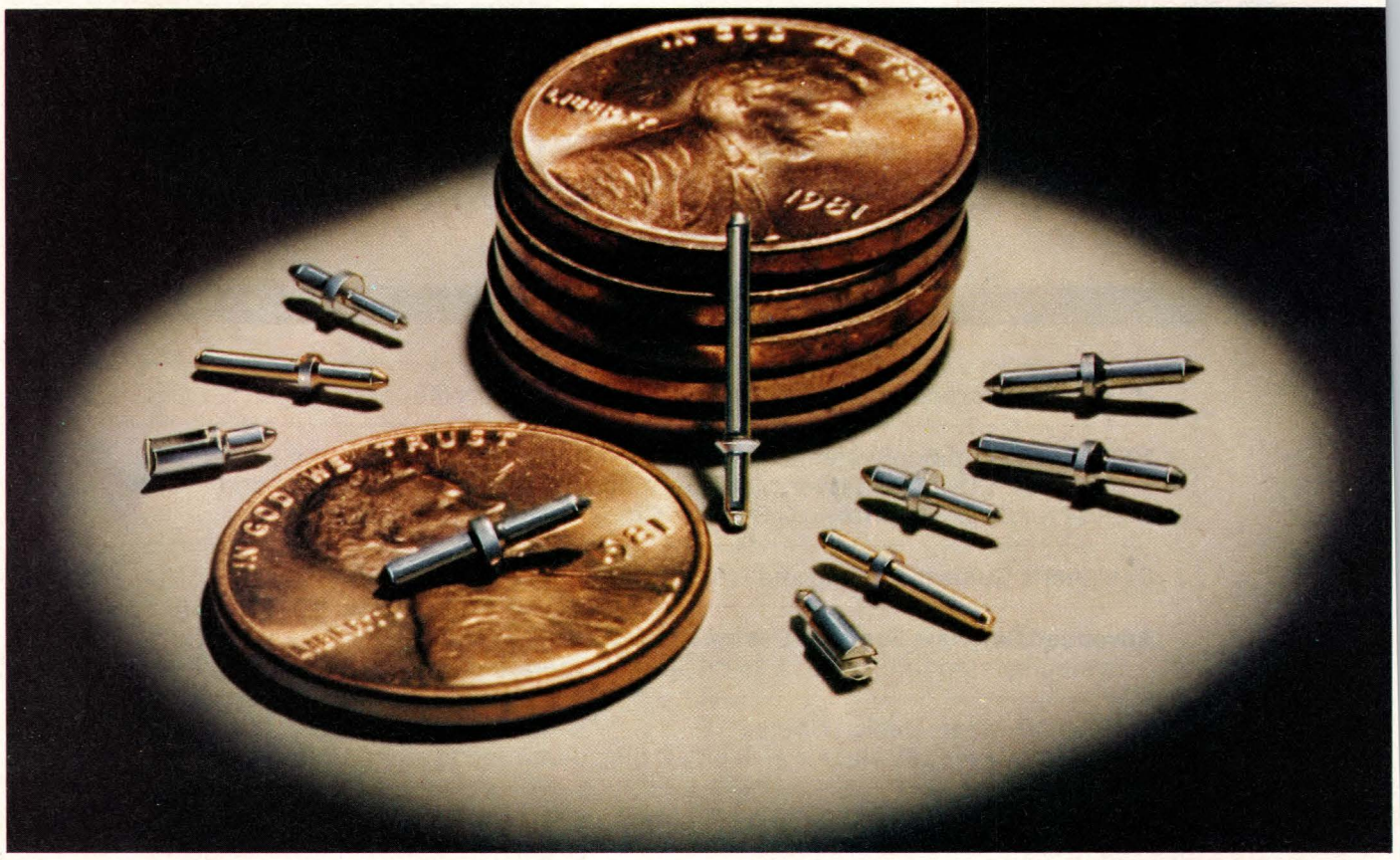

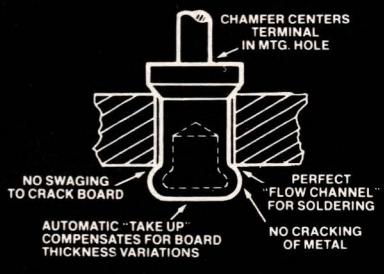

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Feature Products

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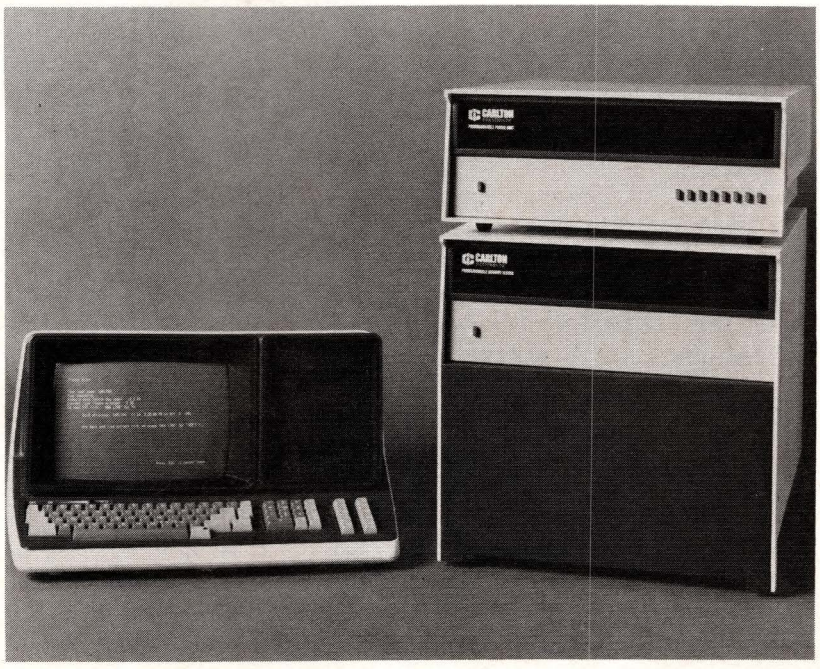
A 16-bit μC and a display terminal provide system control. The terminal executes a control program that issues commands and reads back the status of the system's other modules. The control unit includes dual double-density, double-sided 5¼-in. floppy-disk drives for program and data storage; it can be equipped with an optional printer.

System software, written in PASCAL, is query/response oriented to lead an operator through system operation with a minimum of training and supervision. Programs include Go/No-Go testing, fault diagnosis and board burn-in.

You enter test parameters for these programs via a board-definition program that stores memory-board test parameters under each board's part number. To execute any of the test programs, you only enter board numbers. The control unit logs test results by board part and serial number.

The programmable memory-tester module contains a high-speed processor and firmware-programmable device-under-test interface. The processor generates address and data patterns from test parameters it receives from the control unit, and it transmits test results back as status information.

The module includes 16 standard test patterns to exercise a memory array and control logic on the board under test. It can also be downloaded with user-provided test programs. The firmware interface to the unit under test replaces hardware personality boards and cuts the preparation time required to handle new board types.



Designed for production and depot-level field-service testing, *Model C16 memory-board tester fits on a benchtop and costs less than $55,000.*

The C16's programmable power unit provides dc power to the board under test. It contains as many as four power-supply modules and a μP-based controller. Voltage margining allows you to specify high and low voltage levels for all supplies and set a supply at its nominal value or at either voltage level. The unit can also slew one or more supplies between margins while a test is in progress.

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Circle No 450

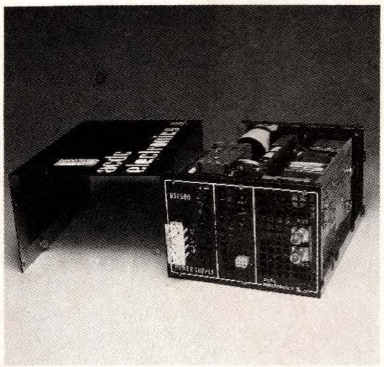
Fan-cooled switchers produce 500W

Although they come in a compact (5×8×10.5 in.) case, RSF Series switchers deliver 500W max in single- through quad-output configurations. One model even furnishes two high-current 400W output channels.

Single-output units produce 2 to 28V dc at 18 to 100A. Multiple-output versions provide additional 5 to 28V outputs at 2 to 20A. For applications that use disk drives, printers or other less critical loads, one version offers a 24V semiregulated output.

RSF100 models provide any combination of two voltages (2 to 28V) at 14A to 80A. Total output can't exceed 500W.

All supplies use a submodular architecture that breaks the switcher into manageable building blocks. The latest LSI inverter-control circuitry, power semiconductors and fault/error-detection ICs increase the design's reliability.



Despite their 5×8×10.5-in. size, *RSF Series switchers furnish 500W outputs.*

Other features include protection against reverse voltage applied to the output terminals (to the rated current on the main output and to 3A on all secondary outputs) and SCR crowbar protection for an overvoltage condition.

Options include ac power-fail detect (the supplies spec a 30-msec nominal hold-up time), remote inhibit, output out-of-tolerance indication and margining. $575 (single-output unit) to $745 (quad-output model). Delivery, 6 to 8 wks ARO.

ACDC Electronics Inc, 401 Jones Rd, Oceanside, CA 92054. Phone (714) 757-1880.

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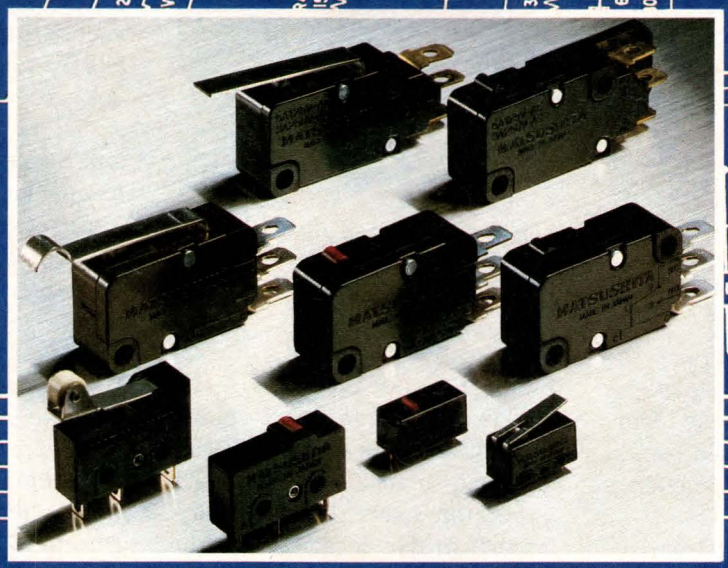

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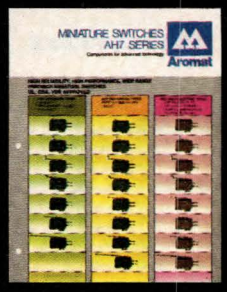

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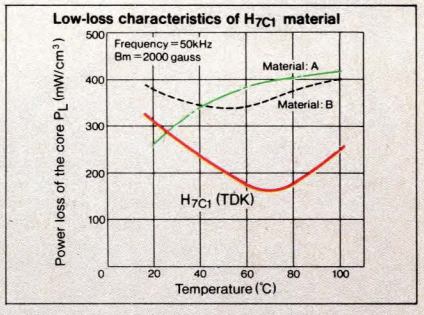

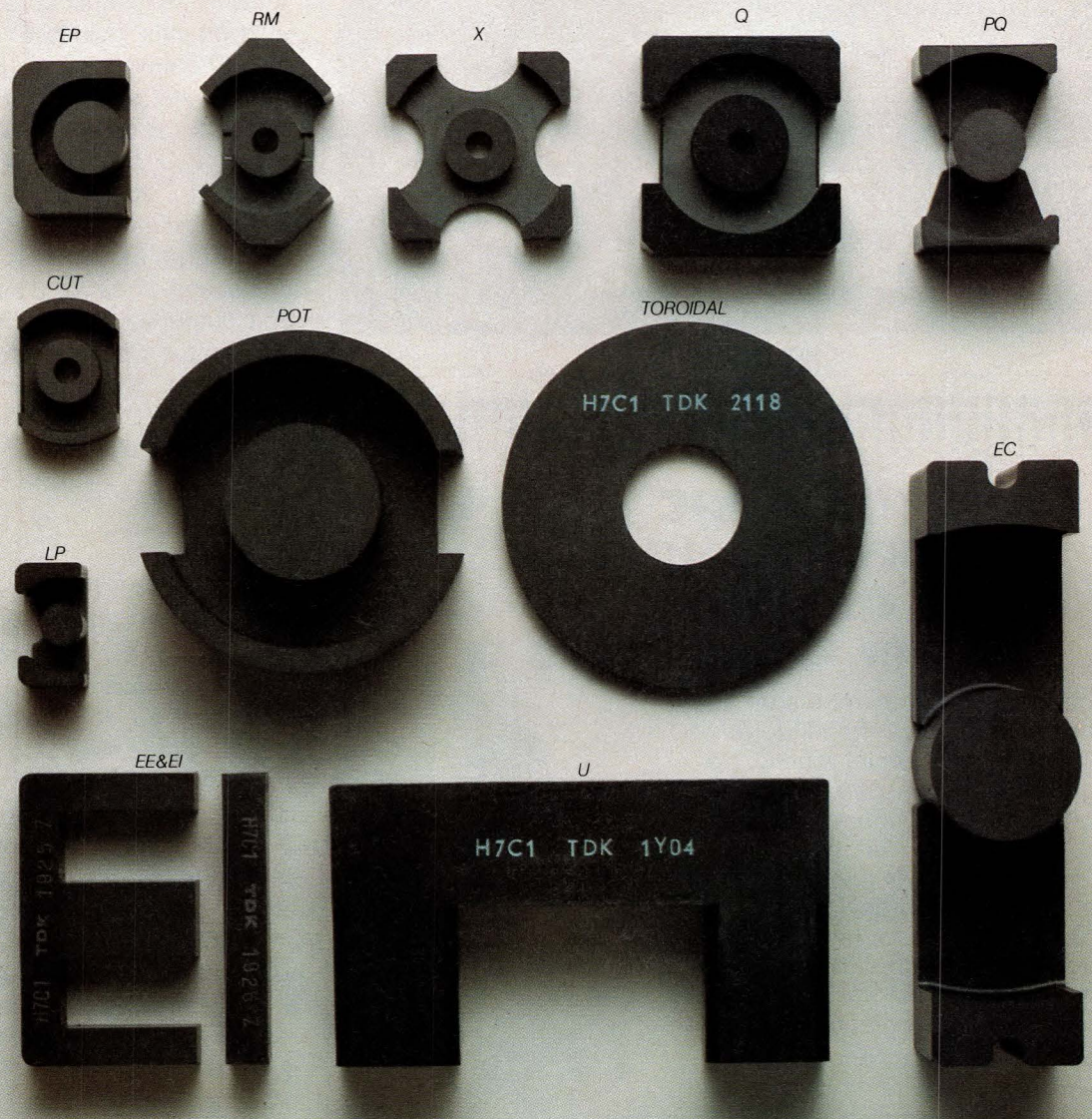

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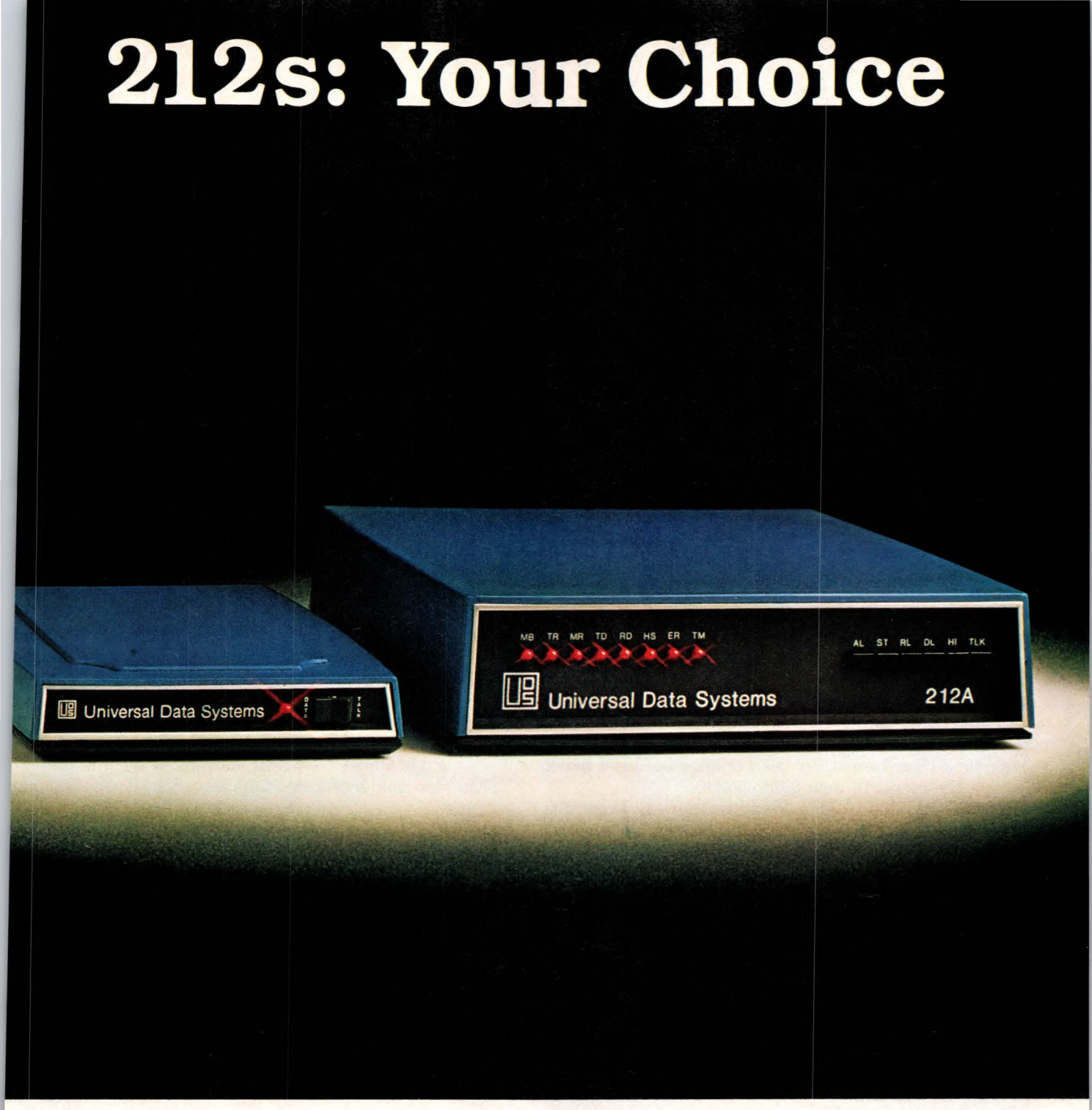
212s: Your Choice



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GREENVILLE, SC — Kid Kemet, out of the Union Carbide camp, scored a stunning victory over rival L. Legibility with his newly acquired Golden Max capacitor punch.

Using the same outstanding performance and reliability characteristics associated with his old Blue Max style, Kid Kemet revealed crisp, clear laser markings — the result of new gold colors.

Employing this Golden Max strategy, L. Legibility suddenly became easy to read, easy to find and easy to replace as champion of the heavyweight circuit.

"What I like best about the Golden Max," Kid Kemet remarked, "is that it has so many variations.

"I can go in the ring using either my ultrastal COG, NPO; stable X7R, BX/BR or general purpo Z5U — depending on my opponent. Then I have choice of over 300 CV values which can be used in 5 100 or 200-volt arenas. And I can operate over a f temperature range, from −55 °C to +125 °C.

"What's best," the Kid continued with a smile, ' the new gold look helps fans see my laser-applied mar ings."

Kid Kemet's manager and trainer, "Hi" Reliable, a credits his fighter's quick success to his rigid manufa turing and process control training program.

KID KEMET TO TOUR COUNTRY TOUTING NEW GOLDEN MAX PUNCH

GREENVILLE, SC — Kid Kemet's manager an trainer, "Hi" Reliable, today announced that th heavyweight circuit champion will tour the U.S. pro moting his new Golden Max capacitor punch.

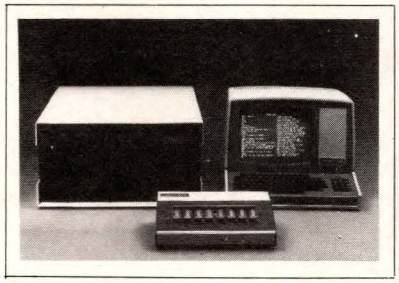
The purpose of the tour will be to show the advan tages of using Golden Max to future heavyweight ci cuit champions.

"The kid's really got a story to tell," noted the men tor.

Kid Kemet elaborated, "The plain fact of the matte is that anyone who uses Golden Max to its fulles potential, can easily become a winner."

Currently Kid Kemet is scheduled to appear in New York, Boston, Chicago, Los Angeles and San Fran cisco.

Additional cities are likely to be added. Local Kid Kemet representatives have more information.



TEST SYSTEM. Incorporating the TM-8 EPROM test head, monitor software and an Inspector-100 μC controller, the Inspector 100/8 test system programs, verifies and copies EPROMs. In Ganged mode, it can program eight EPROMs with the same data. In Serial mode, it loads the EPROMs with contiguous serial segments of larger programs. Both modes can handle 16-bit data. The modulator test head works with any existing Inspector-100 or -200 system. The menu-driven monitor software allows you to enter, modify, program and verify an EPROM. It can load standard hexadecimal CP/M-translated programs directly into the system for programming. The CP/M-based system includes a 4-MHz Z80 μP, dual 8-in. floppy drives (512k storage), 32k of RAM and terminal. $10,950. Delivery, 8 wks ARO. **Pragmatic Designs Inc,** 950 Benecia Ave, Sunnyvale, CA 94086. Phone (408) 736-8670. **Circle No 308**

TRANSIENT RECORDER. Sequences of as many as eight independent transient signals can be digitized and stored on each of two channels in Model TR8837. Its internal 16k sample memory divides equally between two channels operated as rapidly as 25M samples/sec and is available for single-channel converting at rates to 50M samples/sec. Analog signal processing in front of the 8-bit A/D converter provides digital signal offset, 25-MHz analog bandwidth and full-scale sensitivities from 250 mV to 16V. Selectable portions of each record contain the parts of the signal waveform that occurred before the trigger. Full programmability and computer I/O are supplemented by a companion control and display unit that allows complete manual control of as many as seven transient recorders (14 channels). Transient recorder, $5900; control and display unit, $4000. Delivery, 8 wks ARO. **LeCroy Research Systems of California,** 1806 Embarcadero Rd, Palo Alto, CA 94303. Phone (415) 856-1800. TWX 910-373-1791. **Circle No 309**

The LTS-2010 Linear Test System.

The capabilities of a mainframe, the convenience of a benchtop.

Now you can get the accuracy, power and flexibility of a mainframe linear tester with all the advantages of decentralized testing in one compact, cost-effective benchtop.

The LTS-2010 provides an overall measurement accuracy to better than 16-bits for guaranteed 12-bit absolute accuracy measurements. Its handler interface capability for 12-bit D/As and A/Ds also allows accuracy to be maintained at the handler level. And the LTS-2010 even offers NBS traceability (a Certificate of Compliance comes with every system).

With its measurement system and powerful 16-bit CPU, you can write device programs that will test practically any linear device you want—ADCs, DACs, op amps, regulators, comparators, and more—to the manufacturer's own specifications. You can also design your own hardware to test custom circuits on the User Prototype Family Board.

You can program in BASIC or "fill-in-the-blanks," and with a complete file management capability you get the flexibility of fast and easy access to the CPU. The LTS-2010 also offers such "big system" features as interactive debug, datalogging, statistical analysis, yield analysis, IEEE/RS232 interfaces, self-calibration and board diagnostics.

The LTS-2010 is a lot more than another benchtop tester—it's a big performance system without the big system price.

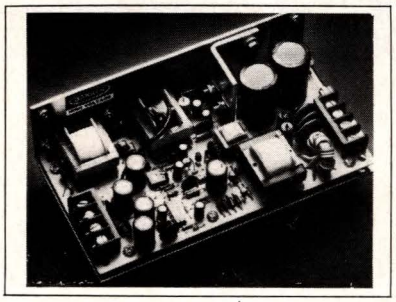
For more information on this powerful benchtop, contact: Joe DiPietro at (617) 273-4780.

