EDN
computer hardware In this Issue

exclusively for designers and design managers in electronics

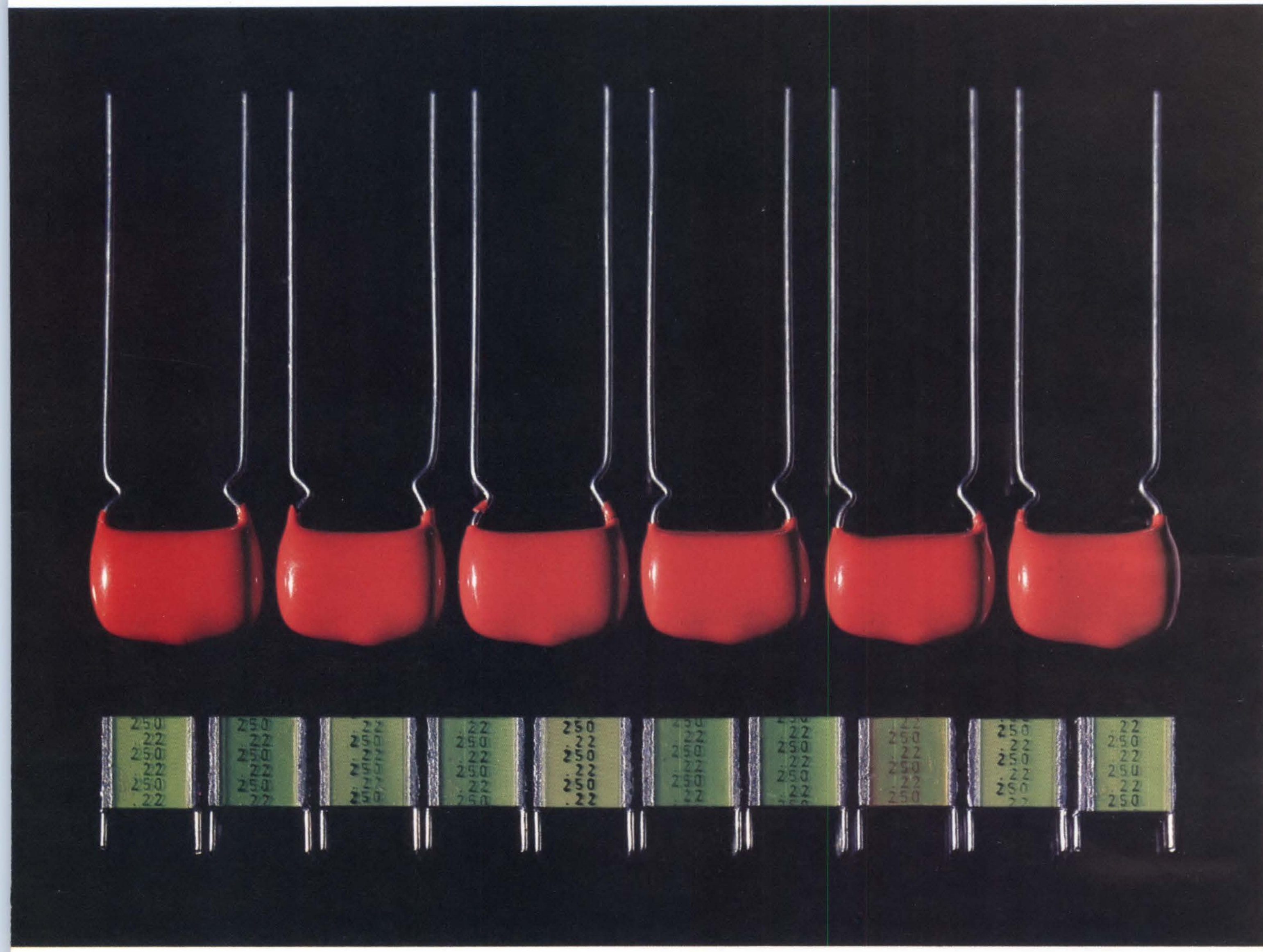
EEE

Many functions combined in a single module

A CAHNERS PUBLICATION

APRIL 15, 1972

Siemens



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SIEMENS

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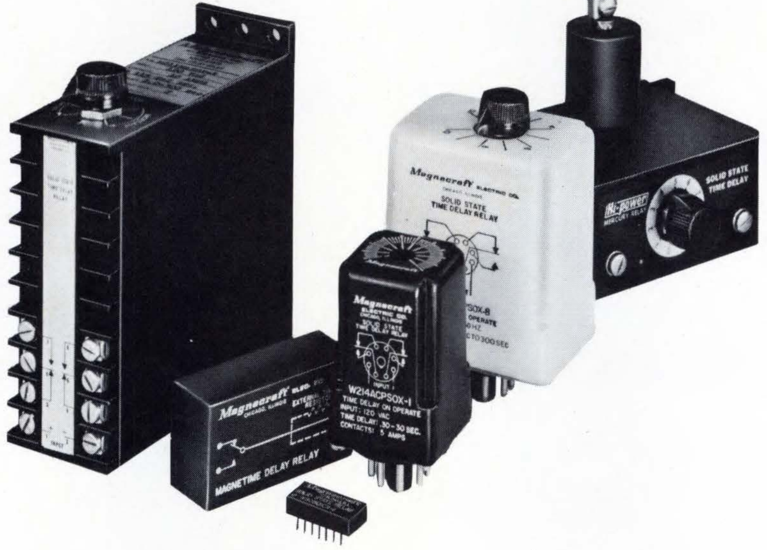

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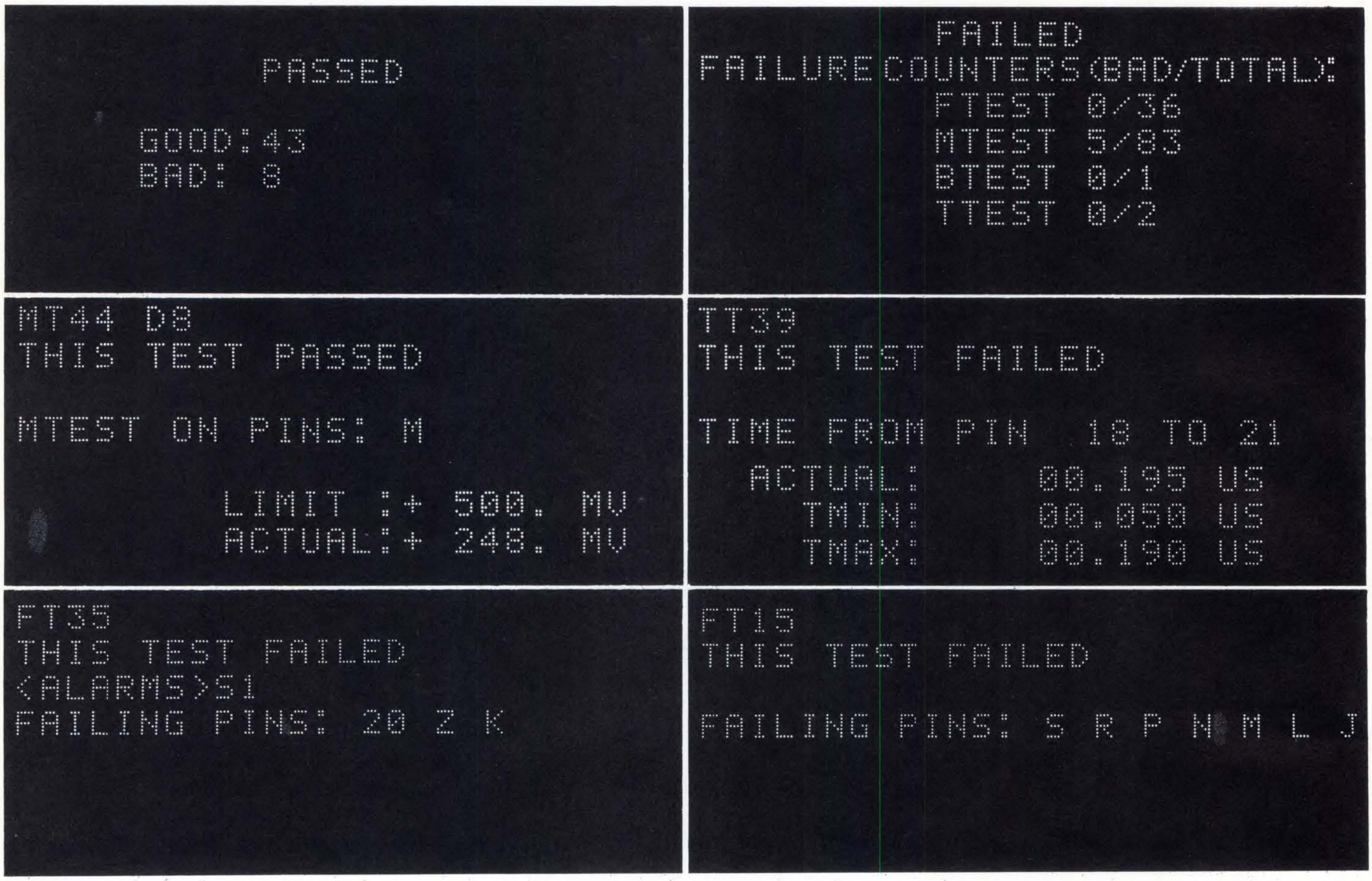

If you test circuit boards, you get the message. The L100 doesn't just tell you a bad board is bad. It helps you find out why. And in a fraction of the time you'd usually spend trouble-shooting. We'd like to send you a brochureful of reasons why the L100 is the most money-saving system you can buy.

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183 Essex Street
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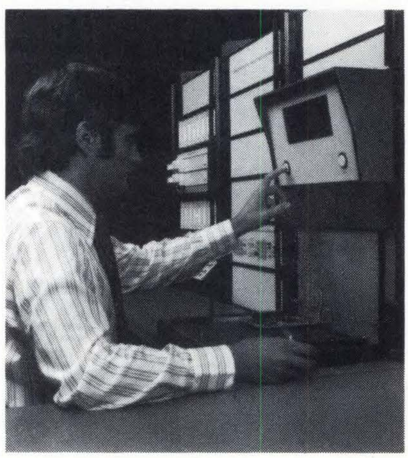

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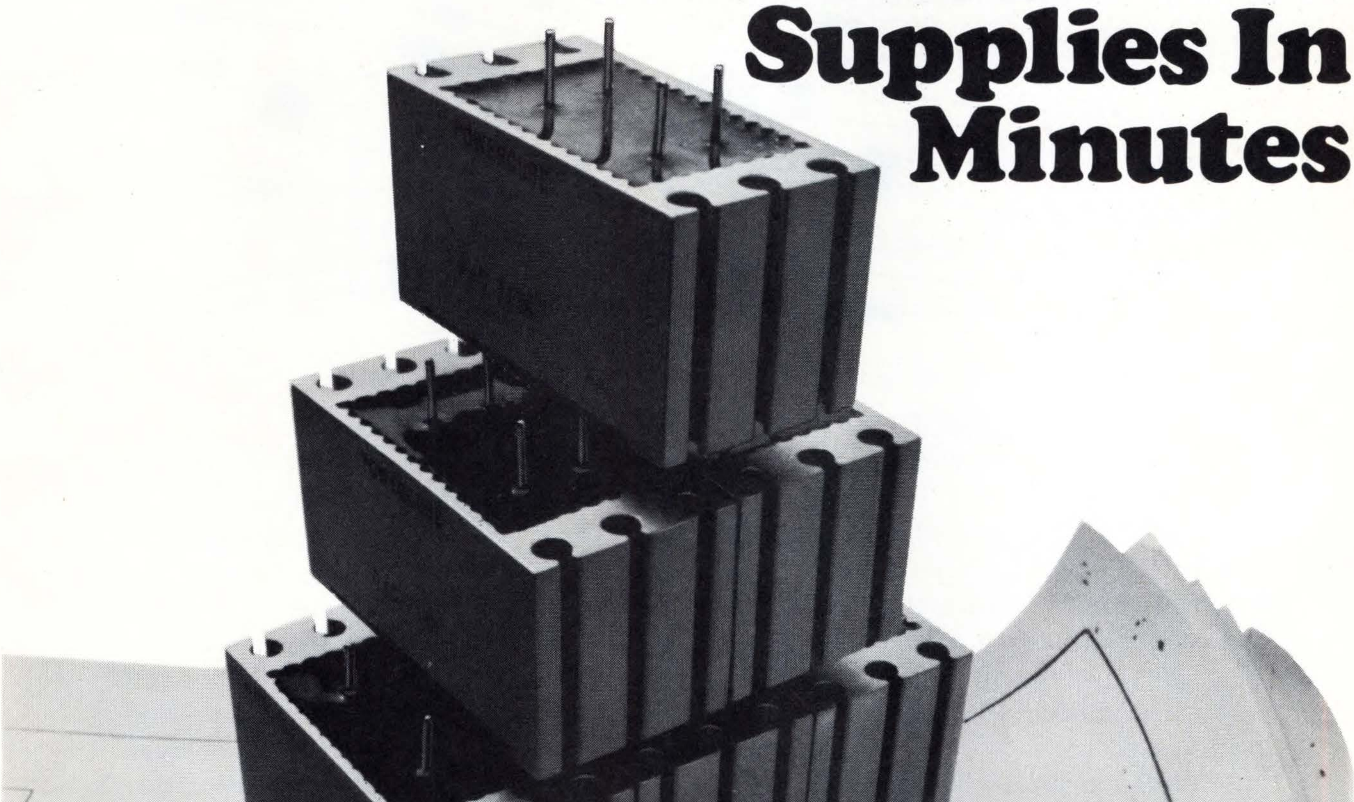
Original Powercube Module®

Cirkitblock functional modules not only save design time and money; they're also a lot of fun to work with. Circle reader service number to learn more about Powercube's Cirkitblock functional modules.

Breadboard Custom Power Supplies In Minutes



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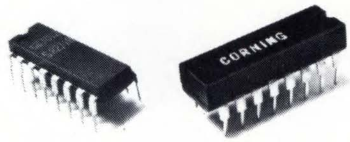
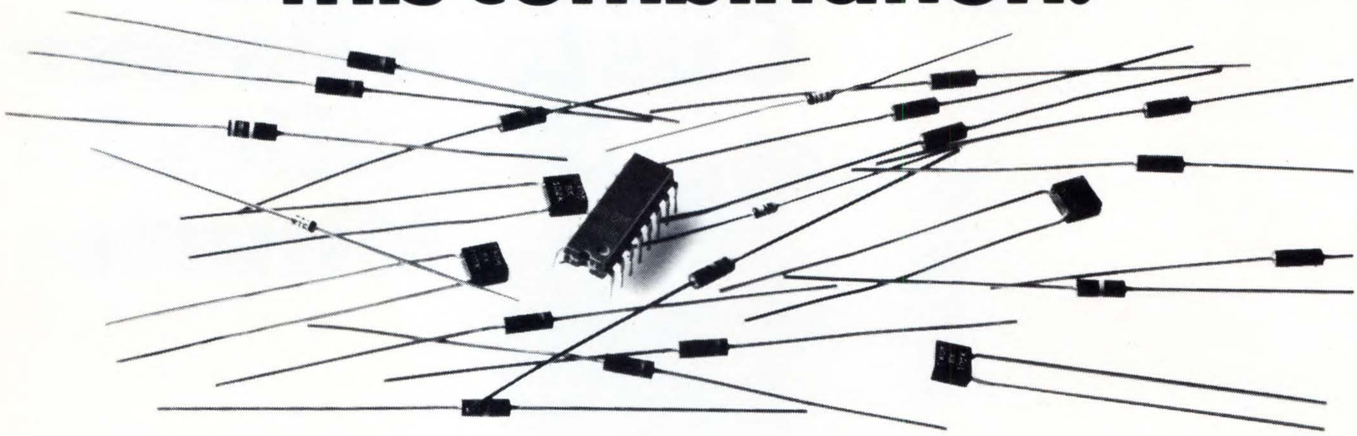
CIRCLE NO. 4

This Combination

Integrated circuit  CORDIP™ Component Network

replaces this combination.



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With combinations of up to 20 components in a standard 14-pin package. Up to 23 in a 16-pin package.

With virtually unlimited circuit complexity. With all inter-connections inside the pretested package.

Which gives you greater reliability and fewer production losses.

Combinations of resistors, capacitors and diodes with different tolerances, temperature coefficients and ratings are available in one package.

Which makes it possible to give you almost any custom combination you specify.

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And we can make prototypes quickly for you, with almost any combination you specify.

CORDIP component networks are ready to plug in and are fully compatible with IC sequencing and insertion equipment.

CORDIP component networks. You'll save a lot of board space and production costs; you'll gain a lot more reliability and flexibility.

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	Resistors	Capacitors	Diodes
Range	10Ω-150K	10-27,000 pF	Low Signal Silicon Planar Types
Tolerance	from 1%	from 5%	
TC	from 50 ppm	+ 2%, −10%	
Ratio	>15,000:1	>2,700:1	

CORDIP™ COMPONENT NETWORKS
From

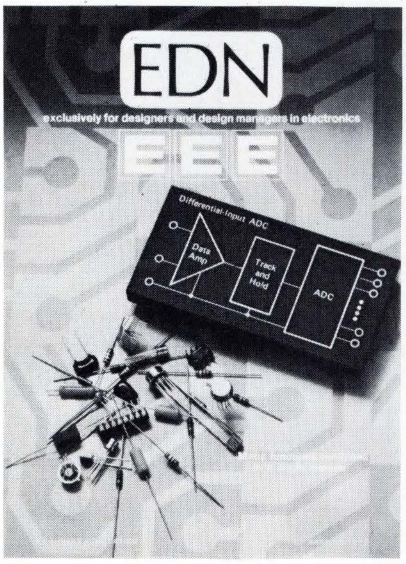
CORNING
ELECTRONICS

CIRCLE NO. 5

APRIL 15, 1972
VOLUME 17, NUMBER 8

EDN/EEE

EXCLUSIVELY
FOR DESIGNERS
AND DESIGN MANAGERS
IN ELECTRONICS



COVER
New hybrid modules from Function Modules, Inc., combine multiple circuit functions in a single package. For the complete story, see page .

DESIGN NEWS

DESIGN FEATURES

PROGRESS IN PRODUCTS

DESIGN PRODUCTS

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Mirror, mirror on the wall

We've always felt that a magazine should maintain perspective and never let its own image of itself cause it to lose track of reality. And when a magazine can do this under trying circumstances, we think it's a cut above most.

Such a case occurred recently with one of the American Medical Association's specialty journals. This particular journal is for dermatologists. It seems as if the editors accepted an advertisement from the FBI describing one of the 10 most-wanted criminals on the FBI's list.

The fugitive suffered from very severe acne, of a type that frequently requires medical attention. So the thesis was to alert those physicians who might likely be sought out by the fugitive. Little did the editors realize that by performing what they thought was a public service, they would unleash on themselves a storm of protest and criticism from both their readers and some in the higher echelons of the AMA.

Most of the criticism centered around medical ethics and the doctor/patient relationship. And some just complained that it was not in keeping with the professional image and tone of the journal.

Try as we may we can't find justification in such criticism, so we were pleased to read where the top editor said he couldn't either, and would do the same thing if he had it to do over again.

We saw a somewhat similar notice a few weeks ago in a national magazine aimed at amateur and professional photographers. This one asked anyone who had taken pictures at last year's Italian-American Appreciation Day parade in New York where Joseph Colombo was shot, to please contact the New York City Police Department.

As far as we know, this hasn't started any flood of criticism. So it would appear that either photographers are more public spirited than doctors or that doctors are more ethical than photographers. Or maybe it is just a case of some people tripping over their own image.

That brings us to our main point. Everyone has his own image of himself and his company, and engineers are no exception. Such self impressions are valuable insofar as they can boost self esteem and provide motivation. But when they begin to undermine one's job execution or relations with others, they are a decided handicap. Have you tripped over yours lately?

Frank Egan

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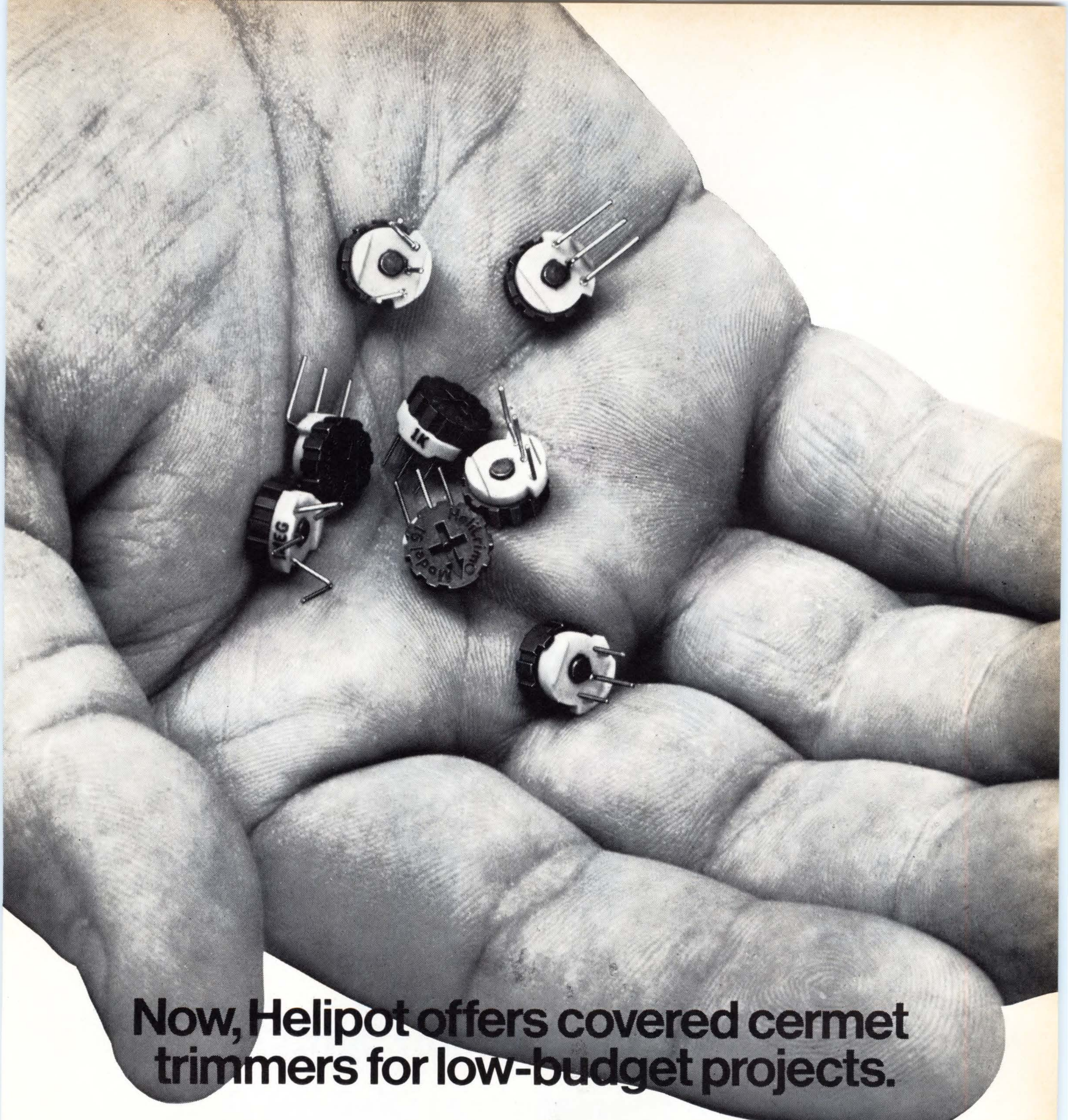

Now, Helipot offers covered cermet trimmers for low-budget projects.

There's not much sense in using cheap wirewound or carbon trimmers anymore. Not when the new Helipot Series 91 Cermet Trimmers are available *off-the-shelf* for a few cents more.

These single-turn, ⅜", covered trimmers come in 10 different mounting styles and 19 standard resistance values from 10 ohms to 2 megohms. Covered construction helps protect against moisture, corrosive atmospheres, dust, oil and other contamination. Which means, in addition to cermet stability and better resolution, you get long-term dependable performance.

The breakthrough price is just 35¢ each in the 50,000 piece quantity, and they're equally well-priced in other quantities.

Send now for complete data on the Series 91 Trimmers... the finest of their class. We've made them for your projects where the budget may be tight, but you don't want to compromise performance.

Beckman®
INSTRUMENTS, INC.
HELIPOT DIVISION
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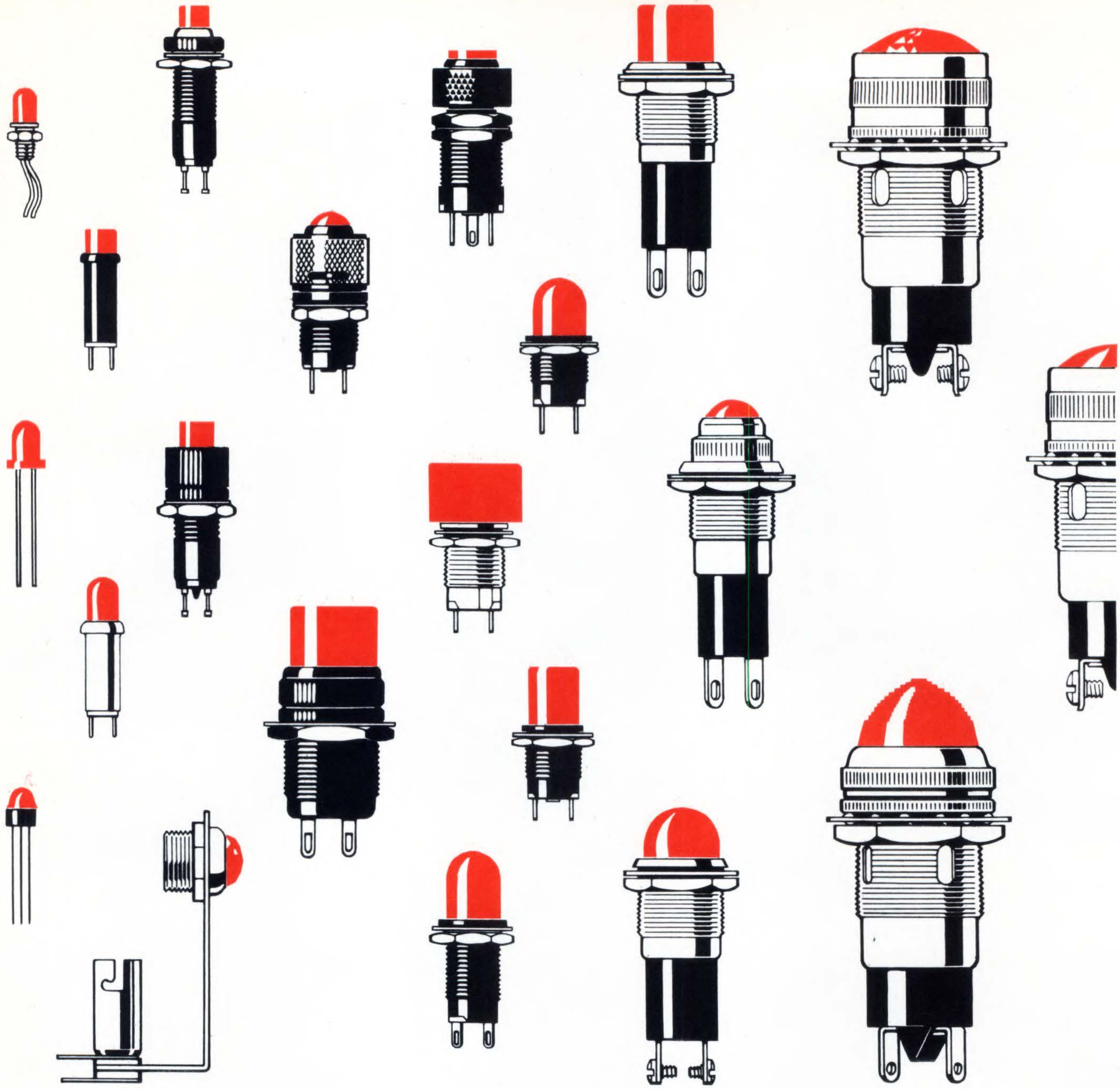
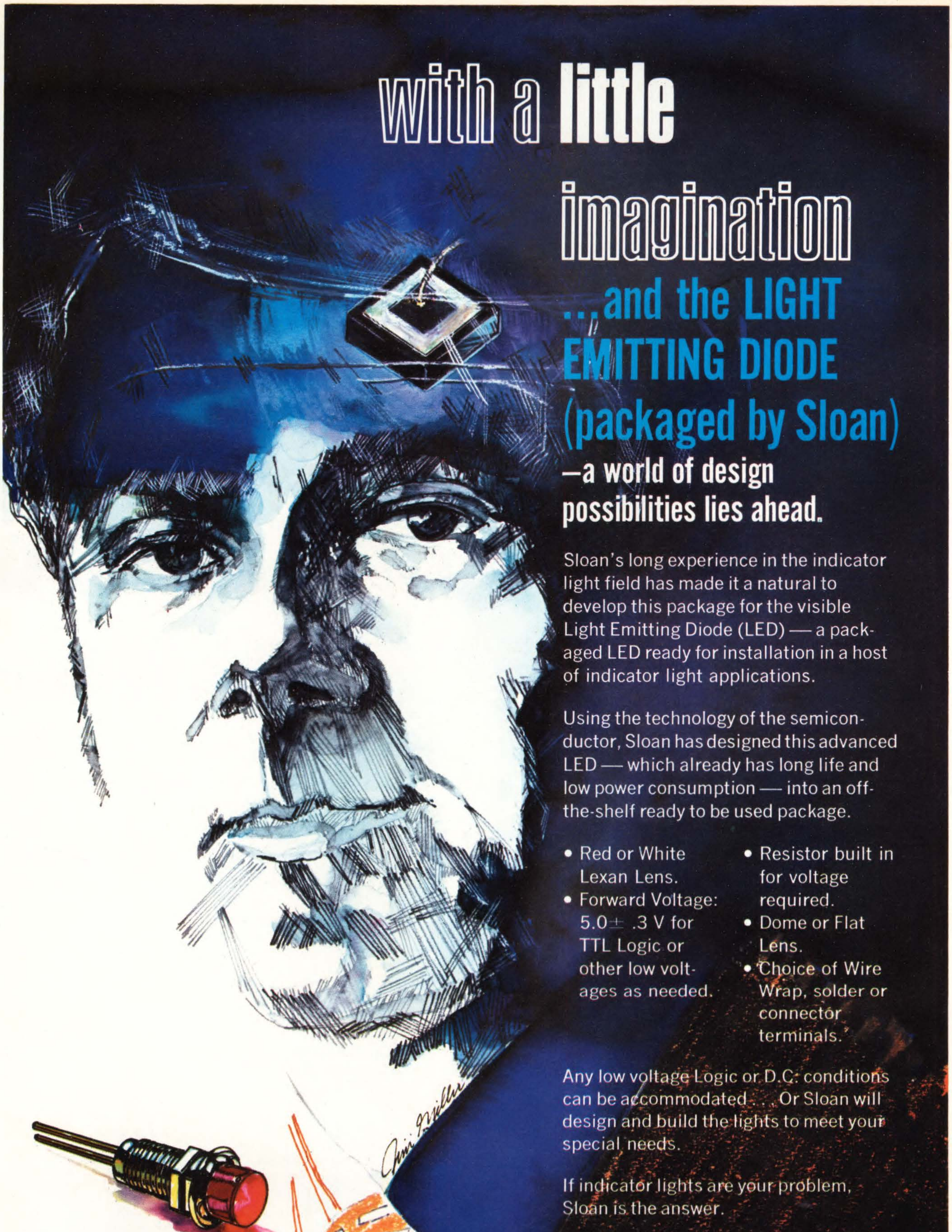
CIRCLE NO. 9




with a little
imagination
...and the LIGHT EMITTING DIODE
(packaged by Sloan)
—a world of design possibilities lies ahead.
Sloan's long experience in the indicator light field has made it a natural to develop this package for the visible Light Emitting Diode (LED) — a packaged LED ready for installation in a host of indicator light applications.
Using the technology of the semiconductor, Sloan has designed this advanced LED — which already has long life and low power consumption — into an off-the-shelf ready to be used package.
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Any low voltage Logic or D.C. conditions can be accommodated . . . Or Sloan will design and build the lights to meet your special needs.
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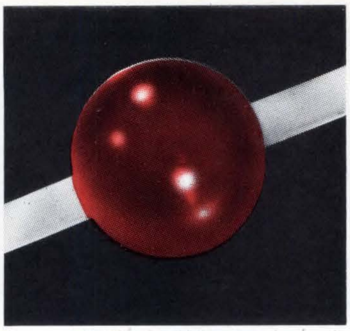
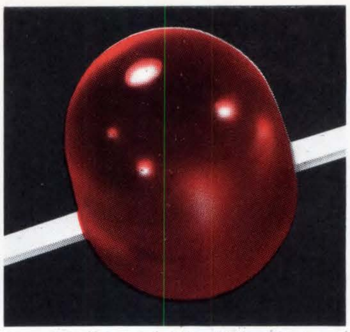
CIRCLE NO. 11


MLED50 Red LED Shows Big Performance
- 1 mcd luminous intensity
- PC-board mountable
- Wide viewing angle

CIRCLE NO. 73

MLED55 LED Turns Red from Any Angle
- 140° viewing angle
- New diffusing lens
- 600 μcd luminous intensity

CIRCLE NO. 74

MLED600 Mini-T* Gives High-Visibility Red
- 1,100 fL brightness
- Economical plastic
- Unique, molded lens

*TRADEMARK MOTOROLA INC.

CIRCLE NO. 75

MLED610 LED Offers High-Density Reliability
- Tiny, metal "pill" design
- 1,100 fL brightness
- Easy, PC-board mounting

CIRCLE NO. 76

See Us Speak In Our

Everybody talks about optoelectronic capability but nobody documents anything about it.
Nobody but Motorola.

DOCUMENTATION #1:

Motorola opto products are made on the same machines that turn out millions of plastic transistors *each week*. The same machines made Motorola the unquestioned production leader in this field in a few short years. Same stripline, leadframe stamping machines . . . same automatic die and wire bonders . . . same molding encapsulation processes. All tuned to instantaneous production of opto devices. Optomation.

DOCUMENTATION #2:

Lower-cost, highly-available opto products are final-tested on fully-automated and computerized semiconductor test equipment. You get Motorola's traditional, fast factory turnaround on all your factory orders. Optomation again.

Plastic IR LEDs Do Invisible Things @ 9,000 Å
- Spectrally-matched to silicon
- 350 or 550 μW output @ 50 mA
- Naturals for card/tape reading

CIRCLE NO. 81

Metal IR LEDs Emit 9,000 Å, Small or Large
- Tiny "pill" or TO-18 case
- 150 to 650 μW output
- Hermetically-sealed

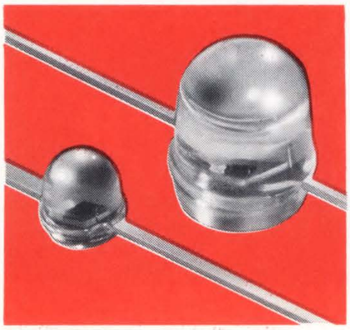
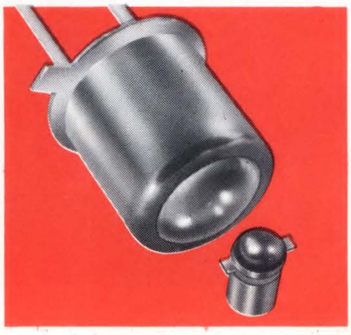
CIRCLE NO. 82

MRD500/510 PIN Photodiodes Respond In Nanoseconds
- 1 ns typical response
- Convex or flat lenses
- Sensitive through visible/near IR range

CIRCLE NO. 83

Plastic Photo Darlingtons Offer Economical Sensitivity
- 40-cent, 100-up prices
- typical sensitivities to 4 mA/mW/cm²
- Ideal for high-volume insertion

CIRCLE NO. 84

MLED630 Shines Out From TO-18 Package

- 120° field-of-view
- 1,100 red fL
- Panel indicator

CIRCLE NO. 77

MLED650 Lights Up Panel Indicators

- Wide viewing angle
- Mounting hardware available
- 200 mil bright viewing surface

ADVANCE INFORMATION

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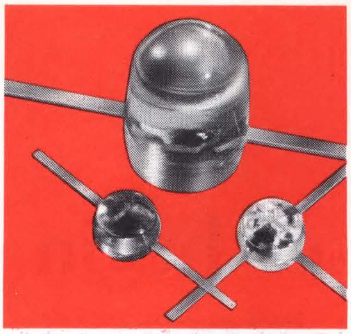
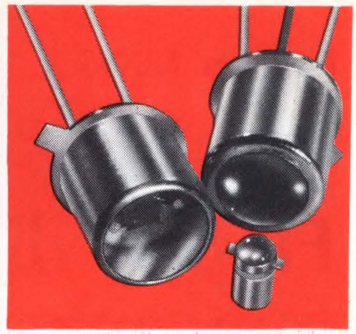


Plastic Photodetectors For All Arrangements

- High (MRD150) or moderate (MRD450) mounting densities
- Low-as-75¢, 100-up
- Sensitivities to 0.2 mA/mW/cm^2

CIRCLE NO. 79



Metal Photodetectors Are Fast And Rugged

- TO-18 or "pill"-cased
- Microsecond switching
- Curved or flat lenses

CIRCLE NO. 80

Volumes Living Color

DOCUMENTATION #3:

Motorola's huge investment in in-house, III-V raw material facilities including crystal-pulling and epitaxial deposition will ensure unparalleled wafer supplies to satisfy any and all high-volume requirements. Motorola, the production house of the industry.

DOCUMENTATION #4:

The largest factory and distributor sales organization in the semiconductor industry — over 750 trained technical salesmen and engineers — in 96 U. S. and Canadian locations — is ready to serve your prototype or production needs. Right now.

For the latest word on optoelectronics in new-design considerations, write on your letterhead for "Opto Glossary" — a handy new designer's aid with opto terminology, a complete offering of LEDs, couplers, displays and photodetectors plus comprehensive cross-reference data. Box 20912, Phoenix, AZ 85036.

