VOL. 20 NO. 11

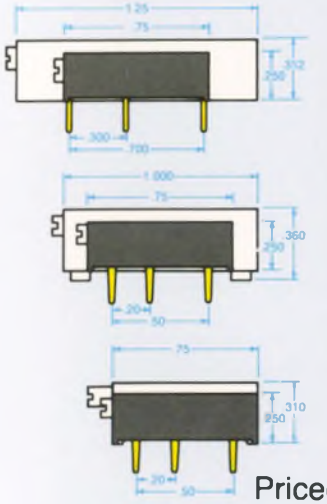
Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

MAY 25, 1972

DMM, heal thyself. We're not there yet, but a new multimeter with 5 full digits allows a user to make 16 internal-operation and calibration tests with front-panel switches or a remote program. He can localize faults quickly with the help of software or a pull-out chart stored in the meter. For more details, see page 77.

Wirewound or cermet—Dale's new low profile trimmers have important design advantages for your circuit.



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Tolerance	±10%	±10% 100-500K ±20% all other values
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Wattage	1 watt/70° C	1 watt/70° C
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Adjustability	20 turns (with clutch to prevent overtravel damage)	
Dimensions	.25" high by .165" wide by .75" long	

Priced less than 60c in 50,000 quantities. Available fast. Many standard decade values stocked for off-the-shelf delivery. Get the details. Write today or phone 402—564-3131.

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INFORMATION RETRIEVAL NUMBER 3

Electronic Design 11

VOL. 20 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS

MAY 25, 1972

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Cover: Courtesy of Hewlett-Packard, Loveland Division, Loveland, Colo. Photos by Alan Howe.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 50 Essex St. Rochelle Park, N. J. 07662. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N. Y., postage pending Rochelle Park, N. J.

82501 copies this issue.

EIA DRIVER HAS INTERNAL INHIBIT AND SLEW RATE CONTROL.

Our new 9616 EIA triple line driver provides simple, low-cost solutions to EIA applications. Our new 9617 EIA triple line receiver completes the set.

Our new 9616 Driver and 9617 Receiver meet all EIA-232-C/CCITT V.24 specs. And more. Together they provide the simplest low-cost solution to problems at the interface in data terminal equipment and data communications.

Unlike conventional EIA drivers, which are implemented by a positive NAND function, our 9616 is implemented by an And/Or/Invert function. With this logic configuration, you can perform the inhibit function without any external gating.

In addition, the 9616 incorporates internal slew rate control. No need for an external capacitor for each driver. Result: significant savings on board space, components, assembly.

In meeting RS-232-C recommendations our 9616/9617 feature:

9616 EIA Line Driver

- All inputs TTL compatible
- Each driver is output protected
- Symmetrical driver output voltage levels and current limits
- Supplies are +12V and −12V @ ±10% regulation