ANALOG DEVICES

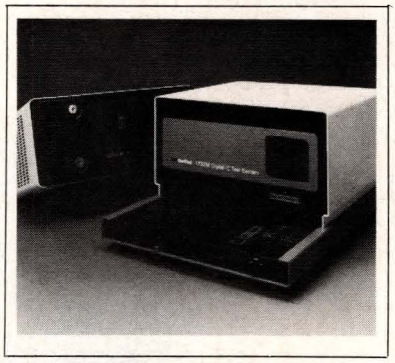
For mainframe performance in a benchtop linear tester, think analog.

Analog Devices, Inc., One Technology Way, Norwood, MA 02062; Headquarters: (617) 329-4700; California: (714) 842-1717, (408) 947-0633; Illinois: (312) 653-5000; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094; (713) 664-6704; Washington: (206) 251-9550; Belgium: 031/37 48 03; Denmark: 02/84 58 00; France: 01/687 34 11; Holland: 016/20 51080; Israel: 052/28995; Italy: 02/68 98 045; Japan: 03/263 6826; Sweden: 08/282740; Switzerland: 022/31 57 60; United Kingdom: 01/941 0466; West Germany: 089/514010.

CIRCLE NO 104



POWER SUPPLIES. The four 50W multiple-output units in the OES-50 Series provide various dc outputs: Model -101, 5V at 8A and ±12V at 1.5A; Model -102, 5V at 8A and ±15V at 1.5A; Model -103, 5V at 6A, ±12V at 1A and −5V at 1A; and Model -104, 5V at 6A, ±15V at 1A and −5V at 1A. The jumper-selected input accommodates 90 to 135V ac or 180 to 270V ac. ±0.2% line regulation and ±1% load regulation on 5V output (±3% on all other outputs) come standard. The 7½×4×2½ in. open-frame units feature soft start, full overcurrent protection, input EMI filter, ±5V overvoltage protection, brownout protection and >70% efficiency (typ). Models OES-50-101 and -102, $63; Models OES-50-103 and -104, $69 (1000). Delivery, 14 to 16 wks ARO. **General Instrument Corp,** 1401 Lomaland Dr, El Paso, TX 79935. Phone (915) 592-5700. **Circle No 310**



IC TESTER. For dc parametric and functional testing, the 16- to 48-pin Model 1732M μC-controlled digital-IC test system handles both wafer-probe and final-package levels, testing all device technologies without multiple test heads or complex adapters. It offers all the features of its 1732 predecessor plus faster multiprocessing, expanded menu programming, increased binning capability, greater failure and result reporting and additional tests, including isolation tests on unused pins. A pattern memory with 4k×4 bits for each driver/sensor pin stores test vectors. The test program controls input voltages, sensor thresholds and sensor load currents, checking them

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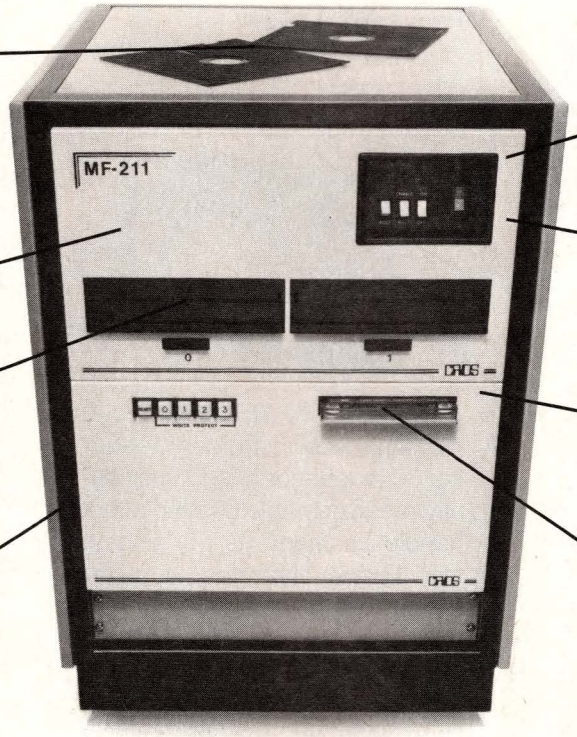

DEC- licensed RT11V4

LSI-11/23 central processor with 128 kbytes of memory

Chassis with eight-quad-slot backplane and power supply

Floppy disk controller, hard disk controller, and quad serial interface

Dual double-density floppy disk drives

20.8 megabyte Winchester hard disk (equivalent to four RL01s)

30-inch-high, office-style enclosure, including cabling

Optional cartridge tape backup

Guess Again.

The price tag on this remarkably potent LSI-11/23-based system is just $16,000. That's well below the combined list price of its components and probably a lot less than you'd expect to pay. And this is only one of a whole series of 11/23 and 11/2 configurations we're offering right now at special complete-system prices.

You don't have to give up security for low cost, either. These are carefully integrated and fully DEC-software-compatible systems, backed up by a free 90-day warranty, our very efficient and economical module exchange service policy, a complete documentation package, and our eight years' experience building DEC-compatible systems.

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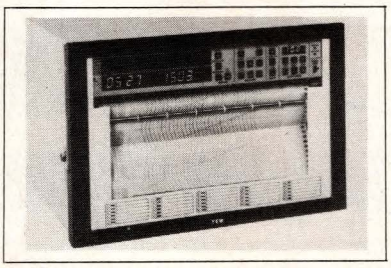
CIRCLE NO 106

Instrumentation & Power Sources

against an internal voltage source and autocalibrated software. From <$50,000 for 16-pin unit. **GenRad Inc,** 170 Tracer Lane, Waltham, MA 02254. Phone (617) 890-4900.

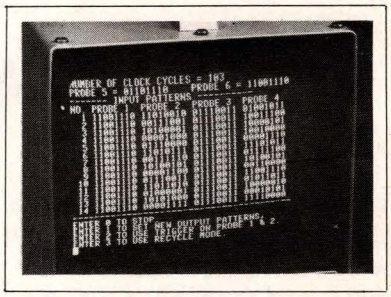
Circle No 311



STRIP-CHART RECORDER. A μP-controlled instrument featuring 30 independent and individually programmable channels that handle as many as 30 ranges, the ER250 features a high-speed, 6-color dot-matrix printer that can produce data for all channels in 8 sec. A front-panel keypad facilitates all programming functions; an LED display indicates data, time and date. Channel-identification numbering to the right of each trace and a digital printout of channel and data are provided in the chart margin. A printout in red of each of two alarm signals per channel comes standard. Accuracy is better than ±0.25% of span, chart speeds are programmable from 1 to 99 mm/hr and input range spans 3 mV to 50V dc. $3540. **Yokogawa Corp of America,** 2 Dart Rd, Shenandoah, GA 30265. Phone (404) 253-7000. **Circle No 312**

DEVELOPMENT SYSTEM. Featuring EPROM/EEPROM-programming capability, Z80-based in-circuit emulation, 48k of RAM and two double-density diskette drives, this development system also includes an editor, macro assembler, debugger/disassembler, interactive assembler, linker, relocator and spooler and an enhanced TRSDOS operating system. Programs for programming and reading PROMs and in-circuit testing of RAM and ROM are also included, and compatible cross assemblers are available for the Z8, F8/3870, 8048, 1802, COP400 and S2000. The EPROM programmer comes with a universal personality module that can program 2716, 2516, 2758, 2508 and 2532 EPROMs as well as 2816 and 48016 EEPROMs. Ports in the target system respond to application programs run on the TRS 80. The software permits interactive checkout of programs in small modules that can later be linked into a large sytem. $2495; EPROM programmer/Z80 emulator, $329. **Orion Instruments,** 172 Otis Ave, Woodside, CA 94062. Phone (415) 851-1172.

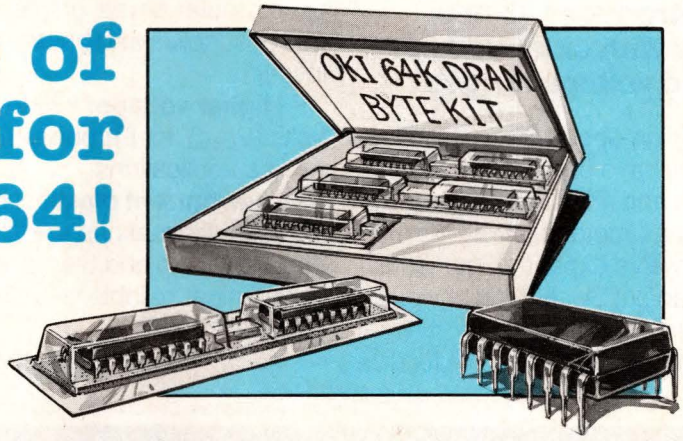
Circle No 313



LOGIC ANALYZER. For analyzing TTL-compatible MOS and TTL circuits, the A2-1 connects to the Apple II microcomputer. 32 input and 16 output data probes link to the card via three ribbon cables. System software displays input signals as binary data on the screen. A trigger pattern can use one to 16 inputs. BASIC, PASCAL and assembler routines help you create programmed interaction with the circuit under test. $400. **Kanel Corp,** 1025 Reynolds Rd, B202, Johnson City, NY 13790. Phone (607) 798-9818. **Circle No 314**

For Easy Prequalification of OKI 64K Plastic DRAMS:

a Byte of Memory for Only $64!



8 x 64K = $64. A $64 check to OKI Semiconductor delivers eight full-functioning plastic 200ns 64K Dynamic RAMs, with data sheet **plus** a summary of "Environmental Testing Data". Eight MSM 3764-20RS chips, packaged in a special money-saving Evaluation Kit — a very cost-effective way to check out a byte of DRAM on your boards. OKI answers the $64 question of where to get VLSI memories **in plastic** for automated insertion equipment ... today! OKI volume production assures the volume quantities that OEMs need — to realize the 20-25% cost-savings available through robotized handling of high-density memory PC boards, in both production and testing.

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Now shipping at 600,000 pieces per month, with quantity capabilities rapidly expanding: OKI MSM 3764 DRAMS. Alpha-particle protected 65,536 bits of NMOS dynamic memory, fully environment tested — ready to go. With reliable volume availability secured by new large-scale OKI manufacturing facilities.

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Please send ___ set(s) of the MSM3764 Byte Kit containing eight production-ready parts and full technical data. Offer limited to 6 kits per customer. Price per kit is $64 plus $5.00 for handling and delivery ($69/kit total, sales tax included).

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Company_____ Tel (___)_____

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OKI SEMICONDUCTOR

Return coupon order with check to: **OKI Semiconductor, 1333 Lawrence Expressway, Santa Clara, CA 95051.** All orders promptly shipped UPS. Offer expires April 30, 1982.

CIRCLE NO 108

Now "Old Reliable" doubles your SwitchMax power options.

RCA introduces 13 new devices with extended current and voltage ranges.

RCA high-speed SwitchMax transistors have proven their performance and reliability in power supplies and motor controls.

Now we've expanded our family, so you can put SwitchMax to work in even more applications.

Higher current: 25 amps for disk drives, motor drives, uninterruptable power supplies and battery operated inverters.

Higher voltage: 800 to 1000 volts (V_{CEV}), for European and U.S. off-line applications.

Low-current plastic: Now, for low cost applications, we're also offering 1 amp and 5 amp families in economical, reliable versawatt (TO-220) packages.

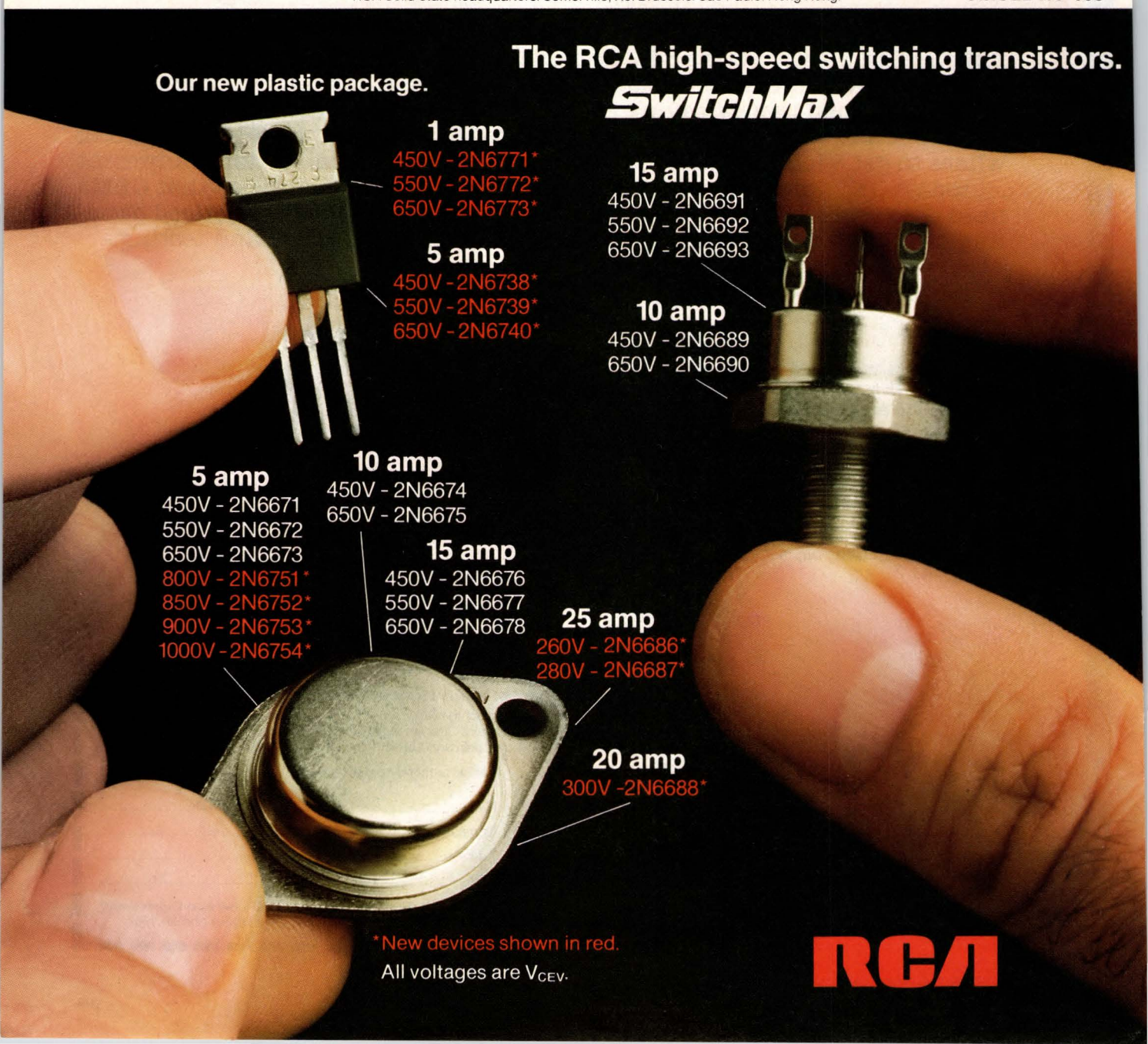
All SwitchMax transistors are 100-percent tested for all switching parameters at maximum recommended operating temperatures and at 25°C. So you won't have to make projections from 25°C ratings only.

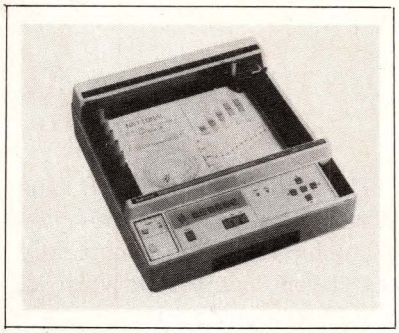
This eliminates the concern and guesswork about thermal runaway failures at worst case temperature operation.

For our new SwitchMax brochure, contact your local RCA Solid State sales office or distributor.

RCA Solid State headquarters: Somerville, NJ. Brussels. Sao Paulo. Hong Kong.

CIRCLE NO 109





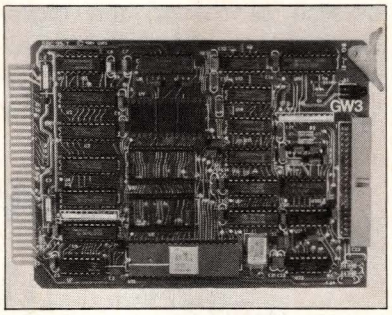
DIGITAL PLOTTER. High-speed, 6-color continuous recording characterizes the VP-6801A intelligent X-Y function plotter. It features 20-cm/sec plotting speed, 0.1-mm resolution, a 23×18-cm plotting area and six felt-pen wells. Intelligent functions allow the plotter to draw horizontal and vertical grids and axes as well as circles of specified radius. The 10-kg, 36×40×16-cm unit has RS-232C, GPIB and standard ASCII 7-bit parallel interfaces. $1900. **Matsushita Communications Industrial Co Ltd (Panasonic),** 2446 Watson, Suite C, Palo Alto, CA 94303. **Circle No 315**

MULTIPLEX ANALYZER. Full A/D and D/A measurement sets separately characterize PCM encoders and decoders in the HP 3779C/D primary multiplex analyzer (PMA). Providing rapid automatic testing of PCM terminals, codecs and line cards for digital switching systems, the unit features a nonvolatile program store and receiver-filter selection. D-D measurement capability permits integrated-digital-network testing. Swept-level peak-codes measurement facilitates testing of codecs. The digital transmitter employs a bit-slice processor; the digital receiver allows full digital processing of input signals. C-version voice-channel A-Law measurements meet CEPT and CCITT recommendations; the D μ-Law version meets Bell and CCITT recommendations. $26,690. Delivery, 8 to 12 wks ARO. **Hewlett-Packard Co,** 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office. **Circle No 316**

STD Bus single-board μC uses TMS 9995 processor

Capable of stand-alone operation, Model SBC 95/1 unites the STD Bus and Texas Instruments's TMS 9995 μP. The 16-bit CPU comes as an OEM product without memory installed; you can, however, add as much as 16k bytes of EPROM and 4k bytes of RAM. Two asynchronous serial communication ports independently configure to either RS-232 or RS-422 standards. RS-422 drivers permit programmable party-line use.

Additional I/O capability includes a parallel 8-bit TTL input port and 5-bit TTL output port. An edge-triggered event-counter line and an RS-422 clocked serial channel and automatic first-Wait-state inhibit/enable are also provided on the I/O connector. A diagnostic LED indicates the active status of the RS-422 driver.



Combining the widely used STD Bus and a 12-MHz μP, *the SBC 95/1 single-board μC carries two serial ports, configurable for RS-232 or RS-422.*

The 16-bit TMS 9995 μP runs at 12 MHz and carries 256 bytes of on-chip RAM. It is completely object-code compatible with all other 9900-family μPs.

Memory sockets employ jumpers to configure for several types of EPROM and RAM. EPROM sockets accommodate TMS 2516/i2716, TMS 2532 or TMS 2564. RAM sockets accept TMS 4016 (Hitachi 6116) DIPs.

$349; with evaluation kit (4k RAM, EPROM debug monitor, hardware hookup and documentation), $624.

GW3, 7239 Belinger Ct, Springfield, VA 22150. Phone (703) 451-2043. **Circle No 262**

BOSCHERT. STAYING POWER IN EUROPE.

BOSCHERT NOW OFFERS THE FIRST U.S. SWITCHING POWER SUPPLY TO WIN VDE 0730 CERTIFICATION.

Regulations of the Verband Deutscher Elektronika (VDE) set tough new operating standards for electronic equipment sold in West Germany and most of the rest of Europe. Now Boschert can help you gain VDE approval for your OEM systems in European markets, with the first 200-watt switching power supply to comply fully with VDE 0730 safety specifications and meet VDE 0871 noise requirements.

We're introducing the XL 200-3501—good news for any manufacturer of microcomputer-based systems. This super-efficient switching power supply delivers up to 200 watts of power in a compact, lightweight, field-proven design. Its two jumper-selectable input ranges (95-130V and 190-265V AC), four outputs and cost-effective design make it ideal for word processors, intelligent displays, and the full range of small business computers.

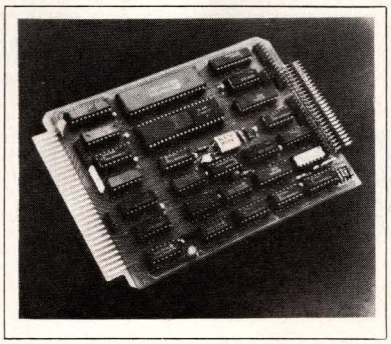
Best of all, our XL 200-3501 is here today!

So remember, if you're marketing systems in Europe today, two things are certain: VDE 0730 is here to stay—and so is Boschert, first with total support for all your power supply needs. From 25 to 1500 watts, from prototype to full production, Boschert leads the way.

For more information on the XL 200-3501 or any of our open frame switchers or submodules, write Boschert Inc., 384 Santa Trinita Ave., Sunnyvale, CA 94086. Or call (408) 732-2440.

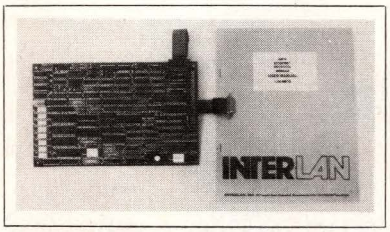
Boschert
SWITCHING POWER

CIRCLE NO 112

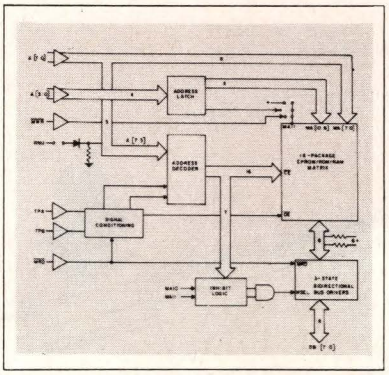


DISK CONTROLLER. For mixing different floppy-disk-drive types, the ST4315 controller handles any combination of a maximum of four soft-sectored, single- or double-density, single- or double-sided, 5¼ or 8-in. drives. It also communicates with hard-disk controllers. You can select drive density and size with an optional software package. Other options include programmed I/O or DMA, single- or multiple-port hard-disk interface and 4- or 6-MHz clock. Incorporating a Z80 PIO circuit, the controller supports Mode 2 interrupt-structured software. $345. **Applied Micro Technology,** Box 3042, Tucson, AZ 85702. Phone (602) 622-8605. TWX 910-952-1164.

