EDN

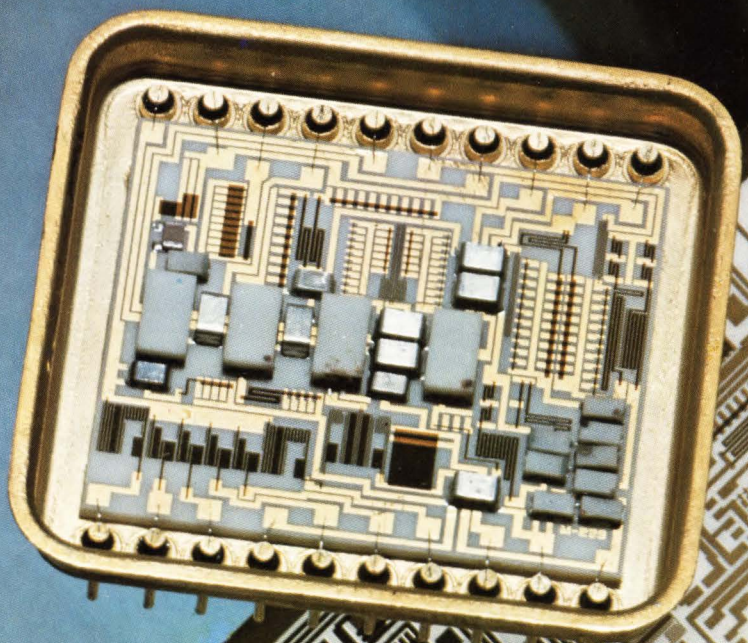
EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Big Batches of Thin Films

Analog Multiplier Primer

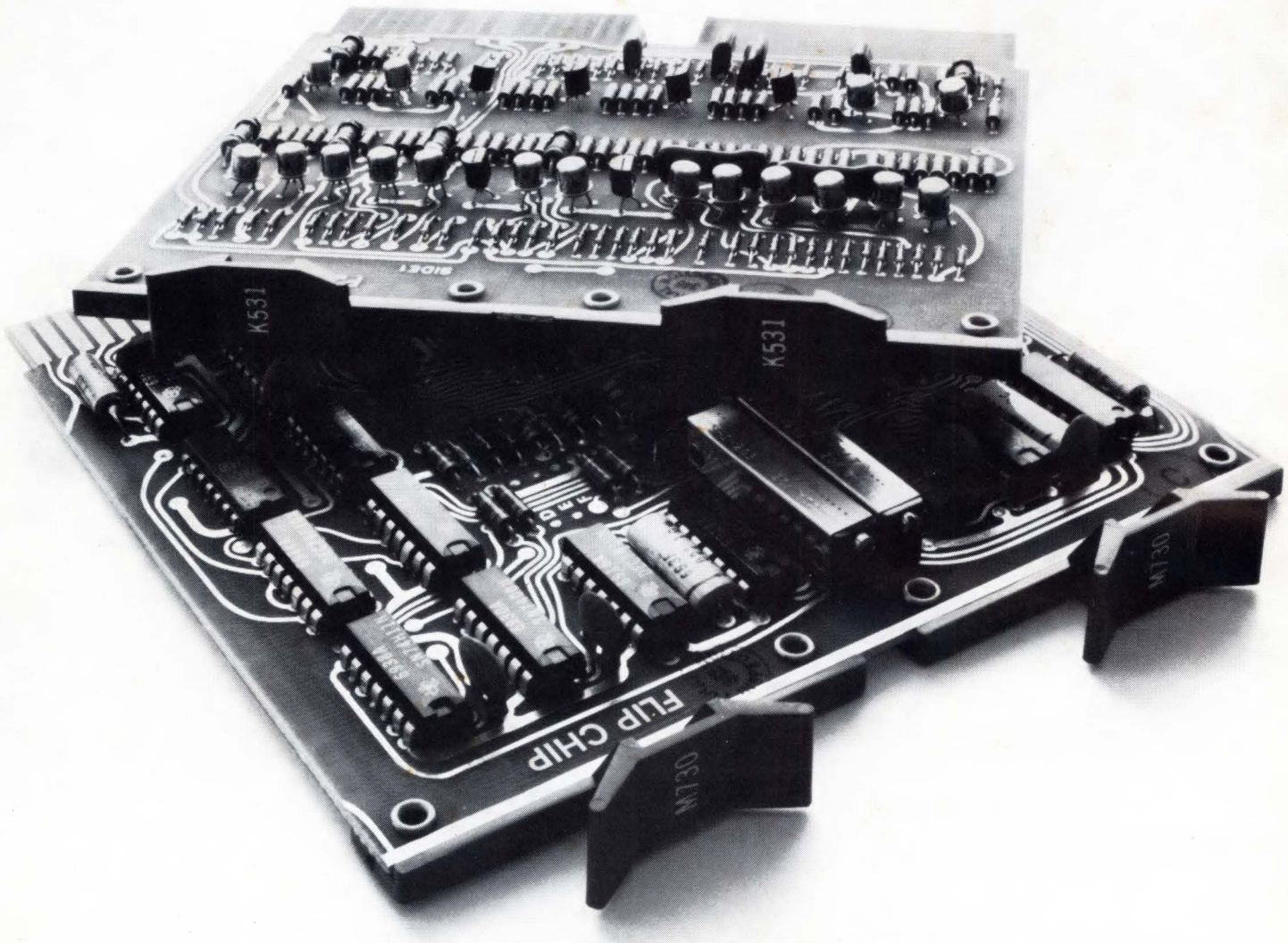
Taming Tantalums

Patents Cross-Examined



A CAHNERS PUBLICATION

OCTOBER 15, 1970



The tortoise and the hare

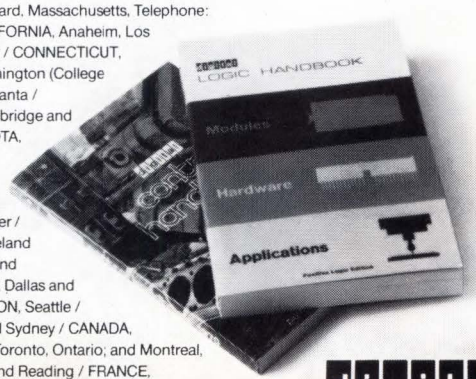
Sometimes, you want all the speed you can get. Interfacing a computer, for instance. Or building an instrument that measures, or tracks, or controls events that require that speed. Digital offers a full line of hare modules . . . M-series, that fly at 10 MHz.

But sometimes, you want something a lot slower. For general laboratory control, or to replace old-fashioned relays, or to control a machine. Designing them slow means that you can also design them immune from electrical noise. Digital has a full line of tortoise modules as well . . . K-series, that crawl at 100 KHz.

Each series is physically, electrically, and logically compatible. 100 modules in M-series. 70 modules in K-series. Each comes with a full line of hardware, power supplies, plug-in boards, cabinets, racks, and so forth. Each comes with Digital's guarantee. Each comes with the knowledge that Digital uses them in their own computers and controllers.

Two free books describe them completely—module by module and function by function. Write.

DIGITAL EQUIPMENT CORPORATION, Maynard, Massachusetts, Telephone: (617) 897-5111 / ALABAMA, Huntsville / CALIFORNIA, Anaheim, Los Angeles, and Palo Alto / COLORADO, Denver / CONNECTICUT, New Haven / DISTRICT OF COLUMBIA, Washington (College Park, Md.) / FLORIDA, Cocoa / GEORGIA, Atlanta / ILLINOIS, Chicago / MASSACHUSETTS, Cambridge and Maynard / MICHIGAN, Ann Arbor / MINNESOTA, Minneapolis / MISSOURI, St. Louis / NEW JERSEY, Parsippany and Princeton / NEW MEXICO, Albuquerque / NEW YORK, Centereach (L.I.), New York City, and Rochester / NORTH CAROLINA, Chapel Hill / OHIO, Cleveland and Dayton / PENNSYLVANIA, Philadelphia and Pittsburgh / TENNESSEE, Knoxville / TEXAS, Dallas and Houston / UTAH, Salt Lake City / WASHINGTON, Seattle / AUSTRALIA, Brisbane, Melbourne, Perth, and Sydney / CANADA, Edmonton, Alberta; Carleton Place, Ottawa; Toronto, Ontario; and Montreal, Quebec / ENGLAND, London, Manchester, and Reading / FRANCE, Paris / GERMANY, Cologne and Munich / HOLLAND, The Hague / ITALY, Milan / JAPAN, Tokyo / SWEDEN, Stockholm / SWITZERLAND, Geneva.



digital
MODULES · COMPUTERS

CIRCLE NO. 1

SAMPLING 18GHz

REAL-TIME 250MHz

STORAGE 100MHz

ECONOMICAL 500kHz

HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

What's new in HP Scopes? 18 GHz, dual-channel sampling! New, faster HP diodes now extend sampling capability through 18 GHz. For the first time, you can directly view and measure 18 GHz CW signals (or 20 psec risetime pulses).

But there are more new scope innovations from HP. There's the new, easy-to-use, 250 MHz real-time scope ... and new, direct read-out TDR with ¼″ resolution ... and new variable persistence and storage scopes for measurements up to 100 MHz ... and a whole new series of low-cost 500 kHz scopes.

AND, *there are more eye-popping scope ideas just around the corner!*

Next time you see your HP field engineer, ask him what's new in scopes. You'll be surprised by all that's happening to give you better, more economical scope measurements. One thing, we bet you'll get a new (and better) answer, every time you ask!

Are you thinking about a new scope? Are you wondering whether you should continue down the same old road? Or is it time you took a look at another manufacturer? The HP road means going with the demonstrated leader — maker of performance champs.

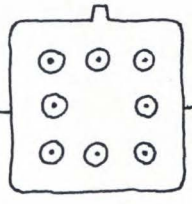
Call your HP field engineer, right now, if 18 GHz sampling is your interest. Complete 18 GHz sampling system available with delayed sweep, or w/o delayed sweep. If you already have an HP 12.4 GHz sampling system, add the new 18 GHz HP 1430B remote sampler. Write Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

080/6

CIRCLE NO. 2

CENTIGRID*

The Low Profile .100 Grid Relay



Packaging and Production Engineers please note: CENTIGRID* Series 112 Relay's 8 leads, spaced on 0.100 centers — all on the periphery of the header — permit direct plug-in convenience on all PC boards. This relay won't be the highest component on the board. It's only .225 high, thereby minimizing board spacing. It's only .370 per side.

Design and Circuit Engineers please note: The CENTIGRID* has the same performance as our TO-5 relays. Coil voltages, in 6 choices, range from 5 to 26.5 VDC.

Using CENTIGRID* Series 112 relays permits compliance to Mil Std. 275B and Mil-P-55110A circuit board specifications without complicated lead spreading.

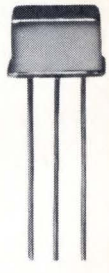
*TM App.

Space-wise Engineers please note: Ease of installation and inspection makes CENTIGRID* the perfect answer to any packaging density problem.

We're not complacent. We're relay innovators.

- First with the TO-5 Relay.
- First with an internal coil diode.
- First with an internal transistor driver.
- First with an internal op-amp.

And now: CENTIGRID* . . . another big breakthrough from the "little relay people." All the problem-solving low-down is yours for the asking. Simply write or call:



TELEDYNE RELAYS

3155 West El Segundo Boulevard, Hawthorne, California 90250 • Telephone (213) 679-2205

CIRCLE NO. 40

PETP FILM CAPACITORS

SIZE & COST: NO BIG THING.

EASIER THAN EVER TO FIT YOUR BOARD & BUDGET.

BROAD LINE GETS BROADER. 8 LOWER CAPACITANCE VALUES (100 pF thru 390 pF @ 200 V).

Type 192P Pacer® Polyester Film Capacitors are mass-produced to beat the space/cost squeeze in commercial and industrial applications. Extended-foil PETP film sections with metal end caps provide best possible non-inductive construction. End caps also act as moisture barriers. Ideal for automatic insertion on printed wiring boards. Expanded line includes capacitance values from 100 pF to .47 μF. Voltage range, 80 to 600 vdc. Write for Bulletin 2066C.

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SPRAGUE®
THE MARK OF RELIABILITY

4SM-0143

***THE* BROAD-LINE PRODUCER OF ELECTRONIC PARTS**

CIRCLE NO. 4

OCTOBER 15, 1970
VOLUME 15, NUMBER 20

EDN

EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Cover

Amperex precision (0.01%) signal conditioner and synchronous phase detector is a thin-film hybrid IC produced on batch-processed, multicircuit sputtered ceramic plates. This one's used in an air data computer.

Design News

Design Predictions

Design Features

Design Ideas

Design Interface

Design Products

Design Departments

EDN's DESIGN ACTIVITY FILING SYSTEM is used to classify all Design Feature and Design Idea articles. The first word indicates the activity discussed in the article. The second word denotes the principal product being used in the activity. The third word modifies the second word. Finally, a number is used to specify frequency, where applicable. This number is the $\log_{10}$ of the frequency in hertz.


BROADWAY
W 42 ST

We make components for guys who can't stand failures.

No one likes to be left in the dark. Especially by some "sophisticated" complex of control equipment that failed.

That's why we make our resistors and capacitors for guys who can't stand failures. Guys like your most important customers, guys like you.

We build an extra measure of reliability into all our components to help you build extra reliability into all your systems.

To be specific, we make tin oxide resistors—now including both miniature RLR05's and flame proofs—and glass and Glass-K™ capacitors. They're the best you can get, though they'll cost you no more.

Take our tin oxide resistors—no other resistors can deliver the same stability and reliability over life. They offer guaranteed moisture resistance across all ohmic values, for reliability that can't be matched by metal film, wirewounds, carbon comps or metal glaze resistors.

This kind of extra performance comes in miniature size, too. Our new RLR05 (commercial style C3), developed for dense packaging applications, competes costwise with carbon comps.

And we lead the field with flame proof resistors. Ours will withstand overloads in excess of 100 times rated power without any trace of flame. And because they open rather than short under severe overload, they provide protection for the rest of the system—a vital consideration in critical and expensive EDP, telecommunications, and instrumentation gear.

Or take our glass capacitors. The Air Force has confirmed they have much better stability and much higher insulation resistance than the ceramic, mica, and other capacitor types tested. That's why our glass capacitors have been designed into so many major aerospace and missile projects. And why industry has designed them into the most important EDP and instrument applications.

Or our Glass-K™ capacitors—we developed them to give you the volumetric efficiency and economy of monolithic ceramic capacitors, but with the much improved stability and reliability that only a glass dielectric can add. Our Glass-K™ capacitors are now being used in pacemaker heart units and in several major EDP systems. And these Glass-K™ capacitors can now be used in BX characteristic applications.

As you might expect, both our resistors and capacitors meet Established and High Reliability standards, such as MIL-R-39017, MIL-R-55182, and Minuteman.

At Corning we make components for guys who can't stand failures. Guys like your most important customers. Guys like you.

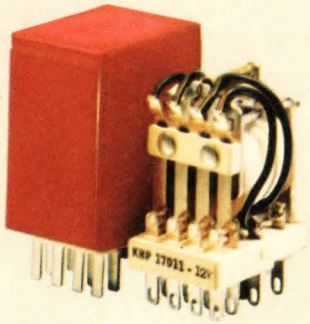
And even though you might expect to pay a lot more for these features, you don't. Because as the largest manufacturer of these type components, our production volume affords us economies that enable us to be competitive in price.

So the next time you're designing a system, design-in an extra measure of performance. Reach for your CORNING® resistor and capacitor catalogs or look us up in EEM. Or for in-depth technical information write us at: Corning Glass Works, Electronic Products Division, Corning, New York 14830.

Then call your local CORNING authorized distributor for fast off-the-shelf delivery. He not only stocks components for guys who are demanding, but he offers service to match, too.

CORNING
ELECTRONICS

CIRCLE NO. 6



We'll stop adapting our KHP relay when you run out of new applications.

You have a tough relay requirement, right? You need a relay with the reliability of bifurcated contacts. Must have U/L Component recognition. Need .078 taper tab terminals and 400 milli-watts sensitivity. Color coded cases.

No problem. Just call us. We are all tooled and in production. Probably no other manufacturers of our KHP design can say the same.

You see, we've been making this relay longer than anyone because we designed it. We've made it for more different applications than anyone else. That's why we have more combinations of contact materials, terminals, sockets, and mountings than anyone else.

Available in 2 Form C, 4 Form C or Form Z contact arrangements. Contacts rated 3-amps at 30V DC or 120V AC resistive. Choice of 8 different mountings and 8 contact materials. Coil voltages from 6 to 120 volts.

Complete specifications and ordering information are in our new 194-page Catalog '70. Ask your P&B representative for a copy today. Or write us direct: Potter & Brumfield Division of AMF Incorporated, Princeton, Indiana 47570. Or call 812 385 5251.

CIRCLE NO. 7

AMF | POTTER & BRUMFIELD

Editorial

Jolted by a Soft Landing

In the wake of recent news that the USSR is well on the road to world naval superiority comes word of their unmanned soft landing on the moon and subsequent return to earth with soil and rock samples.

Aside from two sentences on the morning news and a six-column-inch story on p. 34 of today's paper, the event has been largely ignored. This event simply has failed to register. The mass news media obviously feel it is insignificant.

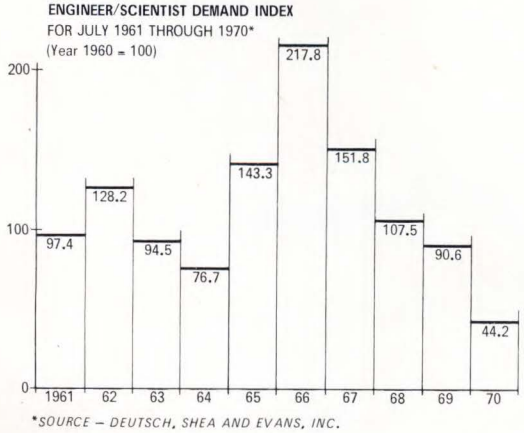
Another fact that is not news, has practically nobody concerned, but serves as a disquieting backdrop for today's announcement, is the contrasting emphasis on technology between the U.S. and USSR. They are graduating six times as many engineers as we are, and we are methodically destroying the engineering teams that have kept us in contention for leadership.

So who cares? Not our fellow Americans. Our national preoccupation is with inflation, Vietnam, campus unrest, crime, racial violence, the environment. Technical excellence is either taken for granted or associated with the war-making, environment-wrecking "establishment".

Unfortunately, our science and technology base is a sensitive and fragile resource. It is not like an ore vein that can be tapped when necessary but left dormant when demand is slack. Rather, it must be used to be preserved.

Considering current national priorities, the only way it can be preserved is for its image to be changed into the role of a solver rather than a source of national problems. Otherwise we will have to wait out a period of technological atrophy until technology and priorities are again aligned.

Editor



*SOURCE – DEUTSCH, SHEA AND EVANS, INC.

Our new compact oiltight pushbuttons give you up to six functions in a 1 7/16" square.

Size is the only thing that's small about our new compact pushbuttons. They handle full-size jobs.

We've gone square to give them style, and full 600-volt quality and flexibility.

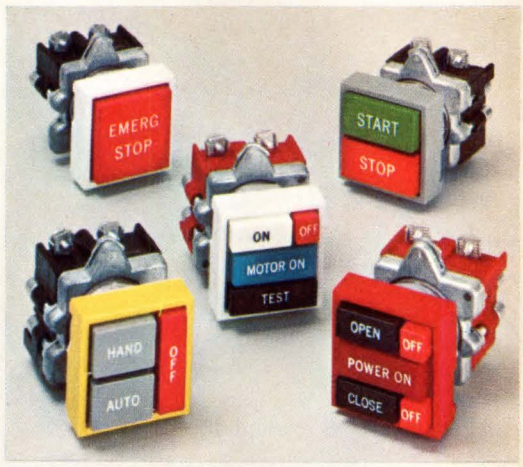
And we've gone small to give you six operating and indicating functions in a 1 7/16" square. You save space, and money.

You also get unlimited flexibility with stacking contact blocks.

And a choice of pushbuttons and indicating lights that doesn't quit—with a virtually unlimited range of sizes, forms and colors of buttons and lenses.

With all you're getting, you still get the same oiltight performance you're used to with full-size Cutler-Hammer oiltight pushbuttons.

Ask your Cutler-Hammer Distributor or Sales Engineer to show you our six packs. Remember, the best things come in small packages.



New Cutler-Hammer compact pushbuttons put a world of control into a 1 7/16" square, and mount in industry-standard 1 3/16" round holes.

Try our 6 pack.

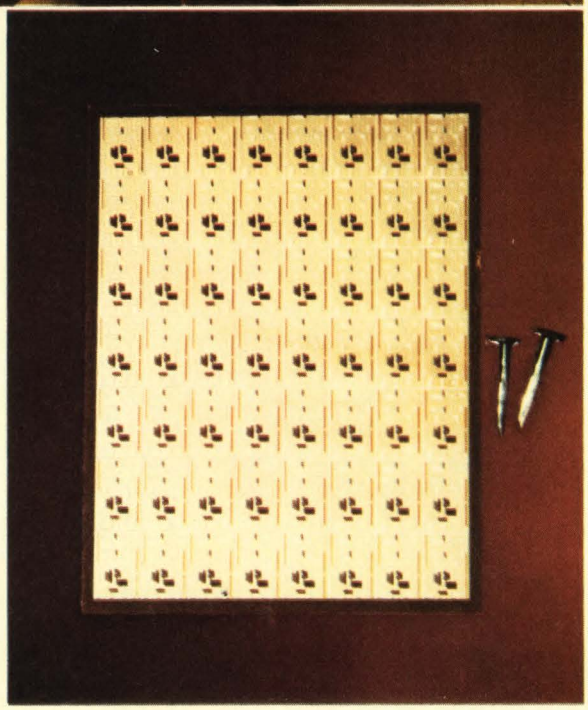
See your Cutler-Hammer Distributor—the man who has everything

CONTROL

CUTLER-HAMMER

POWER DISTRIBUTION & CONTROL DIVISION, Milwaukee, Wis. 53201

CIRCLE NO. 8



Batch processing of sputtered thin-film hybrid circuit plates—photo above shows exposure and chemical etching stations. **Completely processed** thin-film plate with 56 substrates ready for scribing and assembly.

Sputtered Thin-Film

Sputtering cannot be called a new manufacturing technique, but its application to hybrid circuit production certainly is. Thin-film hybrid circuits, long considered the high-cost brother to thick films, will shed this stigma now that Amperex Hybrid Circuits Div., Cranston, R.I., has borrowed successful batch-process metallizing techniques from monolithic IC houses and applied them to processing large area hybrid substrates. Along with lowered costs for thin-film substrates come smaller size per circuit and more highly defined conductors and passive components, leading to new low-cost applications.

Cost savings come from quite a few areas, but the major factor is Amperex's ability to batch-process large area ceramic substrates. The latest system can process 16 ceramic plates (3-1/2- by 4-1/2-in useful active area) with sheet resistivity accurately controlled within ±5% over the entire area. These plates contain as many as 240 circuits each (30 circuits typical), so volume production of repeatable and extremely accurate substrates is routine. Variability from substrate to substrate associated with individual small substrate processing by evaporative techniques is also eliminated.

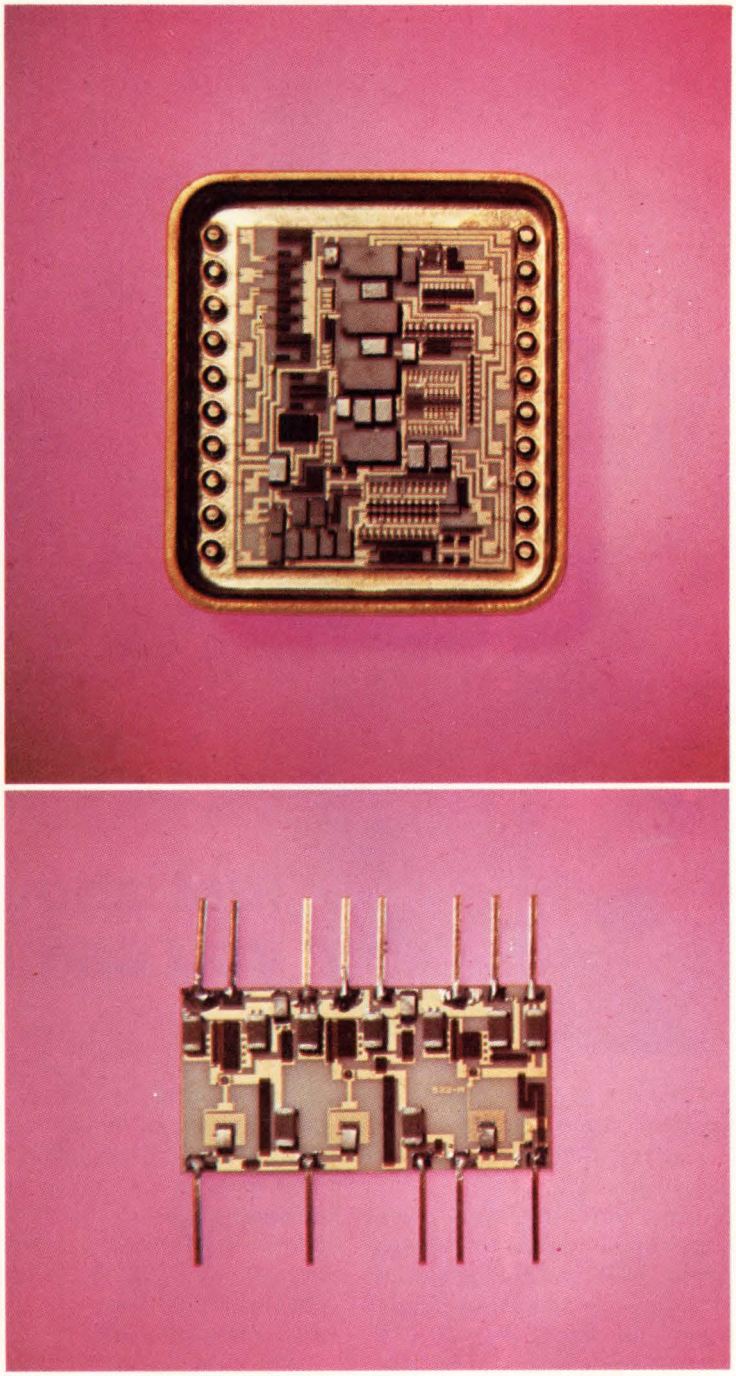
Plates with nichrome resistive materials and nickel conductor base material can be preprocessed and stocked with guaranteed ±5% resistor tolerances (without trimming). Later, custom conductor and passive component patterns are applied by common photochemical processes, hence line definitions are quite precise (2 mils standard). Use of lower cost unglazed ceramics leads to better thermal conductivity, and consequently to more power per square inch and smaller circuits. Further economies come from less handling of individual substrates. With a 2:1 improvement in con-

Circuits Stop Inflation

ductor adhesion, direct connection of lead frame to substrate and use of lower cost packages are possible.

New applications are opened up to thin-film hybrids that were previously either too costly or not attainable. Precise control of conductor line width and thickness gives excellent performance in microwave applications, UHF/VHF broadband amplifiers and CATV drive circuits. *Untrimmed* 8-bit ladders with 1/2 LSB accuracy and trimmed 14-bit ladders lead to economical and compact A/D and D/A converters. The process also lends itself to small, accurate (λ = 2-3%) inductors ranging up to 1000 μH (600 μH occupies 0.2 by 0.2 in). Resistance ratios of $\pm$0.1% without trimming, TCR tracking <0.5 ppm, TCR-140 $\pm$10 ppm and resistor range 2Ω to 1 MΩ $\pm$5% are standard and built into the process.

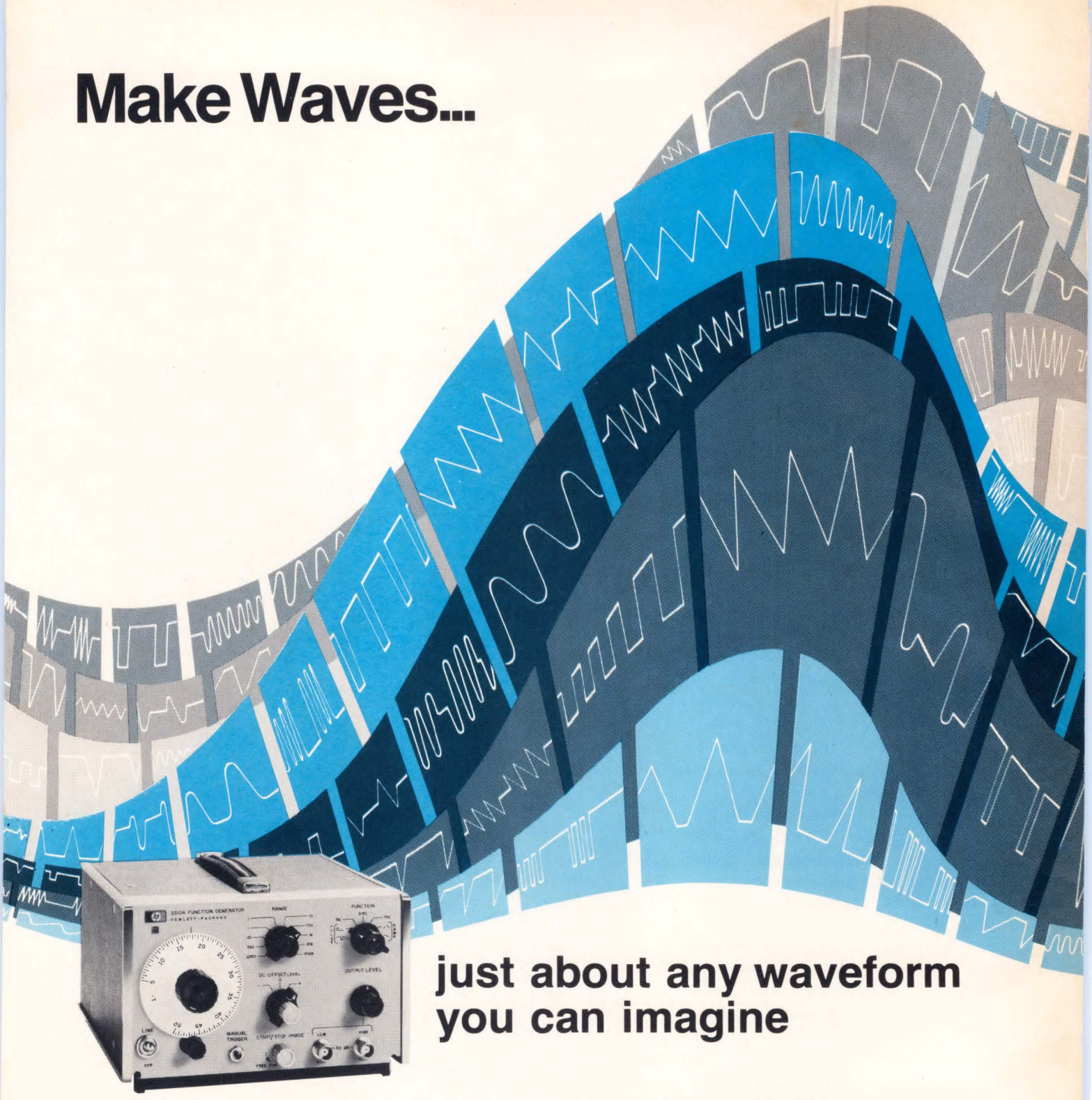
Since just about everything in the total manufacturing process is a variation or direct application of tried-and-true methods, reliability and repeatability is high. A typical sequence of events illustrates this. Nichrome is first sputtered on the ceramic plate, then nickel. During nichrome sputtering, resistance is constantly monitored to assure consistent 5% accuracy. Conductors and inductors are defined by standard photolithography and plated, then excess nickel is stripped. Finally, resistor networks are defined by photolithography and are chemically etched. The plate is then ready for scribing and separating into individual circuits.



Combined 0.01% ladder network and phase converter (top) provide signal conditioner-demodulator function in a single thin-film assembly.

Broadband VHF amplifier with 3 precision thin-film inductors dissipates 3W on 1/2- by 1-in substrate.

Make Waves...



just about any waveform you can imagine

HP's 3310A is the function generator that gives you seven different waveforms—in three different modes—in one inexpensive package.

In its basic form, the 3310A gives you a continuous output of square waves, sine waves, and triangle waves – plus positive and negative ramps and pulses—for only $595.

By adding HP's new Option H10 (only $140), you can generate each of these seven waveforms in two other modes—single-cycle and multiple cycle "bursts." These "bursts" can be triggered either manually or by an external oscillator; starting-point phase can be varied by ± 90°.

With or without Option H10, the 3310 gives you a choice of ten frequency ranges—from 0.0005 Hz to 5 MHz—and an output voltage range from 15 mV pk-pk to 15 V pk-pk into 50Ω load. Dc offset of ±5 V into 50Ω load is also standard.

With Option H10, the 3310A can be used in frequency-response and transient-response testing, as a waveform converter, for generating phase-coherent waveforms, and as a frequency multiplier or divider, among other things. Applications include testing television and communications systems, radar systems, and analog or digital circuits.

For further information on the 3310A and Option H10, contact your local HP field engineer, or write to Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

090/41

HEWLETT hp PACKARD

SIGNAL SOURCES

CIRCLE NO. 13

When the lights go out, the only really portable Digital Multimeter goes on

...and on.

Run the Fluke 8100A 0.02% digital multimeter anywhere, anytime up to 8 full hours off the rechargeable battery pack. Printer output now available.

There are twenty or thirty digital multimeters around that lay claim to portability. The only one you can move around easily and use without a nearby wall plug is ours. It's the only portable machine that works where you need a portable machine.

True portability is just part of the story. The Fluke 8100A, with an accuracy of 0.02% and a selling price of $795, with rechargeable battery option, gives you nine times the accuracy of three digit instruments for half the price of comparable four digit multimeters. We've used a new A to D technique to give you an instrument with low power drain for eight-hour continuous battery operation without recharging. (line operation only $695)

The Fluke 8100A measures ac and dc volts in four ranges to 1200 volts and ohms in five ranges to twelve megohms. Readout is four full digits plus "1" for 20% overranging. Features include an active 2-pole switchable filter and automatic polarity indicator. All functions are push-button selectable.

Also available are RF and high voltage probes, switched ac-dc current shunts, a ruggedized case, and data output (line operation only).

John Fluke Mfg. Co., Inc., P.O. Box 7428, Seattle, Washington 98133. Phone (206) 774-2211. TWX: 910-449-2850 / In Europe, address Fluke Nederland (N.V.), P.O. Box 5053, Tilburg, Holland. Phone: (04250) 70130. Telex: 884-50237 / In the U.K., address Fluke International Corp., Garnett Close, Watford, WD2 4TT. Phone: Watford, 27769. Telex: 934583.

FLUKE®

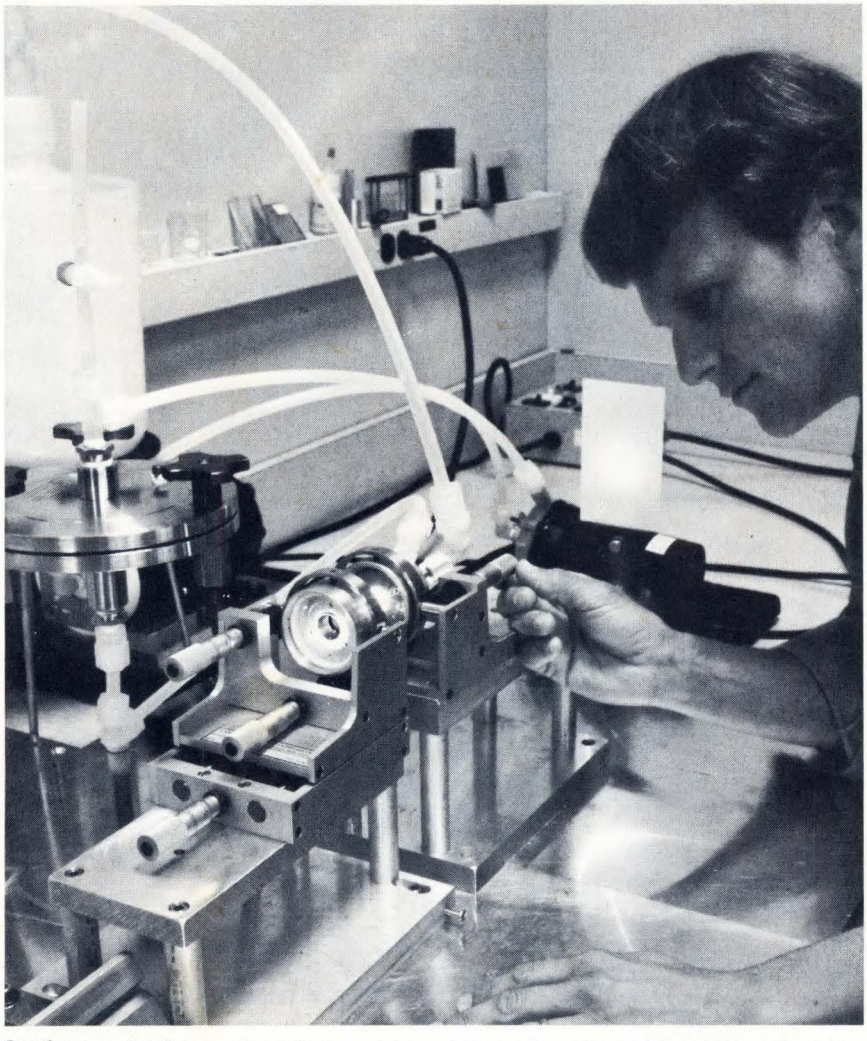
CIRCLE NO. 15

Color TV Gains 2-in-1 Tube

OWENSBORO, KY.—First combination of horizontal output and damper in one envelope rated for color television service, designated Y-2014 by its developer, General Electric, combines two previous high performance tubes.

The Y-2014 Compactron (photo) contains a high-perveance diode and a beam-power pentode. Like those previously available for black-and-white, the diode is intended for service as the damping diode and the pentode as the horizontal-deflection amplifier. The combination offers ratings highly compatible with requirements for horizontal service in 18-in, 90° color receivers.

Dye Laser Goes CW



Continuous dye laser output is tuned by Dr. Otis G. Peterson, Kodak Research Labs., who reported breakthrough at Kyoto conference on quantum electronics.

KYOTO, JAPAN—Three American physicists disclosed successful operation of a liquid laser with a continuous output that may make it useful in communications. At the Sixth International Conference on Quantum Electronics, Dr. Otis G. Peterson, Sam A. Tuccio and Dr. Benjamin B. Snavely told how a continuous yellow laser beam was produced from a water solution of an organic dye excited by an argon ion laser.

With continuous operation proved feasible, it now becomes possible to exploit the low cost and tunable wavelength advantages of organic dyes. Future developments could lead to simplification and even mass production of inexpensive lasers, since a single organic dye laser can be tuned to the wavelengths produced by many of today's other lasing materials, the Kodak Research Labs. scientists noted.

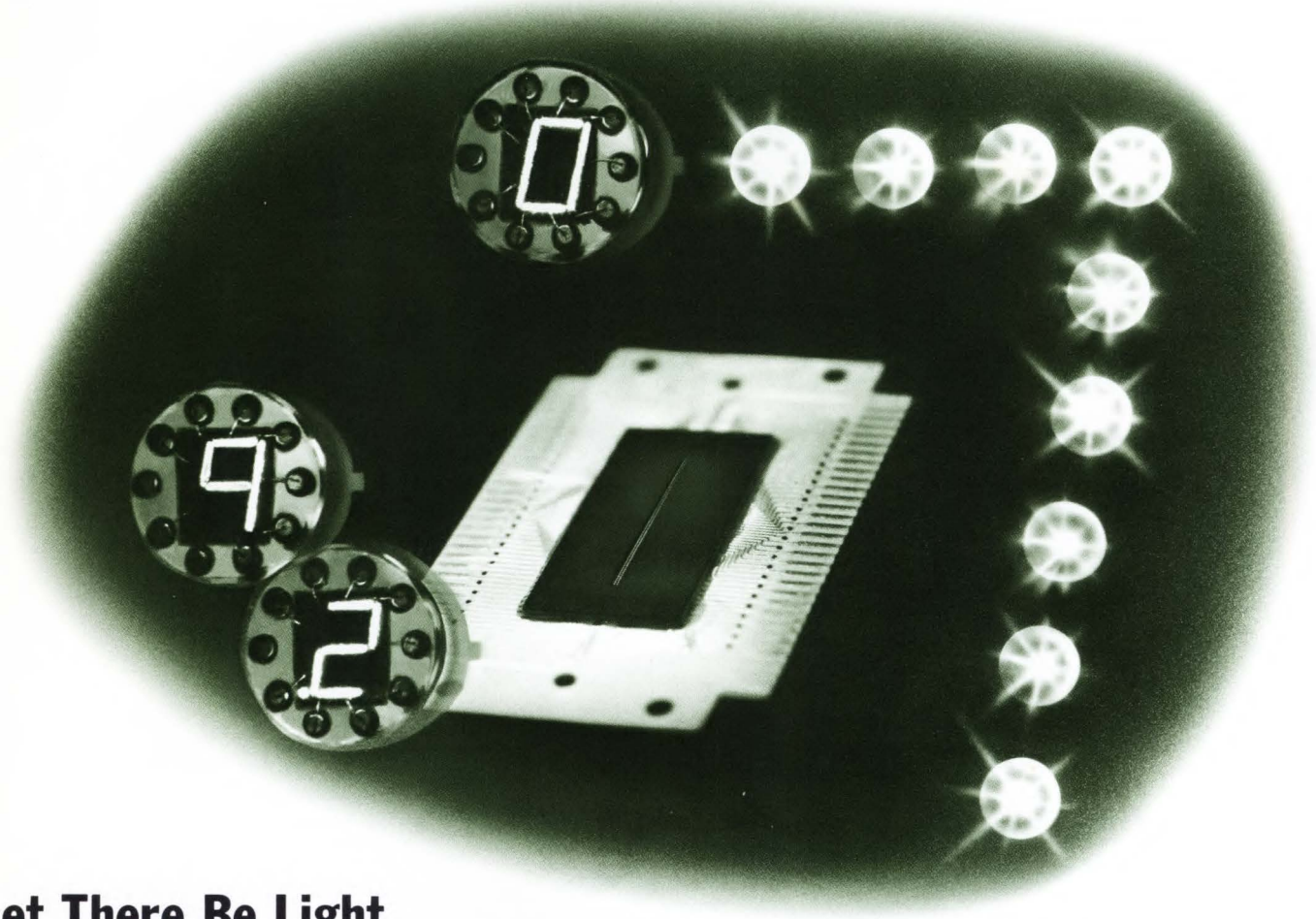
Dr. Peterson and his associates anticipate that they will be able to tune the output wavelength of CW dye lasers by introducing low loss dispersive elements into the optical cavity, as has been done with pulsed dye lasers. With further research it may also become possible to excite the CW dye laser with a high intensity arc lamp.