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Let There Be Light

Custom Display Panels Count Up, Spell Out

Available with or without decoder drivers

- Any combination of alpha or numeric digits
- Ultra-reliable 0.7" digits

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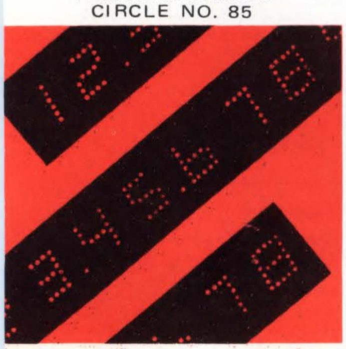
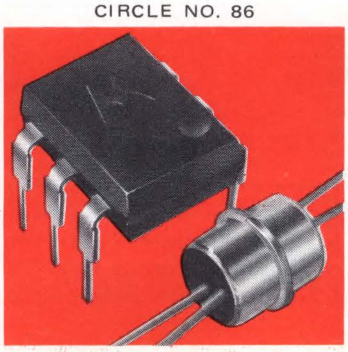


Opto Couplers Isolate Interfacing Perfectly

- 1,500 V dielectric isolation
- 60% transfer ratio — phototransistor
- Phototransistor or photodarlington

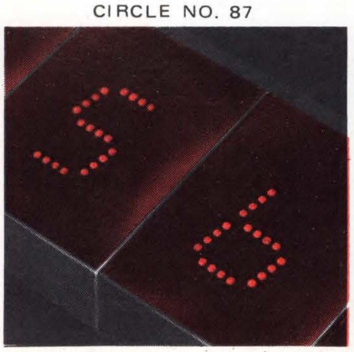
CIRCLE NO. 86



MOR10 Excellent Character For New Readout Role

- 0.120" character light
- Wide angle, single plane
- Straight or spread leads

CIRCLE NO. 87



MDP70 Displays 7/10" Readouts Through BCD Inputs

- Readable to 20 feet
- Compatible with T^{2}L
- Easy insertion to connector

ADVANCE INFORMATION

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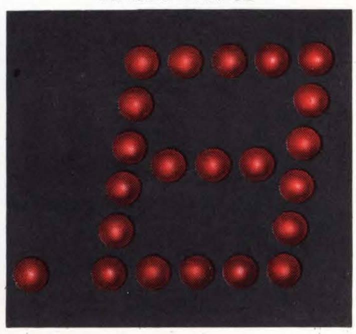


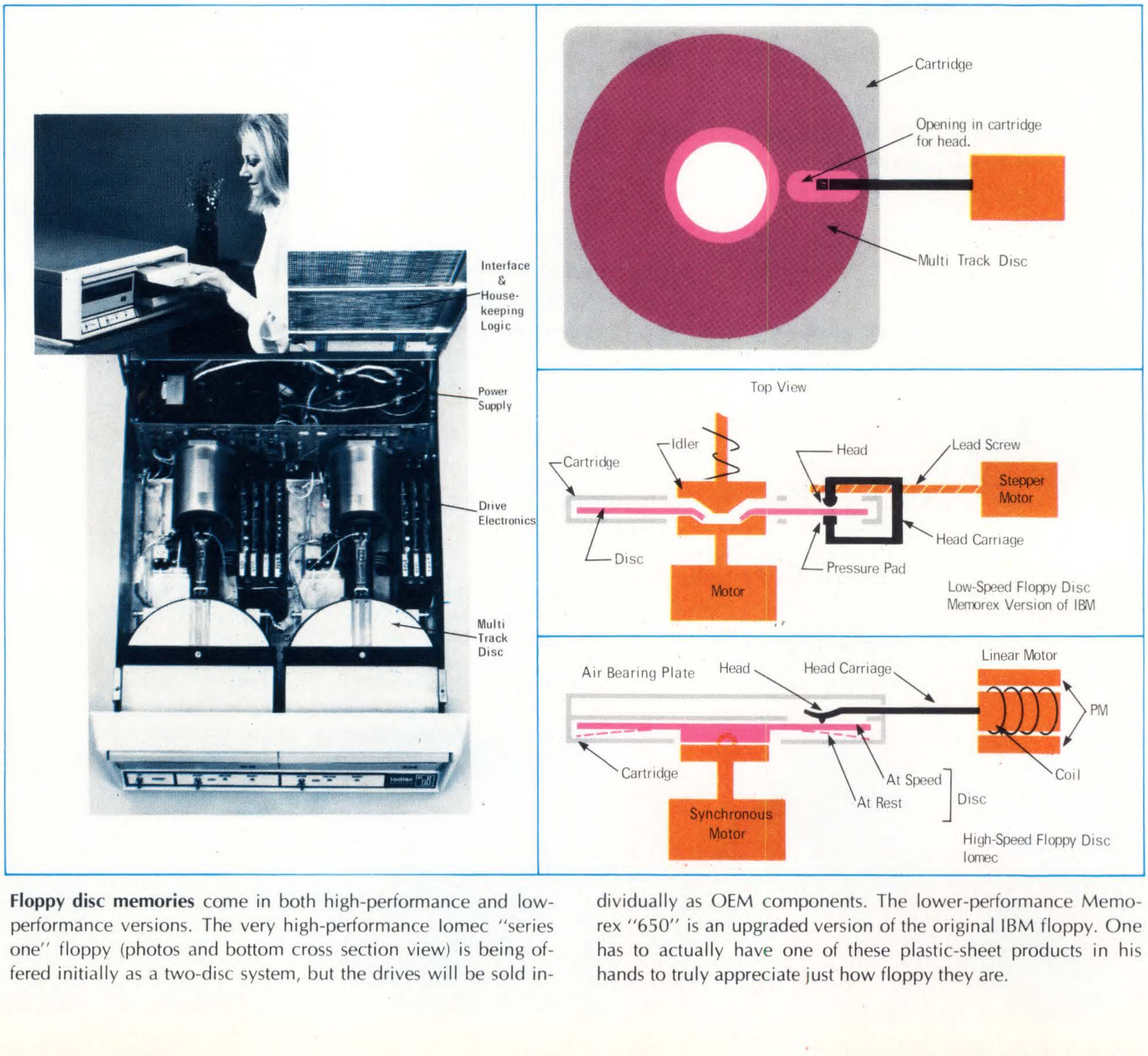
Floppy discs begin to enter the mini-mass-memory arena

Yet another form of moving-medium magnetic memory is joining the competition for the low-cost mini-bulk-memory market. This is the "floppy" disc. It will contend with the Philips cassettes and new tape cartridges for such applications as data-entry buffers, program loaders and minicomputer mass memories.

The floppy disc is physically a lot like the cheap flexible versions of 45 rpm audio records. They are just 7-1/2-in sheets of mylar, several mils thick, coated with magnetic oxide. The lowest-cost floppies are even housed in cartridges that look like plastic versions of the cardboard jackets 45 rpm records are sold in. The floppies, in their cartridges, are pushed into their record/playback drives like a coin is pushed into the slot in a modern pay telephone. A motor in the drive rotates the floppy inside its cartridge while a head contacts the tracks through a hole in the cartridge.

Companies who now offer floppies include: Memorex Corp. and Iomec, Inc. both of Santa Clara, Calif., Century Data Systems, Anaheim, Calif. and, of course, the originator, IBM, San Jose, Calif. In addition, Potter Instruments Co., Inc., Plainview, N. J., told EDN it is hard at work on a floppy that it expects to have on the market soon.

The appeal of these floppies is that



Floppy disc memories come in both high-performance and low-performance versions. The very high-performance Iomec "series one" floppy (photos and bottom cross section view) is being offered initially as a two-disc system, but the drives will be sold individually as OEM components. The lower-performance Memorex "650" is an upgraded version of the original IBM floppy. One has to actually have one of these plastic-sheet products in his hands to truly appreciate just how floppy they are.

they have high performance-to-cost ratios. They can have the high data transfer rates and relatively low access times of discs, yet be in the same price ball park as cassettes. The floppy cartridges, it is predicted, will sell at less than the $5 of a Philips cassette, once the volume rises (a Century spokesman said $2!). The drives will sell at roughly the $300-to-$500 level of a medium-to-high performance cassette drive, with volume. The total memory capacity will not equal the maximum obtainable with cassettes and certainly not that obtainable with some of the new 1/4'' tape cartridges; but for many applications, large capacity is not needed.

IBM started it all

The concept of a floppy was kicked off by IBM when it introduced its large 3330 disc file system just about a year or so ago. The 3330 used floppies for loading the micro-program into the controller. This original floppy was a slow, 90-rpm unit with an in-contact head and 1600 bpi density. Century Data Systems brought out an almost identical floppy as part of its plug-to-plug replacement for the 3330. But when Memorex was designing its version of the 3330, that company decided that the floppy concept had enough potential to warrant improvements. So Memorex increased the rpm to 375 and the density to 2337 bpi.

The sketch of the Memorex system indicates how these discs are driven despite their floppyness. The cartridge is slid in and held like a PC card in a card cage. An idler cone forces the center of the floppy disc against a rotating drive hub plate, and this rotates the disc inside the fixed cartridge. This is possible because the inside of the cartridge is lined with a silicone-lubricated bearing material—like a ''KemWipe'' tape cleaner. The read-write head is brought up to an opening in one side of the cartridge and a pressure pad brought up from the other. The head is moved from track to track by a lead screw driven by a stepper motor.

Memorex says the head life and data reliability of its disc is much superior to cassettes. They say they only have to use a light, 5 gm, pressure on the head and the wiping action of the silicone-impregnated lining gives them error rates as low as 10^{10}, compared to the 10^7 error rates for cassettes.

The as-yet-to-be-unveiled Potter floppy can be expected to be similar to IBM's, as Potter is also developing its floppy as part of a program to bring out a 3330 replacement.

Rough comparisons of various low-cost moving-magnetic-medium memories

	Floppy Discs			Mini-Tapes	
	IBM	Memorex	Iomec	Cassettes	Cartridges
Data transfer (kbit/sec)	33	200	1200	10	560
Cost, cartridge ($)	2-5	5	12-18	5-9	2-10
Cost, drive ($)	300-500	500-900	1600	100-500	100-1000
Average access time (msec)	800	200-300	60	10,000	1,000
Storage capacity (Mbits)	0.64	1.5	2	5	30
Disc dia. (in.)	7½	7½	7½	----	----
Disc speed (rpm)	90	375	1800	----	----
Recording density (bits/in)	1600	2337	3300	1600	3200
Recording speed (in/sec)	30	120	500-600	10-	10-80

In contrast to these IBM-inspired floppies, Iomec's floppy is more like a high-performance main-memory disc. It has the same 7-1/2-in dia., and the same several-mils-thick mylar base material, but there the similarity ends. Iomec spins its floppy at high speed—1800 rpm—so that centrifugal force holds it out. The disc is further stabilized by being spun against a flat aluminum plate in the middle of the cartridge. The aerodynamic forces between the floppy and this plate hold the disc so precisely positioned that a ''flying'' or no-contact head can be used. The head carriage rides in a slot in the plate and holds the head 80 μin. above the oxide coating on top of the floppy. This head, then, has no wear and never has to be cleaned.

Due to the much higher rotational speed and, to a lesser extent, Iomec's higher bit density, this floppy system achieves data transfer rates as high as 1200 kbits/sec. This compares favorably with those of large tape transports that operate in parallel.

The head is moved from track to track by a linear motor that consists of a ''voice coil'' piston operating inside a cylinder composed of two fairly large permanent magnets. Optical feedback is used to servo position this head drive over the tracks on the disc.

The price is higher cost

The Iomec floppy system is more bulky and expensive than the lower-speed in-contact floppies. The cartridge is almost an inch thick and it is rigid. The drive is larger and more complex. The cartridges are expected to cost $12 apiece even with large volume, and the minimum single-drive system will cost $1600. ☐

Think Twice:

Extra contribution is one way to the top. Specifying HP scopes will help you, too.

Here's why.

You're an engineer on the way up. Your ideas, your designs, your work all reflect the extra contribution you're making. (You might even slip back to "the shop" after dinner and on weekends.) Rewards won't be long in coming.

There's one more thing you can do for yourself and your management. Show them a way to cut operating expenses and boost profits. How? By being critical and downright hardnosed in making your cost/performance comparisons on instrument purchases.

Scopes Have Changed.

Take laboratory oscilloscopes for instance. In the past several years, scope design and performance have changed—for the better. Many companies, maybe yours, are in the process of replacing older scopes, to take advantage of the extra capability these new models offer. To get the best buy now, you're going to have to do more than look at the name tag and spec sheet. Plug-ins are not compatible. Calibration is completely different. Controls and operations have changed radically. It's a whole new ball game. *Little* that you learned or used on older scopes —*whether theirs or ours*—can be transferred to the new models. You need new techniques, new training materials, new parts. Here are three specific reasons why you should investigate the HP 180 Series... why you should think twice.

HP Scopes Cost Less To Buy

Analyze your total measurement needs, then ask both manufacturers to submit prices. On latest model plug-in lab scopes, you'll find that HP can consistently save you money — lots of it. For example on a 75 MHz non-delayed sweep, plug-in system, ours is 24% less (with delayed sweep, 18% less); at 100 MHz, ours is 16% less; for 1 GHz sampling, you'll pay 54% less if you buy ours.

HP Scopes Cost Significantly Less To Operate

Because scopes have changed, training, operation, calibration, and repair are expenses that you'll have to contend with—no matter which make you buy. HP's new scopes are supported by simplified operation and live or videotaped training and repair sessions that can substantially cut your start-up and overall operating costs.

Calibration? We've cut the number of adjustments by 50%—and eliminated interactive adjustments. Therefore, when you're comparing oscilloscopes be sure to include in that comparison the cost of calibrating each manufacturer's unit.

Our users are reporting shorter training periods, faster, surer measurements, and savings up to 50% on calibration time and costs. Some companies buying Hewlett-Packard, cite this as the main reason.

HP Technological Leadership. More Performance. Fewer Problems.

HP innovations in general purpose lab scopes include: the first scope with a real time bandwidth of >250 MHz; the first 18 GHz sampling scope; the first 100 MHz variable persistence and storage scope; and the first and only 100 MHz scope with a "big-picture" CRT (8x10 div, 1.3 cm/div). These are meaningful, functional innovations that boost your performance, not your costs.

Think twice! Once you make the comparison, we're certain you'll choose HP. Many engineers like yourself—engineers on the way up —have already made the switch. For more information on how you can help your company boost profits and how you can help yourself make faster, more positive measurements, write for our free "No Nonsense Guide To Oscilloscope Selection."

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OSCILLOSCOPES

082/6

CIRCLE NO. 13

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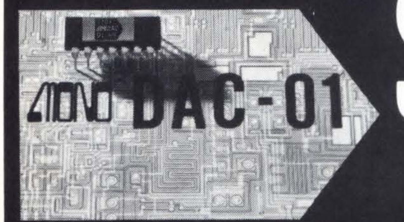

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• Input: 115 VAC ±10% 47 to 440 Hz; • Outputs: From 5 to 28 VDC, Current to 35 AMPS; • Ripple: 1 mv RMS; • Response: 20 to 50 μsec. typical; • Foldback current limiting overload protection.

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CIRCLE NO. 15

From 3M...

Flammability protection

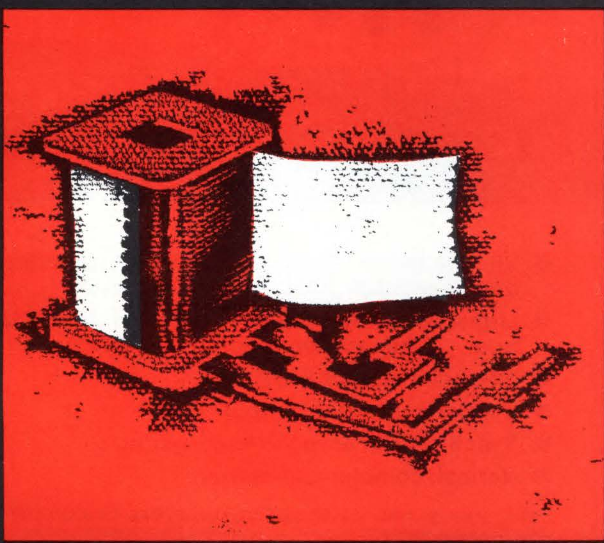
New flame retardant materials for insulation safety.

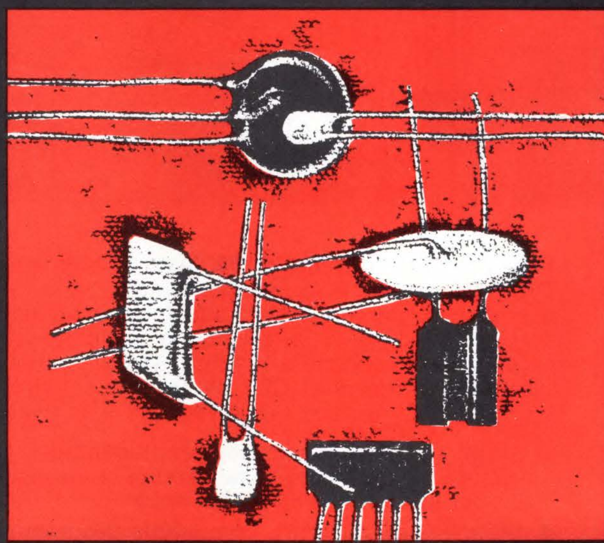
"SCOTCH" BRAND FLAME RETARDANT TAPE NO. X-1266.

Resin-fiber construction with flame-retardant pressure-sensitive thermosetting adhesive for 130°C use. Excellent conformability. Handles like conventional paper or acetate cloth tapes. Flame-out in 3 seconds or less (ASTM-D1000-70 test). Meets UL flame retardancy requirements for SE-O materials, as well as UL Standard 492.

"SCOTCHCAST" BRAND FLAME RETARDANT RESIN NO. XR-5217.

For radial and axial lead components — thermistors, resistors, RC networks, film foil, ceramic, tantalum, diced chip and mica capacitors. Suited for semi-automatic or automated production equipment. Coats at 300°-350°F. Fast cure time: 2 min. at 350° to 30 min. at 275°F. Meets flame retardancy requirements of UL Standard 492.





Check these other flame retardant materials.

"SCOTCH" BRAND TAPES.

No. 69 — glass cloth, thermosetting silicone adhesive.
No. 66 — vinyl, UL recognized 105°C meets MIL-1-7798-A.
No. X-1264 — epoxy web solvent-resistant wire and cable ID tape.
"Temflex" Brand No. 2585 — non-adhesive vinyl plastic, flexible, self-extinguishing.

"SCOTCHCAST" BRAND RESINS.

No. XR-5192 — arc and track-resistant 130°C, liquid epoxy.
No. XR-5126 — room-curing two-part epoxy, 130°C, semi-flexible.
No. 255 — thermal and mechanical shock-resistant, 130°C, meets MIL-1-16923E.

TUBINGS.

"3M" Brand 3001, 3002, 3003, 3008 — extruded vinyl, general purpose, 105°C rated.
"Scotchtite" No. 3028 — heat shrinkable, clear or colors, thin wall. UL recognized 105°C, meets MIL-1-631 and MIL-1-23053B.

COPPER CLAD.

"Cuflex" Brand Flexible Laminate 6540 — copper-clad epoxy polyester web for printed wiring.

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Dielectric Materials & Systems Division 3M COMPANY

CIRCLE NO. 29

Your computer will find a 150 "easy to talk to"
The 150 automatic pulse generators were engineered with your test system and its many variations in mind, resulting in an all-around flexibility which permits you to choose a 150 that FITS your specific system requirements. Choose from the following standout features and FIT a 150 into your system:

- **Serial by 12-bit character programming (using built-in pulser memory) or parallel programming if your system has memory capability**
- **BCD format, DTL/TTL compatible programming inputs**
- **Positive or ground true logic**
- **With or without manual control capability**

And . . . even if your system isn't computer controlled, there's a 150 that FITS. Automatic, semi-automatic or manually controlled, your system will like a 150 . . . so will your budget!

150 means quality pulses to fit the most exacting requirements
The 150 outputs match the flexibility of the programming inputs with the finest pulses available — from any pulse generating equipment:

- **Every repetition rate to 50 Megahertz**
- **Delay and width from 10 nanoseconds to 10 milliseconds**
- **Voltage levels (pulse top and baseline) independently settable from -10 to $+10$ volts**
- **Linear transition times independently settable from <5 nanoseconds to 10 microseconds**
- **Internal/external triggering**
- **Normal/pulse pair output**
- **Synchronous/asynchronous gating**
- **Normal/complement output**

And, every one of these parameters is completely programmable.

To learn how the remarkable 150's FIT into your pulse testing program, contact your nearby Scientific Devices man, or call us direct . . . today. **Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, Calif. 90230. Tel: 213/836-6100. TWX: 910-340-6766 Telex: 67-3219**

OR, IF YOU NEED A COMPLETE TEST SYSTEM but don't need the problems of doing it yourself, call Jim Cunningham at Systron-Donner Computer Systems, (415/682-6161 — ext. 355) . . . He'll put together a complete system to FIT your particular test requirements.

SYSTRON DONNER

CIRCLE NO. 10

COOL POWER FROM SEMTECH	# SEMTECH NEWS	SILICON RECTIFIERS & ASSEMBLIES CERAMIC CAPACITORS

Published from time to time by SEMTECH CORPORATION • 652 Mitchell Road, Newbury Park, California 91320 / Phone: (805) 498-2111

METOXILITE RECTIFIERS SET INDUSTRY STANDARDS

Metoxilite, the material that pushed Semtech to the forefront of the industry for sub-miniature medium power silicon rectifiers, now makes its debut in a whole new spectrum of "state-of-the-art" devices. Metoxilite (metal oxides) is fused to the metallurgically bonded junction-tungsten pin assembly forming a "tough" sub-miniature package. Designed to electrically approach the theoretical, the Metoxilite rectifier, introduced in 1969, is the result of years of applied research and extensive testing. You'll see them used in stringent military and space environments as well as industrial and commercial applications. JAN and SIN parts available in most types.

PRESENT STANDARDS

The Metoxilite 3-amp series is the first family introduced by Semtech. Supplied in an axial leaded package, it filled the product gap in the industry between the lower current axial leaded rectifier and the higher current stud packages.

3-AMP METOXILITE RECTIFIERS (6-AMP/MIL-STD-750)

MEDIUM RECOVERY (Trr) 2 μs
Peak Inverse Volt.: 200, 400 600, 800 & 1000V
Reverse Current @ 25°C: 1.0 μA; @ 100°C: 20 μA
Forward Voltage @ 3A, 25°C: 1.0 to 1.1V
Single Cycle Surge: 150A; Recurrent Surge: 25A
Body Dimension: .165″ D x .165″ L
Types: 1N5550-54

FAST RECOVERY (Trr) 150-250 ns
Peak Inverse Voltage: 50, 100, 200, 400 & 500V
Reverse Current @ 25°C: 1.0 μA; @100°C: 20 μA
Forward Voltage: @ 3A, 25°C: 1.1V
Single Cycle Surge: 150A; Recurrent Surge: 25A
Body Dimension: .165″ D x .165″ L
Types: 1N5415-19 **CIRCLE NO. 20**

RECTIFICATION EFFICIENCY IMPROVED

The Metoxilite LO VF rectifiers open the door previously barred to the designer who required high efficiency rectification with ultra fast recovery times. These units are ideally suited to today's power supply design technology.

LO-VF WITH FAST RECOVERY (Trr) 100 ns
Peak Inverse Voltage: 30 and 50V
Reverse Current @ 25°C: 1.0 μA; @100°C: 20 μA
Forward Voltage @ 3A, 25°C: 0.9V
Single Cycle Surge: 150A; Recurrent Surge: 25A
Body Dimension: .165″ D x .165″ L
Types: 3L03 & 3L05 **CIRCLE NO. 21**

RADIATION RESISTANT RECTIFIERS

Specifically designed to operate in a radiation environment. Now available in Metoxilite. Extremely rugged part is ideally suited for missile and space applications.

Peak Inverse Voltage: 100, 200, 300 & 400V
Average Rectified Current: 1A
Forward Voltage @ 1A 25°C: 1.2V
Reverse Current @ 25°C: 1 μA; @ 100°C: 25 μA
Single Cycle Surge: 30A; Recurrent Surge: 6A
Reverse Recovery: (Trr) 300—1000 ns
Body Dimension: .070″ D x .165″ L
Types: R1, R2, R3 & R4 **CIRCLE NO. 22**

THE WORK HORSE

The Metoxilite 1-amp rectifier family introduced with the 3-amp family has since become the workhorse of the industry. Utilizing the .060″ diameter die, it offers more capability than the similar devices now available in the industry.

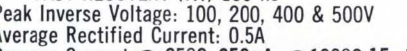
1-AMP METOXILITE RECTIFIERS (3-AMP/MIL-STD-750)

MEDIUM RECOVERY (Trr) 2 μs
Peak Inverse Volt.: 200, 400 600, 800 & 1000V
Forward Voltage @ 1A. 25°C: 1.2V
Reverse Current @ 25°C: 0.5 μA; @100°C: 25 μA
Single Cycle Surge: 50A; Recurrent Surge: 10A
Body Dimension: .065″ D x .165″ L
Types: 1N5614-22

FAST RECOVERY (Trr) 150-500 ns
Peak Inverse Volt.: 200, 400, 600, 800 & 1000V
Forward Voltage @ 1A. 25°C: 1.2V
Reverse Current @ 25°C: 0.5 μA; @100°C: 25 μA
Single Cycle Surge: 25A; Recurrent Surge: 6A
Body Dimension: .065″ D x .165″ L
Types: 1N5615-23 **CIRCLE NO. 23**

NEW GENERATION 1N645

Our new ½-amp Metoxilite rectifier is small enough to replace the unreliable whisker type devices (1N645-7). This rectifier is now available in the Metoxilite non-cavity case with a high temperature metallurgically bonded internal assembly.

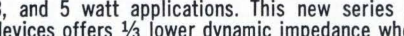


NEW ½-AMP METOXILITE RECTIFIER

MEDIUM RECOVERY (Trr) 2 μs
Peak Inverse Volt.: 200, 400, 600, 800 & 1000V
Average Rectified Current: 0.5A
Reverse Current @ 25°C: 100 nA ; 100°C: 7 μA
Forward Voltage @ 0.5A, 25°C: 1V
Single Cycle Surge: 25A; Recurrent Surge: 5A
Body Dimension: .070″ D x .165″ L
Types M2, M4, M8 & M0

FAST RECOVERY (Trr) 150 ns
Peak Inverse Voltage: 100, 200, 400 & 500V
Average Rectified Current: 0.5A
Reverse Current @ 25°C: 250 nA; @100°C: 15 μA
Forward Voltage @ 0.5A, 25°C: 1V
Single Cycle Surge: 12.5A; Recurrent Surge: 3A
Capacitance @ 4V: 20 pF
Body Dimension: .070″ D x .165″ L
Types: F1, F2, F4 & F5 **CIRCLE NO. 24**

LO-DYNAMIC Z-ZENERS



Semtech's new Metoxilite low dynamic impedance zeners offer voltages of 30 to 120 volts for 1, 3, and 5 watt applications. This new series of devices offers ⅓ lower dynamic impedance when compared at the same operating current to those presently available. As an added plus, the device is radiation resistant. The zener body measures .165″ long (max.) and is .110″ in diameter (max.). Types SX30-120. **CIRCLE NO. 25**

FOR VOLTAGE MULTIPLIERS

Introducing the Ministac in Metoxilite, multi-chip high voltage rectifier, particularly adaptable for high frequency applications such as voltage multipliers.

NEW METOXILITE MINISTAC

MEDIUM RECOVERY (Trr) 2 μs
Average Inverse Voltage: 2, 3, 4, & 5 KV
Average Rectified Current: 125 mA
Reverse Current @ 25°C: 100 nA; @100°C: 7.0 μA
Forward Voltage @ 125 mA, 25°C: 5V
Single Cycle Surge: 7A; Recurrent Surge: 1.25A
Body Dimension: .070″ D x .215″ L
Types: M20, M30, M40 & M50

FAST RECOVERY (Trr) 250 ns
Peak Inverse Voltage: 1.5, 2.0, 2.5 & 3 KV
Average Rectified Current: 100 mA
Reverse Current @ 25°C: 100 nA; @100°C: 7.0 μA
Forward Voltage @ 100 mA, 25°C: 5V
Single Cycle Surge: 5A; Recurrent Surge: 1.25A
Body Dimension: .070″ D x .215″ L
Types: F15, F20, F25 & F30 **CIRCLE NO. 26**

SUB-MINIATURE HIGH VOLTAGE METOXILITE RECTIFIERS

A sub-miniature high voltage rectifier obtained by Semtech's unique technology. A multi-junction device high temperature metallurgically bonded and fused in a non-cavity Metoxilite case. This small device is designed to solve packaging problems where size and environmental criteria are critical.

MEDIUM RECOVERY (Trr) 2 μsec
Peak Inverse V: 1000, 1500, 2000, 2500 & 3000V.
Average Rectified Current: 250 mA
Forward Voltage @ 100 mA, 25°C: 3.5V
Reverse Current @ 25°C: 1 μA; @ 100°C: 20 μA
Single Cycle Surge: 14A; Recurrent Surge: 2.5A
Body Dimension: .110″ D x .215″ L
Types: 1N3643-47 & SM20, SM25 & SM30

FAST RECOVERY (Trr) 300 ns
Peak Inverse Voltage: 1500, 2000 & 2500V
Average Rectified Current: 250 mA
Forward Voltage @ 100 mA, 25°C: 4V
Reverse Current @ 25°C: 1 μA; @ 100°C: 20 μA
Single Cycle Surge: 10A; Recurrent Surge: 2.5A
Body Dimension: .110″ D x .215″ L
Types: S15F, S20F & S25F **CIRCLE NO. 27**

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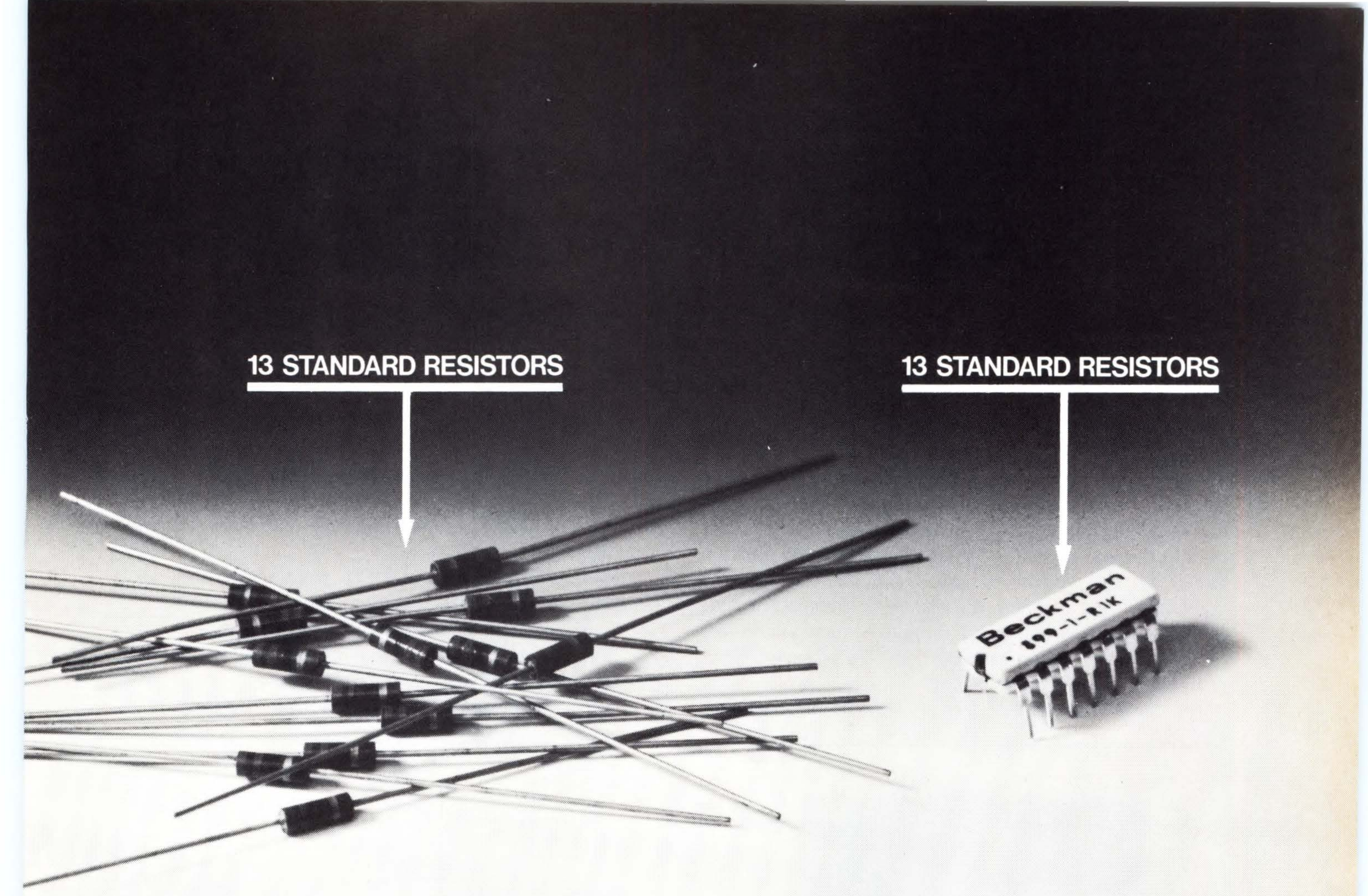

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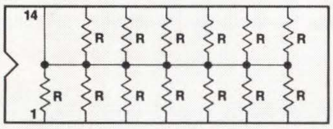
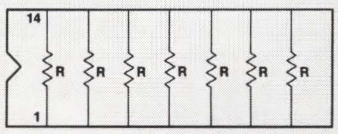


MODEL SERIES 899-1
Resistance Values (ohms): 100, 150, 220, 330, 470, 680, 1K, 1.5K, 2K, 2.2K, 3.3K, 4.7K, 6K, 6.8K, 10K, 15K, 22K.
Common Applications: Digital pulse squaring; MOS/ROM pull-up/ pull-down; "wired OR" pull-up; power driver pull-up; open collector pull-up; TTL input pull-down; TTL unused gate pull-up; high-speed parallel pull-up.
Standard Tolerance: ± 2.0%

Pricing:		
	1-99	$1.45
	100-499	1.12
	500-999	0.97

MODEL SERIES 899-2
Resistance Value (ohms): 10K
Common Applications: Inverting operational gain; potentiometric gain; differential gain; noninverting gain; gain adjustment.
Standard Tolerance: ± 2%

Pricing:		
	1-99	$2.75
	100-499	2.15
	500-999	1.86



MODEL SERIES 899-3
Resistance Values (ohms): 68, 100, 110, 150, 220, 330, 470, 680, 1K, 1.5K 2.2K, 3.3K, 4.7K, 6.8K, 10K, 15K, 22K.
Common Applications: Line termination; long-line impedance balancing; power gate pull-up; ECL output pull-down resistors; LED current limiting; power driver pull-up; "wired OR" pull-up; TTL input pull-down.
Standard Tolerance: ± 2%

Pricing:		
	1-99	$1.25
	100-499	0.99
	500-999	0.86

Don't forget the optical isolator when solving your coupling problems

This easy-to-apply device combines the speed and reliability of a semiconductor and the electrical isolation of an electromechanical relay.

Mike Bottini, Monsanto Commercial Products Company

The field of solid-state optoelectronics is providing today's designer with a wide range of extremely useful devices and design techniques. And nowehere is this more evident than in the area of opto-isolators. These versatile devices, which are also known as optical couplers, can provide convenient replacements for electromechanical components such as reed relays or pulse transformers in applications where the requirements of long life or severe environmental conditions are critical.

The basic opto-isolator (**Fig. 1**) consists of a gallium-arsenide (GaAs) infrared light-emitting diode (LED) optically coupled to a photo-sensitive silicon detector, which may be a diode, a transistor or an SCR. Both the light-emitting diode and the detector are contained in the same package. Attractive characteristics of the opto-isolator include:

- The electrical isolation of an electromechanical relay
- The speed of a semiconductor
- The reliability and long life of a semiconductor

In addition, new packaging techniques and high-volume production are rapidly bringing the price of opto-isolators down to the point where they now compete with coupling devices like pulse transformers and reed relays.

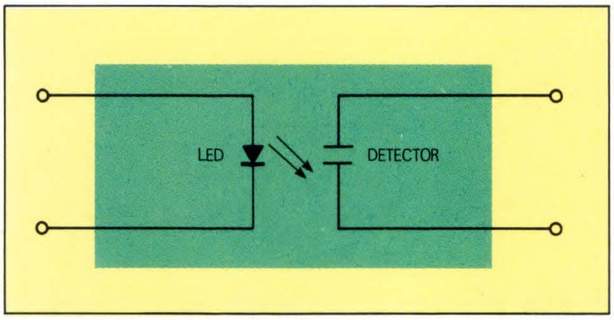


Fig. 1. The basic opto-isolator consists of, within a single package, a GaAs light-emitting diode optically coupled to a photosensitive detector.

The following examples show some of the typical applications where opto-isolators are well suited because of their unique characteristics. A conceptual rather than a "cook book" approach is used in the examples, since the purpose is to show typical capability rather than detailed design.

Digital signal isolation

The coupling of data loggers, card punches, typewriters and other peripheral equipment into a computer system generally creates intolerable problems with the computer. These problems present themselves as ground loops, noise spikes, and other common impedance problems. The electromechanical approach to solving these problems is shown in **Fig. 2**. This approach, however, has the following disadvantages:

- The transfer rate of information has been sharply reduced because of slow reed-relay speeds.
- Bouncing reeds can cause problems in the computer.
- Diodes must be added across each relay coil to prevent destruction of the drive gates and terminations.
- Resistors must be added across the coil to prevent the coaxial cable from ringing.
- Maintenance costs are high. One intermittent reed relay can keep the system down.

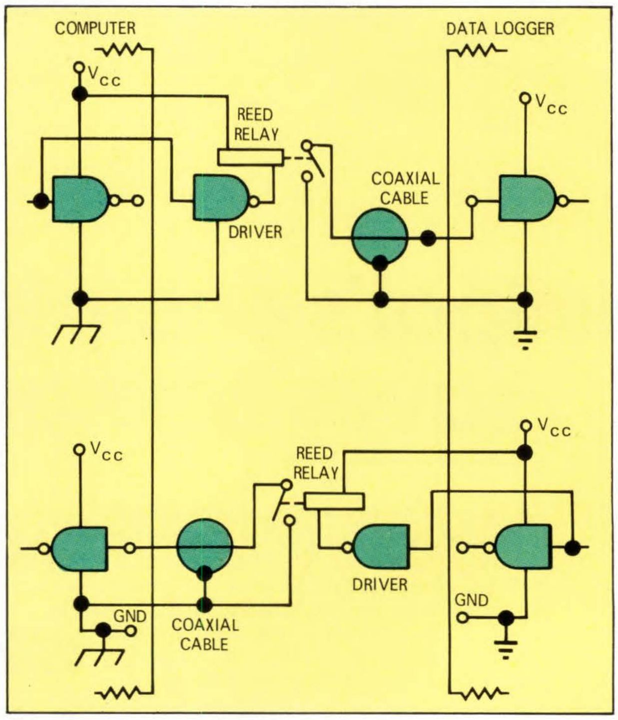


Fig. 2. The electromechanical coupling of peripheral devices into a computer system generally involves reed relays. This technique suffers drawbacks caused by the slow speed and mechanical nature of the reeds.

Using opto-isolators, a data logger is connected to the computer as shown in **Fig. 3**. This design employs a balanced line driver at each generator terminal and a balanced line receiver at each input terminal. The generator and receiver are interconnected using 300-ohm twisted pair. Diodes D_1 and D_2 balance the line receivers. These diodes can be visible LEDs and can be used to indicate the logic level of the receiver.

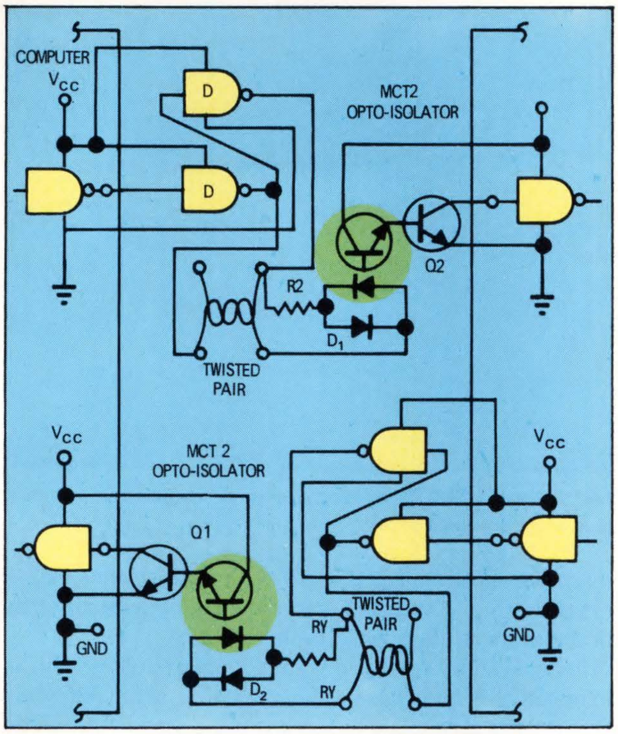


Fig. 3. Opto-isolator coupling of peripheral devices into a computer system eliminates many of the problems inherent in the use of electromechanical coupling.