Circle No 263



ETHERNET DEVICES. Incorporating the full Ethernet protocol on a plug-in module, the μP-controlled Model NM10 Ethernet Protocol Module implements all necessary network-protocol operations and interfaces directly to widely used 8- and 16-bit-μP families. Providing a ROM-based diagnostic program that verifies the integrity of the module hardware upon power-up or at a software command, it collects network statistics that can be read by user software. N1010 and N12010 Ethernet Communications Controllers, respectively, interface DEC Unibus and LSI-11 Q-bus systems to Ethernet networks. Providing full DMA capability and on-board buffer memory, they permit chaining of noncontiguous memory buffers in user memory to create one packet and can operate at the full Ethernet data rate with minimum CPU overhead. NM10 module, $1725; NI1010, $2940; NI2010, $2625 (25). **Interlan Inc,** 160 Turnpike Rd, Chelmsford, MA 01824. Phone (617) 256-5888. TLX 951909. **Circle No 264**



MEMORY BOARD. CDP18S626 universal memory board accommodates 32k or 64k bytes of ROM, RAM and EPROM in its 16 24-pin sockets. It furnishes on-board address latches and decoders along with buffered address and data lines that minimize loading of the Microboard bus interface. Capable of inhibiting 1k- 2k- or 4k-byte segments of contiguous memory in selected banks, the board incorporates all the Cosmac Microboard system's features, including 5V operation and expandability via the Microboard Universal Backplane. $225. **RCA Solid State Div,** Box 3200, Somerville, NJ 08876. Phone (800) 526-3862. **Circle No 265**

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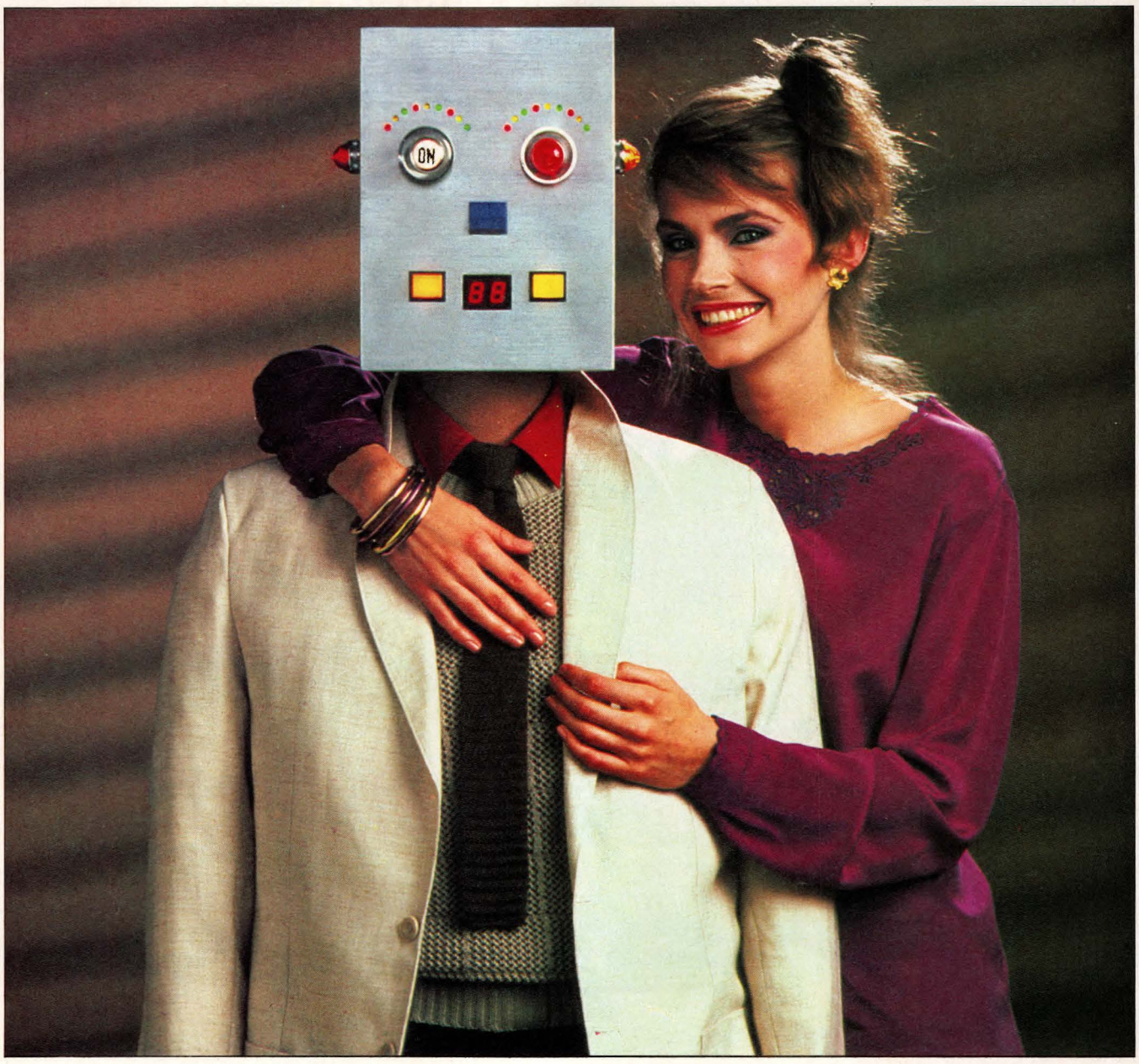
CIRCLE NO 115

THE DESIGNER LOOK.



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Other suppliers may settle for sample testing. That's like leaving reliability to chance. You don't take chances with your designs, and we never will with our illuminated switches.

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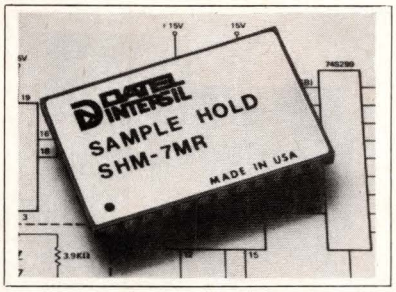
And remember, our product line isn't limited to just illuminated switches. In fact, Dialight is the only supplier who can outfit your entire product with handsomely matched indicator lights, rockers & toggles, LEDs and readouts.

DESIGN IN DIALIGHT

CIRCLE NO 116

Computer-System Subassemblies



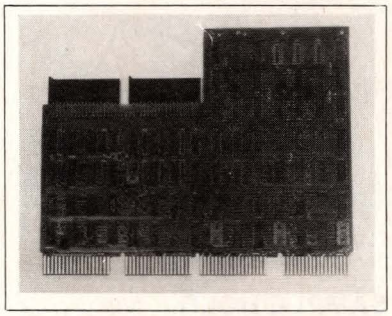
SAMPLE/HOLD. Very-high-speed sampling applications such as video data conversion can employ the SHM-7. The 24-pin ceramic-packaged unit acquires a 2V input change to 0.1% in 40 nsec. 20-nsec settling time permits sampling rates to 17 MHz. The unit has an aperture-uncertainty time of 10 psec max and a Sample-mode bandwidth of 40 MHz. Dual outputs, each with ±5V output voltage at 30 mA and output impedance of 13Ω, facilitate 2-stage conversion. Fixed gain specs at 0.995. 0 to 70°C version, $129; −125 to +85°C model; $159. Delivery, stock to 8 wks ARO. **Datel-Intersil,** 11 Cabot Blvd, Mansfield, MA 02048. Phone (617) 339-9341. TWX 710-346-1953.

Circle No 266

DISK CONTROLLER. I/O mapped as an 8-bit port, D100 disk controller supports a variety of 5¼- or 8-in. Winchester and floppy disks. The S-100 board provides Shugart-compatible interfaces and operates with IBM-formatted diskettes. It employs an 8X300 microcontroller and furnishes a sector buffer, a data separator and a diagnostic LED. The card also provides CRC logic for error checking of floppy disks and error correction of hard disks. The unit responds to the NEC-765 command format, and CP/M BIOS is available. $745 (100). **Piiceon Inc,** 2350 Bering Dr, San Jose, CA 95131. Phone (408) 946-8030.

Circle No 267

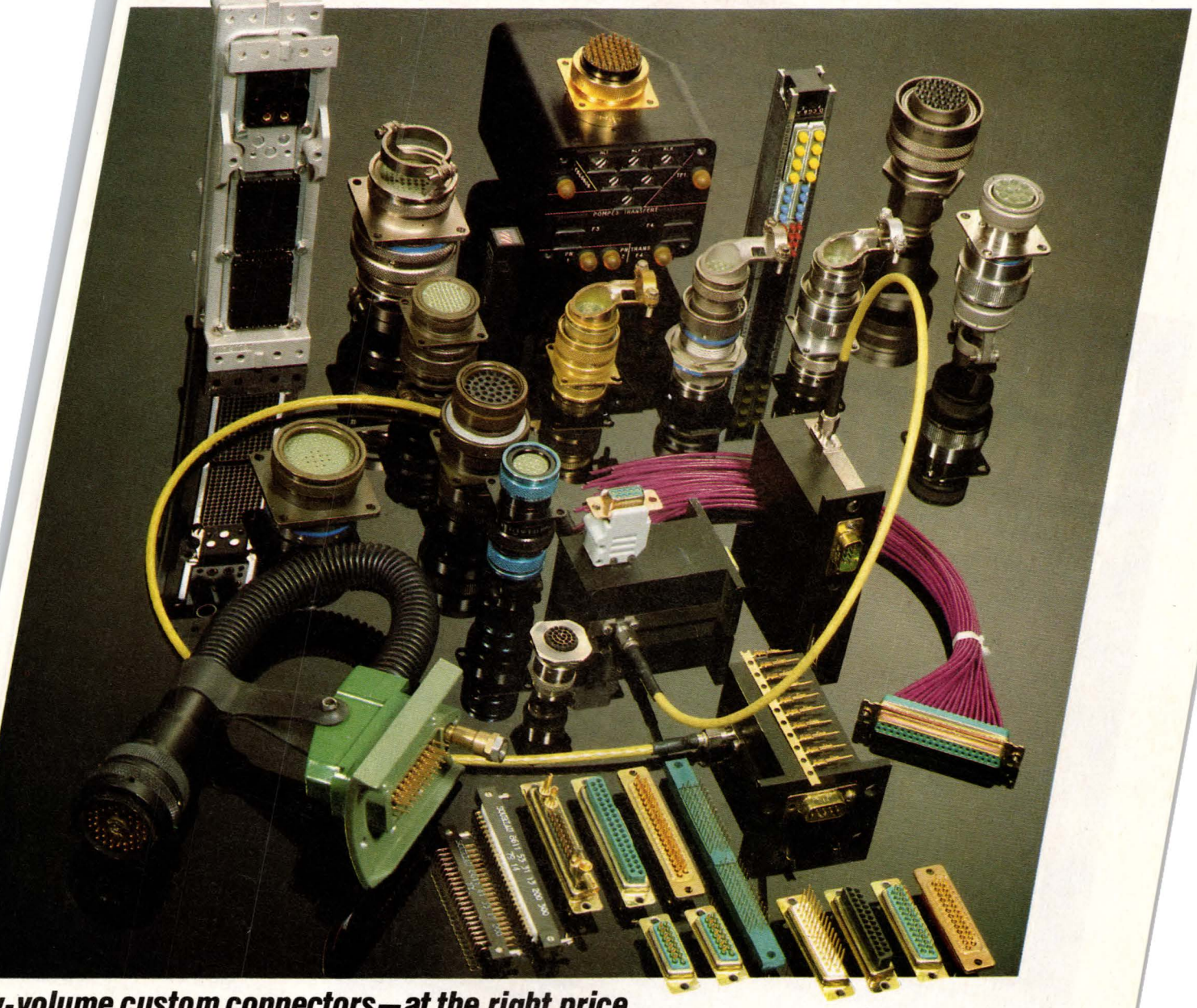
Computer-System Subassemblies



I/O MAPPER. Providing LSI- and PDP-11/23 systems with certain Unibus capabilities, the Unimap converter uses I/O mapping to implement full Q-bus 22-bit addressing. Using it, Unibus DMA devices can access 4M bytes of Q-bus main memory. Memory options include Unibus dual-port or bus-window operations. A line-time clock and bus converter are also furnished on the extender board. $1500. **Able Computer,** 1751 Langley Ave, Irvine, CA 92714. Phone (714) 979-7030. TWX 910-595-1729. **Circle No 268**

μC MODULES. Single-board-μC GMS6506, -6526 and -6527 modules furnish 6502, 6809 and Z80 CPUs. For Motorola Exorciser/Micromodule and Rockwell System-65/Aim-65 buses, they provide 4k bytes max of static RAM, 16k bytes of EPROM/ROM and ACIA, GPIB and printer ports. Each module also includes eight I/O lines, two 16-bit timers and two 8-bit shift registers with VUA/VXA and bootstrapping available. Other features include power-on reset; reset; base-address and enable/disable switches; fully buffered data, address and control lines; and overvoltage and reverse-polarity protection. Software, including operating systems for each CPU, is also available. GMS6506 (with 6502 CPU), $489. **General Micro Systems Inc,** 1320 Chaffey Ct, Ontario, CA 91762. Phone (714) 621-7532. **Circle No 269**

SOURIAU INTRODUCES ITS "MADE IN USA" CUSTOM CONNECTOR PLAN.



...-volume custom connectors—at the right price.

...ne will build you a ..., low-volume ...tor at a reasonable ...ou just found a ...y that will. Souriau ...connector manu- ...that actually ...s your small- ...pecial-order

We can build you just about any kind of connector you want because we already build just about every kind of connector there is.

If you want state-of-the-art technology, we've got that too. We're Boeing's leading supplier of the Arinc A600—a 600-contact connector regarded by many as the most advanced connector in the world today.

In short, we've got you covered from every angle. We've got breadth of product line. We've got high technology. We've got prices you can afford. And now we've got the capability to design and manufacture your order right here in California.

So call our Marketing Department today for a fast quotation. Better yet, send us your RFQ.

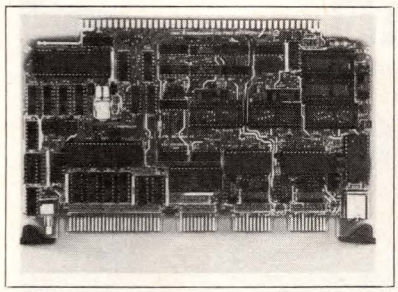
*Souriau employs 3,500 people at plants in Germany, Britain, France, Italy and the United States. Its sales in 1981 exceeded $200 million.

SOURIAU THE "CAN DO" CONNECTOR COMPANY.

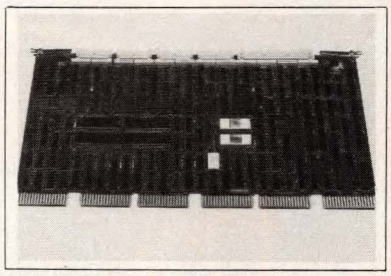
Souriau Inc. 7765 Kester Ave., Van Nuys, CA 91405
(213) 787-5341 TWX: 910-495-2028
(Souriau is pronounced Soo-ree-o)

CIRCLE NO 118

Computer-System Subassemblies



MICROCOMPUTER. Utilizing the MC6809 μP, the 8-bit Micromodule 17 (Model M68MM17) suits high-level-language execution in advanced controller applications. It provides five 28-pin sockets for installation of 26- or 28-pin MOS or bipolar PROMs, masked ROMs for operating firmware or pin-compatible RAMs. Exorciser compatible with a full Exorbus interface, the unit features control logic for RAM refresh, one parallel and two serial I/O ports (a buffered PIA and two ACIAs) with baud rates to 9.6k and RS-232C terminal or modem interface, and an MC6840 triple programmable 16-bit counter/timer. A debug/monitor/linker firmware package, Superbug, is also available. $495. **Motorola Semiconductor Products Inc,** Box 20912, Phoenix, AZ 85036. Phone (602) 244-5714. **Circle No 270**



WINCHESTER/SMD CONTROLLER. Model S33/A1 interfaces any combination of 80M-byte SMD and 80M-byte / 160M - byte Winchester drives (to 320M bytes) to DEC PDP-11 minicomputers. Drives supported include the Control Data 9762 SMD or equivalent and Winchester drives from CDC and Fujitsu. Software compatible with all DEC operating systems that support the RM02 disk system, the Unibus-compatible controller features a 32-bit ECC, permitting correction of one 11-bit error burst and a 16-bit CRC for header error detection. A 4-sector (2k) buffer is included. Self-test capability comes standard, as does dual-port compatibility. $3900. **Dataram Corp,** Princeton Rd, Cranbury, NJ 08512. Phone (609) 799-0071. TWX 510-685-2542.

Circle No 271

adac...

The leader in LSI-11 I/O interfaces now offers software to match.

ADAC offers the widest selection of complete LSI-11 systems and function cards... both analog and digital. And now two new software subroutine libraries support all of ADAC's extensive line of interfaces for LSI-11. ADLIBRT is fully compatible with RT-11 (single user) real-time operating system software. ADLIBRSX enhances RSX-11M (multi-tasking/multi-user) operating system software.

Both ADLIB packages are simple to use, yet powerful, software tools that slash the time needed for program development.

ADLIBRT and ADLIBRSX support:

- mV Level A/D Conversion
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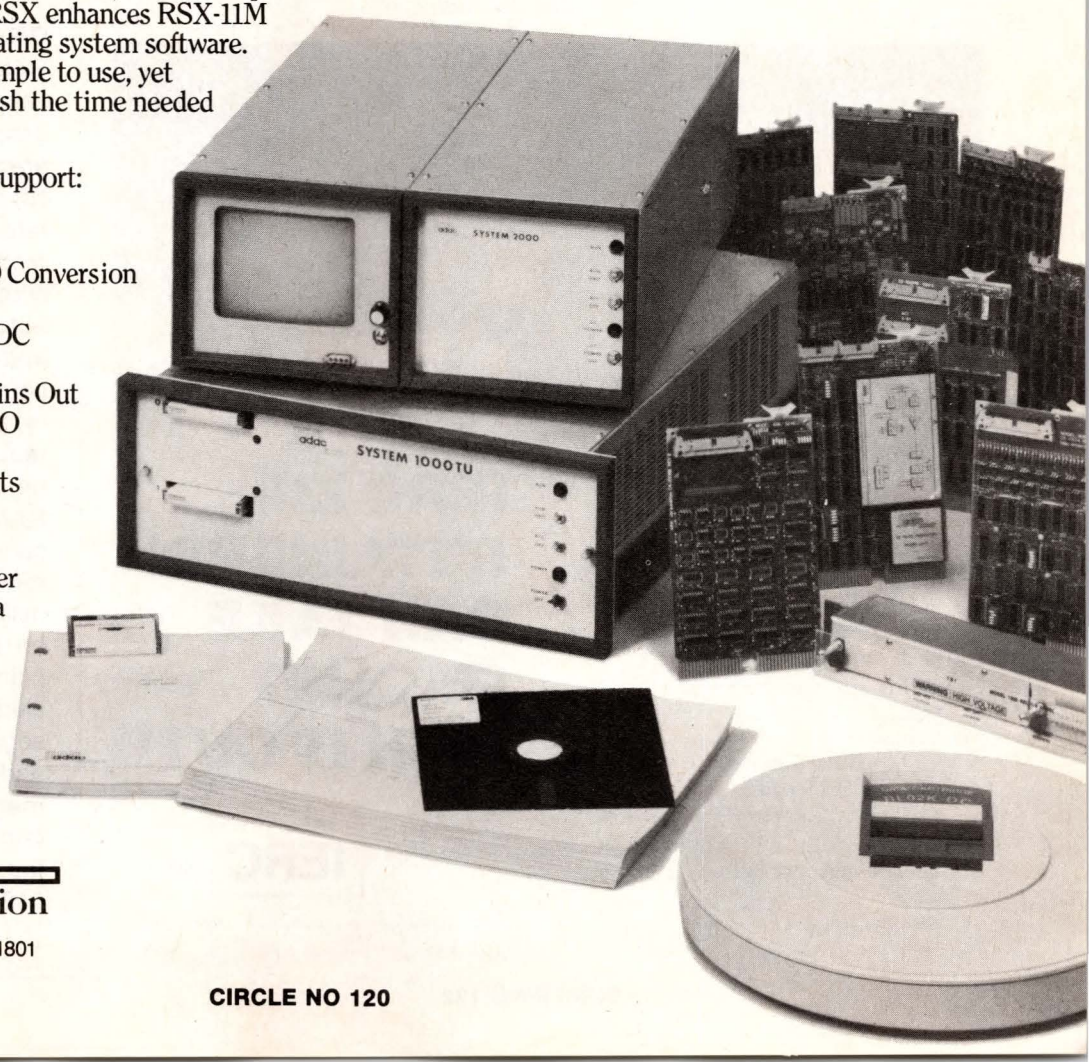
- Discrete, High Voltage, AC/DC Interfaces
- Pulse Counters and Pulse Trains Out
- Optically Isolated Discrete I/O
- Contact Closure Sensing
- Discrete High Current Outputs
- Programmable Clock
- Serial Interfaces

Call, write or circle the number below to obtain our ADLIB data sheet and new catalog describing all of ADAC's LSI-11 compatible interfaces.



adac corporation

70 Tower Office Park • Woburn, MA 01801
(617) 935-6668

CIRCLE NO 120

Computer-System Subassemblies

CLOCK/CALENDAR. QCLK-11 real-time crystal-controlled clock with calendar contains a CMOS clock circuit with addressable registers for year, month, day of month, day of week, hr, min and sec. It can be programmed to generate an interrupt when clock data is available in response to a Clock Hold command. A once-per-sec interrupt, which occurs when the clock counters are stable, can also be programmed. Contained on a dual-height Q-bus-compatible board, the unit can operate in 12- or 24-hr mode. Self-recharging batteries maintain operation for three months without computer power. Introductory price, $195; thereafter, $295. **Quantek Corp,** 244 Shore Dr, Winthrop, MA 02152. Phone (617) 846-4047.

Circle No 272

GRAPHICS CONTROLLERS. Raster-scan video controllers capable of generating vectors, arcs, circles and rectangles at speeds to 800 nsec/pixel, resolutions to 1280×1024 and refresh rates to 60 Hz/pixel, the five models in the HRG Series are compatible with Multibus computers. The units support black-and-white or color graphics and combine a video refresh memory, DMA bus interface and video raster formatting and generation on one board. On-board 64k RAMs relieve the bus and main computer memory of all video-refresh chores. As many as 2 million pixels of screen data can be stored in one to four video planes. Graphics functions include selection of any memory segment for display, panning and scroll or zoom to 16× magnification. From $3150 (small qty). **Ikier Technology Inc,** 16 Sears St, Burlington, MA 01803. Phone (617) 273-1909.

Circle No 273

WE'VE GOT YOU COVERED.

With simultaneous programming of all three power supply variables.

Whatever your programmable power supply needs, chances are there's a fast, accurate, Systron Donner IEEE-488-compatible system to meet them. And because every Systron Donner power supply gives you full three-variable programming (voltage, current, and voltage limit) you'll find them exceptionally easy to use.

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Combine any modules with a programmer to create the multiple-output, programmable system that best meets your needs. An ideal resource in the lab, or in production or system applications, you can change from analog to digital operation—and back—at the flip of a switch.

Local or remote 3-variable programming.

All our power supplies can be programmed locally or remotely through one of two programmer configurations—rack mounted or stand alone. Local programming provides a fast and easy way to step through a program sequence or to test system response to a new set of values. The programmers can command up to 8 power supplies, with individual voltage, current, and limit commands for each power supply output parameter.

Full spectrum selection.

Choose from our PHR series for up to 400 watts output with greater than 60 percent efficiency. Our PH series delivers up to 150 watts, also in half-rack width. Or select from our compact PQ series, with 50 watts of DC power in a quarter-rack package.

Best of all, you don't have to wait 4 to 6 months for delivery. In most cases, we've got the power supply models you need in stock.

Model	Voltage Range (VDC)	Rated Current (AMPS)	Package Size
PQ 10-3	0 to 10	0 to 3	Quarter-rack
PQ 20-2	0 to 20	0 to 2	Quarter-rack
PQ 50-1	0 to 50	0 to 1	Quarter-rack
PQ 100-0.5	0 to 100	0 to 0.5	Quarter-rack
PH 10-10	0 to 10	0 to 10	Half-rack
PH 20-6	0 to 20	0 to 6	Half-rack
PH 50-3	0 to 50	0 to 3	Half-rack
PH 100-1.5	0 to 100	0 to 1.5	Half-rack
PHR 20-12	0 to 20	0 to 12	Half-rack
PHR 50-8	0 to 50	0 to 8	Half-rack
PHR 100-4	0 to 100	0 to 4	Half-rack

Call the power supply hotline: (415) 671-6637.

Whatever your test and measurement needs, call our hotline for full details on the most flexible precision-performance programmable power supplies you can buy. And we've got you covered with the finest in service and application support, too. For more information write us at 2700 Systron Drive, Concord, California 94518 (TWX: 910-481-9749).