No. 10-70

SEMICONDUCTOR

newsbriefs

PUBLISHED BY MOTOROLA SEMICONDUCTOR PRODUCTS INC.



Let There Be Light

Optoelectronics — sparkling new star for the 70's at Motorola where 5 new red and IR light-emitting diodes, 13 new photodetectors and 2 new photodiode and transistor arrays have just debuted.

In new visible red LED's, price and brightness play equal roles. The MLED-50, cased in the economical, subminiature, plastic Micro-T package, features 750 fL-@-20 mA brightness and costs only $1.50, 100-up. For equally compact designs, the MLED610 in the hermetic "pill-package" offers reliability and 1100 fL brightness @ 50 mA for only $2.60. And for perfect spectral matching with silicon, Motorola infra-red emitters in plastic Mini-T, "pill" or TO-18 package combine versatility with power outputs from 150 μW to 650 μW and 100-up prices low as $1.50.

In detectors, a great performer is the MRD3050 series — fast, rugged TO-18 packaged devices with a wide range of sensitivities that offer ultra-economical, 100-up prices low as 80¢! In addition, 5 new Darlington amplifiers in Unibloc plastic packages furnish ultra-high h_{FE} of 5,000, sensitivity from 1 to 4 mA/mW/cm^2 and 100-up costs down to 40¢. The new units bring Motorola's photo diode, photo transistor and PIN detector-unit-total to 24.

Challenges in character recognition can now be met with the industry's first standard, 39-element, monolithic photo diode array in ceramic flat-pack and a super-sensitive, 5-mil-spaced, 39-element photo-transistor array. The MRD6039D and MRD6039T are ideal for OCR, star tracker and mark sensor applications or any design requiring high-resolution radiation sensitivity.

A special, basic design guide containing all opto device specifications, applications and characteristics is available now.

For details, circle 20

Beam Lead Intros Boost TTL Systems Reliability

Beam lead TTL! Motorola, longtime supplier of proven high reliability Safeguard beam lead devices, now offers seven MTTL series 5400 functions built with beam lead technology. The initial introductions provide a basic family of standard logic – and more devices will be announced shortly.

The TTL Beam Lead ICs provide the user with specifications similar to their 5400 series counterparts. They differ in that beam lead interconnect metal is gold rather than aluminum. And the aluminum bonding pads formerly required for flying wire leads are replaced with strips of gold 6 mils long, 3 mils wide and 0.5 mils thick that cantilever over the chip edge for connection purposes. Silicon nitride passivation renders the chip impervious to impurities and contaminating ions.

Use of beam lead devices eliminates both die and wire bonding. The result is simple, faster, and more reliable bonds. Beam lead ICs are especially well suited for use in hybrid systems because the higher bond reliability minimizes the replacement of costly hybrid circuits. In hybrid circuit use, the nitride passivation of the ICs eliminates the need for hermetic packaging and reduces costly yield loss. And beam lead chips make higher density hybrid techniques possible.

Motorola Beam Lead ICs – the ultimate in bond reliability for TTL systems.

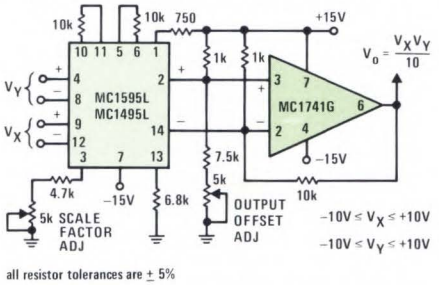
The newly available devices are produced in chip form (MCBC5400 series) or in flat packages (MCB5400F series). Check the table and contact your local Motorola distributor for evaluation units.

DEVICE TYPE (Chips)	DEVICE TYPE (Flat Packs)	DESCRIPTION	100-UP PRICES (Chips)	100-UP PRICES (Flat Packs)
MCBC5400	MCB5400F	Quad 2 Input NAND Gate	$3.65	$6.20
MCBC5440	MCB5440F	Dual 4 Input NAND Buffer	4.15	6.80
MCBC5453	MCB5453F	Expander 4 Wide 2 Input AND/OR/INVERT Gate	3.65	6.20
MCBC5454	MCB5454F	2 Wide 2 Input AND/OR/INVERT Gate	3.65	6.20
MCBC5460	MCB5460F	Dual 4 Input Expander for AND/OR/INVERT Gate	2.70	5.05
MCBC5472	MCB5472F	J-K Flip Flop	5.10	7.90

For details, circle 21

MC1595 Multiplier Level Shift Circuit Uses MC1741 Op Amp – Cuts Component Count

In your **MC1595 four-quadrant multiplier** applications where level shifting is required, a simple, new circuit



all resistor tolerances are ± 5%

can greatly reduce external components, increase accuracy, and simplify adjustment. The circuit takes advantage of the high common-mode range of the **MC1741** (or MC1556) op amp. As shown, you save seven resistors and one capacitor over the multiplier data sheet version.

In this circuit, by operating the multiplier at 2 mA with 10k resistors, linearity is 0.5% (typ) for the X input and 1.0% (typ) for the Y input.

As illustrated, both inputs to the MC1741 op amp are at 11.5 V, one-half volt below the 12 V minimum and 1.5 V below the 13 V typical input common-mode range. The MC1741 acts as a differential current to single ended voltage converter with V_{OUT} referenced to ground. Note also that you can accommodate ±10 V inputs using conventional ±15 V symmetrical supplies.

For details, circle 22

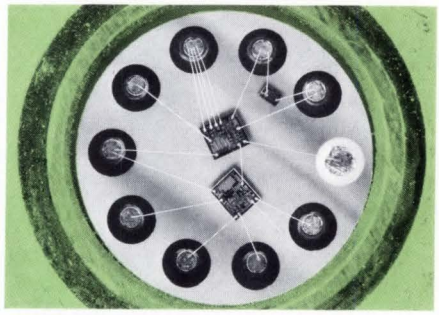
Op Amp And Power Booster Circuits Joined In MCH2870 Hybrid Power Op Amp IC

The end is at hand for many of the problems and much of the cost in op amp circuits for driving low impedance loads. Motorola has combined the MC1741 op amp and MC1538 power booster circuits in one hybrid Power Op Amp, the MCH2870. And you get the function in the nine-pin case 614 formerly required for the power booster, alone.

Now the MCH2870 offers the merged benefits of the op amp and booster in both full and limited temperature range versions, with each priced below the equivalent in separate ICs. In 100-999 quantities, the MCH2870MR (−55 to +125°C) is $16.00; the MCH2870CR (0 to +75°C $8.50. Further savings are realized through reduced external interconnection and board space requirements, and through halved handling.

The output current of the MCH2870 can be limited to any value from 100 mA (typ) to a full 300 mA (typ) with the simple addition of two external resistors. Or, the MCH2870's internal limiting can be utilized to provide a typical 100 mA (pins 2 & 4 open) or 200 mA (pins 2 & 4 shorted). Open loop Z_{OUT} is a low 10 ohms (typ) and A_{VOL} is a high 200,000 (typ, MCH2870MR). The MCH2870 is internally compensated and offers offset voltage null.

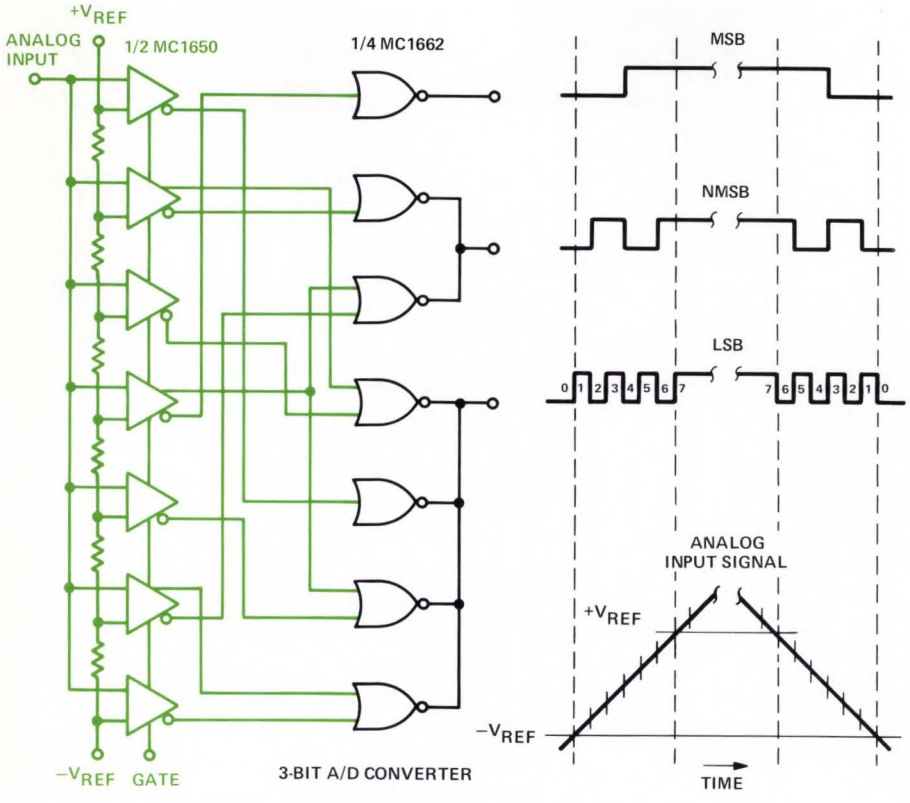
The MCH2870 was designed for driving low impedance/high current loads and is ideal for line driver and servo-synchro amplifier applications. Nine representative applications are described on the data sheet including inverting amplifier, unity gain voltage follower, programmable voltage source, and power splitter circuits.



The MCH2870 Power Op Amp combines three chips in a single nine-pin case.

Your Motorola distributor will meet requests for product from stock.

For details, circle 23



MECL III Devices Convert And Move Data—Faster

Would you believe an A/D conversion time of 3.5 ns *and* a line receiver with a typical delay of 1.0 ns? MECL III now offers two new devices, the MC1650 A/D comparator and the MC1692 quad line receiver – opening up new concepts of high-speed data handling.

When its control gate is in the logic "1" state, the MC1650 compares an analog signal to a reference voltage. If the analog level is greater than the reference, the output of the comparator is a logic "1." If the analog signal is less than the reference voltage, the comparator output voltage goes to a logic "0."

Operating at a typical delay of 3.5 ns, the MC1650 accepts analog signals with slew rates up to 340 v/μs. Used in an A/D converter, the MC1650 is capable of providing digital information at rates up to 200 megabits per second, at the least significant bit (LSB). And, for sample and hold applications, when the control gate is taken to a logic "0" level, all bits of digital information remain in their present state, regardless of a change at the analog input. For maximum design flexibility, the MC1650 incorporates two comparators in one package – both with complementary outputs.

The MC1692 Quad Line Receiver is used to terminate long lines over which high-speed information is transferred. Typical applications might be a cable between a computer installations central processor and a peripheral device or between a measurement terminal and the control center of an instrumentation or navigation system. Comprised of four differential amplifiers with emitter follower output transistors, the MC1692 is especially well suited to accept complementary signals from twisted pair transmission lines and provide high external noise immunity.

Evaluation quantities of these devices are available now in your choice of the ceramic "stud" flat-pack (suffix S) or the 16-lead ceramic dual in-line package (L). 100-up prices are: MC1650L/$21.95; MC1650S/$27.20; MC1692L/$9.25; MC1692S/$11.00. Introduce your system to new high-speed dimensions in data handling.

For details, circle 24

More MC9300/8300 MSI Eases DTL/TTL Design – Reduces Can-Count

DTL/TTL designers! Five additional MC9300/8300 functions offer you an easier building block approach to design. Direct replacements (electrically and functionally) for older 9300/8300 types, the versatile DTL/TTL compatible functions will reduce can-count and board space in your system.

For instance, the MC8308 dual 4-bit latch can replace eight flip-flops or two 4-bit latches. Each half of the device contains four latches with common enable (E0 and E1) and common master reset (MR).

Then the MC9310/8310 presettable decade counter and the MC9316/8316 presettable 4-bit binary counter accomplish counting functions that would require four J K master-slave flip-flops plus additional gating. Both devices have parallel inputs for presetting data and parallel outputs for full counting flexibility.

These counters are typically used for multistage counting and high-speed programmable division.

The MC8311 one-of-sixteen decoder converts four BCD inputs to select 1-of-16 outputs. Two enable inputs provide increased logic capability. The MC8311 function plays an integral part in memory selection control, demultiplexing and data routing.

For an economical high-speed serial storage building block, there's the MC9328/8328 dual 8-bit shift register with separate clocks and a common master reset. Each 8-bit register is provided with a 2-input multiplexer circuit and complementary serial outputs. If desired, the two registers can be clocked together with a common line.

Your Motorola distributor has these DTL/TTL "compatibles" waiting for your evaluation. Give your system the advantages of building block design.

For details, circle 25

0 to +75°C	100-Up Price	−55 to 125°C	100-Up Price
MC8308P	$ 7.50	MC9310L	$18.55
MC8310P	9.40	MC9316L	18.55
MC8311P	7.30	MC9328L	19.00
MC8316P	9.40	L = Dual in-line ceramic	
MC8328P	7.40		
MC8310L	11.70	P = Dual in-line plastic	
MC8316L	11.70		
MC8328L	11.90		

New MMT Micropower Series Advances High Frequency/Low Power State-Of-The-Art

Attention designers!! Have you been having nightmares because your miniature, high frequency amplifier design

Miniaturization of portable electronics is made easier by the MMT806 Micropower series of amplifiers and switches.

requires transistors capable of over 100 gain at microamperes collector current. Is your dream of a miniature counter for a portable instrument "impossible" because it requires a transister capable of over 1 GHz operation?

Wake Up!! Heed this Motorola reveille! Here are two complementary pairs of switching and amplifier transistors – the MMT806 Micropower series – that provide the previously unobtainable combination of low input/output capacitance and high-frequency operation at ultra low power levels that is ideal for portable communications gear, medical electronics and remote control monitoring systems. In their rugged, Micro-T plastic package, the MMT806 (NPN), MMT808 (PNP) switches and MMT-807 (NPN), MMT809 (PNP) amplifiers make the miniaturization of your design a waking reality.

Check the Micropower spec highlights then take advantage of the low introductory 100-up prices of $13.00 for the MMT806/807 and $15.00 for the MMT808/809. There's plenty of warehouse stock to breadboard that dream design.

For details, circle 26

Six-Amp Axial-Lead Silicon Rectifier Series Offers "Twice The Amps Per Dollar"

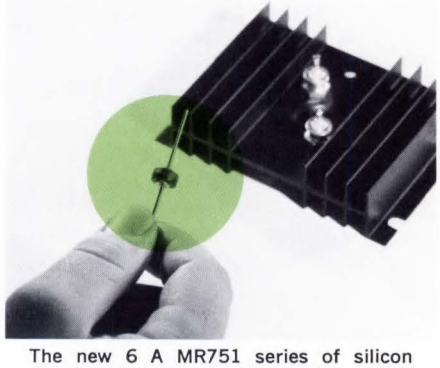
If you're getting hot from looking for dollar rectifier savings and finding pennies . . . cool it! Let the industry's first 6-amp axial-lead rectifiers save *real money* in your design by providing both "twice the amps per dollar" and significant mounting and assembly savings.

Compared to stud rectifiers of similar current rating, the **silicon MR751 series devices** install quicker, easier and take less space. And, their new, button-shape, voidless plastic case provides insulation against accidental shorting or grounding.

But the *big* savings is in the initial cost . . . less than half that of the typical stud-packaged 6-amp counterpart.

The MR751 series rectifiers come in four working peak reverse voltage ratings up to 600 volts. Each features a 600-ampere inrush current surge capacity for increased capacitive-loaded design latitude.

And if you *really* want to cool it – with a proper heat sink and mounting –



The new 6 A MR751 series of silicon "button" rectifiers reduces heat-sink costs.

this little "button" will handle up to 26 amperes. These and other outstanding characteristics – like complete surge current specs, forward voltage drop of 0.9V (max), reverse current at rated dc voltage of 0.25 mA (max) – make the MR751 series rectifiers a real cool buy.

Buttonhole your nearest Motorola rep and ask for evaluation samples – today!

Use the bingo number and get a free 200V MR752 plus a data sheet.

VOLTAGE RATING	100-Up PRICES: Typical 6-A Stud ASP	100-Up PRICES: MR751 Series Device
V_R 100V	$0.90	$0.45 MR751
V_R 200V	1.25	0.49 MR752
V_R 400V	2.00	0.62 MR754
V_R 600V	3.75	0.90 MR756

For details, circle 28

Twenty Versions of 2N3055 Fill 5-25 Amp Industrial Gap!

Next time you need the dependable "old standby," 2N3055 NPN power transistor in a new circuit design – but at a current rating different from the 3055's, 15 amps – don't panic!

BECAUSE . . . There are twenty, new, 2N3055-type devices that do just that – give 2N3055 performance at 5, 7, 10, 15 and 25 amperes of continuous current. And, they're complementary! Offering you the exact current-gain you want, the **new 2N5867-86 family** handles up to 200 W of power. No need now for expensive 2N3055 "specials."

Their complementary symmetry means simplified, audio-servo amplifiers less output transformers and installation costs. In dc-coupled pulse generators, they give positive and negative outputs when used as PNP/NPN pairs.

These 60-80 volt units specify gain at 3 points within each individual current category, and provide a complete gain range of 20-100 at 6 A. V_{SAT} characteristics are given at two points also, providing a full picture of operation making the choice of the right "2N3055" for your design even easier.

Design the 2N5867-86 transistors into relay and solenoid drivers, inverters, converters and audio/servo amplifiers – get all the 2N3055 silicon power you need, for the price you want to pay!

Type PNP	Type NPN	I_C (Cont) A	P_D W	h_{FE} @ I_C (min/range)	$V_{CE(sat)}$ @ I_C V	Rise & Fall Time μs	PRICE, 100-UP PNP	PRICE, 100-UP NPN
2N5867 2N5868	2N5869 2N5870	3	87½	35 @ 0.3A 20-100 @ 1.5A 5 @ 3A	1 @ 2A 2 @ 3A	1.0 @ I_C (max)/2	$1.35 1.75	$1.25 1.60
2N5871 2N5872	2N5873 2N5874	5	100	35 @ 0.5A 20-100 @ 2.5A 5 @ 5A	1 @ 4A 2 @ 5A		1.60 1.95	1.40 1.75
2N5875 2N5876	2N5877 2N5878	8	150	35 @ 1A 20-100 @ 4A 5 @ 8A	1 @ 5A 3 @ 8A		2.45 2.85	1.70 2.00
2N5879 2N5880	2N5881 2N5882	12	160	35 @ 2A 20-100 @ 6A 5 @ 12A	1 @ 7A 4 @ 12A		3.70 4.20	2.70 3.00
2N5883 2N5884	2N5885 2N5886	20	200	35 @ 3A 20-100 @ 10A 5 @ 20A	1 @ 15A 4 @ 20A		4.10 4.50	3.75 4.25

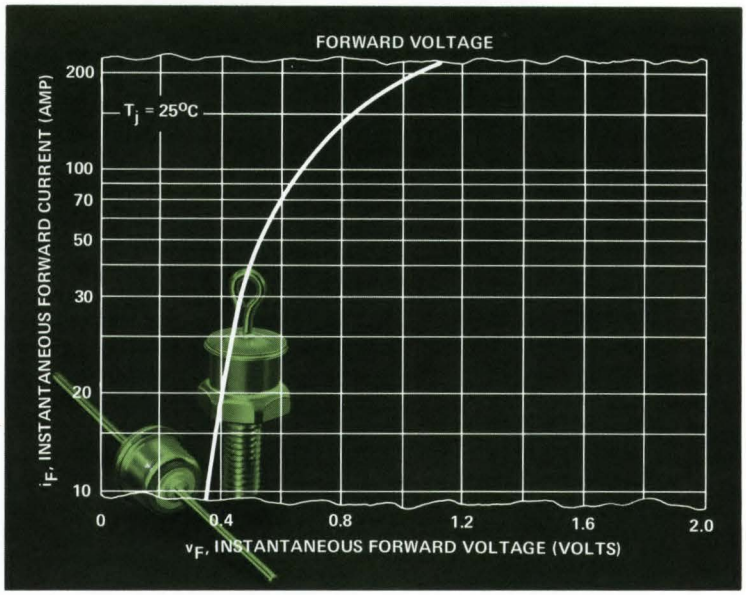
For details, circle 27

Hot Carrier Rectifier Trio Halves Power Loss

With hot carrier diodes, the word is rectification efficiency. At Motorola, the story is *three* hot carrier rectifiers—MBD-5500A, the 50 amp, 20 volt industry first, and now the 5 amp, 20 volt MBD5300 and the 25 amp, 20 volt MBD5400.

Like the MBD5500A, the new rectifiers employ the Schottky barrier principle in a large area, metal-to-silicon power diode. The state-of-the-art geometries feature epitaxial construction, oxide passivation and metal overlay contacts. The result is a forward voltage drop less than half that of conventional silicon rectifiers, low stored charge from majority carrier operation, and high surge current capacity. These three features translate into major benefits:

- The extremely low V_F over the entire forward current range means 50% less power loss than conventional alloy or diffused devices, a real breakthrough for low voltage power supplies and other applications where power loss hurts.
- Majority carrier operation results in virtually no stored charge (even at very high frequencies) plus extremely fast forward and reverse recovery times. Rectification efficiency is flat to beyond 50 kHz and rectification continues into the megahertz range making the rectifiers ideal for high frequency use, where low stored charge is required or where reduced commutation transients are desired.
- High surge current capacity allows extra design latitude in capacitive loaded circuits as well as providing extra protection.



Even at 20 amperes the forward voltage of the MBD5400 is less than 0.4 V, a real benefit for low voltage power supplies.

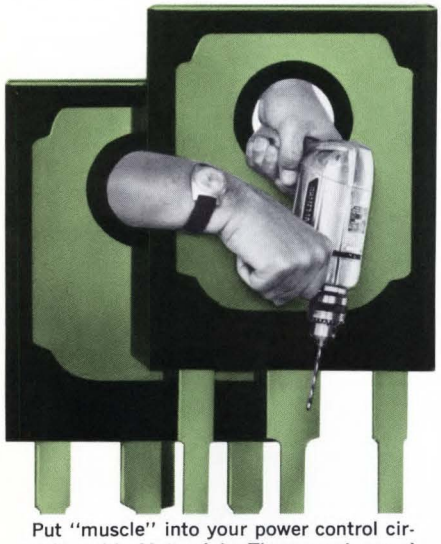
The MBD5400 is encased in the standard DO-4 stud package, the MBD-5300 in an axial-lead hermetic metal Motorola 60 case. 100-up prices are MBD5400 – $6.00, MBD5300 – $3.60, the non pareil MBD5500A – $8.50. Production quantities of both devices are in the warehouse now, ready to rectify – efficiently.

For details, circle 29

Plastic Trigger/Triac Pairs Lower Control Cost

Now, a plastic thyristor/trigger power control pair that will match your design needs for cost and performance!

The new **MAC10/11 Series Triacs** control full-wave power to 500 V and are the answer for 10 A current handling in light dimmers, motor controls, home appliances, anywhere a balance between price and performance is desired.



Put "muscle" into your power control circuits with Motorola's Thermopad cased Triac/Trigger Pairs.

These Thermopad-packaged devices offer symmetrical gating and holding (1st and 3rd quadrants have the same limits), low "on" voltage and 50 mA gate trigger (quadrants I & III) and holding currents.

Their hand-in-glove partner in phase-control, the MBS4991-92 bilateral switch, provides 0.2% / °C temperature coefficient and uniform conduction characteristics in both directions.

Cost for the new "dynamic duo"? Just $1.15, 100-up!

And when half-wave SCR control is your need, reach for the **MCR106/MUS4987 SCR/Trigger** combination that has an ultra-economical, 100-up price as low as 92¢!

MCR106's are Thermopad-cased, compatible with existing sockets, capable of 110°C junction temperature and available in quantity from stock. They're favored in consumer-industrial heat, light and motor control where cost is important.

Their confederate in control – the MUS4987 unilateral switch – offers uniform characteristics and an excellent, 0.02% / °C temperature coefficient for stable performance.

Motorola plastic Triacs and SCR's now provide hermetically-sealed junctions for uncontaminated, reliable operation. Pair up with them today!

New Thyristor Series	I_F A	Blocking Voltage Range V	Thyristor/ Trigger Pair Price (Lowest 100-up)	"On" Voltage V (max)	Typical Switch Voltage V	New Trigger Series
MCR106-1 thru -4 Plastic SCR's	4	30-200	$ .92	1.5	8	MUS4987,88 Unilateral Switch
MAC10/11 Plastic Triacs	10	25-500	$1.15	1.7	8	MBS4991,92 Bilateral Switch

For details, circle 30

NEW PRODUCT BRIEFS

MODULATOR-DEMODULATOR GETS NEW PACKAGE

— And A Limited Temperature-Range Running Mate

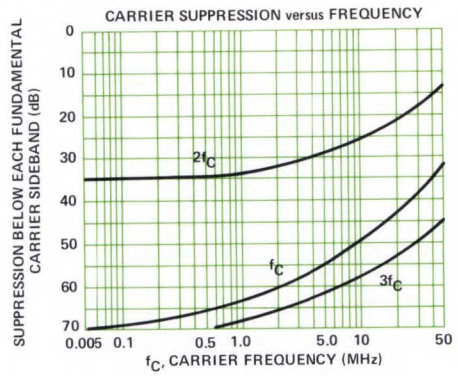
Now you can get Motorola's versatile, low cost MC1596 monolithic balanced modulator-demodulator, and the new limited temperature range MC1496, in "easy insert" ceramic dual in-line "L" packages.

Balanced inputs and outputs, high common-mode rejection of 85 dB (typ), adjustable gain and signal handling, and carrier suppression of 65 dB (typ) @ 0.5 MHz are just a few of the factors which make the circuit popular.

Remember, these devices are used wherever the output voltage is a product of signal and carrier in communications applications such as suppressed carrier and amplitude modulation, synchronous AM-FM and phase or single sideband detection, and frequency doubling or mixing. They've also been found excellent as choppers, as comparators for phase locked loop receivers, and as components in phase correcting and phase encoding circuitry.

The MC1596L is a low $4.80 (100-up) and the MC1496L is only $2.25. Units are available from all Motorola distributors.

For details, circle 31



RADIATION-HARDENED AMPLIFIER/HIGH-SPEED SWITCH

— Provides Balanced Resistance To All Forms of Radiation

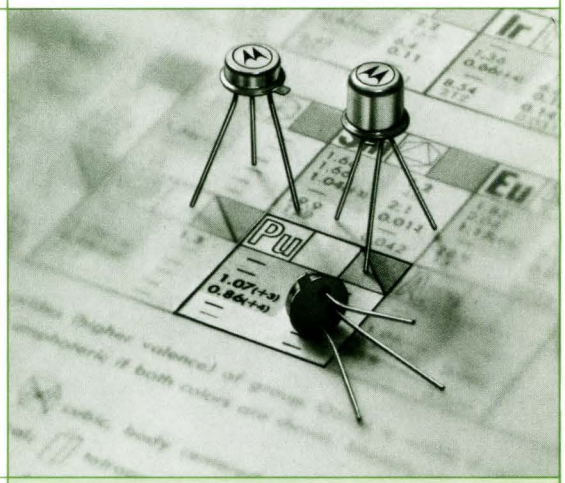
Semiconductor devices are generally the most radiation-vulnerable element of an electronic package. Recently, designers have been able to obtain special, radiation resistant devices for "hardening" systems that must operate in nuclear reactor or Van Allen Belt types of environments. Most of these, however, are resistant to only a part of the different kinds of damaging radiation.

Now, from Motorola, you can get two new, off-the-shelf, PNP silicon transistors that are specially designed to cope with the *entire spectrum* of harmful radiation, and, provide this performance:

- The **2N5763 general purpose amplifier** features a dc current gain specified from 1.0 to 500 mA and high collector to emitter breakdown voltage of BV_{CEO} = 60 Vdc and BV_{CER} = 65 Vdc.
- The **2N5332 high-speed switch** displays typical switching times of t_{on} = 9 ns and t_{off} = 40 ns.

500-up prices: In the TO-18 package, the 2N5763 is $10.80; in the TO-46 package, the 2N5332 is $8.45.

For details, circle 32

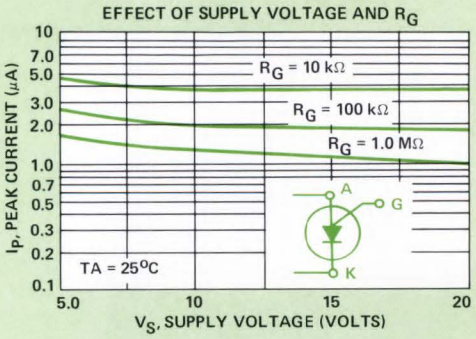


METAL PROGRAMMABLE UNIJUNCTION

— Puts Hermetic, High-Reliability Into Pulsing, Timing and Sensing

Now you can program specs of unijunction transistors that come in a rugged, reliable package. In their hermetic, metal TO-18's, the MPU231-33 PUTs offer an operating temperature range of −55° to 125°C . . . ideal for demanding industrial and military pulse sensing, timing, thyristor-triggering and relaxation oscillator applications. "Big brother" to the lower-cost, plastic MPU131-33 PUTs, the hermetic series has identical specs including low, 1.5 V on-state voltage, 5 nA maximum leakage current, 16 V typical peak output voltage and, of course, the option of programming R_{BB}, eta, I_V and I_P simply by varying the two external resistor values. The MPU233 is especially suited to long-interval timers with its 150 nA I_P. 100-up price range is $.90 to $1.85.

For details, circle 33



NEW TTL QUAD LATCHES

— Fill Need For Temporary Data Storage In High Speed Systems

Two new TTL latches have joined Motorola's growing latch line. The 4-bit devices — MC4035/4335 and MC4037/4337 — are ready to act as temporary stores in the transfer of binary information between processing units and input/output units in your high speed system.

The MC4035/4335 consists of four latch circuits with open collector outputs, a common strobe input, and an output enable. The open collector feature is useful for bussing or wire ORing outputs together and the output enable facilitates gating information out of the latches according to a predetermined timing scheme. The MC4037/4337 features an active pullup network for driving highly capacitive loads.

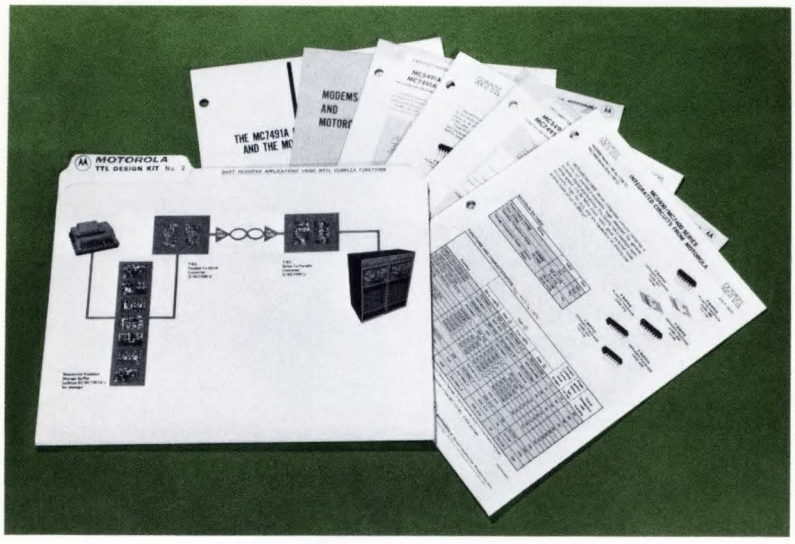
Both latches are supplied in plastic and ceramic dual in-line, and ceramic flat packages. 100-up prices are — MC4035P or MC4037P: $3.50, MC4035L or MC4037L: $4.40, MC4035F or MC4037F: $4.40, MC4335L,F or MC4337L,F: $8.80.

For details, circle 34

Device Number	Package	Strobe Inputs	Q and $\overline{Q}$ Outputs	Open Collector	Typ Power Dissipation	Typ Prop Delay	Output Enable
MC4035	14 Pin	1	no	yes	140 mw	25 ns	yes
MC4037	14 Pin	1	no	no	150 mw	25 ns	no
MC7475	16 Pin	2	yes	no	160 mw	30 ns	no
MC7477	14 Pin	2	no	no	160 mw	30 ns	no

Note: all latches are available in full and limited temperature range.

NEWSBREAKS



Shift Register Applications Detailed In New TTL Systems Design Kit

Designers concerned with data transmission will find prime use for Motorola's new TTL Design Kit #2. The file provides typical shift register applications evolving around the MC5491A/7491A 8-bit shift register, with emphasis placed on the data transmission capabilities of the devices. Included in the kit are data sheets, an application note, and comprehensive listings of 54/74 circuits and complete functions. A "special offer" sheet enables designers to obtain additional data on MODEM ICs.

To obtain your copy, circle 35

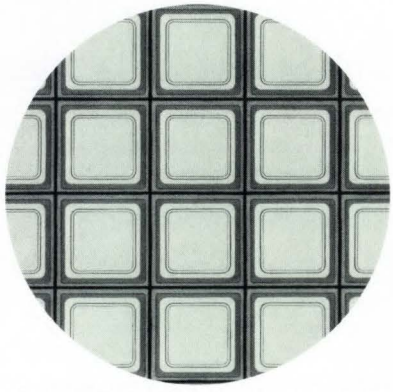
Laser Beam Zener Chip Scribing Increases Yield, Reliability

Motorola's zener chips are the first in the industry to be scribed by the revolutionary, new laser beam method. Under development for 18 months, the state-of-the-art technique is producing cleaner, smoother, and straighter chip edges than can conventional means.

By removing the uneven stresses inflicted on a wafer by the former "scratch" method, cracks that can extend into the active junction area have been virtually eliminated, resulting in an improvement in long-term reliability.

The exclusive use of the laser scribing of zener chips at Motorola has increased yield in this operation to a startling 99% — and at a rate four times faster than with previous methods. The increased yields will result in quicker response to customer volume requirements.

In the laser-scribe process, the use of a very short laser pulse duration (500 ns) and the slow thermal conductance (time constants of μs are typical) in semiconductor materials confine the heat generated in the kerf (scribed area) to a region approximately 2 mils wide.



A repetitively Q-switched, continuous wave, neodymium-doped YAG laser is used to scribe the zener products at Motorola. Depth of penetration into the semiconductor material is 1 mil.

For details, circle 36

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NEW LITERATURE BRIEFS

Master Guide / Price List Now Updated Quarterly

In 137 efficient pages, the latest revision of the Master Selection Guide And Price List brings together all the selector guides and price lists for every product line offered by Motorola. The Oct., Nov., and Dec. prices for more than 14,000 semiconductors are listed along with selector guides for 17 product families.

To make it easy for you to keep tabs, a quick reference section lists new additions and the devices affected by this guide. Pricing and ordering policies for all products are included.

For details, circle 37

Fifth "Industry Bible" Edition Published And Second IC Data Book Supplement Ready

No working library will be complete without Motorola's just published, fifth edition of the Semiconductor Data Book. This version is the largest ever — 2560 pages — and provides three indexes for sure entry to the device you want.

The indexes also serve as a 208 page listing of the key parameters of all semiconductors registered by the EIA plus Motorola non-registered devices. The book proper includes 2150 pages of complete specifications for all 1N, 2N, 3N and Motorola discrete semiconductors and features a new microcircuit components section.

Single copies of the book are $5.95 and an updating service is available for $2.00 entitling you to a minimum of two supplements.

The 336 page Supplement 2 to the Microelectronics Data Book provides complete specifications for 68 new devices. The app note abstract section now includes abstracts for all current Motorola application notes. Sections devoted to the new additions to each digital logic family also provide logic diagrams and truth tables for *all* functions in that family.

To order either the fifth edition or the supplement, use the handy coupon on the left.

NOTE: If Motorola's Literature Request Coupon is missing, use magazine's standard Reader Service Card.

Computers Speed Ecology Studies

ROSEVILLE, MINN.—Electronic scanners, sensors and computers are aiding interpretation of aerial photographs of forests here, in a Honeywell research program designed to provide faster, more detailed knowledge of the earth's resources. In a fraction of the time it would take a human "reader", the electronic system can analyze photographs and tell the species and size of trees in a given forest tract.

The firm's automatic tree species classifier has potential use in management of crops, water resources and urban development, as well as forests.

A skilled photo interpreter studies a series of aerial photographs of a given area. He assigns symbols to identify typical features such as texture, density and shape. He then programs the computer to extract automatically those features of interest, ignoring other material. When the series of photos is fed into the classifier, it evaluates them in minutes rather than the hours or days it normally takes a human interpreter. It can reject data such as buildings or vegetation while evaluating a photograph for water pollution caused by effluents put into a lake or stream.

From aerial photograph like that held by Honeywell scientist Leonard Kirvida the array of 25 optical sensors (right) can classify type, density and population of forest trees in minutes for conservation analysis. Technique originated at the firm's Systems and Research Center in Roseville, Minn.

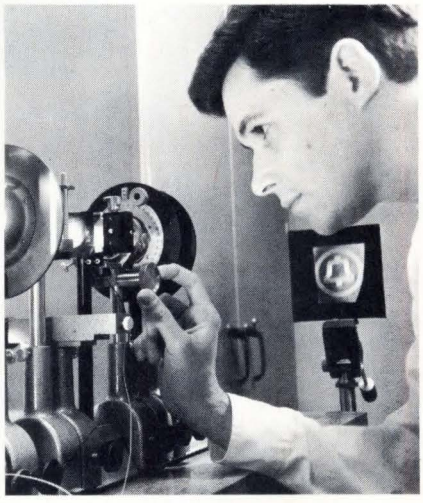
'Ferpic' Offers New Display Potential

MURRAY HILL, N. J.—Imagine an erasable, reusable 35-mm slide on which an operator can electronically erase all or part of the image, add new material, and reproject a new image on the screen.

Scientists at Bell Labs. are investigating such devices called ferpics (ferroelectric ceramic picture devices) made of material first announced by Sandia Corp.

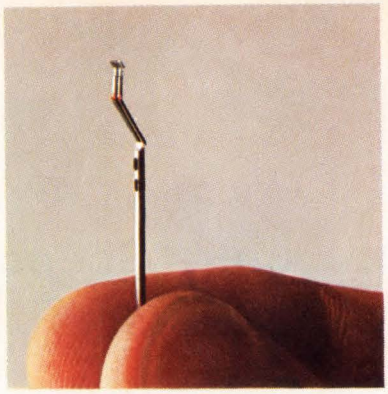
The device is a sandwich structure consisting of transparent electrodes, a photoconductive film and a thin plate of fine-grained ferroelectric ceramic. To change the stored information, a "strain-biasing" technique flexes a transparent substrate so as to stretch or "strain" the attached ferpic sandwich.

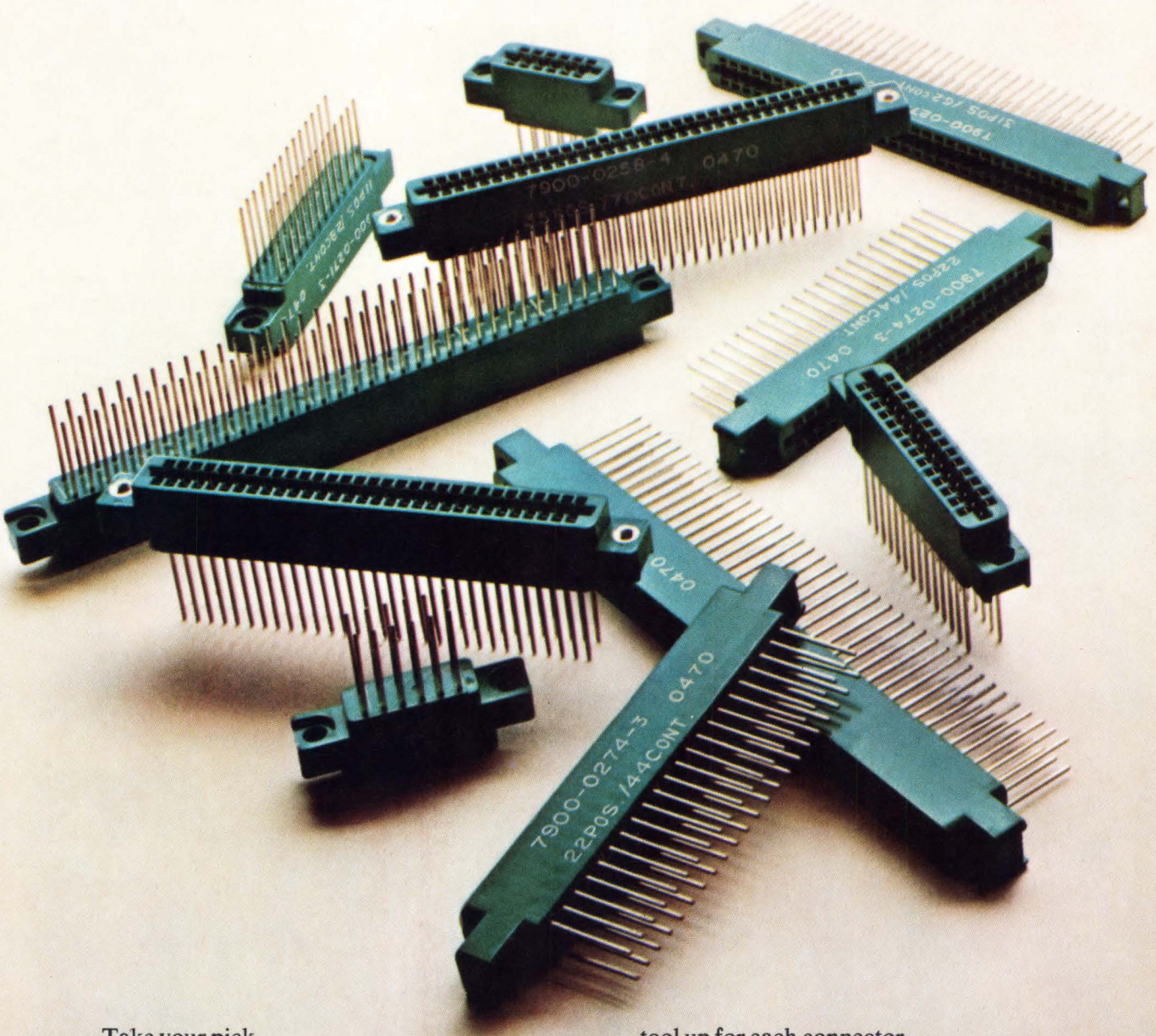
A scanned laser beam records an image on the photoconductive film while a voltage applied to the transparent electrodes develops a field across the ceramic. Resulting birefringence allows viewing or projection by polarized light. To erase, the structure is flooded with light in the presence of a reversed electric field.