Triggering SCRs

Many applications involve the triggering of high-voltage, high-power SCRs from low-voltage, low-power logic circuits. Electrical isolation between the logic and the SCR is a requirement in such a scheme. One way of doing this is shown in **Fig. 4a**. In this arrangement the photosensitive element, which is an SCR, must support the full system voltage. Blocking voltages available with photo-SCR type opto-isolators range from 200 to 600V. The current required to trigger the power-SCR is adequately handled by the photo-SCR, which has 1/8A capability.

Another method for triggering an SCR, using a phototransistor as the photosensitive element, is shown in **Fig. 4b**. In this example a floating power supply is used to bias the transistor. This would be economical if many SCRs were being triggered. Note that the phototransistor does not "see" the SCR blocking voltage, inasmuch as it is triggering at the gate-cathode portion of the SCR.

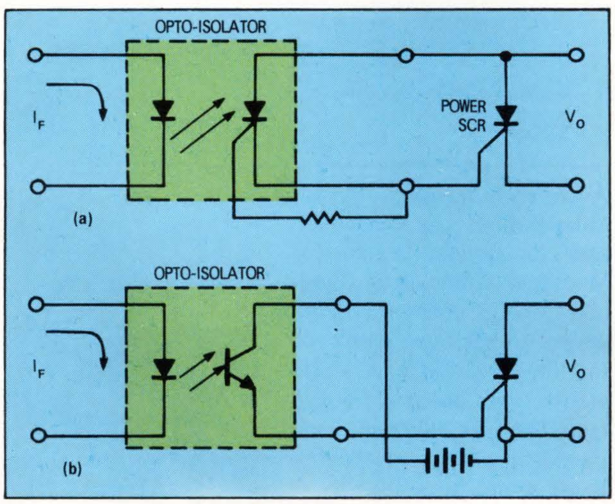


Fig. 4. High-power SCRs can be triggered conveniently from logic circuits by opto-isolators. Either a photo-SCR (a) or a phototransistor (b) can be used as the photosensitive element.

Triggering triacs

Using opto-isolators for triggering triacs is similar to triggering SCRs, in that isolation from the logic source is of absolute importance. One method of optically triggering triacs is shown in **Fig. 5**. With this method it is possible to control 80A, 600V triacs with as little as 20 mA at 1.3V via the light-emitting diode! The diode bridge is used to convert the ac signal to dc for the photo-SCR. Whereas the ac would turn the SCR on and off, it is desired that the SCR be controlled only by the light-emitting diode, not the ac line.

Patient isolation in medical electronics

As the medical electronics market looks to an ever-expanding patient monitoring market, the interest in increased safety and reliability in this equipment continues to grow. In these applications the patient is used as the signal generator. The signal produced must then be transmitted to monitoring equipment, which must be electrically isolated form the patient. Optical isolators can be used to perform this task (**Fig. 6**).

Solid-state relays (for power applications)

The term solid-state relay is frequently misused and misunderstood. It has meant anything from FET switches to reed-triggered triacs. Since the term solid-state grew out of semiconductor technology, it would seem proper that the term "solid-state" be confined exclusively to the description of devices that are 100 percent semiconductor. In this more precise use of the term a reed-triggered triac would not be a solid-state relay.

At the other end of the definition spectrum, what criteria determine that a device be considered a "relay"? The fun-

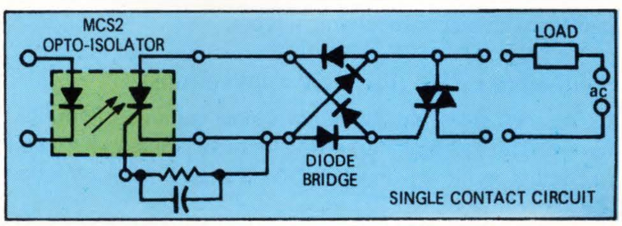


Fig. 5. The triggering of triacs with opto-isolators is accomplished relatively easily. The diode bridge converts the ac to the dc required by the SCR.

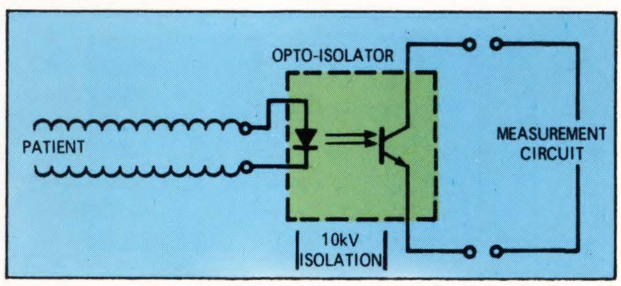


Fig. 6. Excellent isolation between patient and monitoring equipment can be achieved by opto-isolators when used in medical electronic applications.

damental feature of a relay is the total electrical isolation of the control circuit from the driven circuit. Relay isolation is normally characterized by a minimum of 500V at $10^{10}\Omega$ of isolation between coil and contacts. Yet, many "solid-state relays" sold today do not have over 50V of electrical isolation.

Within the strictest definition the opto-isolator allows one to construct a 100 percent semiconductor, totally isolated, (to 10,000V if necessary) solid-state relay (**Fig. 7**).

At this point in time the most economical solid-state relay

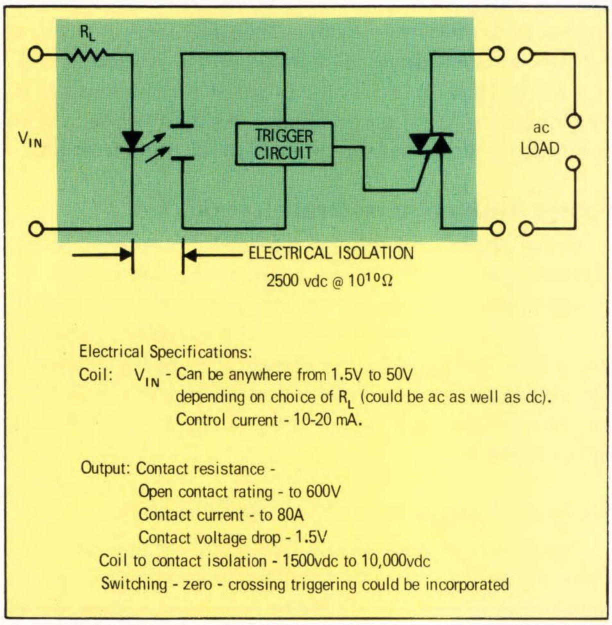


Fig. 7. A 100% solid-state relay can be built using an opto-isolator. Isolation to 10,000V is possible with such a unit.

relative to electromechanical relays is the SPST. It is possible, however, to construct solid-state DPDT relays, although the economics are not appealing. In time, though, the traditional semiconductor cost-volume curves will undoubtedly bring solid-state relays into direct price competition with electromechanical types.

Solid-state relays (for logic applications)

The reed relay has gained wide acceptance in applications requiring a high degree of electrical isolation from coil to contact and a very low "on" resistance. Signals switched are generally below 125 mA.

In some cases the electromechanical task the relay performs can be performed better with an opto-isolator. Equivalent opto-isolator circuits for two popular types of reed

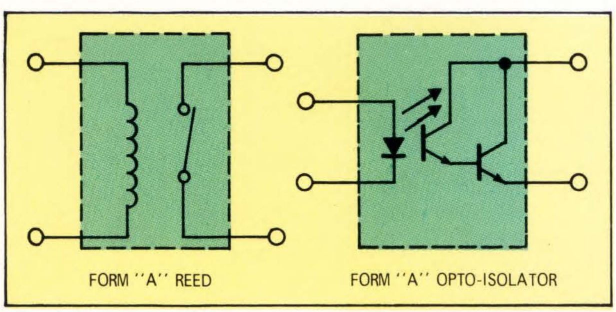


Fig. 8. Form A (SPST) relays can be of the reed type or the opto-isolator type.

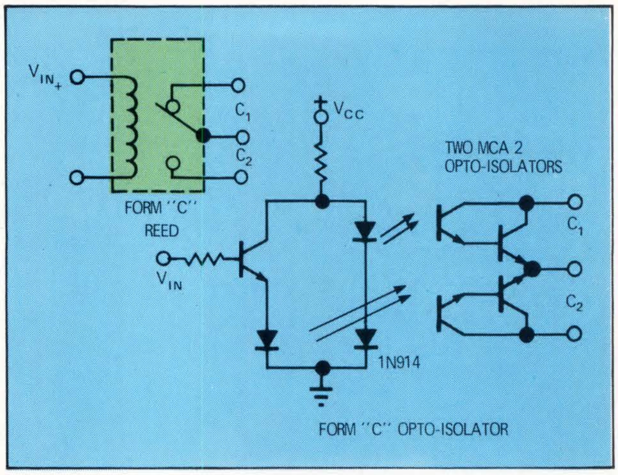


Fig. 9. Form C (SPDT) relays can also be constructed in either reed or opto-isolator form.

relays are shown in **Fig. 8** and **9**. Comparative characteristics of the form-A reed and opto-isolator types when used in dc applications are given in **Table 1**.

In applications where an "offset" contact voltage can be tolerated, the opto-isolator approach offers a reliable solution. An example might be a relay that is used to trigger indicator lights. Other applications where an analog signal need not be transferred are the already mentioned triac triggering and digital signal isolation areas.

Table 1. Typical dc relay characteristics

Parameters	Opto-isolator	Reed-type
Open-contact withstand voltage	50V	200V
Contact load rating	125 mA	500 mA
Closed-contact voltage drop	1.0V	10 mV
Operate time with 100Ω load	10 μsec	1.0 msec
Release time with 100Ω load	20 μsec	0.5 msec
Turn-on voltage	1.3V	6V
Turn-on current at rated contact load	50 mA	30 mA
Dielectric strength, contacts to coil	2000V	800V
Isolation resistance, contact to coil	$100^{11}\Omega$	$10^{12}\Omega$

Author's biography

Mike Bottini is product manager for optical isolators at Monsanto Commercial Products Co., Cupertino, Calif., where he has been employed for three years. He was previously with the Hybrid Circuits Dept. of Fairchild Semiconductor. Mike received a BSME from the University of Santa Clara and an MBA from the University of California, Berkeley. He lives in San Jose.

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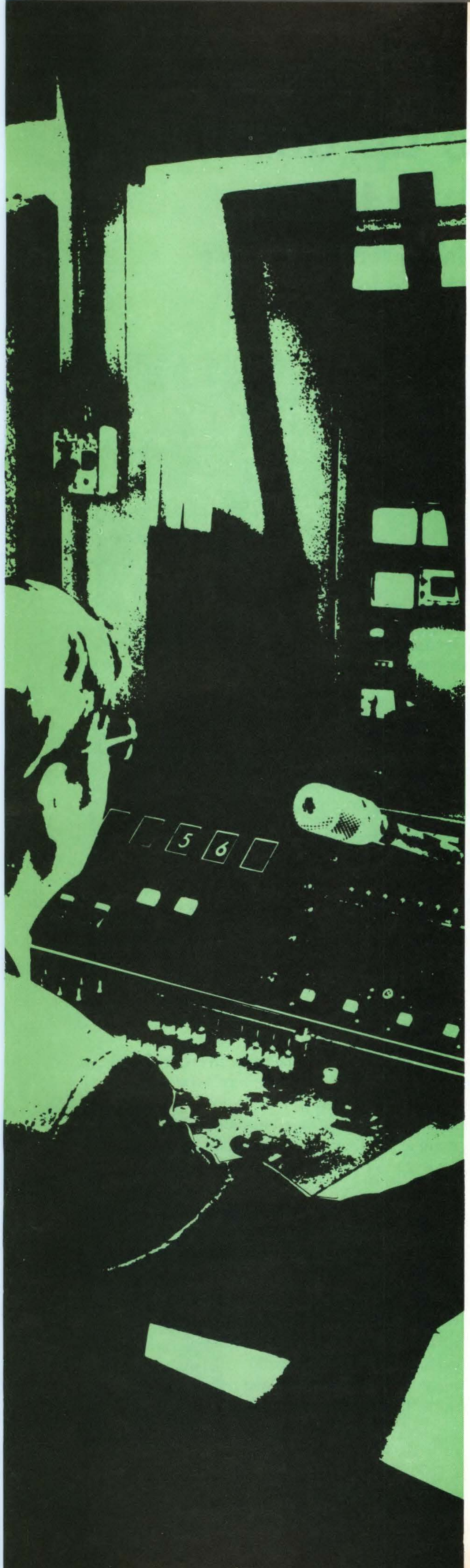

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CIRCLE NO. 19

Programmable-modulo up/down counter makes a flexible timer

Take a fast race-through clock and a programmable up/down counter, and make yourself a straightforward and versatile counting system.

Eric G. Breeze, Fairchild Semiconductor

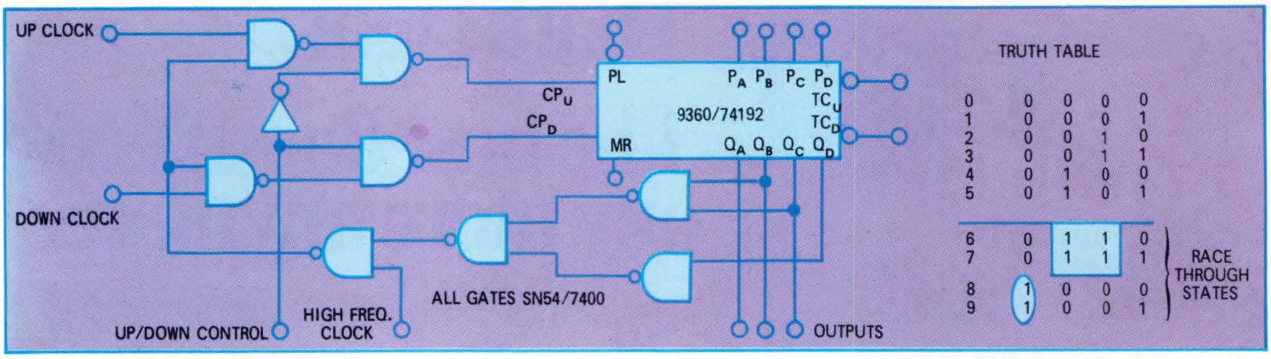


Fig. 1 — Modulo 6 up/down counter requires a high-speed clock from either a previous stage clock or a high-frequency source within the system. This fast clock is gated through only for undesired count states: counts six (0110) through nine (1001), or nine through six. If codes for six or higher are loaded into the parallel inputs, the counter races either to zero or to five.

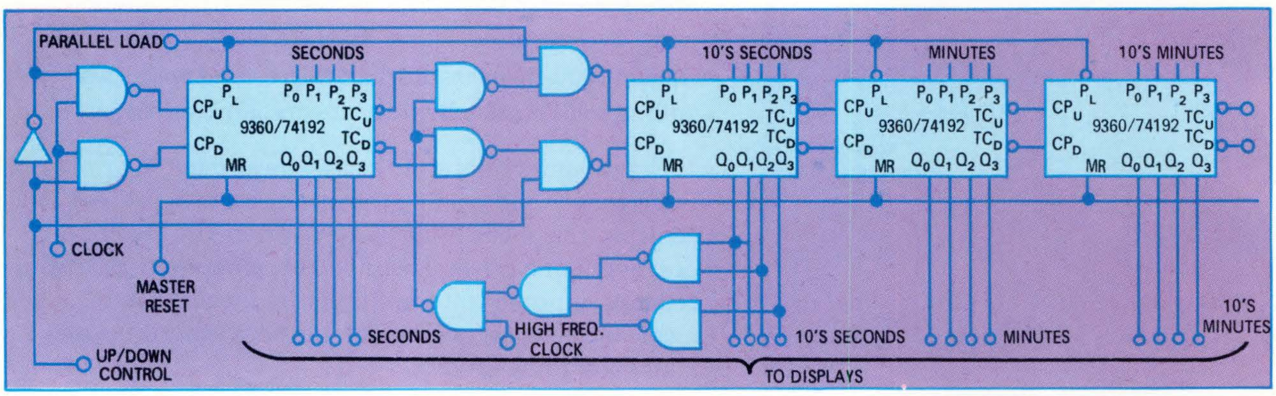


Fig. 2 — Programmable up/down digital timer uses programmable modulo 6 counters for simplicity of logic and for system flexibility. The seconds, minutes and tens-of-minutes counters count to ten; however, if hours were to be indicated, the tens-of-minutes counter would be decoded in the same manner as the tens-of-seconds. The timer as is counts to 99 min, 59 sec.

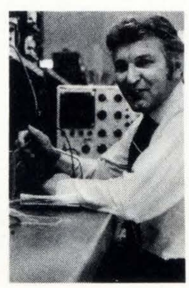
When a normal logic approach is taken to alter the modulo count of current IC up/down counters, it becomes difficult and cumbersome to retain such features as parallel load, BCD code output and terminal count. This is because most counter systems are only concerned that each counter section provides the correct functions to its neighbor, rather than what the actual function of the individual counter section is.

These difficulties can be eliminated by using a programmable modulo up/down counter, such as the modulo six shown in **Fig. 1**. In this counter, the count is decimal, even in the modulo-six stages. However, for any other state not required, the counter will run at high speed up to zero in the "up" mode, or down to five in the "down" mode. In order to make such a system work, the high-speed clock frequency must be at least six times higher than the normal clock input.

Such a system can be made to work in other modulo counts by changing the decoding network. For example, the programmable up/down digital timer in **Fig. 2** decodes one counter stage at the modulo-six count, while the other stages are allowed to count to ten.

This method of using a fast race-through clock can be applied to a number of other counting systems, such as binary-to-BCD or BCD-to-binary code converters. ▭

Author's Biography



Eric Breeze is a senior engineer for digital applications at Fairchild Semiconductor, Mountain View, CA. Prior to this he worked at Kaiser Aerospace, MVR Corp., and Ampex International in Switzerland. He graduated from Salford Technical College, England and is a member of IEEE, SMPTE and SID.

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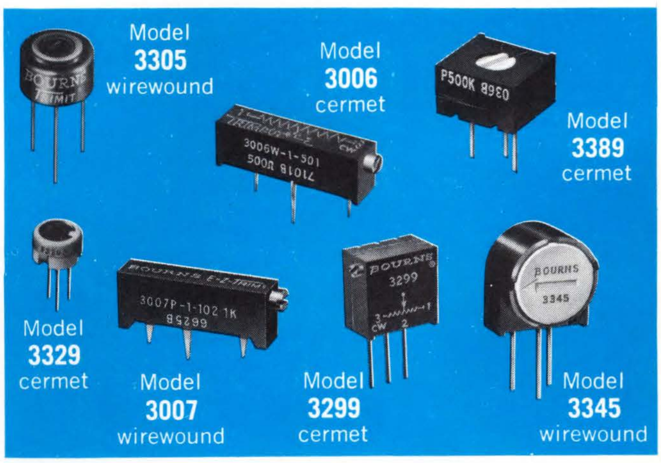

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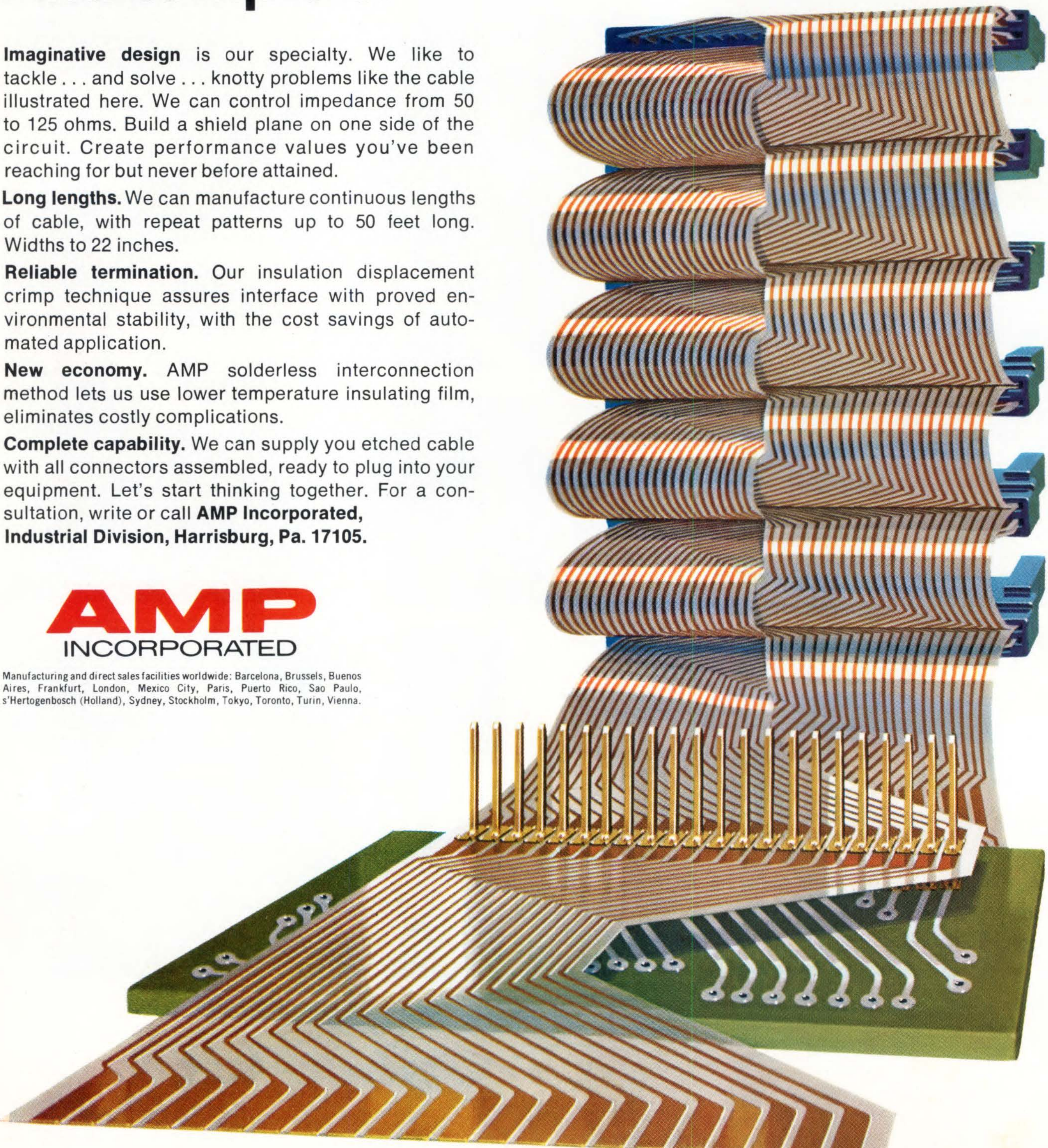

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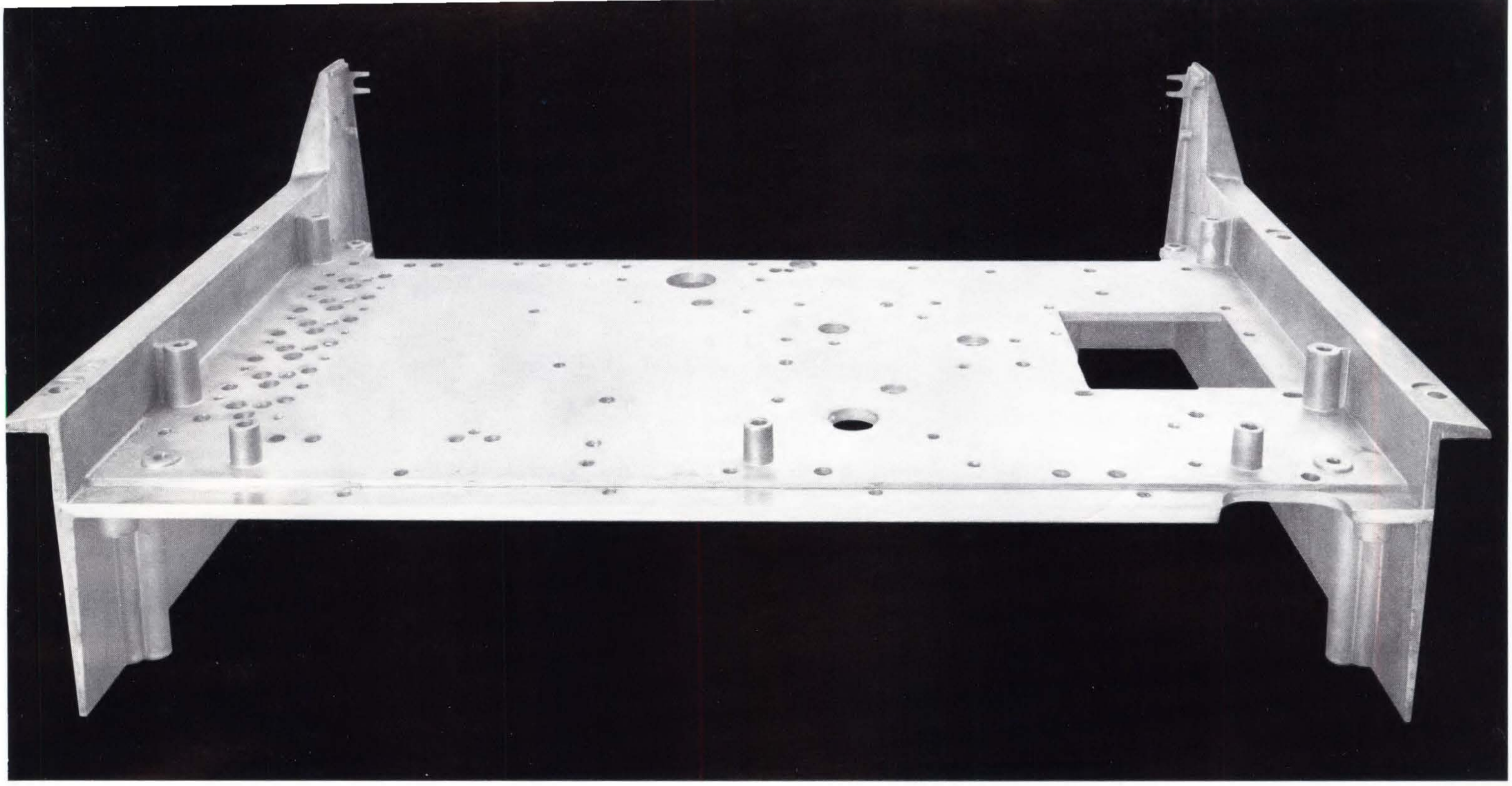

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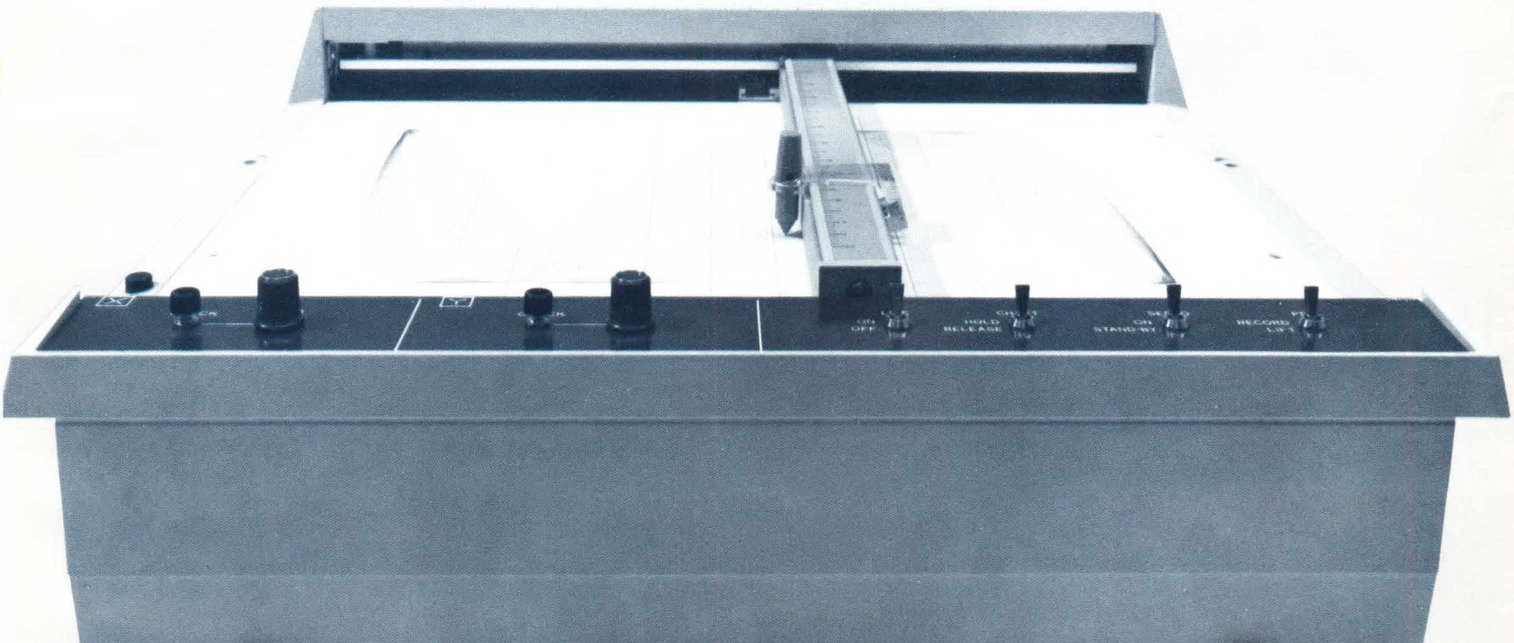

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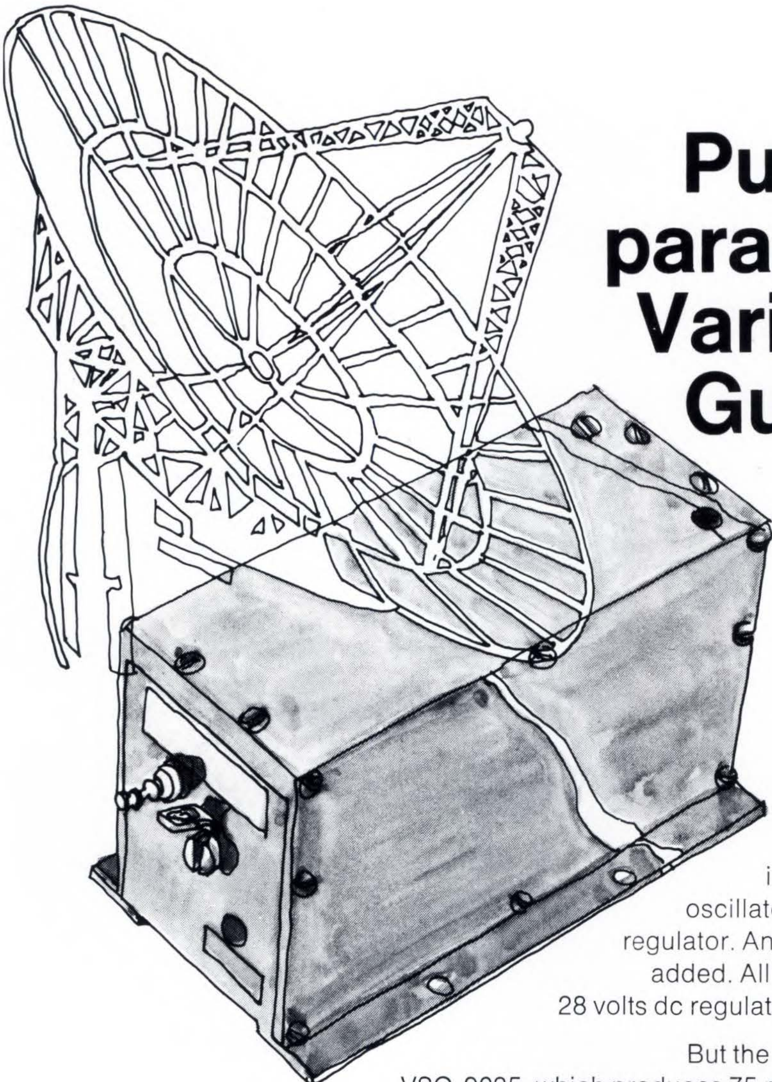

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CIRCLE NO. 33

Simple linear PLL demodulator uses discrete components

Flexibility, simplicity and low component cost mark this discrete phase-locked loop (PLL) demodulator.

Thomas Mollinga, Hengelo, The Netherlands

Phase-locked loops are not new. What is new, though, is the increasing recognition of their potential as highly efficient and sensitive detectors. In part this has come about because inexpensive integrated circuit versions are available, though these sometimes are not as flexible as might be desired.

Here, then is a PLL made with discrete components. It costs little, and can readily be adapted to many uses. The circuit is a practical working version of that shown in block form in **Fig. 1** (See box), which has the ideal output waveforms and conversion characteristic as shown in **Figs. 2** and **3**. The actual circuit is shown in **Fig. 4**.

Voltage controlled oscillator (VCO)

This oscillator consists of Q_1 through Q_4, plus their associated components. Basically an emitter-coupled multivibrator, it provides two significant advantages: (1) a single capacitor or resistor can be used for rough timing and (2) high operating frequencies are possible because all transistors operate unsaturated.

Q_1 and Q_2 are current sources for Q_3 and Q_4, supplying currents i_1 and i_2, respectively. Suppose that Q_4 has just turned ON. The current $i_1 + i_2$ then flows through Q_4, and the collector voltage of Q_4 jumps from V_2 to $(V_2 - \Delta V)$. Q_3 is reverse biased by ΔV, which equals $(i_1 + i_2) \times R_1$. The voltage across C_1 decreases linearly, so the emitter voltage of Q_3 decreases for a time interval, t_2, equal to $C_1 \times \Delta V/i_1$. Q_3 then becomes forward biased and regeneratively turns ON again.

The base voltage of Q_3 jumps from $(V_2 - \Delta V)$ to V_2, and this voltage step is transmitted through C_1 to back bias Q_4 by ΔV. The current $(i_1 + i_2)$ is now supplied to Q_3. The capacitor charging current, i_2, reduces the back bias on Q_4 until Q_4 turns ON (after a time interval, t_1, equal to $C_1 \times \Delta V/i_2$). The resulting voltage step turns off Q_3, thereby completing the cycle.

The VCO's frequency is thus

$$f = 1/(t_1 + t_2) = i_1 i_2/(i_1 + i_2)^2 R_1 C_1$$

and the duty cycle is

$$\delta, = t_2/(t_1 + t_2) = i_2/(i_1 + i_2)$$

Evidently frequency and duty cycle are determined by the ratio of the currents and not by their absolute values. Therefore the current ratio, $k = i_1/i_2$, is introduced as a convenient circuit parameter so that

$$f = k/(1 + k)^2 R_1 C_1 \qquad (1)$$

and

$$\delta = 1/(1 + k) \qquad (2)$$

Eq. 1 is illustrated in **Fig. 5**, and because the objective is to modulate f as linearly as possible by varying k, we see that the point of inflection of the curve is a good choice for locating the center frequency f_o. By taking the second derivative of **Eq. 1**, we find that this point is located at $k = 2$, and $f_o = 2/(9R_1C_1)$, while $\delta = 1/3$. Thus, modulation can be accomplished by varying i_1 (that is by varying the base voltage V_c of Q_1), and the rate of change is found by differentiating **Eq. 1**:

$$df/di_1 = (df/dk) \times (dk/di_1) = -f_o/6i_2$$

and since

$$df/di_1 = (df/dV_c) \times (dV_c/di_1) = R_{e1}(df/dV_c)$$

we find for the gradient, G, of the VCO:

$$G = df/dV_c = (-f_o)/3V_{eo} \qquad (3)$$

where V_{eo} is the emitter voltage of Q_1 and Q_2 at balance.

In the circuit of **Fig. 4**, the current ratio of 2 is set by adjusting the 500Ω potentiometer R_2 for zero voltage between the emitters of Q_1 and Q_2.

Phase detector, amplifier and filter

The phase detector is the parallel chopper, Q_5, which chops the input signal at a rate determined by the VCO frequency.

The chopped input signal is inverted and amplified by Q_6, the collector current of which provides the control voltage, V_c, at the base of Q_1. This control voltage is filtered by the RC network consisting of R_3 plus part of R_2 and C_2.

The operation of the phase detector is not as simple as **Fig. 2** might suggest, which is because of the input blocking capacitor, C_3. In **Fig. 6** the idealized waveforms at the collector of Q_5 and at point P are shown at the low-frequency side of the lock range. The chopping waveform has a duty cycle of 1/3. The average dc level at the collector of Q_5 is indicated by V. Ignoring R_5, we see that no dc current passes through R_4, so the average dc level at P is also V.

From **Fig. 6** we find

$$V = -1/2mE + 1/2\,(1 - m)E \qquad (4a)$$

If the input signal at the collector of Q_5 is attenuated by b, because of the input impedance of Q_6, we also have

$$V = -1/2mbE + 1/6\,(1 - m)bE \qquad (4b)$$

from which we find

$$V = E \times \frac{-b}{2(3 - 2b)} \qquad (5)$$

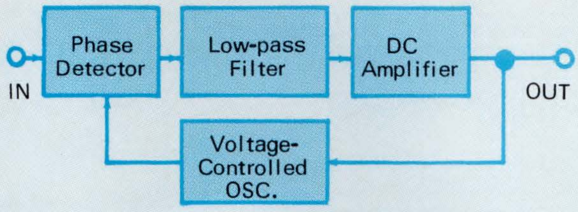

Fig. 1—Basic PLL elements.

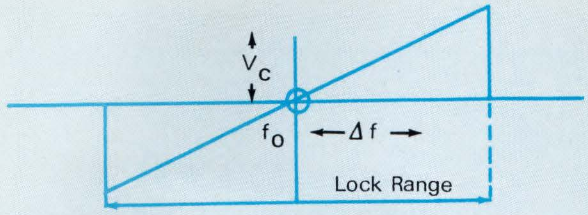

Fig. 3—Conversion characteristic of an ideal linear PLL demodulator.

How a PLL works

Phase-locked loops have been known variously as phase demodulators, product demodulators, coherent detectors and synchronized detectors. Despite the multiple name tags, however, they are basically quite simple, as shown in **Fig. 1**.

The input signal and the signal from a voltage-controlled oscillator (VCO) are compared in a phase-detector (PD), the output of which is an error voltage proportional to the phase difference of the two signals. The signal from the PD is filtered in a low-pass filter, amplified and then used to control the frequency of the VCO.

Numerous papers have contained a mathematical analysis of PLL operation, so it will only be discussed here on a qualitative basis. **Fig. 2** shows voltage waveforms of the phase detector output. Note that both the input waveform and that of the VCO signal are assumed to be symmetrical square waves.

In **Fig. 2a** the input frequency is the same as the free-running frequency, f_o of the VCO, and the control voltage is zero. This implies that the two signals have a 90° phase difference. If the input frequency then decreases from f_0 to a lower frequency, f_1, the phase of the two signals changes. This change produces a control voltage, V_c, that shifts the VCO frequency to f_1 (**Fig. 2b**).

Fig. 2c shows conditions that exist with the lowest input frequency that will permit the VCO to remain synchronized. Here the control voltage has its maximum value and the phase-difference is zero. A further decrease of input frequency tends to decrease the control voltage (**Fig. 2d**), thereby increasing the VCO frequency. As this is an unstable situation, the VCO desynchronizes and its frequency returns rapidly to f_o.

When the VCO is locked to the input frequency, there exists a span of input frequencies centered around f_o over which the VCO will track the input signal frequency. This frequency span is called the *lock-range*. Also, when the input frequency approaches f_o from outside the lock-range the VCO will track the input frequency over a certain range. This is called the *capture-range*. It can be shown that the capture-range is always smaller than the lock-range.