Practical technology from

SYSTRON DONNER INSTRUMENT DIVISION

Member THORN EMI Group

CIRCLE NO 123

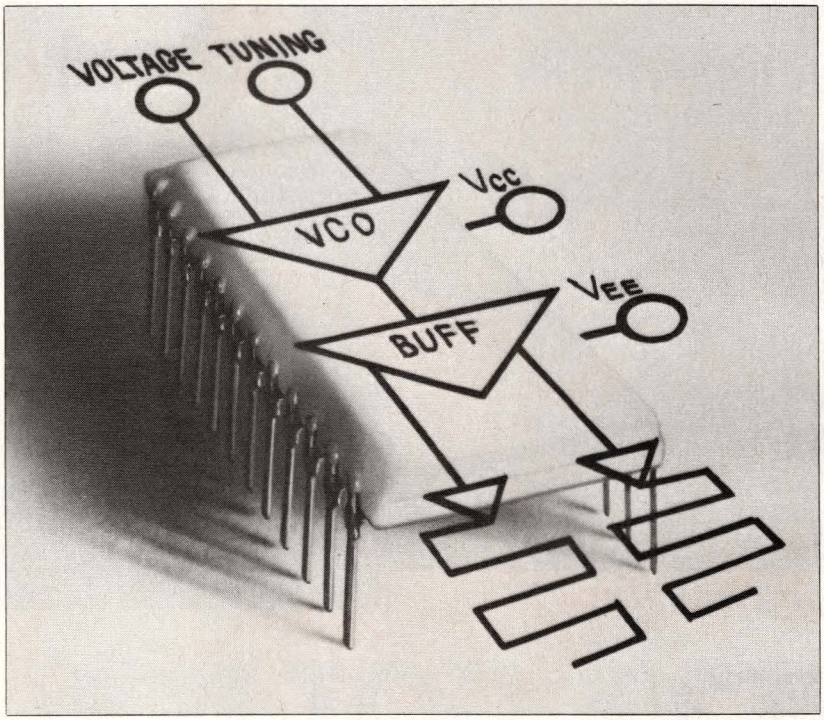
Hybrid voltage-controlled oscillators pack high stability into a 24-pin DIP

KJ1000 Series voltage-controlled oscillators (VCOs) are unlike other DIP-sized variable signal sources. Compared with the MC1648, for example, these devices house the necessary inductor, tuning varactor and miscellaneous resistors and capacitors in a common plug-in package. Nearly optimum performance is the result: The individual components match and track each other over temperature and supply variations. (Typical values for these parameters are −250 ppm/°C and −4 ppm/mV, respectively.)

Four basic units constitute the ECL-compatible KJ1000 family: The KJ1021 covers a 21- to 30-MHz span; the '25 straddles that band with a 25- to 36-MHz output; a 30- to 44-MHz range is supplied by the '30; and the '36 brackets that band by providing a 36- to 53-MHz signal. (You achieve these ranges via a 1 to 20V tuning voltage).

Because these VCOs operate from a +5V (or −5.2V) supply, their tuning range for lower voltages is also a key spec. The KJ1021 typically tunes from 20.6 to 24.4 MHz for a 1 to 5V control-voltage input. The other family members also show a typical 1.19:1 Δf for this ΔV. For truly linear applications, apply a 4 to 12V input; under these conditions, the '21 typically covers a 23.5- to 28-MHz range.

When operating from a −5.2V supply, all units require a maximum supply current of 60 mA (42 mA typ) and outperform other VCO types in terms of off-carrier phase noise. For example, at 1 kHz from the carrier, the KJ devices show a single-sideband (SSB) phase noise of only −65 dBc/Hz; an MC1648's jitter is approximately −21 and an SN74S124's level is still at 0 dBc/Hz.



High stability and ease of use *result from combining this voltage-controlled oscillator's critical components in a 24-pin package. Providing ECL-compatible complementary outputs, KJ1000 Series devices can—depending upon the particular model—tune from 21 to 53 MHz.*

The KJ1000 data sheet is very complete. You'll not only find complete min/max specs, but also 12 applications hints—including component part numbers and resistor/capacitor values. No block diagrams here.

Housed in 24-pin DIPs, Series KJ1000 devices operate over 0 to 70°C and cost $22.80 ($14.35 (100)).

Frequency Sources, Semiconductor Div, 16 Maple Rd, Chelmsford, MA 01824. Phone (617) 256-8101. **Circle No 251**

HIGH RIPPLE SWITCHING INPUT CAPACITORS

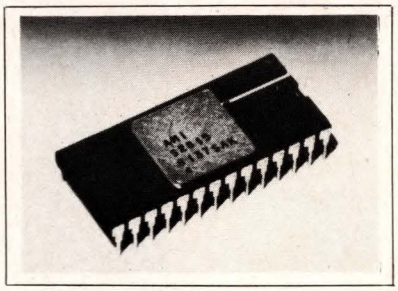
Actual Size

- 200V 820μF
  1.40" (35.0 mm) x 2.00" (50.0 mm)
- 4.0 amps RMS, 120 Hz at 85°C
- 2000 hours (85°C) full rated ripple
- All welded construction, vented
- Date coded, lot traceable
- Models available with voltage up to 250 VDC, capacitance values 100 to 1000μF

UNITED CHEMI-CON INC.

9801 West Higgins Road, Rosemont, Illinois 60018
Phone: 312-696-2000 TWX: 910-253-2964 TELEX: 282406

CIRCLE NO 124



FILTER. For signal-filtering, -measurement, -conversion and -generation functions, the S2815 digital filter/utility peripheral provides parallel Multibus architecture and 300-nsec instruction cycle, permitting wide-bandwidth signal processing. You can process a 16-tap transversal filter with a 60-kHz bandwidth in 7.8 μsec. Indirect-jump instructions can cascade together most of the filter's 21 preprogrammed routines to form complex functions. Preprogrammed routines include two independent 30-tap transversal filters that can combine to form a 60-tap filter. Two additional independent recursive filters provide a total of 16 filter sections. Other routines include signal integration and rectification; μ-Law-to-linear, linear-to-μ-Law and linear-to-dB conversions; block multiplication; and sine-wave and pseudorandom noise generation. $250 (100). **American Microsystems Inc,** 3800 Homestead Rd, Santa Clara, CA 95051. Phone (408) 554-2091. **Circle No 252**

TRANSISTORS. Featuring breakdown voltages of 450 to 650V, Models 2N6774, -6775 and -6776 Switchmax npn power transistors can carry 15A of collector current. Containing an integral commutating diode and base-emitter resistor, the monolithic units eliminate the need for external base-emitter resistors and high-voltage diodes in high-power designs such as half-bridge and bridge converters, variable-frequency motor drives and ultrasonic power generators. At 15A of collector current (25°C), maximum collector-to-emitter voltage (V_{CE}(sat)) specs at 1.5V. Fall time equals 0.5 μsec with a supply voltage of 200V. Collector - to - emitter breakdown voltages (V_{CEO}) measure 300V for the 2N6774, 350V for the 2N6775 and 400V for the 2N6776. 2N6774, $5.90; 2N6775, $6.60; 2N6776, $7.45 (100) in steel hermetic TO-204MA package. **RCA Solid State Div,** Box 3200, Somerville, NJ 08876. Phone (201) 685-7102. **Circle No 253**

Points to ponder when looking for a custom LSI house.

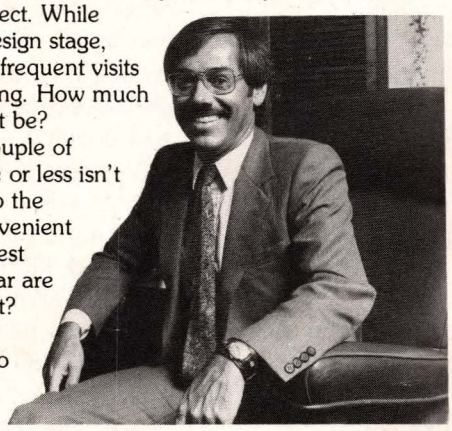
Can you work closely with their engineers?

It's really essential that you be able to. A custom MOS/LSI circuit is *truly* a custom job, and the more active the interplay between you (or your engineers) and the custom house's engineers, the more perfectly it will fit your product.

Our customers tell us that we, at LSI Computer Systems, are *very* easy to work with. We, of course, have no standard of comparison, but those who have, tell us that engineers at big houses are relatively inaccessible. We'd like to be big some day, too, but accessible is one thing we'll always be. It's one of the things that made us as big as we are.

How easy are they to reach?

While on the subject of accessibility, we really must mention the geographical aspect. While your chip is in the design stage, you *will* be paying it frequent visits to help nurture it along. How much of a problem will that be?



In the jet age, a couple of thousand miles more or less isn't all that significant. So the question is, how convenient is it to fly to the nearest airport — and how far are they from that airport?

Well, New York's *airports* are as easy to get to as any in the country — directly, from almost anywhere — and we're maybe half-an-hour away from both Kennedy *and* LaGuardia.

Of course, if you're in the New York area, we're an easy drive over fast highways.

In short, we're accessible in every way.

How fast can they turn around?

Another advantage of being relatively small is that you can get a chip out and into production fast. Again, customers who've had experience with bigger houses tell us we're more flexible, and move faster. We're not going to claim any specific time period for designing a chip, because some take longer than others, but one thing we will say: when we give you a date, you can count on it.

Are they going to try out a glamorous new technique on you?

Being at the forefront of technology is exciting, but if you're counting on a chip for a product you've got a lot of money riding on, it can also be injurious to your health. That's why we stick to the stodgy, safe, tried and true techniques. And after all: even the stodgiest, safest MOS/LSI technology is pretty close to the forefront.

Can they take peaks?

This brings us to a very vital subject: in-house production versus subcontracting.

Naturally, houses that have their own production facilities will give you their side, but here's ours: if anything happens to *their* equipment, where are *you?* If they can't produce they can't deliver, but there's something else, too: no matter how big they are, they have limits, and if you're gearing up for, say, a big Christmas production run, they may have trouble keeping up with you.

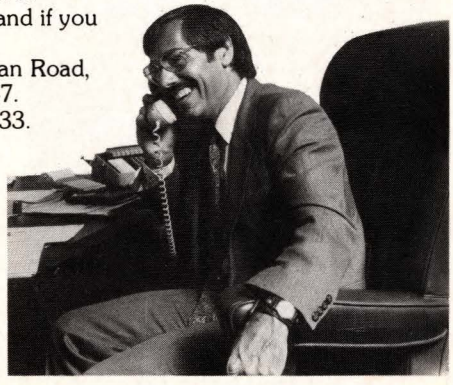
When you subcontract, as we do, if something happens to production house A, you switch to B. And we can keep up with any peak demand you may make, by just adding production houses.

Do they use conservative design rules?

Speaking of going from production house to production house, you can only do that if you use design rules conservative enough to work on everybody's facilities. Right here we have to say that our rules may make your chip a shade bigger, and hence cost a little more, but in terms of count-on-able delivery in any quantity, on time (and also, incidentally, in terms of reliability) we think it's well worth it.

There are other points worth considering, but these will do for a start. The man who can tell you about the others (and expand on these), is Ron Colino, our VP/Marketing.

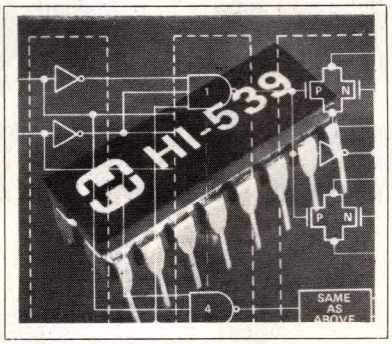
You can reach him at (516) 271-0400, and if you want to write, it's 1235 Walt Whitman Road, Melville, NY 11747. TWX 510-226-7833.



LSI COMPUTER SYSTEMS INC.
Beyond the Microprocessor
Since 1969
Manufacturers of Custom and Standard LSI circuits.

CIRCLE NO 126

ICs & Semiconductors



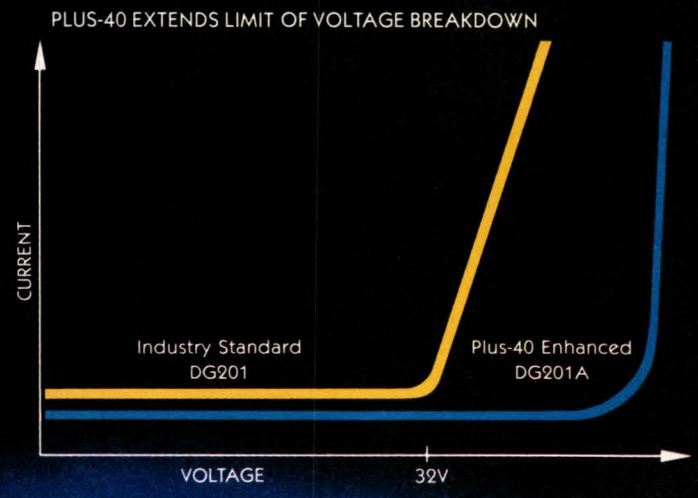
MULTIPLEXER. Billed as the first available monolithic 4-channel, low-level differential-input circuit, HI-539 uses linear silicon-gate CMOS technology. It provides channel-selection inputs and an Enable input that disconnects all channels. Although performance is guaranteed for each channel over a ±10V range, optimal performance occurs with low-level differential signals. The part is available in 16-pin Cerdip or chip versions for commercial and MIL-spec temperature ranges. Model HI-539-6 (chip), $7.42; Model HI-539-2 (−55 to +125°C), $24.74; Model HI-539-5 (0 to 75°C), $12.50; Model HI-539-8 (MIL-STD-883 Class B), $29.90 (100). **Harris Semiconductor,** Box 883, Melbourne, FL 32901. Phone (305) 724-7800. **Circle No 254**

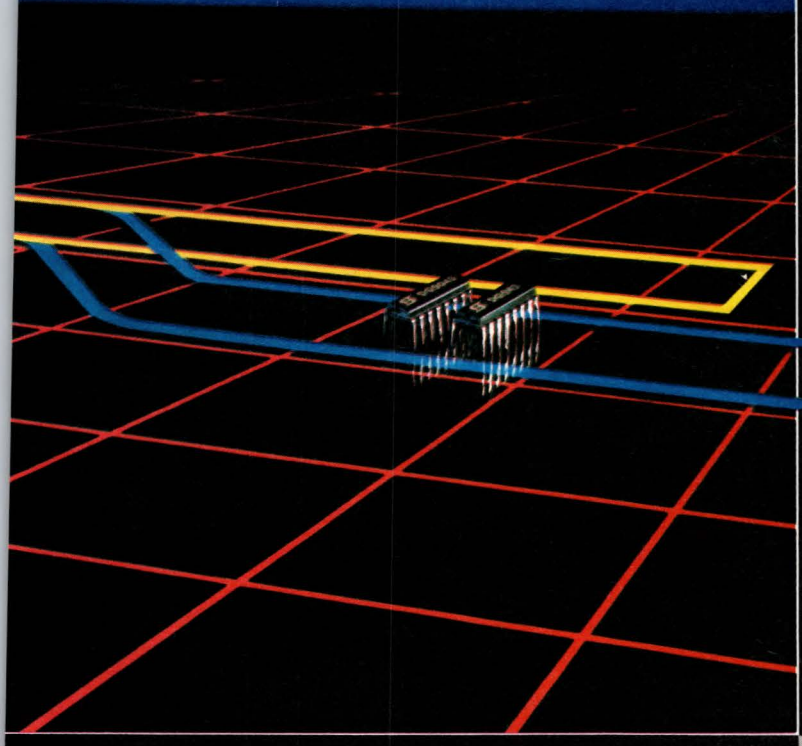
SCHOTTKY ICs. Extending the manufacturer's low-power Schottky (LS) and advanced low-power Schottky (ALS) lines, these 12 ICs include transceivers, counters and gate inverters. Eight of the devices use ALS technology, achieving higher speed and lower power than LS devices. Model 74ALS245 20-pin ALS bus transceiver provides low/high and high/low propagation delays of 9 nsec max. The device's maximum power dissipation equals 315 mW. Model 74ALS568/569 synchronous 4-bit up/down counters furnish a 12-nsec low/high propagation delay into a load of 50 pF, two-thirds of the delay time of its LS568/569 counterparts. Models 74ALS245/645 and 74ALS1245/1645 octal bus transceivers, $3.30; Models 74ALS245-1 / 645-1 / 1245-1/ 1645-1 octal bus transceivers, $4.12; Models 74ALS568/569 counters with 3-state outputs, $2.67; Models 74LS18/19 Schmitt-trigger gates/inverters, $0.47; Model 74LS24 Schmitt-trigger gate/inverters, $0.52; Model 74LS169B up/down counter, $1.07 (100). **Texas Instruments Inc,** SC-355, Box 202129, Dallas, TX 75220. Phone local office.

Circle No 255

OPTOCOUPLERS. Comprising GaAs IR sources coupled to high-gain phototransistors, these six devices provide 500% typ current-transfer ratios and ±1000V electrical isolation. Models 4N47, 4N48 and 4N49 come in TO-78 metal cans and can meet JAN, JANTX and JANTXV specs. They can withstand collector-emitter voltages >40V, collector-base voltages of 45V max and continuous collector currents of 50 mA while dissipating 300 mW max at 25°C. The units can operate as photodiodes with ON and OFF currents of 80 μA and 1 nA, respectively, or as phototransistors with ON currents of 0.5 to 2 mA and OFF levels of 4 μA typ. 3N261, 3N262 and 3N263 devices come in TO-72 metal cans and operate only as phototransistors. Model 4N47, $6.25; Model 4N48, $7.50; Model 4N49, $10.63; Model 3N261, $4.50; Model 3N262, $5.87; Model 3N263, $7.25 (100). Delivery, 6 wks ARO. **Texas Instruments Inc,** Box 202129, Dallas, TX 75220. Phone local office.

Circle No 256





The Discovery Company brings you Plus-40 enhanced DG5040 analog switch ICs for a safer ride.

Get on the safe track. And avoid high-voltage breakdown. Go with our new DG5040 Series of Plus-40 enhanced analog switch ICs. Our proprietary new Plus-40 high-voltage CMOS process protects our devices and your circuits from rail-to-rail surges up to 44 volts! This means you get a comforting 33% power supply overshoot margin on ±15 volt power supplies.

All DG5040 analog switch ICs, including the popular 5043 and 5045 models, are pin-compatible with Harris, Intersil and Datel 5040 devices. Compared to these other products, our Plus-40 analog switch ICs offer a lot more at no extra expense. A wider analog signal range (from V+ to V−). Low $r_{DS(on)}$ that reduces voltage errors in your present designs economically. A minimum of switching errors. True TTL compatibility. Wide dynamic range switching at both audio and RF. And lower charge injection for immediate plug-in improvement.

Discover how our sensible switch can let you ride the rails safely up to 44V! For details, simply use the coupon below.

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Siliconix incorporated
The Discovery Company

Part No.	Type
DG5040	SPST
DG5041	SPST (Dual)
DG5042	SPDT
DG5043	SPDT (Dual)
DG5044	DPST
DG5045	DPST (Dual)

The Sensible Switch.

Siliconix incorporated, P.O. Box 4777, Santa Clara, CA 95054

Gentlemen: I want to make the sensible switch to your Plus-40 enhanced DG5040 Series analog switch ICs. Send support literature now.

FREE SAMPLES. Please send me:

☐ DG5043CJ* (dual break-before-make): list price $4.08 ea.@ 100 qty. *Same pin-out

☐ DG243CJ* (dual make-before-break): list price $2.65 ea.@ 100 qty.

Please send details on these other new Siliconix devices:

☐ MOSPOWER® FETs: VN3500/4000 family (350V/400V)

☐ Have an engineer call me.

Name_____

Position_____

Address_____

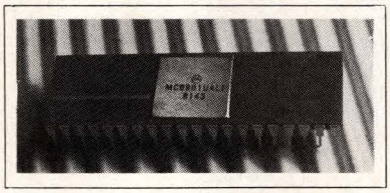
City_____ State_____ Zip_____

Company_____ Phone( )_____

EDN 317 Expiration date 12-31-82

PROMs. 4-bit-wide 8k NiCr-fuse devices, 53XX/63XX units come in commercial (53XX) and military (63XX) temperature ranges and with open-collector and 3-state outputs (Models 5388/6388 and 5389/6389, respectively). Available in 70- (5388/6388-1 and 5389/6389-1) and 55-nsec (5389/6389-2) speed ranges, they feature low input current, pnp inputs and full Schottky clamping. Nichrome fuses store a HIGH and are programmed to the LOW state. Special on-chip circuitry and extra fuses provide programming tests. Models 5388/6388-1 and 5389/6389-1, $10; Models 5389/6389-2, $10.75 (100). **Monolithic Memories Inc,** 1165 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 739-3535. TWX 910-339-9229.

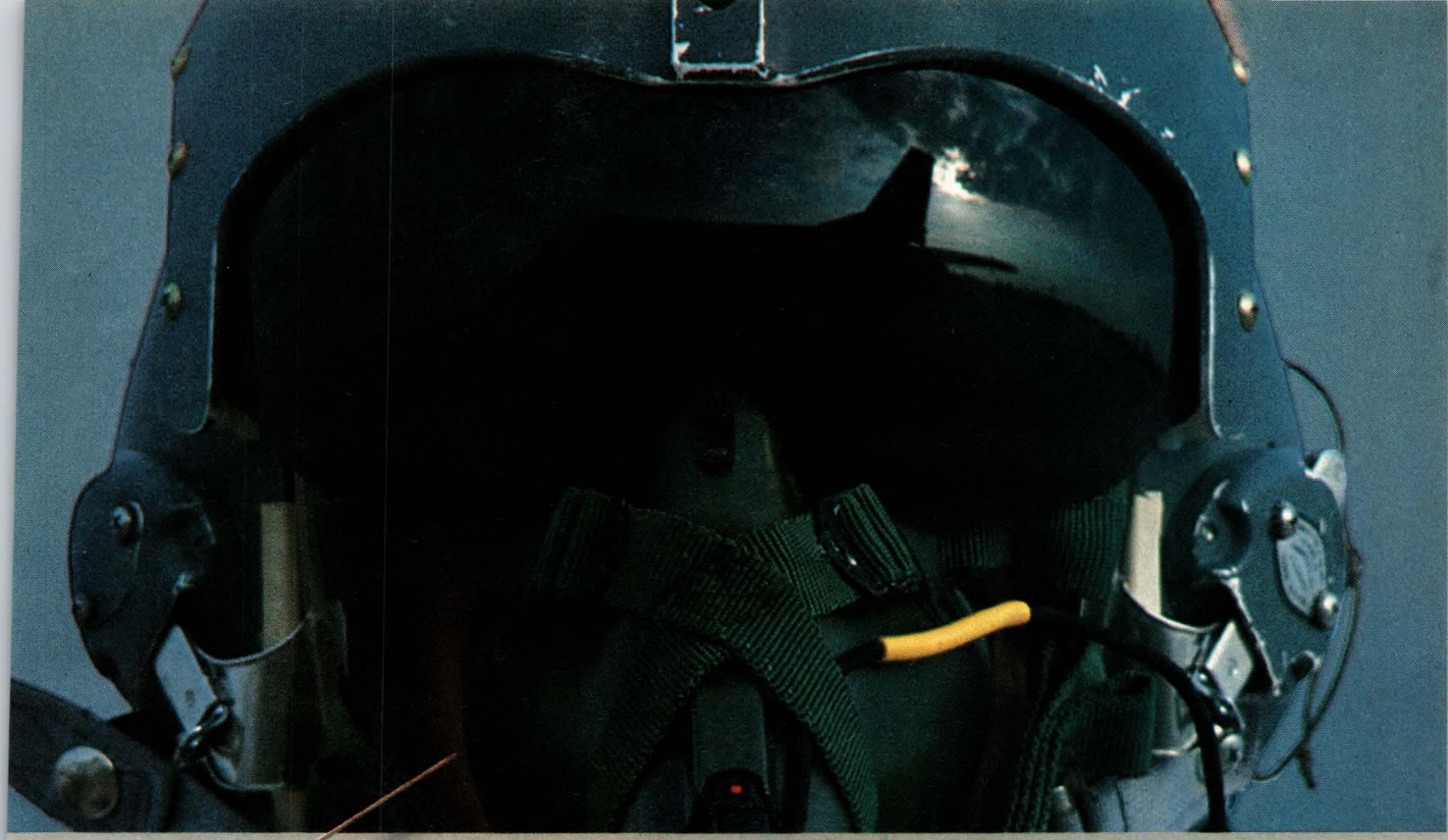
Circle No 257

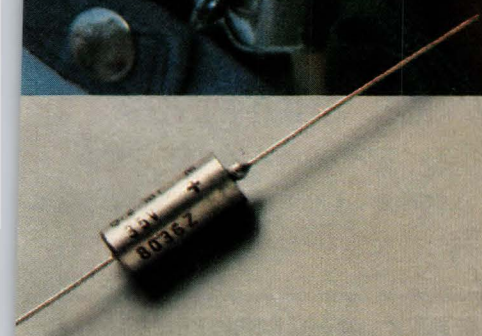


μC. An enhanced version of the MC6801 single-chip microcomputer, Model MC6801U4 maintains pin compatibility with that μC and source/object-code compatibility with the MC6800 μP. It provides 4k of ROM, 196 bytes of RAM and a timer with two input compare registers, three output compare registers and eight baud rates. $14 (1000). **Motorola Inc,** 3501 Ed Bluestein Blvd, Austin, TX 78721. Phone (512) 928-6510. **Circle No 258**

GATE ARRAYS. Containing the equivalent of 200 gates, Series 24 programmable-array-logic (PAL) chips perform combinatorial logic functions. Bipolar, fusable-link devices housed in 24-pin DIPs, they provide AND arrays that drive fixed OR arrays, resulting in sum-of-products transfer functions. Parts in the six-chip series range from the PAL12L10, a 12-input, 10-output AND-OR-INVERT array, to the PAL20C1, a 20-input single-output AND-OR/AND-OR-INVERT unit. All devices feature I/O delays of 40 nsec max and access times of 25 nsec typ. PALASM, a FORTRAN program, converts Boolean-logic equations into fuse patterns for the chips. $8.33 in plastic; $10 (100) in Cerdip for commercial versions. Delivery, 8 wks ARO. **Monolithic Memories Inc,** 1165 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 739-3535. TWX 910-339-9229.