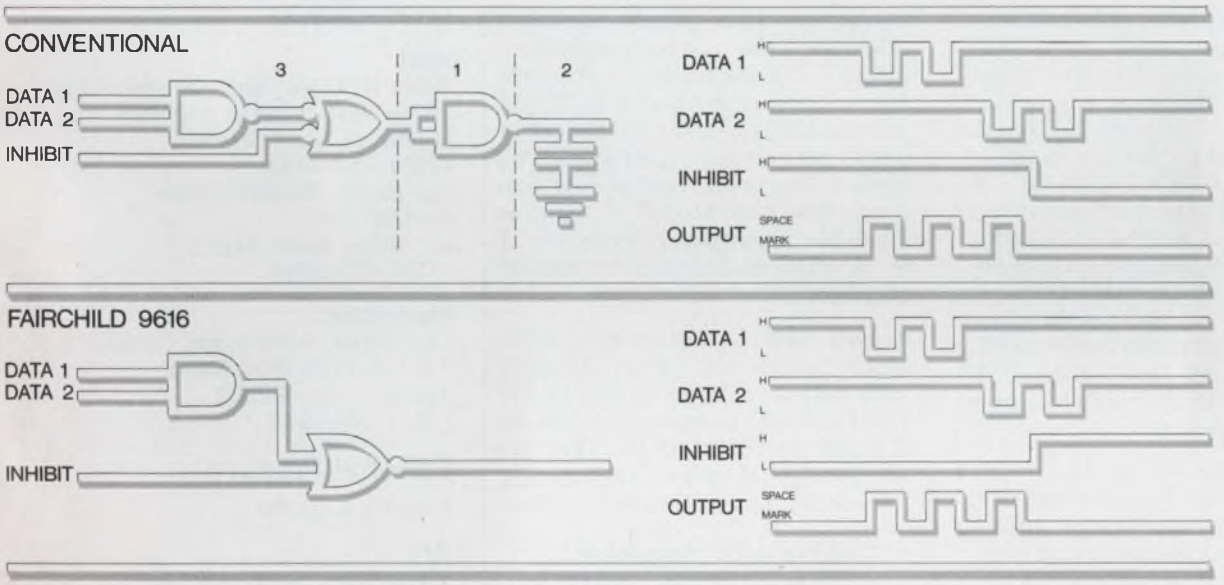
9617 EIA Line Receiver

- 3 to 7K Ω input resistance
- Inputs protected to ±25V
- Each Receiver operates in fail-safe mode
- Controllable slicing or hysteresis operation
- Individual response pins to increase AC noise immunity
- Outputs TTL/DTL compatible
- +5V supply operation, ±5% regulation

Both the 9616 Driver and the 9617 Receiver are available from distributor stock. Design-in quantities available now; production quantities in late March. The 9616 @ $4.50 and the 9617 @ $3.50 in quantities of 100-999.

Other Fairchild Drivers & Receivers

9614	Dual Differential Line Driver
9615	Dual Differential Line Receiver
9620	Dual Differential Line Receiver
9621	Dual Line Driver
9622	Dual Differential Line Receiver
SN75107-108	Dual Line Receivers
SN75109-110	Dual Line Drivers



COMPARISON OF CONVENTIONAL AND 9616 EIA DRIVERS
Conventional EIA Driver (1) requires external slew rate control capacitor (2) and external gating for inhibit function (3). Fairchild 9616 EIA Driver requires neither.

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across the desk

Unionization backed to spread work

Congratulations to Robert Bruce on his letter of March 16 (see "A Strong Labor Group Urged for Engineers," ED 6, p. 7). His description of the difficulties in changing engineering specialties reminded me of my own experience. When I graduated, transistors hadn't hit their stride yet, so we used relays and stepping switches. I finally saw the handwriting on the wall, but it was a lot easier to see the trend than to do something about it. The available positions explicitly called for transistor experience. The local university was characteristically four years behind and more devoted to theory than the practical application that the job called for.

Fortunately one company started a transistor-design training program to help offset its shortage. I was lucky enough to get in. But who's going to retrain today's unemployed aerospace engineer? There's no shortage now, and surveys show that the EE field will be "soft" until at least 1975.

I believe that if we are to restore that climate where enough companies are willing to retrain engineers, we shall also have to restore the manpower shortage. We can begin by organizing to end unpaid overtime. This would encourage the hiring of unemployed engineers and end the unfair squeeze on those already employed.

A subsequent goal could be a shorter work week. The steelworkers are going for 32 hours. Considering our unemployment and underemployment, why not organize for a nine-hour, four-day week or five days of seven hours each?

These are only a few of the organized objectives that would reduce engineering unemployment as well as benefit those already employed.

Name withheld on request
Los Altos, Calif.

Words in defense of 'paper shufflers'

The editorial in your April 1 issue ("Design or Shuffle Paper, Which Goal?" ED 7, p. 35) took to task those former engineers who had allowed themselves to be promoted to administrative positions, to the detriment of their engineering expertise. It implied that the subsequent shakeout of these "paper shufflers" was nothing less than they deserved for such foolishness.

I question your statement that, as a group, these ex-engineers are worse off now than those who remained in the profession. The older, unemployed engineers—of which there are now large numbers—don't have an easy time finding a professional job, let alone one that suits his particular speciality or talent. But even if it is true that engineers who have gone on to administrative or management jobs have laid themselves open to greater risks, what lesson is to be learned? Are you saying that it is a shame to venture from the safe profession of engineering out into the cold world governed by profit and loss? Or do you believe that the ex-engineer in a management job is somehow being disloyal to his former profession?