When the VCO's voltage-to-frequency conversion is linear, its control voltage, V_c, represents (follows) the modulation of the input frequency, and the circuit acts as a frequency demodulator. **Fig. 3** shows the conversion characteristic of an ideal demodulator.

The response of the PD is expressed in volts/radian of phase shift, and denoted by K_1. Similarly the VCO response is expressed as frequency deviation per volt or rad/sec/volt, and denoted by K_2. The K_1K_2 product is called the *gain factor*, and is the frequency deviation in rad/sec per radian of phase shift. When the total phase change over the lock-range equals B radians, the lock-range equals BK_1K_2 rad/sec.

Dc amplification in the loop has the desirable effect of increasing the lock-range. This can be explained as follows: Because the VCO frequency is locked to the input frequency (requiring a certain control voltage V_c), less phase shift between the two signals is required to produce this control voltage. Consequently the lock-range is increased by the gain, A, of the amplifier, and the total lock-range is $L = ABK_1K_2$.

The low-pass loop filter determines the maximum modulation frequency.

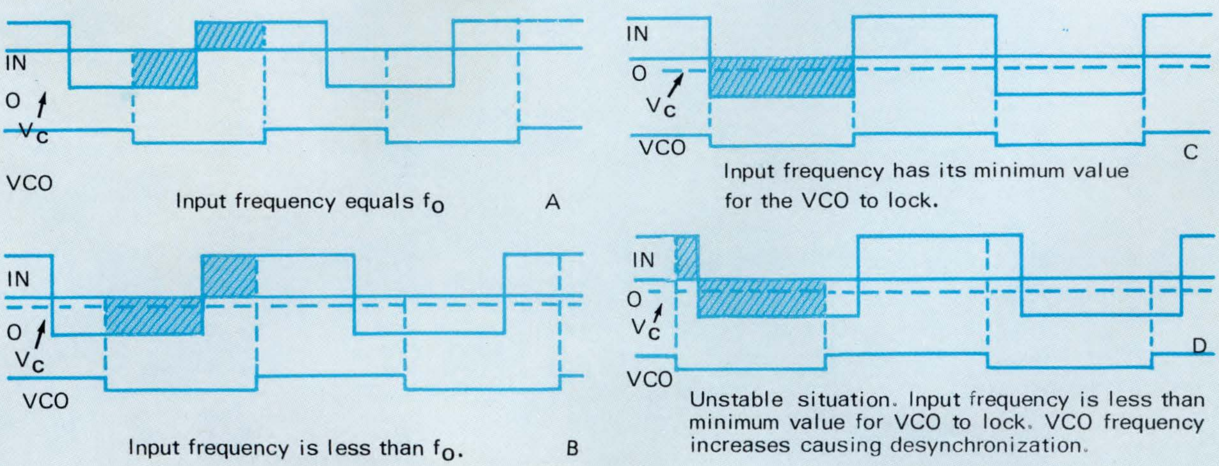

Fig. 2—Phase detector output voltage waveforms. Shaded areas are averaged by the loop filter.

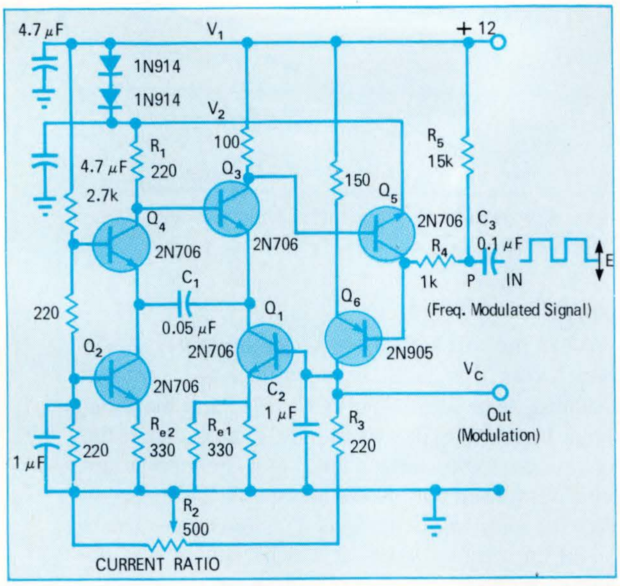

Fig. 4—Complete circuit of phase-locked demodulator. For the values shown, f_0 = 20 kHz.

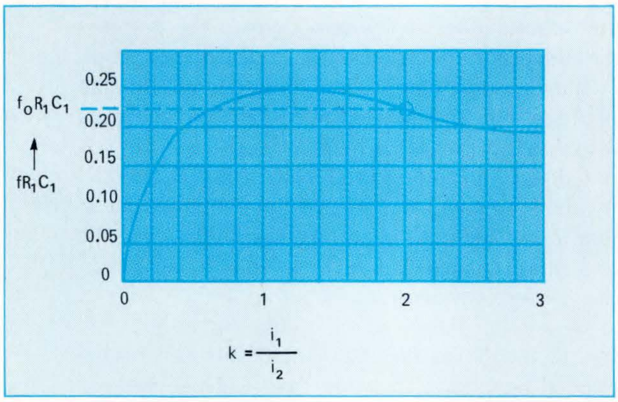

Fig. 5—Conversion characterisic of voltage-controlled oscillator.

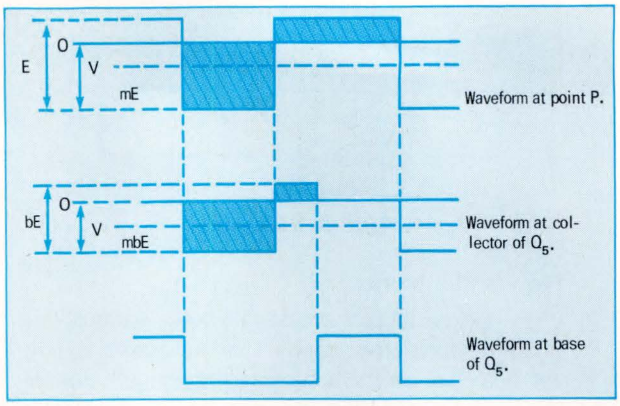

Fig. 6—Idealized waveforms that show operation at the low-frequency side of the lock range.

The phase at this point has shifted 60°, or $\pi/3$ radians, from the center position. When A is the low-frequency gain of Q_6, we obtain for the conversion gain of the phase detector $K_1 = 3V/\pi \times A$ volts/radian. And, since $K_2 = 2\pi G$ rad/sec/V (**Eq. 3**), we have K_1K_2 = 6 VAG, where G is the gradient of the VCO. The lock range covers a total of $2\pi/3$ radians, so it is $2\pi/3 \times 6$ VAG rad/sec—or L = 2 VAG Hz.

Substitution of **Eq. 5** gives $L = EAG\,(b/3 - 2b)$ (6)

The relative lock range, L*, is thus

$$L^* = L/f_0 \times 100 = \frac{EAb}{3V_{eo} \times (3 - 2b)} \times 100 \qquad (7)$$

Distortion

Returning to **Eq. 1** and **Fig. 5**, we expect the tangent of this curve at k = 2 to be a good approximation of the voltage-to-frequency conversion. **Fig. 7** shows the expanded area around k = 2, with the tangent drawn as a solid line and the points on the curve as circles. It is apparent that the

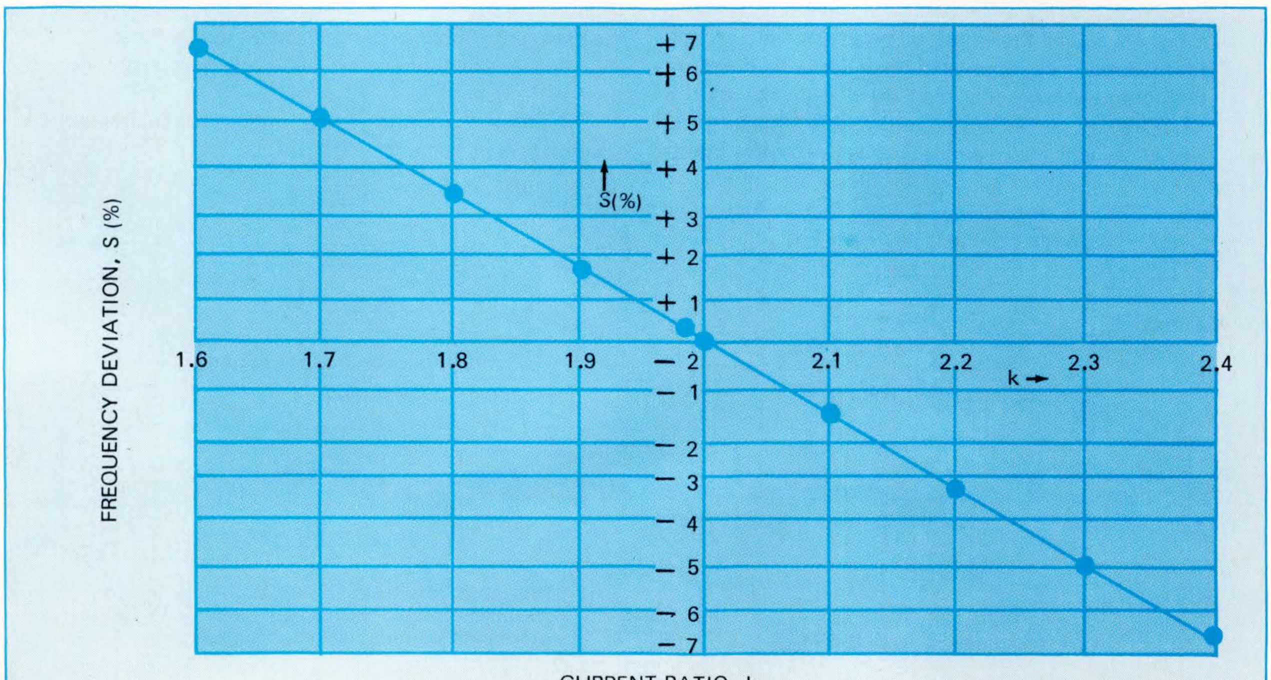

Fig. 7—Relative frequency deviation, S, vs current ratio, k, around the value k = 2.

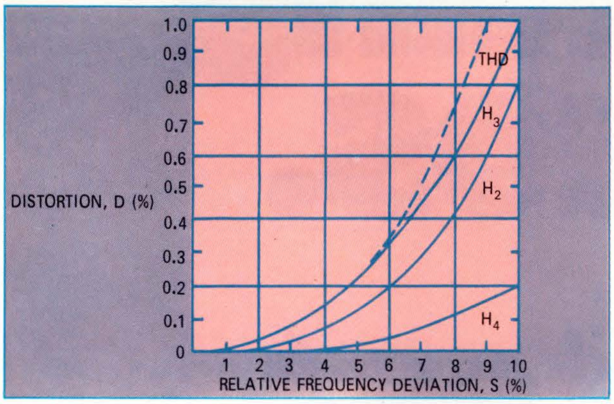

Fig. 8—Relationship between distortion and frequency deviation.

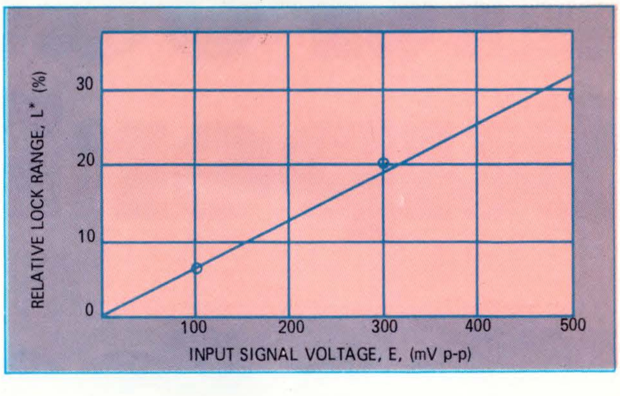

Fig. 10—Relative lock range, L*, vs pk-pk input signal voltage, E.

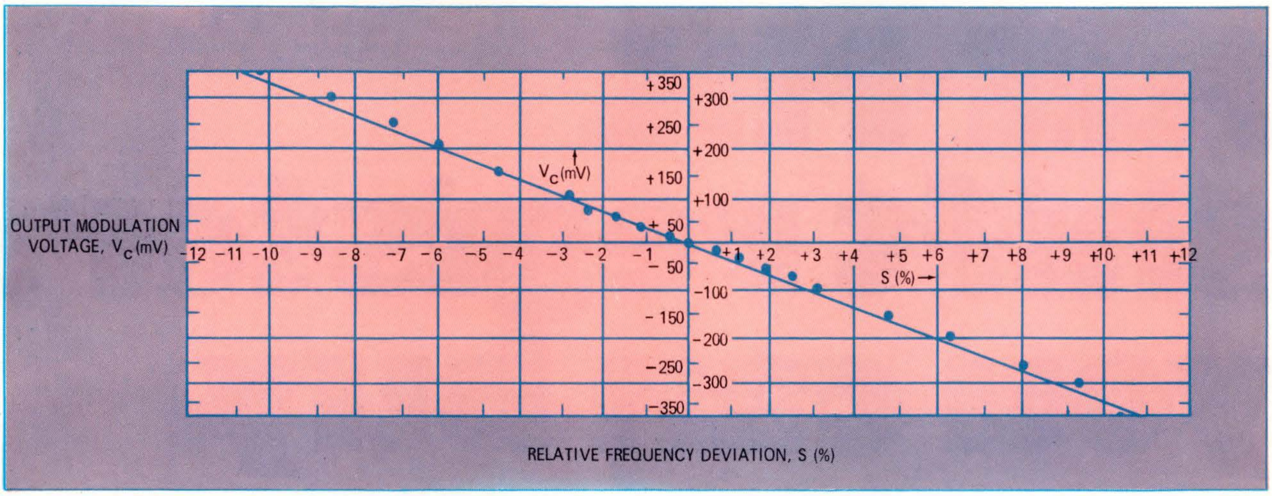

Fig. 9—Demodulation curve for the PLL of Fig. 4. Plotted points are measured values.

error is very small over a large range of k values. **Fig. 8** shows H_2, H_3, H_4 and THD for values of S up to 10%.

Calculations and measurements agree

With the component values shown in **Fig. 4**, the low-pass filter cut-off frequency is about 340 Hz, so 340-Hz sine-wave modulation of the input signal is attenuated by 3 dB after demodulation.

The gain, A, of Q_6 is about 2.7, and an emitter voltage V_{eo} of 1.25V was measured at balance. Calculations yielded the following data: from **Eq. 1**; $f_0 = 20.2$ kHz, and from **Eq. 3**; $G = 5.38$ kHz/V.

Taking the input impedance of Q_6 as 15 kΩ, the collector signal of Q_5 will be attenuated by $b = 15/16$. Hence, from **Eq. 5**, $V = 0.417E$.

Thus the gain factor is

$$K_1K_2 = 6(0.417)\,(2.7)\,(5.38)E = 36.3\ E\frac{\text{rad}}{\text{sec}}\Big/\text{rad}$$

the lock range, L, = 12.1 E
and the relative lock range is

$$L^*, = E \times \frac{(2.7)\,(0.834)}{3(1.25)} \times 100 = 60E.$$

Measurements gave an f_0 of 23.64 kHz, and a G of 7.36 kHz/V, making S = 31.2%/V and L* = 62E.

Measured values of S and L* are shown in **Figs. 9** and **10**, respectively. Observation of **Fig. 9** shows that good linearity was obtained over about 6% of f_0, in agreement with **Fig. 7**.

Differences between calculated and measured data can be attributed to a subtractive error term in the denominator of **Eq. 1**—a term that results from the base-emitter thresholds of Q_3 and Q_4. This error term becomes less significant when a larger value of $(i_1 + i_2) R_1$ is selected.

Working at higher frequencies

. The circuit of **Fig. 4** can be scaled up in frequency to be used as a demodulator for commercial FM. When scaled to an f_0 of 10.7 MHz, the lock-range is about 300 kHz for stereo reception, and the low-pass filter should be designed for cut-off at 100 kHz.

In practical use, the PLL should be preceded by an IF amplifier with about 80 dB of gain, and the recovered modulation, V_c, should be amplified by about 30 dB. □

Author's biography

Thomas Mollinga, a staff engineer at Hollandse Signaalapparaten, Hengelo, Netherlands, works on control circuitry for weapon control systems. Educated in Holland (M.Sc. in Math. and Physics from Univ. of Amsterdam), he holds 8 patents and has worked in both the USA and the Netherlands.

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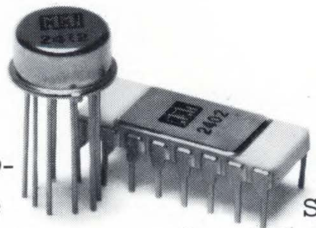

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1403A MM3403 **MM2403**	Dual 512 Multiplexed output	0 to 70°C 0 to 75°C −55 to +125°C	10 Hz to 10 MHz 5 Hz to 20 MHz 5 Hz to 20 MHz	500 Hz to 5 MHz 60 Hz to 10 MHz 60 Hz to 10 MHz	100 μW/bit 50 μW/bit 50 μW/bit	7.20 8.00 16.00
1404A MM3404 **MM2404**	Single 1024 Multiplexed output	0 to 70°C 0 to 75°C −55 to +125°C	10 Hz to 10 MHz 5 Hz to 20 MHz 5 Hz to 20 MHz	500 Hz to 5 MHz 60 Hz to 10 MHz 60 Hz to 10 MHz	100 μW/bit 50 μW/bit 50 μW/bit	7.20 8.00 16.00
1406 **MM2406** MM3406	Dual 100 Open Drain	−55 to +125°C −55 to +125°C 0 to 75°C	10 Hz to 3.5 MHz 2 Hz to 8 MHz 2 Hz to 8 MHz	500 Hz to 2 MHz 30 Hz to 5 MHz 30 Hz to 5 MHz	400 μW/bit 200 μW/bit 200 μW/bit	2.25 5.00 2.50
1407 **MM2407** MM3407	Dual 100 20K	−55 to +125°C −55 to +125°C 0 to 75°C	10 Hz to 3.5 MHz 2 Hz to 8 MHz 2 Hz to 8 MHz	500 Hz to 2 MHz 30 Hz to 5 MHz 30 Hz to 5 MHz	400 μW/bit 200 μW/bit 200 μW/bit	2.25 5.00 2.50
1405A MM3405 **MM2405**	512 bit Recirculating	0 to 85°C 0 to 75°C −55 to +125°C	8 Hz to 2.5 MHz 2 Hz to 6 MHz 2 Hz to 6 MHz	200 Hz to 2 MHz 30 Hz to 4 MHz 30 Hz to 4 MHz	300 μW/bit 100 μW/bit 100 μW/bit	3.60 4.00 7.20
MM2412 MM3412	1024 bit Recirculating	−55 to +125°C 0 to 70°C	2 Hz to 6 MHz 2 Hz to 6 MHz	30 Hz to 4 MHz 30 Hz to 4 MHz	75 μW/bit 75 μW/bit	14.00 7.00

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CIRCLE NO. 34

Simple IC meter amplifier circuit measures 100 nanoamps, full-scale

A programable op amp, a handful of components and two flashlight batteries are all you need to make ultra sensitive voltage and current measurements.

Marvin Vander Kooi, National Semiconductor Corp.

Meter amplifiers normally require one or two 9V transistor batteries. Due to the heavy current drain on these supplies, the meters must be switched to the OFF position when not in use. The meter circuit described here operates on two 1.5V flashlight batteries and has a quiescent power drain so low that no ON-OFF switch is needed. A pair of Eveready #950 "D" cells will serve for a minimum of one year without replacement. As a dc ammeter, the circuit will provide current ranges as low as 100 nA full-scale.

The basic meter amplifier circuit shown in **Fig. 1** is a current-to-voltage converter. Negative feedback around the amplifier insures that currents I_{in} and I_f are always equal, and the high gain of the op amp insures that the input voltage between pins 2 and 3 is in the microvolt region. Output voltage V_o is therefore equal to $-I_fR_f$. Considering the ±1.5V sources (±1.2V end-of-life) a practical value of V_o for full scale meter deflection is 300 mV. A unique feature of the LM4250 type programmable op amp is the provision for an external master bias-current setting resistor (R_s) at pin 8. With this resistor set at 10MΩ, the total quiescent current drain of the circuit is 0.6 μA for a total power supply drain of 1.8 μW. The input bias current required by the amplifier at this low level of quiescent current, is in the range of 600 pA.

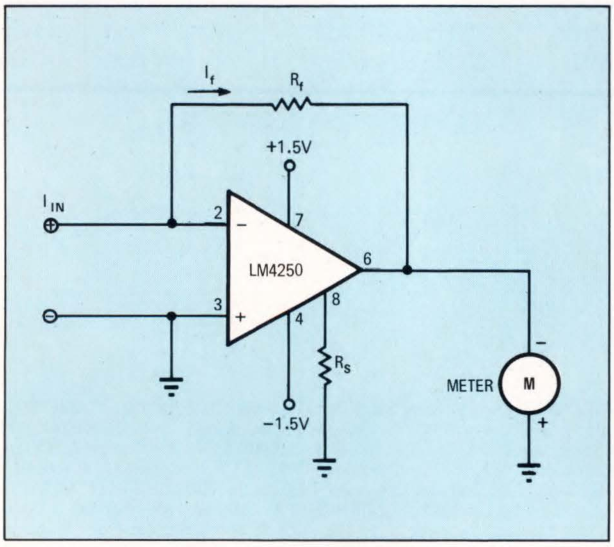
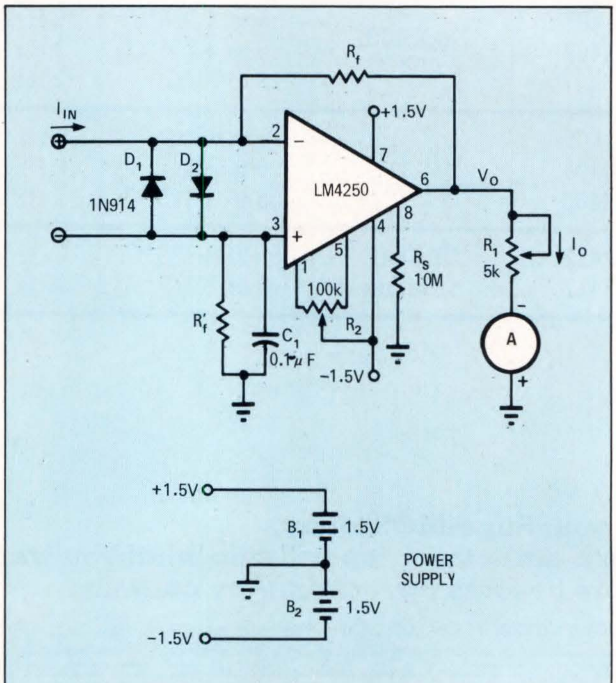


Fig. 1—Basic meter amplifier circuit is a current-to-voltage converter. The external bias-current setting feature (at pin 8) of the programmable op amp allows the use of a large value for resistor R_s, to hold quiescent current drain to 600nA total.

The complete nanoammeter

The complete meter amplifier shown in **Fig. 2** is a differential current-to-voltage converter with input protection, zeroing and full scale adust provisions, and input resistor balancing for minimum offset voltage. Resistor R_f (equal in value to R_f for measurements of less than 1 μA) insures that the input bias currents for the two input terminals of the amplifier do not contribute significantly to an output error voltage. The output voltage V_o for the differential current-to-voltage converter is equal to $-2I_fR_f$ since the floating input current I_{in} must flow through R_f and R'_f. R'_f may be



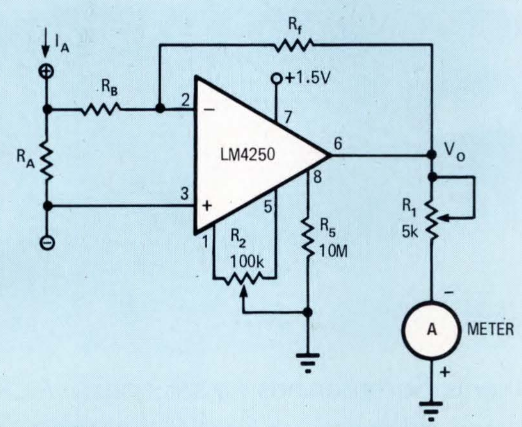
RESISTANCE VALUES FOR D.C. NANO AND MICRO AMMETER

I FULL SCALE	R_f[Ω]	R'_f[Ω]
100nA	1.5M	1.5M
500nA	300k	300k
1 μA	300k	0
5 μA	60k	0
10 μA	30k	0
50 μA	6k	0
100 μA	3k	0

Fig. 2—Complete circuit for a dc nanoammeter and microammeter uses resistor R'_f on the lower scales to reduce output errors caused by low input bias currents when R_f is a very large value. This precaution is not needed when measuring currents larger than 500 nanoamperes.

omitted for R_f values of 500kΩ or less, since a resistance of this value contributes an error of less than 0.1% in output voltage. Potentiometer R_2 provides an electrical meter zero by forcing the input offset voltage V_{os} to zero. Full scale meter deflection is set by R_1. Both R_1 and R_2 only need to be set once for each op amp and meter combination. For a 50 microamp 2KΩ meter movement, R_1 should be about 4KΩ to give full scale meter deflection in response to a 300 mV output voltage. Diodes D_1 and D_2 provide full input protection for overcurrents up to 75 mA.

With an R_f resistor value of 1.5M the circuit in **Fig. 2** becomes a nanoammeter with a full scale reading capability of 100 nA. Reducing R_f to 3kΩ in steps, as shown in **Fig. 2**



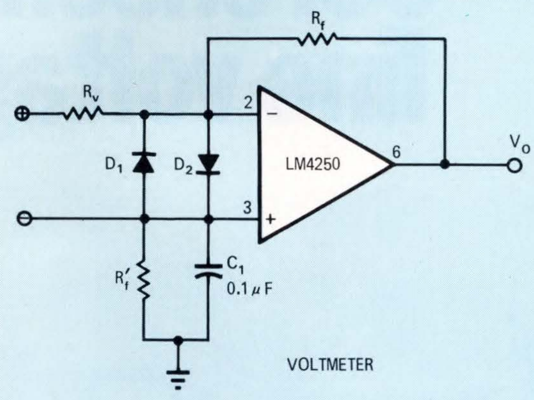
RESISTANCE VALUES FOR dc AMMETER			
I FULL SCALE	R_A[Ω]	R_B[Ω]	R_f[Ω]
1mA	3.0	3k	300k
10mA	.3	3k	300k
100mA	.3	30k	300k
1A	.03	30k	300k
10A	.03	30k	30k

Fig. 3—Ammeter circuit for measurement of currents from 1 mA to 10A. Diodes D_1 and D_2 from the previous circuit **Fig. 2** are no longer required, but will not degrade performance, and may be left in the circuit on all ranges if a multirange meter is desired.

increases the full scale deflection to a 100 μA, the maximum for this circuit configuration. The voltage drop across the two input terminals is the equal to the output voltage V_o divided by the open loop gain. Assuming an open loop gain of 10,000 gives an input voltage drop of 30 μV or less.

Circuit for higher current readings

For dc current readings higher than 100 μA, the inverting amplifier configuration shown in **Fig. 3** provides the required gain. Resistor R_A develops a voltage drop in response to input current I_A. This voltage is amplified by a factor equal to the ratio of R_f/R_B. R_B must be sufficiently larger



RESISTANCE VALUES FOR A dc VOLTMETER			
V FULL SCALE	R_V[Ω]	R_f[Ω]	R'_f[Ω]
10mV	100k	1.5M	1.5M
100mV	1M	1.5M	1.5M
1V	10M	1.5M	1.5M
10V	10M	300k	0
100V	10M	30k	0

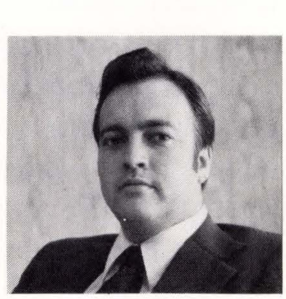
Fig. 4—Voltmeter conversion of the amplifier circuit is accomplished by simply inserting R_v in series with the input. All other connections remain as shown in the circuit in **Fig. 2**, and the resistor values given permit readings as low as 10mV full scale.

than R_A, so not to load the input signal. **Fig. 3** also shows the proper values of R_A, R_B and R_f for full scale meter deflections of from 1 mA to 10A.

A 10 mV to 100V full-scale voltmeter

A resistor inserted in series with one of the input leads of the basic meter amplifier converts it to a wide range voltmeter circuit, as shown in **Fig. 4**. This inverting amplifier has a gain varying from −30 for the 10 mV full scale range to −0.003 for the 100V full scale range. **Fig. 4** also lists the proper values of R_V, R_f and R'_f for each range. Diodes D_1 and D_2 provide complete amplifier protection for input overvoltages as high as 500V on the 10 mV range, but if overvoltages of this magnitude are expected under continuous operation, the power rating of R_V should be adjusted accordingly. □

Authors biography



Marvin Vander Kooi is an applications engineer for linear ICs at National Semiconductor, Corp., in Santa Clara, Calif. He received his B.S. and M.S.E.E. degrees from Ohio State University and he is a member of Sigma Xi and the IEEE.

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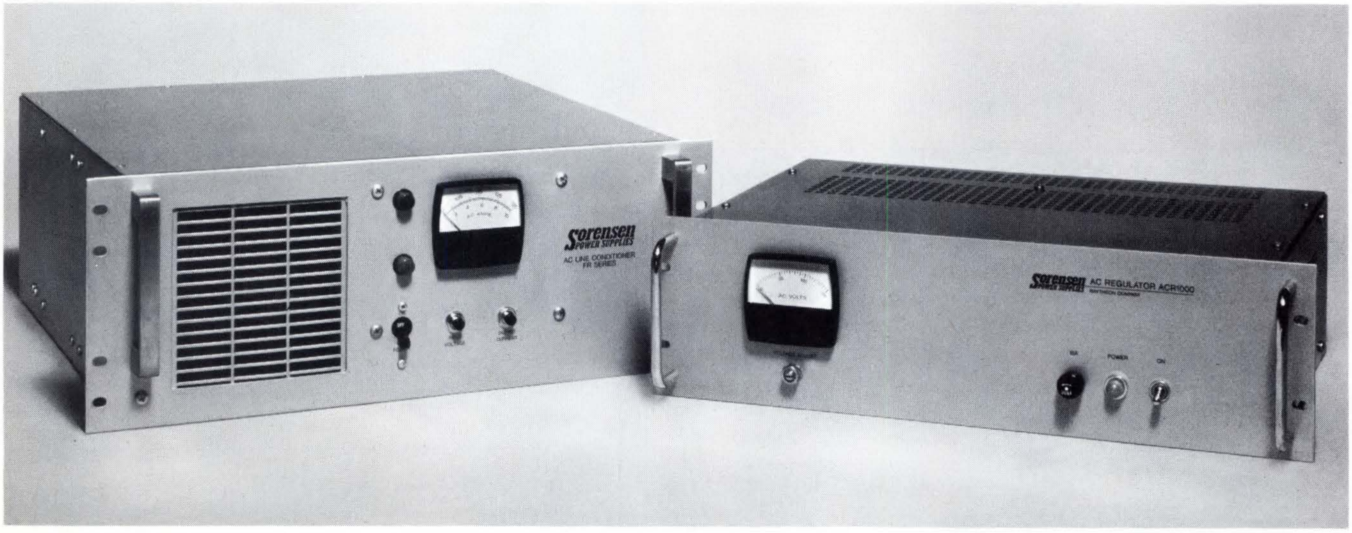

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Model	Output		Input		Voltage Regulation		Price*
	Voltage (Vac) (Settable Range)	VA	Voltage (Vac)	Freq (Hz)	Line	Load	
ACR500		500			±0.1%	±0.1%	$ 380
ACR1000		1000			±0.1%	±0.1%	$ 450
ACR2000		2000			±0.1%	±0.1%	$ 575
ACR3000	110	3000	95	47-53	±0.1%	±0.1%	$ 700
ACR5000	to	5000	to	or	±0.15%	±0.15%	$ 850
ACR7500	120	7500	130	57-63	±0.15%	±0.15%	$1025
ACR10000		10000			±0.15%	±0.15%	$1450
ACR15000		15000			±0.15%	±0.15%	$1775

FR Series

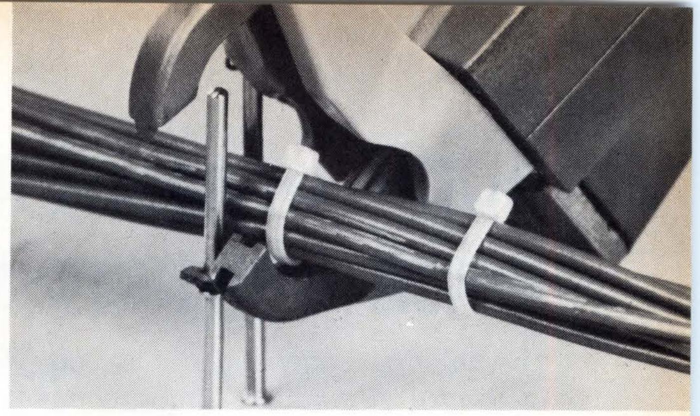
Model	Output		Input		Combined Regulation	Price*
	Voltage (Vac)	VA	Voltage (Vac) (Switch Selectable)	Freq (Hz)		
FR516A **	115	500	95-115/105-125/115-135	59-61	±0.05%	$ 925
FR1016A	115	1000	95-115/105-125/115-135	57-63	±0.05%	$1500
FR1015A	115	1000	95-115/105-125/115-135	47-53	±0.05%	$1500
FR1026A	230 (115 opt.)	1000	190-230/210-250/230-270	57-63	±0.05%	$1650
FR1025A	230 (115 opt.)	1000	190-230/210-250/230-270	47-53	±0.05%	$1650
FR2516A	115	2500	95-115/105-125/115-135	57-63	±0.05%	$3425
FR2515A	115	2500	95-115/105-125/115-135	47-53	±0.05%	$3425
FR2526A	230 (115 opt.)	2500	190-230/210-250/230-270	57-63	±0.05%	$3650
FR2525A	230 (115 opt.)	2500	190-230/210-250/230-270	47-53	±0.05%	$3650
FR5016A	115	5000	95-115/105-125/115-135	57-63	±0.05%	$6800
FR5015A	115	5000	95-115/105-125/115-135	47-53	±0.05%	$6800

**No CM Rejection

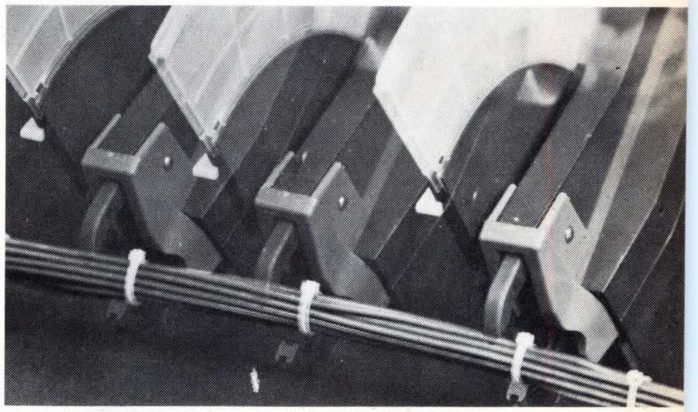
*USA List

Sorensen POWER SUPPLIES

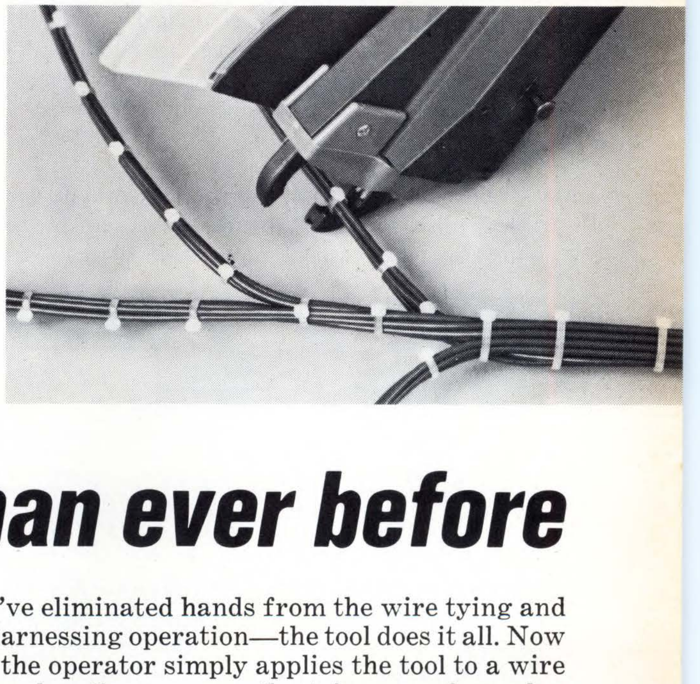
CIRCLE NO. 35



goes where hands can't



ties in less than a second



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NOW tie faster than ever before

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489

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Build an ON-OFF timer using inexpensive ICs

The timer has independent ON and OFF modes of operation and provides up to 8 hours of control. Accuracy is almost completely dependent on the ac line.

Carl Brogado, University of Colorado Medical Center

A relatively inexpensive and highly accurate ON-OFF timer that does not require calibration can be designed and built to control any instrument operating from an ac or dc power source. The timer uses digital techniques and employs the ac 60 Hz line frequency as its time base.

It has independent ON and OFF modes, settable by means of front-panel toggle switches, and arranged in binary form (1, 2, 4, 8, 16, etc.). The toggle switches provide ON times from 1/2 to 31.5 minutes, Settable in 1/2-minute increments. OFF times from 1 minute to 8 hours and 31 minutes are settable in 1-minute increments. Output of the timer to the instrument being controlled is provided through a spdt relay. The relay's contacts are rated at 5A each. A SET-START switch is available to put the timer in a standby mode (SET) and to initiate timer control (START).

How it works

Fig. 1 shows the basic approach taken to design such a timer. No IC numbers are shown because of the many equivalent types available. Also, there are many variations or modifications that can be made to the basic approach by using different IC types to produce a different timer than the one shown.

A 110V ac step-down transformer is used to trigger a programmable-unijunction transistor on the positive excursion of the 60-Hz input. The PUT then triggers 4-bit ripple counters, C_1, C_2, and C_3, every 16.6 msec to provide the time-base frequency. The corresponding output lines of the counters are summed together in NAND gates A_1 and A_2 to give the required occurance of time, i.e., (1024 + 512 + 256 + 8 = 1800 ÷ 60 Hz = 30 sec.). As a result, a 1-msec pulse occurs at the one-shot multivibrator output OS_1 every 30 sec of the ON time. The same logic is used to obtain a 1-msec pulse at the OFF side.

The ON sequence occurs first, since NOR gate O_1 is enabled by the Q output of the J-K flip flop. The output lines of counters C_4 and C_5 and NAND gate A_3 are interfaced together by toggle switches. These are settable in binary form for from 1/2 to 31.5 minutes.