Circle No 259





BREAK THE RIPPLE BARRIER.

Mallory's THF Solid Tantalum Capacitor, with its high ripple current capability at high frequency, is now military approved to MIL-C-39003/9 established reliability style CSR-21 specifications. Its many applications include broad usage in miniature and military type power supplies. The patented anode configuration provides low ESR and impedance at high frequencies. This inherent ability of the THF and CSR-21 device allows a much higher ripple current capability enabling one device to carry the ripple current that would normally require up to 4 type CSR-13 capacitors. It offers superior electrical characteristics at high frequencies over a wide temperature range. And more than any other electrolytic capacitor, the CSR-21 remains stable at temperature extremes. Mallory also provides a broad line of aluminum electrolytic capacitors for applications where high ripple capability is required. Contact your local Mallory Sales Representative or request our Technical Information Bulletin from Mallory Capacitor Company, Mallory Components Group, P. O. Box 372, Indianapolis, IN 46206. Phone (317) 636-5353.

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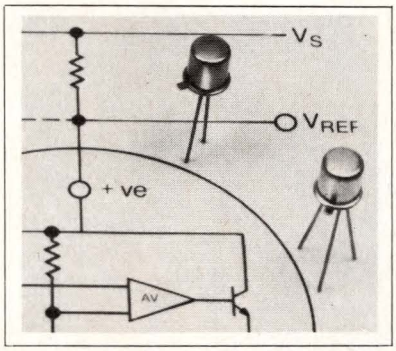
ELECTRICAL/ELECTRONIC GROUP

EMHART

CIRCLE NO 130



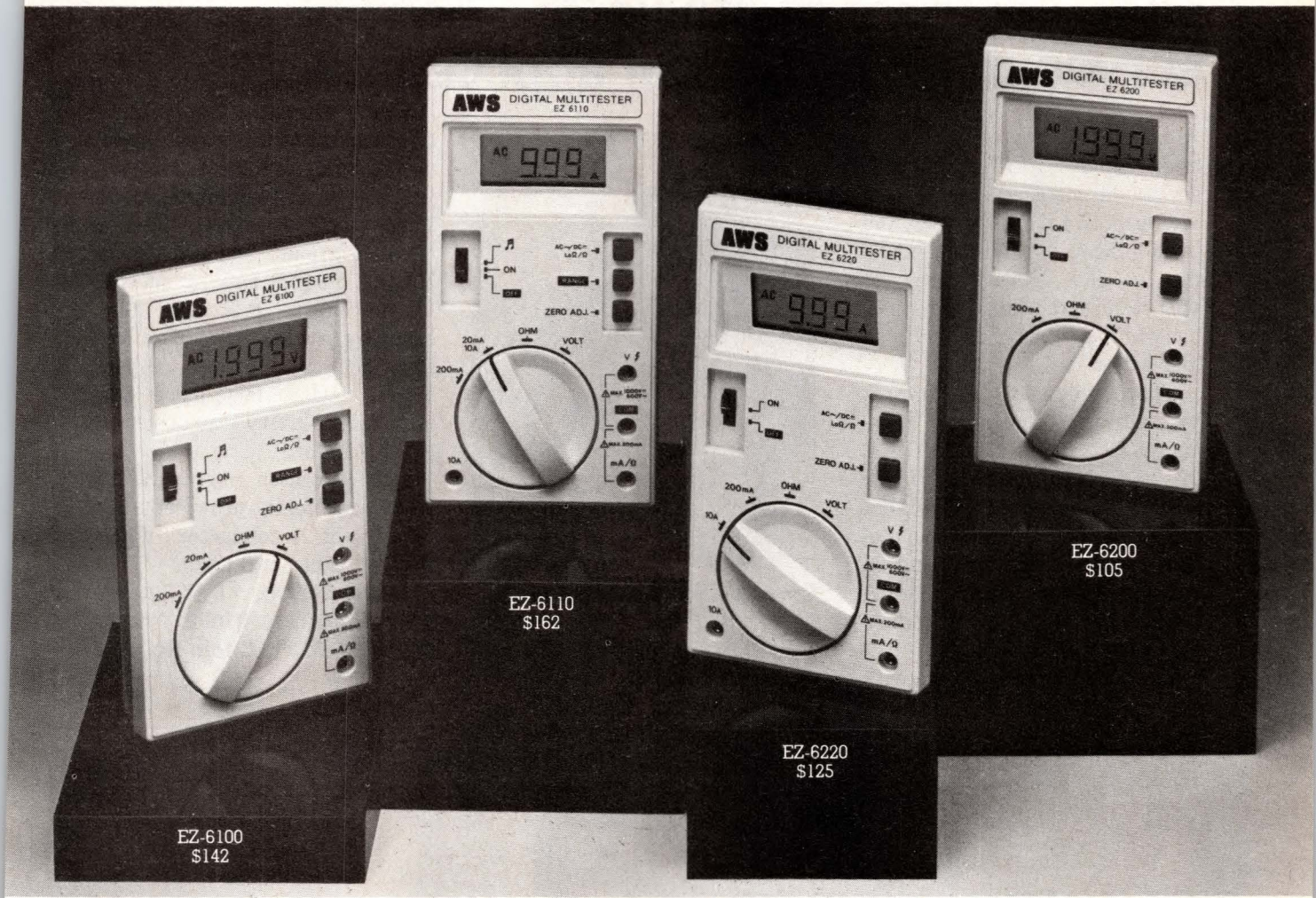
BAND-GAP REFERENCES. These 3-terminal trimmable devices suit use in instrumentation, A/D- and D/A-conversion and power-supply applications. The precision monolithic units come in commercial-, automotive- and military-temperature-range versions, permitting positive or negative trimmable output operation with low power consumption and a reference-current range of 0.15 to 75 mA. Four voltage outputs of 2.5 to 10.0V (±1%) are available, with a trim range of ±5% for fine tuning. The reference sources feature slope resistance as low as 0.2Ω, as well as long-term stability of 10 ppm/1000 hrs. RMS noise equals <10 μV, and ΔV_o is as low as 25 ppm/°C with any combination of TC, line and load within specified limits. Custom voltages are available. $1.45 for 3-terminal sources in TO-18 package. **Ferranti Electric Inc,** Semiconductor Products, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200.

Circle No 260

CLOCK/CALENDAR. A 1-chip CMOS real-time clock/calendar for use with 4- and 8-bit μCs, the MSM 58321 features a multiplexed address/data bus; permits addressing of seconds, minutes, hours, day, date, month and year in 4-bit nibbles; and contains an on-chip provision for leap year. An improved version of its manufacturer's MSM 5832 clock/calendar circuit, it has a busy-out feature, providing a faster loading and setting function compared with the hold-count approach of its predecessor. Furnishing on-chip oscillator circuitry for use with a 32.768-kHz crystal, the unit draws 100 μA typ operating from a 5V supply. $5.65 (100) in plastic DIP. **Oki Semiconductor Inc,** 1333 Lawrence Expressway, Suite 401, Santa Clara, CA 95051. Phone (408) 984-4842.

Circle No 261

When it comes to choosing the right DMM, you really only have four choices...



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- Automatic indication of units and signs
- Low battery warning sign
- Zero adjust feather-touch button
- Economically powered with two "AA" 1.5V batteries
- Safety fused
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RANGES

EZ-6100 & 6110		EZ-6200 & 6220	
DCV 0-1000	5-Autoranges	DCV 0-1000	5-Autoranges
ACV 0-600	4-Autoranges	ACV 0-600	4-Autoranges
AC/DCA 0-10	1-Range (EZ-6110)	AC/DCA 0-10	1-Range (EZ-6220)
AC/DCMA 0-200	2-Ranges	AC/DCMA 0-200	1-Range
Ω 0-2000KΩ	5-Autoranges	Ω 0-2000KΩ	5-Autoranges
Low Power Ω: 0-2000KΩ	4-Autoranges	Low Power Ω: 0-2000KΩ	4-Autoranges
Continuity Buzzer			

For more information on the Easy-Meter™ Series or any of the other fine AWS test instruments call your local A.W. Sperry distributor today or contact A.W. Sperry Instruments Inc., 245 Marcus Blvd., Hauppauge, N.Y. 11788, **800-645-5398 Toll-Free** *(N.Y., Hawaii, Alaska call collect 516-231-7050).*

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CIRCLE NO 133

Fast, compact photoelectric control serves many industrial applications

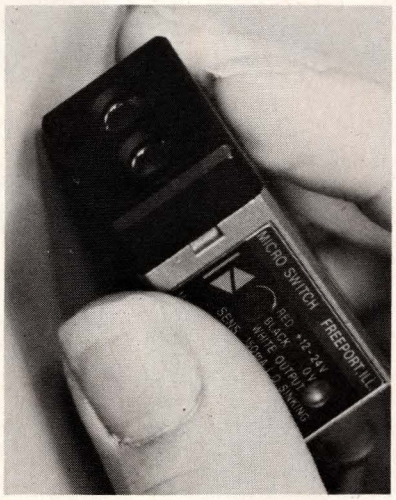
A 2.5-in.-long photoelectric control, Model FE3 is a self-contained infrared device providing both retroreflective- and diffuse-scan capabilities. Pulsing at 100 operations/sec, it withstands traditional industrial contaminants such as grit, oil and water.

Thoroughly tested for humidity, vibration and shock resistance, FE3 meets NEMA 1, 3, 4, 12 and 13 requirements for adverse environments. Its 1-in. mounting center and zinc die-cast case permit mounting in relatively inaccessible areas. A novel visible-alignment indicator facilitates installation.

The control is compatible with programmable controllers or relay logic. Each of its four versions operates from inputs of 12 to 24V dc, draws 40 mA (excluding load) and provides a 150-mA current-sinking output. Units feature 8-ft and 8-in. scanning ranges in retroreflective and diffuse modes, respectively. Noise, false-pulse and reverse-polarity protection come standard.

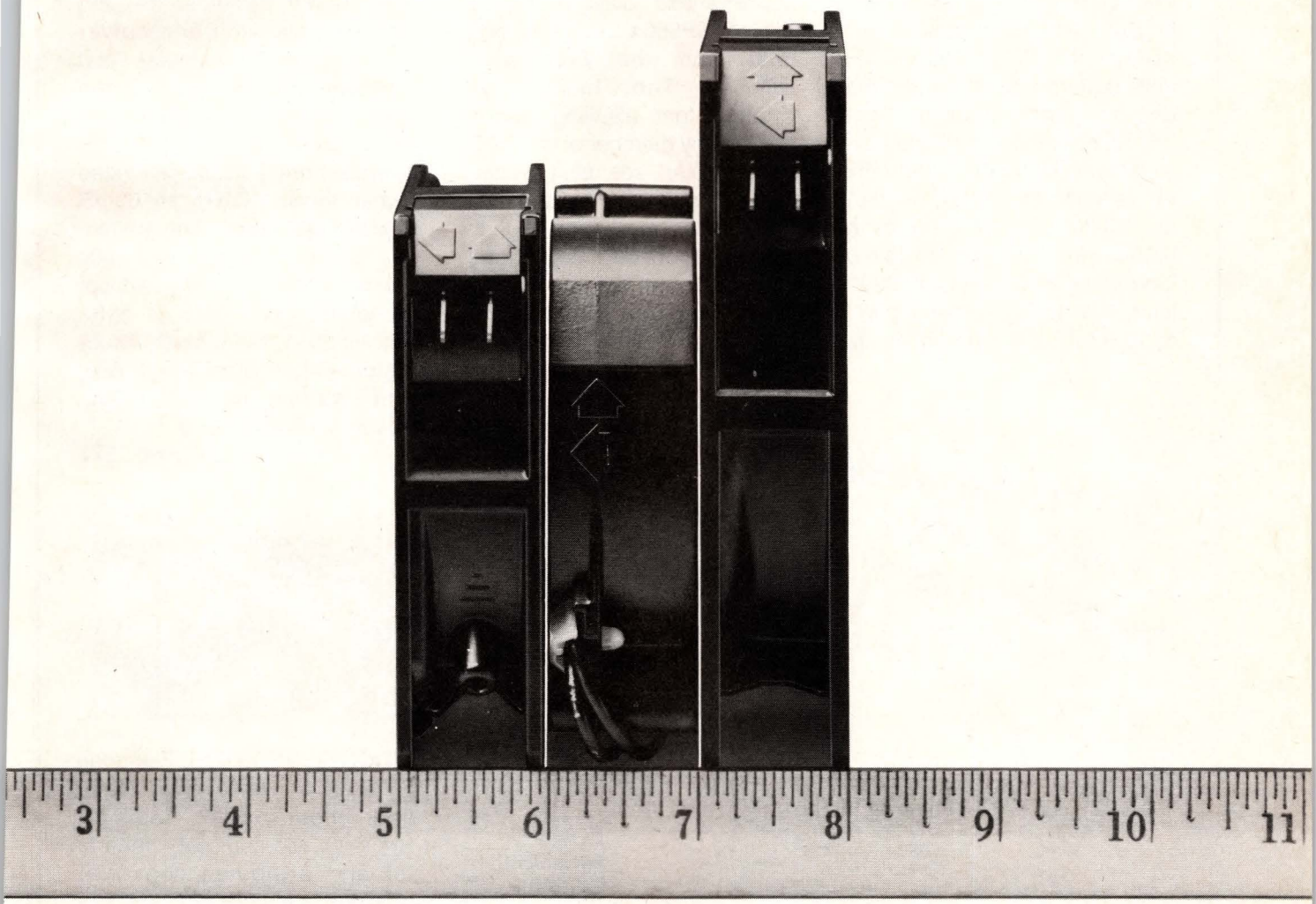
FE3 operates over −25 to +55°C and comes prewired with 6.5 ft of 3-conductor vinyl-covered cable. $60 (250).

***Micro Switch, 11 W Spring St, Freeport, IL 61032. Phone (815) 235-5731.* Circle No 274**



Compatible with programmable-controller or relay logic, *the FE3 photoelectric control meets NEMA 1, 3, 4, 12 and 13 requirements for adverse environments.*

No other company in the world can do this.



If any other company in the world put a 3⅝ inch fan, a 3 inch fan and a 4⅝ inch fan next to each other, they'd need a lot more than three inches.

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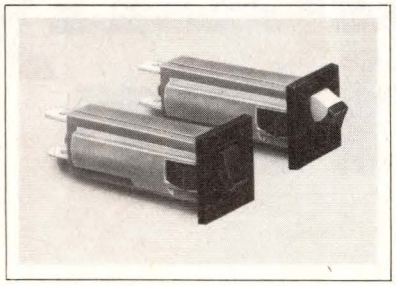
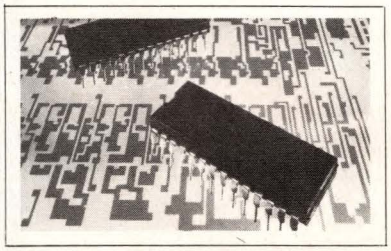


CIRCUIT BREAKERS. Single-pole thermal circuit breakers in the W28 Series snap into standard panel cutouts and employ ¼-in. quick-connect terminals. UL-1077 recognized, the units feature a Reset button that doesn't permit manual circuit break or reset override and have a dielectric strength >1500V rms for voltages to 32V dc or 250V ac, 50/60 Hz and currents of 0.25 to 15A. Units trip at 135% of load within 1 hr at 25°C. At 200% load, 0.25 to 2A models trip in 2 to 10.5 sec; 3 to 15A models trip in 4 to 11 sec. Interrupt capacity equals six times rated current for 0.25 to 2A models and 10 times rated current for 3 to 15A. $1.38 (100). Delivery, 6 to 8 wks ARO. **AMF Potter & Brumfield Div,** 200 Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-1000. **Circle No 275**

LED DISPLAYS. Red LED alphanumeric displays include the HDSP6504, a 4-character unit, and the 8-character HD6508. They have a 16-segment font, allowing them to display any member of the ASCII 64-character set plus special characters. The characters measure 3.81 mm high. Under typical operating conditions, each segment has an average forward current of 0.8 mA. Maximum reverse voltage for each segment at 25°C equals 5V. Operating temperature spans −40 to +85°C. HDSP6508, $23.58 (100). Delivery, 4 to 6 wks ARO. **Texas Instruments Inc,** Box 202129, Dallas, TX 75220. Phone local office. **Circle No 276**

TRANSMISSION SYSTEM. For use in most black-and-white and color CCTV systems, the XV/RV-1100 transmitter/receiver connects to TV cameras and monitors, drawing power from them. Usable in systems with bandwidths <10 MHz, the units operate from 1 to 3V p-p video signal levels (75Ω) at 60-dB signal/noise ratios. The system can employ low-loss fiber-optic cables <6000 ft long without repeaters, equalizers or extra amplification. $495. **Math Associates Inc,** 6 Manhasset Ave, Port Washington, NY 11050. Phone (516) 944-7050.

Circle No 277



VIDEO GENERATOR. Featuring an on-chip character generator and video shift register, SND8002 video-display generator and attributes converter provides four modes of character and graphics operation. On-chip logic includes reverse video, character blank, blink, underline and strikethrough, available in all modes. The internal ROM character set and/or on-chip graphics capabilities can be extended through the external-input mode by inserting symbols from an external RAM, ROM or PROM.

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For more information about the CA3440, contact any RCA Solid State sales office or appointed distributor.

*1000+ quantity, U.S. optional distributor resale. RCA Solid State headquarters: Somerville, NJ. Brussels. Sao Paulo. Hong Kong.

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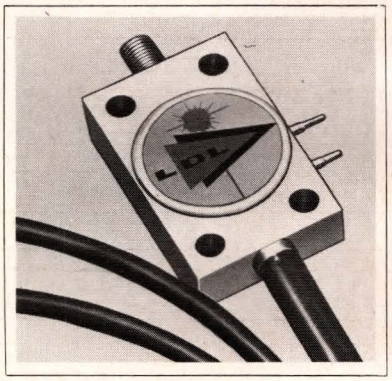
CIRCLE NO 137

RCA

Available in plastic and Cerdip 28-pin packages, the unit operates to 20 MHz, requires a 5V supply and functions to 70°C. SND8002E (plastic), $15.95 (100). **Solid State Scientific Inc,** Montgomeryville, PA 18936. Phone (215) 855-8400. TWX 510-661-7267. **Circle No 278**

INTERFACE PANEL. For Texas Instruments's 990/4/10/12 Series minicomputer, Model 8136-UG322-2 features a universal pattern with capacity for 200 16-pin devices. Its ground plane is on the wire-wrapping side with traces running between pins. Three 50-pin headers are provided on the back of the panel. ±12V and ±15V buses reside in the middle of the component side for easy access. $598.75 (10) for version with gold contacts and tin-plated posts. Delivery, 4 to 6 wks ARO. **Augat Inc,** Interconnection Systems Div, Box 1037, Attleboro, MA 02703. Phone (617) 222-2202. TWX 710-391-0644.

Circle No 279



LASERS. Pigtailed lasers LDT-357 and-349 contain a logitudinal-mode laser coupled to a standard 50-μm-core graded-index fiber. Flatback packages provide rear-facet monitor ports. The LDT-349 also furnishes an isolated internal silicon detector to monitor laser output. Both units provide 4-mW max output power from the optical fiber, 815- to 855-nm output wavelength with a typical spectral width of 0.1 nm, 35-mA threshold current and 50-mA drive current. LDT-357, $1150; LDT-349, $1245. Delivery, stock to 6 wks ARO. **Laser Diode Laboratories,** 1130 Somerset St, New Brunswick, NJ 08901. Phone (201) 249-7000. TWX 710-998-0597.

Circle No 280

SWITCHES. Momentary push-button switches, Series 585 and 587 units mount on pc boards through the front panel. Model 583 has epoxy-sealed terminals

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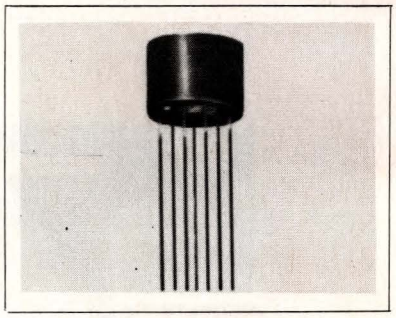
CIRCLE NO 139

bent vertically or horizontally at 90°. Model 587's support brackets mount on pc boards parallel to the front panel. All switches come in spdt or dpdt versions. Contacts can be gold plated for current rating of 0.4 VA at 20V ac/dc max or gold-over-silver for current rating of 1A resistive at 120V ac or 28V dc max. Both models have pretravel plunger action for audible switch response. Model 583, $1.55; Model 587, $1.49 (1000). **Dialight,** 203 Harrison Pl, Brooklyn, NY 11237. Phone (212) 497-7600. **Circle No 281**



DC/DC TRANSFORMERS. Accommodating input voltages of 5, 12, 24 and 48V and power levels to 40W, these ultraminiature devices can be used in self-saturating or linear switching applications. Ambient-temperature range spans −55 to +105°C. The units meet the requirements of MIL-T-27 (TF5S40ZZ) and can be supplied with higher or lower secondary voltages at the same power levels. The secondary can be connected for full-wave or dual-bridge operation. $13.22 to $22.88 (100). **Pico Electronics,** 453 N MacQuesten Parkway, Mt Vernon, NY 10552. Phone (914) 699-5514.

Circle No 282

REFERENCE JUNCTION. Model NC111 is a half-bridge cold-junction temperature-com-

DBM-1650

3.7-4.2 GHz MICROWAVE DOUBLE BALANCED MIXER

GUARANTEED DATA:

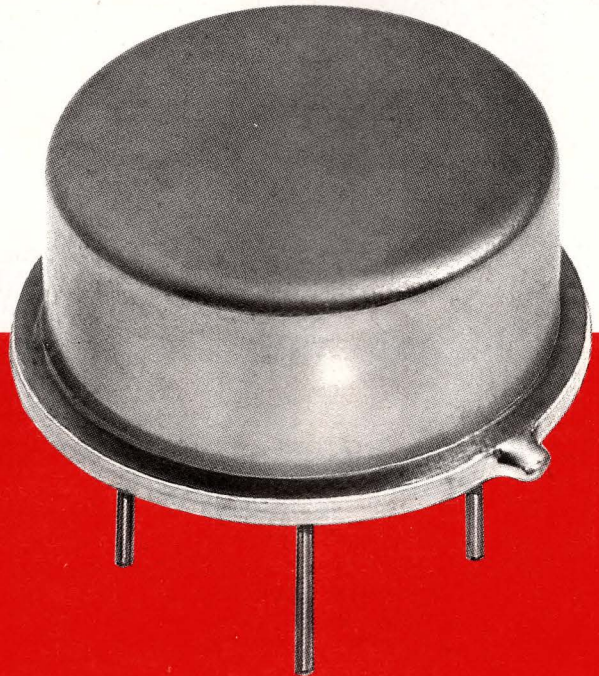
LO Drive: +9 dBm

Conversion Loss: 6.5 dB Max.

Temperature Range: −54 to +100°C

All Isolations: 20 dB Min.

Polarity: Negative



The DBM-1650 is a miniature double balanced mixer especially designed for single conversion satellite communications equipment. This excellent device has a typical conversion loss of 4 dB, typical port to port isolations of 30 dB, and an IF response from DC to 1200 MHz. The rugged transmission line transformers and a quad of precisely matched Schottky diodes are sealed in a TO-8 package for easy printed circuit board mounting.