Competent men are going to strike for higher goals, regardless of risk. The fact that some will come to grief is an unfortunate fact of life. I see no reason for

(Continued on p. 10)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St. Rochelle Park, N. J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

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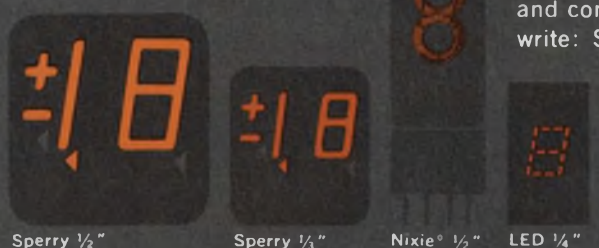
Sperry displays are brighter, sharper and easier to read than tube-type displays and the much publicized LED's. They have no screens, filaments or "off" numbers to impair readability. In fact, they're so much better looking that it is impossible to show the difference on the printed page. You have to see the actual display to fully appreciate their excellent appearance. Compare them side-by-side with any other display. You'll find Sperry beats them all.



COMPARE THE BRIGHT, NO GAP APPEARANCE OF SPERRY DISPLAYS WITH **ANY OTHER** DISPLAY.

Sperry displays also come in colors — attractive, easy to read orange or red. Not always true of other types. And Sperry beauty is also more than skin deep. There's the wider viewing angle, low power consumption and proven reliability, not to overlook the cost — $1.00** per digit in large OEM quantities for either the ½" or ⅓" display.

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Find out how great Sperry displays can look on your product. Check the reader service card for sample ⅓" and ½" self adhesive, printed display strips and complete technical information, or phone or write: Sperry Information Displays Division, Post Office 3579, Scottsdale, Arizona 85257. Telephone (602) 947-8371.

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°°Price is $2.30 in 5,000 digit quantity.

ACROSS THE DESK

Continued from p. 7

castigating them or for dissuading others who may choose the same route.

John M. Paterson
9201 21st Ave. N.W.
Seattle, Wash. 98107

Regarding your April 1 editorial:

Several gross contradictions and errors in judgment reveal exactly the same "holiness of engineering" attitude that is driving engineers out of the professional societies and out of "engineering" engineering. Your attitude ignores the fact that these one-time engineers are also people—with families, bills, mortgages and personal goals that don't stop at $20,000 a year after 30 years' service! Why should they deny their families and themselves the gratification of social advancement, as well as the financial comfort that can be attained, just to be "holy"?

If the ex-engineers you interviewed were employed in such positions as chief engineer or manager, you might not expect them to be involved in the details of DVM purchasing. Their "boys" certainly would, however, because that would be what was required at the normally low level of the engineering engineers!

These ex-engineers have such "unholy" and insipid responsibilities as recognizing and coaching the future leaders of their companies, defining task flow, controls and budgets for $500,000 of company funds and solving personnel morale problems caused by truck drivers who earn 80% more than engineering engineers do.

Maybe the ones you interviewed hadn't made it big, but some may have been close.

As for another period of prosperity for what you call "paper shufflers," the greatest famine in U.S. industry is now for good paper shufflers! They are known as Managers. The agonizing convulsions and spasms that many companies are going through right now are caused by a lack of good paper shufflers.

R. B. Wright
3919 N. Vista St.
Uniontown, Ohio 44685

The perfect combination.

A synthesizer/signal generator that sets a new standard in RF performance—all the way to 1300 MHz!

The new HP 8660B Synthesized Signal Generator has all the precision and stability you'd expect from a synthesizer. Plus performance features, operating functions and ease of operation far surpassing what you would normally find in a signal generator.

The keyboard, plus its 10-digit LED display, gives you error-free fingertip control of operating frequencies. For example, enter your center frequency and then the frequency increment corresponding to channel spacing. Now you can change the frequency up or down by that precise increment just by pushing the STEP button. Similarly you can enter sweep width for precision swept frequency testing. For total operating flexibility you can also tune the generator manually over its entire frequency range. In all these modes you get accurate signals with synthesizer stability and spectral purity.