At the end of the time set by the toggle switches, A_3 is

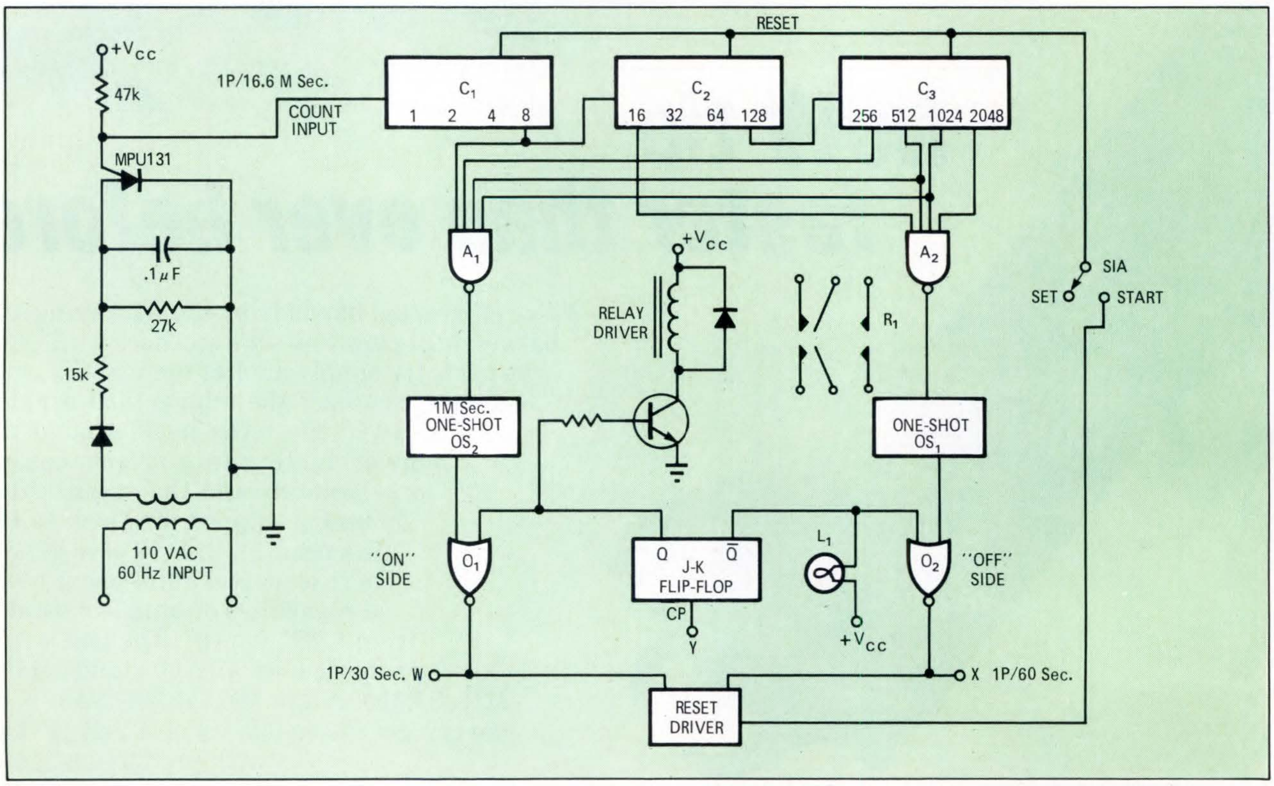


Fig. 1—Using the 60-Hz line frequency as its time base, the timer employs digital techniques to provide variable ON and OFF times for controlling instruments or other devices. The durations of the separate ON and OFF modes are set by toggle switches.

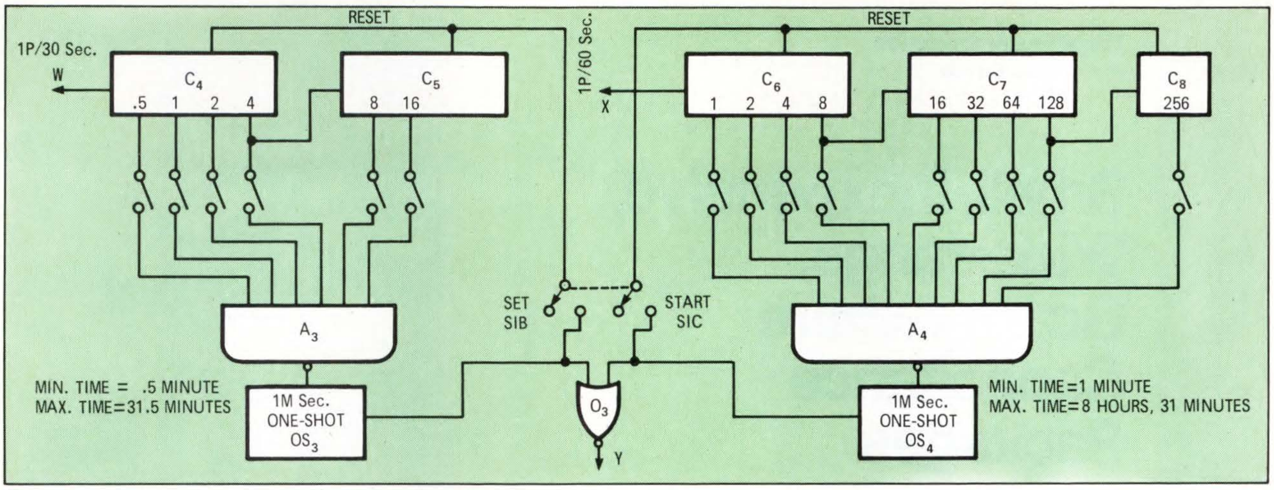
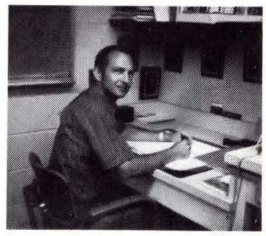


Fig. 2—The output of the timer is applied to the instrument or device being controlled by means of spdt relay R_1. (Note that leads marked x, y and w in this illustration are connections to corresponding leads of **Fig. 1**).

enabled, causing a pluse to occur at the output of one-shot multivibrator OS_3. This pulse serves to reset counters C_4 and C_5 and also to change the state of the J-K flip flop by way of NOR gate O_3. This disables NOR gate O_1 while enabling O_2 and the OFF sequence. The sequence of events is the same for the OFF side as the ON side. Any time a pulse occurs at the output of NOR gates O_1 or O_2, the reset driver is enabled, resetting counters C_1, C_2 and C_3.

A lamp (L_1) indicates unit starts in the OFF mode. □

Author's biography



Carl Brogado is an engineering technician in the bio-engineering department at the University of Colorado Medical Center, Denver, Colorado. Carl attends the University of Colorado and is a consultant for BMK Engineering Lab.

FOR A FREE COPY OF THIS ARTICLE **CIRCLE L65**

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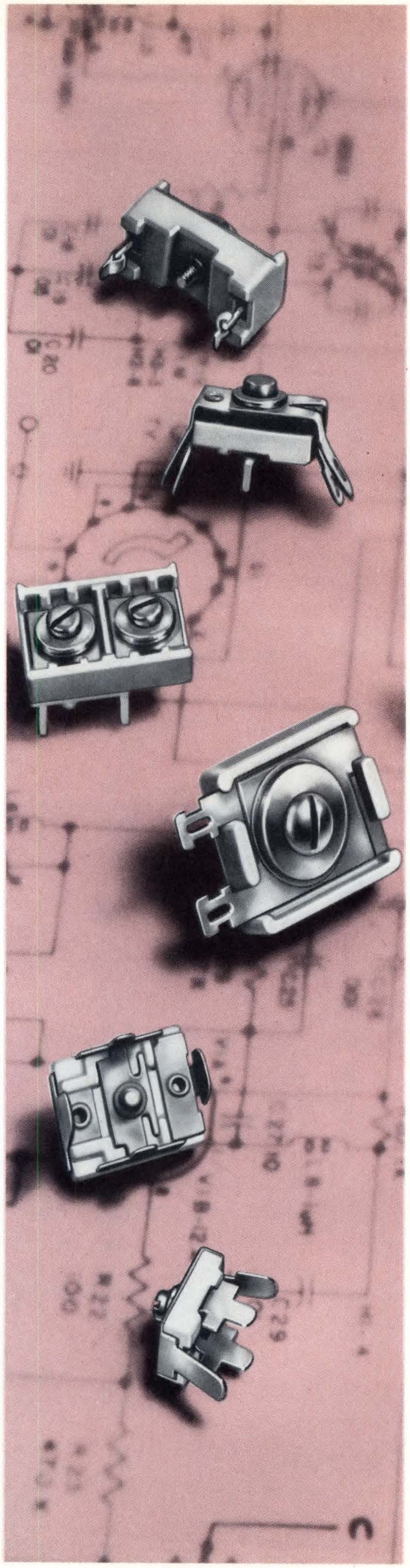

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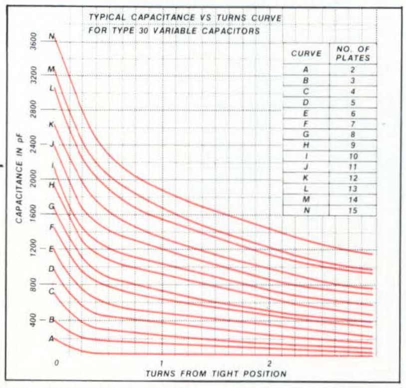

CURVE	NO. OF PLATES
A	2
B	3
C	4
D	5
E	6
F	7
G	8
H	9
I	10
J	11
K	12
L	13
M	14
N	15

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CIRCLE NO. 38

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Device Type	Slew Rate	Flatpack* Order P/N	Price 100-999	TO-99* Order P/N	Price 100-999
2500	30V/μs	HA9-2500-2	$24.30	HA2-2500-2	$18.15
2502	30V/μs	HA9-2502-2	18.40	HA2-2502-2	12.70
2505	30V/μs	HA9-2505-5	12.55	HA2-2505-5	7.35
2510	60V/μs	HA9-2510-2	26.70	HA2-2510-2	18.15
2512	60V/μs	HA9-2512-2	20.20	HA2-2512-2	12.70
2515	60V/μs	HA9-2515-5	13.70	HA2-2515-5	7.35
2520	120V/μs	HA9-2520-2	26.70	HA2-2520-2	18.15
2522	120V/μs	HA9-2522-2	20.20	HA2-2522-2	12.70
2525	120V/μs	HA9-2525-5	13.70	HA2-2525-5	7.35

*Suffix -2 designates −55° to +125°C temperature range.
Suffix -5 designates 0° to 75°C temperature range.

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CIRCLE NO. 39

Need a job? So what else is new?

Should the need ever arise, a look at the experiences of one recent job hunter and his successful approach to job-hunting will save you lots of time and wasted effort.

A. Nonny Moose (name withheld at author's request)

If you are near 50 years of age and if your salary is near $20,000 per year, you are being watched! Oh yes, you graduated at the top of your class and you have been with the company 9-3/4 years, with only a few months to go toward being vested—or you are near 60 years old and nearing retirement, and oh, you have a PhD! So what else is new? If you are not a manager or a prolific politician, look out (or ahead). This is not to say that all companies arbitrarily lay off all their older engineers. However, it does happen, and the shock will be lessened if you realize this, and also if you have an inkling of what's ahead as you hunt for a new job.

It is only a matter of time when all the lines of technical maturity versus salary (plus future cost-of-living raises) converge on a graph to weigh your fate and perhaps, spell your disposition. Disposition is a kind word which means "you are being turned out to pasture". It may be this or it may be just the fact that when budget cuts demand a cutback in personnel, it is a lot easier to layoff one high-salaried older engineer vs. two young lower-priced men. In any case it all amounts to the same thing, you are out of a job. Suddenly, what was once a pleasant place to work, looks like hell and that understanding manager bears a resemblance to an ogre. What to do? If you panic, you may be headed for disaster. Instead you should stop and take stock of yourself. You may be surprised at how good you look. But before we proceed with a methodical approach on what to do to secure a new position, let's analyze the situation and look at what NOT to do.

1. Don't burn your bridges behind you. Remember that your new employer may be investigating you through your present employer.

2. Don't run to the boss' boss and further up the ladder unless you have solid support behind you. You may be surprised at how few friends you have when it comes to a showdown with the top brass.

Ask for clarification of the reasons for the disposition. You may wish to examine each detail. However, you can be asssured of one thing; regardless what the reasons for disposition may be and how convincing your supervisors may be, it all comes out "Salary and age are too high". Once you are convinced of this fact, your most humble approach is "What do you suggest I do?" They could have (arrangements made in advance) a resumé writer, typist, photographer, copier and unlimited telephone usage at your disposal. Some companies carry a placement service that you should use to the fullest. *But don't depend on them to do all your work.*

Resumés. At this point, it is extremely important to get your resumé written and in circulation as soon as possible. Employment placement officials indicate that it takes an average of six weeks to relocate *after the resumé* is in circulation. Your resumé writer will have many good and general suggestions about the format, but it is up to you to make it effective. Be sure to supervise its design as you would a project. Make it your best effort. Remember though, you should list your strong points first. On the other hand, age should definitely be at the end. Also list achievements and awards of all types. This shows that you are one who gets things done. Under experience, positions held are generally listed in chronological order. In the description of duties, be sure to use strong active verbs, such as "created", "designed", "directed", "specialized in", "planned", "developed", etc.

Have your resumé typed on an "executive" typewriter and be sure to duplicate about 30 copies before the original is sent to the graphic arts department for reproduction. These initial copies can be used for in-house distribution and quickie interviews where the gingerbread is not needed. Don't get uptight about letting your associates know that you are looking. In fact, you may be pleasantly surprised at how helpful they could be in suggesting opportunities. (My best leads were obtained that way!)

Tell The Family. It's easier than you think but only you will know how to do it. Keeping this information from your wife could cause irreparable harm. After you get over this blow, be sure to tell your best friends. Your true friends will show their colors by suggesting and helping. (You may find that you also had some false friends, too!)

Personal Evaluation. How long has it been since you took stock of yourself? In the beginning while your resumés are being made and some of them are working for you, make a list of jobs you prefer. Decide whether you are willing to leave the city, that state, etc. Are you willing to travel? How often and to what extent? Do you want to stay with your present company, and which division?

If you decide to leave the company, make a list of companies, executives' names and your desires. Be sure to reach high. You may even consider a 10 to 20% increase in salary. Keep in mind that although you many not be in good standing with your present company, you may have much valuable knowledge to a competitor, and it may be a better match. Other considerations may be positions such as teaching, consulting, sales, TV and appliance servicing, manufacturing, electrical contracting; or you may consider going into business for yourself. If so, list the possibilities, keeping in mind the legal and financial entanglements involved.

A review of your personal analysis may reveal a "now-I-can-do-what-I've-always-wanted-to" attitude. To some, it may be a blessing in disguise. People have escaped ulcers and heart attacks by having the wisdom to assume a favorable attitude.

Keep a running list of your contacts. List the person to be contacted, the company, the phone number, the date the resumé was sent, date of follow-up calls and pertinent remarks. Strive to deliver resumés in person. Most resumés are set aside to be "read later". It helps to keep in touch with the industrial relations head at all times. He can be of great assistance or he can be unintentionally harmful.

Do not depend on the IEEE. To me, this was a severe disappointment. After 15 years of membership, they had nothing to offer a senior member in the way of assistance. The PSPE was much more cooperative, and they do have an engineering placement assistance program.

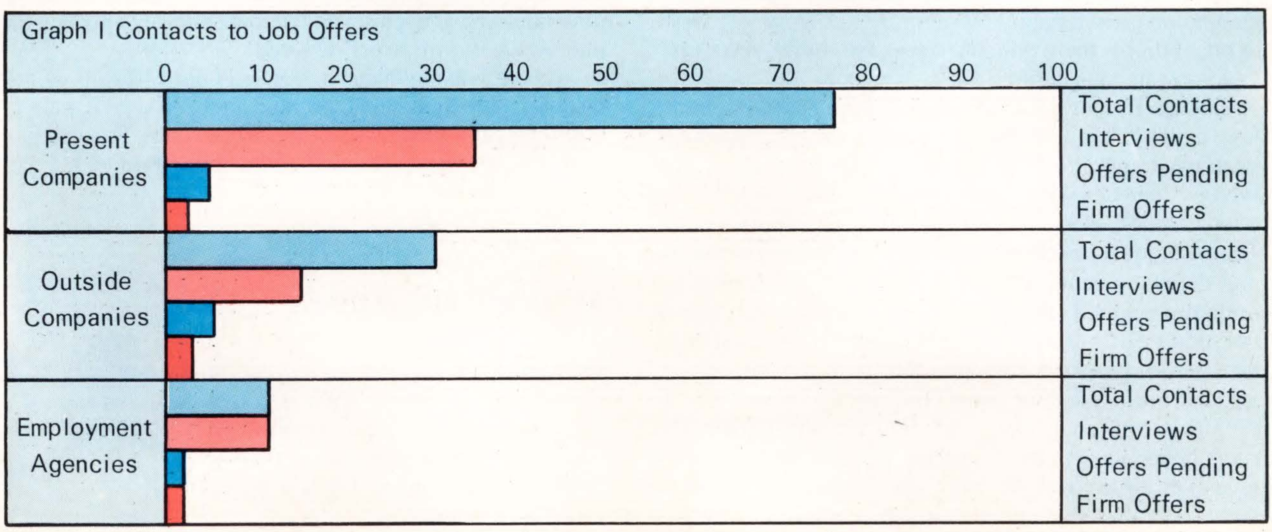
"How To Be Well - Remembered -- And Soon Forgotten!"

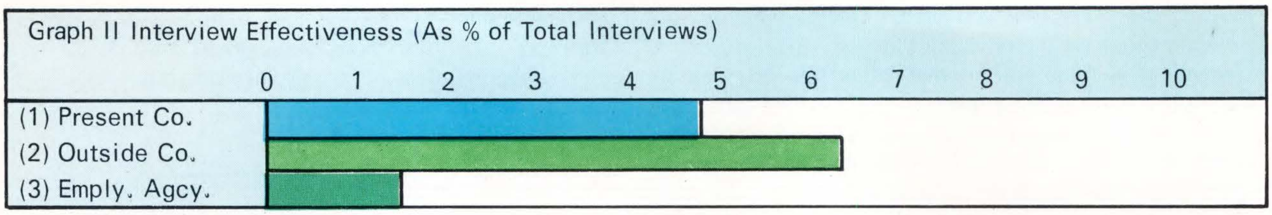
Interviews. The best possible interviews are those made through personal friendships or through associates and friends. By unfavorable comparison, employment agencies take the most time, keep you waiting the longest, and do the least for you.

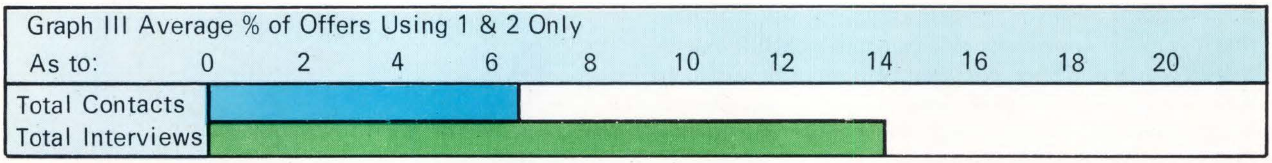
Be smart in arranging your interviews. Get as much mileage as you can by covering as much of the town as possible during one trip. Time is of the essence. In a nut-

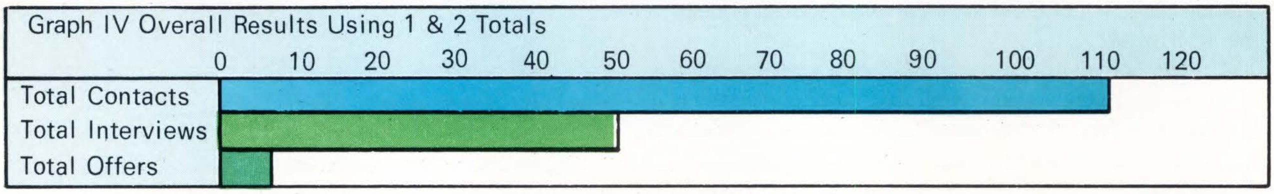
TABLE I

Item No.	Potential Source	Contacts	Personal Interviews	Sincere Promises	No. Of Offers	Offers As % Of Contacts	Offers as % of Interviews	Offers as % of Total Interviews
1	Present Co	78	35	5	3	3.85	8.60	4.85
2	Outside Co	32	15	6	4	12.40	26.50	6.45
3	Empl. Agcy	12	12	1	1	8.33	8.33	1.56
	TOTALS	122	62	12	8	6.55 (Ave.)		13.00
TOTALS 1 & 2 Only		110	50	11	7	6.35	—	14.10









shell, the greater the number of interviews, the greater the chance for re-employment.

The best possible interview is one made for you by your supervisor, or at least with his approval. It carries more weight if you can say, "I'm calling at the suggestion of Mr. Dodo, manager of the Mathematics Department". Also, at the end of each interview, ask your interviewer to make suggestions as to where you might look next. This does two things for you. First, his reaction indirectly lets you know the value of the interview and secondly, if he does not have exactly the match you need, he may know someone who does.

At the interview a number of pointers are worth reviewing. Above all, be on time and make sure you present a good appearance. Find out as much as you can about the company and the job beforehand. Then at the interview, be attentive, ask pertinent questions and show how you fit into the picture. Finally, talk salary, position, benefits, etc., for this is the time to settle such things. Either agree or disagree, but don't let it dangle. Remember, employment is like a marriage—both sides must have a match. If there is no match, ask the interviewer for recommendations and names of other companies or departments. You have nothing to lose.

Pause occasionally and review your interviews. Is there a common denominator that seems to turn your interviewer on, and/or is there one that closes the show? Make each interview an education.

Closing. By this time, you may have many irons in the fire. Don't relent just because one of your favorites appears favorable. It can very quickly turn sour. Keep after the best matches without becoming a nuisance. When an offer is made, don't fall all over yourself. Remain calm. This is an ideal opportunity to review all aspects of the job and company benefits involved. Although these items are normally covered during the initial interview, this line of questioning acts as a double check and it shows keen business sense. It also assures him that you are seriously interested in the position. Now, you ask for several days to discuss it with your family. Ask him to hold it open. This short delay allows time for others to come through and it gives you time to check with other preferreds. Don't be surprised if they start coming through at once!

How Did I Make Out?

My personal batting average is as follows:

1. Of 78 contacts made within the present company, 35 resulted in interviews. Five of these were pending offers, 3 of which became offers.

2. Thirty-two contacts were made with outside companies as a result of newspapers and personal contacts; 15 became interviews; 6 resulted in pending offers and 4 became definite offers.

3. Twelve employment agencies were contacted; all became interviews resulting in 1 job offer.

Table 1 shows the entire picture. Assuming that each interview consumes 3 hours including traveling time, the employment agencies fare the worst. In reality, more time is spent interviewing at agencies because there is at least one additional hour of waiting and application writing. Conversely, the least time is spent with the present company because appointments are usually on time and there are no applications to fill out. Also many interviews can be localized. The averages at the bottom of **Table 1** show that by eliminating employment agencies, it would change the averages only slightly. On the other hand, it would save considerable waiting and travel time. This comparison can also be seen in the graphs. If employment agencies were ignored, it is estimated that about a week of job-hunting time could have been saved without seriously affecting the percentage of firm offers received.

So there you are! Need a job? Send out 110 well-written resumes, participate in 50 exciting interviews, anticipate 11 firm offers and then choose one of the 7 jobs. So what else is new? Your well being and a new job! Good luck!

AUTHOR'S BIOGRAPHY

Mr. Moose has spent about 25 years in electronics. He has a BSEE and is a P.E., among other achievements. To this credit, add a number of patents and published articles. He is a senior member of the IEEE.

FOR A FREE COPY OF THIS ARTICLE, **CIRCLE L66**

CIRCUIT DESIGN AWARDS

High-speed circuit detects phase-difference

John C. Freeborn, Honeywell, Inc.,
West Covina, Calif.

This circuit detects a small relative phase shift between two ac signals and generates an output which indicates the magnitude and direction of the shift. It was designed for a metal detector, but other applications are possible.

Two dual D flip-flops, SN 7474s, are interconnected as shown in **Fig. 1**, so that two seperate outputs are generated as a result of the phase comparison between the input signals. Characteristics of this dual D flip-flop are: On a positive going clock pulse to input C the level at input D is transferred to Q; on a negative going (clear) pulse to input C1 the Q goes to "ZERO". As long as the clear input (C1) is maintained at "ZERO," clock pulses are not effective.

At the beginning of a cycle, all four flip-flops are in the reset (a = "ZERO") state. Two ac signals, S_1 and S_2, are applied to the two input points of the SN 7474S. If S_1 leads S_2 in time, an output pulse will appear across V_1 and $\bar{V}_1$, the duration of which will be equal to the phase difference. If S_2 leads S_1, an output pulse will appear at V_2 and $\bar{V}_2$. In practice, useful pulses as narrow as 20 nsec have been generated. No dead spot or zero phase shift condition has been observed, indicating that the circuit's ability to detect phase differences is limited by noise and drift rather than by response of the circuit.

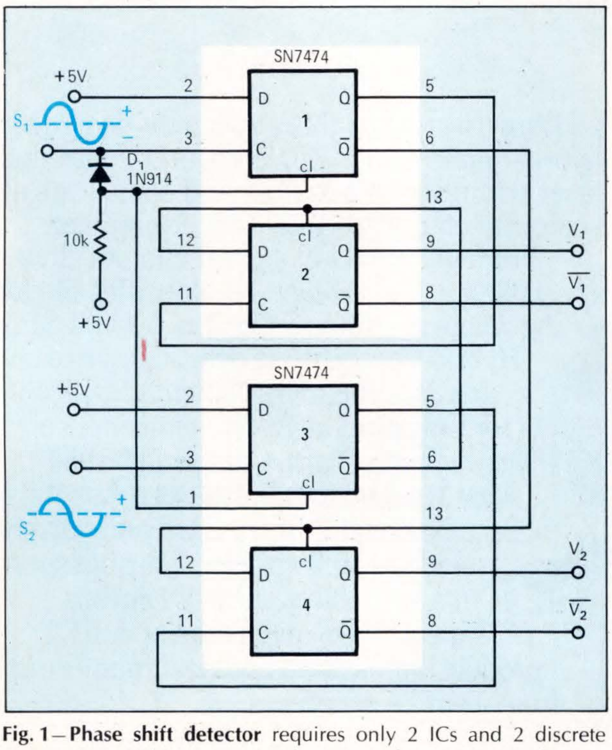
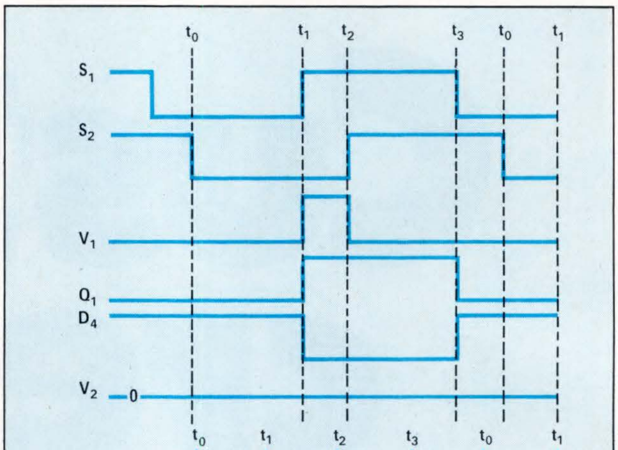


Fig. 1—Phase shift detector requires only 2 ICs and 2 discrete components. When input signals at S_1 and S_2 are not in phase, a pulse will be present at the output of the leading phase.



C1	0	1	1	0	0
Q1 = C2	0	1	1	0	0
$\bar{Q}1$ = D4	1	0	0	1	1
C3	0	0	1	1	0
Q3 = C4	0	0	1	0	0
$\bar{Q}3$ = D2	1	1	0	1	1
Q2	0	1	0	0	0
Q4	0	0	0	0	0

Fig. 2—Timing waveforms and truth table depict circuit operation when S_1 leads S_2 in phase. All flip-flops are reset on the negative half-cycle; thus, phase detection occurs at the input signal rate.

The circuit compares the inputs at the positive-going clock-pulse threshold level (about +2.OV) and requires a reset prior to the next expected comparison. In the circuit shown, both S_1 and S_2 go negative, and this half of the signal is used through D, to reset the flip-flops.

The detailed operation of the circuit can be seen from the timing diagram and truth table of **Fig. 2**. These show signals vs time for the case in which S_1 leads S_2. Square signals are used for clarity. Significant times are labeled t_0, t_1, t_2, t_3. These time symbols are used to separate various circuit states in the truth table. The subscripts refer to flip-flop number assignment (1 through 4) made in **Fig. 1.**

Note the addition of a dc bias to the input signals will influence the apparent dc detection level and thus provide a means for balancing or zeroing.

To Vote For This Circuit
Circle 160

2 CMOS gates convert counter into capacitance meter

Roger Melen Stanford University,
Stanford California

In many applications it is very convenient to have a direct digital readout of capacitance. The circuit shown in **Fig. 1** will convert any counter into a digital readout capacitance meter with good accuracy for values measured between 1000 pF and 10 μF.

Two CMOS gates (A and B) are connected to generate a 1 Hz squarewave which drives the SN74121 monostable multivibrator. The monostable, when triggered, generates a pulse, the width of which is determined by the capacitor under test. The pulse output of the monostable turns on a 100 kHz oscillator (made up of gates C and D). The output, when a capacitor is being measured, is a 100 kHz burst every second. The direct measurement of capacitance is possible because the duration of the burst, hence the number of pulses in the burst, is proportional to the capacitance under test.

An ordinary dc voltmeter connected to the output terminals can also be used to measure capacitance, since the average value of the output waveform is directly proportional to the capacitance under test.

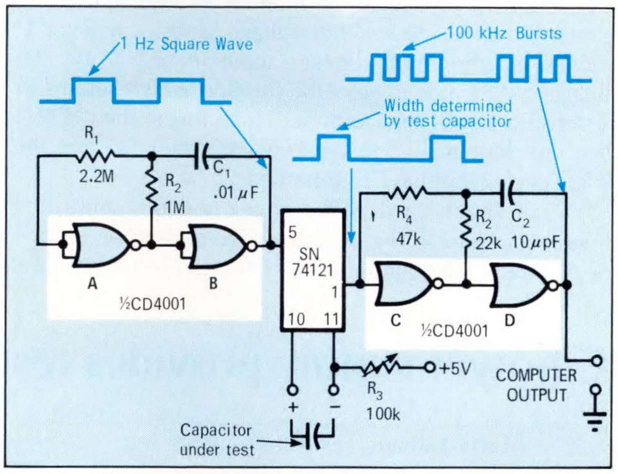


Fig. 1—Direct readout of capacitance with any digital counter is a very quick operation with this CMOS circuit. The system is calibrated with a known capacitance by adjusting R_3 so that one output pulse equals 100pF.

To Vote For This Circuit
Circle 161

Timer produces time delays from μsecs to hours

Y. Kurahashi, Exar Integrated Systems, Inc.
Sunnyvale, Calif.

Commercially available one-shot IC's are usually limited to applications requiring relatively short delays of a few milliseconds or less. By adding several external components, including one transistor, a one-shot IC can be used to generate timing periods of up to one minute. A new multifunction IC, the XR-220, can further simplify the external connection and provide greater versatility.

The functional block diagram and basic external connections for timing applications of the XR-220 are shown in **Fig. 1**. The monolithic device contains a linear current source and reference circuit, voltage comparator, flip-flop, timing switch, buffer amplifier and a driver amplifier. The connection shown for a timing circuit requires only three external components: a timing resistor, R, timing capacitor, C, and load resistor, R_L.

Two outputs are available. Terminal 10 is a low-current output which is normally "LOW" and TTL compatible. An external resistor is required to provide a load for the open collector, which is internally coupled to the next stage.

Terminal 12 is normally "HIGH," and is also TTL compatible. Although somewhat slower, it offers a 100 mA output capability in either "HIGH" or "LOW" states.

With the component values shown in **Fig. 1**, the circuit has a delay period of 30 sec. The period can be extended to several hundred seconds by increasing the value of R. The practical limits of R range from 3 kΩ to 1 MΩ for a 5V power supply. The circuit is non-retriggerable. The timing cycle is initiated by grounding terminal 5 or applying a positive pulse to terminal 6.

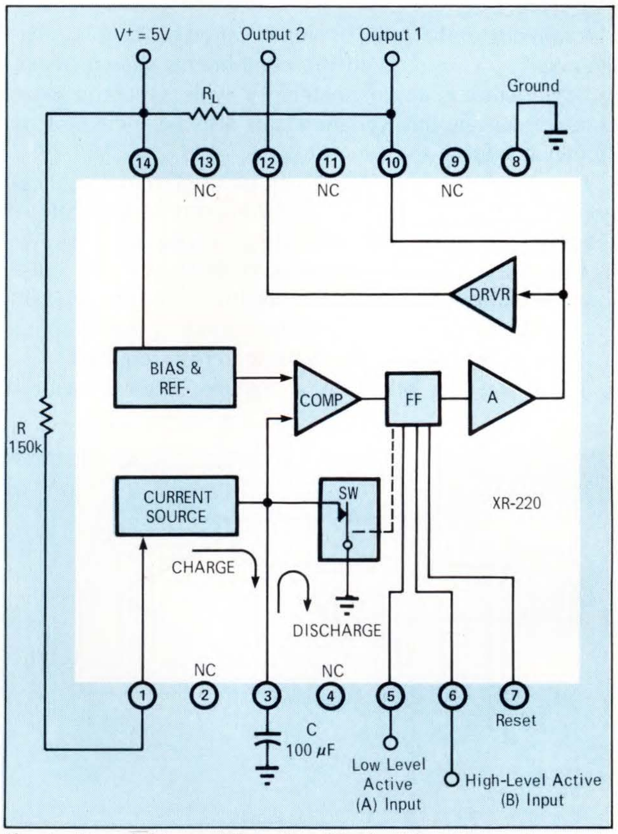


Fig. 1—Monolithic multifunction IC, the XR-220, requires only three external components to generate timing pulses. In this configuration the internal constant current generator is programmed, by R, and charges C linearly until the voltage across C reaches the threshold of the comparator, ending the cycle.

The amount of the current delivered is dependent on the value of R. This yields a timing period of precisely 2 RC. The factor of 2 is due to the internal arrangement of the reference voltage. When the voltage across capacitor C reaches the threshold voltage (approximately 2.4V) the voltage comparator triggers the flip-flop which returns to its previous state. Thus, terminal 10 returns to the "LOW" state and terminal 12 to the "HIGH" state. To reset the timing cycle, terminal 7 is grounded.

The maximum length of the timing period is limited by three main factors: The dc leakage current of the capacitor, the input bias current of the internal comparator, and the leakage current of the analog switch. Of the three, capacitor leakage is the dominant factor.

The 100 μF aluminum tubular capacitor used in this circuit has a maximum leakage of 1 μA. This means that the value of R can be no greater than 1 MΩ. If a higher power supply voltage is available, one can increase both the timing capacitor and resistor values and generate delays that exceed one hour.

To Vote For This Circuit
Circle 162

IC power supply provides test spikes or level shifts

Larry Latham, Texas Instruments, Inc.,
Attleboro, Mass

There are times when power supply level shifts or voltage spikes are needed to check the performance of equipment subjected to these varying conditions. The circuit shown in **Fig. 1** accurately provides these test signals. Spike or step width depends directly on the input pulse width, and the reference voltage is programmable by means of R_2.

The component values chosen for the circuit illustrated provide a reference voltage range of approximately 2.0V (4.7V to 6.7V). However, a much greater variation in reference voltage is possible (0 to 18V) if different component values are used.

Amplitude of the spike or step is varied by R_5 (for a negative spike or step). With the components shown, maximum variation is approximately 5V with respect to reference. However, this variation can also be increased by changing values.

The circuit shown in **Fig. 1** can be used in any application requiring less than 100 mA of current. In applications requiring less than 20 mA, the circuit configuration shown in **Fig. 2** can be used, allowing faster spikes. The pulse input amplitude required for a negative spike or step output is zero to +3.0V. For a positive spike or step output a negative-going pulse from +3.0V to zero is required.

The circuit is primarily a voltage follower with a switched voltage divider on the input. R_7 and R_3 set the voltage variation range of R_2. A_1 and Q_2 are connected in the unity gain voltage follower configuration with resistor R_8 acting as an output limiter. Q_1 acts as a switch, connecting resistors R_5 and R_6 in parallel with the divider resistors R_2 and R_3.

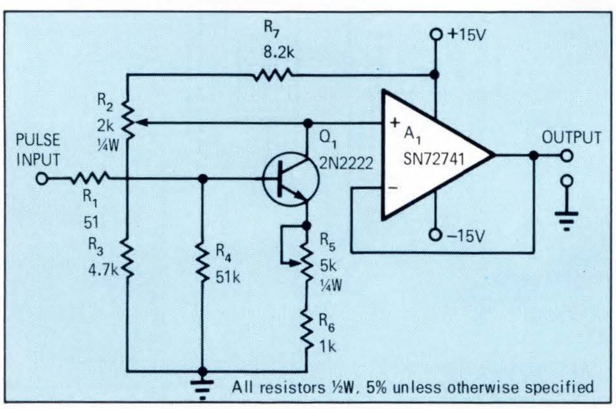


Fig. 1—Power supply level shifts or voltage spikes, for test purposes, can be programmed into IC circuits requiring less than 100 mA with this circuit. Using the values listed, the output reference voltage level is 4.7 to 6.7V.

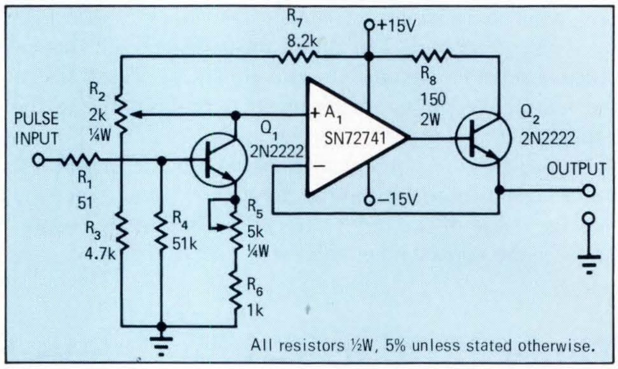


Fig. 2—Low power version of the pulsed power supply eliminates Q_2, and can supply up to 20 mA. Faster test spikes can be generated with this circuit. Either circuit can provide spikes or level shifts of up to 5V.

To Vote For This Circuit
Circle 163

Rules & Announcements

Your vote determines this issue's winner. All circuits published win a $25 U.S. Savings Bond. All issue winners receive an additional $50 U.S. Savings Bond and become eligible for the annual $1000 U.S. Savings Bond Grand Prize.

Vote now, by circling the appropriate number on the reader inquiry card.

Submit your own circuit, too. Mail entries to Circuit Design Program Editor, END/EEE, 221 Columbus Ave., Boston, MA 02116.

Readers have voted:

Roland J. Turner winner of the January 15 Savings Bond Award. His winning circuit was called, "Reduce integrator transients with synchronized gate signals." Mr. Turner is with RCA Missile and Surface Radar Div. Moorestown, N. J.

C-LINE
POWER DARLINGTONS

more types to choose from at less cost...

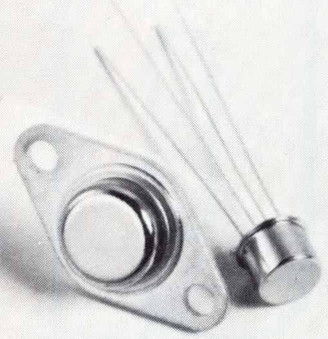
and we're only beginning.