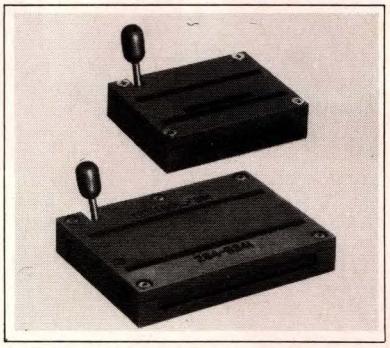
Price: (1-9) $75.00

VARI-L

VARI-L COMPANY, INC., 11101 EAST 51ST AVENUE, DENVER, COLORADO 80239 (303) 371-1560, TWX: 910-931-0590

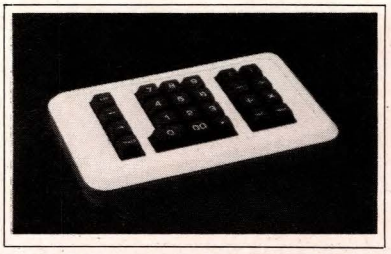
pensating network that can serve as a secondary thermocouple standard. Compensation accuracy specs within ±1.0°C over an ambient-temperature range of −54 to +100°C. Units handle a wide range of standard excitation voltages; the manufacturer stocks full-bridge resistors for all interfaces. Fully encapsulated, the unit comes with leads or for pc-board mounting. $28.50 (10). **Hades Manufacturing Corp,** 151 Verdi St, Farmingdale, NY 11735. Phone (516) 249-4244.

Circle No 283



DIP SOCKETS. Plug-in sockets in the Zip DIP series accommodate 0.05-in.-center devices with 24 leads (0.3 in. row to row), 30 to 44 leads (0.4 in. row to row) or 40 to 64 leads (0.6 in. row to row). Beveled entry holes and staggered contact exits are featured, and a built-in stop prevents handle overstress. Top-mounted screws provide access to damaged or worn parts. Ryton material resists temperature extremes. From $10.19 (OEM qty). **Textool Products/3M,** 1410 W Pioneer Dr, Irving, TX 75061. Phone (214) 259-2676.

Circle No 284



NUMERIC KEYPAD. In addition to double zero and a decimal point, this numeric keypad has a full set of operator keys, complete with parentheses, print, return and four basic arithmetic functions. Its VisiCalc section uses three keys to control cursor movement: Two keys control the directional movement; depressing the third key changes the cursor horizontal movement to vertical. Holding down either directional-movement key initiates the Autorepeat mode. A fourth key deletes entries.

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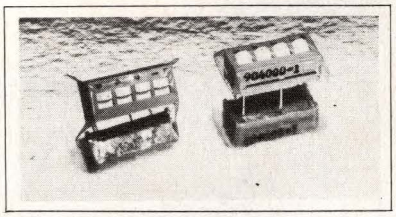
CIRCLE NO 141

Components & Packaging

$149.95 with interface board and cord. **The Keyboard Co,** 7151 Patterson Dr, Garden Grove, CA 92641. Phone (714) 891-5831. **Circle No** 285

INDICATOR / ALARM. The DTA100 indicator/alarm monitors the temperature differential between two points, independently of variations in the temperature at the measuring points. ΔT is displayed continuously on a 3½-digit LED readout. The alarm circuit has an amber warning light and a red overtemperature light and two 2A, 115V ac Form C relays for remote display or control activation. The warning circuit, set at a pre-established level below the overtemperature point, also actuates automatically in the event of an open or short in either of the stainless-steel-enclosed sensors or if power to the relays fails. $495, including probes and calibration circuits. **Hades Manufacturing Corp,** 151 Verdi St, Farmingdale, NY 11735. Phone (516) 249-4244. **Circle No** 286



DIGITAL ATTENUATOR. For telecommunications applications that require that a signal remain stable or constant as it passes through a transmission chain, Series 1700 AttenuSmart digital attenuator features a 600Ω unbalanced T network available in values from 0.1 to 12 dB in increments of 0.1 dB. A sealed housing prevents contamination during assembly operations, according to the manufacturer.

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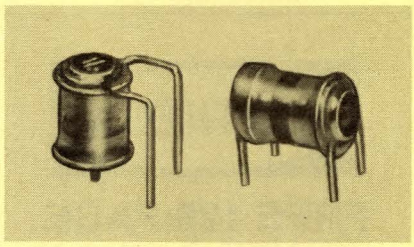

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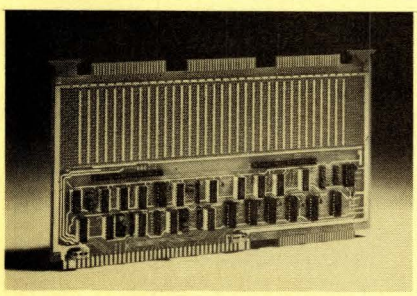

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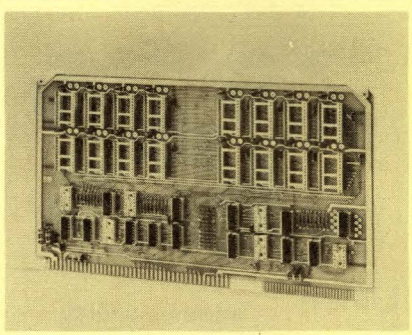

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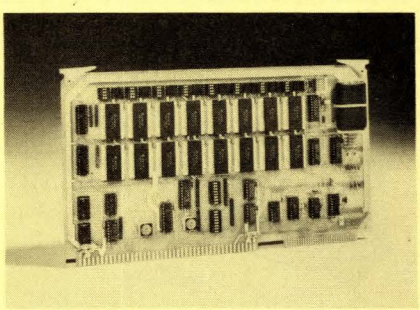

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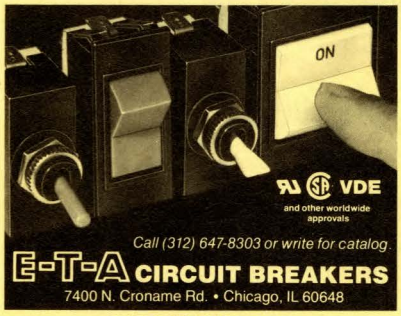

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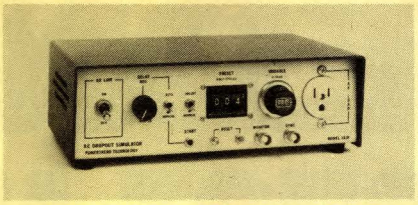

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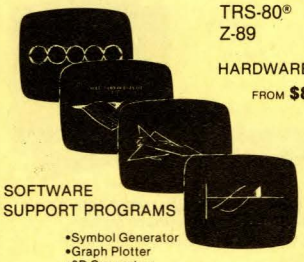

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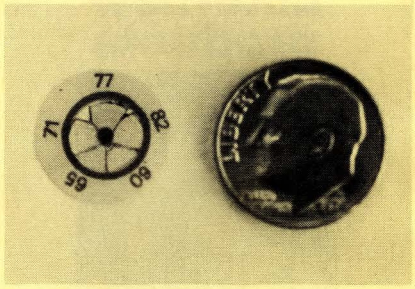

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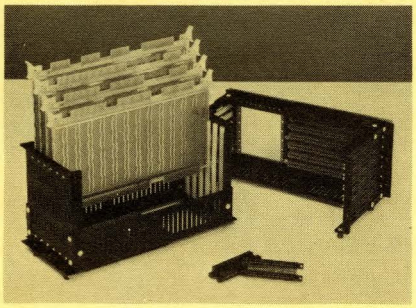

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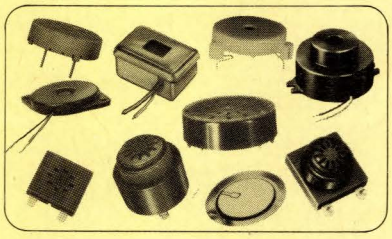

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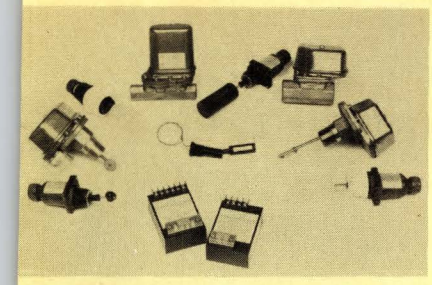

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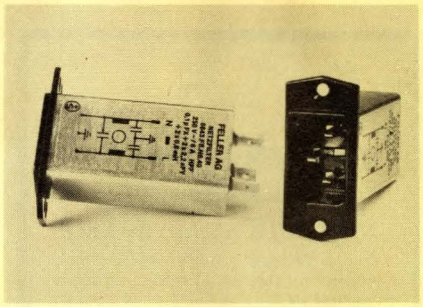

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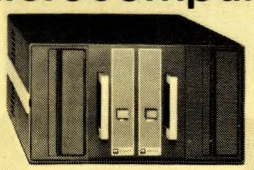

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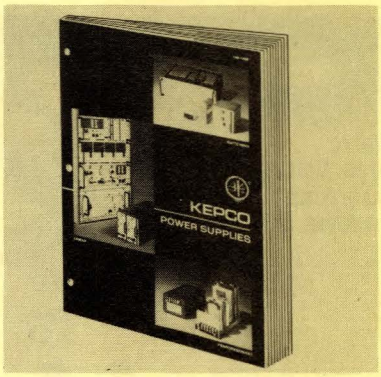

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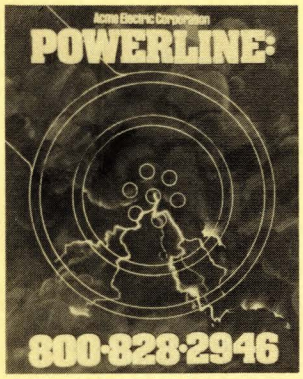

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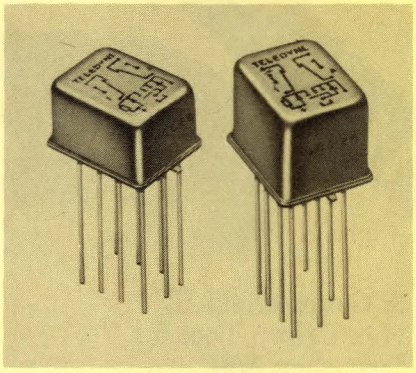

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Teledyne's 116C general purpose, and 136C sensitive relays contain an integral power FET driver to allow relay operation directly from CMOS level signals. Hermetic package also houses Zener protection diode, coil suppression diode and DPDT relay which utilizes Teledyne's proven TO-5/Centigrid® design. Relay features .100 grid lead spacing, dry circuit to one amp contact rating, and excellent RF characteristics up through UHF. Standard coil voltages are 5V, 6V, 9V, 12V, 18V and 26.5V. Complies with MIL-R-28776. **Teledyne Relays,** 12525 Daphne Ave., Hawthorne, Ca. 90250 (213) 777-0077

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RFI SUPPRESSION UNITS APPROVED BY UL. The Rifa interference suppression units PME265 (capacitor) and PMR210 (RC unit) have been judged by UL to comply with the requirements in UL1414 "across-the-line" capacitors. PME265 and PMR210 are also approved in Europe according to IEC65 (safety norm for electronic equipment). These capacitors are specially designed for across the line and line bypass RFI Suppression. **WORLD PRODUCTS, INC.,** P.O. Box 517, Sonoma, CA 95476 (707) 996-5201.

RIFA'S PME265/PMR210 SUPP. UNITS

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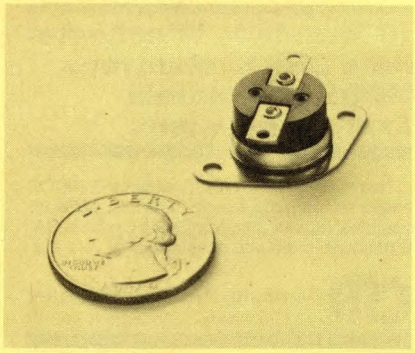

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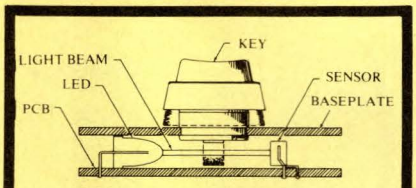

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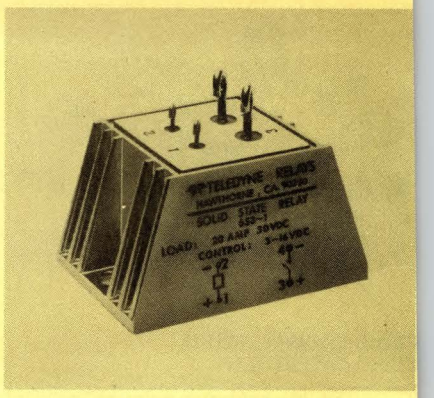

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Teledyne's 652 AC relay features load rating of 25A at 250VRMS over frequencies of 45-440Hz. Synchronous "zero voltage" turn-on and zero current turn-off result in significantly lower EMI levels compared with mechanical relays. Highly immune to transients. Optical isolation is 1500VRMS. Control range is 3.8 to 32VDC @10mA. Logic compatible. Case is 1.57 in. x 2.41 in. x 1.30 in. Meets MIL-R-28750/10 and MIL-STD-704B. Model 653 is the DC version. **Teledyne Relays,** 12525 Daphne Ave., Hawthorne, CA 90250 (213) 777-0077

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The **AN2577** is a high resolution, high performance 4¾ digit (±39999 count) bipolar digital panel instrument. It provides a choice of either of two full scale ranges: ±3.9999 Volts (100μV/count) or ±399.99 millivolts (10μV/count). Features such as a floating, guarded, gigaohm differential input, microvolt sensitivity, and programmable TRI-STATE BCD outputs make this instrument a low-cost high quality performer for precision data acquisition, distribution, and control systems.

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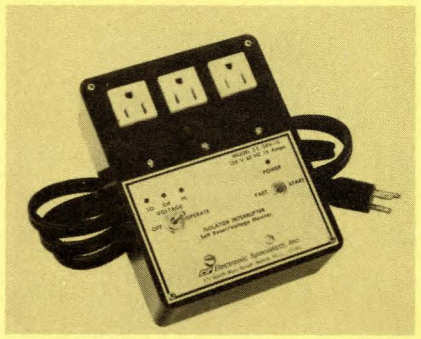

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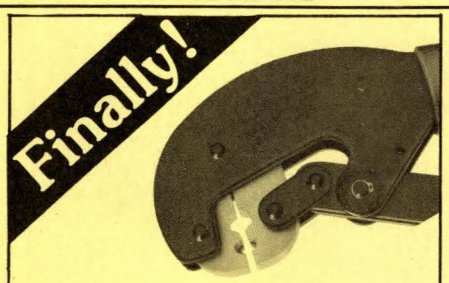

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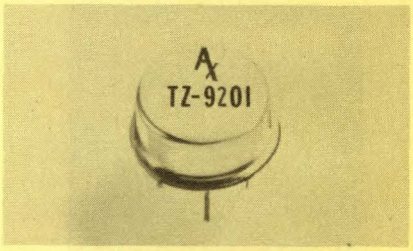

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CIRCLE NO 176

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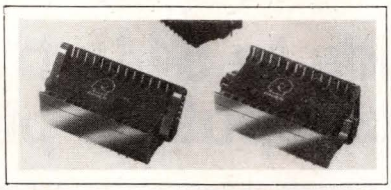
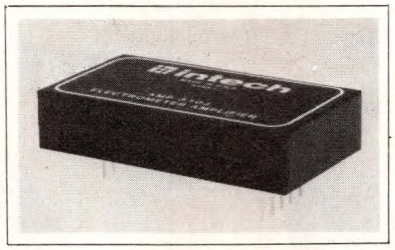


ZIF SOCKET. Three actuating-lever lengths are available in this ZIF socket, which has tin- or gold-plated heat-treated beryllium-copper contacts that open with a cam action, gripping the flat side of an IC's legs. The final 15° of cam movement removes storage or plating residue. The 30%-glass-filled thermoplastic unit comes in 24-, 28- and 40-pin versions on 0.600-in. centers and a 64-pin version on 0.9-in. centers. The 0.45×0.79-in. unit permits in-line stacking. $2.50 to $8. **Aries Electronics Inc,** Box 130, Frenchtown, NJ 08825. Phone (201) 996-6841. **Circle No 290**



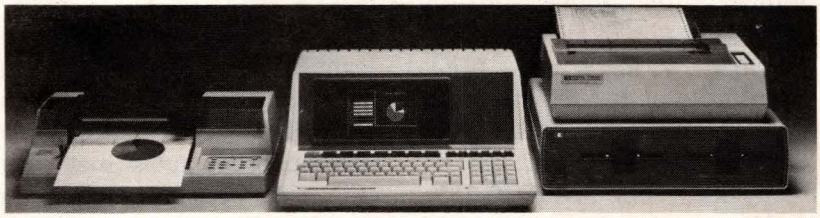
OP AMP. Featuring $3\times10^{11}\Omega$ input impedance and $\pm10^{-14}$ A bias current, AMP-310J inverting amp has a safe differential-input-voltage rating of ±300V max. Rated for ±15V power supples, it operates from ±12 to ±18V supplies. Other specs include ±10V output range at 5 mA min, open-loop gain of 10^5, small-signal frequency response of 2 kHz, full-power response of 7 Hz min and slew rate of 0.4V/msec min. Spec'd over a 10 to 70°C range, the device operates over −25 to +85°C. $53 (100). **Intech Microcircuits Div,** 2270 Martin Ave, Santa Clara, CA 95050. Phone (408) 988-4930. TWX 910-338-2213. **Circle No 291**

Memory expands to 544k bytes with personal computer's plug-in modules

Featuring an 80-column text and graphic display and expanded software support, the HP-87 furnishes a user memory that expands from 32k to 544k bytes.

In the minimum configuration, an HP BASIC interpreter resides in 48k of ROM, and the display reserves 16k of RAM. You can increase user RAM by plugging in 32k, 64k or 128k modules in any combination into the μC's four ports. All memory appears as a contiguous block for execution and data storage.

An additional plug-in module configures the machine as a Z80-based 64k CP/M system. Additional software support includes a graphics pack for generating graphs, charts and text slides; a statistics pack; an electronic-engineering pack; and financial and management-analysis packages.



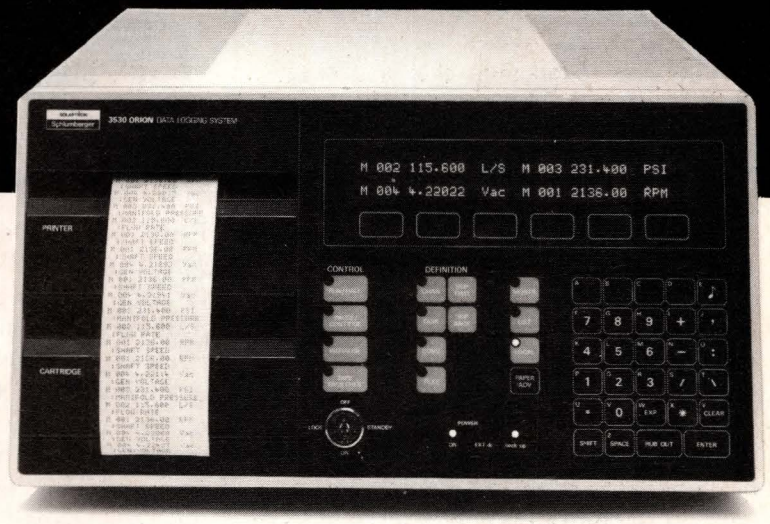
Providing 544k bytes max of user memory, *the HP-87 features an 80-column 544×240-resolution screen supported by enhanced HP BASIC. A plug-in module configures the machine to run the CP/M operating system.*

The HP-87 provides 14 user-definable function keys. Interfaces include HP-IB, RS-232, general-purpose I/O, BCD, interface loop (HP-IL) and Centronics-standard parallel printer. $2495; 32k memory module, $295; 64k module, $450; 128k module, $795; CP/M system, $495.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 292

WHATEVER YOUR LOGGING PROBLEM ORION HAS THE ANSWER.



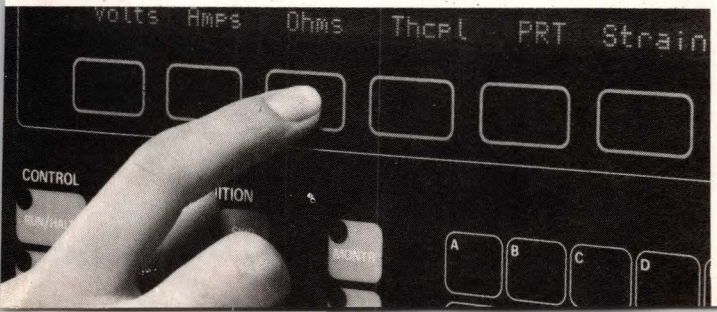
A SIGNIFICANT CLAIM FROM SOLARTRON

Orion measures thermocouples, resistance bulbs, strain gauges, flow meters, status switches, event inputs, binary and BCD data, and provides energisation and conditioning for virtually any type of transducer or input.

Easy to use menu selected facilities include standard and user defined conversion equations, limit, threshold and significant change alarms, max/min, mean and standard deviation statistics.

Up to 600 channels and scan speeds to 500 points/second can be configured to carry out eight independent logging activities – or they can be inter-related to provide powerful event driven logging and control functions.

The integral magnetic tape cartridge and strip printer, together with GPIB, RS232 and RS422 interface options, make Orion ideal for stand-alone or computer linked systems for both laboratory and plant operation.



And for all this performance Orion is still extremely competitively priced.

To find out more, phone or write to the address below.

The Solartron Electronic Group

USA:– 17972 Sky Park Circle, Irvine, Cal. 92714
Tel: 7146417137

UK:– Farnborough, Hampshire, GU14 7PW Tel: 0252 44433

GERMANY:– AM Kirchoezl, 15 8032 Graefelfing, Munchen
Tel: 89-854-3071

FRANCE:– 1, Rue Nieuport, 78140 Velizy-Villacoublay
Tel: 9469650

SWEDEN:– Vesslevagen, 2-4, Box 944, 5-18, Lidingo 9
Tel: 4687652855

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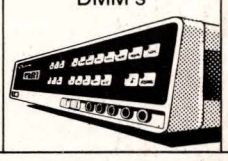
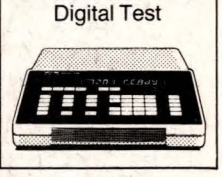
		

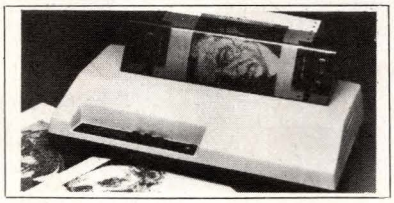
SIGNIFICANTLY FROM SOLARTRON

CIRCLE NO 180

Computers & Peripherals

DESIGN SOFTWARE. CP/M-based μCs can become automated design systems with MAGIC software, a pair of circuit - design / documentation and pc-board-generation packages. The first package includes a design editor for generating files containing the necessary artwork and information for a documented design. An associated device-library editor builds libraries listing ICs, discrete components, connectors and other circuit-design parts. A starter library contains most standard TTL ICs. The software generates ANSI-standard schematics and a net list, parts list and wire list. The pc-board package contains a specifications editor for board outlines, accommodating double-sided boards to 12×6 in. Software routes the pc-board traces. Either package, $729. **Dasoft Design Systems Inc,** 21845 SW York, Aloha, OR 97006. Phone (503) 642-9386.

Circle No 293



PRINTER. With its quad-density graphics, the IMP-4 printer can produce 19,800 dots/in.^{2} Alphanumerics in six sizes and boldface, all with true descenders, print bidirectionally at 100 cps directed by μC-generated control codes. The unit handles single sheets, continuous forms and roll paper and provides plug-in Apple, TRS-80, PET, Atari, HP and RS-232C interfaces. $699. **Axiom,** 1014 Griswold Ave, San Fernando, CA 91340. Phone (213) 365-9521.