The instrument's modular concept allows for great flexibility in both frequency coverage and modulation. Two RF plug-in units have these outstanding characteristics: 0.01 to 110 MHz or 1 to 1300 MHz frequency coverage, settable in 1 Hz steps; −80 dB spurious; < 1.5 Hz residual FM; $3x10^{-8}$/day stability; +10 to −146 dBm calibrated output. Precision AM and FM modulation capability, available as an option, greatly increases the 8660's versatility.

The 8660B keyboard-entry mainframe is $6000. RF plug-ins, 0.01 to 110 MHz, $1975; 1 to 1300 MHz, $4800. Modulation plug-in, $900. A lower cost unit ideally suited for remote program applications is the 8660A mainframe. The variety of modular options makes it possible for you to "custom-tailor" a system to your exact needs, with prices for a complete system starting at $5875.

Ask your field engineer for complete information about the immensely versatile 8660 Synthesized Signal Generators. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

04204

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SIGNAL GENERATORS

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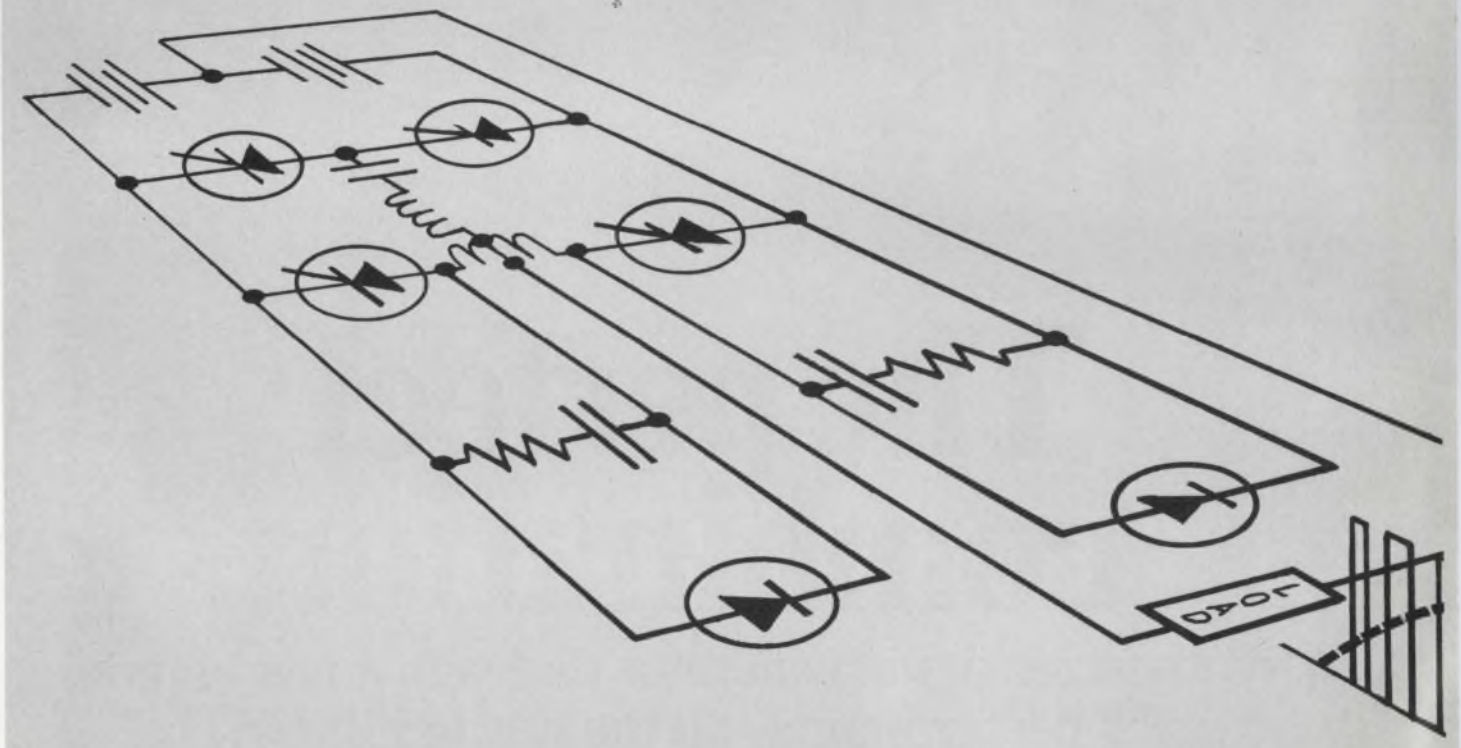
INVERTERS