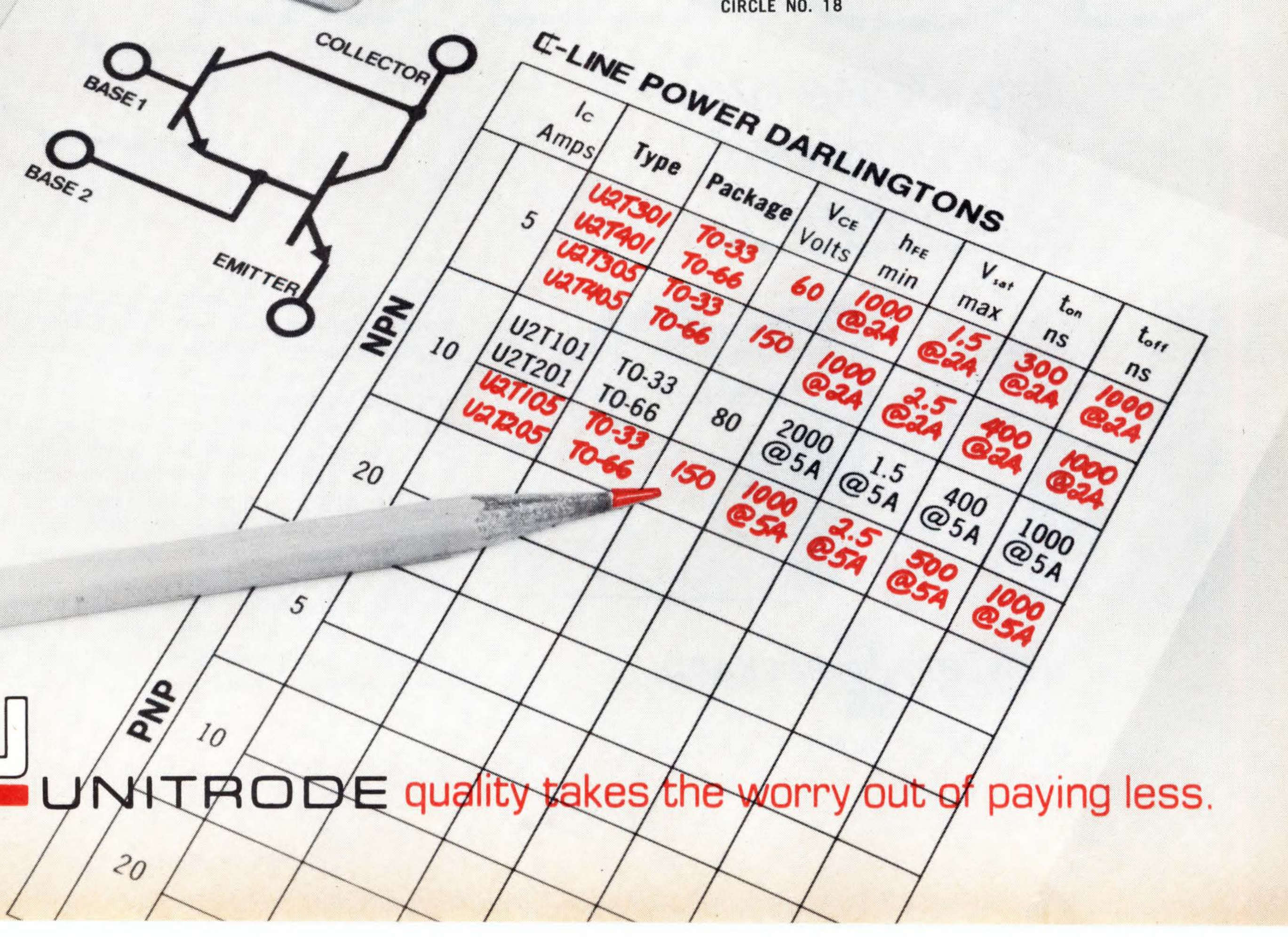
The Unitrode Darlington transistor line is expanding. It now includes eight types. New are 5 Amp and 150 V Darlingtons in two hermetically sealed metal packages — a lead-mounted TO-33 and a chassis-mounted TO-66 — available in power ratings up to 25 watts. They're ideal for high gain switching and amplifying applications such as print hammer, solenoid, servo, and relay drivers and motor controls. The wider choice of alternative types available, coupled with an across-the-board price reduction, can help you realize savings of up to 50%. (For example, U2T301 is $1.25 ea. in lots of 100) They're all available off-the-shelf at your local Unitrode distributor.

For fast action, call Sales Engineering collect at (617) 926-0404 Unitrode Corporation, Dept. 4 Z, 580 Pleasant St., Watertown, Mass. 02172

Application note U64 available on request.

CIRCLE NO. 18





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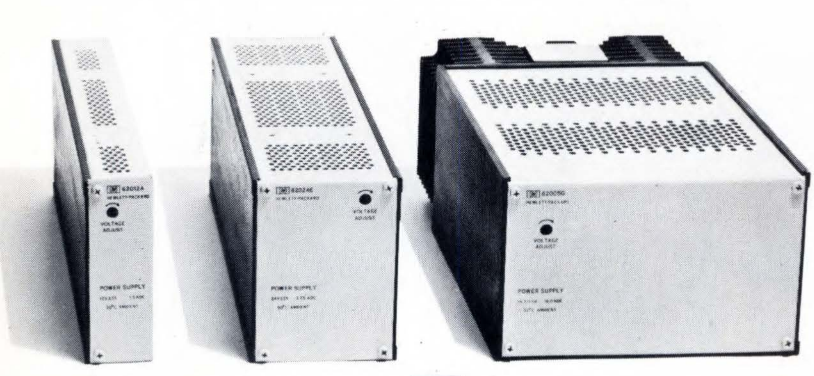
for those who
think about
tomorrow!



Value has always been synonymous with HP power supplies, and these new 62000-series modular power supplies are no exception. They're competitively priced (with quantity and OEM discounts), reliable, systems compatible, and available now. Coverage is from 3 to 48 volts, at up to 200 watts, with performance assured to specifications. Best of all, HP offers applications assistance and service support before and after the sale. It's all backed up with an international network of 220 offices to serve you. For detailed information, contact your local HP field engineer. Or, write: Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

POWER SUPPLIES

21201

CIRCLE NO. 42

computer hardware

FOR DESIGNERS OF COMPUTER MAINFRAMES, PERIPHERALS AND SYSTEMS

Designing low-cost memories

A CAHNERS PUBLICATION/APRIL 15, 1972

Testing digital IC's?

8013A, $625

8007A, $1600

HP's new pulsers give you the most capability per dollar

If digital IC's are your big interest, HP's new 8000-Series pulse generators are for you. You not only get **versatile capability,** but you **save money** as well! These new pulsers offer you a choice of price/performance packages to meet your needs, within your budget—whether you're working with computers, communications, telemetry, or any other digital system.

The new 8007A gives you rep rates from 1 kHz to **100 MHz, variable transition times** (2.5 ns to 250 μs), $\pm$5 V amplitude, and $\pm$2.5 V dc offset – all for **$1600**. With the 8007A, you can design and test the fastest of today's digital devices—ECL IC's and bi-polar memories—and have "speed to spare" for tomorrow's advances.

If you don't need 100 MHz, you can save. For only **$875**, you can get the new 8012A, which gives you rep rates from **1 Hz to 50 MHz.** Like the 8007A, it offers **variable transitions** from 5 ns to 0.5 s, with $\pm$5 V amplitude and $\pm$2.5 V dc offset.

If you don't need variable transitions, you can save even more. Our 8013A gives you rep rates from **1 Hz to 50 MHz** with a fixed transition time of $<$**3.5 ns,** $\pm$5 V with dc offset, and dual outputs—all for **$625.**

All three of these new pulsers give you pulse-shaping capabilities, allowing control of NRZ or RZ waveform parameters with the output width determined by the input waveform width. Normal external triggering and gating are also supplied.

The 8007A also gives you a double-pulse mode, and all three models have square-wave capabilities. And the 8013A offers simultaneous positive and negative outputs, with $\pm$5 V amplitude across 50Ω ($\pm$10 V open-circuit or with high-impedance internal source).

Other HP pulse generators, listed in the catalog, begin **as low as $225.**

For further information on any of these new 8000-Series pulsers, contact your local HP field engineer. Or write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

081/11

HEWLETT *hp* PACKARD

SIGNAL SOURCES

CIRCLE NO. 402

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the end of the temperature compensating oven!

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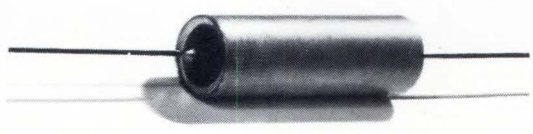
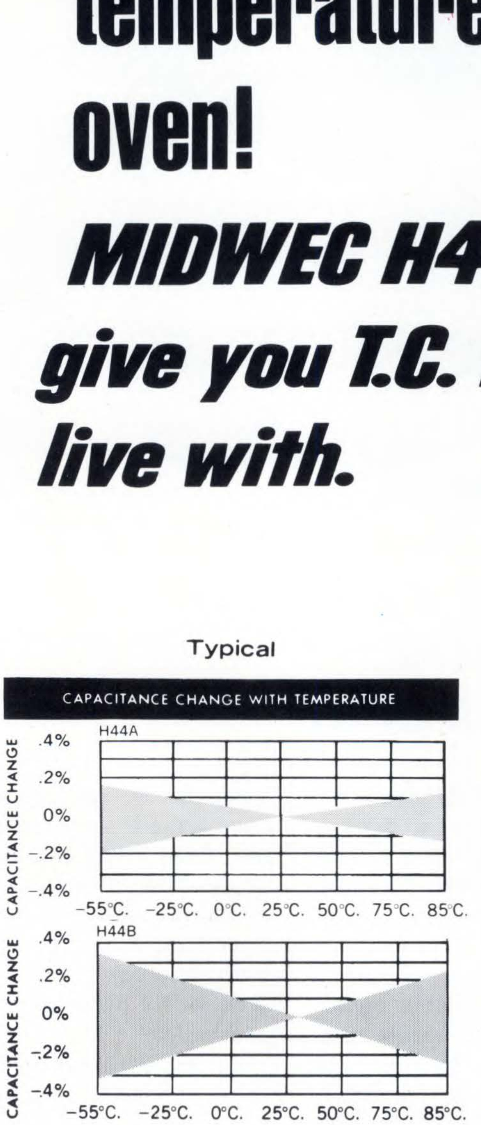


H44A & H44B
FILM CAPACITOR

Typical



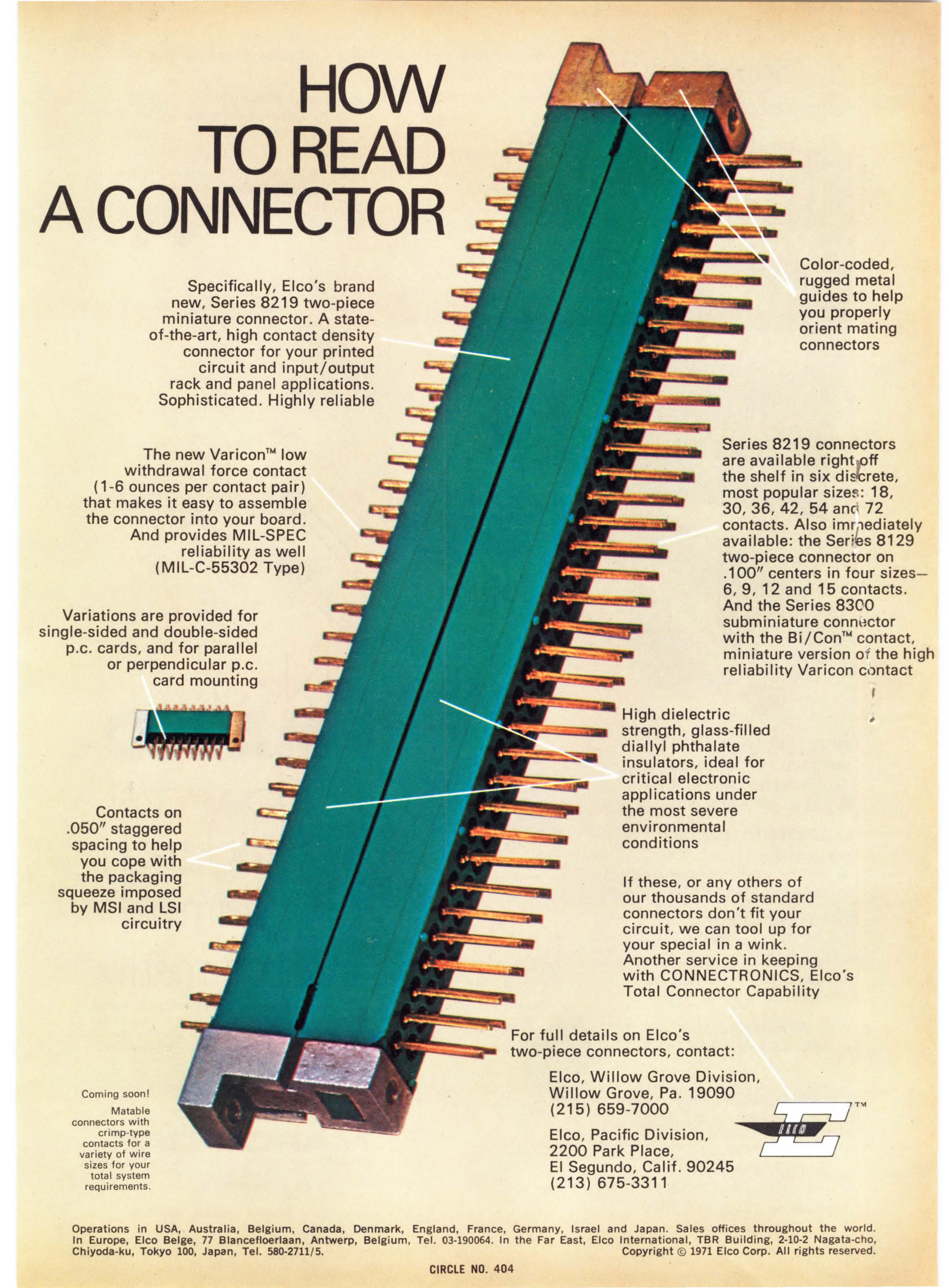
These new film capacitors achieve an almost zero temperature coefficient in the smallest possible physical size as a result of MIDWEC's exclusive design and processing techniques. Uniform performance of standard units is inherent because of the design and production procedures. Tighter TC than is shown in the charts at left can be attained on special order.

H44 capacitors are available in two standard TC ranges: H44A, $\leqq \pm$20PPM/C°, and H44B, $\leqq \pm$40PPM/C°. Capacitance range from .010 mfd to 1.0 mfd.

For complete data sheets, write to:

MIDWEC CORPORATION
P.O. BOX 417
SCOTTSBLUFF, NEBRASKA 69361
Phone: 308/632-4127
A Subsidiary of Southwestern Research Corporation

CIRCLE NO. 403


HOW TO READ A CONNECTOR
Specifically, Elco's brand new, Series 8219 two-piece miniature connector. A state-of-the-art, high contact density connector for your printed circuit and input/output rack and panel applications. Sophisticated. Highly reliable
Color-coded, rugged metal guides to help you properly orient mating connectors
The new Varicon™ low withdrawal force contact (1-6 ounces per contact pair) that makes it easy to assemble the connector into your board. And provides MIL-SPEC reliability as well (MIL-C-55302 Type)
Series 8219 connectors are available right off the shelf in six discrete, most popular sizes: 18, 30, 36, 42, 54 and 72 contacts. Also immediately available: the Series 8129 two-piece connector on .100″ centers in four sizes—6, 9, 12 and 15 contacts. And the Series 8300 subminiature connector with the Bi/Con™ contact, miniature version of the high reliability Varicon contact
Variations are provided for single-sided and double-sided p.c. cards, and for parallel or perpendicular p.c. card mounting
High dielectric strength, glass-filled diallyl phthalate insulators, ideal for critical electronic applications under the most severe environmental conditions
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CIRCLE NO. 404

computer hardware

EXCLUSIVELY FOR DESIGNERS OF COMPUTER MAINFRAMES, PERIPHERALS AND SYSTEMS

COVER

Efficient packaging is one of the key ingredients to make low-cost memories. To see what the others are, read "Low-cost core memories don't have to be slow and bulky" on p. CH14. Cover photo courtesy of Ampex Corp., Marina del Rey, CA.

DIRECTIONS

Patent issued for dual-bus minicomputer is an industry first.

A U.S. Patent has been issued to GRI Computer Corporation covering the basic organization of their general purpose minicomputers. It is believed to be the first patent of this nature ever issued. GRI is currently marketing these computers as the GRI-909 series, available in four basic models.

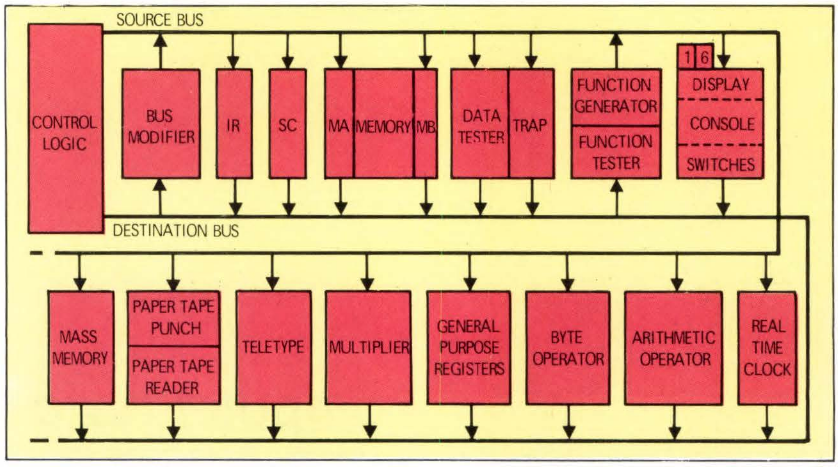
The Patent specifically covers a Direct Function Data Processing System employing a Universal Bus System in which a number of functional elements are all connected to either an input or output data bus or both, so as to function as a data source, a data user or both. The system also includes a programmable data transmission link which serves to connect the input and output functions.

The major characteristics of a computer organized in this manner are:

•**Multiprocessing:** Multiple processing elements may be used within the bus system to tailor or expand the computer power to fit the application for which it is used. The instruction repertoire can be expanded to include thousands of instructions. Processors can be either microprogrammed ROMs or logic or a combination of

•**Communications:** Since all system components as well as computer elements share a common bus system, information can be moved directly between system devices and computer elements including memory. This eliminates many "housekeeping" instructions usually required to move data about in conventional computer organizations, thus reducing program memory requirements and increasing computer throughput. It also permits certain tests to be performed directly on data residing in peripheral device registers without first transferring the data to special registers within the computer proper.

•**Programming:** In addition to the normal logic and arithmetic instructions found in conventional computers, GRI Direct Function Processors can execute functional instructions related to the system devices themselves. This allows programming languages that are simple to learn and use, combined with the efficiency of machine language programming. It is ideally suited for real-time applications where com-



Dual bus structure allows all elements of the computer to be connected across the same busses. They are then directly addressable by using compiler-type functional language.

DIRECTION

piler languages may be too costly to use, or inefficient.

Saul Dinman, VP of engineering at GRI and author of the new patent, stated, "Judging by recent trends in major competitor minicomputer design, there is a definite course being established and directed along the lines of the GRI innovated Universal Bus Concept." One such example is the SUE computer recently announced by Lockheed Electronics.

Largest memory-computer system provides instant statistics at the 1972 Summer Olympics.

The 1972 Summer Olympics in Munich, Germany, are expected to draw over 4000 journalists, 15,000 athletes, trainers and guests and many thousands of sports fans. Providing instant statistical information on all the athletes for these people will be a mammoth job for any data system. Siemens Corp., the German electronics giant, has provided the answer with what it says is the world's largest sports memory—two computers that will give instant information on not only the players, officials, trainers and guests of honor, but also data on all the rules, victories, and latest ranking lists and on cultural events taking place. Historical data on the first six athletes in every Olympic sports event since 1896 will also be available.

The information system is based on a process for the storage and retrieval of information developed by Siemens known as GOLEM (a German abbreviation for a random-access storage-oriented inquiry system with list-type organization). This data bank system has been used successfully in a wide variety of applications and was changed slightly for the special requirements of the Olympic Games.

The pair of computers are part of a Siemens computer center in the south of Munich which handled the evaluation results for the 1970 World Alpine Skiing Championships in Val Gardena, Italy. The storage is of the multi-spindle disk type with two standby magnetic card storages and contains around 150,000 information records.

To get some idea of the magnitude of the material to be stored, the data memorized would fill over four million punched cards. Seventy-two information stations are linked with the computer center via 1200-bit/sec serial modems. These stations are set up in the press centers, at the various competition sites and at focal points of tourist traffic. Each consists of a data display terminal and a keyboard operated by a specially trained hostess. Fifty of the 72 terminals are connected with data printers. A number of conventional copying machines are also provided for printout reproductions.

Instant statistics—that's what this CRT terminal provides for the upcoming 1972 Summer Olympics in Munich, Germany. The terminal is part of a two-computer system set up at the Olympics by Siemens of Germany. The system supplies details of practically everything connected with the Olympic games.

The largest section of the Olympic data bank, which numerous Siemens employees have been compiling for two years, contains the personal data on the 10,000 athletes and 5,000 officials. The system will be able to provide, for example, full name, date of birth, nationality, height, weight, marital status, number and sex of children, hobbies, club memberships, best events and previous successes and victories. The complete rules of all 196 events of the 21 Olympic sports and significant sporting terms in German, English and French are also stored. A daily summary of the Munich competition results will be fed into the system during the night by means of a special updating service.

The particular advantage of this

DIRECTION

The particular advantage of this electronic information system is that the desired answer can be obtained very quickly from the vast source of information using simple search questions without spending time referring to key-word catalogs. In written form, the personal data alone would fill a book two-meters thick. The search-key method permits data and facts to be logically combined. In this way it is possible to determine in a matter of seconds the athletes from a particular country who have won a medal in the 100-meters dash (since 1896), or have beaten a time specified by the inquirer, for example.

And now a taxi by computer—for instant and more efficient cab dispatching

The Yellow Cab Company of Los Angeles has turned to computers to improve taxi operations in the sprawling Los Angeles area. Computat, as the new system is called, is providing faster and more reliable service by quickly and accurately matching telephone cab requests with the nearest available taxis.

The system is built around two NCR Century 100 computers linked to eight NCR 795 CRT terminals. Handling up to 10,000 calls a day for the 700 cabs operated by the company, the system works as follows:

Yellow Cab operators take telephone orders and enter these into one of the Century 100s via the CRT units. The computer determines in which of the city's 200 numbered grid areas the callers are located and then matches the orders with the nearest available cabs, displaying the information on the CRT screen of the dispatcher who then relays the order to the appropriate taxi driver via radio.

Logs of incoming calls, the dispatching of cabs and the times and places of pickups and deliveries are stored in the computer's magnetic disk files. The second computer system is used for company statistical reporting and the processing of payroll and accounts receivable and payable.

Call RCA if you want to talk about MIL-M-38510 COS/MOS

Now, for high-reliability types in COS/MOS ICs – for full MIL-STD-883 – call RCA.* And let's talk about advanced MIL-M-38510 techniques. In RCA's rapidly evolving 38510 program, high-reliability type product becomes not just the result of screening, it will be built in, through procedures being developed to the specification:

- Scanning electron microscope (SEM)
- Radiographic inspection
- Product traceability for permanent product control
- Rigorous operator training to maintain high quality-control standards

The COS/MOS CD4000A series is available in high-reliability types now being produced under MIL-STD-883, with SEM inspection specified in NASA-Goddard Space Flight Center specification GFSC-311-P12A, on special order.

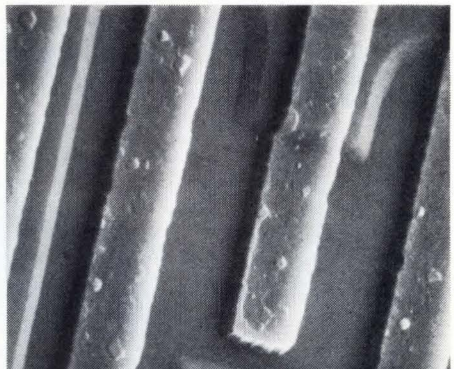
And, since RCA's COS/MOS production is a single, integrated process, process advances that are developed for high-reliability product are automatically reflected in the commercial type you specify.

If you want the leader's standard of quality plus volume capability and systems cost effectiveness, go COS/MOS. See your RCA Representative or your RCA Distributor. Or write, RCA Solid State, Section 171D , Box 3200, Somerville, N.J. 08876. International: RCA, Sunbury-on-Thames, U.K., or P.O. Box 112, Hong Kong. In Canada: RCA Limited, Ste. Anne-de-Bellevue 810, Quebec.

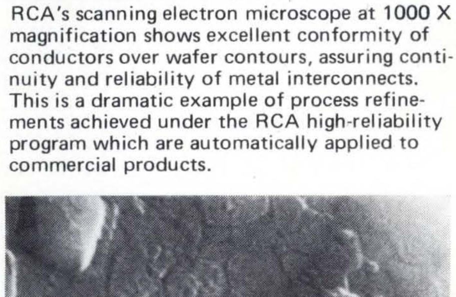
**For information on high-reliability COS/MOS and our MIL-M-38510 progress, call RCA's high-reliability marketing specialist, Garry Miller (201) 722-3200 Ext. 2805.*

RCA Solid State

products that make products pay off

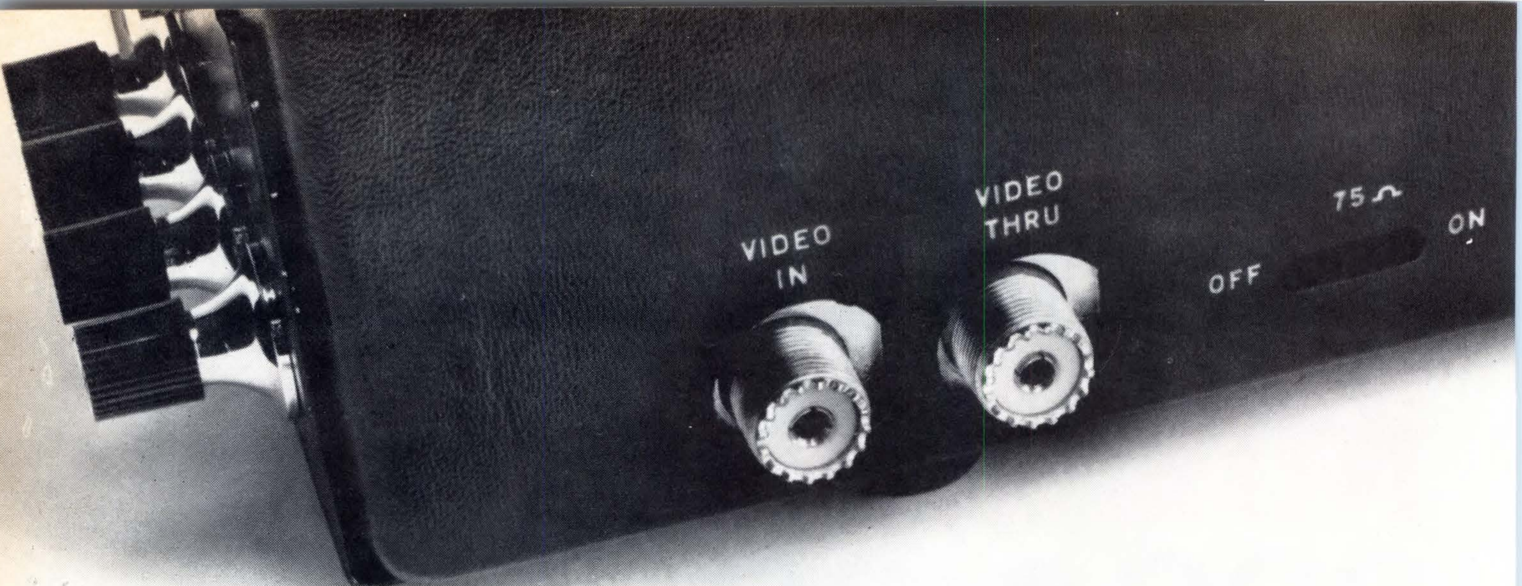


RCA's scanning electron microscope at 1000 X magnification shows excellent conformity of conductors over wafer contours, assuring continuity and reliability of metal interconnects. This is a dramatic example of process refinements achieved under the RCA high-reliability program which are automatically applied to commercial products.



6000 X magnification shows excellent metal coverage over an oxide step.
The scanning electron microscope has become a major tool in RCA's diagnostic and high-reliability procedures.

CIRCLE NO. 413



This is where you come in.

Right at the back of our 12-inch CRT monitor module.

You supply a composite video signal between 0.5 and 1.5 V, and we supply the rest—a complete CRT display package designed for alphanumerics that is suitable for rack, console or cabinet mounting.

Of course, you also have to provide a power source, but we've even made that easy. Your module comes off-the-shelf for either 120 V AC or 22 V DC operation.

Despite the fact that our 12-inch display module is an off-the-shelf design, you'll be surprised at the number of options available to you. Depending on lighting conditions you can have 92%, 70%, or 55% light-transmittance filter plates, with or without antireflection coating. You have a wide choice of phosphor types. All of our tube types meet UL requirements for implosion protection.

If our 12-inch monitor doesn't meet your needs, send us your specs and we'll come up with a custom design.

You take care of the system. We'll take care of the display module.

Because that's where we come in.

Sylvania Electronic Components,
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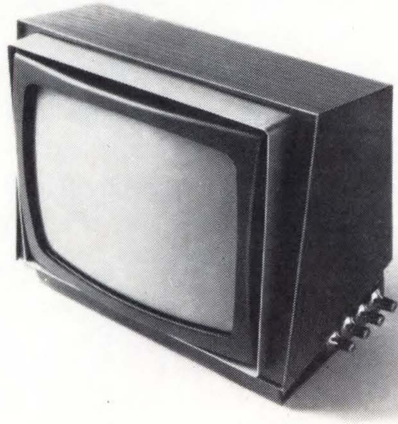
GTE SYLVANIA



CIRCLE NO. 414

World's smallest power supply for op amps...$14

This 2.3 x 1.8 x 1-inch module has tracking outputs of ±15 V @ 25 ma with regulation of ±0.1% and ripple of 1 mv. It costs $14.00 in 1,000 lots and only $24.00 for one. Requisition Model D15-03. (For ±12 V @ 25 ma, order Model D12-03.) Three-day shipment guaranteed.

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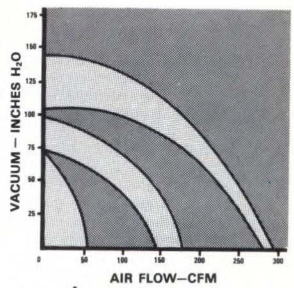
Lamb will work with you in developing new systems . . . prototype to final design. Delivery of quantity lots can be scheduled to meet your production requirements.



FOR DESIGN DATA, Contact: AMETEK/Lamb Electric, Kent, Ohio 44240. Telephone: (216) 673-3451.

AMETEK / Lamb Electric

AMETEK

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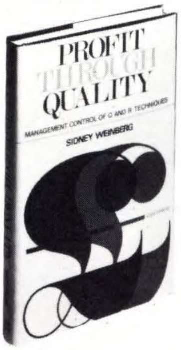

Profit Through Quality

By Sidney Weinberg

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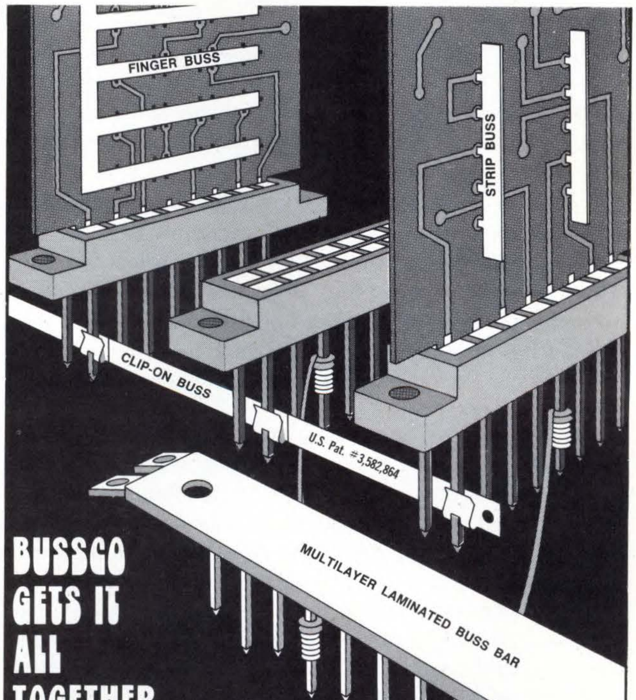

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CIRCLE NO. 417

Low-cost core memories don't have to be slow and bulky.

In the past, core memories designed to be compact and fast were also expensive. Here is one way to improve speed and packaging without increasing cost.

Joseph A. Lake, Ampex Corporation

If core memory systems are to remain competitive with semiconductor memories through the 70's, then designers must become more cost conscious than ever before. Dramatic cost reductions of integrated circuits now make semiconductor memories more attractive. However, this also lowers core memory costs because semiconductors can make up two-thirds of it's cost.

Ampex recently designed a small memory whose largest size module is 8K words of 18 bits each and with a cycle time of 850 nsec. The object was to reduce cost while achieving at least equal performance to previous systems, and wherever possible, improving it. The effect of this renewed emphasis on low cost can best be shown by examining some of the trade-off decisions made during the design of this memory.

Three wire, 3D is best

At an early stage, the decision was made to use 3 wire, 3D organization. Other possibilities were considered, but rejected for the following reasons. Three wire, 2-1/2D eliminates the need for inhibit driver circuitry, however it is costly since it greatly increases the number of other selection circuits required. Cost tradeoffs can vary widely according to the cicuitry used, but 2-1/2D generally becomes more economical only at larger capacities and word sizes than those being considered.

Two-wire, 2-1/2D offers the possibility of reducing stack cost, but requires elaborate sensing circuits to sense the signal on a line that is also used for read half select currents. This increases access time, since the signal cannot be sensed until the noise generated by the first read half select current has recovered to an acceptable level. Even with a third wire, the access time is greater with 2-1/2D because of increased delta noise.

An argument for a two-wire system is that it offers the possibility of a fully automated wiring stack. The more complicated wiring configurations of the inhibit winding in a 3 wire stack normally require that this wire be strung by hand, even if the stringing of the other two wires has been automated. This comparison becomes somewhat academic because automated wiring is still relatively unproven except at IBM, where millions of dollars were spent to develop suitable techniques. Automated wiring of cores smaller than 22 mils has not been reduced to practice anywhere, and the cost of hand wiring stacks overseas still remains competitive to projected automated wiring costs.

Transformers still work best in switching circuits.

Having decided on a 3 wire 3D organization, the next step was the XY selection circuitry to be used. Here again, there were no real surprises.

The 2 diode per line switching system shown in **Fig. 1** has been used in core memories for many years and still offers the most economical alternative available. To quickly review its operation, this schematic represents a matrix of eight pairs of switches on the left and sixteen pairs of switches on the right, connected to 128Y lines. To select one line and to drive read current through it, the two diagonally opposite "read" switches (RS) are turned ON. Then the "read current" source is turned ON after the current path has been set up by the switches. The procedure is reversed for turning OFF the current, with the "read current" source being turned off first, followed by the "read" switches. Switching of "write" current in the opposite direction on the line is accomplished in a similar manner with the "write" switches (WS) and the "write current" sink circuit.

Some small memories are designed without current sources, replacing each current source circuit with one resistor. This has several disadvantages. The memory becomes dependent on the switching characteristics of numerous switch circuits instead of just one circuit which can be more carefully controlled. Also, and perhaps more important, is the fact that power is dissipated by the element which actually turns the current on and off. If this element is a current source and current sink circuit rather than read/write switches, it results in a lower maximum junction temperature for those switches and thus greater reliability.

Although this is one of many cases where it is difficult to show lower cost, improved reliability may well be enough

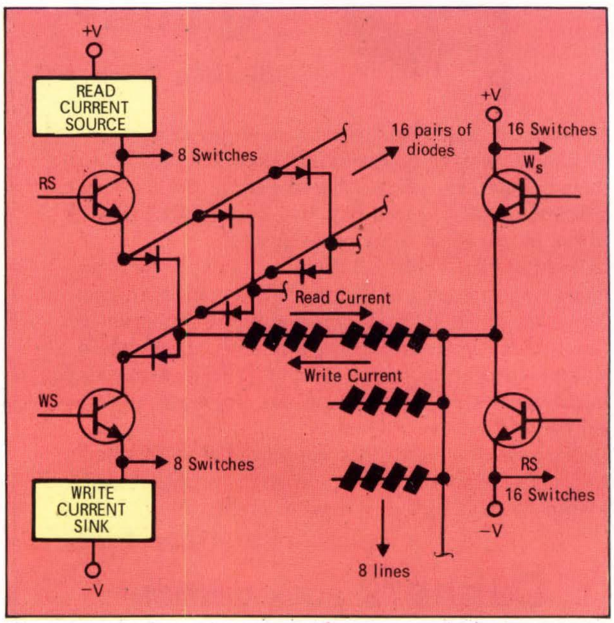

Fig. 1 Two diode per line switching system provides economical selection circuitry.

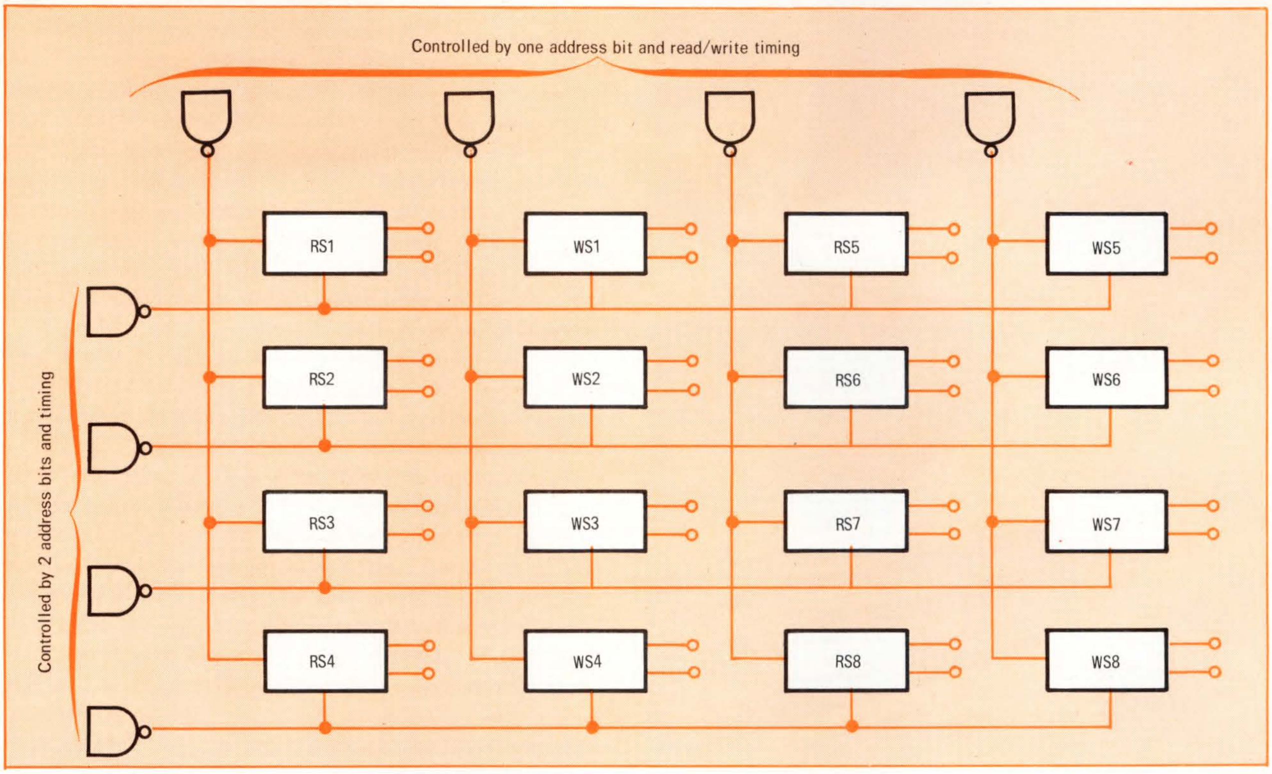

Fig. 2 One of four switch matrices required in selection circuitry.

to offset the small cost of the current source circuits. These circuits give a more linear rise time to X and Y currents which result in a slightly faster access time and somewhat improved margins. They also provide the required temperature compensation for core current.