Bell Labs.' scientist adjusts focus on image of Bell System symbol projected from ferpic (ferroelectric picture device) onto small screen.

What a line.





Take your pick.

Sylvania gives you a choice of either gold-dot contacts or gold-plated bellows contacts in any of our new P-101 PC-card edge connectors.

Our gold dots are just as reliable as conventional bellows contacts, and they save you money because they use less gold.

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For instance, you don't have to pay tooling costs for any P-101 connector you buy from us. We're using new expandable molds, so there's no need to tool up for each connector.

The molds allow us to change over from one connector to another fast, so we can give you quick delivery.

And they let us make connectors with a small or large number of contacts. (Even the oddballs are now conventional.)

For connectors with .125″ contact spacing, you can specify anything from 12 to 100 contacts.

For connectors with .100″ contact spacing, you can get 36 to 100 contacts.

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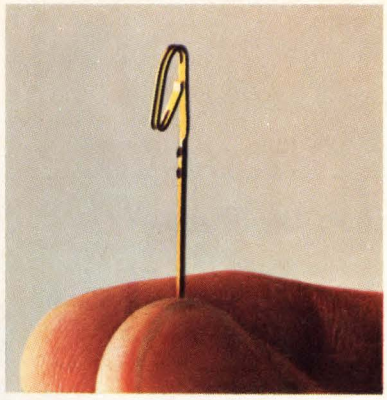

All these connectors are designed to meet Mil Spec C21097B—which requires 500 or more trouble-free insertions.

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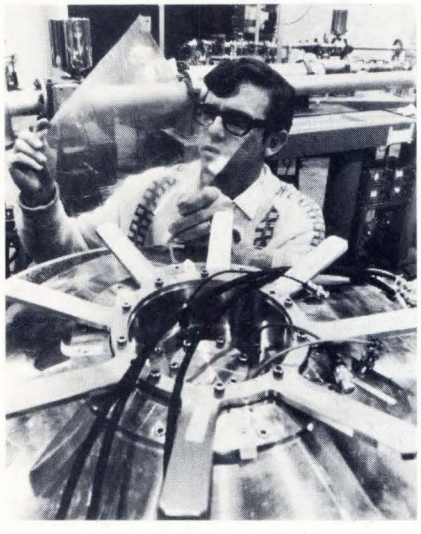
CIRCLE NO. 14

Measures 10^{-17} Sec.

W. M. Gibson of Bell Labs. examines the detector (photo) used to perform the shortest direct time measurement ever made. The clear plastic sheet recorded impacts of tiny fission fragments given off by disintegrating neptunium nuclei. The sheet was placed near a crystal (in radial housing, foreground), in which the short-lived neptunium nuclei were formed. Fragment impacts were individually counted during microscopic examination of the sheet.

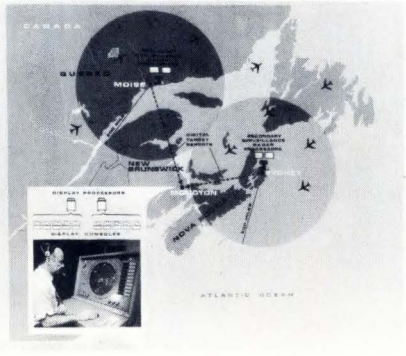


Radiation, Inc. Dubbed Harris SemiConductor

Radiation Inc.'s microelectronics division has taken a new name, opened a new $6.6 million production facility and plans to enlarge its share of the industrial and commercial integrated circuit markets. Now named Harris Semiconductor, Radiation is a division of Harris-Intertype Corp. The new 113,000 ft² plant in Melbourne, Fla. more than triples the division's production capacity, bringing total floor space in four plants to 175,000 ft². The division presently has 1000 employees, compared with about 400 2 years ago. Part of new facility (photo) includes clean rooms with Brute diffusion units in clean room modules.

Better Air Traffic Controls in Canada

A new radar system to show an aircraft's identity and altitude alphanumerically is now being built for the Canadian Ministry of Transport by Cutler-Hammer's AIL Div. In artist's concept, two radar sites will relay digitized beacon surveillance reports to the Area Control Center at Moncton (on the southeast corner of the province of New Brunswick). The Area Center controllers at Moncton presently handle most of the arrival and departure traffic from Canada and the United States via the North Atlantic sector, a prime European routing.

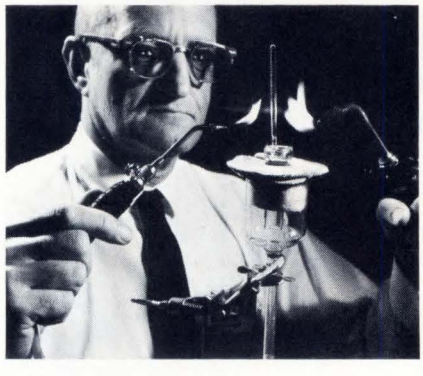


Easier M.S.

The thesis requirement for an M.S. in engineering may be on its way to oblivion. Faculty at Polytechnic Institute of Brooklyn voted to substitute elective courses and/or projects for theses. Prof. Edward S. Cassedy says, "Our faculty in engineering feel that the required master's thesis has become outmoded . . . and that properly chosen projects or technical electives provide an education superior in scope and more responsive to the student's needs in a rapidly changing society."

Ancient Art

Glass fabrication techniques are used by Harold Small, Honeywell Radiation Center to assemble super-modern mercury-cadmium-telluride detector. He invented technique of encasing wire connectors in glass to make precise sensor elements for space and defense systems at Lexington, Mass.

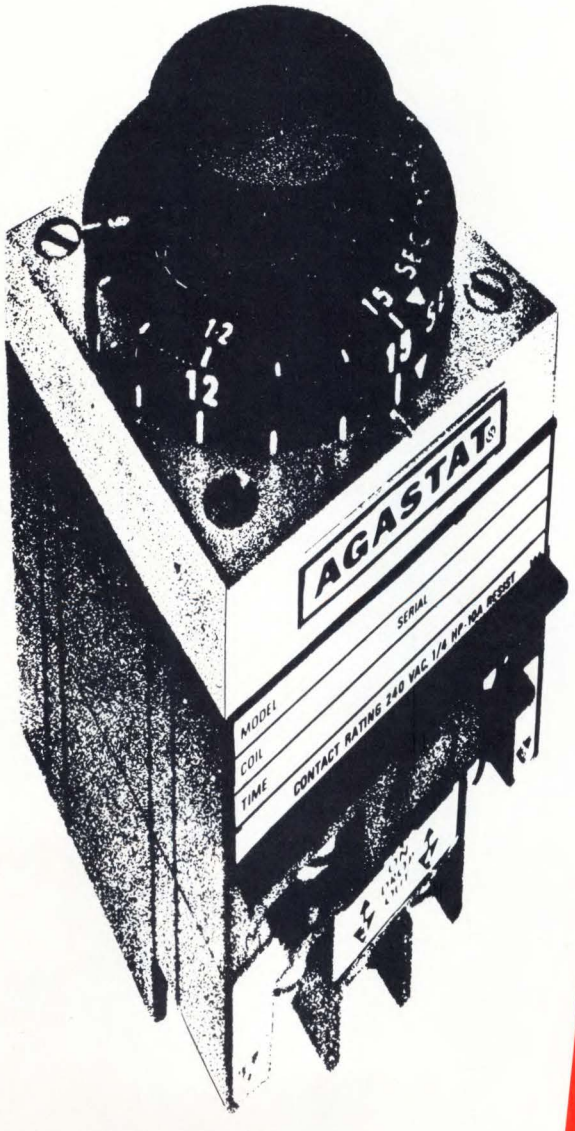


Call for Consultants

Electronic Connector Study Group of Philadelphia, Pa. says it is frequently queried about specific connector problems. Often such questions are answered immediately, but occasionally consultation is necessary. The Connector Study Group wants interested connector specialists to serve as consultants. The group will establish and maintain a list of qualified specialists and distribute applicable names to engineers having specific connector problems. Interested connector specialists are requested to contact the Electronic Connector Study Group, Box 3104, Philadelphia, PA 19150 stating interests and qualifications.

NEW 2-WAY TIMER

for surface or panel mounting —helps cut inventory requirements!



With the new 7000 Series Agastat Electropneumatic Timer and the handy adaptor kit, you're set for either surface or panel mounted applications! (This means reduced inventory for you, and reduced inventory for your distributor, so he has *what* you need when you need it.) The oversize time-calibrated knob sets the precise time delay with one quick turn. Choose from both "on-delay" and "off-delay" models in ten separate time ranges from milliseconds to 60 minutes! For more information about this and other Agastat controls, call your local Agastat representative, or write us today at Dept. EDN-57.

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AGASTAT

CIRCLE NO. 16

Custom(er) Cable Constructions by Chester

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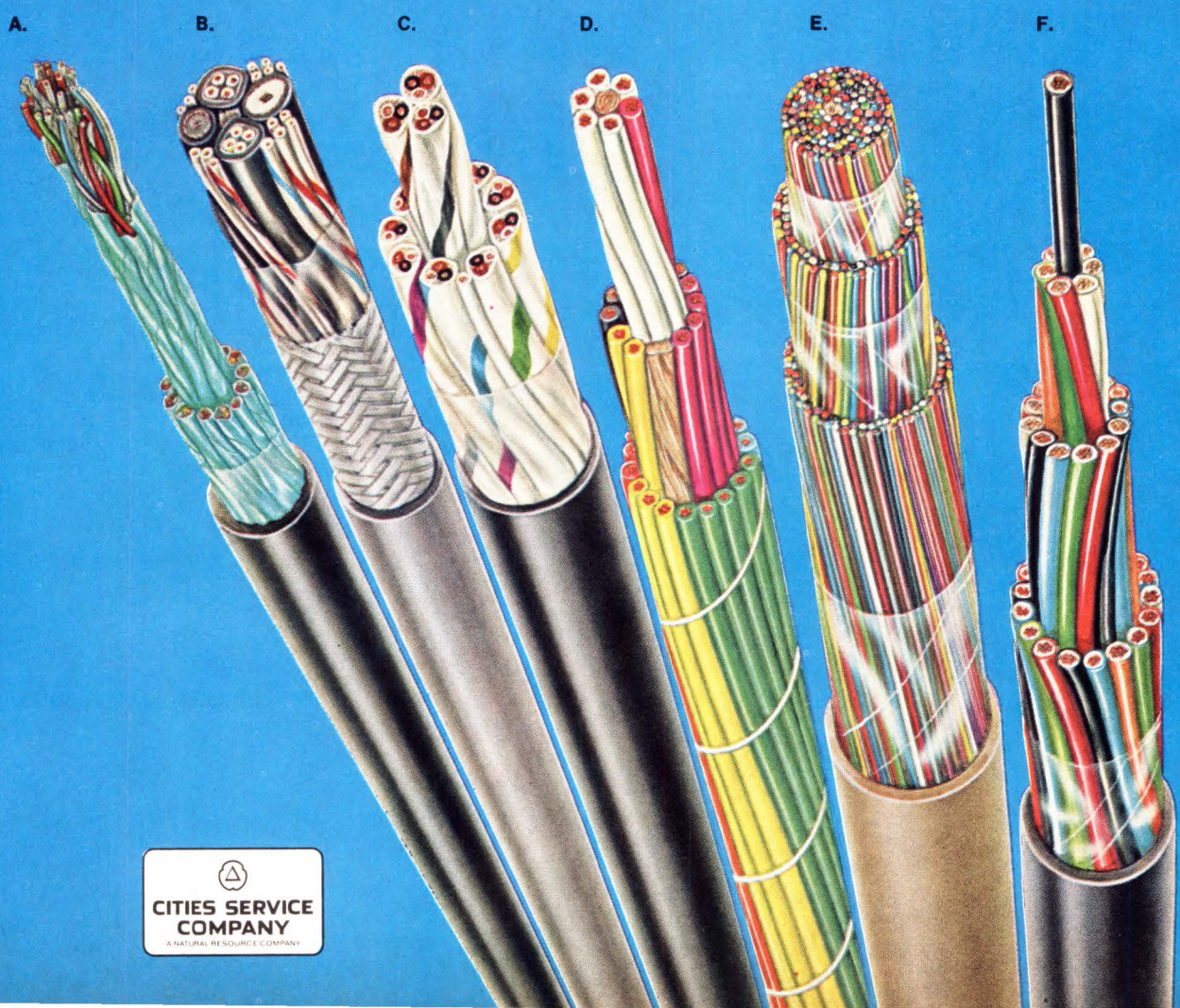

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B. TV CAMERA MFR.: Camera control cable for Audio and Video signals: a composite of PVC and polyethylene insulated conductors, cabled, overall braid shield, PVC jacket.

C. AIRCRAFT SIMULATOR MFR.: Control cable: 12 triples shielded jacketed, stranded copper conductors, PVC insulated, individual shield jacket color coded, cabled overall PVC jacket.

D. ELEVATOR MFR.: Control cable: 35 conductors, stranded copper, PVC insulated, conductors coded by colors and printed numbers, cabled with open binder; individual conductors U/L listed.

E. INTERCOM EQUIPMENT MFR.: 250 conductor inter-office communication and signaling cable: solid bare copper, PVC insulation, paired, cabled, PVC jacket; U/L listed.

F. ELECTRIC UTILITY CO.: Station control cable for general use: 37 conductors, stranded, polyethylene and PVC insulated, color coded, cabled, overall tough PVC jacket; per NEMA/IPCEA Specifications.

G. LARGE CITY: Communication cable: 50 pairs, polyethylene insulated, cabled, continuous layer of copper shielding tape, PVC jacket; per spec. IMSA-19-2, 600 volts.

H. LEADING SHIPBUILDER: shipboard cable: stranded conductors, nylon-jacketed PVC insulation, pairs shielded and jacketed, cabled, PVC jacket, and aluminum braid armor overall; per spec. MIL-C-915.

I. U. S. GOVERNMENT: Coaxial cable: type RG-218/U, solid copper conductor, polyethylene insulated, copper braid shield, PVC jacket; per spec. MIL-C-17/79.

J. BROADCASTING COMPANY: Remote control broadcasting cable: stranded conductors, polyethylene insulation, pairs & triples shielded and jacketed, cabled, PVC jacket overall.

K. COMPUTER MFR.: Computer control cable: 55 conductors, stranded copper conductors, PVC insulated, formed into 7 groups of 7 conductors, cabled, PVC jacket; U/L listed.

L. MACHINERY MFR.: Bus drop cable: 3 PVC insulated stranded conductors, with split uninsulated grounding conductor, cabled, overall PVC jacket; U/L listed; per NEC.

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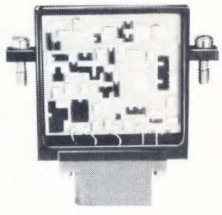

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CIRCLE NO. 17

NEW VISTAS FOR MICROWAVE COMMUNICATIONS

"Microwave communications is still a squalling infant," says Thomas E. Ciochetti, president of Varian's affiliate, Communications Transistor Corp. He predicts the infant field will grow phenomenally, spurred by mass market demand.

Though the microwave communications field has been preoccupied with military projects, its future growth will unquestionably stem from the consumer/industrial and computer segments of the marketplace. With the advent of digital data links and videophone transmission networks, it will become necessary for most microwave hardware manufacturers to revise their profit goals—as well as their *modus operandi*—if they wish to penetrate these so called "mass markets". More specifically, large companies must reduce their manufacturing costs—and smaller firms must create or seek out new components that will make their product line competitive.

Many believe that the computer will influence human life for the next thousand years. I will be more specific and state that the influence will not come from the mainframe or the console, but rather the remote data terminal. Though it may never be practical for every engineer to have his own computer, the time is fast approaching where every engineer can have his own data terminal.

And what's to stop it with engineers? With MOS technology providing functional blocks for arithmetic units, shift registers, read-only memories and keyboard interfaces—I foresee the cash register in your local department store becoming an input/output data terminal. This same future awaits a host of other equipments such as credit-card handling devices, postage meters and copy/duplicating machines. Microwave data links are just now being implemented between data terminals and their mainframe. This usage will continue to grow—and be augmented by additional microwave networks that will tie data terminals together. After all, there's going to be a need to handle an information exchange among data terminals—information that never gets back to the mainframe. To handle this, I predict that future data terminals will be equipped with small microwave transcievers.

Now if the microwave hardware market is going to double by 1975, and I believe it will—the microwave industry must do two things. First: identify the markets which contain high volume business. Second: lower manufacturing costs by several orders of magnitude. This can be best achieved by orienting production methods away from the military and toward the commercial market. Microwave communications is still a squalling infant. Only those companies who are able to move quickly, remain flexible, and gear their operation for the profitable mass markets will survive beyond the phenomenal growth period that is imminent.

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A PRIMER ON ANALOG MULTIPLIERS

Without analog multiplication in your bag of circuit tricks, you can't consider yourself a well-equipped EE. Here's a quick rundown of what you need to know.

RICHARD C. GERDES, Optical Electronics, Inc.

Multiplication is too basic an operation to ignore. Until recently, a designer could be excused for ignorance of analog multiplication because it was such an expensive, difficult function to implement. This is no longer true. Suitable components and circuits are readily available, including well-matched, wideband transistor pairs, wide-dynamic-range log diodes – and circuits for multiplying with these devices.

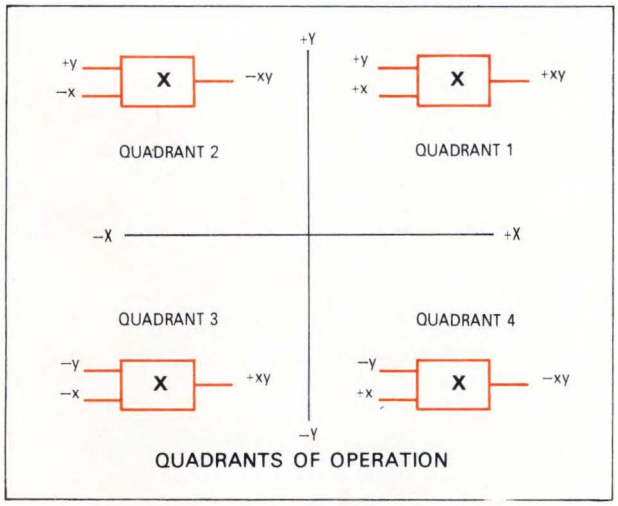
There are also good practical reasons to bone up on analog multipliers. For one, the constantly-growing emphasis on sophisticated wideband signal processing is making multiplication an essential part of many advanced systems. Only with an analog multiplier, for example, can you complete a system that will perform real-time signal correlation economically.

Even more than op amps, multipliers are the type of circuit subsystem that you must first understand before you can apply them intelligently. So, as a starter, let's take a once-over-quickly look at the basic multiplier terminology and hardware categories.

The Quadrants

As used to categorize multipliers, the term "quadrant" refers to the four sectors of a Cartesian graph that has the multiplier inputs x and y on its axes:

Inputs x and y going into a multiplier block (shown with transfer function symbolically labeled "X") produce output xy. The sign of this output xy will vary with the signs of the inputs x and y, and the four quadrant areas show the possible polarity combinations. The output xy will be positive in quadrants 1 and 3 because the inputs are alike (both positive or both negative), and negative in quadrants 2 and 4 because the input polarities differ.



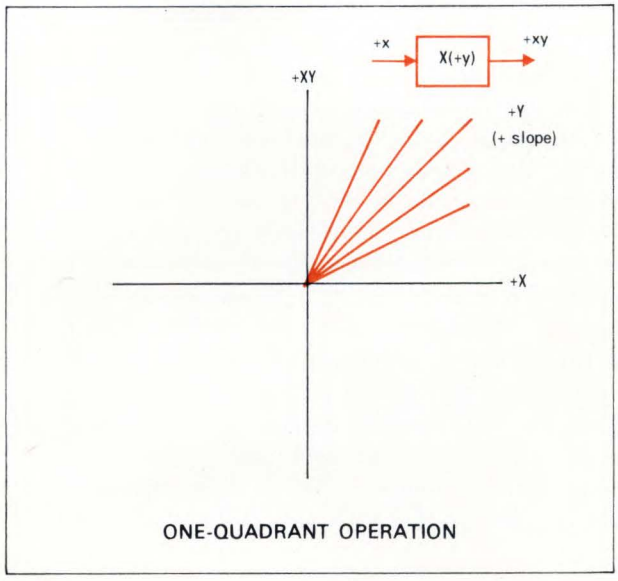
QUADRANTS OF OPERATION

The y vs x plot is confusing, however, for it implies that y is a function of x, which in multipliers is not true. Therefore, we will now use a graph of product xy vs x, with y shown as a curve plotted on the graph. Now, in proper fashion, xy is a function of x, with y showing what particular function. Obviously, the roles of x and y could be reversed without changing the meaning.

The quadrants get shifted around quite a bit, as will be seen, with only quadrant 1 remaining the same. Really just a technicality, this is only mentioned to alert you that the signs of the quadrants with respect to the multiplication differ between a y vs x plot and an xy vs x plot.

One-Quadrant Multiplier

If the nature of the signal or multiplying circuit restricts both inputs to just one polarity, then operation will be confined to one quadrant:



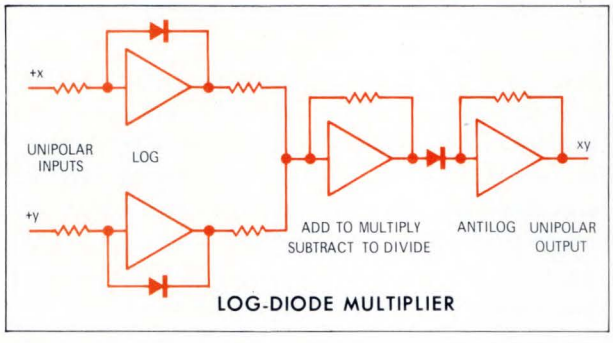
ONE-QUADRANT OPERATION

(Continued)

Analog Multipliers (Cont'd)

Here, both x and y are of positive polarity, so the operation stays within the first quadrant. Only positive xy products will result, but, as will be seen later in four-quadrant operation, positive products can also be produced by $-x$ and $-y$ inputs in quadrant 2 of an xy vs x graph (or quadrant 3 of the original y vs x graph).

One-quadrant multipliers often result when the multiplication is performed by diodes. Typically, such multiplication uses the logarithmic characteristic of a forward-biased diode. In one approach, the diodes are placed in the feedback loops of op amps to take the logs of the x and y inputs. These logs are then added in an op-amp summer, after which the antilog is taken by employing an op amp that has a diode in its input, thus:



LOG-DIODE MULTIPLIER

Actually, the log diodes don't do the multiplication, they just transform the input signals into a form that the summer can handle (as on a slide rule). Then the final diode restores the output signal to regular linear form.

Clearly, this circuit can accept only one-polarity inputs because the diodes must be forward-biased to operate in a logarithmic mode. Its relative simplicity makes this approach inexpensive, and it offers quite wide-band operation. Good-quality log diodes are available. These are designed to accentuate the natural logarithmic diode characteristics, while minimizing such spurious side effects as bulk resistance, noise and leakage. High-quality log diodes will operate logarithmically over as many as six decades.

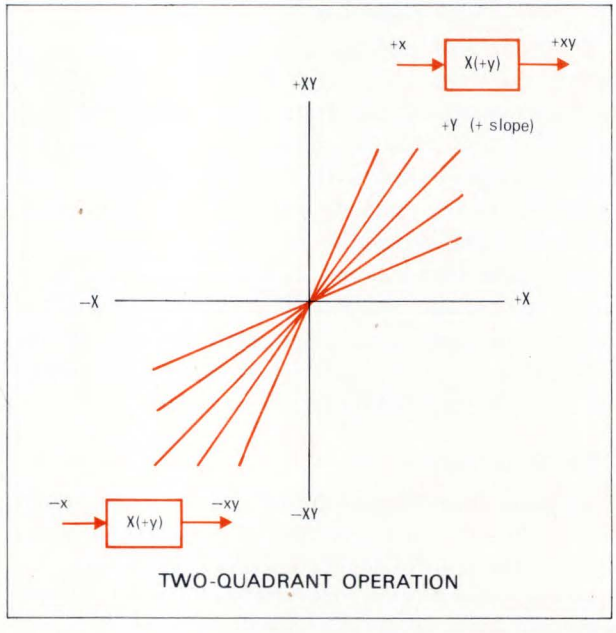
Accordingly, this method is worth considering for certain instrument applications. In some cases, the inputs may already be in log form (say they come from square-law transducers such as temperature-sensing diodes or thermistors), so only the last two stages of the multiplier will be needed. In other cases, logarithmic amplification may still be desirable to permit the handling of a wide range of signals without overloading. In still other cases, the signal may be purposely unipolar (such as from an absolute-value amplifier). In any of these special situations, the designer may be able to economize by working a one-quadrant multiplier into his existing circuitry.

Some products that might profitably use one-quadrant multipliers are: polar (dc) wattmeters; voltage-controlled amplitude modulators and ac variable-gain blocks (for as can be seen by the graph, this is really the transfer function of a linear ac amplifier); function generators; and, of course, positive multipliers.

Disadvantages of the one-quadrant multiplier (at least of the diode type) are the limited accuracy unless carefully-selected log diodes are used, and the fact that it cannot be used as a general building block.

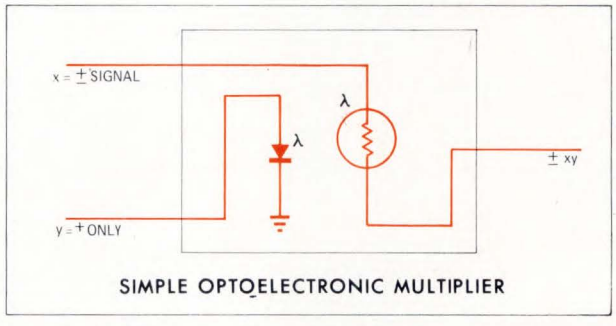
Two-Quadrant Multipliers

If one of the circuit inputs can have bipolar excursions, the operation will fall in two quadrants:



TWO-QUADRANT OPERATION

A simple case example would be a light-emitting diode modulating a photocell:

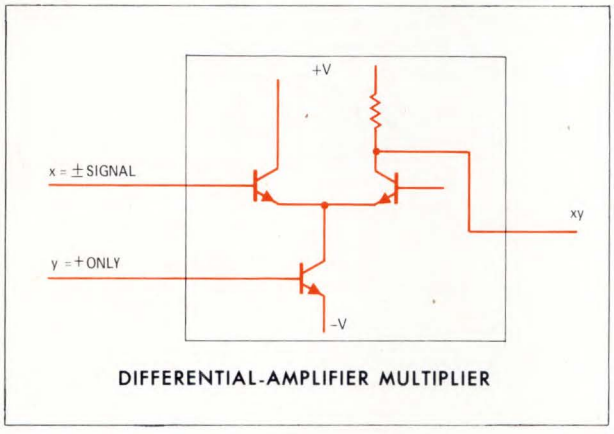


SIMPLE OPTOELECTRONIC MULTIPLIER

The photocell is bilateral and can accept bilateral signals while the LED must be forward-biased to emit

light. If the photocell were to be replaced with a phototransistor, the circuit would revert to one-quadrant operation. (Not shown are the necessary means for linearizing the circuit.)

Other forms of two-quadrant multiplication employ magnetics or variable transconductance. A simple two-quadrant variable-conductance multiplier can be implemented by varying the common-mode constant-current source of a differential amplifier stage:



DIFFERENTIAL-AMPLIFIER MULTIPLIER

It could be quibbled that all two-quadrant multipliers could be made four-quadrant by suitable biasing schemes. Likewise one-quadrant multipliers could be upgraded into full-quadrant operation by biasing. It could also be pointed out that it is possible to increase the range of quadrants by paralleling one- (or two-) quadrant multipliers. Here, however, we are considering only circuits that have the natural ability to operate in the various quadrants.

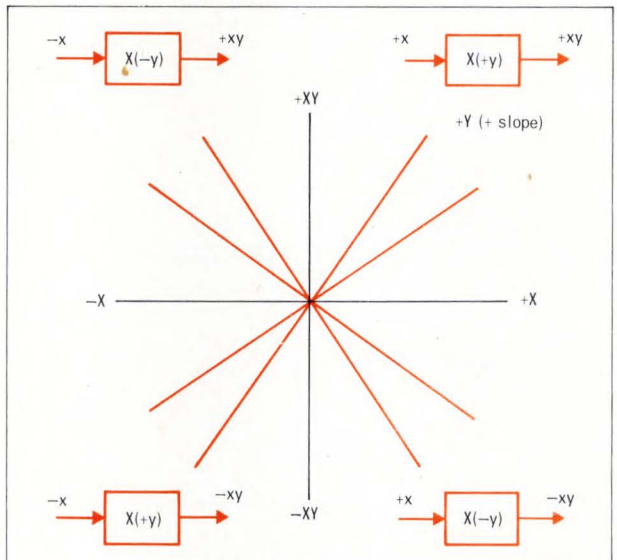
Simplicity of the two-quadrant multipliers gives them an advantage over the four-quadrant ones. Also, because they are built from more generally-available and less-critical components (they need only half the matching that four-quadrant operation demands), they can be less expensive and easier to repair in the field.

Two-quadrant multipliers make excellent amplitude modulators and variable-gain devices. (They have the transfer function of a linear dc amplifier.) When placed in the feedback loop of an operational amplifier, they will provide full-performance square rooting and common two-quadrant division. Two-quadrant multipliers, when driven by a unipolar square wave on the restricted-polarity input, make full-performance analog gates.

Their disadvantages are that they cannot be used as completely general (four-quadrant) multiplication building blocks, and that their linearity and temperature stability are often inferior to the four-quadrant types, because the two-quadrant multipliers are not completely balanced differential circuits.

Four-Quadrant Multipliers

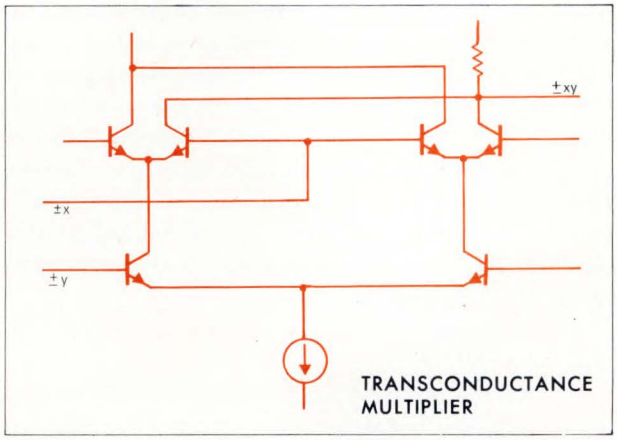
When the circuit permits bipolar excursions on both inputs, the operation covers all four sectors:



FOUR-QUADRANT OPERATION

The four-quadrant multiplier can perform the full algebraic multiplication function. Now we have a true general-purpose analog building block—or we would have if the module was made with the correct impedance and voltage levels so that it could be freely mixed with standard operational amplifiers. However, many present-day multipliers still require the designer to provide signal conditioning.

A circuit becoming widely used for four-quadrant operation is the so-called variable transconductance design.

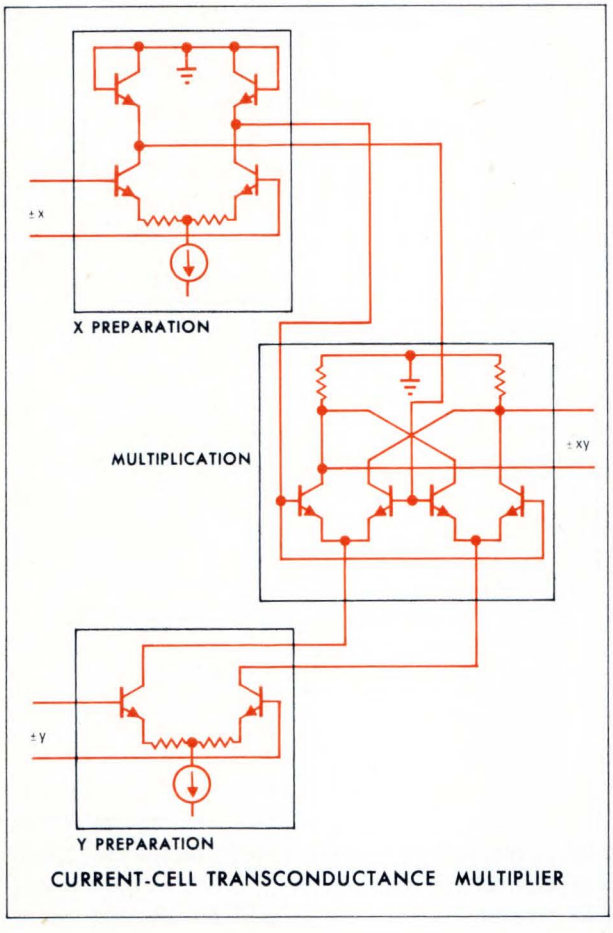


TRANSCONDUCTANCE MULTIPLIER

(Continued)

Analog Multipliers *(Cont'd)*

This operates in balanced differential mode throughout. A popular form of transconductance multiplier is the current-gain-cell multiplier.



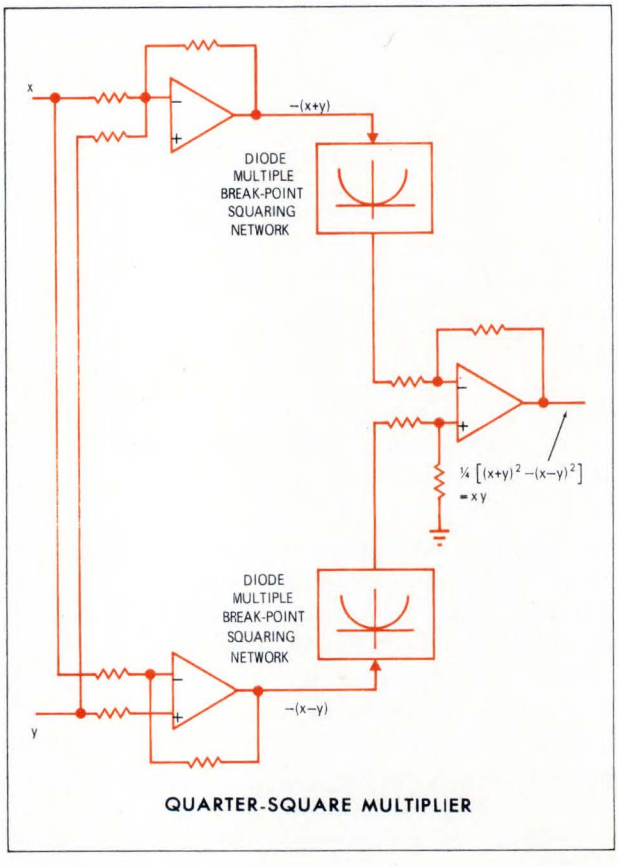
CURRENT-CELL TRANSCONDUCTANCE MULTIPLIER

What distinguishes the current-gain-cell circuit is the compound transistor-diode combinations on each side of the differential amplifier stages. These insure linear amplification (logarithmic amplification is not wanted here).

Their balanced operation makes transconductance multipliers well suited to partial or complete monolithic integration. When each differential stage is on the same chip (or all stages are on one chip), close pairing of the devices and close temperature tracking can be achieved, leading to good linearity. Current rather than voltage-mode operation of the current-gain-cell type multiplier gives it excellent bandwidth: commercially-available units have −3 dB bandwidths in the 100 kHz to 30 MHz range.

Prime disadvantage of the transconductance multipliers is limited accuracy, for their static accuracy rarely exceeds 1%. If full analog-computing of 0.1% and better accuracy is desired, then you must go to more elaborate and expensive schemes.

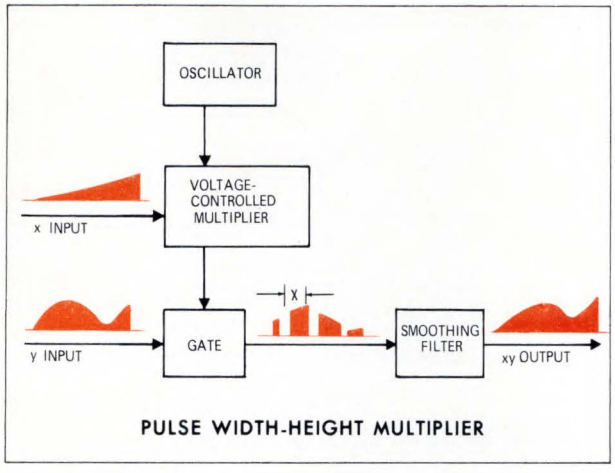
One type of multiplier that has been used for at least 20 years by builders of analog computers because of its combination of very high static accuracy and fairly good bandwidth is the quarter-square multiplier. It uses diode function generators (diode-resistor networks) to implement the quarter-square equation:



QUARTER-SQUARE MULTIPLIER

In a sense this is a four-quadrant version of the logarithmic one-quadrant multipliers discussed earlier. From the number of separate hardware blocks needed to implement the equation, it can be seen that this approach has to be expensive. Quarter-square multiplier cost is in the hundreds of dollars—an order of magnitude more than the usual tens-of-dollars price tag for variable-transconductance multipliers. However, that order-of-magnitude price increase will buy a proportional increase in accuracy. Some quarter-square types approach 0.01% static accuracy.

There is also a whole group of multipliers that form the product in a periodic timewise manner. For example, the x input can be used to control a voltage-controlled oscillator or multivibrator which, in turn, controls an analog gate that periodically interrupts the y signal.



PULSE WIDTH-HEIGHT MULTIPLIER

The x input "multiplies" the y signal by controlling the "area" of y waveform that gets through. For four-quadrant operation, the negative x inputs must also invert the y signal.

For this approach not to hamper the signal bandwidth appreciably, the oscillator or multivibrator must run at a frequency three or more times that of the highest signal. Then, an output filter can eliminate the modulation.

There can be many variations of this modulation approach to multiplication, such as triangle-averaging and other pulse-width schemes. Their main advantage lies in better accuracies than are generally achieved with the quarter-square approach. Too, the circuits are more simple, and frequently more familiar.

Their chief disadvantages are the switching noise and decreased bandwidth, but the increasing availability of high-speed switching devices and circuits makes this approach worth keeping in mind for certain applications. For example, a low-accuracy form of it has been used to perform the multiplication in a commercial correlation instrument.

An entirely different group of multipliers is based on magnetic circuits of various types. One, a timewise modulated multiplier, evolved from the old magnetic amplifiers. Like the magnetic amplifiers, it shows superior resistance to nuclear radiation and nearly unbelievable stability with time. Drawbacks of this type include expensive fabrication and very limited frequency response.

Quite a few magnetic circuits are based on the response of various semiconductor elements to magnetic fields. Among these are the older Hall-effect multipliers and the newer magnetic diodes and transistors. All these magnetic types bear investigating when the application calls for isolation between the inputs.

Over the past few years, the four-quadrant approach has become the most popular because, at a cost not too much greater than the one- and two-quadrant approaches, it can do all multiplication functions. This has come about largely because of the introduction of low-cost transconductance monolithic and hybrid modules. They have done for the "multiplier" at the start of the '70s, what similar low-cost modules did for the "operational amplifier" in the mid-'60s.

A four-quadrant multiplier **is** required for true multiplication, bipolar squaring, mean square, autocorrelation, cross correlation, true product modulation and demodulation. It **is not** required for analog division, square rooting, gain control, amplitude modulation and gating.

If used when not really needed, the four-quadrant multiplier adds unnecessary cost and complexity. Its bandwidth is not always impressive, and in some systems its use produces undesired effects. One unwanted effect can occur in gain control circuits if one of the inputs reverses polarity. When this happens, four-quadrant operation can cause an undesired phase reversal. A two-quadrant multiplier would be incapable of such a phase reversal.

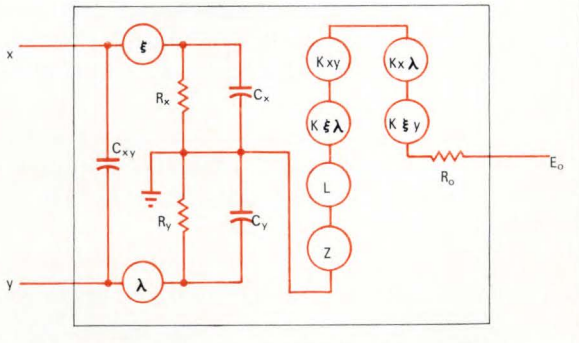
Accuracy of Multipliers

So far analog multipliers have been assumed to obey the simple equation, product $xy = x \cdot y$. We assumed this to be true for each of the quadrants in which the various multipliers were able to operate.

In real-world multipliers, various scaling factors and sources of error require use of a more complex equation to describe static accuracy,

$$e_o = K(x + \xi)(y + \lambda) + L + Z,$$

where e_o is the actual output voltage, K is the scale factor, ξ and λ the input offset errors, L the linearity error and Z the output offset error. In terms of a multiplier circuit model, these errors could be shown thus:



GENERALIZED CIRCUIT MODEL FOR MULTIPLIER

(Continued)

Analog Multipliers (Cont'd)

Here, capacitances C_{xy}, and C_x and C_y, coupled with resistances R_x, R_y and R_o, model the frequency limitations and the input and output impedances. They would affect dynamic and loading errors, but not the static errors described by the equation.

The new terms in the equation help pinpoint the sources of static inaccuracy in multipliers of all types. They help the designer know which errors he can do something about and which he must live with.

The scale factor K does not pose a problem, for it can be taken care of in the usual overall scaling of the system.

By expanding the equation we can group the errors into separate terms:

$$e_o = \underbrace{Kxy}_{\text{Ideal}} + \underbrace{K\xi y + K\lambda x + L + Z}_{\text{Errors}}$$

Now our first term is the ideal one, and the rest are the five isolatable sources of error. Four of these—all except the linearity L—usually can be trimmed to zero. Lower-cost multipliers commonly provide enough access points to permit externally trimming these to zero. More expensive modules are factory trimmed, so can be used without tweaking.

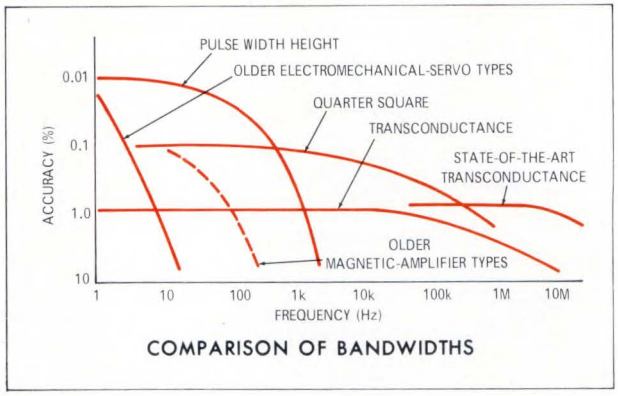
The linearity term, L, is very difficult to modify. It is a composite result of the design principle of the multiplier and the care with which it is made (for example, how precisely its internal transistors and diodes have been matched). Therefore, if linearity is important in a multiplier application, L becomes a key selection criterion.