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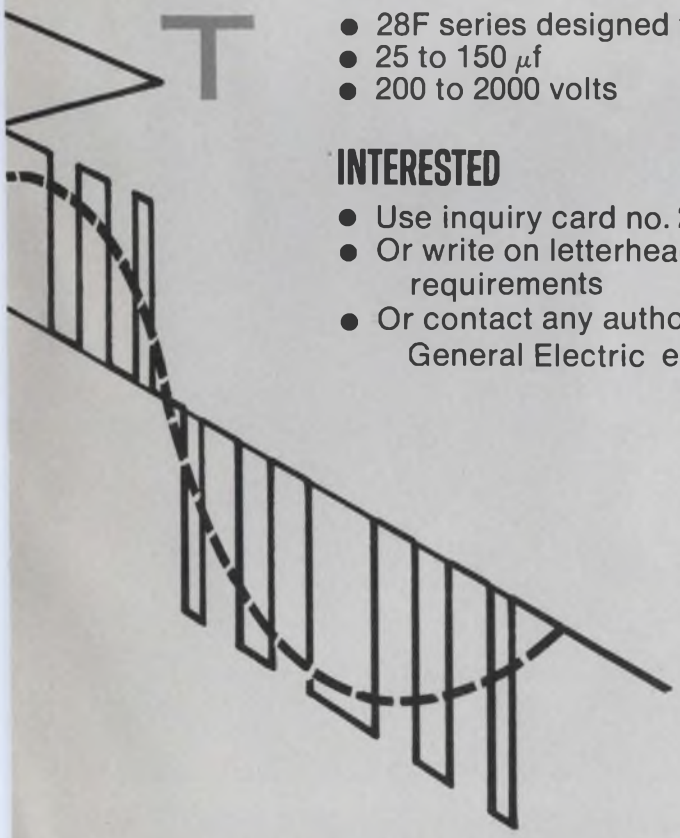

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- Or write on letterhead stating your current and voltage requirements
- Or contact any authorized General Electric distributor or any General Electric electronic component sales office