Only one of the eight pairs of switches on the left is ever on at any given time. The same applies to the sixteen pairs of switches on the right. This suggests that these switches should be arranged in some kind of matrix. What is then achieved is a matrix of switches driving a matrix of diodes driving a matrix of cores. In each case, an optimum matrix of circuits is the goal because cost is minimized by having as little circuitry as possible at each intersection in a matrix. The 64X lines are driven by separate circuitry identical to that shown except that it is a matrix of 8 × 8 pairs of switches instead of 8 × 16.

Fig. 2 shows one of the four switch matrices required. A low-cost configuration can be designed by using a switch which can be selected and driven by standard low-cost integrated circuits. Then the circuitry which must be repeated sixteen times can be minimized.

One possibility for this switch is illustrated in **Fig. 3a**. The switch itself consists of only four low-cost components. The IC gate G_1 is a selected TTL circuit because standard logic circuits cannot guarantee the required output drive in the high voltage state. It costs less than 10% extra to test all of these packages. There are two reasons why the increased cost is so low: 1) the tested yield is high, and 2) all circuits which don't meet the criteria for this circuit can be used elsewhere in the system.

Some designers don't like to use transformers because the aren't as easy to package as semiconductor devices, and use of a pulse transformer adds a new list of parameters for circuit designers to worry about. These include turns ratio, droop, recovery time and leakage inductance. However, in this case, it is still worth the trouble to use transformers. This is because it takes only four components to provide a switch with perfect d.c. isolation from the driving source, and primary current variation has almost no effect on the current flowing in the floating switch as long as Q_1 remains saturated.

The most practicable alternative to this circuit would be

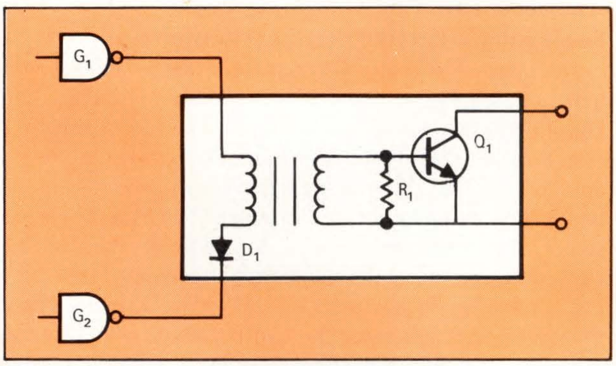

Fig. 3a Low cost transformer coupled switch has fast turn-on but suffers from slow turn-off.

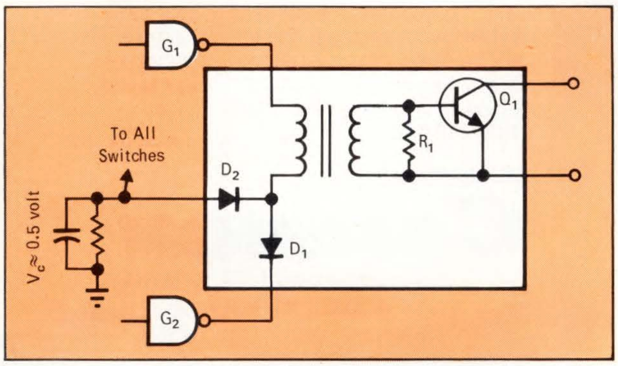

Fig. 3b Turn-off is speeded up by adding one more diode.

one of the several IC core drivers now available. Some of these cost no more than the components needed for transformer coupled switches, however they still have several drawbacks. Most have comparatively low breakdown voltages in the output transistors, and also have interaction between the drive and output circuits. The latter affects the tolerance of the output current. In addition, most are not as fast as the transformer coupled switch. If you have an inhouse capability for making transformers, it is relatively easy to minimize the cost and to optimize the design of the transformer itself.

The circuit in **Fig. 3a** has one drawback. While adequate current can be provided to turn the switch ON fast, it is difficult to turn it OFF fast, since reverse base current is inadequate to remove the stored charge from Q_1.

Several methods have been used to accomplish fast turn-off. One way is to design the circuit with a low inductance transformer so that the build-up of magnetizing current or droop results in a reverse secondary current being generated at the end of a pulse. This however, requires more initial turn-on drive and makes a worst case design quite difficult for any reasonable temperature range. Another way to achieve reverse base current is to reduce the value of R_1 to a point where it conducts enough current to rapidly turn off the switch. This again requires increased turn-on drive, making the primary circuit design quite difficult.

A better alternative is shown in **Fig. 3b**. Here, one more diode (D_2) has been added. Just as before, to turn the switch ON, the ouput of IC gate G_2 must be in a low voltage state, and the output of G_1 must be in a high voltage state in order to deliver primary current to the transformer. At the end of the pulse, the states of these two gates are reversed, and the voltage at the output of G_1 stays very close to zero volts. If the output transistor Q_1 remains saturated, its base-emitter voltage will be approximately O.5V. This voltage will be reflected to the primary transformer winding causing it's negative end to go to -0.4 or -0.5V. The added diode whose anode is connected to a $+0.5$ volt source will then be forward biased and provide a reverse current path through the primary. The result is a reverse current induced in the secondary winding which continues to flow as long as Q_1 remains saturated. A reverse current of approximately 50 mA can be achieved in this way resulting in typical turn off times of 20 to 30 nsec. The $+0.5$V source is common to the turn off diode (D_2) for all switches, and only D_2 is repeated in each switch, thus adding a very small cost to the switch circuit. (D_2 represents about 10% of the switch circuit cost.)

Sense-inhibit circuits need no transformers

The next set of trade-offs come with design of sense-inhibit circuitry. **Fig. 4** shows three possible configurations. In **Fig. 4a** the two halves of the inhibit line are driven by a common switch. A balun transformer is usually required to equalize the two currents since the line impedances of the two halves are often not well matched. The expected sense signal, also in **Fig. 4a**, shows a double peak characteristic caused by one half of the signal from the selected core having to travel a longer distance to the sense amplifier input than the other half. Since the two halves do not coincide, the peak amplitude of the total differential signal seen at the sense amplifier is less than the total voltage generated by the switching core. This becomes less important as the length of the sense line is reduced, however, it is quite important for systems at 8K sizes or larger.

The second alternative (**Fig. 4b**) has terminations at each end of each half of the sense line. This approach removes the double peak effect because the half of the core signal which propagates away from the sense amplifier is terminated by the resistors and never reaches it. The core signal amplitude in **Fig. 4b** is equal to one-half the amplitude of the signal generated by the switching core. The balun transformer is not necessary in this configuration because the two resistors guarantee equal currents in the two halves of the line.

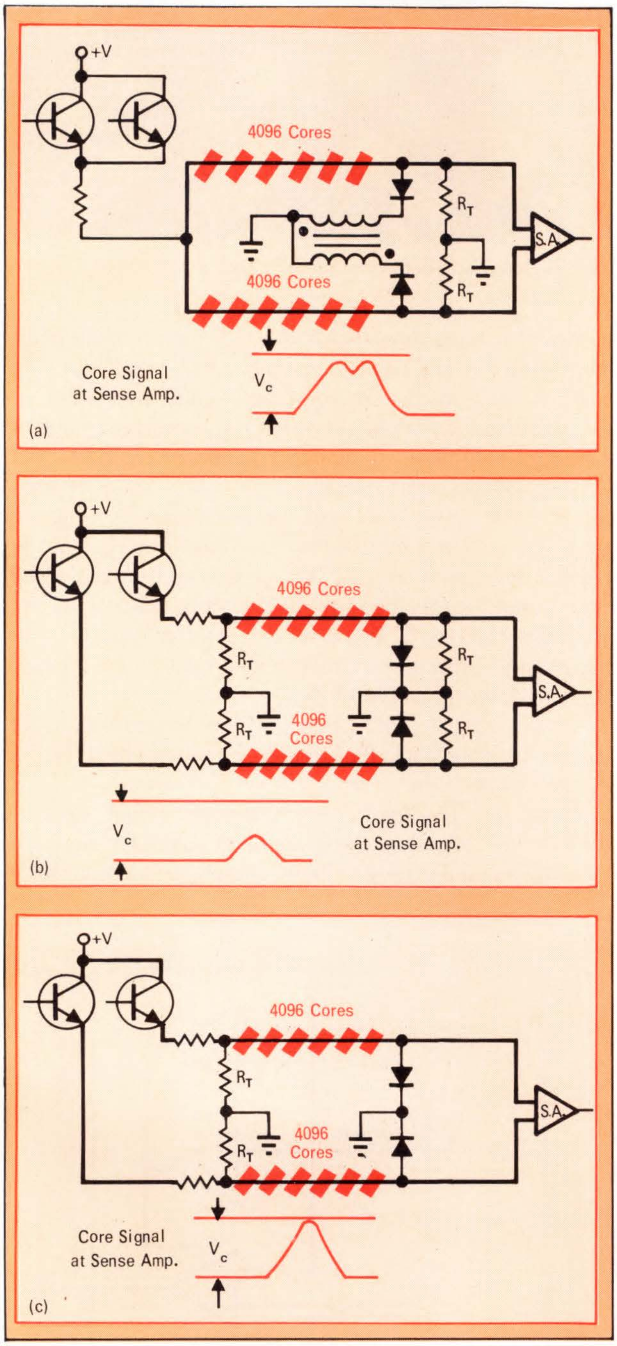

Fig. 4 Three possible configurations for sense-inhibit circuitry. Fig. 4a has an undesirable double peak. Fig. 4b eliminates double-peak but has only one-half amplitude. Fig. 4c is optimum low-cost design and has full-amplitude signal.

The best alternative is the one in **Fig. 4c**. It is the same as **Fig. 4b** except that terminating resistors at the sense amp end of the line have been removed. When a core switches, half of the signal propagates away from the sense amplifier as before, and is terminated by the remaining resistor. The other half propagates toward the sense amplifier input and sees a very high impedance there. It is almost doubled because of the in-phase reflection generated. This results in a signal at the sense amplifier approximately equal to the signal generated by the switching core. The in-phase reflection then propagates away fron the sense amplifier and is absorbed by the other terminating resistor.

Since this configuration eliminates the double peaking effect and still allows the full amplitude of the core signal to be sensed by the sense amplifier, a better signal to noise ratio is achieved. This scheme used with 18-mil cores achieved a very acceptable signal to noise ratio with a 16K sense segment, which is twice as long as that generally accepted as practical.

Core packing density is doubled

Another reason for the uniformity and good signal to noise ratio is the high packaging density achieved in the Ampex 18-mil core stacks. The packaging density in **Fig. 5** is approximately double that normally seen in similar stacks using 18-mil cores. This results in shorter lines with less signal delay, less inductance, and therefore less noise. A module using 16K sensing has been developed for larger systems. However in 8K segments, the large sense window makes them quite tolerant of voltage and timing variations.

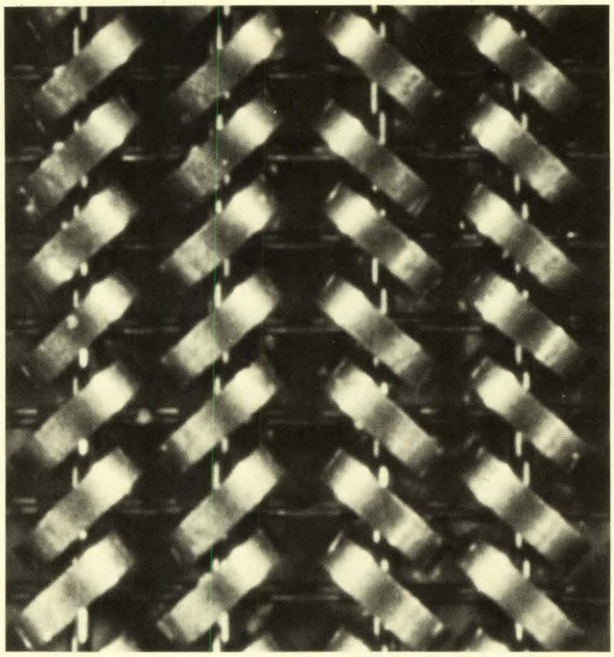

Fig 5 **High packing density of 18-mil cores** results in good signal-to-noise ratio.

Noise margins improve without increasing cost

Noise margins of the memory can be improved further by reducing the allowable threshhold spread of the sense amplifiers. The threshhold spread specified by the manufacturer for the sense amplifier is 11 to 19 mV (an 8 mV spread). Reducing this spread to 4 or 5 mV by individual device selection could result in a considerable increase in cost.

Another way to achieve the same result is to have the sense amplifiers grouped into three overlapping groups, as shown in **Fig. 6a**. The sense amps can then be color coded and guaranteed by the manufacturer so that all threshholds for sense amplifiers color coded as group A will fall between 11 mV and 15 mV. Similarly, the other groups are specified to have threshholds that fall between the other limits shown in **Fig. 6a**. The result is a high yield with little or no increase in cost. These sense amplifiers are then assembled into the memory by specifying a different value of resistor in the reference divider (**Fig. 6b**) for each group of sense amplifiers. This effectively shifts the center of each group to the same point and the threshhold of all sense amplifiers is then held within a total spread of 4 mV. The value of the resistor (R_A, R_B, R_C) to be used for each of the three groups is specified on the assembly drawing for the printed circuit board. This is an inexpensive assembly procedure, not a trim procedure, since no measurement has to be made at the time of assembly.

Another way to hold costs down is to use redundant cores in the core stack, thus requiring a minimum of rework to replace bad cores.

In very small systems it is practical to mount the core stack on the same board with the drive and sense circuitry. The circuitry and stack can then be tested as one unit, elim-

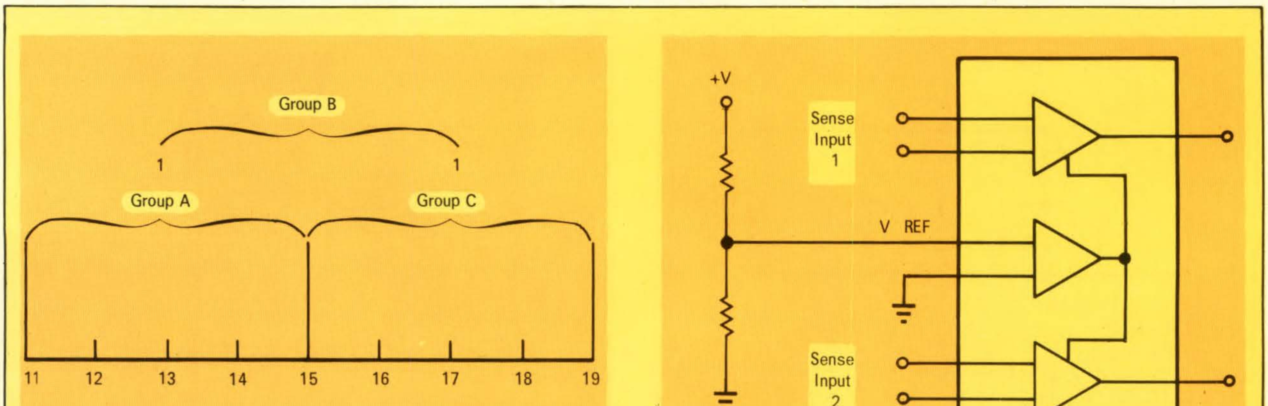

Fig. 6 Sense amplifier grouping scheme reduces threshold spread without increasing cost.

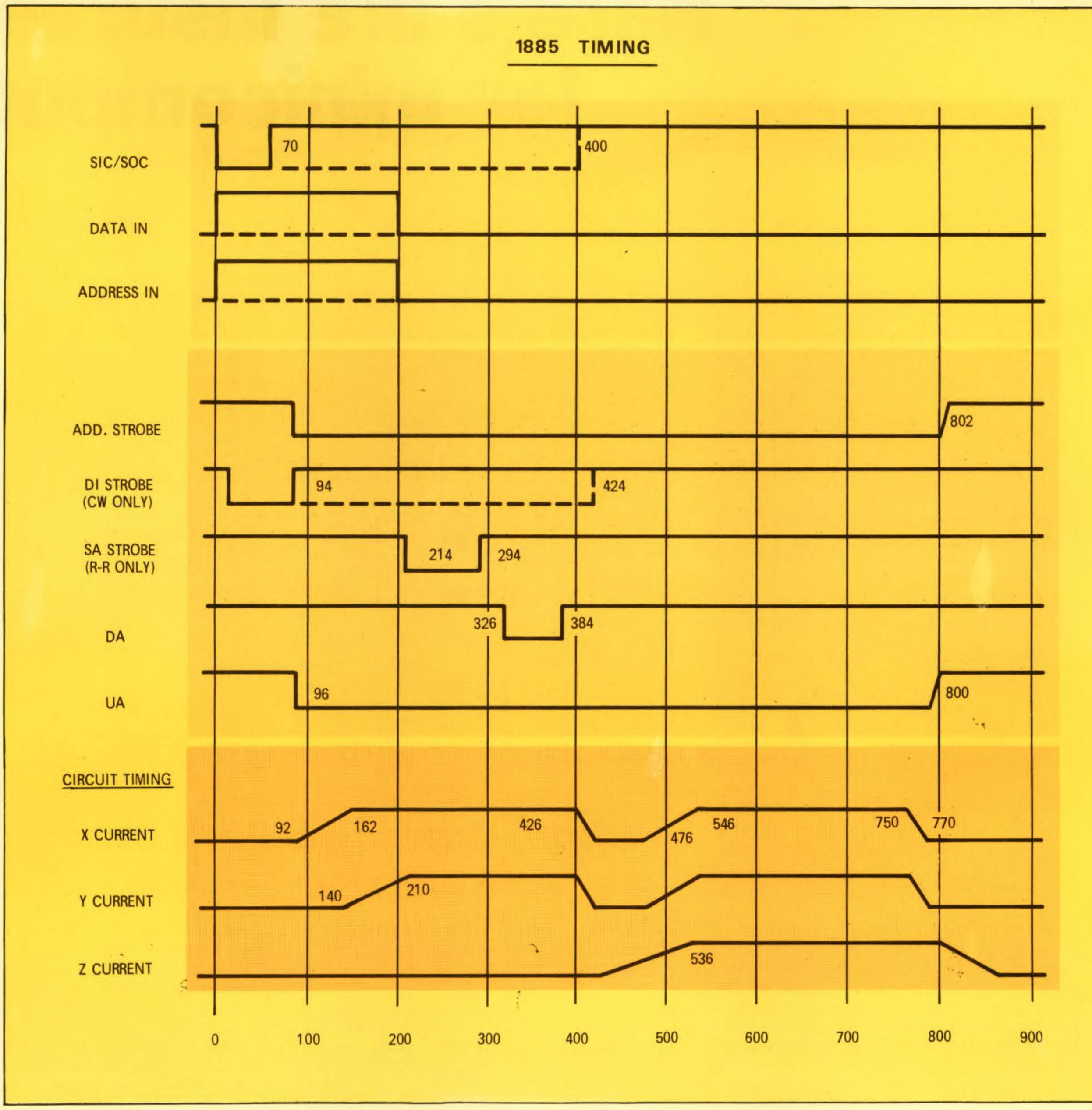

Fig. 7 Timing diagram for final low-cost memory. The sense amp strobe (S.A.) normally occurs at 214 nsec. Data available pulse (DA) indicates that data out of the memory is good at 326 nsec thus meeting the 340 nsec specification for this memory. The entire cycle is finished with the inhibit current (Z) coming down before 800 nsec. Other pulses shown are the SIC (start input cycle), SOC (start output cycle), Address Strobe (ADD), Data In Strobe (DI) and Unit Available (UA).

inating the need for a separate stack test. In larger systems however, like the Ampex 1885 (8K by 18), it is still desirable to have a fully tested stack and tested electronics before they are mated.

Delay lines cost less than shift registers

Timing for the 1885 memory (**Fig. 7**) uses a delay line which recirculates a pulse two times during each full cycle. Although IC shift registers and counters are desirable as possible alternatives, they are still too expensive for the desired degree of resolution. The delay line offers good tolerance with minimum circuitry. However, a single shot in addition to the delay line is needed in order to achieve the desired resolution for the sense amp strobe. With some circuit changes the speed of this unit can be increased to a 650 nsec cycle time. □

Author's biography

Joseph A. Lake, Jr. is a core memory development and support supervisor for Ampex Corp.'s computer products division in Marina del Rey, CA. Prior to joining Ampex in 1970, Mr. Lake held memory engineering positions with IBM in Poughkeepsie, NY and the General Precision-Kearfoot Division of the Singer Co., in Little Falls, N. J. He holds a BSEE from RPI.

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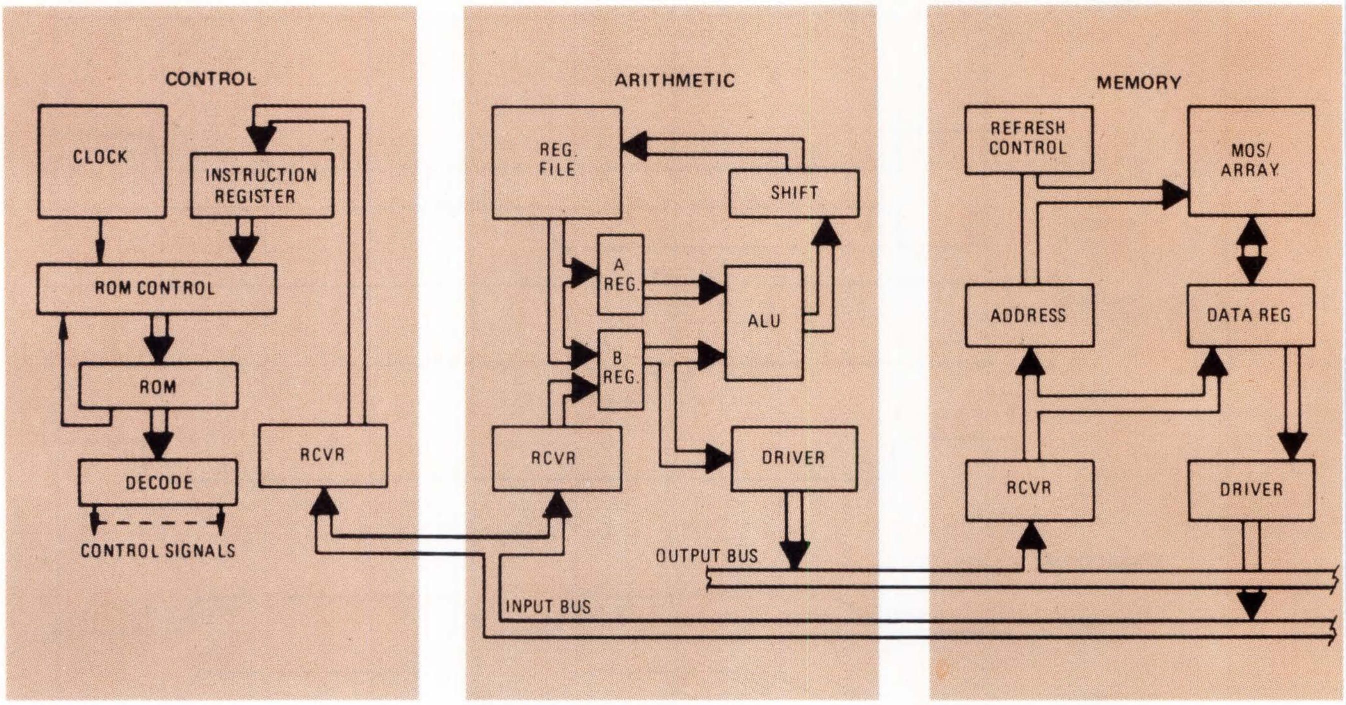

Control — The trend is to use microprogrammed ROM techniques to implement the control section. By comparison, the MECL 10,000 control section cycles four times as fast as the TTL version, needs about the same number of ICs and board area, uses about 1½ times the power, and provides a better cost/performance ratio.

Arithmetic — MECL 10,000 MSI functions reduce delay times considerably as this comparison illustrates:

Function	Delay in Nanoseconds TYP/Worst Case	
	TTL	MECL 10K
Access Register File	35/60	7/12
Load Register A	30/50	3/5
Access Register File	35/60	7/12
Load Register B	30/50	3/5
ALU	60/92	16/21
Shift/Swap/Select	15/25	4.5/7
Store Result in Reg. File	30/50	7/12
TOTAL DELAY	235/377	47.5/74

Memory — MECL 10,000 allows the designer to fully utilize current memory technologies. As memory speeds increase, logic delays become limiting factors when considering total memory system cycle time. TTL delay times are almost as long as memory access times making TTL unsuitable. By using MECL 10,000, memory systems may be upgraded to faster types without any change in control logic except for clock speed.

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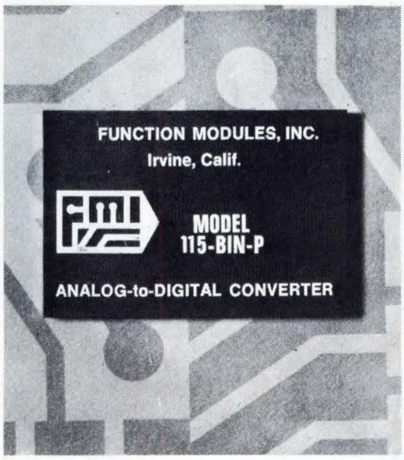
CIRCLE NO. 422

A/D converter module has differential input

Progress In Circuit Modules

A chopper-stabilized instrumentation amplifier in module form that has an input voltage drift of less than $\pm 1.0\mu V/^{\circ}C$, CMRR of over 130 dB and 100 MΩ input impedance is worth knowing about, and a 3-1/2 digit integrating A/D converter module is also newsworthy. But Function Modules, Inc., has developed a module that combines that instrumentation amplifier and the A/D converter in a single package. The result is a unique module, the Model 115 differential-input A/D converter. It is a 2 inch by 4 inch by 0.4 inch module that costs less than $100 in OEM quantities, and its performance rivals that of many expensive DVM's.



How can you achieve low cost and outstanding performance without sacrificing quality? The secret is to eliminate redundant circuitry and to simplify production testing. Since Function Modules noted that instrumentation amplifiers were often mated with A/D converters for use in force- and weight-measurement equipment, DVMs etc., they decided to design an A/D converter module with an integral instrumentation amplifier. By joining the two circuits, they were able to equal the performance of the previously used module pairs. Since the output function of the amplifier was committed to the A/D converter, it didn't need to be as flexible as a general purpose amplifier module. Similarly, the converter could be designed to operate exclusively in conjunction with its amplifier, and the circuits could be designed to share several common sub-circuits.

For example, the oscillator drive for the chopper stabilizing circuit is derived from the clock oscillator in the A/D circuit, thus eliminating an entire oscillator circuit. The calibration of gain and offset is accomplished after the module is completed, avoiding separate calibration of the amplifier and A/D sections. The stabilizing loop in the input circuit helped minimize cost, too. A FET input stage with low drift would have required the use of premium matched FET's at the input, but the stabilizing loop eliminates that need. Also, it is expensive to eliminate switching spikes in a chopper stabilized amplifier. But if these spikes are made to be symmetrical, an integrating A/D converter will automatically eliminate them. So combining a chopper-stabilized amplifier with an integrating A/D converter helps reduce amplifier cost. Thus, by tackling the *total* problem of digitizing low-level signals in the presence of common-mode noise, the engineering team achieved DVM-level performance in a low-cost module.

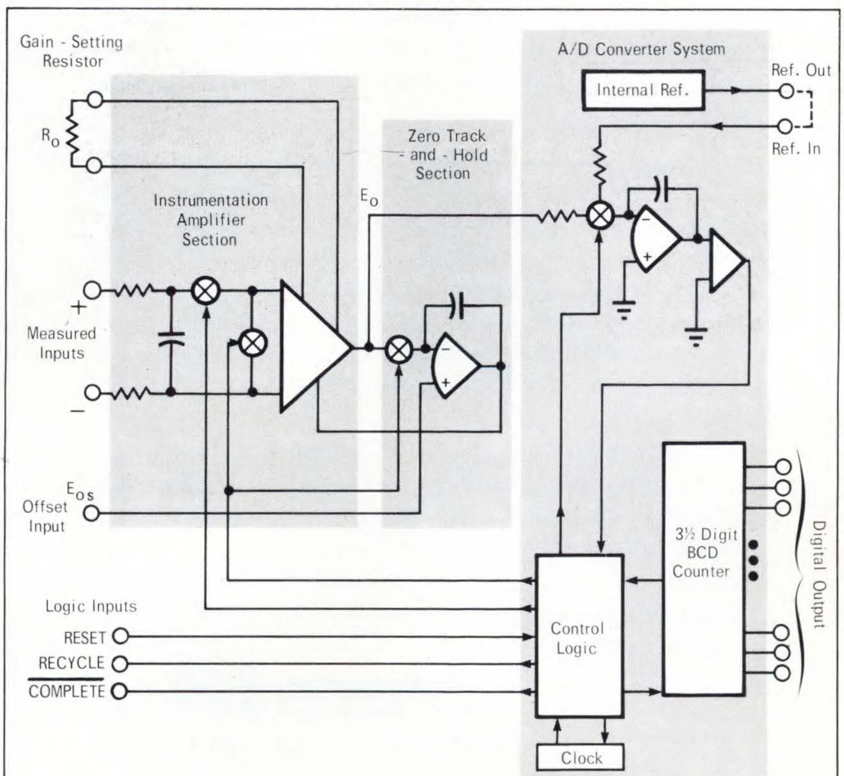
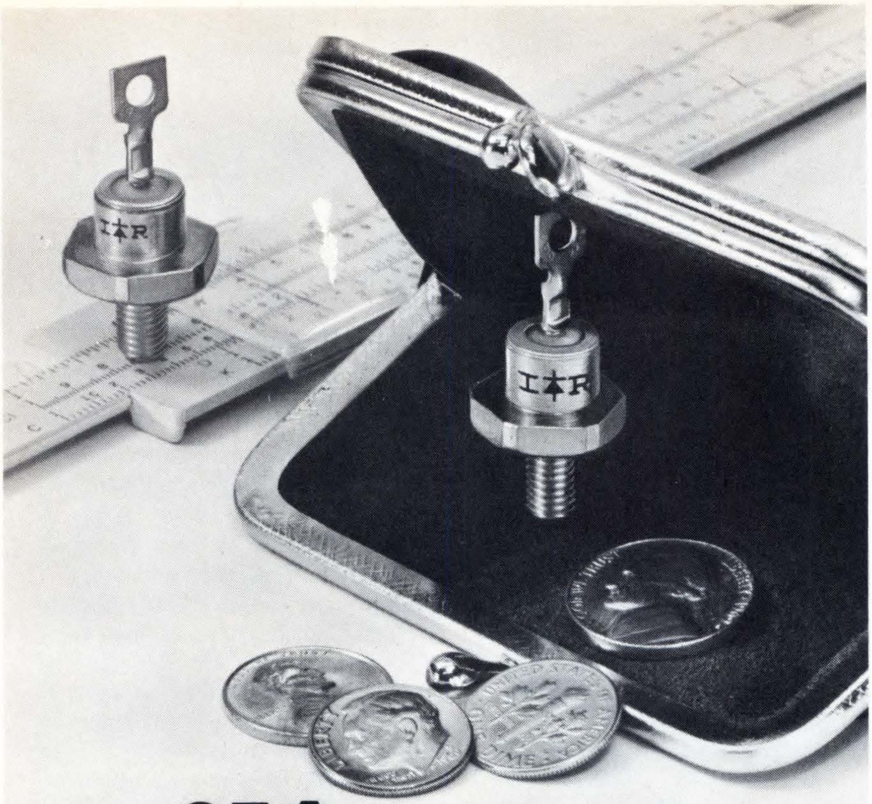


Fig. 1 – Internal functions of the Model 115 instrumentation amplifier and a/d converter module have been designed to eliminate the redundant features encountered when mating separate amplifier and converter modules.



The input voltage is low-pass filtered and amplified by the instrumentation amplifier section. Common-mode inputs (E_{cm}) are rejected and the differential input (E_d) is accurately amplified by any gain from 0.1 to 1000. The gain is set by an external resistor, R_o, selected by calculating $G = 200\ k\Omega/R_o$. The input range is $\pm 10V$, and the output range of the instrumentation amplifier is also $\pm 10V$.

The zero track-and-hold section stabilizes the input offset. The amplifier inputs are periodically switched together and the differential signal is gated "OFF" so that the track-and-hold circuit can track the amplifier offset. It then holds the offset after the input signal is switched "ON" and feeds this offset information into the instrumentation amplifier. This also nulls out the dc component of the error caused by a finite CMRR. Amplifier offset can easily be varied over the full $\pm 10V$ range by applying an external offset voltage E_{os}. The output of the instrumentation amplifier when the input signal E_d is switched in will be:

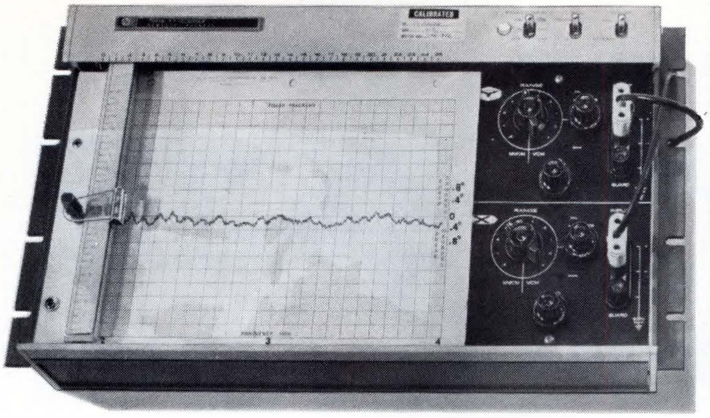
$$E_o = \frac{200\ k}{R_o} E_d + E_{os}$$

The A/D converter section converts the amplifier output E_o to a parallel digital output in BCD form. Full-scale (1001-1001-1001) corresponds to 4.995V at the output of the instrumentation amplifier section. An overrange bit provides 100% overranging. The converter has two modes of operation: "External Reset" and "Recycle." In the "External Reset" mode the conversion takes place only upon external command. Total conversion time will be less than 10 msec. At least 50 μsec must be allowed between the end of one conversion and the start of the next. In the "Recycle" mode, the converter automatically starts another conversion approximately 50 μsec after the end of the previous conversion.

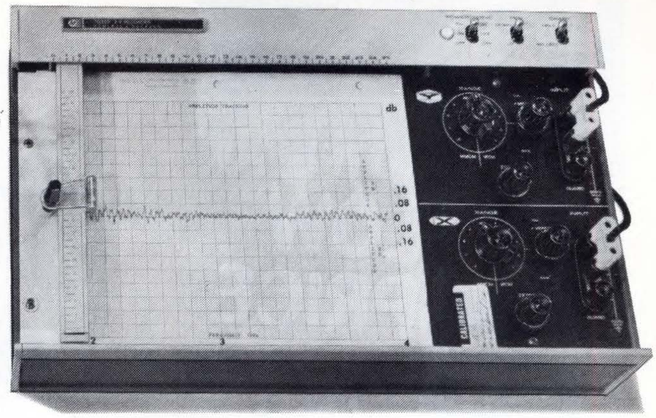
This combination of instrumentation amplifier and A/D converter offers a new and valuable building block to a system designer, and should find use in many instruments.

The Model 115 is priced at $159 each in quantities from 1 to 99, and $99 each on orders of 100 or more. Function Modules, Inc., 2441 Campus Drive, Irvine, CA 92664. Phone (714) 833-8314. **#246**

Phase tracking



Amplitude tracking



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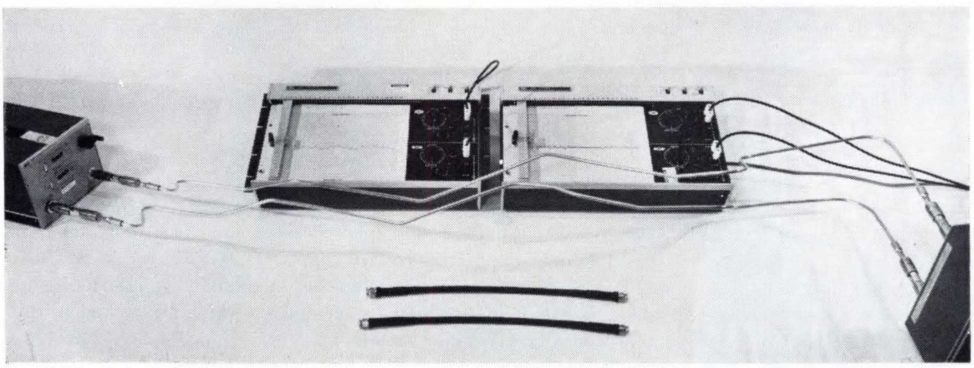

TIMES

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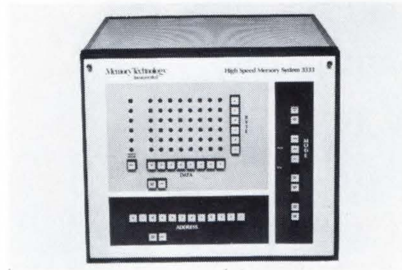
CIRCLE NO. 44

COMPUTER PRODUCTS



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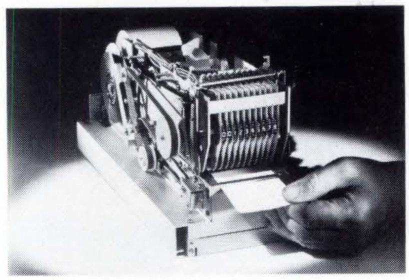

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COMMUNICATIONS TERMINAL has plug-in tape cassette. The 4100 is plug compatible to most data terminals and minicomputers. Featured are switch selectable speeds from 110 to 2400 baud, high speed with ability to re-write data and to shrink or expand already recorded data files, and auto answer for unattended data station operations. Basic price is $1650. Techtran Industries, Inc., 580 Jefferson Rd., Rochester, NY 14623. Phone: (716) 271-7953. **172**

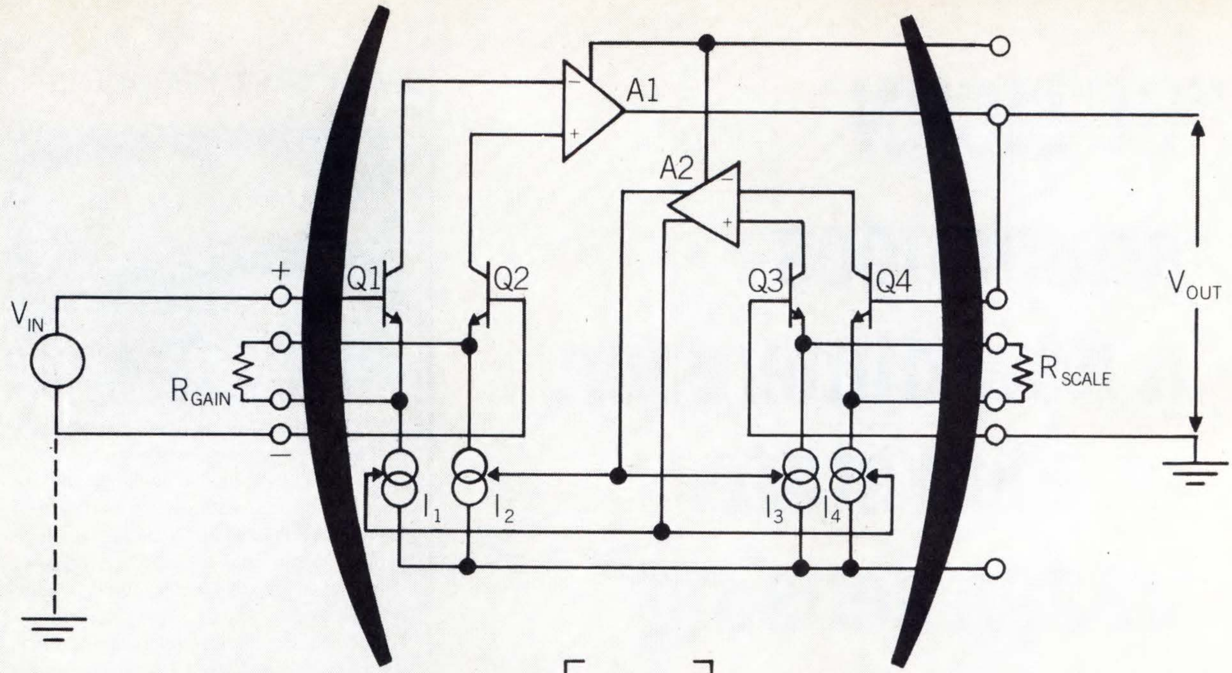
DUAL-CHANNEL WORD GENERATOR has 16-bit word length on each channel. Both RZ and NRZ data is available from each word output at all times. Two rows of data content switches provide the capability to select a binary "1" or "0" for each bit of both words. First and last bits are available for both words at all times. Price is $1195. Dytech Corporation., 391 Mathew St., Santa Clara, CA 95050. Phone: (408) 241-4333. **173**

POSITIONER OPERATES FROM MINIS. System 500 positioning equipment is designed for rugged industrial control applications. It achieves positioning speeds up to 4000 RPM (800 in/min with a five thread/in ball screw) with peak torque ratings from 10 to 40 in-lbs and is available in both single and multi-axis configurations which employ closed loop servo drives with integral DC tachometers and digital encoders. Control Systems Research, Inc., 1811 Main St., Pittsburgh, PA 15215. Phone: (412) 782-4460. **174**

CASSETTE SYSTEM REPLACES PAPER TAPE in PDP-8/e minicomputer. The two transport KYDEK cassette system is plug to plug compatible with the PDP-8/e and replaces the operations of the paper tape reader and punch. The DEC standard programs such as the EDIT-8 editor, the PAL-III assembler, and FOCAL utilize the KYDEK as an input/output peripheral without modifications to the programs. Price is $3495. KYBE Corp., 132 Calvery St., Waltham, MA 02154. Phone: (617) 899-0012. **176**

BATTERY OPERATED DATA TERMINAL provides two-way 103-type modem compatible communications via standard telephone lines. The data terminal includes accoustic coupler, full alphanumeric ASCII coded keyboard, and digital strip printer housed in a thermoformed A.B.S. carrying case. The total unit weighs less than 20 lbs. Dataline Div., Heller Roberts Instruments Corp., 700 Jamaica Ave., Brooklyn, NY 11208. Phone: (212) 647-4600. **177**

ASCII COMMUNICATIONS INTERFACE for the mag card Selectric typewriter (MCST). Model MCS-3 develops 128 ASCII code combinations from the keyboard, prints 88 characters and responds to standard X-ON, X-OFF functions for interactive processor use. Switch selectable speeds of 10 and 15 characters/sec permit operation with teleprinter Models 33, 35 & 37 ASR/KSR and ASCII compatible teleprocessing computers. Price is $3500. Western Telematic Inc., 5507 Peck Rd., Arcadia, CA 91006. Phone: (213) 442-1862. **178**



$$V_{OUT} = \left[\frac{R_{SCALE}}{R_{GAIN}} \right] V_{IN}$$

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It performs both balanced and unbalanced differential measurements with high common-mode rejection. (CMRR=106dB@ Gain of 100 from dc to 100 Hz with source unbalance of 1k Ω).