For OEM applications, the lower-cost "untrimmed" types are often chosen. The user reasons that since he will be trimming other parts of the circuitry anyway, he should not pay the premium for a trimmed multiplier.

For one-shot requirements, there is often a toss-up between the lower purchase cost of an untrimmed module and the saving in set-up time with a pretrimmed module. Trimmed modules do offer obvious advantages to the user who lacks previous experience with these circuits.

For the designer who must think of the possibility of field repair, the pretrimmed modules are attractive, for they can be replaced on a simple pull-out-the-old, plug-in-the-new basis.

When selecting multipliers for wideband systems, the dynamic accuracy of multipliers can pose quite a problem. The following graph sums up the relative accuracy bandwidth tradeoffs for some of the types of multipliers we have been discussing.

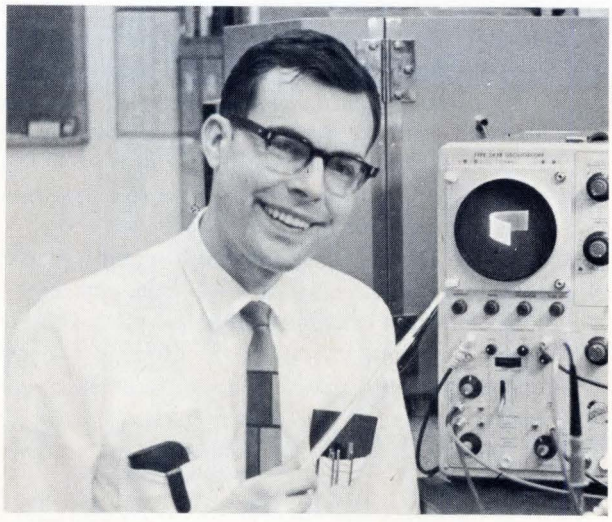


COMPARISON OF BANDWIDTHS

Use Multipliers Like Op Amps

Electronic systems have employed multiplication since the earliest days (modulation in communication systems is perhaps the best example of this). However, now that precision-performance, wideband analog multipliers are available at prices almost as low as op amps, every designer should take a new look at multiplication wherever it now exists, or could be used, in systems he is designing.

Just as the low-cost, wideband op amp has encouraged upgrading ordinary amplifiers into precision-gain amplifiers and active filters, so should the new multipliers encourage upgrading signal mixers into precision modulators and waveform manipulators. It is practical to buy a lot of system sophistication with these circuits. □



Rick Gerdes is what many engineers dream of being—president of his own 10-man company. He says his company is surviving in the present lean times because it concentrates on such multiplier-employing specialties as the 3-D plug-in display shown. He also says he has been surprised at the large number of theory-oriented graduate engineers who lack a feel for practical results.

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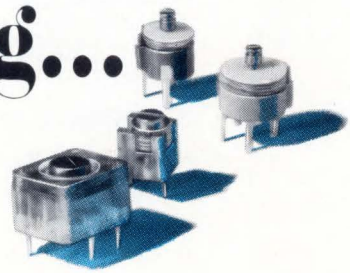
CIRCLE NO. 19

What made Amperex a leading supplier of trimmer capacitors... all of a sudden?

The addition of Film Dielectrics, for one thing...



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In addition to the film dielectrics, Amperex offers a complete line of tubular ceramic trimmers for UHF radio and TV and industrial applications.

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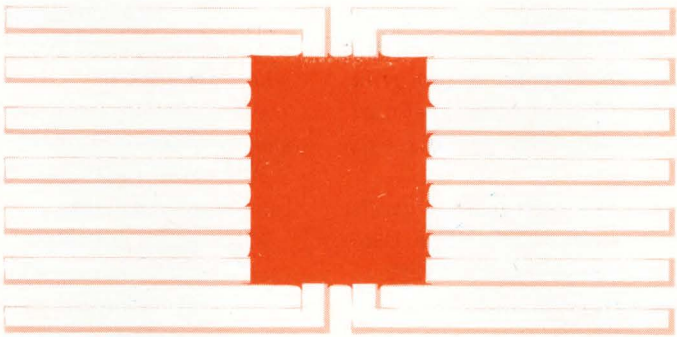
CIRCLE NO. 3

THE LATEST WORD IN LEAK DETECTION



Simple and reliable detection of leaks in hermetically sealed devices is made possible by a new fluorinated liquid and a halogen leak detector. The new method overcomes most of the shortcomings of standard leak-test procedures.

IRVING LITANT, NASA

Sensitive devices often are packaged in hermetically sealed containers to protect them from environmental contamination. Typical of electronic devices so packaged are transistors, integrated circuits and relays. After sealing, these containers must be tested to insure hermeticity.

Although many methods have been developed for the detection of leaks in hermetically sealed devices, only a few will quantitatively determine the rate at which the device as a whole is leaking. Fewer yet will pinpoint the location of the leak in the device to facilitate corrective action on the production line.

Leak sizes are empirically defined as either gross or fine. A gross leak passes 1×10^{-5} standard cc of air or more per second; a fine leak will pass between 1×10^{-5} and 1×10^{-8} standard cc per second.

Various methods are now used to test hermetically sealed enclosures, each dependent upon the size of the leaks being detected.[1,2]

Gross Leak Testing

One method now used for detecting gross leaks consists of immersing the device in a bath of fluid heated to 150°C and watching for bubbles of gas escaping from the heated can. This method is unreliable because it does not account for variables such as operator inattention, selection of test bath medium and number of devices tested at a given time. Recent military standards provide newer methods[3,4], three of which are worth mentioning.

In the first method, the device is evacuated, then pressure bombed up to 90 psi for 3 hours using a fluorocarbon liquid (FC-78) at 70°C. The device is then lowered into another fluorocarbon liquid (FC-75) at 125°C. A leak in the device is observed when bubbles appear.[3,4]

In the second method, the devices are held in a vacuum and then immersed under pressure in a bath of FC-75 fluorocarbon liquid. A change in weight of the

(Continued)

Leak Detection (Cont'd)

device indicates pickup of the fluorocarbon liquid through a leak.[5]

The third uses the standard helium leak detector, but is significantly modified by the use of a sample container having a controlled orifice. Covering the range from gross to fine leaks, its particular advantage is that it can reliably detect leaks that are intermediate between gross and fine.[6]

Fine Leak Testing

The two principal methods now in general use for detecting fine leaks involve pressurization with helium or radioactive Krypton 85. With helium, the devices are pressurized at three to five atmospheres for periods between 1 and 20 hours. Leaks then are detected by a modified mass spectrometer. The Krypton 85 procedure also requires "bombing" for an extended period of time, followed by detection of the radioactive gas by means of a scintillation counter.

By modification of procedures, each method can be used to detect gross leaks. However, with helium, there is such rapid loss of gas from a large leak that little remains to be detected, and the device might be passed as a good unit.

For gross leak testing with the Krypton 85, fluorocarbon liquid must be introduced into the device first. The gas dissolves in the fluorocarbon and then escapes slowly enough to be detected. Mineral oil can be used instead of fluorocarbon but the devices must be flushed with solvent after testing.

Shortcomings of Present Methods

Other procedures now under development show promise of fast, reliable leak detection over the entire range. Yet, in all of these methods, results are given only in terms of the presence or absence of a leak in the device as a whole. Although leak rate may be determined, the leak's whereabouts remains hidden.

There are several good reasons for knowing precisely where the leak is:

– If the sealing equipment is not sealing properly, one side or a corner of the cover may be open.

– If there is insufficient heat used in the sealer, there may be several leaks.

– If the leaks can be pinpointed, more meaningful corrective action can be taken.

If a leak is located in an expensive hybrid, relay or other large device, the device can be resealed.

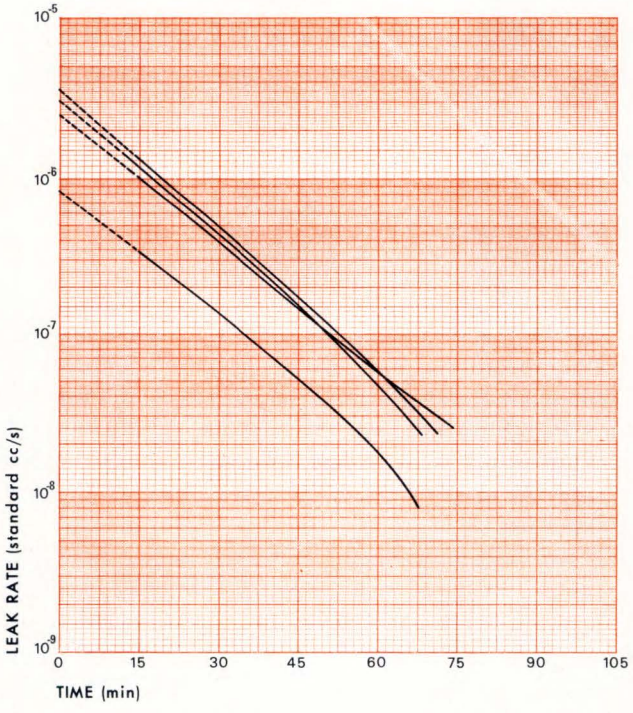


Fig. 1 – **Leak rates** for a 14-lead IC flat pack using "Freon 11". This package had six detectable leaks. Slow decay in leak rates, shown for four of the leaks, leaves plenty of time for testing.

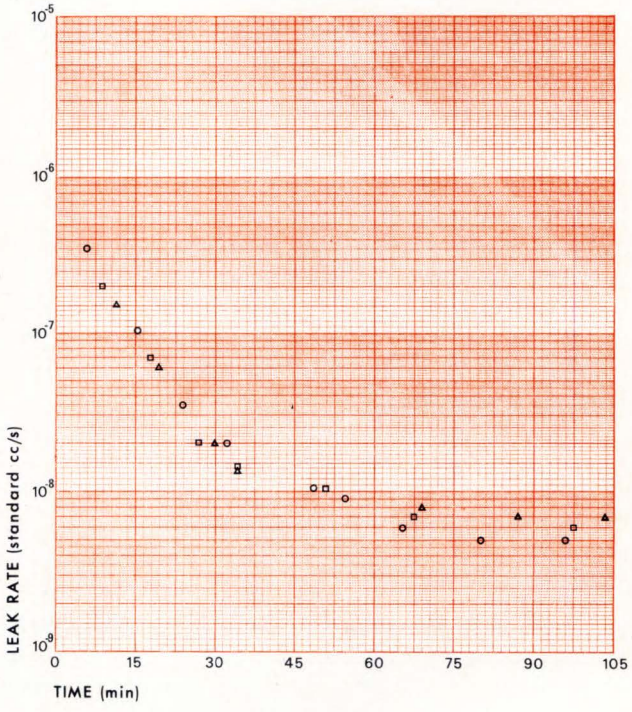


Fig. 2 – **Leak rates** for a 14-lead IC flat pack using "FC-88". Of the three leaks monitored, the largest was initially 3.5×10^{-7} cc/s. Again, decay in leak rates leaves adequate time for testing.

Halogen Leak Detector consists of a General Electric control unit with an H-5P proportioning probe. This instrument is calibrated using a GE Standard Leak, LS-20, calibrated for 1 to 1×10^{-7} standard cc/s. An internal pump in the control unit draws in air and any other gas in the vicinity of the probe head. When the air-gas mixture is drawn between a heated, positively charged platinum emitter within a cylindrical collector electrode, the detector responds to the presence of halogen vapor with an increase in interelectrode conductance proportional to the amount of halogen gas present. The resultant interelectrode ion current is amplified, causing the leak-indicator meter to go upscale and to sound an audible alarm. A 10-position sensitivity selector switch permits detection from 10^{-6} to 10^{-9} cc/s on two scales of 0-3 and 0-10 divisions as well as two low uncalibrated positions.

Located at the end of a hose ($\leq$1m), the probe is modified by attaching to it a sawed-off section of a large hypodermic needle. Tygon tubing links the probe and needle section.

New Method

A new procedure not only pinpoints leaks but also measures the leak rate at each point over a wide range (gross leak to approximately 1×10^{-9} cc/s).

Basically, this new method involves the introduction of a low-boiling fluorocarbon liquid into the sealed container through any leak, and the detection of the resultant vapor escaping from the leak by means of a halogen leak detector. The equipment and procedures required for this method are described at left and below.

Choosing the Liquid

Several criteria are important in selecting a halogen-containing fluid. First, a low boiling point makes the liquid easy to remove from the outside of the package. Such a liquid also vaporizes easily once it has entered the package. Second, low surface tension facilitates penetration into the smallest orifices. Third, chemical inertness makes it safe to allow liquid to remain inside a can after testing. Finally, the liquid must be neither toxic nor allergenic.

At the outset, the liquid that seemed to meet these criteria was trichlorofluoromethane (boiling point 23.8°C, surface tension 18.7 dynes/cm and toxicity very low). The only concern was potential hydrolysis upon contact with certain metals and the possibility of corrosion by hydrolysis products. In spite of this short-

(Continued)

Procedure for new halogen leak test requires four steps:

1. Vacuum Oven Heating. Heat the device (50-150°C) in a vacuum oven at a pressure of 10 Torr or less for approximately 1 hour. This will create a partial vacuum in the device in preparation for the next step, immersion. It is preferable to use the highest temperature that the device can tolerate.

2. Immersion in Liquid. Remove the device from the oven as soon as the vacuum has been broken, and immediately immerse it in FC-88 fluid which is held at 0 to 5°C. Cover the container to prevent condensation of water vapor and contamination by dust and leave the device in the liquid for at least 1 hour.

3. Blowing with Nitrogen. When the device is ready for test, remove it from the FC-88 and rotate it in a rapid stream of dry nitrogen for at least 30s. This will remove any adhering liquid that might contribute to a high background, and should be done in a hood so as not to contaminate the area.

4. Testing for Leaks. Having calibrated the detector as directed, determine the background by setting the detecting range at sequentially higher leak rate settings until the reading is stable. If the needle does not remain steady at least at 1×10^{-8}, environmental contamination is too high.

Because gross leaks are detected so easily, first scan the devices rapidly using the uncalibrated settings. (High halogen concentrations will desensitize the detector's hot emitter. This not only delays testing until the instrument recovers, but also shortens the life of the emitter.)

Select a higher range and move the probe around the sealed areas of the device, pausing only long enough at each pin, or at distances apart of approximately 5 mm to see if the instrument registers. With a 1-meter probe hose, response time is not more than 3s.

Leak Detection (Cont'd)

coming, the liquid was very useful in proving the feasibility of this procedure.

During the course of this work, the 3M Co. marketed a new, completely fluorinated liquid, FC-88 (boiling point 32°C and surface tension 13 dynes/cm), which was directed primarily toward cooling and thermal stabilization of packages and systems containing microcircuits. The liquid is so inert that it can remain in direct contact with electronic devices indefinitely. Further, the literature claims that FC-88 is "essentially nontoxic." It subsequently proved to be superior to the trichlorofluoromethane in producing stable and consistent readings.

Results Validate Method

As mentioned earlier, a major problem with some leak detection methods has been the rapid loss of detector gas from gross leakers, rendering some leaks undetectable by the time the device is inserted in the apparatus. In a series of experiments, devices with different leak rates were checked over a period of time to get an idea of the duration of detectable leaks. **Fig. 1** shows measurements made on a 0.22- by 0.22- by 0.05-in 14-lead flat-pack which was a gross leaker with six detectable leaks. In this case the fluid was Freon 11. The decay rates shown indicate that plenty of time is available for measurement. In **Fig. 2**, using FC-88, the largest initial leak was 3.5×10^{-7} cc/s, and it took over 15 min for the leaks to decay to an easily detectable 1×10^{-8} cc/s.

COMMON-SENSE RULES FOR RELIABLE LEAK TESTS

1. Set up the detector in a well-ventilated area, free from contamination by any halogen-containing vapors such as trichloroethylene, carbon tetrachloride, chloroform and Freons and Genetrons. Note also that pressure cans of many industrial cleaners and lubricants can leak significant amounts of halogen-containing propellant.
2. Tobacco smoke is a contaminant, so prohibit smoking in the area.
3. Filter the FC-88 fluid continuously to remove particles that might clog leaks.
4. For adequate stability, change the air filter in the detector periodically.

In another test, two identical 1- by 1-in ceramic 32-lead hybrid packages were examined both by this procedure and by the standard helium leak test. The first package gave no indication of leaks by either procedure. The other showed a gross leak by both methods. The halogen leak detector method was still indicating several leaks far greater than 1×10^{-5} cc/s 5-1/2 hours later. Moreover, the principal leak area was identified as a large opening at one corner of the device.

In summary, the advantages of this halogen leak detector procedure are:

– Precise leak areas are pinpointed.
– No pressurization is required.
– Quantitative leak rates are measurable both for a total system or for each one of multiple leaks.
– The detector is relatively inexpensive and easy to use.
– Detection is specific for halogen compounds (and tobacco smoke).
– There is plenty of time for detection of gross leaks.
– There is no restriction as to the size of the hermetically sealed device that can be tested. □

Acknowledgment

A. J. Scapicchio made most of the measurements using the Halogen Leak Detector, and **R. H. Coleman** very kindly made the corroborating tests on the Helium Leak Tester.

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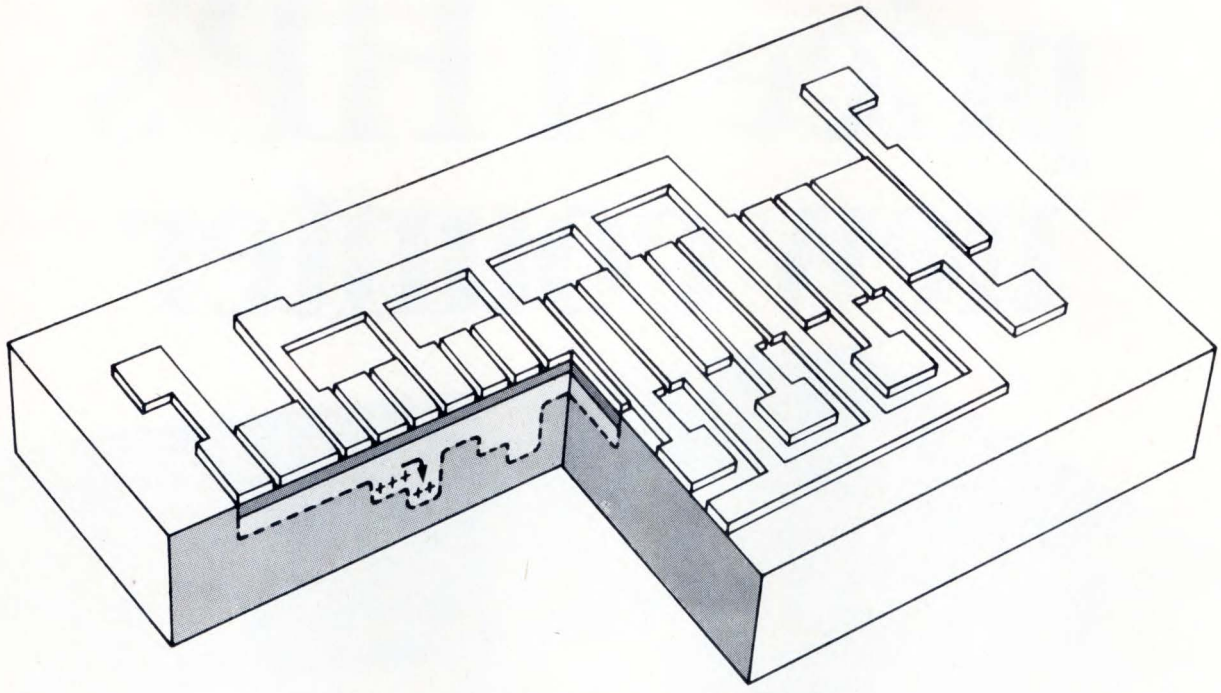
5. P. Nelson and A. Dermarderosian, Raytheon Co., Space and Information Systems Div., Waltham, Mass.
6. T. L. Altschuler, NASA/ERC, ERC Patent Case No. 10150, Tech Brief 68-10562 "Reliable Method for Testing Gross Leaks in Semiconductor Component Packages".

Irving Litant, author, developed the halogen leak detector procedure while a senior scientist with NASA's Electronics Research Center, Cambridge, Mass. New procedure overcomes most disadvantages of older tests, yields information about both size and location of leaks in hermetic devices.



Functional device without junctions

A junctionless semiconductor device that performs complete circuit functions has been invented by Bell Labs scientists Willard Boyle and George Smith. It may replace complex integrated circuits for information storage and other processing.

The new device consists of a layer of semiconductor (silicon) covered by a layer of insulation (silicon dioxide), with a row of closely spaced metal plates on top of the insulation. It operates much like an array of capacitors passing a stored charge—representing a binary information bit—from one capacitor to the next.

If all plates are held at a small negative voltage, the charge (holes) will remain stationary . . . stored in so-called "potential wells" below the plates. If, now, a stronger negative pulse is applied to a plate adjacent to one under which charge is stored, the charge will "spill over" into the deeper potential well thus produced (figure). So, charges can be shifted, plate by plate, along the surface of the semiconductor.

One use is as a shift register. Holes may be created at one end, moved along the semiconductor surface, and detected (read out) at the other end. Charge can be detected through the capacitance change it causes when present under a plate. The basic shift register may be used as part of a recirculating memory or as a delay line.

The new device can also convert images to electrical signals. By projection through a narrow slit, one horizontal strip of the image is focused on the semiconductor. Beneath each plate, this produces charge proportional to brightness. The shifted-out charge stream is an analog of that strip. Successive strips compose a complete image.

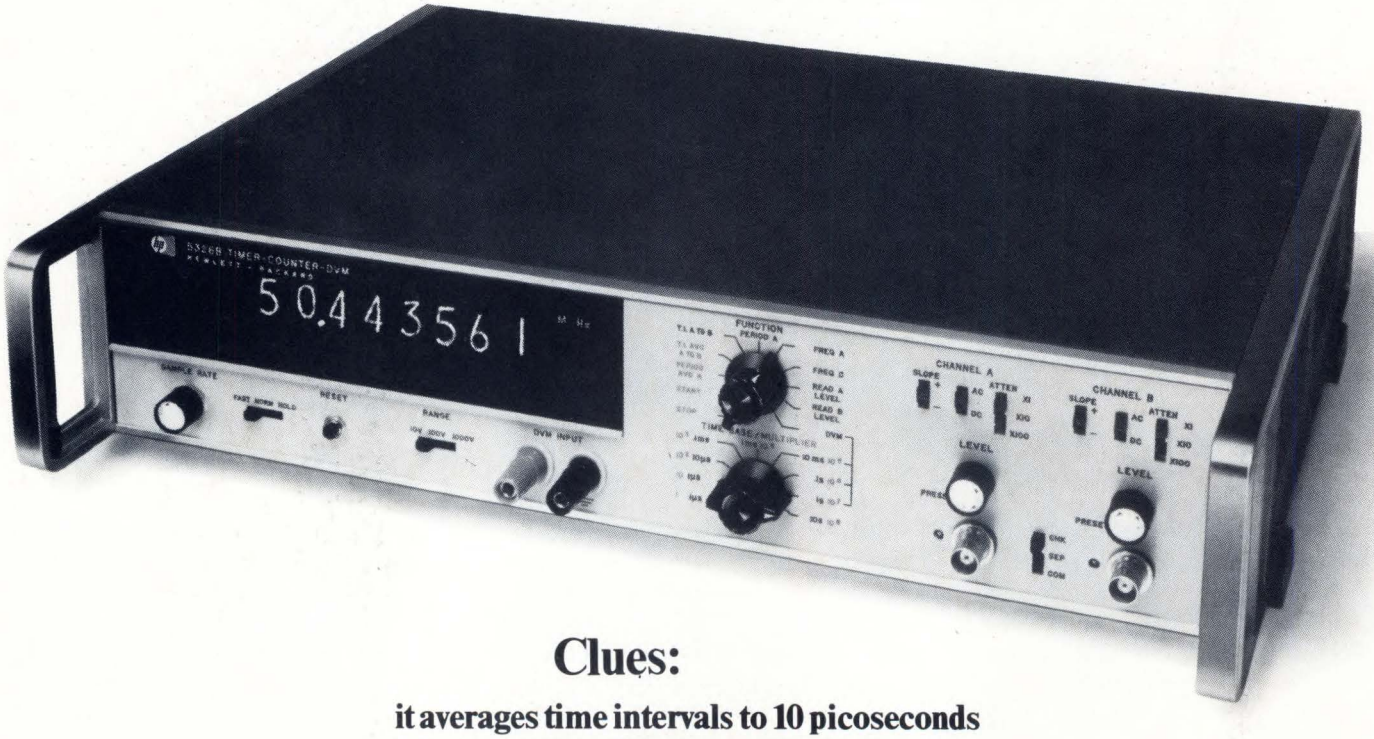
The first device was made of silicon. But since junctions are not needed, devices can be made from many semiconductors.

The device is so new that we haven't explored all possible applications. But its simplicity promises high reliability. And the comparatively few steps required to make it will keep costs low. We expect it to have considerable impact on telephony and on other high-volume information systems.

From the Research and Development Unit of the Bell System:

Bell Labs

Guess the price of HP's new counter



Clues:

it averages time intervals to 10 picoseconds
it has a built-in 0.05% integrating DVM
it's dc to 50 MHz, CW or burst
its counter and DVM are easily programmable

Surprise: $1550. That modest amount buys a Hewlett-Packard timer/counter that does things universal counters never did before. For example, it averages time intervals as short as 0.15 nanoseconds. So you can resolve to 10 picoseconds on repetitive signals.

That modest sum also buys a counter with a built-in integrating digital voltmeter. So it's the only counter that can measure internal trigger level settings or other inputs with DVM precision. Now you can measure 10 to 90% rise times, half power points and other voltage-dependent time intervals. That means unprecedented simplicity, for example, in propagation delay measurements. The counter also features four integration times. As a DVM, it provides three voltage ranges, 60 dB noise rejection and 0.05% accuracy.

Even without these exclusive features, the 5326's are real bargains. They count to 50 MHz direct with seven-digit resolution (eight digits optional), measure period and multiple period average and scale input frequencies by any power of 10 up to 10^8. They measure ratio and they totalize.

With programming and BCD output options, the 5326's fit easily into systems applications. Counter and DVM are DTL programmable through a common connector.

You can get all of these benefits in the 5326B for $1550, or buy the same counter, less the DVM, in the 5326A for $1195. Any way you look at the 5326 A or B—either is a great counter value. Your local field engineer has all the facts about HP's new IC counter line. Give him a call or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

ELECTRONIC COUNTERS

CIRCLE NO. 41

02003

DC MOTOR CONTROL

IS EASY WITH TRANSISTORS

Uncomplicated transistor circuits can provide most dc motor control functions such as starting, stopping, protection and speed control—and do it simply and reliably.

FRED W. KEAR, Sparton Southwest, Inc.

Increased use of small dc motors in industrial control and military electronics has spurred the demand for reliable solid-state control circuits. These uses include timing, control, programming, data recording and a host of other applications in which close control of motor power affects accuracy and efficiency of the device.

A great number of circuits can be used for controlling dc motors with transistors. Transistors are attractive not only because they are very accurate, dependable, and provide fast response for dc motor control, but also because only a relatively small signal is needed to control larger amounts of power.

"Start" and "stop" are the most common control requirements for dc motors. The circuit in **Fig. 1** is especially useful when it is necessary to remove motor power by switch closure, or for some remote applications where power cannot be interrupted directly by a switch.

When constant motor speed with varying loads is required, the circuit in **Fig. 2** will do the trick. It provides an amplified response for any motor torque load, thus

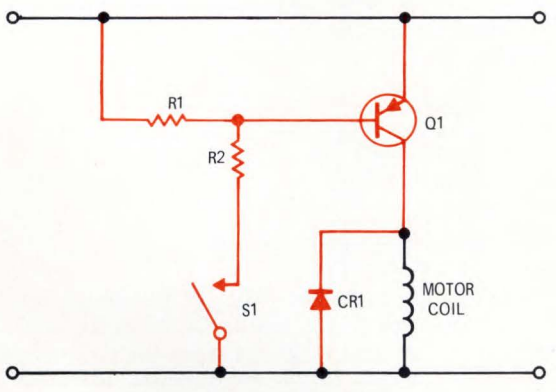


Fig. 1—**Motor starting and stopping.** When S1 is closed, base bias resistors R1 and R2 forward bias Q1, applying power to the motor. CR1 protects Q1 by removing reverse voltage spikes. When S1 is open, R1 reverse biases Q1, thus removing power from the motor.

(Continued)

Motor Control (Cont'd)

furnishing load compensating current to the motor.

Some applications are sensitive to excess current caused by overloaded dc motors. For such a case, the circuit in **Fig. 3** quickly shuts down motor power and must be reset manually or by a separate time delay device.

Other applications can't stand motor overspeed, especially during startup. An inertial governor in addition to the circuit in **Fig. 4** handles this situation with ease.

One last application, **Fig. 5**, is useful for determining motor speed and for providing signals to a motor speed control. A more common method for doing this is to use a segmented commutator and UJT trigger circuit. □

Fred W. Kear, besides being Chief Production Engineer at Sparton Southwest, has authored more than 50 engineering papers, three published in EDN, and has written a book on printed circuit manufacturing.

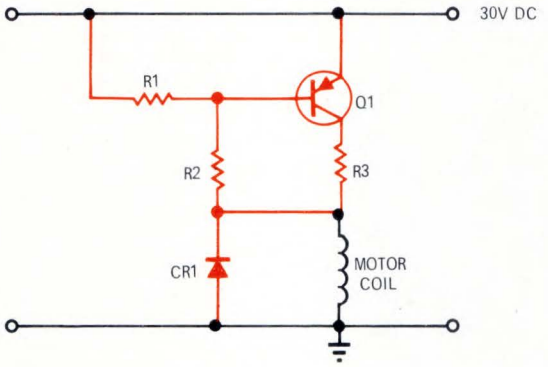


Fig. 2—**Motor constant speed maintenance.** Q1, again in series with the motor, controls power to it. R3 is of low enough value to provide a small voltage drop when increased torque loads increase motor current. R1 and R2 are high values to provide forward bias to Q1, maintaining motor speed under normal conditions. CR1 protects Q1 as in **Fig. 1**. When motor torque load increases, the motor slows down and draws more current. The increased current will further forward bias Q1 through R1 and R3, thus providing more current to the motor to compensate for the overload.

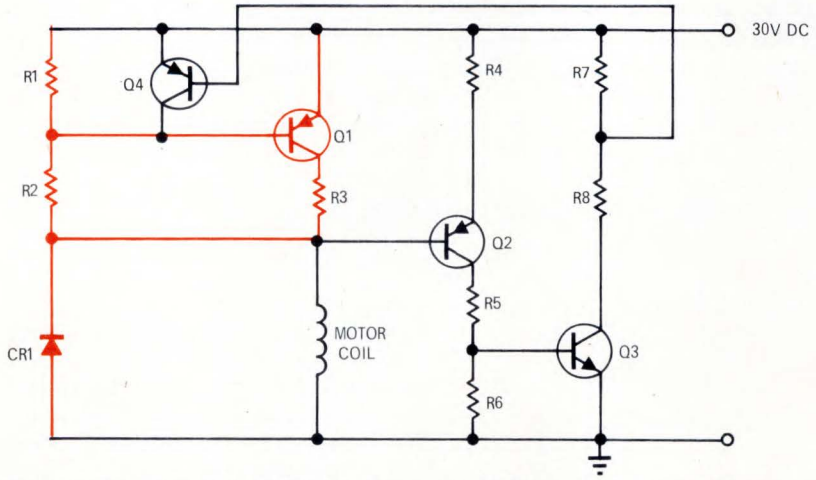


Fig. 3—**Excess motor load protection.** Q1, CR1, R1, R2, R3 control the motor in a manner similar to **Fig. 2**. Equipment protection is provided by the remainder of the circuit. R4 provides just enough emitter bias to Q2 so that it becomes forward biased when any value of motor current exceeds a preselected nominal value. The increased current from Q2 through R5 and R6 turns Q3 on, thereby dropping the voltage at R7-R8 junction and forward biasing Q4. When Q4 turns on, it clamps the base of Q1 to the positive bus, thus shutting it off and cutting motor power. The motor can only be restarted by shorting the + motor lead to +30V bus, grounding the base of Q3, or shorting Q4 base to +30V bus.

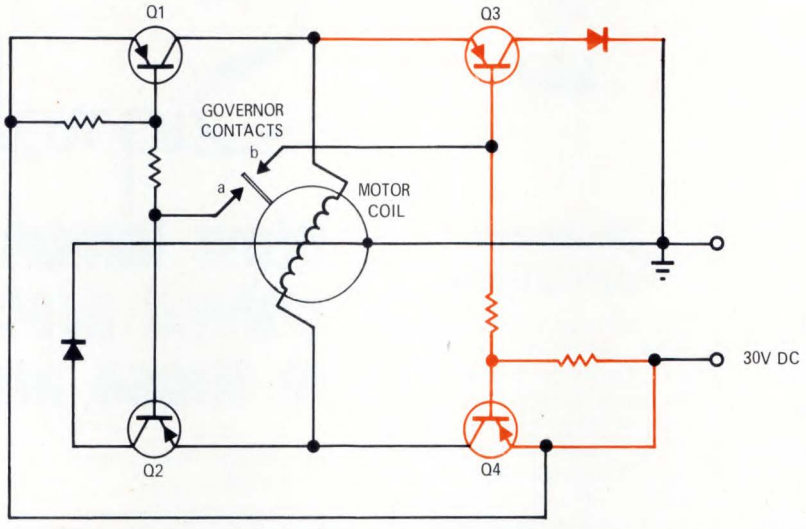


Fig. 4—**Overspeed protection.** There is a tendency for any motor to overshoot its control speed, especially on startup. Contact **a** is normally closed causing Q1 and Q2 to conduct and drive the motor in a forward direction. If the motor overspeeds, the inertial governor opens contact **a** and closes contact **b**. Q3 and Q4 then conduct, applying reverse motor current to catch motor overshoot quickly.

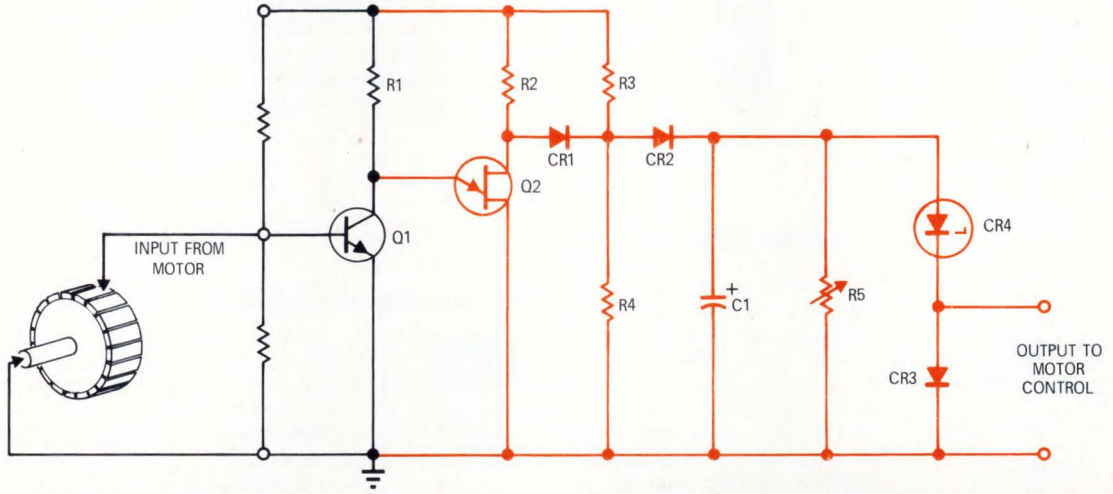


Fig. 5—**Motor speed sensing.** The segmented commutator provides pulse signals in digital form to the UJT circuit in direct proportion to motor speed. The UJT circuit converts this to an analog signal for motor speed control. Commutator output, amplified by Q1, triggers (UJT) Q2 which provides constant amplitude pulses to charging network C1, R5, CR3, CR4. Commutator pulses charging C1 are constantly bled off at a rate set by R5, thus setting motor speed. When pulse rate (motor speed) exceeds the discharge rate through R5, CR4 conducts, providing a feedback signal to a separate motor speed control. (An additional integrating circuit between Q1 and Q2 will assure constant width commutator pulses to the UJT, and constant amplitude and constant width pulses from it to the charging circuit.)

FOR A FREE REPRINT OF THIS ARTICLE, **CIRCLE NO. L63**

circuit problems?

ultra-high leakage resistance

Devices with leakage resistance in excess of 10^{12} ohms are available for circuits requiring this property. Such applications would include sample and hold for A to D conversion, and capacitor memory systems. See Signalite Application News for typical applications.

voltage regulators better than 1% accuracy

These subminiature voltage regulators are used in regulated power supplies, as reference sources, photomultiplier regulators, oscilloscopes, calibrators, etc. They are available in voltages from 82 to 143 V. They are used in multiples as regulators in KV ranges. See Signalite Application News for typical applications.

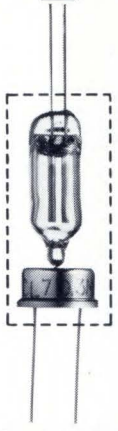


photo-cell applications

The A074 and A083 have been designed for use with Cadmium Sulfide or Cadmium Selenide photocells. Applications include photo choppers, modulators, demodulators, low noise switching devices, isolated overload protector circuits, etc. Speed of operation is limited only by the photo-cells. See Signalite Application News for typical applications.

neon timers

The bi-stable characteristics and high leakage resistance of Signalite's special glow lamps make them ideal as a component for timing circuits. The basic circuit resembles a relaxation oscillator network. See Signalite Application News for typical applications.

Signalite

glow lamps have solved problems in these areas:

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- SCR Triggering
- Timing
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SIGNALITE APPLICATION NEWS — CIRCLE NO. 45

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CIRCLE NO. 46

319

Domed Light Link Isolates Circuits

Light beams replace relay contacts in this optical signal coupler that achieves efficient light transmission with a low-cost plastic cover.

JEFFREY L. MONROY, Dana Labs. Inc.

Electrical isolation is a persistent problem, especially at such places as the interface between instrument guard circuitry and outside circuits. Until recently, when isolation was critical in a signal transmission system, the best a designer could do was to employ a well-guarded reed relay —but even the best of these have limited mechanical life and offer relatively slow operation.

When matched pairs of light-emitting diodes (LEDs) and phototransistors first appeared, interfacing with a light beam instead of an electromechanical device became enormously appealing. The task was to devise an effective method of conducting the light beam from the LED to the phototransistor—one that was economical and would give good isolation. Additionally, the phototransistor needed shielding from ambient light.

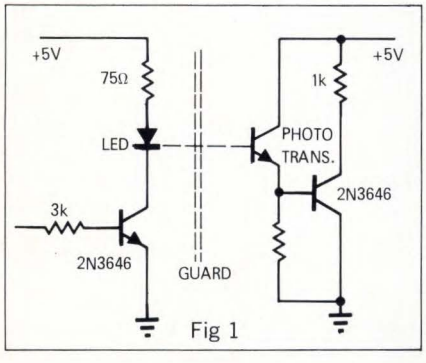


Fig 1

The circuit in **Fig. 1** shows one implementation of this idea. In this Series 7400 TTL-compatible circuit, the LED and the phototransistor mount in an upright position on a printed circuit board. Electrical isolation is improved by adding a guard strap between the two ground systems on both sides of the PCB.

To insure efficient light transmission, a half-ellipsoid cover snaps in place over the LED and the phototransistor. This cover is designed so that the LED is at one focus of the ellipse and the phototransistor is at the other. By definition of an ellipse, then, any ray generated at one focus will be reflected through the other focus (**Fig. 2**), resulting in maximum transmission.

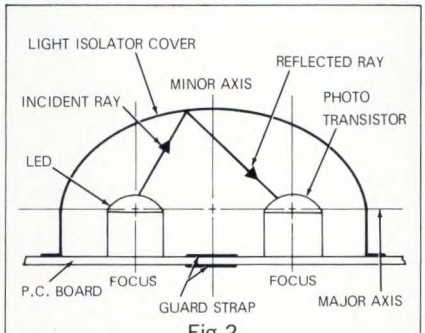
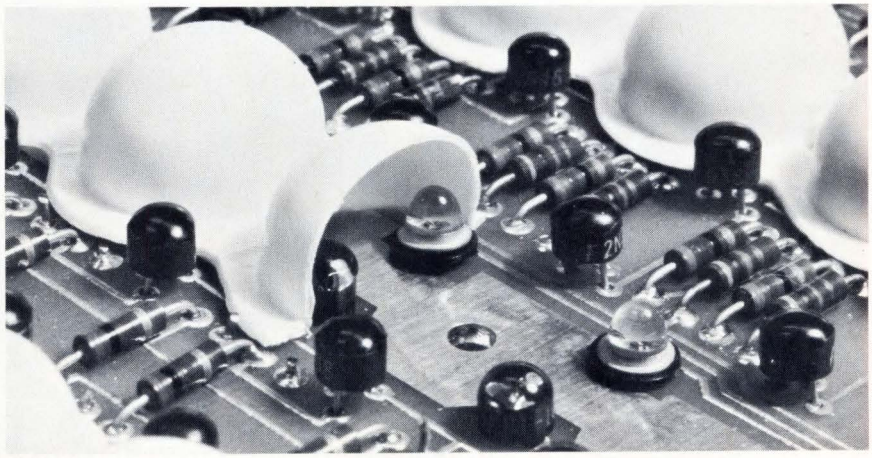


Fig 2

Vacuum-formed polystyrene molding techniques (such as those used to emboss letters on sheet plastic signs) provide a quick and easy method of forming large numbers of the half-ellipsoid covers.

Simple, inexpensive and long-lived, this low-cost system of optical coupling achieves 0.08 pF isolation and a signal risetime <10 μs. □

Jeffrey L. Monroy has been a senior designer with Dana Labs., Inc. for the last 4 years. With his A.A. degree from Santa Ana College, he specializes in packaging design for electronic test instruments.