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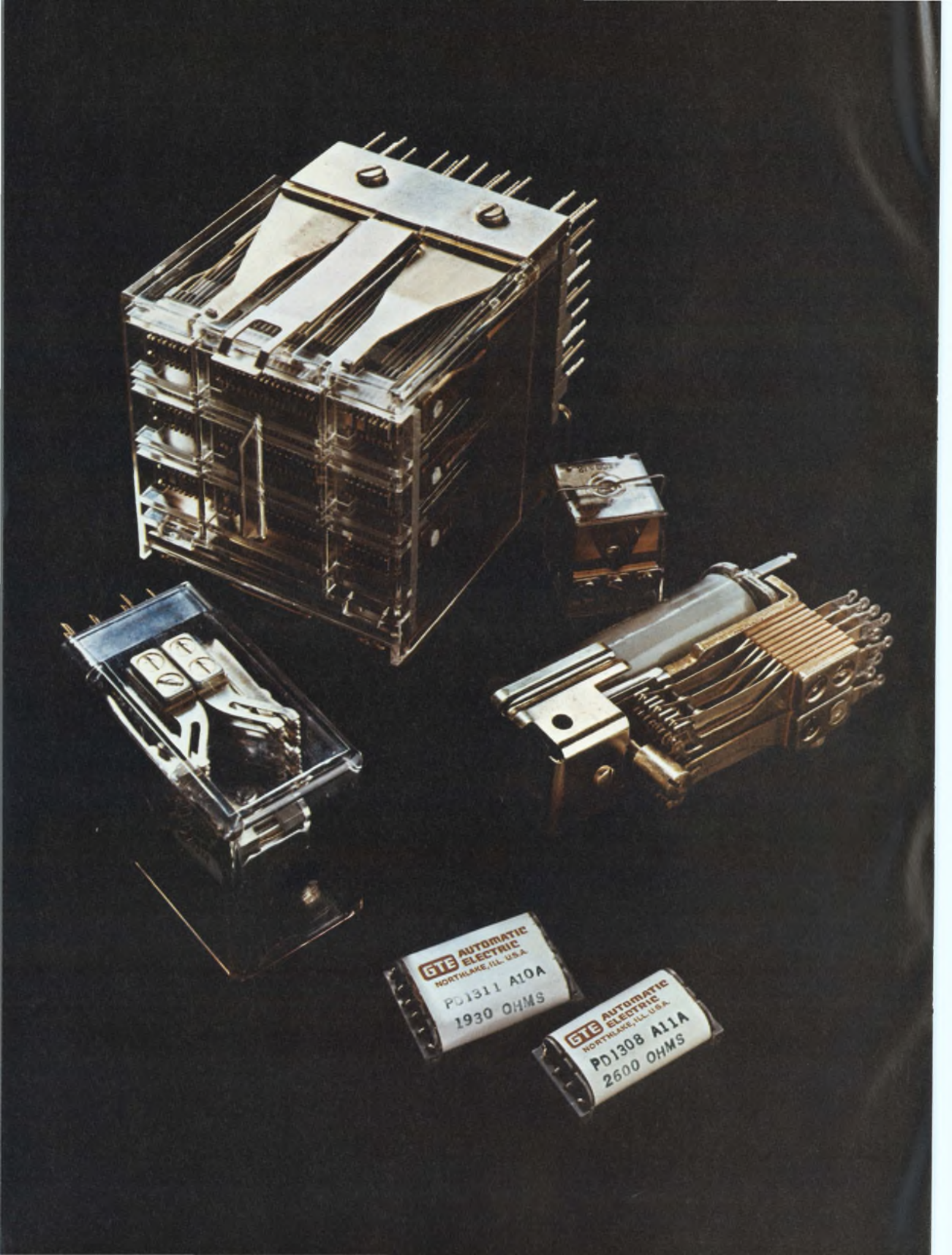
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Announcing the rediscovery of the relay.

In an age when most people think solid state is the only way to go, some designers have rediscovered the good old electro-mechanical relay. They found relays still can't be beat when it comes to certain jobs. And when they're dealing with tight fisted cost control committees. Maybe you can save some effort and expense by rediscovering the relay whenever you need these things:

1. Simple logic:

Relays let you combine both power switching and logic functions economically. Memory can usually be retained, even after a power loss. And you don't need special power supplies or noise suppression techniques.

2. Easy troubleshooting:

Most relay failures (and they do occur occasionally) can be identified visually. You can see what's wrong. And fix it easily.

3. Heat resistance:

A relay shrugs off a short dose of overheating. Give a solid state device the same treatment while it's functioning near capacity and it's ruined forever. The amount of heat a solid state device can take is usually dependent on the heat sink used. It can take up all the room you expected to save with solid state in the first place. And finding the right heat sink design can become very involved.

4. Electrical isolation:

Relays have a natural isolation between input circuits, between output circuits, and between output and input control circuits. You can't get that with junction type semiconductors.

5. High insulation resistance:

Open relay contacts have an insignificant amount of leakage (10^{10} ohms or more). Semiconductors can't match this. And, their leakage rates vary greatly with temperature changes.

6. Wide operating power range:

Relays work with operating power anywhere from milliwatts to watts. And they usually don't require regulated power. Semiconductors do.

7. Transient voltage immunity:

Transient voltage doesn't bother a relay. But high voltage, short duration transients can be sure death to semiconductors.

8. Forgiveness:

Relays give you a little margin of safety should you want to change your mind. Maybe you find you need more contacts, or uncover a timing problem, or discover a need for absolute input-output isolation. You can change your circuit design a lot easier with relays.

If your project or product needs any of these things, just ask our salesman to help you rediscover relays. GTE Automatic Electric, Industrial Sales Division, Northlake, Illinois 60164.