Circle No 294

BUSINESS COMPUTER. The if800 is a fully integrated workstation that includes keyboard, printer, 10M-byte disk drive and a high-resolution color display. It features a Z80A μP and the CP/M operating system. WordStar, SuperCalc, Multiplan and other CP/M-based programs are also available. Options include IEEE-488, Centronics and RS-232C interfaces and an A/D converter that handles as many as eight separate channels with 12-bit resolution. <$12,000. **BMC Computer Corp,** 860 E Walnut St, Carson, CA 90746. Phone (213) 323-2600.

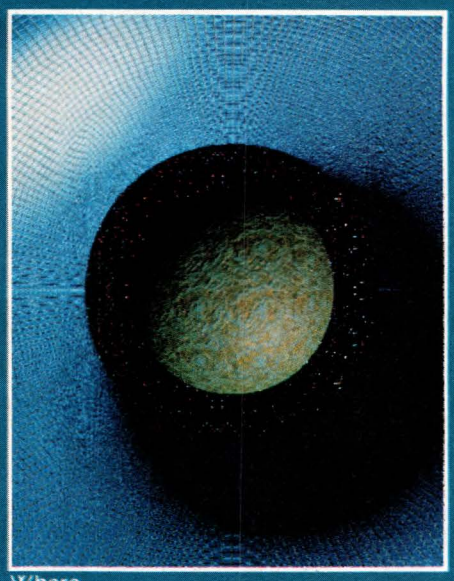
Circle No 295

the future of electronics is suitable for framing

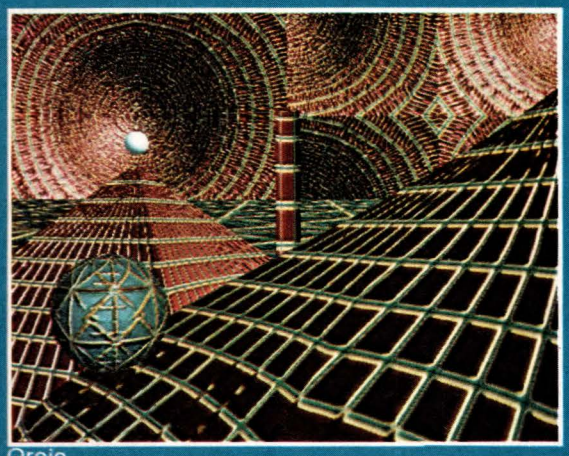
The editors of EDN are proud to offer a limited edition of three works of computer generated art by David Em.

These prints showcased in the October 14 EDN special section **Electronic Technology: The Next 25 Years** are each 20" x 26" and have been printed on high quality presses personally supervised by the artist.

Transjovian Pipeline



Where



Orojo

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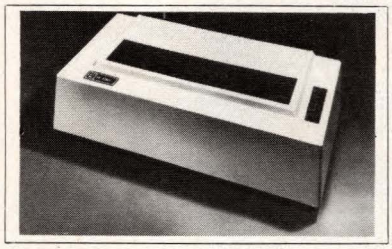
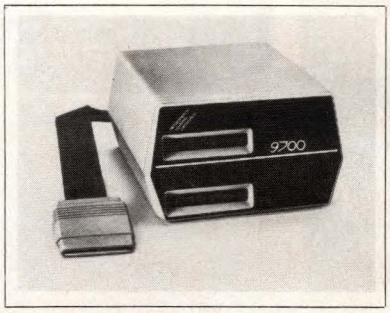
Computers & Peripherals

DOT-MATRIX PRINTER. Providing draft-quality 7×9 printing at 240 cps, memo-quality 33×9 output at 80 cps and 2-pass letter-quality 33×8 printing at 30 cps, Letterprinter 100 also furnishes a 133×72 Graphics mode. A ROM carries selectable Courier-10 and Orator-10 fonts. Additional fonts in ROM are available. Speed, fonts, tabulation, print density and margins are software or user selectable. Paper to 14⅝ in. wide can be handled, and the unit provides 50- to 9600-baud data rates and a standard 325-character buffer. (A 4000-character buffer is optional.) $1495 (100). Delivery, starting in summer. **Digital Equipment Corp,** 146 Main St, Maynard, MA 01754. Phone (617) 897-5111. **Circle No 296**



MATRIX PRINTERS. Operating at 150 cps, Series 900 bidirectional 80- or 132-column dot-matrix devices use a 9×9 matrix. Printing 6 or 8 lpi and 10, 12 or 16.5 cpi, they provide 96 ASCII characters, serial RS-232C or current-loop interfaces, a 350-character buffer (expandable to 3422 characters) and a cartridge ribbon. Also featured are expanded, condensed and double-density characters; standard, alternate and downloadable character sets; a 600-million-character printhead; tractor and optional friction feed; multiple copies (6 parts max); and graphics capability. The printhead can be replaced in the field without mechanical or electronic adjustments. 80-column model, $995; 132-column unit, $1195. **Hi-G Co Inc,** 580 Spring St, Windsor Locks, CT 06096. Phone (203) 623-3363.

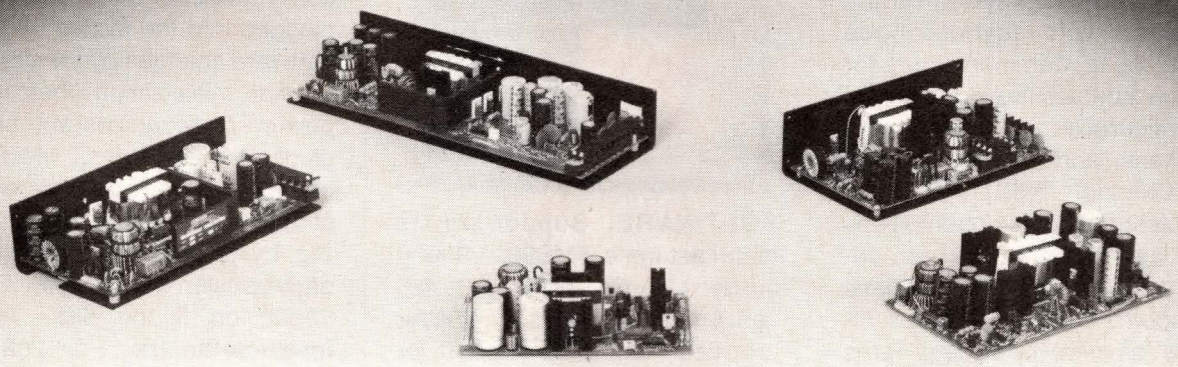
Circle No 297



HARD-DISK SUBSYSTEM. You can use interchangeable Host Adapter Personality Cards to adapt MSC 9700 to a wide variety of μCs, including Apple II, Xerox 820, IBM PC, TRS-80, Q-bus, S-100, Multibus and STD Bus systems. Emulating the software protocol of the host computer, the unit comes in 1- or 2-drive versions with 5M- or 10M-byte storage. Backup is available in two forms: a second Winchester disk drive or an optional mini-floppy disk drive. The 7.5×13.01×14-in. system utilizes a Seagate Technology ST-506 5¼-in. Winchester, a Xebec S1410 controller and a 115V/230V power supply to furnish 22-bit error detection, 11-bit error correction, full-sector data buffer and switch-selectable bus-device address. <$3000 for basic subsystem; host adapters, <$200. **Microcomputer Systems Corp,** 432 Lakeside Dr, Sunnyvale, CA 94086. Phone (408) 733-4200.

Circle No 298

VDE APPROVED



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All table top office products sold in Europe must meet the Class B limit of VDE 0871 for conducted noise in order to get a general license. These are the same test conditions as the recent FCC requirements but cover a broader frequency range. Products introduced after Oct. 1981 must comply with the FCC limits. CONVER's on-board filters are matched to the supply (which contains internal noise suppression) to assure compliance. Radiated noise measurements must be made in your equipment because of other noise sources. CONVER open-frame power supplies contain shielding and tailored printed circuit boards to minimize radiation and facilitate compliance of your system.

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3. Tough Burn-In — 96 hours at 75°C under load.

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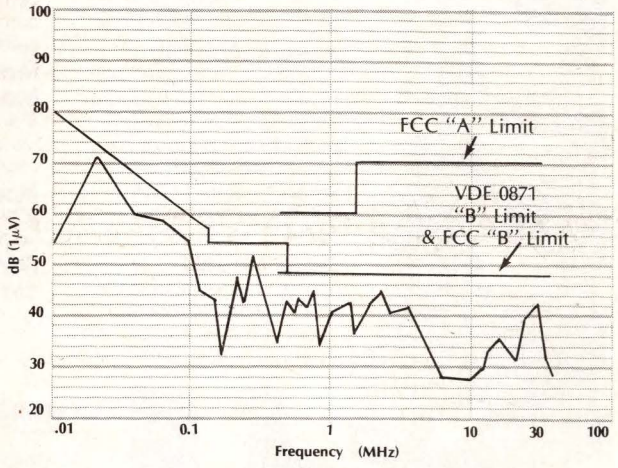

CONDUCTED EMI FOR MODEL AC-65 (5 OUTPUT, 65 WATT) SILENT SWITCHER®.

CONVER Corporation

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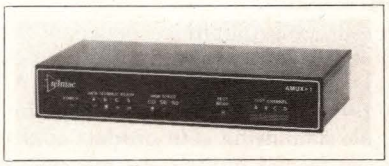
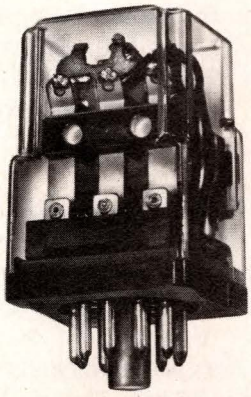
MODEM/CONCENTRATOR. A statistical multiplexer combined with a matched MOS LSI modem in a compact desktop cabinet, Micro8000 can support as many as 16 terminals operating at 9600 cps. The built-in modem functions at 2400, 4800 or 9600 bps. Features include concurrent statistical multiplexing of as many as four synchronous channels with asynchronous channels; a Command port for on-line troubleshooting, channel reconfiguration and other control functions; and Terminal-Activated Channel Test (TACT) for troubleshooting telephone lines and communications components from the user's terminal keyboard. Optional features include asymmetrical data rates for viewdata applications and satellite compatibility. From $2050 for 2-channel concentrator with 2400-bps modem to $8800 for 16-channel, 9600-bps version. **Micom Systems Inc,** 9551 Irondale Ave, Chatsworth, CA 91311. Phone (213) 882-6890. **Circle No 299**

SOFTWARE. Supporting its manufacturer's TMS9900/99000 family of μCs, MPP 4.0 Advanced Microprocessor PASCAL provides automated support for locating collections of small program modules in a large memory-address space by utilizing a memory manager, BINDER, that assigns program modules to physical addresses and resolves all extended-addressing requests. The package additionally permits the choice of optimal speed-vs-program-size tradeoffs with each PASCAL procedure designated for interpreted- or native-code execution. Functional modules can be plugged into the system without software changes by means of a special initialization that upon power-up recognizes any newly plugged-in modules. Message channels, a set of software bus controls, support multiprocessing by providing the necessary data-transfer mechanism. From $3200 on floppy disk. **Texas Instruments Inc,** Box 202129, Dallas, TX 75220. Phone local office. **Circle No 300**



MULTIPLEXER. AMUX-1 asynchronous 4-channel multiplexer/line driver can transmit high-speed data 5 to 20 mi using twisted-wire pairs, depending on transmission rate. It provides four RS-232C low-speed interfaces; data is combined into one high-speed stream for the line driver. The high-speed port operates at four times the data rate of the low-speed ports and is transparent to them in operation. Data-channel rates of 300, 600, 1200 and 2400 bps are switch selectable, as are character lengths of seven and eight bits. The line interface conforms to Bell Publication 43401. $895. **Telmac Inc,** 770 Privet Ct, Sunnyvale, CA 94086. Phone (408) 737-1534. **Circle No 301**



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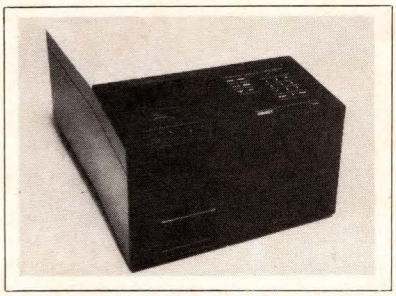

DISKETTE COPIERS. Models 5208 and 5248 can duplicate and verify single- and double-sided 5¼-in. 48-tpi diskettes. Number of copies is operator selectable to 999. An automatic accept/reject output stacker is included. Model 5208 performs as a peripheral subsystem under host-computer control, compatible with personal and business computers via an RS-232 serial interface. Model 5248 functions as a stand-alone copying system for single- and/or double-density diskettes. Throughput equals 68 single-sided copies per hr (35 double-sided copies per hr) for nonformatted diskettes. Optional personality modules add intelligence to the system. Model 5208, <$10,000; Model 5248, approximately $13,000. Full production, starting mid-year. **Media Systems Technology,** 17991 Fitch Ave, Irvine, CA 92714. Phone (714) 752-6171. **Circle No** 302

SOFTWARE. For the 68000 μP, these relocatable macro-assembler, linking-loader and librarian programs are written in FORTRAN IV and run on most computers with a minimum word length of 16 bits. The assembler is compatible with Motorola's instruction mnemonics and largely compatible with the directives (pseudo-ops) used by that manufacturer's Resident Structured Assembler. Features include conditional assembly, program-assisted base-register usage, 16 user-named relocatable program sections and the ability to produce a symbol or cross-reference table. The loader combines several independently assembled relocatable object modules into one absolute program. Large programs can be subdivided into smaller units, and a load map, displaying the names of each object module and each section and their starting addresses, is included in the loader's output. The librarian creates and maintains program libraries from frequently used relocatable object modules. ASM68K package, $1750. **Microtec,** Box 60337, Sunnyvale, CA 94088. Phone (408) 733-2919. **Circle No** 303

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For further information, write or call Bill Maxwell or Roger Mailloux, Semiconductor Division, Sprague Electric Company, 115 Northeast Cutoff, Worcester, Mass. 01606. Tel. 617/853-5000.

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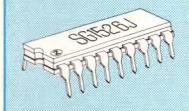
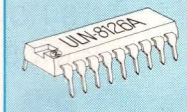
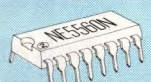
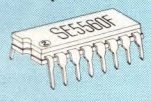
• High-Performance • Fully-Protected • Maximum-Versatility • 8 to 35V Operation • Precision Reference • Dual 100mA Outputs • Programmable Soft Start • Programmable Deadtime • Double-Pulse Suppression • Undervoltage Lockout	 	ULN-8126R	SG3526J	0°C to +70°C	27466.10
		ULN-8126A	—		
		ULQ-8126R	SG2526J	−40°C to +85°C	
		ULQ-8126A	—		
		ULS-8126R	SG1526J	−55°C to +125°C	
• Full-Feature • Fully-Protected • 40mA Output • Feed-Forward Control • Remote ON/OFF Switching • External Sync. • Double-Pulse Protection	 	ULN-8160A	NE5560N	0°C to +70°C	27466
		ULN-8160R	NE5560F		
		ULS-8160R	SE5560F	−55°C to +125°C	
• Low-Cost • Basic-Control • 40mA Output • Internal Reference • Miniature Package		ULN-8161M	NE5561N	0°C to +70°C	27466.1

*Sprague suffix 'A' or 'M' indicates a plastic DIP; suffix 'R' indicates a glass/ceramic hermetic DIP.

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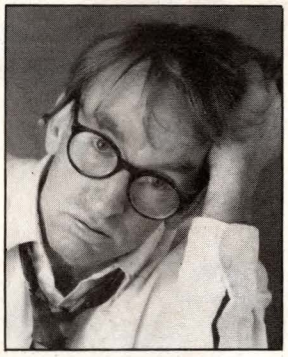
CIRCLE NO 192

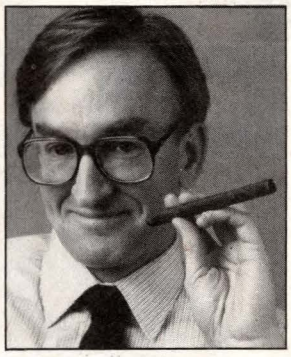


Barney Stevenson,
Programmer

PROGRAMMING LANGUAGES USED:
High-Level and Assembly Code

PROGRAMMING PROCEDURES FOLLOWED:
Loads Editor, edits
Loads HLL, compiles
Loads Assembler, assembles
Links Object Files
Loads Object Files
Runs Program

RESULT:
Barney works for
his program



Ralph Stevenson,
Programmer

PROGRAMMING LANGUAGE USED:
polyFORTH™

PROGRAMMING PROCEDURE FOLLOWED:
Edits
Runs Program
Moves on to next task

RESULT:
Ralph's program
works for him

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it must be the

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CIRCLE NO 193

A Question of Law

Study your employment contract carefully to protect your rights

David Pressman, Attorney at Law
San Francisco, CA

Employment contracts or agreements regulate most aspects of the relationship between technical employees and their employers, covering such areas as invention rights, trade secrets, outside activities and conflicts of interest. If you signed an employment contract as a condition of your employment and are hazy about its provisions, it would be wise to restudy the agreement carefully, especially if you plan to patent an invention, engage in outside work or work for a competitor. Knowing your rights can prevent subsequent problems with your employer.

Engineering-employment-contract provisions roughly divide into three groups: pre-employment, employment and post-employment. Pre-employment provisions cover prior inventions and duties to former employers. Sections governing current employment usually regulate invention rights, conflicts of interest, moonlighting, recordkeeping and preserving trade secrets. Post-employment provisions encompass invention disclosure and working for competitors.

Prior inventions must be disclosed

Most employment contracts have a provision concerning prior inventions. It directs a newly hired employee to list on the employment agreement (or on an attached rider) any inventions he conceived before taking up his new position and not made the subject of a patent application or disclosed to a previous employer. This provision is a good one, for it protects the employee's rights to these prior inventions and also lets the new employer know in advance that the employee has certain rights that it cannot claim. If you have prior inventions, however, you should document them separately in a laboratory notebook or on an invention-disclosure form (EDN, December 16, 1981, pg 41).

If you're asked to sign an employment agreement with a prior-invention provision and you don't have access to your records, try to postpone signing until you can bring in a full list of your prior inventions. If that's not possible, write in a clause (at the place where you are to list your inventions) stating that a full list will be supplied separately. Be sure, though, to provide the list promptly.

Another pre-employment provision centers on duties to former employers. Although rarely used, this section states, in effect, that the new employee recognizes a duty to keep former employers' trade secrets and other proprietary information confidential and will continue to honor this obligation. Some contracts also add a section saying that the employee understands that he has no obligation to any former employer that would prevent him from fully entering into his current employment or that imposes any restrictions on his activities on behalf of the company. Such provisions can be valuable in cases of conflict, and employers are well advised to write them into their employment agreements.

Preventing conflicts of interest

Employment-contract provisions covering the employment period focus on conflicts of interest, moonlighting, recordkeeping and trade secrets. A conflict-of-interest provision can be a powerful legal weapon used against an errant employee. Generally, an employee has a duty under the ethics of his profession (and perhaps under common (judge-made) law) not to enter into any situation that might be considered a conflict of interest. Specifically, a conflict-of-interest section usually provides that the employee has a duty of fidelity to the employer, that he will not become involved in any situation that might be considered to conflict with the employer's rights and that he will report to his employer any borderline situations.

Closely allied with the conflict-of-interest section, an employment contract's moonlighting provision generally states that the employee will not accept or engage in any outside employment that conflicts with his duties to the employer. The employee is also required to report all outside employment and to obtain prior approval for it.

Although this provision might seem unduly harsh (for example, in situations where an engineer might want to teach French at a local community college), it is often used by employers as a means of protection and as a legal weapon should a dispute or litigation arise. Generally, however, almost all courts would

uphold the right of an employee to acquire outside employment (especially in the current highly inflationary period) so long as the outside employer does not engage in a competing business.

An employment contract's recordkeeping provision requires the employee to keep full and accurate records of all inventions and lab tests so that in case of a patent or invention dispute, the employer will have documented evidence to support its position. Because good engineering practice also dictates this precedure, such a provision is a reasonable and fair one—although most engineers probably expend very little effort in complying with it.

Protecting trade secrets

Trade secrets can be extremely valuable to employers, and protection for trade secrecy is now included in many states' criminal codes (EDN, May 27, 1981, pg 271). Thus, a detailed trade-secret section is found in almost all agreements.

Under it, an employee recognizes that the employer has and generates trade secrets, that they constitute a valuable asset and that he will keep them and other proprietary information confidential during and after his term of employment.

Most of the difficulties with this provision center on determining precisely what information is a trade secret and what is legitimate knowledge that an employee is free to use with subsequent employers as part of his trade skills. Often accompanying the trade-secret provision is a requirement that an employee obtain advance approval before publishing any information relating to the company's business.

Patent rights of employed engineer/inventors are another extremely important subject and one that can lead to conflicts between employees and employers. Generally, the patent or invention-rights clauses of most current employment contracts provide that a technical employee must disclose to his employer all inventions made while employed. He must also assign (legally transfer) to his employer the patent rights to all inventions created in the course of his normal duties, made using the employer's time, materials or facilities, and relating to the employer's business (EDN, November 11, 1981, pg 357). An employee is not usually compensated for making the assignment, but as an inducement to disclose inventions, most companies give the employee/inventor approximately $100 to $300.

Regaining the rights to your invention

If you have an invention (or might create one), you should carefully study your employment agreement (especially the operative words governing inventions) to determine exactly what rights you have with respect to borderline inventions—for example, those made at home or that don't directly relate to your employer's business. Additionally, be aware that even if an invention legally belongs to the employer, the company often won't be interested in exploiting it. In that case, you might be able to obtain a release from the employer that turns back to you all or most of the invention rights.

An employment contract's post-employment provisions focus on problems that might arise after an employee leaves the company to take another position or start his own firm. One possible problem area centers on rights to inventions created during the employee's term of employment but withheld until he leaves the company (ie, not disclosed under his employment agreement). To deal with this situation, many employment contracts require that all inventions an employee discloses to another person up to a specified period of time (such as 1 yr) after he leaves his former position also be communicated to his former employer.

Such a provision would enable the former employer to scrutinize inventions that could have been created under the former employee's employment contract and secure or protect the rights to them. If this were not possible, the provision could at least

A Question of Law

serve to deter an employee from carrying over such an invention to his new employer.

However, if an employee creates an invention that is documented at the time of conception and is significantly different from products or processes resulting from the employee's current duties and activity, the former employer would have a difficult time in making a case against him. Furthermore, this provision could be illegal under certain circumstances because it might require the disclosure of information proprietary to the new employer without an adequate basis or need. And if there is no requirement that the former employer keep the disclosed information confidential, a legitimate legal challenge to such a provision could be made. Thus, if you sign a post-employment disclosure provision, consult an attorney before you disclose any inventions to a former employer.

Working for the competition

Finally, another controversial post-employment employment-contract provision deals with working for competitors. Generally, it prohibits an employee from working for a firm competing with his former company for a specified period (as long as 2 yrs) after termination of employment. However, it's usually used only for sales or managerial personnel. And the courts are reluctant to enforce this type of provision because it runs contrary to the accepted principle of permitting people to use their skills in earning a livelihood. Note, though, that if an employee is compensated by a post-employment salary or stipend or if the imposed restrictions are "reasonable" under the circumstances (eg, limited geographically or in time), the courts might uphold them.

An additional consideration is the breadth of the former employee's skills. If he is a salesperson experienced in selling a broad range of products and can secure many positions with noncompeting employers, the courts are more likely to uphold the restrictions than if he is an engineer skilled only in the design of, say, CMOS ICs. EDN

David Pressman, JD, BSEE, received the Juris Doctor degree from George Washington University and a BSEE from Penn State University. Formerly a field engineer at Philco-Ford Corp, a patent examiner with the US Patent Office and a patent attorney for Philco-Ford, Elco Corp and Varian Associates, he is currently in private practice specializing in patent law.