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MSI/TTL CIRCUITS:

DECODERS

SN54/7442 BCD-to-Decimal Decoder*
SN54/7443 Excess-3-to-Decimal Decoder*
SN54/7444 Excess-3-Gray-to-Decimal Decoder*
SN54/7445 BCD-to-Decimal Decoder/Driver*
SN54/7446 BCD-to-7-Segment Decoder/Driver*(30V)
SN54/7447 BCD-to-7-Segment Decoder/Driver*(15V)
SN54/7448 BCD-to-7-Segment Decoder*
SN54/7449 BCD-to-7-Segment Decoder*
■ SN54/74141 BCD-to-Decimal Decoder/Driver*
SN54/74145 BCD-to-Decimal Decoder/Driver*
SN54/74154 4-to-16-Line Decoder/Demultiplexer*
■ SN54/74155 Dual 2-to-4-Line Decoder/Demultiplexer
■ SN54/74156 Dual 2-to-4-Line Decoder/Demultiplexer (O-C)

MEMORIES/LATCHES

SN54/7475 Quad Bistable Latch*
SN54/7477 Quad Bistable Latch*
SN54/7481 16-Bit RAM*
SN54/7484 16-Bit RAM, Gated Write Inputs*
■ SN54/7488 256-Bit ROM, Custom Programmed*
SN7489 64-Bit RAM*
SN54/74100 Dual Quad Bistable Latch
■ SN54/74170 4-by-4 Register File (Buffer Memory)

ARITHMETIC ELEMENTS

SN54/7480 Gated Full Adder*
SN54/7482 2-Bit Binary Full Adder*
SN54/7483 4-Bit Binary Full Adder*
■ SN54/7485 4-Bit Magnitude Comparator
■ SN54/74L85 4-Bit Magnitude Comparator*
SN54/7486 Quad 2-Input Exclusive-OR*
SN54/74L86 Quad 2-Input Exclusive-OR*
SN54/74H87 4-Bit True/Complement*
■ SN54/74181 4-Bit Arithmetic Logic Unit, Function Generator*
■ SN54/74182 Look-Ahead for Arithmetic Logic Unit*
■ SN54/74H183 Dual Carry-Save Full Adder

SHIFT REGISTERS

SN54/7491A 8-Bit*
SN54/74L91 8-Bit
SN54/7494 4-Bit (Parallel-In, Serial-Out)*
SN54/7495 4-Bit Universal*
SN54/74L95 4-Bit Universal*
SN54/7496 5-Bit (Dual Parallel-In/Out)*
SN54/74L98 4-Bit Data Selector/Storage Register
SN54/74L99 4-Bit Universal
■ SN54/74164 8-Bit Serial-In, Parallel-Out*
■ SN54/74165 8-Bit Parallel-In, Serial-Out*
■ SN54/74166 Synchronous Parallel-Load 8-Bit
■ SN54/74198 Universal 8-Bit Parallel-In/Out, Left/Right
■ SN54/74199 8-Bit Parallel-In/Out, J-K Inputs

DATA SELECTORS/MULTIPLEXERS

SN54/74150 16-Bit Data Selector*
SN54/74151 8-Bit Data Selector*
SN54/74152 8-Bit Data Selector
SN54/74153 Dual 4-to-1-Line Data Sel./Multiplexer*

COUNTERS

SN54/7490 Decade*
SN54/74L90 Decade
SN54/7492 Divide-by-12*
SN54/7493 4-Bit Binary*
SN54/74L93 4-Bit Binary*
■ SN54/74160 Synchronous 4-Bit Decade*
■ SN54/74161 Synchronous 4-Bit Binary*
■ SN54/74162 Fully Synchronous 4-Bit Decade
■ SN54/74163 Fully Synchronous 4-Bit Binary
■ SN54/74190 Synchronous 4-Bit Up/Down Decade, 1-Line Mode Control*
■ SN54/74191 Synchronous 4-Bit Up/Down Binary, 1-Line Mode Control*
■ SN54/74192 Synchronous 4-Bit Up/Down Decade*
■ SN54/74193 Synchronous 4-Bit Up/Down Binary*
■ SN54/74196 Asynchronous Presettable Decade*
■ SN54/74197 Asynchronous Presettable Binary*

PARITY GENERATOR

SN54/74180 8-Bit Parity Generator/Checker

■ New circuit introduced 1970 ★Multi-source product

SCHOTTKY-CLAMPED TTL CIRCUITS:

These represent the latest development in TTL integrated circuits. A totally new technology, TI's Schottky-clamped TTL circuits combine the high speed of unsaturated logic and the low power of TTL saturated logic: 3 ns at 20 mW. Here's a brand-new list of recently announced devices. For more information on this fastest TTL family, circle 191 on the Reader Service Card.

■ SN74S00 Quad 2-Input Positive NAND Gate
■ SN74S03 Quad 2-Input NAND Gate, Open-Collector Output
■ SN74S04 Hex Inverter
■ SN74S10 Triple 3-Input NAND Gate
■ SN74S11 Triple 3-Input AND Gate
■ SN74S15 Triple 3-Input AND Gate, Open-Collector Output
■ SN74S20 Dual 4-Input Positive NAND Gate
■ SN74S22 Dual 4-Input NAND Gate, Open-Collector Output
■ SN74S40 Dual 4-Input NAND Buffer
■ SN74S64 4-2-2-3-Input AND-OR-INVERT Gate
■ SN74S65 4-2-2-3-Input AND-OR-INVERT Gate, Open-Collector Output
■ SN74S112 Dual J-K Negative-Edge Triggered Flip-Flop, Separate Preset, Clear and Clock
■ SN74S140 Dual 4-Input NAND Line Driver

SSI/TTL CIRCUITS:

STANDARD SSI CIRCUITS

SN54/7400 Quad 2-Input NAND Gate*
SN54/7401 Quad 2-Input NAND Gate, Open-Collector Output*
SN54/7402 Quad 2-Input NOR Gate*
SN54/7403 Quad 2-Input NAND Gate, Open-Collector Output*
SN54/7404 Hex Inverter*
SN54/7405 Hex Inverter, Open-Collector Output*
■ SN54/7406 Hex Inverter Buffer/Driver, Open-Collector High-Voltage Output
■ SN54/7407 Hex Buffer/Driver, Open-Collector High-Voltage Output
■ SN54/7408 Quad 2-Input Positive AND Gate*
■ SN54/7409 Quad 2-Input Positive AND Gate*
SN54/7410 Triple 3-Input NAND Gate*
■ SN54/7412 Triple 3-Input NAND Gate, Open-Collector Output
■ SN54/7413 Dual 4-Input NAND Schmitt Trigger*
■ SN54/7416 Hex Inverter Buffer/Driver, Open-Collector High-Voltage Output
■ SN54/7417 Hex Buffer/Driver, Open-Collector High-Voltage Output
■ SN54/7420 Dual 4-Input NAND Gate*
■ SN54/7423 Expandable Dual 4-Input Positive NOR Gate with Enable
■ SN54/7425 Dual 4-Input Positive NOR Gate with Enable*
■ SN54/7426 Quad 2-Input High-Voltage Interface NAND Gate*
■ SN54/7427 Triple 3-Input NOR Gate*
SN54/7430 8-Input NAND Gate*
■ SN54/7432 Quad 2-Input OR Gate*
■ SN54/7437 Quad 2-Input NAND Buffer*
■ SN54/7438 Quad 2-Input NAND Buffer with Open-Collector Output
SN54/7440 Dual 4-Input NAND Buffer*
SN54/7450 Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate*
SN54/7451 Dual 2-Wide 2-Input AND-OR-INVERT Gate*
SN54/7453 Expandable 4-Wide 2-Input AND-OR-INVERT Gate*
SN54/7454 4-Wide 2-Input AND-OR-INVERT Gate*
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SN54/7472 J-K Master-Slave Flip-Flop*
SN54/7473 Dual J-K Master-Slave Flip-Flop*
SN54/7474 Dual D-Type Edge-Triggered Flip-Flop*
SN54/7476 Dual J-K Master-Slave Flip-Flop, Preset and Clear*
SN54/74104 Gated J-K Master-Slave Flip-Flop*
SN54/74105 Gated J-K Master-Slave Flip-Flop*
SN54/74107 Dual J-K Master-Slave Flip-Flop, Preset and Clear*
■ SN54/74110 Gated J-K Master-Slave Flip-Flop, Data Lockout
■ SN54/74111 Dual J-K Master-Slave Flip-Flop, Data Lockout
SN54/74121 Monostable Multivibrator*
■ SN54/74122 Retriggerable Resettable Monostable Multivibrator*
■ SN54/74123 Dual Retriggerable Resettable One-Shot*

HIGH-SPEED SSI CIRCUITS

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SN54/74H01 Quad 2-Input NAND Gate, Open-Collector Output*
SN54/74H04 Hex Inverter*
SN54/74H05 Hex Inverter, Open-Collector Output*
SN54/74H10 Triple 3-Input NAND Gate*
SN54/74H11 Triple 3-Input AND Gate*
SN54/74H20 Dual 4-Input NAND Gate*
SN54/74H21 Dual 4-Input AND Gate*
SN54/74H22 Dual 4-Input NAND Gate, Open-Collector Output*
SN54/74H30 8-Input NAND Gate*
SN54/74H40 Dual 4-Input NAND Buffer*
SN54/74H50 Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate*
SN54/74H51 Dual 2-Wide 2-Input AND-OR-INVERT Gate*
SN54/74H52 Expandable 4-Wide 2-2-2-3-Input AND-OR Gate*
SN54/74H53 Expandable 4-Wide 2-2-2-3-Input AND-OR-INVERT Gate*
SN54/74H54 4-Wide 2-2-2-3-Input AND-OR-INVERT Gate*
SN54/74H55 Expandable 2-Wide 4-Input AND-OR-INVERT Gate*
SN54/74H60 Dual 4-Input Expander*
SN54/74H61 Triple 3-Input Expander*
SN54/74H62 4-Wide 3-2-2-3-Input AND-OR Expander*
SN54/74H71 J-K Flip-Flop with AND-OR Input*
SN54/74H72 J-K Master-Slave Flip-Flop*
SN54/74H73 Dual J-K Flip-Flop, Separate Clock*
SN54/74H74 Dual D-Type Edge-Triggered Flip-Flop*
SN54/74H76 Dual J-K Flip-Flop, Preset and Clear Inputs*
SN54/74H78 Dual J-K Flip-Flop, Preset and Clear Inputs*
SN54/74H101 J-K Flip-Flop, AND-OR Inputs
SN54/74H102 J-K Flip-Flop, AND Inputs
SN54/74H103 Dual J-K Flip-Flop, Separate Clock Inputs
SN54/74H106 Dual J-K Flip-Flop, Preset and Clear Inputs
SN54/74H108 Dual J-K Flip-Flop, Preset and Clear Inputs

LOW-POWER SSI CIRCUITS

SN54/74L00 Quad 2-Input NAND Gate*
■ SN54/74L01 Quad 2-Input NAND Gate, Open-Collector Output
■ SN54/74L02 Quad 2-Input NOR Gate
■ SN54/74L03 Quad 2-Input NAND Gate, Open-Collector Output
SN54/74L04 Hex Inverter*
SN54/74L10 Triple 3-Input NAND Gate*
SN54/74L20 Dual 4-Input NAND Gate*
SN54/74L30 Single 8-Input NAND Gate*
SN54/74L51 Dual 2-Wide 2-Input/2-Wide 3-Input AND-OR-INVERT Gate*
SN54/74L54 2-2-3-3-Input AND-OR-INVERT Gate*
SN54/74L55 2-Wide 4-Input AND-OR-INVERT Gate*
SN54/74L71 R-S Master-Slave Flip-Flop*
SN54/74L72 J-K Master-Slave Flip-Flop*
SN54/74L73 Dual J-K Master-Slave Flip-Flop*
SN54/74L74 Dual D-Type Edge-Triggered Flip-Flop*
SN54/74L78 Dual J-K Master-Slave Flip-Flop, Common Clear and Clock*

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MSI choice and complexity. Begin with the opposite page. Here, to help you reduce package count, simplify designs and improve performance, is an unmatched array of catalog MSI functions. The line has just about doubled in the past nine months and there are still more to come of ever-increasing complexity.

SSI back-up in depth. But in using TTL/MSI, you need the substantial back-up of versatile SSI circuits. Check the opposite page again.

Four speed/power choices. Within TI's big TTL family, you have a selection of four speed/power ranges to help optimize your designs. There are 1 mW per gate low power circuits, standard- and high-speed circuits *plus* the revolutionary new Schottky-clamped TTL functions which attain speeds of 3 ns at 20 mW.

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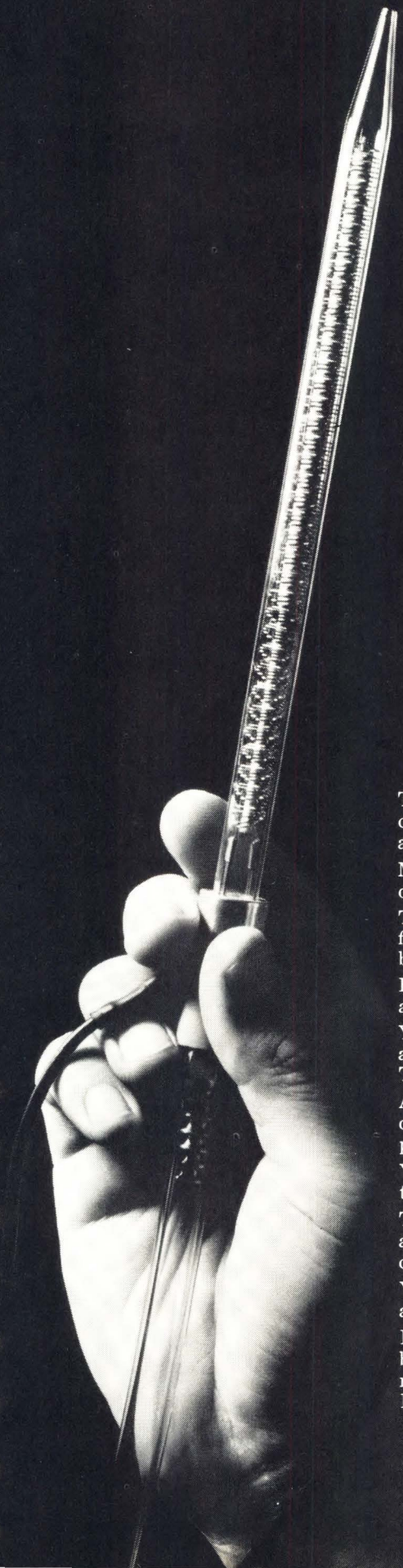

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Taming Tantalum Capacitors

It is generally known that solid electrolyte tantalum capacitors exhibit a phenomenon referred to as scintillation. The effect, however, can be minimized with proper circuit design precautions.

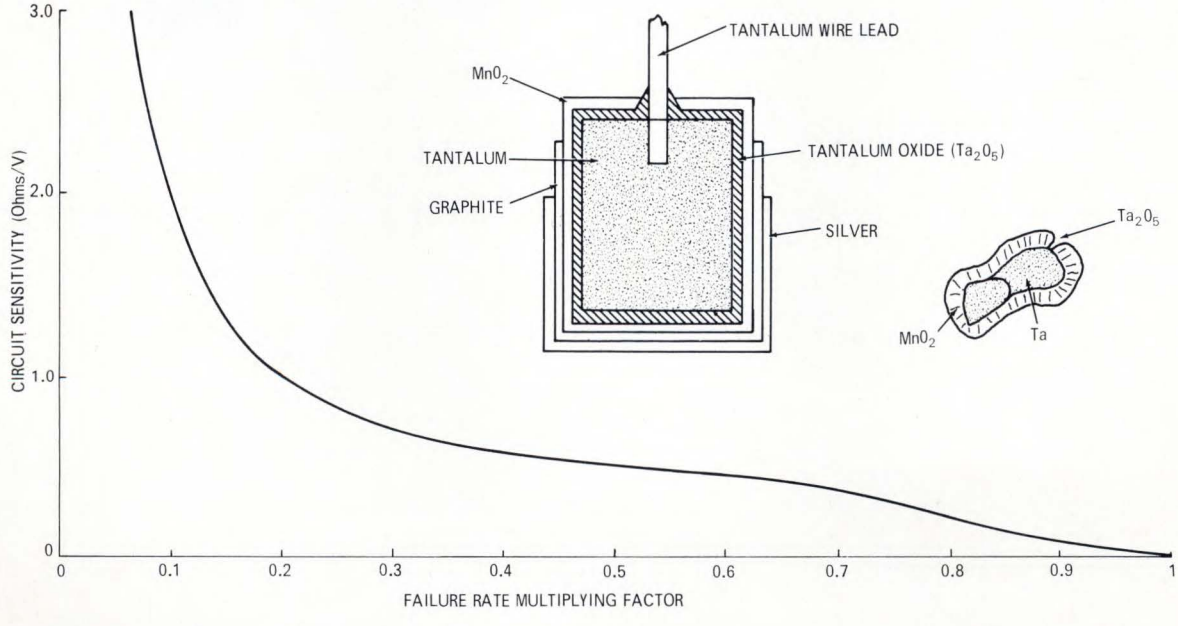
G. SEVERINO, Motorola, Inc.

Catastrophic failures of solid electrolyte tantalum capacitors can be reduced effectively by designs that provide adequate series resistance. These capacitors have a tendency to self-heal under proper circuit conditions, but heat caused by heavy inrush currents can destroy them.

The two most frequent complaints about solid electrolyte tantalums are an increase in dc leakage current and short circuits. Both tendencies are usually caused by dielectric fractures resulting from the thin spots in the Ta_2O_5 film. These thin spots are caused by impurities in the tantalum powder that resist oxide formation, yielding an oxide film which is effectively thinner than that of purer tantalum. These thinner areas rupture under voltage or temperature stress, allowing a localized current inrush and clearing called a scintillation. As a result of the scintillation the leakage current may increase, decrease, or show no change from its original value. This action can also result in a catastrophic (short) failure.

During current inrush, heat is generated in the immediate damaged area, liberating oxygen from the manganese dioxide (MnO_2). Simultaneously, two reactions serve to heal

(Continued)



Failure rate as a function of circuit sensitivity is series resistance in ohms/applied volt across a solid electrolyte tantalum capacitor. The failure rate multiplying factor is to be applied against the accompanying failure rate chart.

Typical construction (inset) shows a cross-section of a porous anode of compacted tantalum powder and solid tantalum wire lead. These have been sintered in a vacuum at high temperature. The resultant slugs possess a large surface area because they are highly porous. The dielectric, a thin layer of tantalum oxide, Ta_2O_5, is formed by anodizing the tantalum metal. The manganese dioxide (MnO_2) cathode is then formed by saturating the slug with an aqueous solution of manganous nitrate which is then decomposed by pyrolysis. Contact to the cathode is made through a layer of graphite and an outer silver coating.

Tantalum Capacitors (Cont'd)

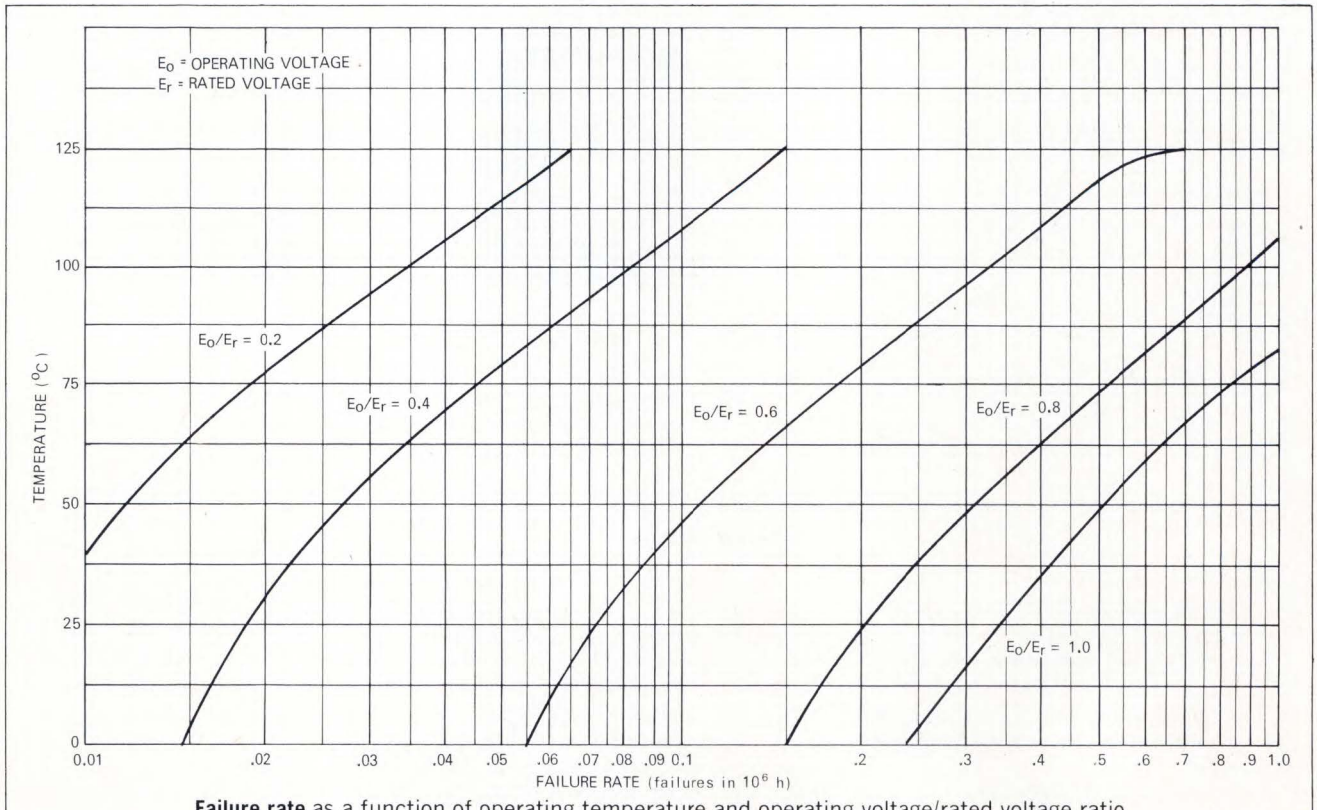
the breach. First, the freed oxygen combines with the exposed metallic tantalum core material to reform the insulating Ta_2O_5 film. Second, the formerly conductive MnO_2 at the hot spot is reduced to a lower-order oxide of manganese of high resistivity. This can result in the healing of the defect; however, unless current inrush is limited, the oxides do not have time to reform before avalanche occurs, destroying the capacitor.

The magnitude of the current surge is influenced by the circuit series resistance. Scintillation is not inhibited by increasing the resistance in series with a capacitor, but oxide film damage is restricted. Series resistance will limit current flow during the momentary breakdown, minimizing localized heating and irreparable dielectric damage.

To encourage self-healing, manufacturers recommend that designers incorporate a minimum of three ohms series resistance per applied volt when using solid electrolyte tantalum capacitors. Because scintillation is a random phenomenon with a high probability of occurrence, most manufacturers perform production burn-ins in an attempt to eliminate gross defectives. Scintillations caused by impurities are an inherent problem regardless of manufacturer. The magnitude of the problem varies between suppliers. It is suspected that these variations between suppliers are a function of their manufacturing techniques and controls, e.g., purer tantalum powder, optimum sintering temperatures, the correct balance of carbon-oxygen, the rate of film growth, the control of formation conditions and the manganese nitrate decomposition techniques.

No generally acceptable criteria have been established to date to determine the frequency of scintillation occurrences. Operating voltage, temperature and series resistance directly affect the magnitude of this phenomenon, as evidenced by the accompanying charts (based upon MIL-HDBK-217 data). Longevity of solid electrolyte tantalum capacitors is enhanced by operating them at less-than-rated voltage and temperature. □

G. Severino is with the government electronics division of Motorola Inc., Scottsdale, Arizona. His educational background includes several courses in radio theory and television theory.



Failure rate as a function of operating temperature and operating voltage/rated voltage ratio.

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Dual Power Supply Delivers Tracking Voltages

JEREMY A. AGNEW, Vicon Instrument Co.

A well-regulated, variable, positive power supply controls a negative slave regulator to provide tracking variable plus and minus outputs.

Two op amps and two series-regulator transistors are the key elements in a dual tracking regulated power supply. A single control varies the positive and negative output voltages simultaneously and equally between the limits of 4 and 25V. The negative half of the supply is slaved to the positive output voltage.

Both positive and negative voltage supplies are required to power most operational amplifiers—±15V and ±18V being typical. Some power-supply schemes provide these voltages by splitting a single supply or using two separate supplies. These approaches, however, usually provide only a fixed output.

When doing breadboard or development work on the lab bench with op amps, it becomes convenient, and often necessary, to observe the effect of varying supply voltages. A supply that lets you vary both the positive and the negative voltages simultaneously thus is desirable. Since no low-cost commercial unit was available that provided variable voltage tracking with good regulation, this circuit was developed.

Specs for the power supply are:

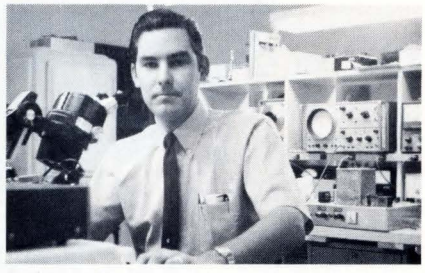
—Output voltages are continuously variable from ±4 to ±25V dc.

—Full load current is 400 mA for both + and − sides.

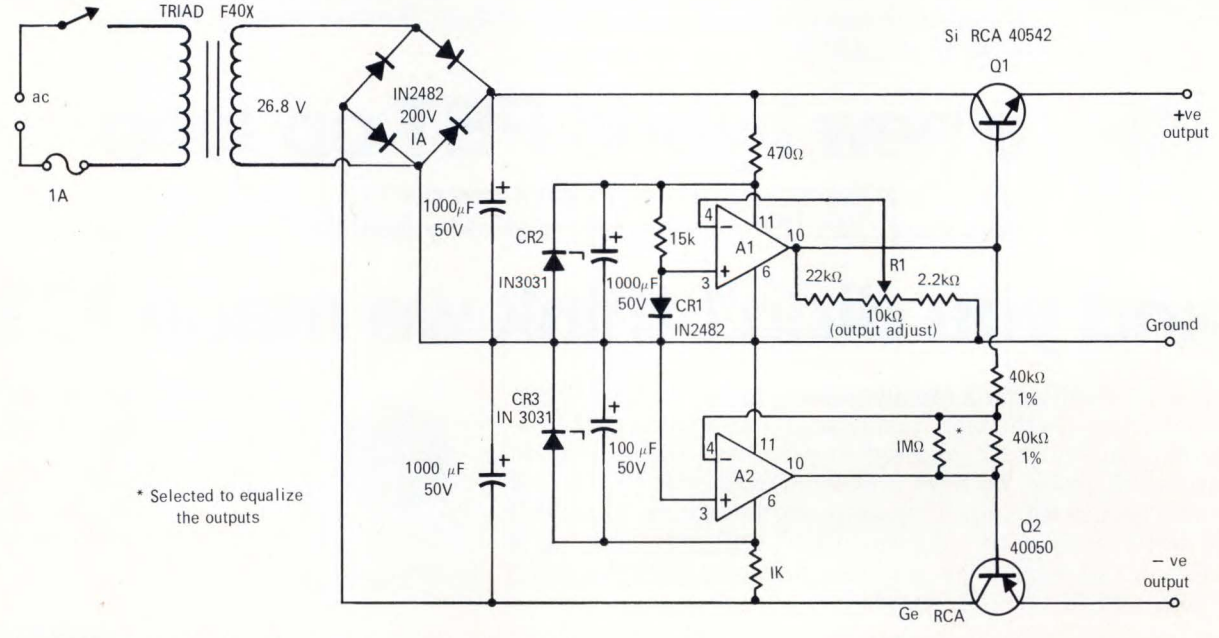
—Voltages track within 0.05V (0.2%) at full output.

—Ripple at full load (25V, 400 mA) is less than 4 mV pk-pk.

—Ripple is too low to be readily measurable up to 100 mA output. □



Jeremy A. Agnew is manager of production engineering for Vicon Instrument Co., Colorado Springs, Colo. Mr. Agnew received his B.A. (Physics) from Colorado College and his B.S.E.E. from University of Colorado. With Vicon since 1967, he is currently engaged in work with hybrid integrated circuits.



Plus and minus dual tracking power supply employs an op amp and series-transistor regulator in each side of the dual-polarity regulator section. Well-regulated, variable, positive portion of power supply obtains its gain from op amp A1 and derives its large output-current capability by driving npn series pass transistor Q1. Negative voltage is obtained by applying part of positive output to another op amp A2, connected as unity-gain inverter. A2's output controls negative series-pass transistor Q2.

Voltage drop across forward-biased diode CR1 provides voltage reference to plus input of A1, and is compared to positive output applied to minus input from pot R1. Zener diodes CR2 and CR3 provide regulated supply voltage to op amps A1 and A2 respectively.

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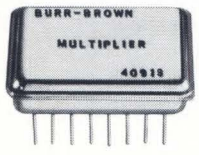

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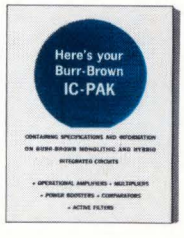

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CIRCLE NO. 43

CUSTOMER ENGINEERING CLINIC

Parallel-Tuned Network Cuts "Off-Station" Noise

RONALD W. LUTZ, Sprague Electric Co.

Problem: Customer evaluation of a sound IF IC (**Fig. 1**) showed excessive "off-station" (or off-channel) noise. Although operation was satisfactory under normal signal conditions, when tuned to a nonbroadcasting station or channel, the noise was about three times that of a conventional ratio detector.

Discussion: The FM quadrature detector uses two inputs to perform FM detection (**block diagram Fig. 1**). Limiter output switches the detector reference pair while a second phase-shifted signal (from an external phase-shift network) is applied to the other set of detector pairs. The level of this phase-shifted signal will have a definite effect on the performance of the quadrature detector. High signal levels will result in hard limiting of the detector input pairs, resulting in lower limiting thresholds, typically 50-100 μV, and increased noise for "off-station" conditions. Operating the detector input signal levels sufficiently low to keep detector operation linear will result in reduced output noise and increased input limiting thresholds, typically 300-500 μV.

High- or low-level signal inputs may be generated by either parallel- or series-tuned LC networks (**Fig. 2**). The series-tuned network will give characteristic high-level signals while a parallel-tuned network can generate either high- or low-level signals depending on the input voltage or value of the series capacitor feed-

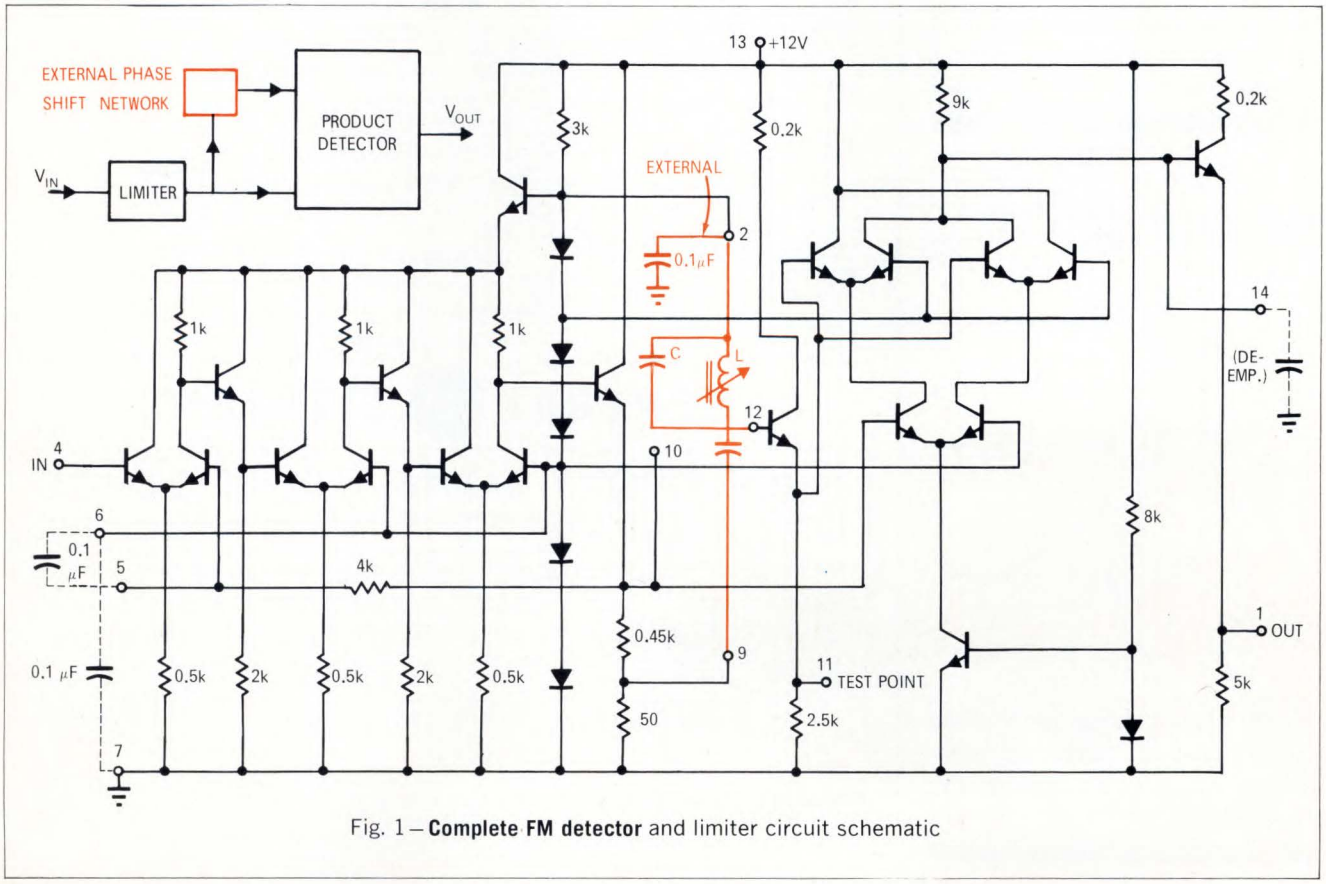

Fig. 1 – **Complete FM detector** and limiter circuit schematic

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CLINIC (Cont'd)

ing the parallel-tuned network.

Solution: By changing his tuning network to that shown in **Fig. 2** the customer obtained noise performance that was compatible with his existing system, while maintaining satisfactory IC performance. Linear operation of detector input pairs was maintained (approximately 60 mV), and detector input was sufficient to provide satisfactory output levels. □

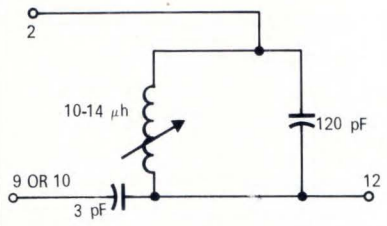

Fig. 2—**Parallel tuning network** alters detector input level depending on series capacitor connected to pin 9 or 10 (high or low level limiter output).

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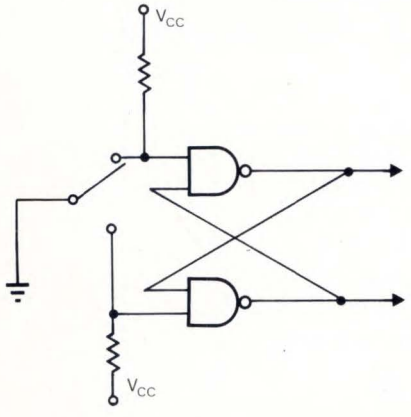
NEXT ISSUE'S PROBLEM

Switch Bounce Eliminator Does Double Duty



A simple circuit comprised of two components guarantees positive switching action every time on the first actuation.

General Electric's new epoxy TO-18 transistors run hot and cold

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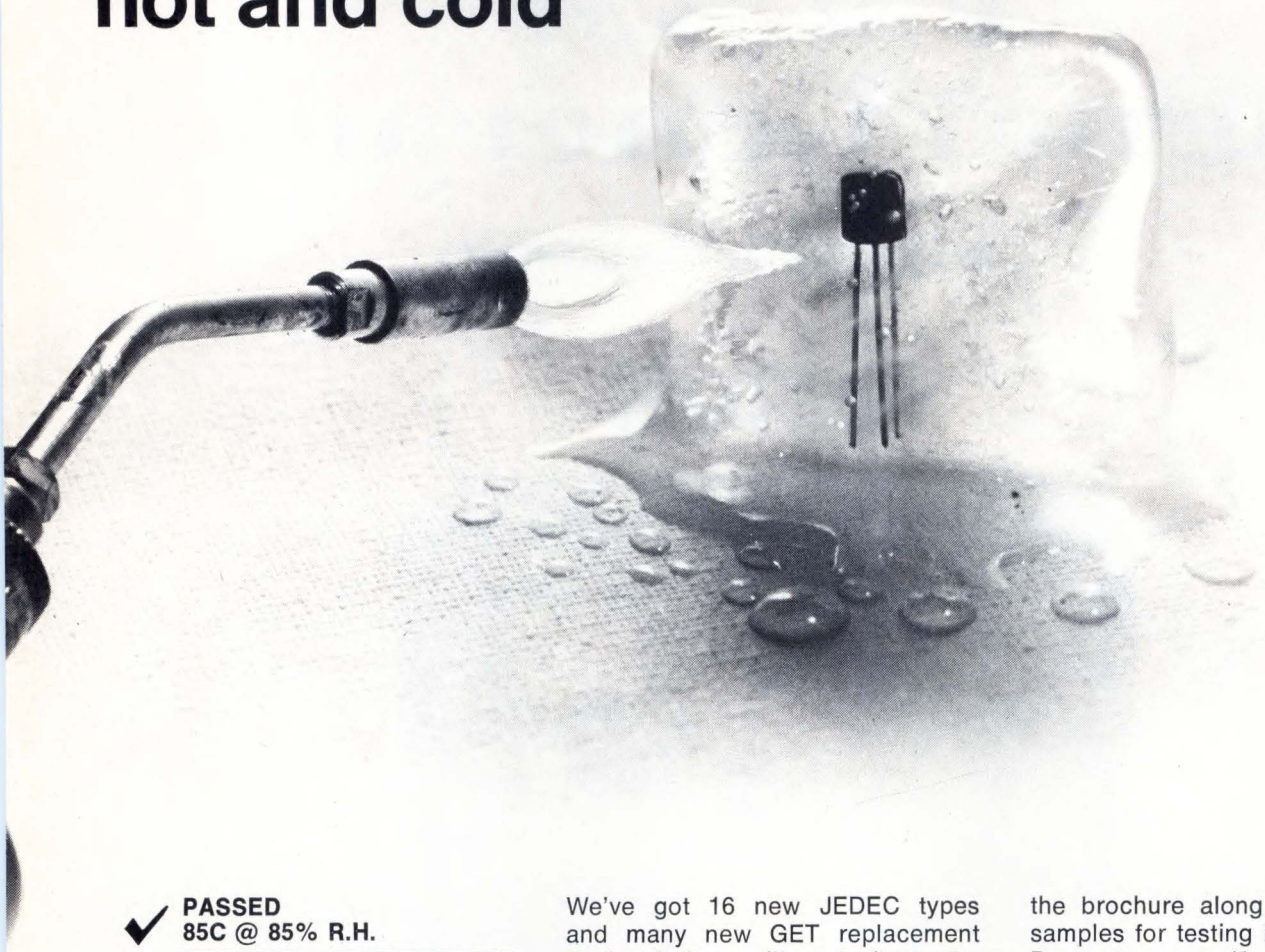

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To get your four free samples, specification sheets and reliability brochure, fill out the coupon on the opposite page and mail it to your authorized GE Semiconductor distributor shown on the list. We think you'll find that GE's new epoxy TO-18 transistors meet your reliability standards with ease. 221-30

PD mW	Ic mA	NPN JEDEC Type	NPN h_{FE} I_C=.1 V_{CE}=1V	NPN h_{FE} I_C=300 V_{CE}=2V	NPN h_{FE} I_C=800 V_{CE}=5V	NPN Noise fig. dB (max)	PNP JEDEC Type	PNP h_{FE} I_C=.1 V_{CE}=−1V	PNP h_{FE} I_C=300 V_{CE}=−2V	PNP h_{FE} I_C=800 V_{CE}=−5V	PNP Noise fig. dB (max)
400†	500	2N6000	50	40		3.0	2N6001	90	35		3.0
400†	500	2N6002	130	80		2.0	2N6003	210	50		1.5
400††	500	2N6004	50	40		3.0	2N6005	90	35		3.0
400††	500	2N6006	130	80		2.0	2N6007	210	50		1.5
500††	800	2N6010	45	85	45	5.0	2N6011	70	65	45	3.0
500††	800	2N6012	90	160	50	3.0	2N6013	180	135	70	2.0
500†††	800	2N6014	45	65	15	5.0	2N6015	70	60	35	3.0
500†††	800	2N6016	90	60	15	3.0	2N6017	180	125	55	2.0

† BV_{CEO}=25V; †† BV_{CEO}=40V; ††† BV_{CEO}=60V

GE Type	Replaces	GE Type	Replaces	GE Type	Replaces
GET706	2N706	GET2221A	2N2221A	GET3013	2N3013
GET708	2N708	GET2222	2N2222	GET3014	2N3014
GET914	2N914	GET2222A	2N2222A	GET3638	2N3638
GET929	2N929	GET2369	2N2369	GET3638A	2N3638A
GET930	2N930	GET2484	2N2484	GET3646	2N3646
GET2221	2N2221				

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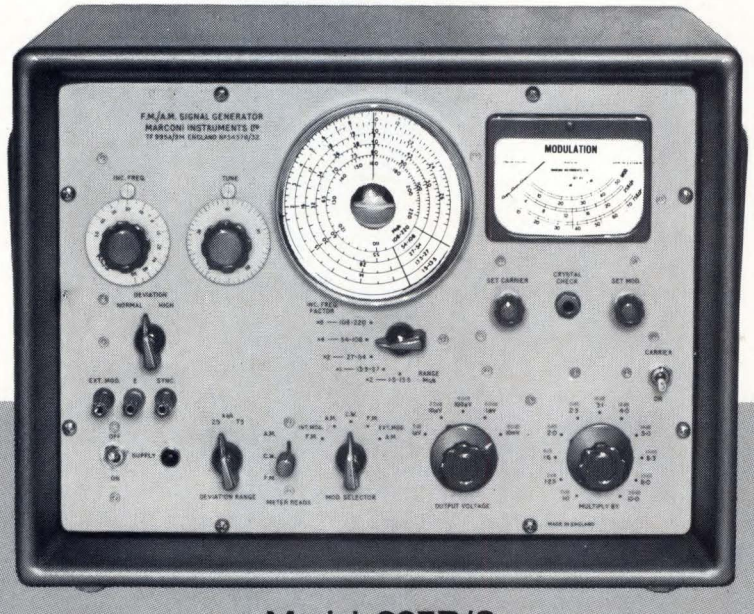

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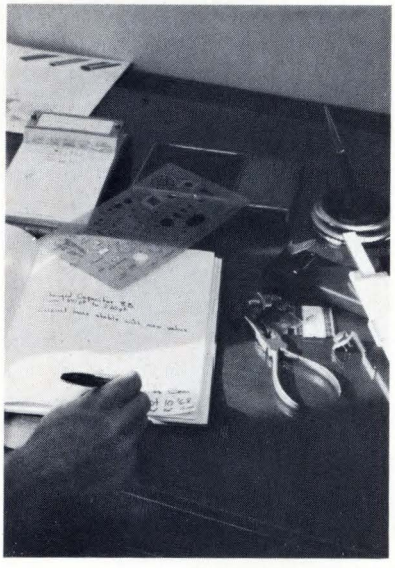
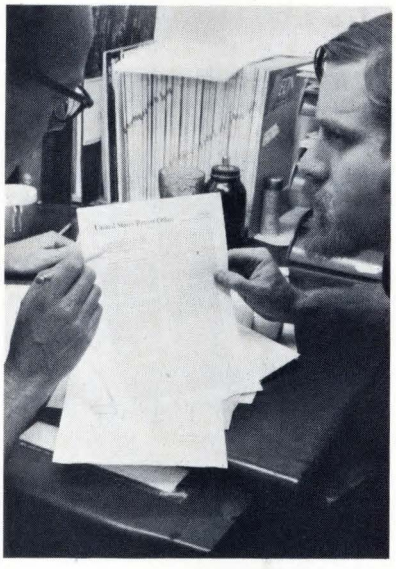
CIRCLE NO. 47





Patents—What Are They?