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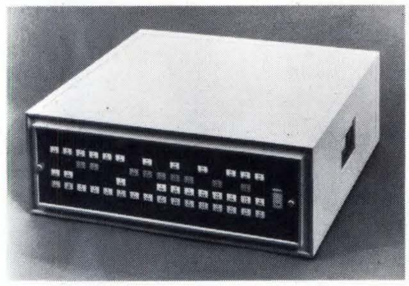
Analog Devices, Inc., Norwood, Mass. 02062. Tel. (617) 329-4700.

ANALOG DEVICES

CIRCLE NO. 46

COMPUTER PRODUCTS



SIXTEEN MODEMS IN ONE CABINET. The 330 Series provides space for up to 16 modems plus a display panel indicating the status of four control and two data functions. Each modem contains a separate power supply, initiate and respond to long-space disconnect, lost carrier disconnect, 10-second fail-safe disconnect, busy-out and loop-back by local and /or remote control. Prices are $465 for the cabinet with display panel. Individual modems are $195. ComData Corp., 7544 W. Oakton St., Niles, IL 60648. **179**

THREE DATA COMMUNICATIONS SYSTEMS. The basic data communications system, DECcomm 11D20, consists of a PDP-11/20 minicomputer with 8K core memory, a Teletype, a real time clock, system control and interface software. The 11D20 price begins at $16,000. The 11D21 and 11D26 remote job entry systems expand IBM 2780 RJE capabilities. DECcomm 11D21 begins at $22,350 and 11D26 system at $18,350. Digital Equipment Corp., Maynard, MA 01754. Phone: (617) 897-5111. **180**

PROGRAMMABLE COMMUNICATIONS PROCESSOR. MODCOMP I, designed as a remote terminal or remote data collection controller contains an internal modem and controller. The asynchronous, full-duplex modem operates at rates up to 9600 baud. It is offered with either 800 nsec core memory or solid state memory. Memory size ranges from 512 to 32,768 words. Unit price is $6400. Modular Computer Systems, 2709 North Dixie Highway, Ft. Lauderdale, FL 33308. Phone: (305) 563-4392. **181**

DIGITAL CASSETTE SYSTEM for the 8 and 16-bit ALPHA and NAKED MINI computers and CAPABLE Logic Tester as well as Model 116/216 and 108/208/808 computers. The cassettes are available in single and triple configurations, with two independent tracks per cassette. Each cassette stores over 500,000 bytes of data. Transfer rate is 9600 bits/sec. The single cassette system is $2950 and the triple cassette is $4850. Computer Automation Inc., 895 West Sixteenth St., Newport Beach, CA 92660. Phone: (714) 642-9630. **182**


api PANEL METERS
Slide-out scales. Great way to cut costs.
With api Series 7000 panel meters, you maintain only a basic stock of meters and modify them as needed with slide-out scales. And the clean, modern styling fits right in with today's panel designs.
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Send for further information and pricing on api Series 7000 meters to LFE Corporation, Process Control Division, 1601 Trapelo Road, Waltham, Mass. 02154. Tel. (617) 890-2000
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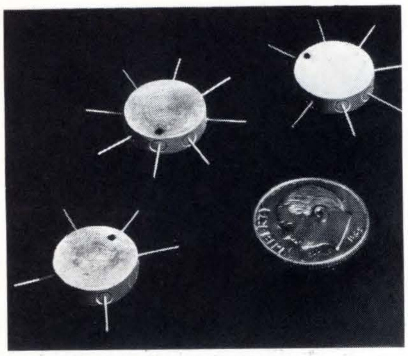
Process Control Division
MICROAMPERES D.C.
MILLIVOLTS D.C.
AMPERES D.C.
CIRCLE NO. 48

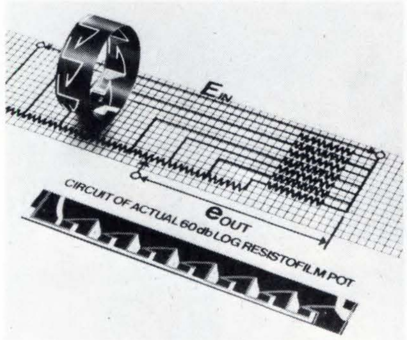


MULTI-THROW SWITCH MODULES provide multi-octave frequency coverage. A series of switch modules ranging from SP3T to SP7T have a 50Ω input and output impedance which makes them suitable for use in stripline and coaxial circuits. The standard module provides series-shunt diode arrangements in each arm, moderate switching speeds and moderate isolation values. Crown Microwave, Inc., 95 Terrance Hall Ave., Burlington, MA 01803. Phone (617) 272-4883. **183**

EPOXY TUBING has electrically-conductive outside wall. The new tubing is manufactured from a special epoxy-silver compound and is available in 50 different O.D. sizes under 2.0 inches. The tubing is also available with graphite, carbon, and other electrically-conductive and non-conductive fillers in the same range of O.D. sizes. Resdel Corp., Bldg. 22, County Airport, Rio Grande, N J 08242. Phone (609) 886-111. **184**

SHRINK-LITE provides instant "on-off" infra-red heat to shrink tubes or solder sleeves. A table-top system designed to shrink tubes or solder sleeves through the heat transfer provided by two infra-red producing halogen lamps, the unit leaves operator's hands free to improve material handling time. The units are priced at \$79.00 each. Spectra Instruments, Inc., 8 Industry Court, Trenton, N J 08638. Phone (609) 882-1860. **185**

MINIATURE ATTENUATORS use thick film resistive substrates. The new attenuators, Series 8120, are rotary types, capable of operating over a frequency range of dc to 2 GHz at a power level of 3 W. Three models are presently available with attenuation ranges of 0 to 100 and 0 to 60 dB in 10 dB steps and 0 to 10 dB in 1 dB steps. Telonic Industries, Inc., 21282 Laguna Canyon Rd., Laguna Beach CA 92752. Phone (714) 494-9401. **186**



CONDUCTIVE PLASTIC FILM eliminates the headaches and expense of designing and producing complex non-linear functions, such as a 60-dB log potentiometer. Using computer-assisted design techniques, RESISTOFILM can meet many complex requirements at minimum cost with maximum reliability. Pots such as the one pictured are custom-designed and quotations will be prepared on request. New England Instrument Co., 18 Alpha Rd., Chelmsford, MA 01824. Phone (617) 256-3711. **187**

ACTIVE RESONATORS are for use in the construction of active filters. The uAR1200 series has been developed for applications requiring a Q of 10 at 15 kHz and by both positive and negative feedback networks. uAR1500 series has stable characteristics over a wide Q range. The uAR1700 series features a Q up to 300 at 5 kHz. Integrated Electronics Inc., 16845 Hicks Rd., Los Gatos, CA 95030. Phone (408) 265-2410. **188**

RF ACCESSORY assortments consist of three versatile combinations of attenuators, matching pads, terminations, video detectors, bias taps, square-waver/modulator, and dc blocks for RF testing covering the HF, VHF, and UHF bands to 1 GHz. The TECH-PAKs (TM) cover the range from dc to 1 GHz and are generally applicable to RF testing and evaluating. American Electronic Laboratories, Inc., P.O. Box 552, Lansdale, PA 19446. Phone (215) 822-2929. **189**

OPTICAL FILTER/DETECTOR is capable of matching human eye response to $\pm2\%$. The KIIOO LED Photometer has been proven to have a variation from the CIE eye response curve of less than $\pm2\%$ over the visible range. It is available as a stand alone tester or may be utilized in conjunction with existing die sort equipment. Single unit price is \$3475.00. Kerant Electronics, Ltd., 745 Harrison, Santa Clara, CA 95050. Phone (408) 247-9222. **190**

SWITCH ACTION FUSE BLOCKS are available in nylon and polypropylene. With 3/4" center-to-center spacing that allows 16 circuits per foot, these blocks will accept #18 to #8 AWG wire sizes or equivalent combinations. A built-fin fuse puller is easily opened and closed manually. Buchanan Electrical Products Corp., 1065 Floral Ave., Union, N J 07083. Phone (201) 289-8200. **191**

DUAL 6" EDGEWISE METER, called the Series 1251, permits the display of related functions in one instrument. In addition to its space-saving characteristics, it is front panel removable. Accuracy of ±1-1/2% F.S. is standard. The Model 1251 0-1 DCMA dual version sells for $99.00 in unit quantities. Sigma Instruments Inc., 170 Pearl St., Braintree, MA 02185. Phone (617) 843-5000. **192**

PANEL MOUNT SWITCH assures positive contact transfer by means of latching on the return stroke. This double pole push-push switch (E79-60A) is actually two independent mechanical systems in combination, providing reliable alternate switching action. The UL listed switch features snap-in mounting. List price is $2.80 each. Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, IL 60085. Phone (312) 689-7600. **193**

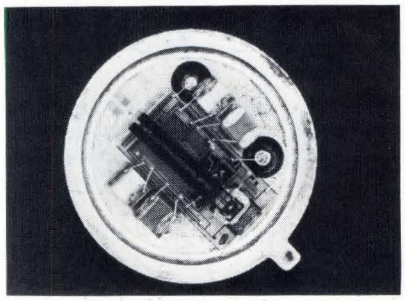
BAR SEGMENT DISPLAY is ideal for long-range viewing. Designated the Series 1060, the new unit displays 2-inch high characters comprised of close-fitting, bar segments that are individually illuminated by incandescent lamps. Initial cost is as low as $9.00 per decade (minus lamps and mounting hardward) in OEM quantities. Industrial Electronic Engineers, Inc., 7720-40 Lemona Ave., Van Nuys, CA 19405. Phone (213) 787-0311. **194**

MOLDED NYLON PILOT LIGHTS, the "L" series snap securely into 0.550 × 1.125 inch openings. 1-3/4 inch back-of-panel depth is required. Lenses are prismed for maximum light refraction and a variety of colors is available. Two bulbs can be provided for maximum light output. Units are available with chrome or stainless steel bezed and wire leads, solder lugs or 0.250 inch tab terminals. Sorenson Lighted Controls, Inc., 530 Oakwood Ave., West Hartford, CN 06110. Phone: (203) 236-3267. **195**

COLLET KNOBS feature miniature size and color coding. The tightening screws or nuts in the recessed top of the knob are concealed by snap-in, color coded, removable caps. Six basic knob sizes are available from 0.350 to 1.41 inch diam. Knob configurations include plain, lined, wing knob, and lined wing knob in colors grey, black, and red. Christel Co., 550 Live Oak Circle Dr., Calabasas, CA 91302. Phone (213) 346-8036. **196**

THUMBWHEEL SWITCHES are available from stock in 50 different output codes. The 2000 Series are offered in either 8, 10, 12 or 16 positions. Switching is accomplished in an enclosed chamber by means of a rotating assembly of gold plated bifurcated brushes. Electronic Engineering Company of California, 1601 E. Chestnut Ave., Santa Ana, CA 92701. Phone (714) 547-5651. **197**

CIRCUITS



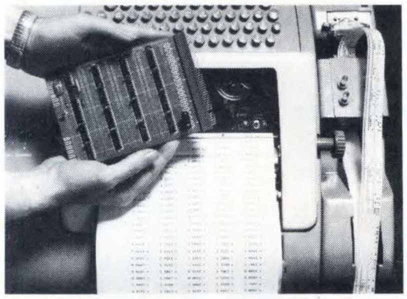
CRYSTAL CLOCK OSCILLATORS are packaged in TO-5 cans. These ultra-miniature units are available in frequencies from 10 kHz to 100 kHz and are TTL compatible. They can operate over the MIL temperature range of −55 to +125°C and can withstand shock greater than 1000 g. The three-pin TO-5 connections are +5V supply, output and ground. Prices are $84 for single quantities and $11 each for 5000 units. Statek Corp., 1200 Alvarez Ave., Orange, CA 92668. Phone (714) 639-7810. **198**

ANALOG MULTIPLIER/DIVIDER, Model M310, has a 50 μV/°C maximum output offset drift while scale factor drift is held to less than 0.01%/°C. Full scale accuracy for four quadrants is better than 0.15% while output offset voltage is less than ±2 mV. The M310 is completely trimmed internally to its rated specifications. It is also available in a full MIL temperature range version (−55°C to +125°C). Intronics, 57 Chapel St., Newton MA 02158. Phone (617) 332-7350. **203**

FET OP AMP, Model F-418, has 10^{-15} A bias current and is hermetically sealed. The new amplifier will operate over the full temperature range of −55C to +125 C and is supplied in a 14-pin DIP package. The F-418 is internally trimmed to less than 1 mV initial voltage offset. Therefore, no external trimming adjustments are required. Bell & Howell, Control Products Div., 706 Bostwick Ave., Bridgeport, CT 06605. Phone (203) 368-6751. **202**

YIG-TUNED HARMONIC MULTIPLIER, Model YHG 1003, delivers power output over 500 MHz to 12.5 GHz. A voltage tuned integrated YIG filter on the output selects the desired single comb frequency output; all others are suppressed by at least 40 dB. Power of the selected comb tooth varies from +20 dBm minimum at the low end to −25 dBm minimum at 12.4 GHz. Price of the THG 1003 is $1750, and delivery is 6 weeks. Advanced Microwave Labs., 825 Steward Dr., Sunnyvale, CA 94086. Phone (408) 245-5770. **204**

CIRCUITS



DPM-TO-TELETYPEWRITER CONVERTER, Model DPT-415, converts digital panel meter BCD outputs to the teletypewriter printer/punch inputs. The DPT-415 automatically generates spaces, carriage returns, and line feeds so that five readings are printed on each line. It also prints plus or minus symbols under control of the DPM polarity signal. Price is $685 for single units and under $200 for large quantities. Digital Laboratories, 377 Putnam Ave., Cambridge, MA 02139. Phone (617) 876-6220. **205**

10-BIT D/A CONVERTER, Model MN329R, is completely self-contained in a 16-pin hermetic DIP package. Power consumption is 500 mW, typical and output voltage range is −4.990 to +5V. The Model MN329 has a linearity of ±1/2-bit over the temperature range of 0 to 70°C, and the MN329R has 1-bit linearity over +15 to +55 C. In quantities of 250 the MN329R costs $23 and the MN329 costs $35. Micro Networks Corp., 5 Barbara Lane, Worcester, MA 01610. Phone (617) 756-4635. **206**

LED INDICATOR indicates logic state of digital circuits. These devices can be driven directly from DTL and TTL logic and are available in voltages from 1.7 to 14V and currents up to 20 mA. Built with a light-emitting diode and an internal series resistor, the molded plastic two-pin device can be inserted into a DIP socket or PC board. Units can be mounted side by side with as many as 10 units to the inch. Price is $1.37 in 1000 quantities. Dialight Corp., 60 Stewart Ave. Brooklyn, NY 11237. **207**

12-BIT A/D CONVERTER, Model 1612, has a total conversion time of 8 μsec and an accuracy of 0.0125% of full scale. Temperature coefficient is 10 ppm/°C. The 1612 will accept ±10.0V full scale and 0 to −10.0V is optional. Both serial and buffered parallel digital outputs are provided. The unit contains its own reference supply and switches. Price is $300. Tustin Electronics, 2103 S. Grand, Santa Ana, CA 92705. Phone (714) 546-1302. **208**

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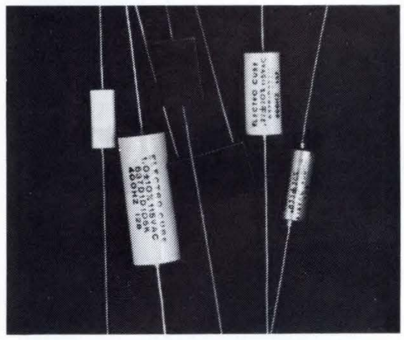

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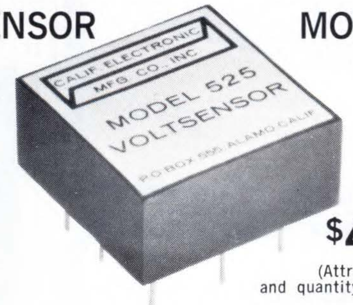

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THEN . . . Patch it into any circuit with a signal range of up to +24 VDC to −24 VDC, set your trip point and watch it repeatably trip within ±1 mv of your set point. OUTPUT? POWER! 80% of power supply voltage at up to 50ma which can be used direct or through relays of up to 5amp, 115 VAC capacity. Response time? Less than 10 microseconds for the VOLTSENSOR, as little as 1 millisecond for VOLTSENSOR and relay.

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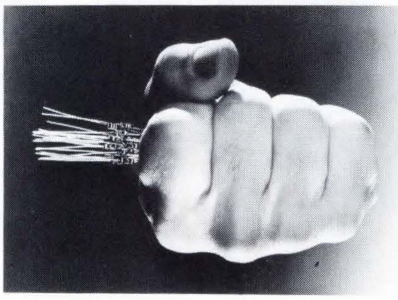
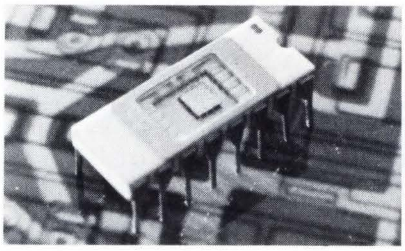
CIRCLE NO. 64

SEMICONDUCTORS

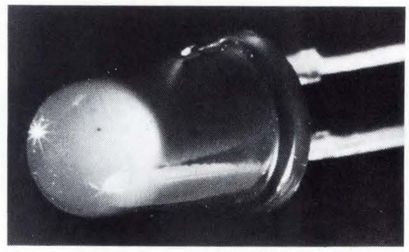


INDUSTRIAL VVCs are designed for low cost commercial applications. The CV5000 Series of High-Q Varactron voltage-variable capacitance diodes provide broad tuning ratios, high Qs, and high working voltages. Devices in this line are priced as low as 59¢ each in quantity. Teledyne Crystalonics, 147 Sherman St., Cambridge, MA 02140. Phone (617) 491-1670. **209**

MOS/LSI PHOTODIODE ARRAY provides direct digital output. It contains 16 diodes, arranged along a 140-mil line on 8.8 mil centers to evaluate light patterns. Operation is over an integration period which is adjusted to achieve thresholds for a given light level such that an equivalent "1" or "0" is parallel shifted into the shift register. North American Rockwell Microelectronics Co., 3430 Miraloma Ave., Anaheim, CA 92803. Phone (714) 632-2321. **212**



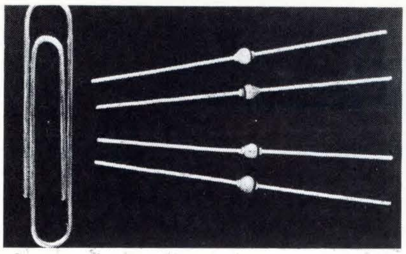
BIPOLAR RAMS exhibit virtually no setup, hold or write recovery time. These two 256-bit IC memories, designated the 82S06 (three-state) and 82S07 (open collector outputs), are extremely fast (35 nsec, typical). The memories are manufactured with the shallow epitaxial, Schottky-diode process. Price is $39.50 each, when ordered in a 25-piece quantity. Signetics, 811 East Arques Ave., Sunnyvale, CA 94086. Phone (408) 739-7700. **210**



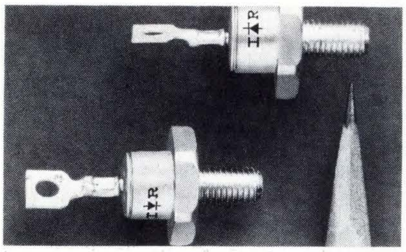
TWO NEW DISCRETE LEDS are introduced. MV54 has a red diffused epoxy lens and a rated brightness of 0.8 millicandelas at 20 mA. MV5026 is a red panel light with a high contrast lens. It comes with a panel mounting grommet. Typical brightness is 1.0 millicandela at 20 mA. MV54 is priced at $0.53 (100-999), and MV5026 at $0.71 (100-999). Monsanto Commercial Products Co., 10131 Bubb Rd., Cupertino, CA 95014. Phone (408) 257-2140. **213**

DIODE CHIPS are channel-mounted, temperature-compensated and available for many JEDEC numbers. The new devices are electrically equivalent to the 1N821, 935, 3154, 941, 4565, 4765, and 4775 series with A and B versions. They carry the same numbers as their discrete counterparts with a CZ designation instead of 1N. Centralab Semiconductor, 4501 North Arden Dr., El Monte, CA 91734. Phone (213) 579-0700. **211**

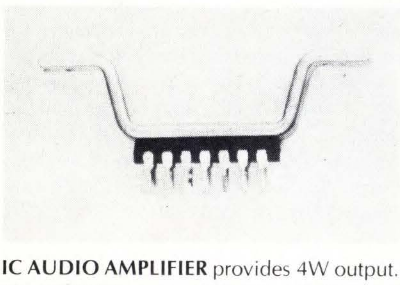
MICROPOWER LED FLASHER is a monolithic integrated circuit designed to permit use of LED indicators in micropower portable equipment. Designated the LP1000 "MISER," it can drive 30 mW LEDs from sources with peak capabilities as weak as 30 microwatts. In a 3-pin TO-18 package it is priced at $1.18 each in quantities of 100. Lithic Systems, Inc., P.O. Box 869, Cupertino, CA 95014. Phone (408) 257-2004. **214**



HIGH VOLTAGE single-junction silicon rectifiers with selected recoveries and PIVs to 1500V are now available in production quantities. The parts are packaged in Glass Amp II Glass Passivated (void-free) packages. Maximum average forward current rating at 50°C is 1.5 (A) with a 1V maximum forward drop at 1A and 25°C. General Instrument Corp., 600 West John St., Hicksville, Long Island, NY 11802. Phone (516) 733-3333. **215**

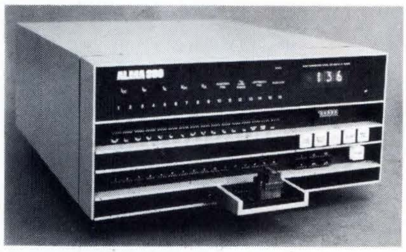


STUD-MOUNTED DIODES boast a 600A, one-cycle surge rating. The 35H series is rated at 35A average with maximum repetitive peak blocking voltage ratings of 400, 300, 200 and 100V. 35H replaces more than a dozen JEDEC series in the DO-5 package, including 1N1183, 1N1191, 1N248-50, 1N2021 and 1N2154. Price for the 400V 35H40 in 100-999 quantities is $2.82 each. International Rectifier Corp., Semiconductor Div., 233 Kansas St., El Segundo, CA. Phone (213) 678-6281. **216**



IC AUDIO AMPLIFIER provides 4W output. The LM354 is a monolithic circuit designed for use in television sets as an audio amplifier. The usable range of supply voltage is very high (from 6 to 24V). The LM354 is assembled in a special 14-lead plastic split-DIP with a shaped heat-sink soldered on a copper bar inserted in the plastic. The package has a very low thermal resistance. Price: 100 up $3.00 each. European Electronic Products Corp., 10180 W. Jefferson Blvd., Culver City, CA 90230. Phone (213) 838-1912. **217**

EQUIPMENT

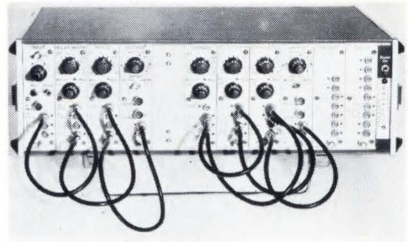


DIGITAL IC TESTER Model 380 features full functional, input-current and fan-in and fan-out testing to manufacturers specifications. Programming and controls provide high-speed testing with full capability for auto-handling and probing systems including independent contact continuity test circuits. Throughput rate as high as 4000 parts per hour is easily obtained. Price is $5750. Alma Corp., 1061 Terra Bella Ave., Mountain View, CA 94040. Phone (415) 961-9837. **218**

DIGITAL DATA TRANSMISSION ANALYZER PAIR are the Model 1200 modem test set and the Model 2000 modem test set printer. The $1650 1200 Modem test both synchronous and asynchronous data links, modems, and multiplexers. The $1750 2000 provides continuous monitoring of test results, printing out bit error rate or block error rate, loss and recovery of synchronization, loss of clock, counter overflows, and external event occurrances vs time. The printer includes a real-time clock. International Data Sciences, Inc., 100 Nashua St., Providence, RI 02904. Phone (401) 274-5100. **219**

DUAL RAMP GENERATOR produces ramp output signal periods from 10 μsec to 100 msec per channel with 0.05% linearity. The ramp period is determined by a four-position range switch and an adjustable period control. The RG-116 enables the display designer to see rasters on a scope as generated by flying-spot scanners, line-scan systems and CRT displays. The output signals can be offset ±5V about ground with continuously adjustable dc bias controls. Celco, 70 Constantine Dr., Mahwah, N J 07430. Phone (201) 327-1123. **220**

MEMORY-PROGRAMMED TRANSISTOR TESTER T317 measures all standard transistor parameters and is supplied with a test capacity of 32, 64, or 96 tests, and a total of 12 bin outputs. Any number of jobs may be stored in its memory up to the capacity of the system, and any two of these jobs may be in operation simultaneously. Price of a basic 1A 200V unit is $17,500. A 30A 400V option is available for $12,000. Teradyne, Inc., 183 Essex St., Boston, MA 02111. Phone (617) 482-2700. **221**

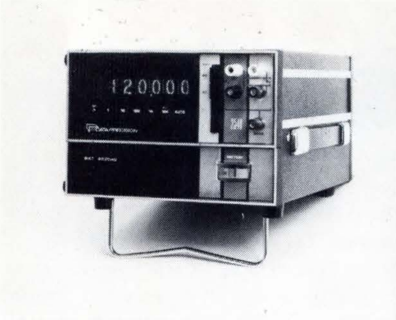


MODULAR PULSE GENERATOR based on a timing module will operate up to 50 MHz. Model 176 comprises a 5-1/4-in.-high mainframe holding up to 11 plug-in modules. Units available include a period module with 1-Hz-to-50-MHz PRFs; a 10-nsec-to-1-sec width/delay module capable of a 100MHz bit-rate word generation and an output module with a 2-ns risetime and 6V amplitudes from 50Ω. G. & E. Bradley Ltd., Electral House, Neasden La., London, N.W. 10, England. **222**

BATCH OR CYCLE CONTROL features LED displays and high-threshold logic circuitry for greater immunity to industrial noise. The number of counts in a batch or cycle are predetermined by setting the desired count on bi-directional pushbutton selector switches. When the count reaches the predetermined level, a dpdt, 10A, 125V ac output is actuated, and a count is recorded on an electric counter indicating the total number of batches or cycles completed. Durant Digital Instruments, 622 N. Cass St., Milwaukee, WI 53201. Phone (414) 271-9300. **223**

SHOCK SPECTRUM ANALYZER Model SD320 provides in a single pass, without the need for a repetitive input of the transient shock signal, detailed amplitude-vs-frequency analyses of either the primary, residual or maxi-max spectra in a fraction of a second with the press of a button. A fourth analytical dimension is added by pressing the "Fourier" button to gain yet another analysis for correlating damage potential with the shock event. Spectral Dynamics Corp., Box 671, San Diego, CA 92112. Phone (714) 278-2501. **224**

MODEL L-10 MEGOHMMETER offers a range of measurement from 10^5 to 10^{14}Ω. Nine discrete test voltages ranging from 10 to 100V dc are available internally and are accurate to ±2%. The $456 instrument's infinity adjustment need be set only once when making measurements and changes in range will not disturb the accuracy of the readings. Beckman Instruments, Inc., 89 Commerce Rd., Cedar Grove, N J 07009. Phone (201) 239-6200. **225**



5-1/2-DIGIT MULTIMETER uses rechargeable batteries and also works from the ac line. Series 2500/A2, comprises four models offering auto-polarity, auto-ranging (in addition to individual range selection), pushbutton selection of function and range, full 20% over-ranging on all but the 1000V range and accuracy of ±0.001% of full scale. Prices range from $1145 to $1345. Data Precision Co., Audubon Rd., Wakefield, MA 01880. Phone (617) 246-1600. **236**

AN OSCILLOSTORE DELAY UNIT allows the continuous monitoring of interference events. A signal waveform in its exact format, without distortion, before, during or after an interference event, can be obtained through the use of the digital delay unit which operates over a frequency range of up to 1000 Hz/channel over six measuring channels. The unit is priced at $6850 and is available on three-months delivery. Siemens Corp., 186 Wood Ave., South, Iselin, N J 08830. Phone (201) 494-1000. **237**

A MINIATURIZED SCAN CONVERTER designated Model MSC-1 writes and stores externally originated video—both sequentially (raster) scanned or randomly positioned—in its scan-converter tube, and reads out the stored video pattern in a 525/625-line, 2:1 interlaced raster format, suitable for display on conventional TV monitors. The new scan converter is priced at $2500 and 30-day delivery is offered. Hughes Aircraft Co., Display Systems Div., 2020 Oceanside Blvd., Oceanside, CA 92054. Phone (714) 757-1200. **238**

SIGNAL-CONDITIONING SYSTEM VISIG II sells for less than $100 per channel. It is designed for multiple-channel data acquisition to measure parameters sensed with a bridge and other types of transducers such as strain, temperature, humidity, flow and level. VISIG II is comprised of Model 611 signal-conditioning modules, Model 111 power modules and their housings. It interfaces with most digital and analog systems. Vidar Corp., 77 Ortega Ave., Mountain View, CA 94040. Phone (415) 961-1000. **239**

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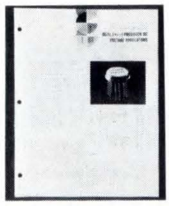
50 WATT ZENER VOLTAGE REGULATORS are described in a new brochure from International Rectifier Corp. Two series are detailed, with nominal zener voltage ratings from 3.9 through 100V. The units are provided in either TO-3 "diamond" or stud packages. Semiconductor Div., International Rectifier Corp., 233 Kansas St., El Segundo, CA 90245. Phone (213) 678-6281. **226**



HYBRID DC VOLTAGE REGULATORS are covered in a new four-page brochure. The Series 844 consists of cermet, thick-film, dual-voltage units hermetically sealed in 12-pin TO-8 packages. The new brochure includes complete performance specifications, diagrams and mechanical characteristics. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd. Fullerton, CA 92634. Phone (714) 871-4848. **229**

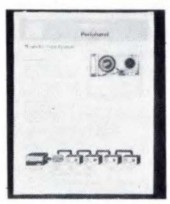
CONFERENCE PROCEEDINGS of the Instrument Society of America are listed in a new brochure titled "1971 Annual Conference Publications." It features over 150 instrumentation papers in the form of preprints and proceedings of the 26th Annual ISA Conference, conducted October 4-7, 1971 in Chicago Illinois. The brochure lists paper numbers, titles, prices and includes an order form. Instrument Society of America, 400 Stanwix St., Pittsburgh PA 15222. Phone (412) 281-3171. **232**

MAGNETIC-TAPE SYSTEM for Microdata's Micro 800 and 1600 computers is described in a four-page bulletin. The bulletin contains specifications and detailed explanations of the interface controller and tape transport unit. Microdata Corp., 644 E. Young St., Santa Ana, CA 92705. **231**

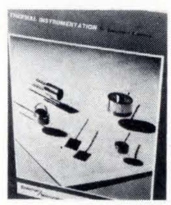
A SELECTION GUIDE TO TEST INSTRUMENTS is now available listing four lines of electronic test instruments from Dana Laboratories. It gives a fast glance at all major specifications needed for selecting any one of Dana's five series of DVM's; two series of data amplifiers; two series of electronic counters and a series of frequency synthesizers. Dana Laboratories, Inc., 2401 Camus Dr., Irvine, CA 92664. **230**

CASSETTE RECORDERS AND MEMORIES are detailed in a new 4-page brochure. The digital recorders and memories are designed for point-of-sale equipment, data capture, peripheral storage, data communications and keyboard-to-tape applications. Telex Communications Div., 9600 Aldrich Ave., South, Minneapolis, MN 55420. **233**

MINIATURE POWER-CONVERSION EQUIPMENT is shown in a new catalog. The equipment enables the system designer to design custom power-conversion equipment. The Catalog describes the features, specifications, modifications and mounting dimensions for miniature and subminiature power-conversion devices. Arnold Magnetics Corp., 11520 W. Jefferson Blvd., Culver City, CA 90230. **228**



INTEGRATED PIN DIODE switch/driver literature, bulletin DM870/871, describes the latest additions to a line of ultra broadband PIN diode control devices. Both units feature continuous coverage from 200 MHz to 18 GHz with minimum isolation as high as 60 dB and TTL-compatible inputs. Low VSWR and insertion loss, and a switching speed as fast as 200 nsec are also featured. General Microwave Corp., 155 Marine St., Farmingdale, NY 11735. Phone (516) 694-3600. **227**



THERMAL INSTRUMENTATION brochure introduces comprehensive line of thermal instrumentation transducers and components. Sensors described are for use in aerospace, aircraft, and industrial applications. All sensors are self-generating transducers and their output is proportional to the absolute magnitude of the thermal parameter being measured. Spectran Instruments, P.O. Box 891, La Habra, CA 90631. Phone (213) 333-0666. **234**

ADVERTISERS INDEX

APPLICATION NOTES

LINEAR/NON-LINEAR CIRCUIT MODULES are shown in a 48-page catalog. All areas of interest are conveniently color coded on page edges for quick location, and the index contains a complete alpha-numeric catalog and cross index of all devices. These include A/D and D/A converters, op amps, power supplies, instrumentation amplifiers, integrators, logarithmic amplifiers, multipliers and dividers and module testers. Background and applications data are also included. Teledyne-Philbrick, Allied Dr. at Rte 128, Dedham, MA 02026. **240**

TESTING RF TRANSMISSION LINE RUNS (coax and waveguide) is the subject of a 16-page data sheet. Test arrays covering 0.01 to 18 GHz are detailed for swept measurements of insertion and return-loss vs frequency. Systems shown can perform frequency-selective location of faults (discontinuities) in the transmission line which are shown by displaying return loss vs distance for carrier frequencies to be used in the line. Hewlett-Packard, Co., 1501 Page Mill Rd., Palo Alto, CA 94304. **241**

BOXCAR INTEGRATOR signal averager applied to resolution and recording of signals consisting of pulses as short as 10 nsec is described in Brochure T-227. A typical application of the technique, described in detail, is the measurement of second harmonics generated in laser excited gallium arsenide. A major advantage of the method is the ability to recover waveforms obscured in noise. Princeton Applied Research Corp., P.O. Box 565, Princeton, N J 08540. Phone (609) 452-2111. **242**

POWER SUPPLIES and controlled power products are covered in a new 104-page handbook and catalog. Included in the handbook is a glossary of terms used to describe power supplies and their operation, a section on the theory of operation of regulated power supplies, and an analysis of operating characteristics and specifying criteria. Raytheon Co., Sorensen Power Supplies, 676 Island Pond Rd., Manchester, NH 03103. **243**

MODULAR POWER SUPPLIES and their applications are covered in a 56-page catalog. Ac-to-dc, dc-to-ac, and dc-to-dc units covering an output voltage range of 5 to 740V with power ratings from 5 to 240W are covered together with thermal data, EMI information, input current curves, and operating hints. Complete price and quantity discount information is also included. Abbott Transistor Laboratories, 5200 W. Jefferson Blvd, Los Angeles, CA 90016. Phone (213) 936-8185. **244**

HIGH NOISE IMMUNITY LOGIC brochure available. The 64-page brochure shows complete HiNIL family characteristics for Series 300 High Noise Immunity Logic (HiNIL), including absolute maximum ratings, summary of propagation delays and I_{cc} currents, pinout reference guide, device data and applications. Copies of the free HiNIL application brochure are available in quantity from Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, CA 94040. Phone (415) 968-9241. **245**

REFERENCE COPIES AVAILABLE

Reference copies of the following articles are available without charge:

Index to Ads, Products and Literature

Fluke problem solvers

The New .005% 8300A DVM: Bare Bones, $1195; 5 Ranges DC, $1295; 5 Ranges DC & 5 Ranges of Ohms, $1445

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