Article Interest Quotient (Circle One)
High **488** ***Medium*** **489** ***Low*** **490**

Literature

A look at gas-discharge displays

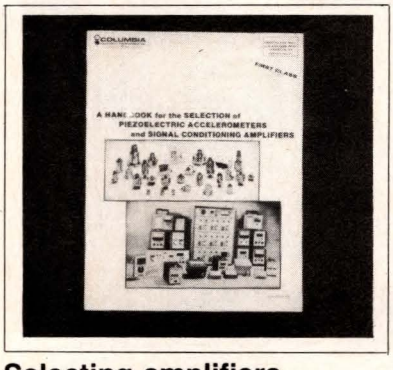
Catalog CE-987 describes a line of gas-discharge displays and display systems. The 16-pg handbook includes application data and specs for standard display panels, custom-format display units, alphanumeric display systems and modular interactive alphanumeric display systems. Mechanical drawings detail typical systems, and environmental - test - condition data is provided. **Cherry Electrical Products Corp,** 3600 Sunset Ave, Waukegan, IL 60085.

Circle No 317

Test accessories for various environments

This 108-pg catalog describes a line of test accessories including banana plugs, patch cords, phone-tip jacks, connecting cords, test clips, probes and holders. Photos illustrate the manufacturer's newest products, and specs and a summary of features characterize the products presented. Dimensional drawings are provided, and a temperature-conversion table concludes the catalog. **ITT,** Pomona Electronics Div, Box 2767, Pomona, CA 91766.

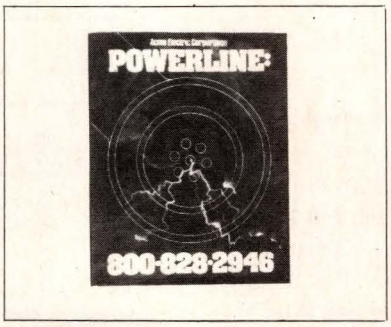
Circle No 318



Selecting amplifiers and accelerometers

Bulletin No 100 details piezoelectric accelerometers and charge amplifiers for various applications. Displayed are stock units and performance specs, including typical sensitivity, frequency response, dimensions and temperature range. A price list for standard, miniature, self-amplifying and special-purpose units, as well as accessories and calibration services, concludes the 22-pg booklet. **Columbia Research Laboratories Inc,** MacDade Blvd and Bullens Lane, Woodlyn, PA 19094.

Circle No 319



Power sources

Featuring the Powerline Series of switching products, this catalog describes ac/dc power supplies and dc/dc converters. It provides specs for AMS Series units with output voltages from 2 to 28V dc and power ratings of 100 to 650W; the units operate from 115/230V ac. Also featured is the AMC Series of ac/dc converters, which accept 12, 24 or 48V dc and provide outputs of 5, 12/15 and 24/28V dc with power ratings of 25 to 140W. **Acme Electric Corp,** Cuba, NY 14727.

Circle No 320

Programming PROMs

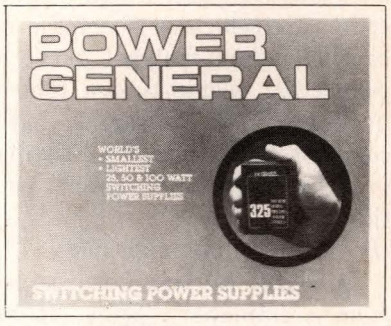
Showcasing the Series 90 PROM programmer and its M910A control unit, this 24-pg brochure also describes the RS-232C communications option, which allows use of the instrument with development systems and computers. It demonstrates how the option permits communication through modems in field applications. A list of the 450 devices that the M910A can program is provided, and the booklet also describes the manufacturer's gang personality modules, which simultaneously program eight PROMs in any family of 5V MOS devices. **Pro-Log Corp,** 2411 Garden Rd, Monterey, CA 93940.

Circle No 321

Choosing filters

A guide to filter specification, this 12-pg booklet defines key terms and details a line of ECM filters, including single-channel units and multiplexers. Fill-in-the-blank work sheets are provided. **Neico Microwave Co,** 105 South St, Hopkinton, MA 01748.

Circle No 322



Data details power-supply line

This 6-pg switching-power-supply catalog provides the electrical and mechanical dimensions for a line of 25 to 100W products. Prices and photos are provided, and specs for output voltage and current are presented in tabular form. **Power General,** Box 189, Canton, MA 02021.

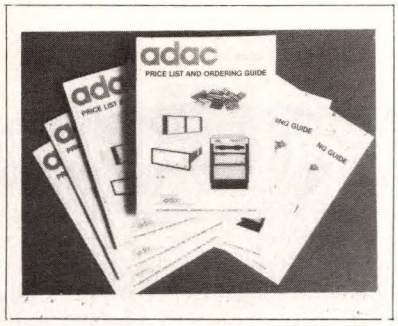
Circle No 323

Advantages of using linear thermistors

Bulletin L-9A details three standard LTN thermistor-network

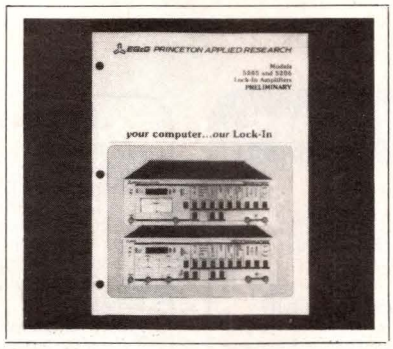
Literature

units: The LIN-M Series (pc-board-mounting module), the LTN-ML Series (module with leads) and the LTN Composite Series, which consists of a thermistor and two resistors. It provides data on linear R-T curves, positive-slope voltage-output mode (output increases with an increase in temperature), negative-slope voltage-output mode (output decreases with an increase in temperature) and basic equations. Characteristics tables include data on temperature, positive slope, negative slope, linearity deviation and resistance. Mechanical drawings accompany specs. **Fenwal Electronics,** Box 585, Framingham, MA 01701. **Circle No 324**



A μC-system assortment

Detailing more than 100 LSI-11-compatible products as well as products for Intel, Data General and Unibus- and Omnibus-compatible systems, the 1982 Ordering Guide describes completely packaged industrial process-control systems. It also examines an assortment of analog-I/0 boards that plug directly into the DEC LSI-11 and other bus backplanes, system enclosures, floppy-disk and Winchester mass-storage systems and CRT terminals. Its product-numbering system and price list permit you to precisely define the board or system level configuration you need. **ADAC Corp,** 70 Tower Office Park, Woburn, MA 01801. **Circle No 325**



Features of two lock-in amplifiers

This 4-pg brochure describes fully programmable Models 5205 (single-phase) and 5206 (dual-phase) lock-in amplifiers. It discusses operating features and automatic functions, noting that the sine-wave-responding instruments suit applications that involve measuring intensities and phase shifts of weak signals, particularly those overwhelmed by noise. The brochure highlights the units' full computer-control capability and provides signal-channel, reference-channel and phase-sensitive-detector specs. **EG&G Princeton Applied Research,** Box 2565, Princeton, NJ 08540. **Circle No 326**

Two μP app notes

AN-834 describes a state-of-the-art color-graphics system using the MC68000 16-bit μP with an economical CRT controller. AN-831, "An IEEE-488 Bus Interface Using DMA," provides data on using the MC6809 μP to form a talker/listener IEEE-488 system. It includes an overview of a data-transfer operation, the GPIB and DMA techniques. Operation of the talker/listener device, consisting of an MC6809 μP, an MC68488 GPIB device and an MC6844 DMA controller, is detailed. **Motorola Inc,** MOS Integrated Circuits Div, 3501 Ed Bluestein Blvd, Austin, TX 78721. **Circle No 327**

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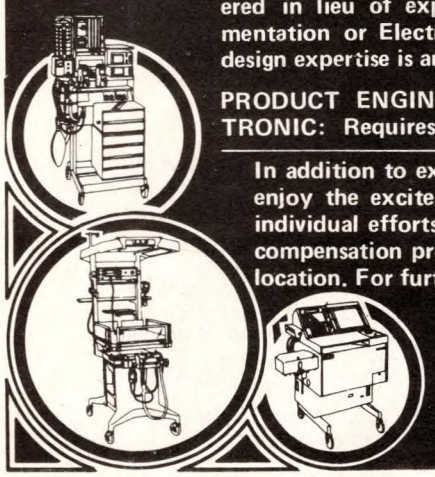

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Circle No. 5000 (on page 276 of **EDN**)

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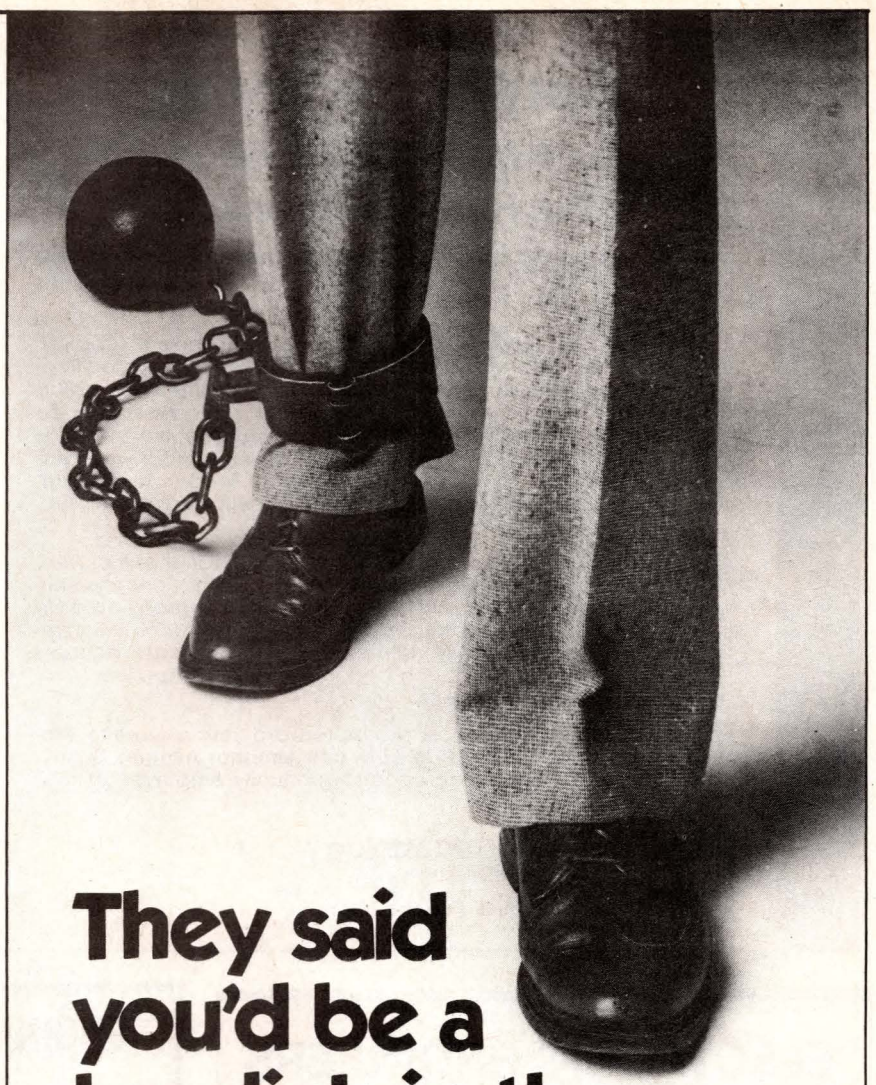

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Circle No. 5001 (on page 276 of **EDN**)

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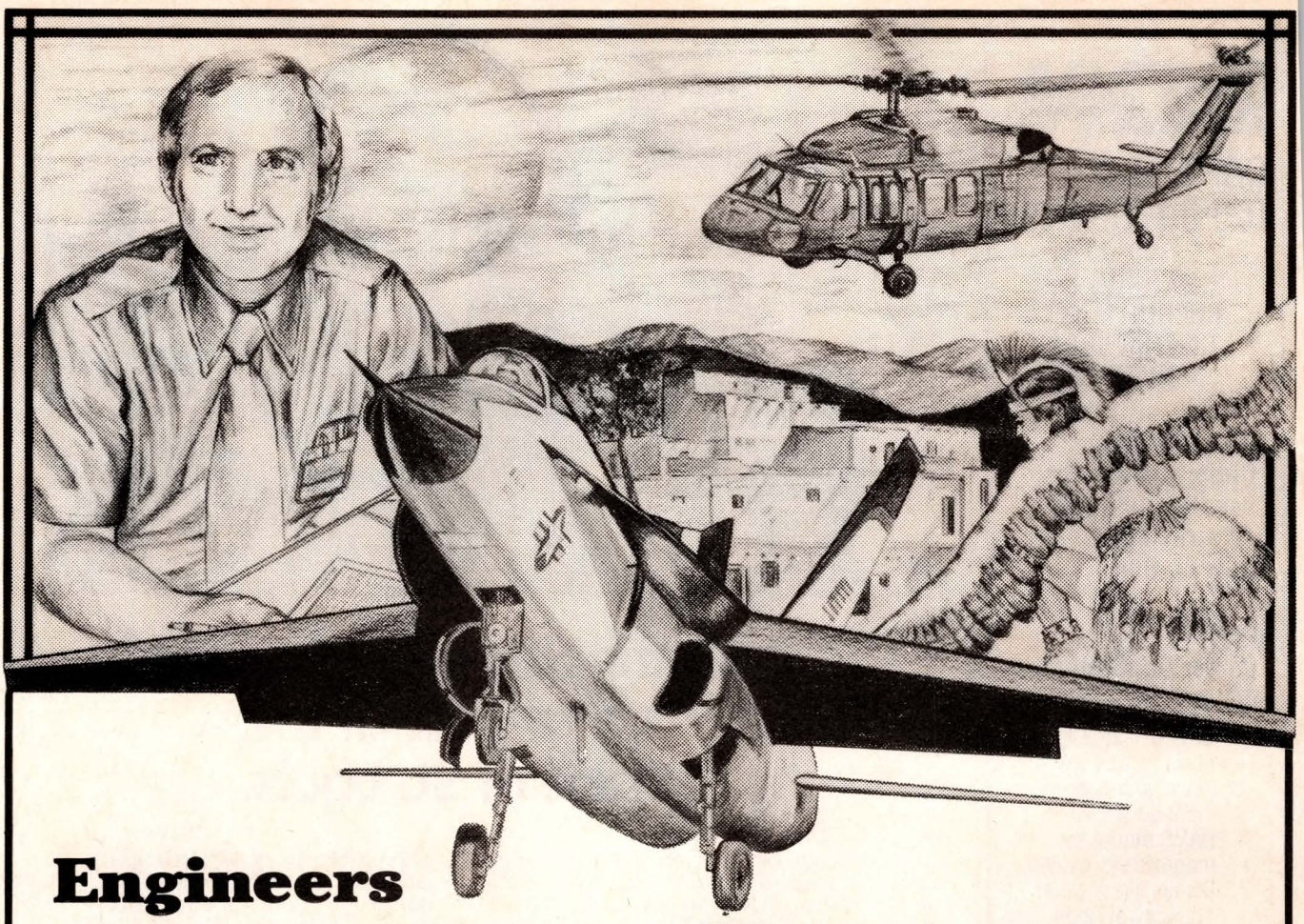

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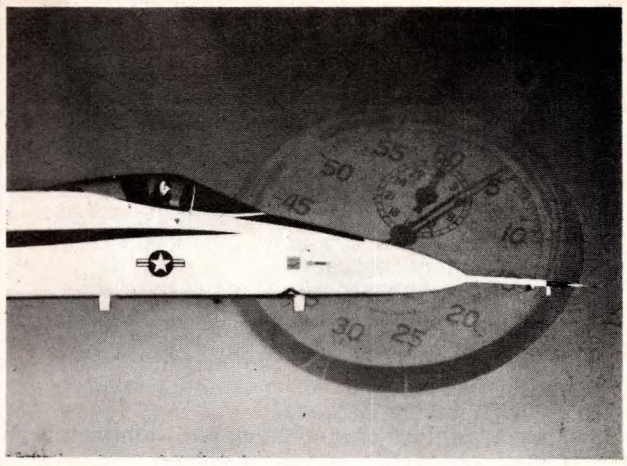

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Circle No. 5014 (on page 276 of **EDN**)

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Advertisers Index

Looking Ahead: Trends and Forecasts

Converters need more production capacity

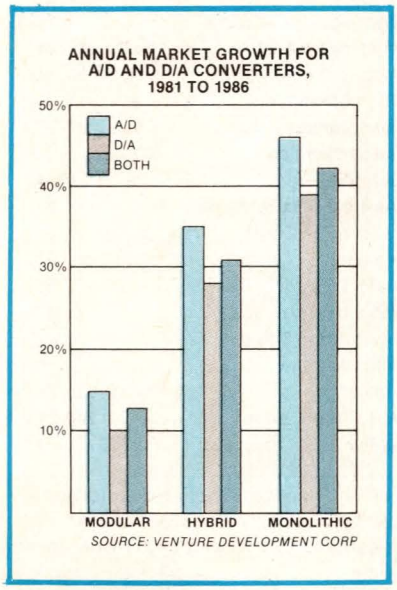
The data-converter market will grow 33.9% annually between 1981 and 1986, predicts Venture Development Corp (VDC), Wellesley, MA. But this unprecedented growth in demand for A/D and D/A converters might be thwarted by the industry's failure to sufficiently expand production capacity.

Parts shortages might be severe in certain high-growth monolithic and hybrid product segments. Although the demand for hybrid A/D converters will expand 35% annually, monolithic-converter markets will show even more dynamic growth. Consumption of monolithic D/A converters will rise at 39% annually, exceeded only by the 46% annual growth in monolithic A/D converters.

The expected fourfold increase in data-converter consumption during the forecast period cannot be achieved by the mere addition of people and machinery, says VDC. Manufacturers must also plan for massive expansions of factory space. Thus, despite several current facility-expansion programs, product shortfalls could still arise.

The failure of the data-conversion-component industry to adequately expand production capacity could permanently alter the industry's future course. Major production shortfalls will trigger a surge of new startups, as in the early 1970s.

Increased captive production is another likely consequence of restricted parts availability, according to VDC. Stretched-out leadtimes and unreliable deliveries would force equipment manufacturers to devise in-house solutions to microprocessor interfacing problems. Should this switch occur, the traditional converter manufacturers might find it impossible to recapture lost business.



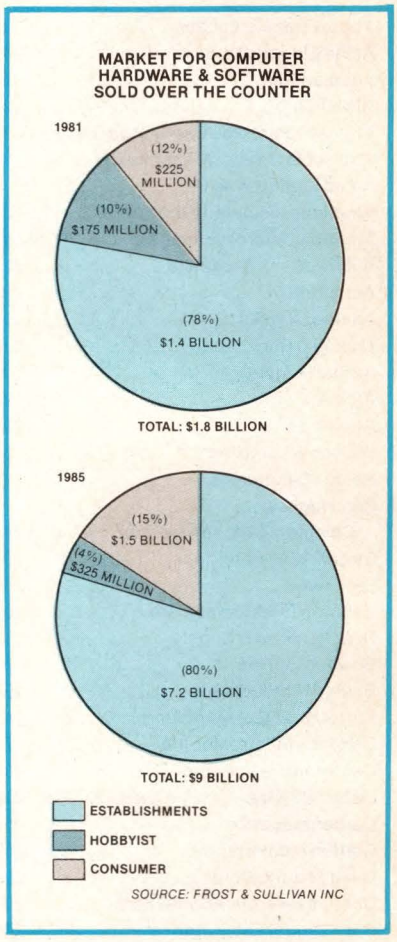
Retail hardware, software to total $22.5B by 1985

The over-the-counter (OTC) computer market, pegged at $1.8 billion last year and only $860 million in 1980, will increase by another $1 billion this year and soar to $9 billion by 1985. The total cumulative market over the 4-yr period will equal $22.5 billion—a 60% annual growth rate over the first half of the decade, forecasts Frost & Sullivan (F&S), New York City.

(Trying to avoid the semantic confusion surrounding the terminology of "personal," "home," "hobby," "small business" and "microcomputer" associated with the retail computer marketplace, F&S suggests "over-the-counter computer" as an all-encompassing reference.)

One pattern that will emerge will be the shrinking of the hobby market as a portion of the whole, although hobbyists will continue to offer significant mail-order business opportunities. Conversely, business establishments will dominate the OTC-computer marketplace; the consumer sector will also significantly pass the hobbyist market's proportion.

Accounting-related software (eg, general ledger, accounts receivable, accounts payable) is by far the largest OTC software market, followed by word-processing software and inventory-control programs.



Material for this page developed from *Electronic Business* magazine and other sources by Joan Morrow, Assistant Editor, and Jesse Victor, Assistant/New Products Editor.

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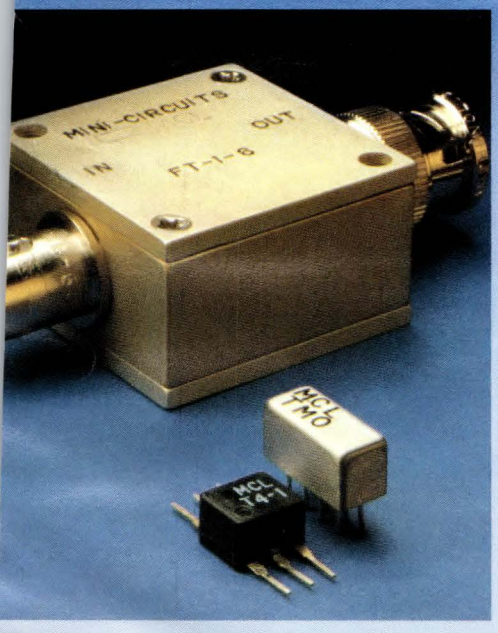

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Freq. (MHz)	.15-400	8-300	.1-300	.01-100	.02-200	.15-200	2-90	.3-120	7-85
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Imped. Ratio	1	2	2.5	3	4	4	5	13
Freq. (MHz)	.05-200	.07-200	.01-100	.05-250	.2-350	8-350	.3-300	.3-120
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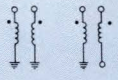
FT **FTB**



Model No.	FT1.5-1	FTB1-1	FTB1-6	FTB1-1-75
Imped. Ratio	1.5	1	1	1
Freq. (MHz)	.1-400	.2-500	.01-200	.5-500
(1-4)	$29.95	$29.95	$29.95	$29.95

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A Division of Scientific Components Corp.
World's largest manufacturer of Double Balanced Mixers
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With PRONTO 48-hour shipment, our inventory is your inventory.

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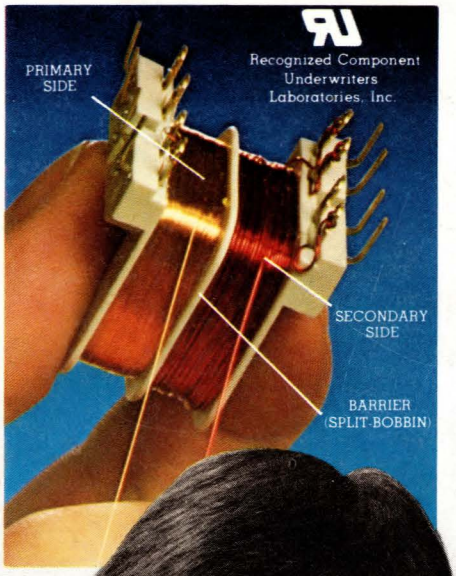
Signal has the solution. We've made a commitment to stocking every part in our vast selection of quality transformers—in depth—so you don't have to. They're always ready for guaranteed PRONTO 48 hour shipment. So you can order only as much as you need, and get it as fast as you need it.

Unique Split Bobbin design.

And Signal offers something more: innovation. Take our ingenious Split Bobbin transformer design, for instance. It gives you high isolation at low cost, by separating the primary from the secondary windings with a plastic barrier, eliminating the need for shielding. It's available on our 2-4-1™ series of miniature power transformers, our Split/Tran™ pc board transformers and our Flathead™ low-profile transformers for high-density pc board applications.



A thousand other reasons.

Split Bobbin transformers are just one part of our full line—our complete catalog includes over 1,000 standard transformers and chokes, from 1 to 10,000 VA. All are available for off-the-shelf PRONTO shipment: at least four pieces within 48 hours. (Tens of thousands of satisfied customers can vouch for our 100% commitment to PRONTO service.) And best of all, since we sell only factory-direct at large volume, we've kept prices *very* low.

Quality, innovation, selection, low prices and PRONTO delivery. Do you need any more reasons to make Signal's inventory your inventory? Of course not! Write or call for your free catalog today: Signal Transformer Co., Inc., 500 Bayview Ave., Inwood, NY 11696; Tel. (516) 239-4510.

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