Do you know how to read a patent? How about what's patentable, or what a patent really protects? Does the granting of a patent guarantee a legal patent? If you can't answer these questions, you probably aren't using the patent system to your advantage, and you might even be compromising yourself and your company.

ROY W. FORSBERG, Boston Regional Editor

An engineer with a general knowledge of the fundamentals of patents and the general rules regarding them, who applies common sense reasoning to such knowlege and rules, can minimize patent troubles for himself and his company, and be of great assistance to his patent attorney in solving patent problems. Merits and faults of a patent do not depend on engineering considerations alone, but on legal considerations as well. An invention, striking from an engineering and ingenuity viewpoint, may be worth little or nothing because it is legally inadequate or defective. On the other hand, an invention requiring no sophisticated engineering skills may still be comparatively valuable if it is covered by a legally sound patent. Engineering and legal judgment together are necessary to determine the merits and limits of a patent. An example of this latter point is a new paper-making machine that was operating at less than expected output until an operator suggested raising one end of the machine several inches. Output was doubled and this seemingly simple improvement was the basis of a good patent.

What Does A Patent Do For You?

An important point not usually understood by many is just what a patent does for you. The fact that a patent has been granted gives you no additional rights to use the invention over those you had before issuance. The awarding of a patent is no guarantee as to validity of the claims in it, however, it does place the burden of proof on the person who disputes it. In other words claims of an issued patent are presumed to be valid until proved otherwise in court. Further, the patent gives you no right to use the invention if it requires use of someone else's invention. For example, if you invented a new starting winding for a motor, you could be prevented from using your invention because of prior patents on the basic motor itself. License arrangements are usually the answer here. It should be obvious then that a patent right is really a preventive right which allows you to use the courts to prevent

(Continued)

others from utilizing your invention.

What Is Patentable?

As defined in the patent statute, the subject matter which may be patented is a "process, machine, manufacture, or composition of matter."

A *process* is a method of producing some new physical result or an old physical result in a new and better way.

A *machine* could be defined to be a device or combination of devices utilizing energy or performing an operation.

Manufacture is just about anything made by man's industry. It must be a physical element, not a product of nature or a natural element, even if newly discovered.

Composition of matter would be the result of intermixing two or more ingredients to get a product which has properties different from those of the ingredients individually. The product could be a mechanical mixture or chemical compound.

The statute goes on to say "any improvements thereof," therefore, the invention can simply be an advance in the particular art or science. And lastly, the statute states that the invention must be "new and useful," that is, have some utility and be novel.

One can learn further what is patentable by looking at "what is not patentable". The statute again states that a patent may not be obtained if the subject matter would have been obvious at the time of the invention to a person having ordinary skill in the particular art to which it relates. Therefore, the invention must show a degree of ingenuity not expected as normal for a skilled craftsman.

Changes in size, shape, adjustability, portability, or materials are not patentable, unless the change produces startling or unexpected results. Nor can ways of doing business, plans of travel, or forms of government be patented.

A collection of known parts, each doing its usual thing so that the final result is simply a sum of the individual part's usual results, is not patentable. Individual parts must perform some new function and some new result must be produced.

Finally, the doctrine of equivalents; that is, the mere replacement of an element of the invention with another known to be capable of performing substantially the same function as the element replaced will preclude allowing of a patent.

Reading A Patent

The actual patent document is divided into sections and subsections as illustrated in **Fig. 1**. The entire printed text, called the *specification,* is a complete description of the invention covered. Law requires it to be so complete and accurate that it tells anyone skilled in the art how to practice the invention. It must be written with care, however, to guard against the implication that the invention might be limited to the specific exemplification described. The specification can be broken down into a number of distinct parts described below.

Abstract of disclosure is the opening statement of the document. This is a relatively new section that is a summary of the original disclosure. It states, without reference to drawings, how the invention works.

The *statement of invention* follows and identifies the field of art to which the invention pertains. It must be carefully stated so it won't limit protection afforded by the patent claims.

Some patents will follow with a *discussion of prior art* which points out inventions and practices already utilized by others, and how the invention improves upon them. The trend has been to omit this section; however, the Patent Office would like to reverse it.

The next section generally found in all patents, both old and new, is the *objects of the invention.* These statements tell just what the invention seeks to accomplish and are often closely examined by the courts in cases when claims are disputed.

Following that is a *list of drawings*, briefly identified, that illustrate some embodiments of the invention.

The *description of embodiments* that follows refers to each drawing and the various elements in it identified by reference numerals. This is really the section of the specification that fulfills the law requiring descriptions to be so clear that anyone skilled in the field covered by the invention can duplicate it when the patent expires.

The last major section of the specification is the *claims*. Here we really get down to the nitty-gritty. To make it possible for others to respect the issued patent and avoid infringement, the inventor must not only disclose his invention, but he must also claim it. In form, each claim is a single sentence whose length can easily exceed 200 words. One can easily get lost between the start and end of each claim unless he keeps in mind that he is simply reading a definition of the invention – that the claim is merely a narration of all the parts of the invention linked together by functional language defining an operative device. The claims are written, not to describe the invention, but to define the exact features the invention protects and the precise boundaries or areas from which others are excluded.

(Continued)

Patent No.

Date of issue

United States Patent Office

3,495,353
Patented Feb. 17, 1970

Inventor

1

Title

3,495,353

DOOR OPERATING MECHANISM

Roy W. Forsberg, Southington, Conn., assignor to The Stanley Works, New Britain, Conn., a corporation of Connecticut

Owner of the patent

Filed Sept. 23, 1968, Ser. No. 761,631

As of this date, title is made public, but not the contents.

Int. Cl. E05f 15/20

U.S. Cl. 49—25 11 Claims

Patent placed in this class by patent office.

ABSTRACT OF THE DISCLOSURE

A door operating mechanism for a door equipped with a motor for producing an opening movement comprising an electric switching element for directing operating energy to the motor, an electrically conductive plate isolated from ground adjacent the area of approach to the door, means to impress on the plate an alternating current potential and means responsive to an increase in the space capacitance of the plate upon the approach of a body toward the plate to actuate the electric switching element and energize the motor to open the door. The actuating means includes a voltage sensor connected across an impedance element serially connected with the plate to form an input circuit for triggering the actuating means.

Summary of how invention works

Statement of invention

This invention relates to door operating mechanisms and more particularly to the opening and closing of doors by power which is controlled responsive to traffic using the doorway.

Objects of invention

An object of this invention is to provide a powered door operator incorporating a control of high reliability and versatility, low maintenance and with the absence of moving parts. Included in this object is a provision of a control which incorporates an adjustable time delay for regulating the period of time the door remains open before returning to its closed position.

Another object of this invention is to provide a door operating mechanism having a low current, low voltage control system which is designed to be electrically affected by a person approaching the doorway. Included in this object is the provision of such a control system which insures against false triggering and for the safety of the users under all operating conditions.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which is exemplified in the construction hereafter set forth, and the scope of the invention is indicated in the appended claims.

List of drawings (in this case there is only one.)

In the drawing:

The single figure is a perspective view of a door operating mechanism incorporating this invention.

Description of embodiments shown in drawings

Referring to the drawing in detail, there is shown a building wall **10** having an opening **12** forming a doorway adapted to be closed by a door **14**. As shown, a motor **16** is supported in the header above the door and is connected thereto in any conventional manner for powering the door between its open and closed positions. Mounted on the wall **10** adjacent the doorway is an electrically conductive touch plate **18** which senses the presence of a part of a body such as a user's finger near or touching the touch plate to initiate the operation of the door opening and closing cycle as hereinafter more fully described.

Generally speaking, the input signal denoting the presence of a person adjacent or touching the touch plate **18** results in the charging of a capacitor during the positive portion of the A.C. input to a level sufficient to trigger a voltage sensing switching device which, in turn, turns on a pair of power switch controlling cascaded transistors. To avoid false triggering, a capacitor is incorporated in

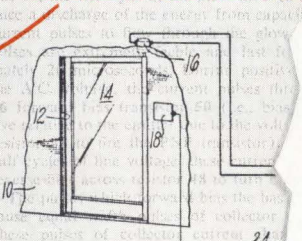


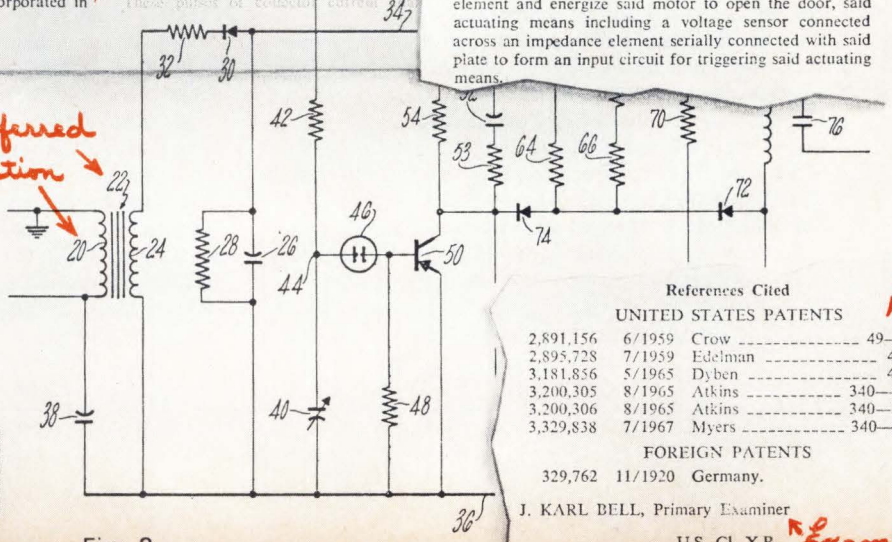
Fig. 1

Patent claims No. 1 defines the invention

1 claim:

1. In a door operating mechanism for a door equipped with a motor for producing an opening movement thereof and an electric switching element for directing operating energy thereto, the combination with said door and electric switching element of an electrically conductive plate isolated from ground adjacent the area of approach to the door, means to impress on said plate an alternating current potential, means responsive to an increase in the space capacitance of said plate upon the approach of a body toward said plate to actuate said electric switching element and energize said motor to open the door, said actuating means including a voltage sensor connected across an impedance element serially connected with said plate to form an input circuit for triggering said actuating means.

List of prior art used by patent office during prosecution of this patent



Numbers referred to in description

Fig. 2

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J. KARL BELL, Primary Examiner

U.S. Cl. X.R.

Examiner

INVENTOR
ROY W. FORSBERG

BY Lindsey, Rudzman and Hayes

ATTORNEYS

Patent Attorneys

The ability to analyze claims is very important to an engineer because it puts him in a position to prevent his company from infringing on another's patents and to prevent others from infringing on his.

There are a few final items an engineer must understand in order to best utilize patents, and they are the language or terms used, elements of claims, and references cited.

The *language*, though mystifying to engineers at first, soon becomes familiar and acceptable because such terms as plurality, predetermined, means for, substantially, comprising, etc. have been used by attorneys for years and have attained a legal certainty. Space does not permit a dictionary of such terms but the wise engineer will insure that his patent department gives him the precise legal meanings. Use of general terms gives the broadest possible coverage, thus a spade is not called a shovel, but a soil working implement.

Patent claims should include the least number of *elements* possible to describe the invention in order to get the broadest coverage. The more elements, the easier it is for others to avoid infringement, since another invention not including all elements listed will seldom be found to be infringing. Usually, narrow claims are included to back up the broad ones, so that some protection could still be retained if one or the other were held invalid.

The very last section of the patent is the list of *references cited*. These are usually U.S. and foreign patents, but could be magazine articles and textbooks. The list comprises prior art which the patent examiner cited against the patent during its prosecution. Value of this list lies in that it determines the scope of patent claims —the range and extent of the invention defined by the claims.

A very important part of a patent, whose significance is rarely appreciated by the uninitiated, is the *filing date* shown on the front page. As of this date, the application becomes secret in the Patent Office, and no outsider other than the applicant or his attorney can have access even to the title until the patent issues. Further, this date establishes a number of priorities like the junior and senior parties in litigations (the burden of proof is on the junior party), an official reduction to practice date if records of earlier reduction are inadequate, and establishment of first inventor in foreign countries where the "first to file" is considered the first inventor. Here, a U.S. patent filing date is accepted as a valid "first to file" date if it occurs before the filing date at the foreign patent office.

The Invention Disclosure

Broadly defined by patent law, a disclosure is the act of an inventor in which he tells someone else about his invention. In order to validate the exact date of conception in case of later litigation, the disclosure should be in writing as soon as possible after an invention comes to mind. A good disclosure should not only give the conception date, but it should also be complete enough to allow a patent attorney to understand the invention and to make a thorough search and determination of patentability. Therefore, the minimum elements of a disclosure should contain the following: the problem to be solved by the idea; all pertinent details of the proposed invention, including what is new and how it represents improvements over the old; any way the invention has been used to date; speculation of commercial importance; any prior sale or publication; the true inventor(s); reference to notebook entries and dates; and a complete sketch or drawing. Finally, the disclosure must be signed, dated, and properly witnessed by at least one person who can understand the

Here are some hints for keeping good records:

- **Put the idea in writing** at the time the idea occurs.
- **Keep notebook entries in ink.** Although there is no hard and fast rule against pencil entries, erasures and smudges leave doubt as to credibility.
- **Sign and date** all entries as they are made.
- **One or more witnesses** should sign and date all entries of especial significance, recording the fact that they understand the subjects recorded.
- **Corroboration** strengthens all records. Without corroboration, entries pertaining to conception, etc., are virtually worthless until a corroborating entry is made.
- **Co-inventors** cannot corroborate. Corroborators make their entries more valid by a similar entry in their own notebooks.
- **Identify projects** by project numbers, if possible. This makes proof of diligence easier.
- **Don't omit** or tear out any pages. At the end of each page sign, date it and note, "entry continued on next page (page xx)".
- **Don't erase.** Draw lines through sections or words to be changed, and initial and date changes.
- **When making sketches** and drawings, have them signed, witnessed and dated. When later changes and modifications are made to the design, it is best to make a new sketch rather than alter the old.
- **Record** even unsuccessful experiments. This helps prove diligence.

invention. A joint inventor is not a proper or legal witness.

What Records Should Be Kept?

There are many reasons why written records should be kept in proper form by engineers. The key reason is to insure proper patent protection, especially when two or more engineers claim the same invention. Generally speaking, the party who is "able to prove" his is the first invention is the one who gets the patent, and since testimony is usually taken in written deposition form, the Patent Office relies on documents and proper records of the inventor. Therefore, it is the inventor's responsibility to keep adequate records from beginning to end of a project, and to have them properly authenticated.

A good set of records should support three essential aspects of an invention in case of future litigation; date of conception, acts of diligence, and reduction to practice. *Date of conception* is the earliest date when the invention is clearly enough defined in the mind of the inventor to be expressed verbally. What better way is there to prove this conception than a written, dated, and corroborated record? *Acts of diligence* include all procedures and experiments performed while perfecting the invention. Date of *reduction to practice* is that date when the invention has been built and successfully demonstrated to work.

Who Is The True Inventor?

It is very, very important that the true inventor(s) be given credit for an invention. To some individuals, it is quite important to have a long list of patents on his resume, and a supervisor may claim co-inventorship simply because he assigned or supervised a project. Subsequent litigation could invalidate an issued patent in such cases, or cases when a true co-inventor was not given credit.

There are general rules and specific guidelines to follow in determining true inventorship, and it would be unwise for a company or individual to treat them lightly. Valuable patent rights have been lost by some who did.

Generally, only actual inventor(s) may apply for a patent. Patents cannot be granted to corporations or companies except as the assignee of the inventor.

In interference actions, the rules of priority of inventorship are as follows:

1. The first to conceive and the first to reduce the invention to practice is the true inventor.
2. The first to conceive but last to reduce to practice will be considered the true inventor if he can prove that diligence (by his records) in reducing his invention to practice started before the other party's conception, and that his own diligence continued until

– **Avoid using** words like "abandoned" when referring to project progress. It may be that only a particular series of tests was abandoned, but not the invention; thus proof of diligence would be difficult.
– **Witnesses** to a reduction to practice must actually see the device work, not just external components but internal, hidden parts as well. It is best to have a person other than the inventor actually run the test of reduction to practice and make the proper notebook entries.
– **Preserve** the first working model if possible. The next best thing is photographs; however, notebook entries must refer to the photos.

Here are some guidelines to help in determining a true inventor:

– **The man who conceives** a new or improved way for accomplishing a result and shows how it can be reduced to practice is the inventor.
– **A man who states a problem** (say a supervisor) or assigns a project whose solution is not obvious to people skilled in the art is *not* the inventor. The person who discovers the actual solution is the inventor.
– **In cases when the true nature** of the problem is not understood, the person who discovers and states the problem is the inventor, even though he may direct others to work out the obvious solution.
– **If two or more people** working together conceive the same idea, they are joint inventors.
– **However, if one conceives** one idea and another a different one, and both are incorporated in the same device, they are separate inventors.
– **When one individual conceives** the main idea, and later another co-worker adds a related one which is inseparable from the first, there is *no* co-inventorship. Only the person who conceived the principal idea is the inventor.
– **Lastly, if one conceives** an idea, but another reduces it to practice for him, the first is the inventor. The exception here occurs when the conceived idea is so vague that it does not suggest a complete obvious solution. In this case both can be co-inventors.

Obviously, there can be exceptions to any rules and guidelines. If doubts arise concerning true inventorship, a patent attorney should be consulted for advice.

(Continued)

success was attained.

3. The last to conceive but first to reduce his invention to practice will be the true inventor if the other person cannot prove diligence.

Public or Experimental Use?

Whether an invention has been in public use or not is another area of much disagreement that has invalidated many patents. Basically, the law says an invention cannot be patented if it was known or used by others prior to being conceived by the inventor in question, if the invention was described in a printed publication prior to conception date or one year before filing an application, or if the invention was in public use for more than one year prior to filing application. Misunderstanding of just what is **public use**, as considered by the courts, creates most problems.

An invention is considered to be in **public use** if it is performing its intended function and when its use is not controlled by the inventor. Under the proper conditions, an invention can be exposed to the public as an experiment for a period of longer than one year without jeopardizing patentability. An invention is considered in **experimental use** if delays in filing application are caused by a *bona fide* effort on the inventor's part to bring his invention to perfection and to make sure that it performs the job that, indeed, it was intended to do.

– When the use is an experimental one, whether paid for by user or not, it must be stated expressly that it is an experiment and that the inventor retains the right to make continuous inspections, revisions, or replacement until he is satisfied that it performs the job intended.

– When the invention is in experimental use, the inventor must keep track of his invention and keep good records to corroborate this.

– It is not necessary for more than one device to be utilized publically to be considered as public use, nor that more than one other person know about its use, if the inventor does not expressly limit or control its use.

– If the invention is concealed as a part of a "sold" assembly, it is in public use, provided that the device was not expressly designated and employed as an experiment.

– If a device is demonstrated to others who then copy and utilize it for more than one year prior to filing of a patent application, the invention is in public use even though the inventor had no part in its public use.

Publication

An invention described clearly enough to be copied in a publication anywhere in the world prior to conception (or one year before filing an application), cannot be patented. However, the publication must be printed and available to the public. A manufacturer's internal publication, not available elsewhere, is not considered a public publication.

The biggest reasons for not publishing information about an invention before filing patent application are: a year after publishing could easily pass while experiments to perfect the invention were proceeding; delays in processing patent applications within a company could exceed a year; competitors might be spurred to make essential improvements necessary for commercial application of the invention; and some foreign countries forbid publication *anywhere* prior to filing applications in those countries.

Marking The Invention

All patented devices should be clearly marked with the correct patent number. The danger of not complying is that your company cannot recover damages for infringement for any time periods before official notification of infringement. It is also the duty of a licensor to insure that licensees mark all devices properly for the same reason.

To be safe, all applicable patent numbers must be clearly and plainly marked on the device itself. However, the nature of some inventions sometimes precludes this; therefore, the container must be so marked.

Use of the terms "Patent Pending" or "Patent Applied For" have no legal meaning except to warn others that a patent application has been filed and that, if a patent is granted, infringement could exist if manufacture of similar items continued.

How To Use The Patent System

Depending on your individual needs, the patent system can be used in many ways as shown in Fig. **3 a,b,c**.

If you wish to secure exclusive rights to an invention, you can try keeping it a secret, usually an ineffective and short-lived advantage; you may obtain a patent, as discussed elsewhere; or you may secure an exclusive license from the inventor or company who holds the patent rights. The last is normally obtained in return for a royalty paid on each device manufactured.

An inventor can assure himself of a perpetual right to use his invention by securing non-exclusive rights.

This also makes the invention free for anyone else to use, but at least no other individual could secure a patent barring use by all others. One way he can secure a non-exclusive right is to build a model and put it in public use for a year; or, if he cannot afford that expense, he can publish a disclosure of the invention. One last thing an inventor could do is to obtain his patent, and then grant a license to anyone who requests it.

One may transfer patent rights by assigning rights to others. This method is commonly used by employers when hiring an engineer—that is, by making a preassignment agreement a condition of employment (EDN Sept. 15, 1970). Another way to transfer rights is by a license as discussed earlier, and the last is by an estoppel process—in which the patent owner knowingly allows infringement to continue for a long time, thus forfeiting his rights to recover.

The more common problem in life for engineers is to avoid infringing upon patents of others. The easiest way is to secure a license, but this could be costly. You could avoid infringement by inverting elements of the invention (make moving parts stationary and vice versa), interchanging elements, using a different device or elements, or building the device by omitting one or more essential elements upon which the claims rest and maybe make a new invention in the process.

Another way to avoid infringing on another's patents is to have them invalidated through the courts. The first method is to find some evidence of prior art like a disclosure or technical article; or evidence or prior construction and public use for more than a year before the patent application in question was filed; or claims of the patent in question that contain prior art of expired patents which inadvertently escaped the examiner's attention. Another method, though more difficult, is to prove there was no invention at all—that the device in question is merely a summation of old parts doing nothing new in themselves and obtaining an end result that would have been obvious to anyone skilled in the arts. A final way of using the courts is to prove that the patent is legally defective, e.g. the inventor(s) are not stated correctly. This was discussed elsewhere in the article and can be used to avoid a given patent.

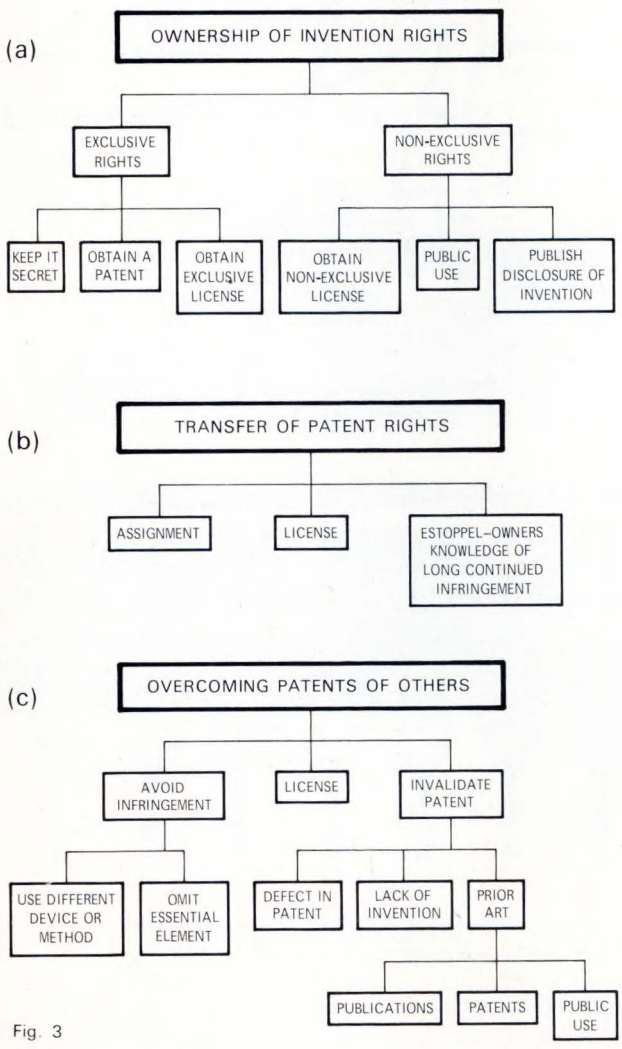


Fig. 3

A Little Knowledge . . .

The subject matter covered in this article is meant to give each engineer a working knowledge of the patent system, not to make himself a self-sufficient expert. You should now be aware of the pitfalls of ignoring the patent system and the advantages of using it. However, all doubtful questions should be referred to a competent patent attorney. He is fully trained in all aspects of the patent law and is up-to-date on the latest changes. Attempts to answer all questions or problems yourself is analogous to a sick person treating himself by refusing to call a doctor. A seemingly minor infraction of the patent laws can turn into a major problem for you and your company. And, like a minor ailment, if untreated, it can turn into a major illness. □

The author thanks the many companies who helped in the preparation of these articles, and especially Mr. Vernon F. Kalb, patent attorney at Hartford, Conn.

Design breakthrough in FM-IF systems: two new RCA IC's for more performance, with fewer components

Two new RCA Linear IC's now offer you a brand new approach to FM-IF system economy and performance. The CA3076 (high-gain IF amplifier/limiter) and the CA3075 (IF amplifier, limiter, FM detector, and audio preamplifier) have been designed to bring you an IF system with dramatic reductions in external components. And—to make the total economics of your system attractive—RCA has priced the CA3076 at $1.60 (1,000-unit level) and the CA3075 at $1.40 (1,000-unit level).

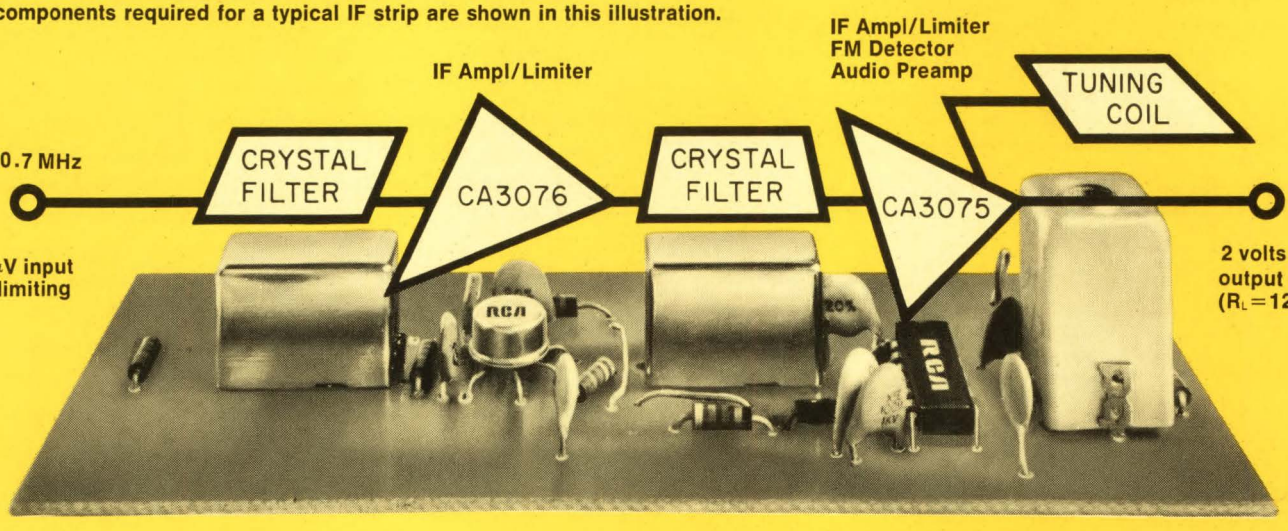
For your applications in communications receivers and high-fidelity equipment, with FM IF's requiring bandwidths to 20 MHz, here are some highlights on these two new RCA types:

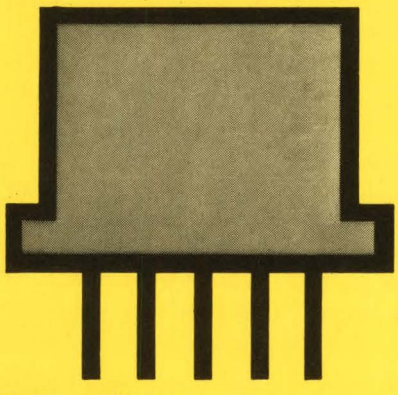
The CA3076 has an input limiting voltage (knee) of 50 μV (typ.) and 80 dB (typ.) gain with 2-kilohm load at 10.7 MHz. It contains an integral voltage regulator, for operation at power supply voltages from 6 V to 15 V.

The CA3075 limits with an input voltage of 250 μV (typ.) at 10.7 MHz. It has low harmonic distortion and excellent AM rejection—55 dB (typ.) at 10.7 MHz. Differential peak detection permits single-coil tuning. The CA3075 incorporates an audio preamplifier with 21 dB (typ.) voltage gain, and an integral voltage regulator, for operation at power supply voltages from 8.5 V to 12.5 V.

For further information, see your local RCA Representative or your RCA Distributor, or write: RCA, Commercial Engineering, Section 50J-15 /CA42, Harrison, N.J. 07029. International: RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P.O. Box 112, Hong Kong.

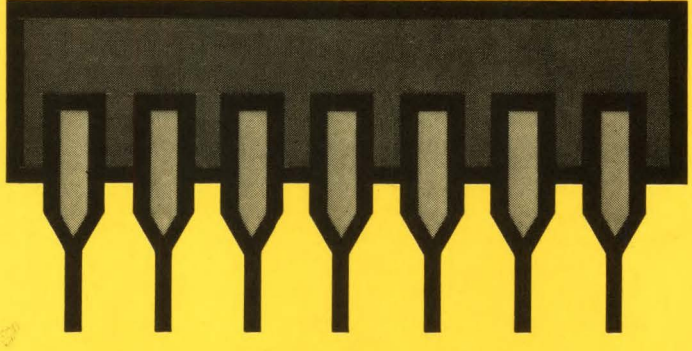
All components required for a typical IF strip are shown in this illustration.





CA3076 IF ampl/limiter

Voltage gain:	80 dB (typ.) with 2kΩ load
Input limiting voltage:	50 μV (typ.)
Freq. capability:	Up to 20 MHz
Package:	8-lead TO-5
Price:	$1.60 (1000-unit level)



CA3075 IF ampl/limiter, peak detector, and audio preamp

Voltage gain (audio preamp):	21 dB (typ.)
Input limiting voltage:	250 μV (typ.)
Freq. capability:	Up to 20 MHz
Package:	14-lead DIP (formed leads)
Price:	$1.40 (1000-unit level)

CIRCLE NO. 48

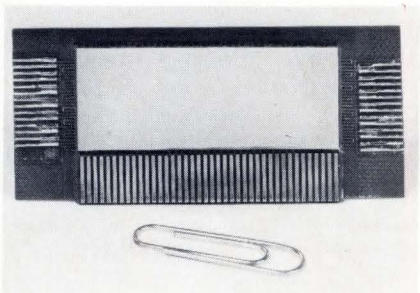
RCA
Integrated Circuits

Miniature Plated Wire Family Debuts

With its modular approach to creating plated-wire memory families, Memory Systems, Inc. continues to expand its off-the-shelf line (See July 15 EDN, *Plated Wire Memory—A Sleeping Giant Awakens*). Built around a MiniPLANE (see photo), the newest plated-wire family aims to find application where small storage capacity (few hundred bits) and moderate speed (1 MHz) must be combined with absolute non-volatility. Made with conventional plated wire, the MiniPLANE employs a unique multiturn geometry that allows low word-drive currents and high output signals. Under typical operating conditions, the MiniPLANE specifications are: I_{write} = 300 mA with 25 ns rise time; $I_{digit} = \pm 50$ mA; E_{sense} = 50 mV in NDRO mode.

Adding IC drivers and simple differential sense amplifiers to the MiniPLANE results in a miniature random access memory (MiniRAM). Already a plug-in MiniRAM of a few hundred bits has found application aboard commercial aircraft. Numerous other applications await the MiniRAM, particularly in digital control systems. Memory Systems, Inc. expects its MiniRAM to find uses in coding/decoding; machine tool control; electrically-alterable formats for display terminals; storing digital values of frequencies (e.g., multichannel systems using frequency synthesizer as a carrier source); storing elapsed time value for equipment performance monitors; storing presettable digital-filter parameters; and totalizer storage for control equipment counters.

Typically, a MiniRAM of 64 words (10 bits/word) comes packaged on a 6- by 9-in plug-in circuit board and costs about $200/each in quantity. A MiniPLANE of this same capacity costs about $70. Designed to meet either commercial or military specifications, the capacities of the MiniPLANE and MiniRAM can be easily tailored to suit the customer. Memory Systems, Inc., 3341 El Segundo Blvd., Hawthorne, CA 90250. **325**

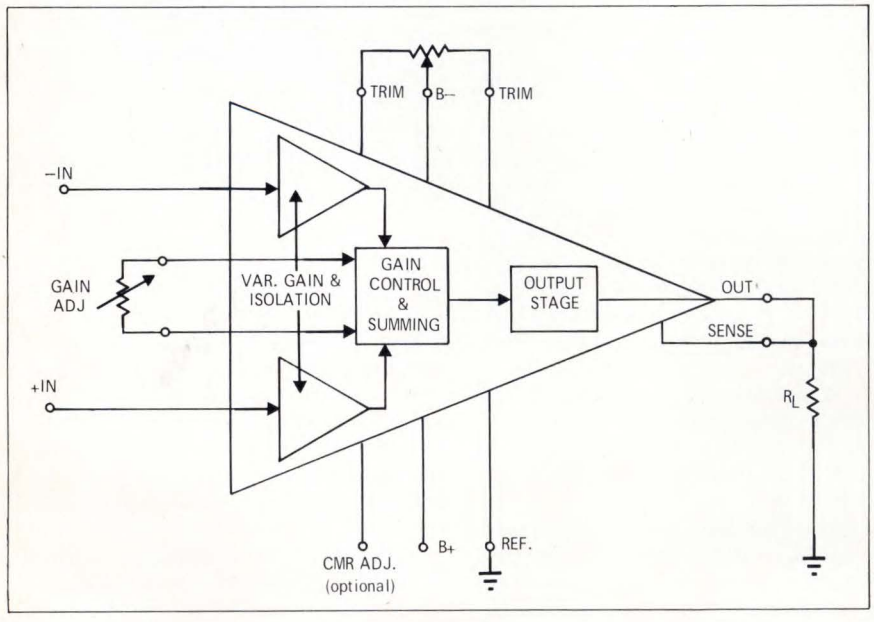


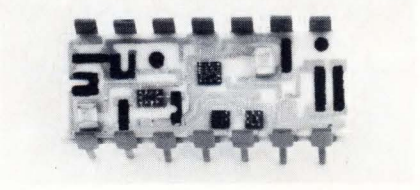
Hybrid Instrumentation Amplifier Comes in Low-Cost DIP

Among six new hybrid devices recently introduced by Zeltex is an instrumentation amplifier, totally packaged in a 14-pin DIP (see photo).

Designated the ZA701D1, the tiny entry aims to become an integral part of transducer systems that employ bridges, strain gauges and other differential-sensing devices. In these applications, the ZA701D1 promises to eliminate lengthy connections, thereby reducing CMRR requirements. The hybrid device can also be used to measure single-ended signals from such devices as thermocouples, photocells, and magnetic pickups with minimal ground loop effects.

Unlike typical differentially-connected operational amplifiers, the ZA701D1 has a high differential input impedance (300 MΩ) with tranference gains of 1-1000 (programmable with a single external resistor). Gain linearity and temperature stability are specified at ±0.05% and ±0.001%/°C, respectively. Because of careful matching of input circuits and close-tolerance trimming of thick-film resistors, the CMRR is 110 dB at ×1000 gain. With a maximum 50 nA bias input current, the differential input range of the amplifier is ±15V and the common-mode voltage limit is ±10V. Full output is ±10V at 7 mA, and, at a gain of 100, the output impedance is 0.2Ω.





Associated with each of the four monolithic ICs used in the ZA701D1 is a functional stage of operation (see block diagram). The output stage is short-circuit-proof to ground and plus or minus supplies. Available off the shelf, this high-performance hybrid sells for $52 (1-9) and $48 (10-24). Zeltex, Inc., 1000 Chalomar Rd., Concord CA 94520. **326**

DPM Has LED Display

Digilin's new Model 3330 chalks up a "first" for digital panel meters with its 3-1/2-digit gallium-arsenide light-emitting-diode display that shrinks the panel area to a mere 1.15 inches high by 2.04 inches wide. Although tiny and lightweight, (8 oz), the new all-solid-state miniature DPM retains the auto zero and high, constant input impedance of the company's larger DVMs that preceded it.

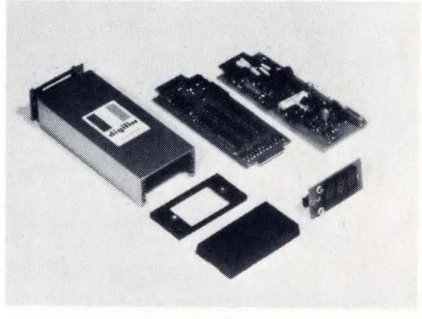
A standard circularly-polarized filter allows the brilliant display to be read in direct sunlight. Because this is a flat-surface display, the viewing angle is far wider than with tube type displays. By changing from tube to LED display devices, power requirements have been reduced to a mere 4W at 5V total, so heating is not a problem and powering by batteries is both simple and inexpensive.

Construction of the new unit is simple. Its three PC boards plug together and are replaceable completely from the front after two holding screws are loosened.

There is 100% overrange capability, with a single light-emitting diode indicating the overrange (over 999) value. When overrranges in excess of 100% (over 1999) are applied, the display blanks and the overrange diode blinks, eliminating any doubt as to whether or not the input is within the meter's reading capability.

Specifications sum up as follows: RANGE, +0.999V FS; ACCURACY, 0.1% of FS ± 1 digit; INPUT IMPEDANCE, >100 MΩ; POWER CONSUMPTION, 4W at 5V dc; OVERVOLTAGE PROTECTION, 100V min; SIZE, 1.15 inches high by 2.04 inches wide by 5 inches deep. BCD output is standard, as is programmability of the decimal point position and of slowing down the sampling rate (including hold). Isolation of the BCD output is available as an option.

Summing up, the Model 3330 is tiny, rugged, a miser on power and easy to service—yet it retains the Digilin automatic zeroing and high, constant input impedance. Price is $275. Digilin Inc., 1007 Air Way, Glendale, CA 91201. **327**



NC Units Interface with CRT Displays

Machine control units that combine the features of positioning (point-to-point) and continuous path (contouring) control are the latest offering of Tektronix. Both Model 1701 (2 axis) and Model 1702 (3 axis) are small and lightweight, and provide 0.0001 inch resolution as standard.

The ability to interface the Tektronix Type 611 storage display unit with the 1701 for tool center-line path observation is unique in the NC field. When checking out a part program tape, the speed at which the path is displayed is only limited by the speed of the tape reader. Programming errors typically are displayed as gross errors in tool path. By virtue of the speed of the CRT checkout mode, the programmer can discover his error quickly and return to his task. Without CRT checkout, the time required to check out a tape on the machine tool is wasted money for the user of NC equipment.

Both the 1701 and the 1702 provide and accept necessary signals for controlling a typical machine tool. However, the analog signals to drive the dc motors must be power amplified, and a position encoder must be provided to feed back position information to the control. Also, a "magnetics package" (typically a relay panel) is necessary to accept the decoded auxiliary information and convert it to information that can be accepted by the machine tool.

A major function of the machine control unit is to accurately control the movement and/or position of a tool in a 2- or 3-axis system. The 1701 and 1702 combine features of both positioning and continuous path control. The absolute dimensioning of the point-to-point control is combined with some of the interpolation techniques of the contouring control, resulting in a control that is adaptable to positioning or continuous path applications.

Both the 1701 and 1702 are "closed loop" controls (with feedback). In this system, X and Y information from the tape reader is decoded and stored in the X and Y axis command registers. The dc motors begin moving the head or the fixture table to the specified location by turning X and Y axis lead screws. A position encoder sends back a pulse for each increment of movement (for example, every 0.0001 inch) on each axis. A position register adds or subtracts feedback pulses from the encoder, and when the position of the table is equal to that of the command, drive to the X and Y motors stops.

Programming is typically accomplished through paper tape. Paper tape offers adequate speed, reliability, and a means of being able to check programmed data quickly through visual interpretation of the punched holes.

The 1701 and 1702 will be referred to, and find their widest acceptance as contouring controls because of their interpolation capabilities. Machine tool applications for contouring controls include milling or metal cutting machines, automatic drafting machines, metal shaping machines and seam welders.

List prices are $9750 for Model 1701 and $11,000 for Model 1702, with OEM discount applicable. Tektronix, Inc., Box 500, Beaverton, OR 97005. **328**

Meet the ComputerWrap Gang

Shari, Darlene, Lois, Shirley, Petie, and Paula. They're the six fastest guns anywhere with Microsystems COMPUTERWRAP™ time sharing system.

How fast? A new girl, on the job one week, can terminate 200 wires an hour. Experienced operators, 300. The ComputerWrap 600 automatically positions the board to optimize each wrapping operation. Provides visual and audible instructions for color coding, routing, length and twisted pair terminations.

Each termination is ideally positioned for operator inspection. Backup and rezeroing controls minimize operator effort.

IT'S FLEXIBLE

The ComputerWrap 600 gives you exceptional flexibility. All your wiring lists are stored in the memory of a computer and called up instantly as needed. It's much easier than juggling cards or trying to keep punched paper tape untangled, and you save dollars and increase reliability by not needing a tape controller with every station. You're not locked in on a single wiring list at a time, either. Each station works independently from different points on one or any number of different wiring lists.

YOU KNOW WHERE IT'S AT

Production control is simplified, too. Your supervisor can have an immediate status report showing wiring rate, estimated time to completion, and number of wires terminated at each station – simply by querying the computer.

YOU SAVE 3 TO 20¢ A WIRE

Studies show that in many applications, the ComputerWrap 600 system will pay for itself in less than a year. Users report savings of 3 to 20¢ a wire over other methods of wire termination.

One reason for these savings is that the ComputerWrap system is relatively inexpensive. In one company, the ComputerWrap system with 4 stations, complete computer control, and software, wraps more than 1000 wires an hour . . . with a capital investment of less than $100,000. Additional stations can be added for as little as $11,000. each.

A TREMENDOUS SOFTWARE PROGRAM, TOO

Our complete software library includes:

On-Line Data Preparation System prepares complete machine instructions using the PDP8/L computer supplied with the system.

Computer Data Preparation System prepares machine instructions on a medium-scale computer such as a 360/30.

Sequence List Editor Program allows operator to make immediate wiring changes directly from the ComputerWrap control keyboard without rerunning the complete program.

Restricted Area Program defines forbidden wiring areas and selects acceptable routes around them.

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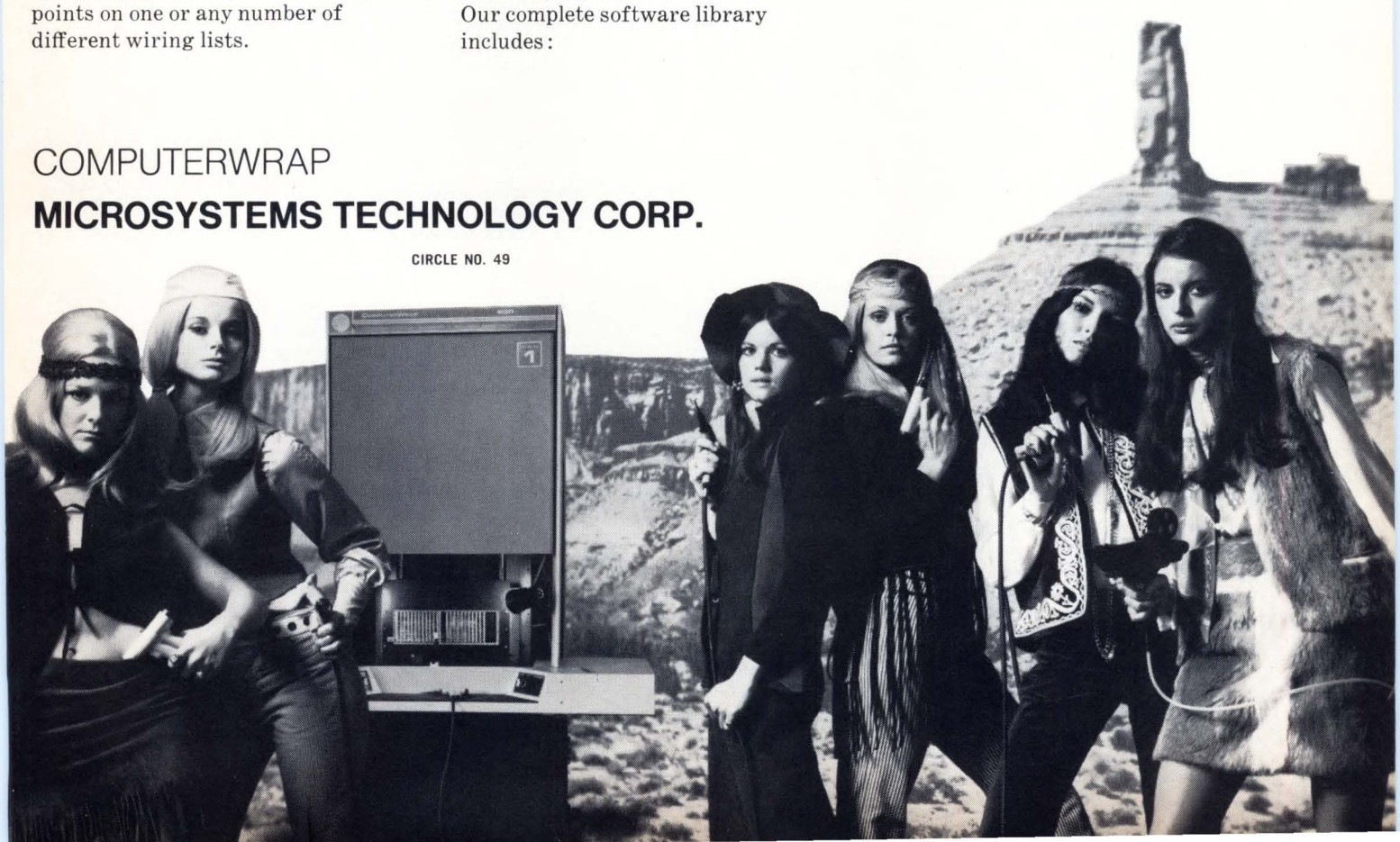
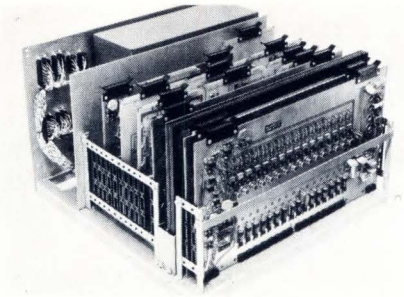
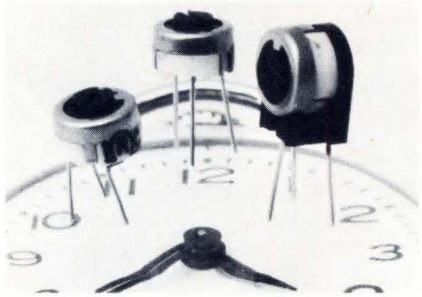
CIRCLE NO. 49

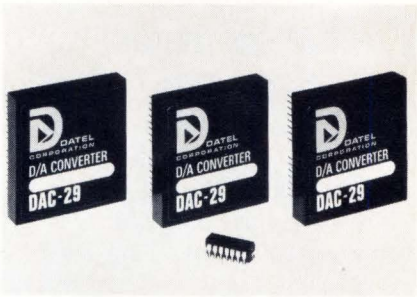




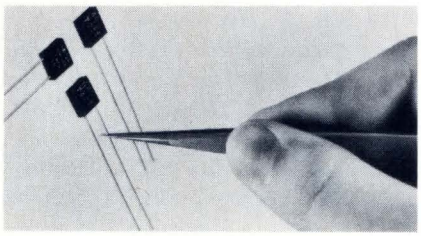
Plated-wire random-access memory, NM-1000 Series, exhibits speeds of 200 ns read access, 300 ns read time and 500 ns write time. Because of the modularity designed into the stack and its circuits, this series can be configured into systems of 4 to 16K words by 8 to 40 bits/word. A minimum system in this series is 4K by 16 or 8K by 8, while a maximum system is 4K by 40, 8K by 20 or 16K by 10. Nemonic Data Systems, Inc., 1301 W. Third Ave., Denver, CO 80223. **329**



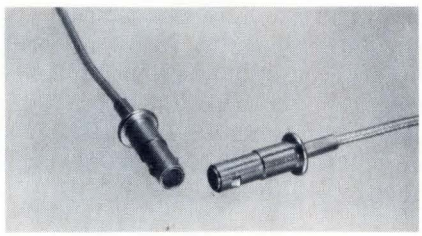
Trimming potentiometer, 170 Series, is obtainable with several different screw adjustments and pin configurations. Available resistance range is 10Ω to 1 MΩ. Temperature coefficient is ±100 ppm/°C maximum (±50 ppm/°C available) over −55 to 150°C temperature range. These 1/4-in round units have a standard resistance tolerance of ±20%, with ±10% available. Power rating is 0.5W at 85°C. IRC, Petersburg Div. of TRW Inc., 2801-72nd St. No., St. Petersburg, FL 33733. **332**



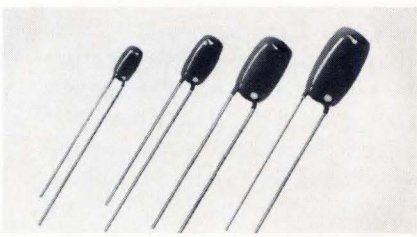
Eight-bit D/A converters, DAC-29 Series, incorporate the latest hybrid technology and are completely self-contained in a 2- by 2- by 0.4-in plastic case. Available in two versions (binary or BCD), their full-scale output can be either 0 to 10V or ±5V at 5 mA. All digital inputs are compatible with standard TTL/DTL logic levels, and pin locations are dual-in-line compatible. Price is $29 each. Datel Systems Corp. 943 Turnpike St., Canton, MA 02021. **335**



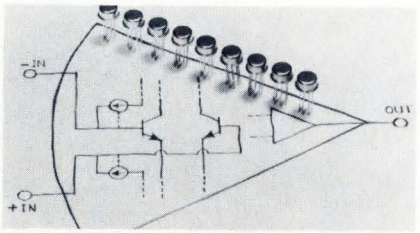
Precision film resistors, Model MK 132, are low cost units designed for high-density packaging. They measure 0.29 in² by 0.095 in thick and are supplied with radial leads. Resistors are noninductive and are rated at 0.5W at 105°C, with a resistance range from 100Ω to 5 MΩ. Standard tolerance is ±1% (±0.1% on special order). Temperature coefficient is 50 ppm/°C. Caddock Electronics, 3127 Chicago Ave., Riverside, CA 92507. **330**



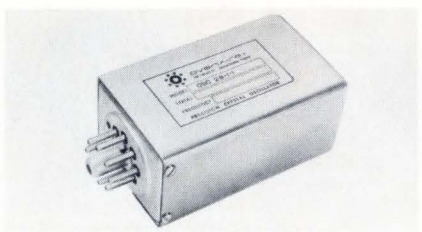
Three-piece "RIDGELOK" all-crimp 50Ω coaxial connectors use the "TWIST/CON" contact system to assure perfect contact alignment with extremely low engaging force. Designed for RF applications, four "RIDGELOKs" can be used in the same area as two 50Ω BNCs. Connectors have an average resistance of 4 mΩ and maximum contact resistance of 8.3 mΩ at 3A. Microdot Inc., 220 Pasadena Ave., South Pasadena, CA 91030. **333**



Dipped solid tantalum capacitors, GS Series, feature rugged plug-in lead construction and operate at full rated voltage from −55 to 85°C. Capacitance/voltage range is 0.47 μF at 50V through 330 μF at 6V. Four cylindrical cases are available ranging from 0.175 to 0.4-inch in diam by <0.35 to 0.75-inch in height. Prices range from less than $0.15 to $3.45. Dickson Electronics Corp., Box 1390, Scottsdale, AZ 85252. **336**

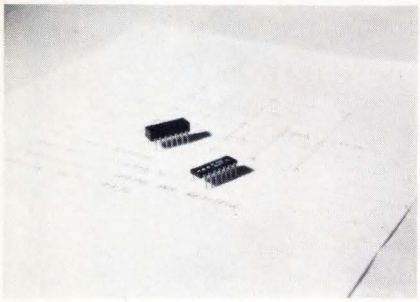


Monolithic operational amplifier, Model 3500, uses a cancellation technique to reduce input bias currents to 10 ns and thermal drift to 0.3 nA/°C. Slew rate is 1.5 V/μs. Input impedance is 5000 MΩ, common mode and 10 MΩ differential. Common-mode rejection is 90 dB and gain is 100 dB. Prices for the Model 3500 start at $10 in unit quantities. Burr-Brown Research Corp., International Airport Industrial Park, Tucson, AZ 85706. **331**

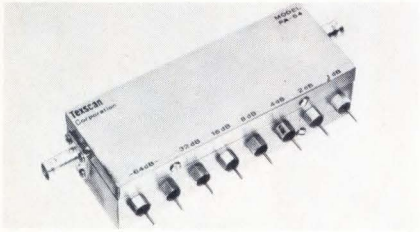


Oven-controlled oscillator, OSC 29 Series, reduces volume up to 52% over earlier models. It is available in any frequency from 2 to 25 MHz and with sine wave or logic outputs. These oscillators vary less than 5×10^{-9} from nominal frequency/°C change in ambient. There is a choice of miniature glass or coldweld crystal. Standard models operate from 28V dc. Ovenaire, Inc., 706 Forrest St., Charlottesville, VA 22901. **334**

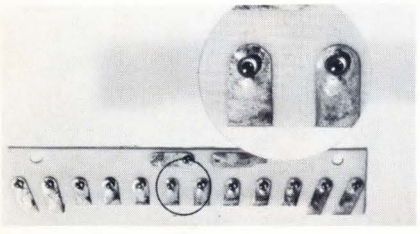
Fifty-ohm termination, Model CT-51, has VSWR of 1.1 nominal, 1.25 maximum from dc to 4 GHz. This device handles 1/2W CW or 1 kW peak power over the −25 to 85°C temperature range and is usable from −55 to 100°C. Model CT-51 is available with Type BNC, TNC, N and SMA connectors. Small-quantity prices range from $8.75 to $11.50 depending upon the connector. Elcom Systems Inc., 151-24 W. Industry Ct., Deer Park, NY 11729. **337**



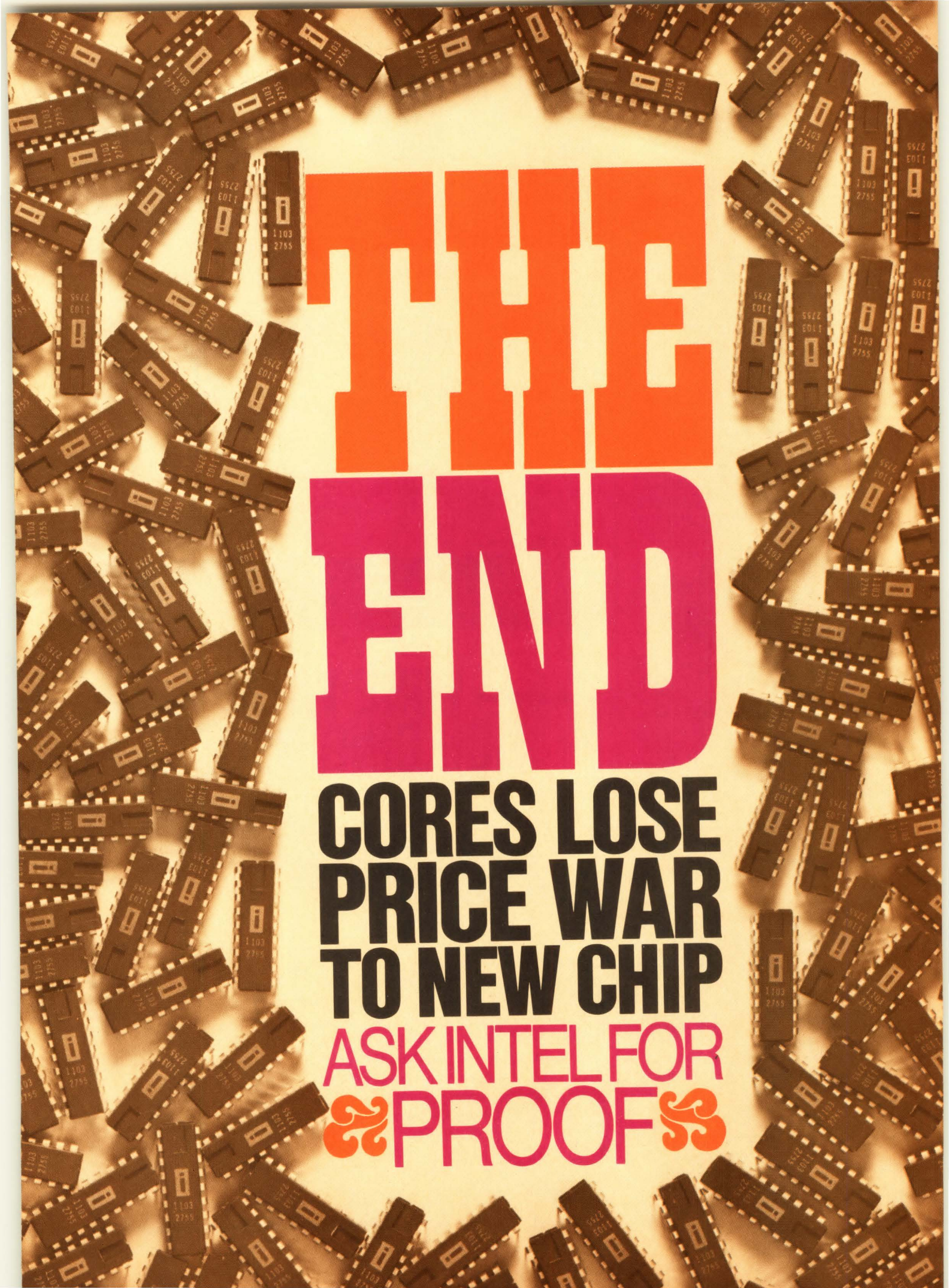
Custom-made, precision thin-film resistor networks come in a standard ceramic or epoxy 14-pin dual in-line package. Electrical specifications include: 1Ω to 100 KΩ resistance range, 5 to 0.25% tolerance, <100 ppm/°C to 25 ppm/°C absolute temperature coefficient. Both industrial and military temperature ranges are available. Price is $1 to $15 each, depending on tolerance and quantity. Micro-Electronic Subsystems, Inc., 20 Burr St., Framingham, MA 01701. **338**



Digitally programmable attenuator, PA-54, covers the frequency range of dc to 1000 MHz with a total attenuation range of 0 to 1277 dB in 1 dB steps. A control voltage of 26.5V dc applied to the dB position inputs sets attenuation in 4 ms. Available in 50Ω, the PA-54 can be obtained with BNC, TNC, N and SMA connectors. Unit price is $795.00. Texscan Corp., 2446 N. Shadeland Ave., Indianapolis, IN 46219. **339**



Punched-card reader units offer matched circuit-board assemblies containing 12 light-emitting diodes on one board and 12 phototransistors on the other, with board-to-board distance of 0.1 to 0.25 in. Spacing between channels is typically 0.25 in. The 12-channel phototransistor board assembly is available separately for customers using other illumination sources. Spectronics, 541 Sterling Dr., Richardson, TX 75080. **340**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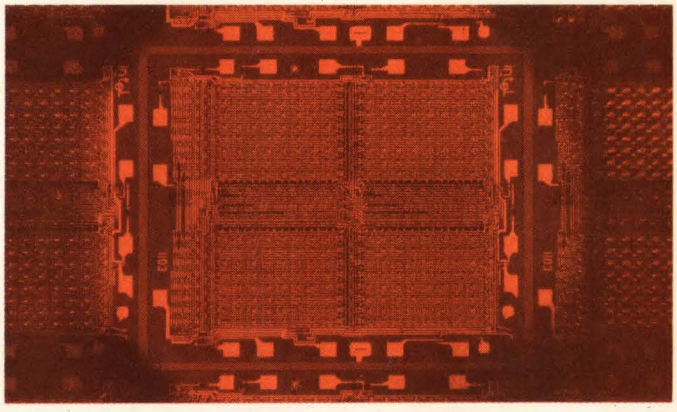

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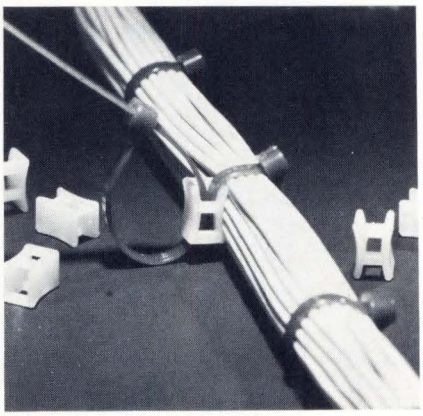
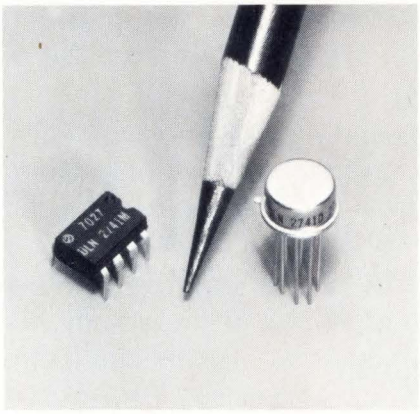
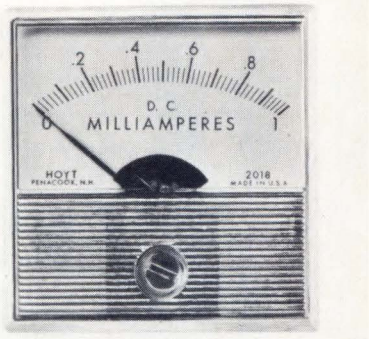


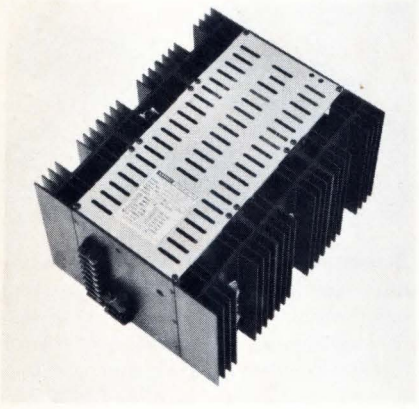
Cable bundle spacer, compact and lightweight TC-339, separates two wire bundles 1/4 in apart to reduce cross-talk or inter-circuit induction for AF and RF applications. Composed of high-strength nylon, the TC-339 is impervious to fungus and most chemicals. To use, each respective cable bundle is held in place by two "TY-RAP" TY-5 or TY25M cable ties looped through the spacer and pulled tight. The Thomas & Betts Co., 36 Butler St., Elizabeth, N J 07207. **341**



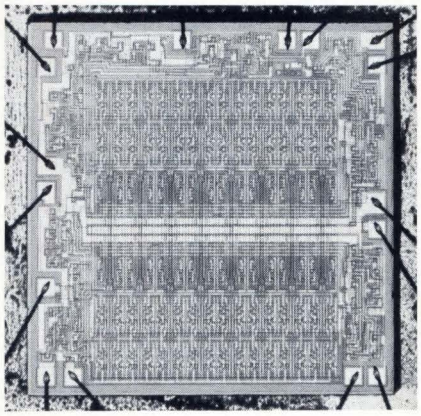
Operational amplifiers, 741 Series, require no frequency compensation networks. In a hermetically sealed TO-78 package, the ULN-2741D, intended for 0 to 70°C operation, is priced at $2.25 each in quantities of 100 to 999. Same device in a miniature 8-pin DIP, ULN-2741M, sells for $2.10 in the same quantities. All units include short circuit protection and 6 dB/octave roll-off. Sprague Electric Co., North Adams, MA 01247. **342**



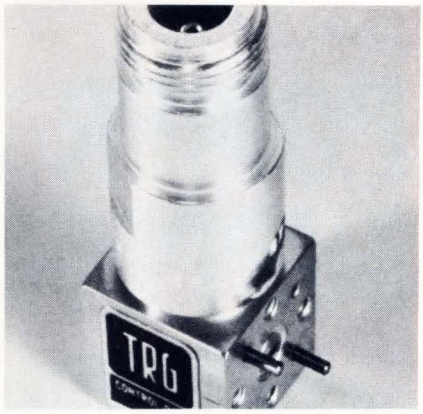
Panel meter Model 2018 is a 1-1/2-in² unit with a frictionless taut-band movement. Movement is completely shielded and will not interact with other meters or be affected by stray magnetic fields. Available sensitivities are from 100 μA up to 5A and, as a dc voltmeter, up to 300V dc self contained. Model 2018 may be used behind the panel with a die cast metal bezel or with painted fronts. Hoyt Electrical Instrument Works, Inc., 556 Trapelo Rd., Belmont, MA 02179. **343**



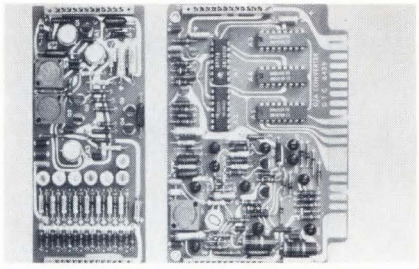
Power module, K6 Series, converts 11 to 13V dc to 115, 220 or 440V ac, 60 Hz at 60 VA. Latest design techniques yield a 5- by 8- by 8-3/4-in package with complete isolation between all inputs and outputs. Regulation is within ±0.2% for 11 to 13V input and is within 1% for load changes of 1/2 to full load. Price is as low as $570 each for two to four piece quantity. Abbott Transistor Laboratories, Inc., 5200 W. Jefferson Blvd., Los Angeles, CA 90016. **344**



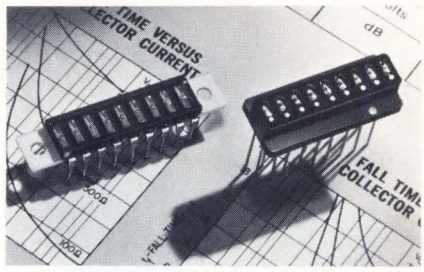
Bipolar random access memory, RAM-0064, is organized in a 16- by 4-bit array and Schottky clamped transistors are employed to attain access times of 35 ns. This fully decoded RAM is available in a 16-pin dual in-line package. Power dissipation is 6 mW/bit. Prices for 100 to 999 quantities are $25.60 (0 to 75°C) and $32.00 (−55 to 125°C). Harris Semiconductor, formerly Radiation, Inc., Microelectronics Div., Melbourne, FL 32901. **345**



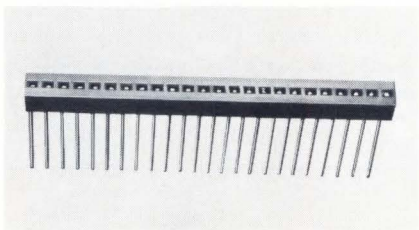
Millimeter Schottky barrier mixers, TRG Series 960, mount in the waveguide and are available in each waveguide size from 26.5 to 220 GHz. Fixed tuned RF bandwidth up to 11 GHz at the upper end of the frequency spectrum is possible. Intermediate-frequency bandwidths up to 4 GHz with IF frequencies up to 8 GHz are available. Model No. W 960 is $1395 including diode. Control Data Corp., Boston Space and Defense Systems Div., 400 Border St., East Boston, MA 02128. **346**



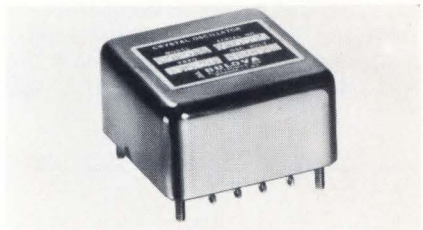
High-speed 9-bit D/A converter, Model 6439, operates "glitch-free" at speeds up to 1 MHz. Settling time is typically 500 ns. Model 6439 is packaged on a double printed circuit board with single edge 44-pin connector. Overall dimensions are 4.5 by 3.33 by 0.75 in. Full-scale output into a 2 KΩ load is ±10V. Parallel TTL outputs are included for special interface requirements. Price is $350. Data Technology, 1050 E. Meadow Cir., Palo Alto, CA 94303. **347**



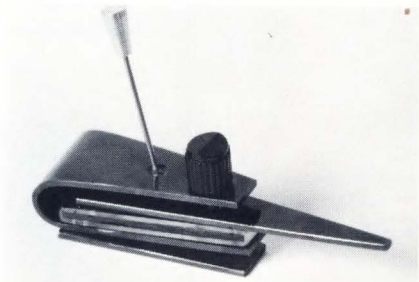
Nine-position array ST/A71 and dual in-line tape reader ST/A72 contain nine matched npn phototransistors, each electrically isolated and mounted on 100-mil centers. They are housed in standard drop-in packages and encapsulated to deliver high illumination sensitivity and stable electrical characteristics even under high-humidity conditions. These units interface directly with DTL, RTL, or TTL logic circuits. Sensor Technology, 7118 Gerald Ave., Van Nuys, CA 91406. **350**



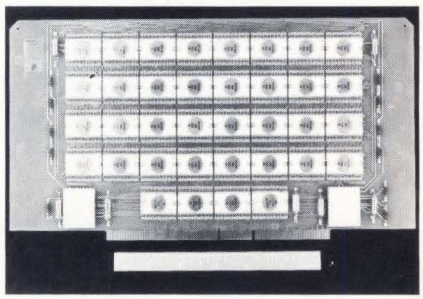
Contact strips provide mounting capability for odd-sized DIP packages. Strips may be butted end-to-end, maintaining the 0.1-in spacing over any length of DIP strips. Leads are in-line on 0.1-in spacing and are up to 0.025-inch in diam. Closed entry chamfered lead-ins permit smoother insertion and less chance for damage to inserted devices. Robinson-Nugent, Inc., 800 East 8th St., New Albany, IN 47150. **348**



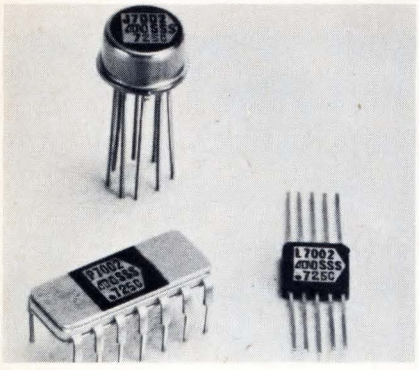
Temperature compensated crystal oscillator, Model TCXO-2, has a frequency stability of $\pm 2/10^7$ over the temperature range of −40 to 75°C. Packaged in less than 4 in^3 and weighing only 5 oz, the Model TCXO-2 operates over a frequency range of 3 to 5 MHz. The unit meets material, parts and environmental requirements of MIL-E-5400, MIL-E-4158 and MIL-E-16400. Bulova Watch Co., Inc., 61-20 Woodside Ave., Woodside, NY 11377. **351**



Ball bearing table glides and a spherical friction drive combine to eliminate the basic weakness of typical wafer probe positioners. Design is free of maintenance screws or adjustments. Delta model offers quick probe change and employs a smooth Z-axis control to set down precisely on target. Olson Industrial Corp., 3910 So. Kalamath St., Englewood, CO 80110. **349**

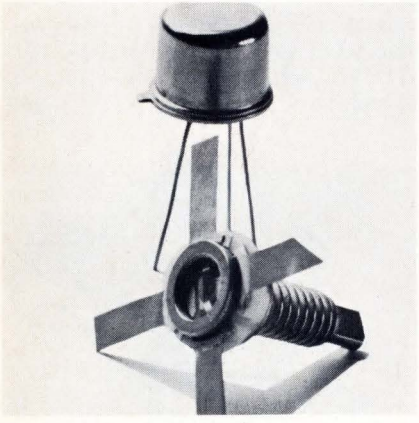


Series of MOS/LSI modular "cards only" memory systems has storage capacities of up to 65,536 words by 1 through 40-bits sequentially. Marketed under the "MEMOS-I" trademark, typical specifications include: 750 ns cycle time, 500 ns access time, and 0.25 mW/bit power consumption. North American Rockwell Microelectronics Co., 34320 Miraloma Ave., Anaheim, CA 92803. **352**

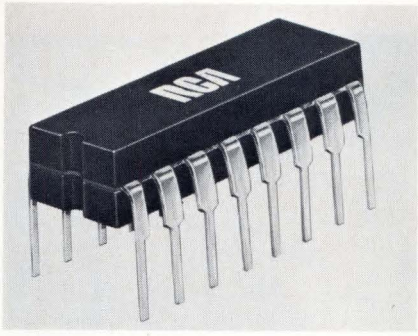


Monolithic instrumentation op amps Models SSS 725 and 725C offer input offset voltages of 0.5 and 1.3 mV max, offset voltage drift of 1 and 1.5 mV/°C max, input offset current of 5 and 13 nA, operational temperature range of −55 to 125°C and 0 to 70°C, voltage gain of 1,000,000 and 500,000, CMRR of 120 and 100 dB; and in lots of 100 items, prices are $25 and $7.50 each respectively. Precision Monolithics Inc., 1550 Space Park Dr., Santa Clara, CA 95050. **353**

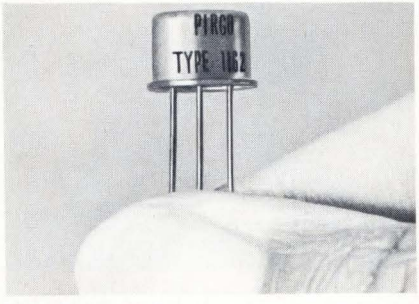
Monolithic ICs for suppression of high noise comprise the Series FZ 100 units that have a static margin of 5 and 8V, depending on the logic state, and a supply voltage of 15V. Circuits are housed in a 16-pin, dual in-line container and operate from 0 to 70°C for Series 1 and from −25 to 80°C for Series 2. Components Div./ Siemens Corp., 186 Wood Ave. S., Iselin, N J 08830. **354**



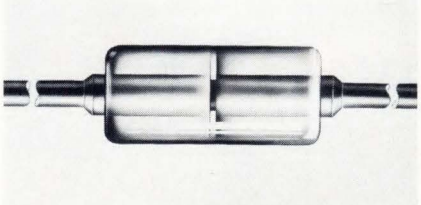
Microwave power transistors operate from 175 MHz to 2 GHz producing 10W of output power with a minimum of 6 dB gain at 1 GHz. The line features the 2N5108A npn "overlay" ultra-low leakage unit that is capable of producing a minimum of 1W ac output power when operated at a frequency of 1 GHz with a gain of 5 dB. In lots of 100 to 999, prices range from $1.50 for a 400 MHz, 1W unit to $60 for a 1 GHz, 10W unit. Raytheon Co., Lexington, MA 02173. **355**



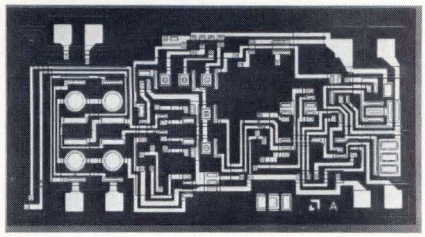
COS/MOS ICs (CD4000E) are packaged in plastic containers, include 19 members in the family. There are seven gates, one flip-flop, two logic-level converters, one multiplexer, three static shift registers, four counters and one adder. In lots of 1,000 items, prices range from $2.20 each to $9.50 each. RCA/Commercial Engineering Dept., Harrison, N. J. 07029. **356**



Monolithic Darlington power transistor Type 1162 is a 7A device that will dissipate 5W. Peak I_C is 10A with a 7A continuous I_C rating. Minimum gain is 2500, and BV_{CEO} is 60V. Price in lots from 100 to 999 is $15.90 each. Pirgo Electronics Inc., 130 Central Ave., Farmingdale, L. I., NY 11735. **357**

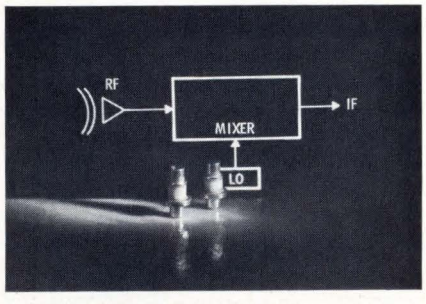


Varactor tuning diode G702A is a 10% tolerance device rated at 2.2 pF at −4V with a Q of 700 and a breakdown voltage rating of 25V at 1 μA dc. The unit has a package inductance of 1.4 nH, and a capacitance of approximately 0.1 pF. It is for applications up to 2.5 GHz , and in quantities from 100 to 999, it is priced $6.72 each. MSI Electronics Inc., 34-32 57th St., Woodside, NY 11377. **358**

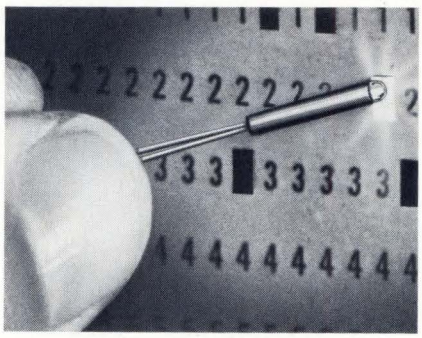


Low-level operational amplifiers for instrumentation applications include the 725, 108 and 108A units. While the 725 incorporates low-current bipolar transistors, input-transistor matching and low-noise technology, the 108/108A units employ super-beta transistors for better performance than FET amplifiers over the operating temperature range, both in offset current and voltage. In 100-up quantities, the 0 to 70°C unit is priced $10.00 (108), $20.00 (108A) and $7.50 (725). Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, CA 94086. **359**

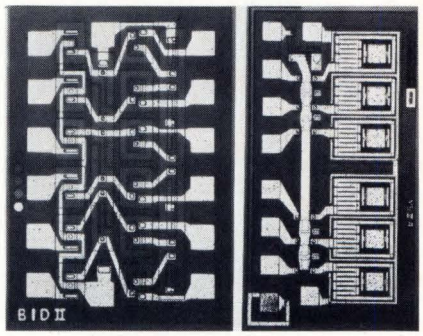
Integrated circuit 64-bit read-write memory SMX 283 is a nondestruct read-out device with access time in the 50 ns range. It consists of 64 flip-flop storage elements arranged in a 16-word by 4-bit matrix. The unit operates from 0 to 75°C, requires a 5V supply. Typical write recovery and sense recovery time is 35 ns with power dissipation to 350 mW. The unit is packaged in a 16-lead, ceramic, plug-in container. Sylvania Advertising Services Center, 7 Empire Dr., West Seneca, NY 14224. **360**



Schottky-barrier mixer diodes include six new devices that offer single side-band noise figures that range from 6 to 8 dB. Designated MD0189-191 and MD0219-221, these units are designed for X-band applications, and maximum noise figures measured at 9.375 GHz are: 6.0 dB, 6.5 dB and 7.0 dB for the 189 through 191 units; for the 219-221 units, used for Ku-band, maximum noise figures measured at 16.0 GHz of 7.0 dB, 7.5 dB and 8.0 dB respectively. In small quantities, units are priced $20 for the 191 unit to $50 for the MD0189 unit. Texas Instruments Incorporated, Box 5012, M/S 308, Dallas, TX 75222. **361**

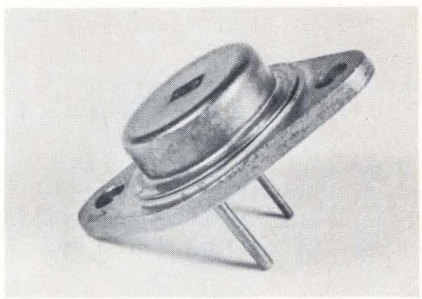


Silicon phototransistor STPT40 is a fast switching unit offering 1.5 μs typical rise time, 5 μs fall time which allow rapid reading for character recognition, tape and card read-out, photo switching and symmetry control. Collector-emitter breakdown voltage is 50V min. Sensor Technology Inc., 7118 Gerald Ave., Van Nuys, CA 91406. **362**

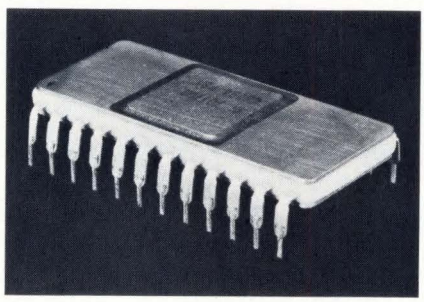


Monolithic driver and MOS FET switches for applications over the temperature range of −20 to 85°C include the D125BK six-channel driver, the G115BK six-channel MOS FET switch, and the G123BK four-channel commutator. In lots of 100 items, prices are $8.25, $9.75 and $6.90 respectively. Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, CA 95054. **365**

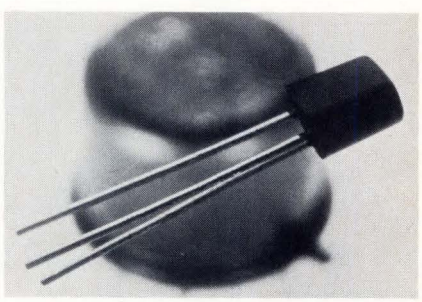
High-performance linear op amps comprise a large standard line of second source units that are pin-for-pin replacements for competitive items. The line includes the QC 101/101A, QC 748, QC 741/747, QC 107, QC 108 and QC 1556. Qualidyne Corp., 3699 Tahoe Way, Santa Clara, CA 95051. **363**



Germanium power pnp transistors 2N2294-96, 2N1073-A-B and 2N2288-93 are 20A diffused alloy units that feature a V_{CE} (sat) as low as 0.4V, a V_{CBO} and V_{CEO} from 60 to 200V. Solitron Devices Inc., 1177 Blue Heron Blvd., Riviera Beach, FL 33404. **366**

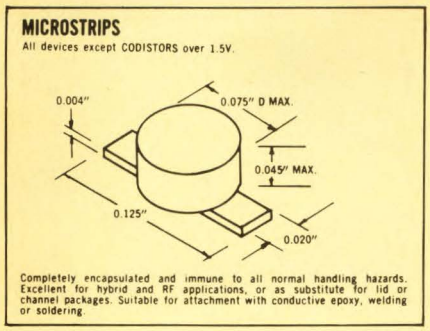


Random access memory (RAM) RM53L is a 512 by 1-bit read-write MOS unit designed for high-speed scratchpad, mainframe and low-power memory applications. The unit contains a 9-bit address word-decoder, a high-speed current-mode data output and a chip disable function. It operates from 0 to 70°C with a 425 ns cycle and 250 ns access time. American Micro-Systems, Inc., 3800 Homestead Rd., Santa Clara, CA 95051. **364**

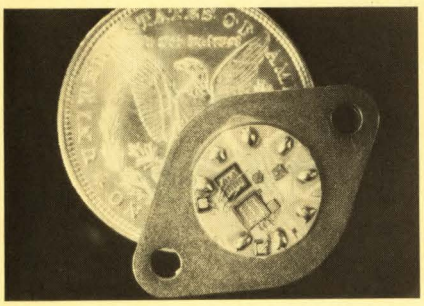


Complementary signal transistors packaged in epoxy encapsulated TO-18 containers are intended for industrial/computer applications. The 2N6000/6007 offer low noise performance with leakage guaranteed to <10NA. The 2N6010/6017 feature power dissipation ratings of 500 mW at 25°C and an I_C rating of 800 mA. In lots of 10,000 units, prices start at $0.27 each. General Electric, Northern Concourse Office Bldg., North Syracuse, NY 13212. **367**

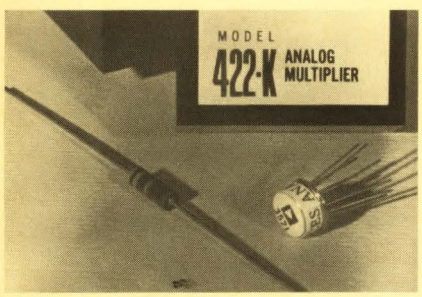
New SC's



Voltage variable capacitors (1N5139A-48A low-leakage, high-voltage, high Q units, 1N4805A-15A high-voltage, low Q units and Types 1001-1019 high tuning ratio units) are packaged in "Ladybug" configuration designed specifically for thick- or thin-film hybrid applications. CODI Semiconductor Div. of Computer Diode Corp., Pollitt Dr., Fair Lawn, N J 07410. **368**



Hybrid power amplifier HMD 2000 operates in either a linear or switching mode and can deliver 3A peak current with supplies of ±25V. Unit is mounted in a TO-3 package, and price is $10.50 each. TRW Semiconductor Div., 14250 Aviation Blvd., Lawndale, CA 90260. **369**



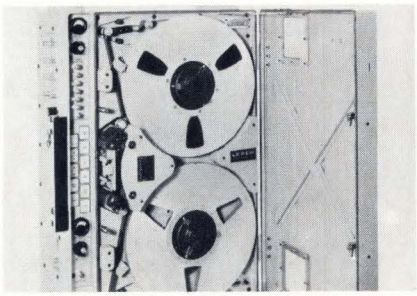
Analog multiplier Model 422 offers a 5 MHz small signal bandwidth, 1.6 MHz full power response, 100 V/μs slewing rate, and only 1° phase shift at 2 MHz. Untrimmed gain accuracy is 1%, which can be improved to 0.7% with external trimming. Nonlinearity remains below 1% to 100 kHz, and dc drift is 2 mV/°C. In lots of one to nine, price is $109 each. Analog Devices Inc., 221 Fifth St., Cambridge, MA 02142. **370**

Portable calculator has 16-digit capability and an 8-digit visual readout. Weighing 40 oz and battery powered, it adds, subtracts, divides and multiplies in milliseconds. Selling price is $495. Dictaphone Corp., 120 Old Post Rd., Rye, NY 10580. **372**

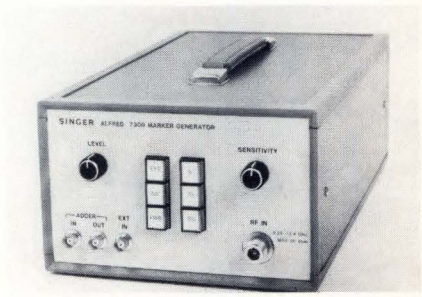
Computer printer is silent, operates on-line at 5000 lines/min and is priced as low as $15,000. The Statos 21 uses 640 writing heads across an 8-1/2-inch page and can produce maps and charts at the same high speed. Varian Assoc., 611 Hansen Way, Palo Alto, CA 94303. **375**

Tape search system, Model 3400, when used in conjunction with a Datatron Model 3200 time code translator, functions under control of a 12- or 16-bit computer. With it, a series of computer input bytes defines start and stop times, tape search unit mode and recorder motion commands. Adopting computer-control adds less than $3000 to the price of a standard translator/tape search system. Datatron, Inc., 1562 Reynolds Ave., Santa Ana, CA 92705. **373**

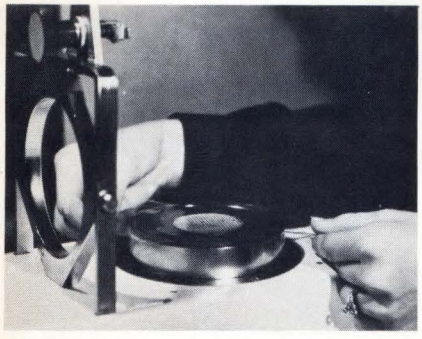
Combination facsimile machine and office copier, Model KD-111, sends and receives printed, typewritten or handwritten documents over regular telephone lines using conventional telephone hand sets. Scanning is at 240 lines/min which allows an 8-1/2- by 11-in page to be transmitted and received in less than 4 min. As a copier, it produces 8-1/2- by 11-in copies for 2-1/2 cents each. Visual Sciences, Inc., 900 Walt Whitman Rd., Huntington Station, NY 11746. **376**



Magnetic recorder/reproducer provides 14 channels record and reproduce on 1-in tape or 7 channels of each on 1/2-in tape. Frequency response of the Model MTR-7100 is 800 Hz to 2 MHz analog data at 120 ips. Tape speed range is from 3-3/4 to 120 ips with accuracy of ±0.2%. Leach Corp., Controls Div., 717 N. Coney Ave., Azusa, CA 91702. **374**

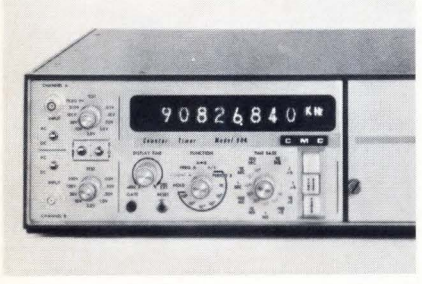


Marker generator, Model 7300, provides 100, 25, and 5 MHz internal markers with 0.0005% accuracy. Marker amplitudes have the ratio 1, 2/3 and 1/3 respectively and markers are very narrow and rectangular. Operating range is 50 MHz to 18 GHz. Price is $1400. Singer, Instrumentation Div., 915 Pembroke St., Bridgeport, CT 06608. **378**

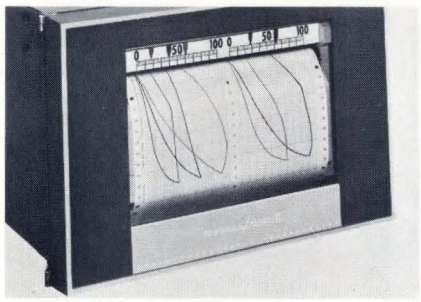


Dice-handling system retains the original wafer orientation during handling and permits probing without reorientation. The Model 2600 Die Matrix Expander measures 18 in² by 8 in high. Price is $1970. Hugle Industries, Inc., 625 N. Pastoria Ave., Sunnyvale, CA 94086. **379**

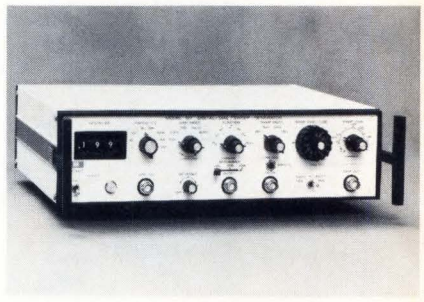
DMM, battery operable, has BCD output and remote program options. Model LX-2 features automatic range and polarity selection on four ranges of ac and dc voltage from 100 μV to 1000V, and resistance from 100 mΩ to 1.25 MΩ. Also standard is a multifunction ratio measurement mode (dc/dc, ac/dc, Ω/dc) and a switchable 60 dB input filter. Reading speed on all function modes is 500 ms. Base price is $795. Non Linear Systems Inc., Box N, Del Mar, CA 92014. **380**



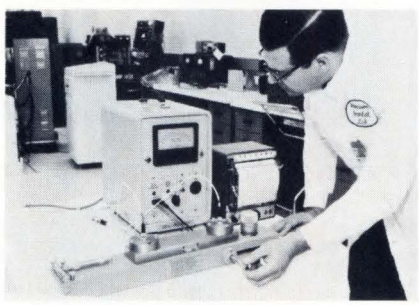
Counter-timer, Model 904, counts directly to 200 MHz without prescaling and measures frequency, period, multiple period averaging, ratio, multiple ratio averaging, time interval, totalizing, and scaling without added plug-ins. Introductory price is $1975. Computer Measurements Co., 12970 Bradley Ave., San Fernando, CA 91342. **381**



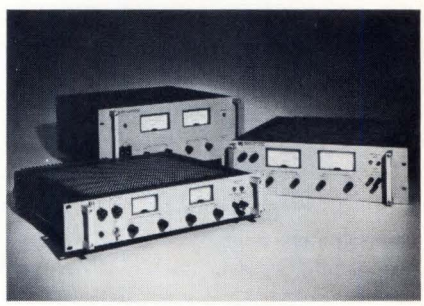
X-Y recorder, the "contour/riter" II, is available with one, two, three or four overlapping pens, or with dual charts up to five pens. Suitable for unattended recording and industrial applications, the unit has accuracy of 0.25%. Linearity on both X and Y axes is ±0.1% of FS, with deadband less than 0.1% of FS. Single-pen model price is $2240. Texas Instruments Incorporated, Digital Systems Div., Box 66027, Houston, TX 77006. **382**



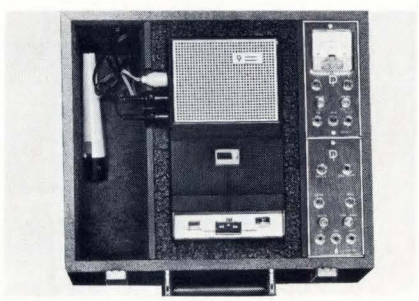
Waveform generator combines digital frequency dial with VCF and sweep operations. Model 127 has frequency range of 0.1 Hz to 3 MHz and produces sine, square, triangle, ramp, pulse and sync waveforms. It can operate in run, gate, triggered, burst, pulse or sweep mode. The sweep generator provides a linear ramp with duration from 100s to 10 μs. Price is $645. Exact Electronics, Inc., Box 160, Hillsboro, OR 97123. **385**



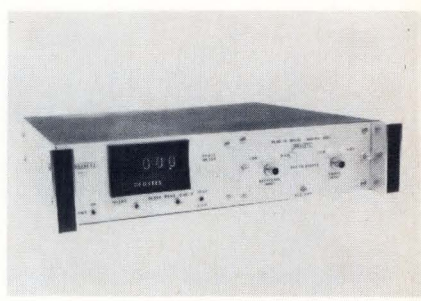
Tilt meter will detect movements of as little as 0.01s of arc, or less than 0.5 inch of tilt in 100 mi. The Model DCTM is sensitive to frequencies from 0.01 to 100 Hz and is valuable for sensing optical table vibrations. Ideal-Aerosmith, Inc., 1505 E. Fox Farm Rd., Cheyenne, WY 82001. **383**



Power supplies, Series LVR-B, feature internal overvoltage crowbar and low pk-pk ripple. Thirteen models with voltages from 10 to 60V and currents up to 100A are available. There is provision for remote programming. Prices start at $350. Hewlett-Packard Co., Berkeley Heights, N J 07922. **386**



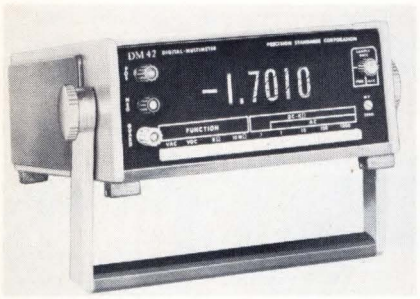
Cassette record/reproduce system, Model 7001, features a dc to 1000 Hz frequency range with signal-to-noise ratio better than 34 dB pk-pk. Continuous record time for this analog unit is 30 min at 1-7/8 ips using a C-60 cassette. An accessory timer allows periodic sampling of slowly varying data. Price is $595. Dallas Instruments, Inc., 9627 Liptonshire Dr., Dallas, TX 75238. **384**



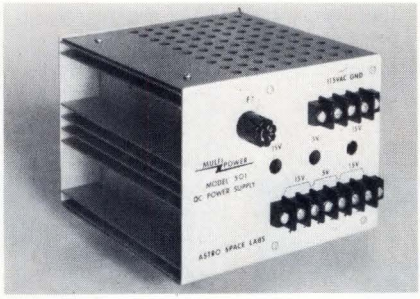
Broadband phase meter, Series 305, has direct reading accuracy of better than ±0.1° over the full 360° range and requires no adjustment for level or frequency. Main frames, available for digital or analog output, accept plug-ins that permit measurement to 10 MHz. Price range is $1200 to $3000. Dranetz Engineering Labs., Inc., 1233 North Ave., Plainfield, N J 07062. **387**

Pulse generator with extremely low output impedance can drive Gunn-effect oscillators directly. When terminated in 10Ω, the Model 304A provides voltage pulses to 50V amplitude with little aberration. Operation is either free-running or gated, and the pulse repetition rate can be varied from 100 Hz to 1 MHz. Maximum duty cycle is 10%. Price is $895. Monsanto Microwave Products, 11636 Administration Dr., St. Louis, MO 63141. **388**

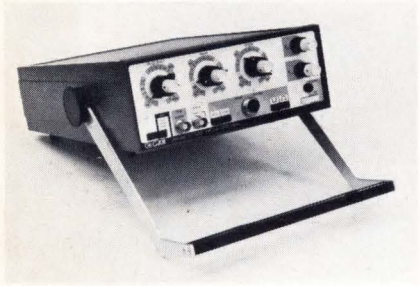
Digital cassette recorder is battery operated yet has true bit-by-bit incremental capability. Model 1100DC draws only 150 mA while recording data and features write speed up to 300 steps/s, rewind speed of 30 in/s and packing density of 100 bits/in. Size is 4.5 by 3.8 by 2.6 in and weight is 30 oz. Cassettes are standard industrial grade (computer-certified after assembly). CompuCord, Inc., 225 Crescent St., Waltham, MA 02154 **391**



Multimeter, the 4-1/2-digit Model DM42, measures dc volts, ac volts and ohms with respective accuracies of 0.02%, 0.2% and 0.05%. Features include 100% overranging, 5 readings/s and 10 μV dc resolution. Price is $690. Precision Standards Corp., 1701 Reynolds Ave., Santa Ana, CA 92705. **389**

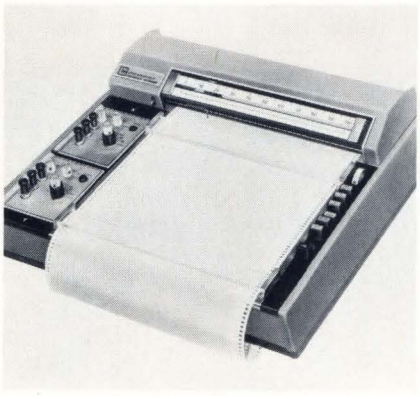


Multi-output power supply, Model 501, delivers +5V at 2.5A, +15V at 0.5A and −15V at 0.5A—each with ±10% voltage adjustment. Current limiting is standard and overvoltage crowbar optional. Price for this convection-cooled supply is $125. Astro-Space Labs., Inc., Research Park, Huntsville, AL 35806. **392**

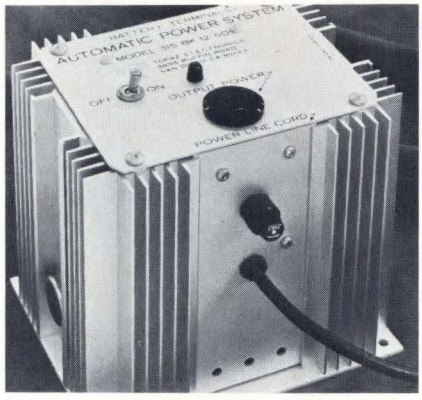


MOS driver, Model G720, is designed as a clock or data driver for MOS integrated circuits and features 5 Hz to 10 MHz repetition frequency, delay and width from 50 ns to 200 ms, risetime of 1 ns/V with a 100 pF load and two separate, buffered trigger outputs. Second in the new "G70" line the unit is priced at $495. E-H Research Labs., Inc., Box 1289, Oakland, CA 94604. **390**

Data terminal, priced at $1650, uses mag tape cassettes and incorporates both low speed incremental and high speed asynchronous interfaces. The Model 4100 has both read and write capability and features attended/unattended operation, data edit, ASCII or IBM coding and serial or parallel interfaces. Technical Concepts, Inc., 580 Jefferson Rd., Rochester, NY 14623. **393**



Flatbed X-Y recorder, Model XL 683, also offers X-t operation. The X-function drives the recorder pen across the chart while the Y-function drives the low-inertia chart beneath the pen. Chart span is 250 mm on each axis. Performance specifications include accuracy of ±0.25% of either span, span-step-response time of 0.5s on the X-axis and 0.7s on the Y-axis and automatic gain and damping on both functions. Leeds & Northrup Co., Sumneytown Pike, North Wales, PA 19454. **394**



Automatic power system supplies 300 VA of ac back-up power in less than one cycle in case of power line failure. Loads up to 300W may be drawn for periods up to 15 min when using a 24 ampere-hour lead-acid battery. Model 315 BK-12-60 has its inverter output automatically protected against overloads and short circuits, and its input is protected against reverse-polarity connection. Price is $200. Topaz Electronics, 3855 Ruffin Rd., San Diego, CA 92123. **395**

Disposable medical thermometer permits 5s temperature measurement accurate within three-tenths of a degree. It consists of a plastic, hand-held meter and a disposable sensing device connected to it by an 18-in cord. The entire unit weighs less than 1 lb and can be cold sterilized. Meter price is less than $40 and disposable cord and sensor assemblies will cost less than $0.10 each. Sloan Technology Corp., Box 4608, Santa Barbara, CA 93103. **396**

Miniature, permanent magnet dc motors are covered in this four-page bulletin. These motors offer continuous-duty outputs to 0.07 hp, and the largest has a diameter of only 2-1/16 in. Pittman Corp., Box 150, Sellersville, PA 18960. **420**

Rocker circuit breakers, Series JC, that come in one-, two- and three-pole models are discussed in Bulletin 3381. Copies are available from Heinemann Electric Co., 235 Magnetic Dr., Trenton, N J 08602. **424**

A/D/A conversion, signal conditioning and digital display products are covered in a new short form catalog. The 16 pages include basic specs and descriptive data on an entire line. Analogic Corp., Audubon Rd., Wakefield, MA 01880. **428**

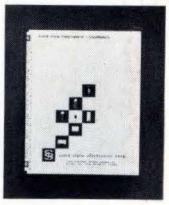
Broadband varactor frequency multipliers for operation from 30 MHz to 16 GHz are covered in this eight-page catalog. The units described combine frequency multiplication and high power output into one highly reliable, solid-state package. Applied Research Inc., 76 S. Bayles Ave., Port Washington, NY 11050. **421**

Miniature solid-state servo amplifiers are covered in eight-page Bulletin No. 100. Servo amplifiers with a range from 2 to 40W output power are discussed along with 400 Hz application units. Servo Products, Electronics Div., Bulova Watch Co., Inc., 61-20 Woodside Ave., Woodside, NY 11377. **425**

Catalog No. 119 contains 64 pages covering over 300 off-the-shelf terminals and features a comprehensive 18-page Soldering Standards Handbook. The right and wrong ways to connect terminal leads are graphically presented in a series of 20 photographs. United Products Co., 451 S. Jefferson St., Orange, N J 07050. **429**

Delay Lines and Filters, 12-page Catalog No. 14, covers custom built, standard fixed, variable and laboratory-type delay lines, in addition to custom-built and stocked L-C filters. The world's smallest delay line having a time delay to rise time ratio greater than 5:1 also is discussed. Allen Avionics, Inc., 224 E. 2nd St., Mineola, NY 11501. **422**

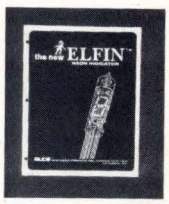
Electronic Sensors and Controls, a three-ring binder catalog for time, voltage, frequency and phase, includes product sections on ac and dc solid state relays, programmers, flashers, ac and dc voltage, frequency, phase and current sensors, time delay relays and power monitors. Logitek, Inc., 42 Central Dr., Farmingdale, NY 11735. **426**



FM-FM telemetering modules are described in this 40-page catalog. The line includes voltage controlled oscillators, dc amplifiers, dc signal isolators, frequency-to-dc converters, tone oscillators, pressure transducers and laboratory telemetering system. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, CA 91343. **430**

Capacitors are covered in this 20-page catalog that includes sections on dc capacitors, dc filter capacitors, pulse and RF capacitors, low-inductance, fast discharge capacitors, instrumentation and signalling units, SCR commutators and snubbers, arc suppressors and noise filters, pulse forming networks and power supplies. Condenser Products Corp., Box 997, Brooksville, FL 33512. **423**

Display computer systems are the subject of this eight-page brochure describing several ways that Series 16 computers are communicating with graphic-display terminals. Customer applications are included in which computers are used as communication centers for a wide variety of display systems. Public Information Dept., Honeywell Computer Control Div., Old Connecticut Path, Framingham, MA 01701. **427**



Displays and lamps are covered in three new catalogs that include the "ELFIN" neon display devices and associated hybrid decoder-drivers, "ALCO-DISPLAY", providing information on an expanded line of incandescent readouts and "ALCO-LITE" miniature indicating lamps and assemblies. ALCO Electronic Products, Inc., 8 Marblehead St., North Andover, MA 01845. **431**

Ferrite applications including inductors, transducers, filters, shielding devices, transformers and magnetostrictive devices are described in a 16-page brochure from Ceramic Magnetics, Inc., 87 Fairfield Rd., Fairfield, N J 07006. **432**

Keyboard key modules, human-engineered for the sound and feel of typewriter keys, are described in Bulletin KM-201. Cherry Electrical Products, 3600 Sunset Ave., Waukegan, IL 60085. **433**

Seven-segment digital panel meter, Model 3350, is a single- or dual-range DVM. It is described in a four-page data sheet from Electro-Numerics Corp., 2961 Corvin Dr., Santa Clara, CA 95051. **434**

Acoustic telephone coupler 701B is fully compatible with conversational terminals operating at data rates in excess of 450 baud. The unit is described in a new six-page brochure. Omnitec Corp., 903 N. Second St., Phoenix, AZ 85004. **435**

Standard numeric keyboards in 10-, 11-, 12-, 14- and 16-key versions featuring dry-reed switch contact and modular construction are described in Bulletin DS 101. Controls Research Corp., 2100 S. Fairview, Santa Ana, CA 92704. **436**

High torque stepping motors that position loads in increments of 10, 12, 18 or 24 positions are covered in eight-page Catalog D-7000. Ledex Div., Ledex Inc., 123 Webster St., Dayton, OH 45401. **437**

Counting, recording and controlling instruments are featured in 72-page total capability Catalog No. 2183. Veeder-Root, 70 Sargeant St., Hartford, CT 06102. **438**

Medium power bench dc power supplies (MPB-3 Series) spanning the range from 7.5 to 100V and 0.75 to 5A are covered in a four-page bulletin. Hewlett-Packard, 100 Locust Ave., Berkeley Heights, N J 07922. **439**

Solid-state laser and laser accessories that range from low-energy minilasers to high-power laboratory and materials processing systems are covered in a 16-page short-form catalog. Hadron, Inc., 800 Shames Dr., Westbury, NY 11590. **440**

Video amplifier, Model 933, offers microvolt sensitivity and is priced at $325. Computer Measurements Co., Div. of Newell Industries, 12970 Bradley Ave., San Fernando, CA 91342. **441**

Connectors, metal-film resistors, terminals, relays, filters, trimmers and lamps are covered in a 110-page fully indexed catalog. Powell Electronic Inc., Box 8765, Philadelphia, PA 19101. **442**

Data acquisition system SY256 features a revolutionary packaging concept for data acquisition systems and is described in a six-page Brochure 450. B&F Instruments, Inc., Cornwells Heights, PA 19020. **443**

"The Doctor Will See You Now" is the title of a bulletin on Doctor 32, an LSI memory test system that performs functional and parametric tests. Adar Associates, Inc., 85 Bolton St., Cambridge, MA 02140. **444**

Digital volt-ohm-milliammeters, Models 8000 and 8000-A, offering 0.1% dc accuracy are described in Data Sheet No. 5170. Triplett Corp., Bluffton, OH 45817. **445**

Component holders, clips, circuit board holders and other electronic hardware are covered in a new 36-page catalog. Atlee Corp., 2 Lowell Ave., Winchester, MA 01890. **446**

Attenuators, filters, switches, double-balanced mixers and tunable band-pass filters are among the components covered in this 80-page 1970-71 catalog. RCL Electronics Inc., 83 Radio Circle, Mt. Kisco, NY 10549. **447**

Laser system SS-218 is designed for trimming resistors and other deposited materials. It is described in a brochure available from Raytheon Co., Laser Advanced Development Center, 190 Willow St., Waltham, MA 02154. **448**

Film-foil and metallized capacitors featuring seven product lines are described in a new catalog. Wesco Electrical Co., Inc., 27 Olive St., Greenfield, MA 01301. **449**

High-current dc power supplies are the subject of Bulletin AC-70. Over 300 basic and modified power supplies are covered. Christie Electric Corp., 3410 West 67th St., Los Angeles, CA 90060. **450**

Continuous integrator with six-digit counter and a predetermining totalizer for automatic batching is covered in four-page Technical Bulletin DS-5540-5541. Brooks Instruments Div., Emerson Electric Co., Hatfield, PA 19440. **451**

Sixteen-bit computer system Series 70 "Skinny-Mini", ranging from small dedicated controllers to complete 32K core systems, are described in a 20-page, two-color brochure. Datamate Computer Systems, Inc., Box 310, Big Spring, TX 79720. **452**

"CompuLOGIC" circuit modules in the CL800 Series offer 17 models, plus all companion packaging accessories. Computer Products, 1400 N.W. 70th St., Ft. Lauderdale, FL 33307. **453**

Silicone molded IC sockets, good for continuous burn-in operation at 270°C, are described in Data Sheet RN100. Robinson-Nugent Inc., 800 E. Eighth St., New Albany, IN 47150. **454**

RF coaxial connector brochure/handbook contains 148-pages of information on mounting installations, cable assemblies and applications data for all commonly used RF connector series. ITT Gremar, 10 Micro Dr., Woburn, MA 01801. **455**

Aroused Sounding Board Fires Comments

(Ed. Note: When EDN reported findings from the latest Sounding Board/70 questionnaire on October 1, replies were reduced to meaningful statistics. Here's a taste of the comments that, for space limitations, could not be presented.)

Gentlemen:

"I believe the organization should protect the interests of the membership as a whole, but each member should be free to act in his own behalf, much like the AMA or ABA. Those organizations protect the membership against actions by larger groups (legislation, Blue Cross, insurance companies, etc.), but each member sets his own fees and office policies. Our group should administer a pension fund because of our migrant way of life, and because as individuals we do not get the tax benefit to establish retirement programs as done by self-employed." (Massachusetts)

"The merit system is almost a myth in many companies – an organization must take care not to kill it completely." (Indiana)

"Judging from this (questionnaire), I guess I'm against unions, *per se*; professionalism demands conduct of individual rights by persons involved." (California)

"To put it quite bluntly, I do not trust you or any other group, yet." (Unsigned, no address given)

"I would like to see an organization with teeth, and I will pay the dues for it. However, I don't want to see engineers organized into a UAW type of union." (Colorado)

"Make membership in the organization available to all engineers, whether management level or not. Since we are professional people, we deserve a professional organization, not a labor union . . . organization membership should indicate professional competence and should require examination similar to state bar exam for layers." (California)

"It is now obvious with the mass layoffs of technical people that organization is necessary. Organization has worked well for other so-called professionals such as teachers. Why not engineers?" (Illinois)

"Why limit organization to electronic design work?" (Pennsylvania)

"I favor an engineer's group not restricted to 'electronic' design." (Illinois)

"Operate a non-profit enterprise to serve as employer of last resort." (Texas)

"Make sure that unqualified individuals are not given engineering *status* and *pay* – either by company contract or perhaps as informal reporting system to bring such situations to light. There are many situations where an unqualified individual is sitting in an engineer's 'chair' and receives the appropriate title and salary benefits. This results from the so-called 'man/manager' relationship. If he likes you, up go your salary and title; if you're on his blacklist, be prepared to stagnate. Although not 100% true, it occurs often enough to dilute the engineering profession." (Colorado)

"Supply and demand will work if monopolies are prevented. A professional organization should restrict itself to upgrading saleable skills." (New York)

"I can negotiate my own salary, if management is denied use of benefits and conditions as a lever." (California)

"Let's wait until we have a police state! Too many of us like to impose regulations on others. It would be much, much better should we start with ourselves." (Indiana)

"Require BSEE or equivalent, or x number of years experience in the field for eligibility in the organization." (Ohio)

"Set educational standards for colleges and universities." (New York)

"Negotiate price discounts for members from wholesalers and retailers, such as automobile fleet prices, etc." (Florida)

"Work with colleges and universities to upgrade their programs, and to limit the number of graduating engineers through higher requirements for degree." (Ohio)

"Discourage crash programs and encourage long-range planning to minimize the practice of 'hire-and-fire-as-needed' policy." (California)

"Membership should not be limited to electronic design. In many locations this rule would eliminate the balance of professionals." (Minnesota)

"Although I am not personally a Registered Professional Engineer, I believe we should all make the effort to do so and that this will help to elevate our profession." (Indiana)

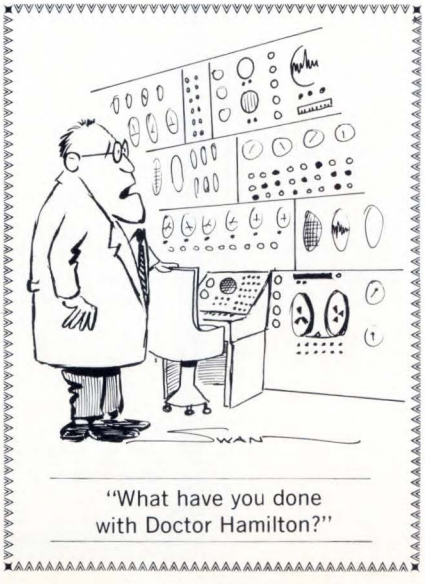
"(Such an organization) should be like the Bar Associations: basic intent to keep up standards, maintain ethical conduct with sanctions, and limit the number of people who may sell themselves as engineers. Most 'engineers' are glorified technicians, and our professional status and salaries suffer for that." (Michigan)

"(Such an organization) should maintain a public relations department to improve and foster the professional image of the engineer in the eyes of the public. It should provide salary survey information to its members with respect to degree, years of experience, age, type of work and geographical location, showing percentile variations.

"This questionnaire is slanted toward a 'union' type of organization, of which I want no part. An organization to which I would belong must be truly professional and must not discriminate between engineers in management and working engineers. This organization must not limit the freedom of its members in any way. It should therefore be a service type of organization rather than a regulatory one. To be professional, membership would have to be limited to those engineers with degrees from accredited colleges only. (California)

"Collective bargaining is not necessary – if reasonable requests are not agreed to, then binding arbitration should be entered into." (Ohio)

"It should protect the rights of individuals not to join such an organization." (Washington)



"What have you done with Doctor Hamilton?"

Advertiser's Index

Subject Index to Articles

Index to Ads, Products and Literature

Application Notes

Microwave Circuit Analysis Package (MCAP) enables a microwave engineer to study the ac steady-state performance of a large group of distributed parameter networks. This is done quickly and efficiently with a time-sharing computer. Shared Applications, Inc., 213 E. Washington St., Ann Arbor, MI 48108. **475**

Fortran IV compiler, P-2000, is the subject of a new 12-page publication. It explains the use of the compiler which can run online; seven tables fully describe features of the compiler. DB 23-254 is available from Computer and Instrumentation Div., Westinghouse Electric Corp., Westinghouse Bldg., Pittsburgh, PA 15222. **476**

"Microwave Power Measurement Techniques—A Comparative Evaluation" is a 12-page application note, No. 21. Techniques for measuring microwave power that include diode detectors, thermistors and thermoelectric methods are discussed and compared in terms of accuracy, dynamic range, and stability. PRD Electronic, Inc., 1200 Prospect Ave., Westbury, NY 11590. **477**

High thermal conductivity dielectric fillers and powders are the subject of four-page Technical Bulletin 3800. Fillers and powders ranging in size from 8 mesh down to 325 mesh in several particle shapes, including microspheres and microfrax are discussed. Physical properties, standard and special grades available, applications and handling are included. National Beryllia Corp., Greenwood Ave., Haskell, N J 07420. **478**

"Floating Measurements and Guarding" is a 17-page Application Note No. 123 that explains how to use the guard and how to make proper guard connections. Guarded instruments will solve most common mode problems if connected properly. Inquiries Manager, Hewlett-Packard Co., 1601 California Ave., Palo Alto, CA 94304. **479**

How to select active filters is the subject of a six-page foldout note that tells when Butterworth, Bessel or Tchebysheff make the best engineering choice. It also provides pros and cons of high pass and low pass types, as well as band pass and band reject versions. Analog Devices, Inc., 221 Fifth St., Cambridge, MA 02142. **480**

"Monitoring Environmental Pollution" is a multi-paged technical report that focuses in depth upon the recent Santa Barbara channel oil-pollution disaster. It sets forth an economical way to monitor scientifically the extent and amount of pollutants produced, as well as providing efficient early-detection services. Spatial Data Systems, Inc., 132 Aero Camino, Goleta, CA 93017. **481**

Economical thick-film hybrid microcircuit assembly is the subject of a one-page bulletin that tells how thick-film circuits can be built at low cost. The compact bulletin illustrates typical screened and fired substrates, complete assemblies and it also compares the use of thick-film circuits with conventional circuit board in an automotive voltage regulator. Circa Tran, Inc., Box 832, Wheaton, IL 60187. **482**

Measurement in hydrology is the subject of a series of application notes prepared to aid engineers who require precise measurements as well as dependable data in the rapidly growing field of hydrology. Statham Instruments, Inc., 2230 Statham Blvd., Oxnard, CA 93030. **483**

Analysis of circuit design, simulation of circuits, and logic simulation and minimization are covered in 14 separate and proven programs. Lifting the burden of calculation off the electronic engineer has increased productivity 30 to 40% by saving time and cost of breadboarding circuits. Tymshare, 525 University Ave., Suite 220, Palo Alto, CA 94301. **484**

Design of Gate-Protected MOS Field-Effect Transistors is a six-page application note, AN-4018. The note describes the design of dual-gate MOS FETs that use a built-in signal-limiting diode structure to provide an effective short circuit to static discharge and to limit high potential build-up across the gate insulation. RCA Commercial Engineering, Harrison, N J 07029. **485**

Threshold Sensitivity and Noise Ratings of Photomultiplier Tubes is a five-page application Note No. E2 that includes discussions on such items as threshold sensitivity defined in terms of equivalent noise input, photocathode size, input image size, leakage currents, cooling, shielding and stabilization time. ITT Electron Tube Div., Tube and Sensor Labs., 3700 E. Pontiac St., Fort Wayne, IN 46803. **486**

Reprints Available in this issue are offered as follows:

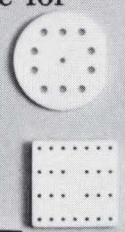
THE WHAT, WHY, WHEN, HOW AND WHOM OF COORS MICROCERAMICS

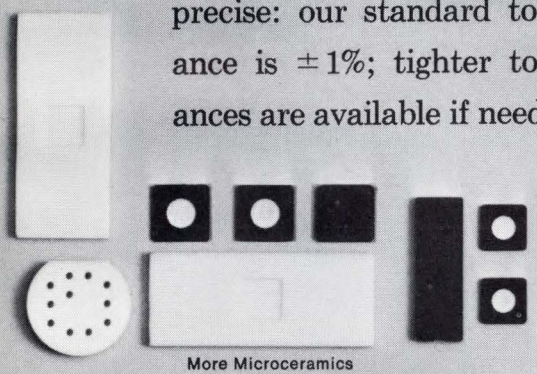
Q. WHAT ARE COORS MICROCERAMICS ANYWAY?


Dime


BB

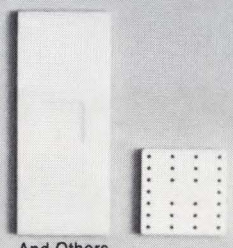
A. Glad you asked. They are small, precise parts of alumina or beryllia ceramic for microelectronic applications. We define small rather loosely as any part between, say, the size of a dime and a BB. The definition of precise is more precise: our standard tolerance is ±1%; tighter tolerances are available if needed.


Typical Coors Microceramics


More Microceramics

Q. WHY SHOULD I USE COORS MICROCERAMICS?

A. (1) Because you can be sure they will be manufactured exactly to your specifications and not modified to suit our production capabilities; (2) Because you can be sure they will be of uniformly high quality; (3) Because of (1) and (2) your yields will improve and your unit costs will be lower.

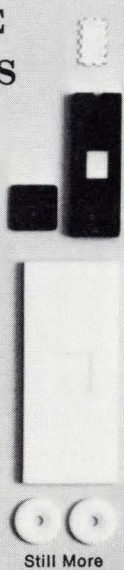

And Others

Q. WHEN SHOULD I USE COORS MICROCERAMICS?

A. When you want ceramic components of highest quality and reliability. Also when you need a ceramic producer with dependable, high-volume production capacity—or one that can turn out prototype and small-run quantities economically. We're geared to do both.

Q. HOW CAN I GET MORE INFORMATION ON COORS MICROCERAMICS?

A. Simply by asking. We'll be glad to counsel with you anytime by letter or phone. Or have our sales engineer in your area contact you for personal assistance. Or send you an informative data pack. Or all three.


Still More

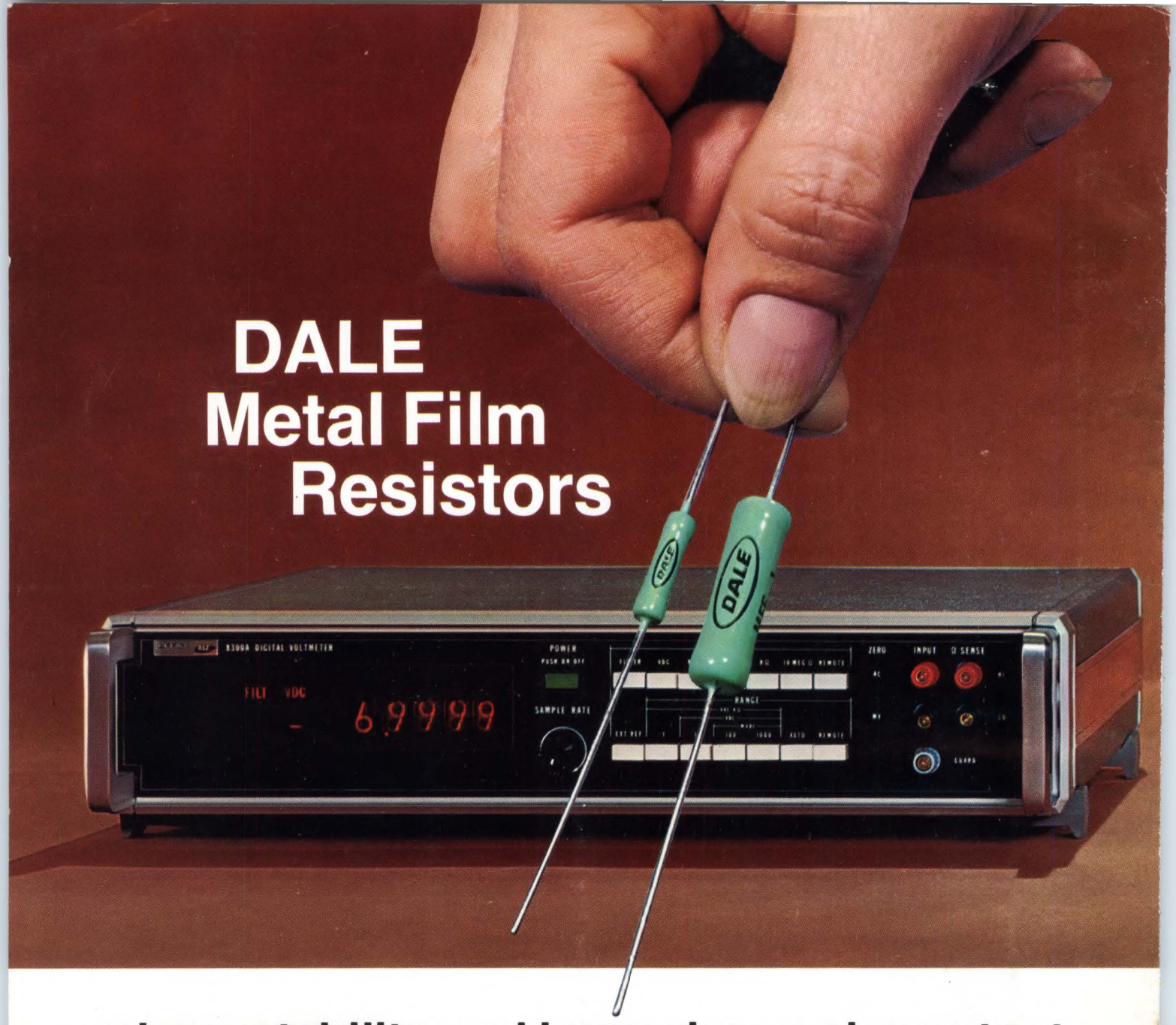
Q. WHOM SHOULD I ASK?

A. Who else?

Coors Porcelain Company • 600 Ninth Street
Golden, Colorado 80401 • (303) 279-6565

Coors/CERAMICS
the tough stuff

CP-137



where stability and low noise are important

Fluke uses Dale Metal Film Resistors in a host of circuit applications... primarily where stability and low noise are important. These conformal coated units combine small size and excellent reliability with low cost and economy of installation. Typical applications in the versatile 5-digit Fluke 8300A DVM are: Current sources for zener diodes • Feedback pairs around operational amplifiers • Secondary ladder networks • Timing circuits and input filters.

Take advantage of Dale's Metal Film versatility. From one quick source you can... choose epoxy coated (MFF) or molded (MF) styles... meet MIL-R-55182, MIL-R-10509 and MIL-R-22684... specify extreme high and low resistance values without sacrificing stability.

Phone 402-564-3131 for details

DALE ELECTRONICS, INC.
1352 28th Avenue
Columbus, Nebraska 68601
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DALE®

DALE MFF—CONFORMAL COATED METAL FILM RESISTORS

Mil. Spec.: Conform to all requirements of MIL-R-10509, except dimensionally smaller. MIL-R-22684 = RL-07, RL-20.

Size Range: 1/10 thru 2 watts

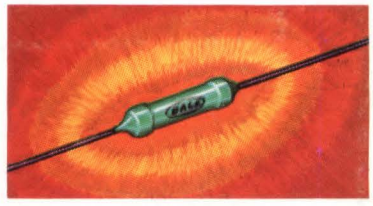
Resistance Range: 10 ohms to 11 megohms*

Tolerances: MIL-R-10509 = 1%, .5%, .25%, .10%; MIL-R-22684 = 2%, 5%.

Temperature Coefficient: 11 standard T.C. codes, ± 200 ppm/°C to ± 25 ppm/°C in −55°C to +175°C range.

*Extended value ranges, 1 ohm to 50 megohms available in MF series. Write for complete specifications.

FLAME RETARDANT COATINGS...



are standard on all Dale 1/10 thru 1/2 watt conformally-coated metal film resistors. These resistors have excellent color stability when subjected to short time overloads and prolonged high temperature operation. They have withstood 100 times rated power for as long as 10 minutes without exhibiting flame.

CIRCLE NO. 71