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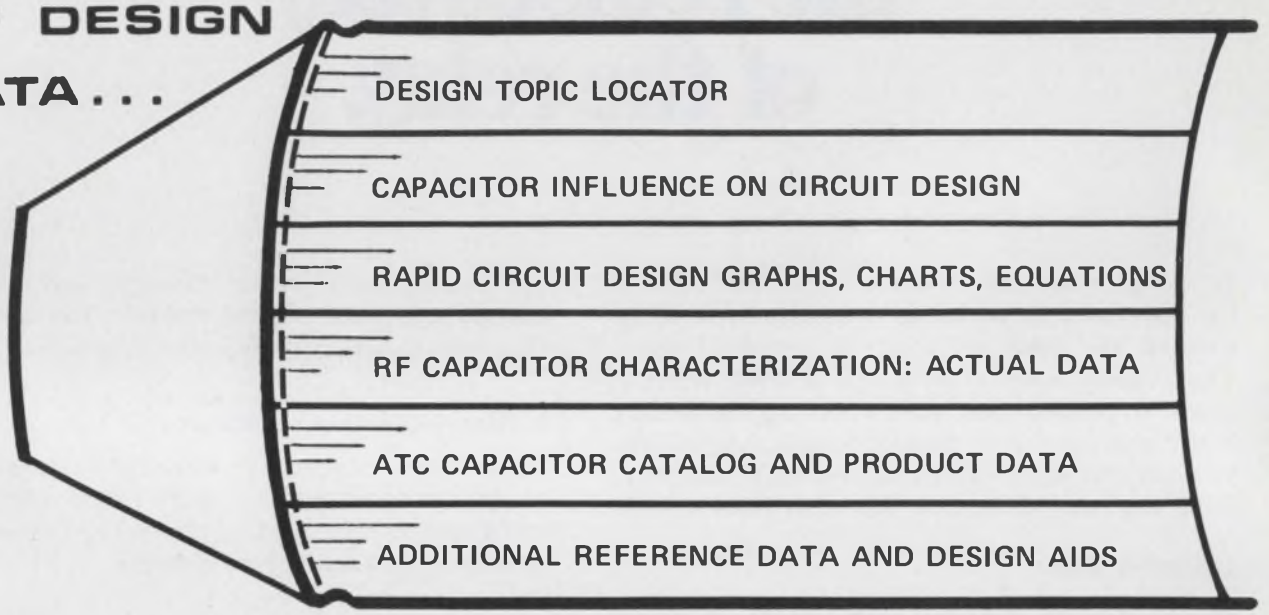
INFORMATION RETRIEVAL NUMBER 12

THE RF CAPACITOR HANDBOOK

OVER 200 PAGES OF DESIGN DATA . . .



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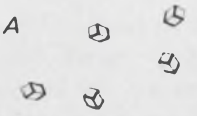
1.0	C	5.1	D	16	J	51	J	200	J
2.2	D	7.5	D	24	J	75	J	470	M
3.6	D	11	J	36	J	100	J	820	M

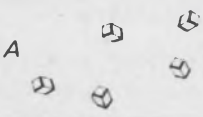
$49.95 KIT ED-2 — *Minicube® Chips*, *Case A*



125 ATC 100 capacitors, five each of the following values and tolerances:

pF	Tol.	pF	Tol.	pF	Tol.	pF	Tol.	pF	Tol.
1.0	B	2.7	D	6.8	K	18.0	K	47	K
1.3	B	3.3	D	8.2	K	22.0	K	56	K
1.6	C	3.9	D	10.0	K	27	K	68	K
1.9	C	4.7	D	12.0	K	33	K	82	K
2.1	C	5.6	D	15.0	K	39	K	100	K

$19.95 KIT ED-3 — *Minicubes®*, *Case A*



40 ATC 100 capacitors, four each of the following values and tolerances:

pF	Tol.	pF	Tol.	pF	Tol.	pF	Tol.	pF	Tol.
1.0	B	2.7	D	4.7	D	12.0	K	47	K
1.8	C	3.3	D	8.2	K	22.0	K	100	K

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INFORMATION RETRIEVAL NUMBER 13

At Last! The Digital Profit Makers!

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First-class appearance will sell your product, so we designed the NEW 4000 series digital panel meters with big, bright, solid displays that are "No. 1" in national user-preference surveys.

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And extra-low input bias current keeps readings accurate and super-stable, even at the highest operating temperatures.

Give your panel the quality look. Your customers will recognize it— *and buy it, too!*

and "Money Savers," too!

We designed the 4000 series to protect you against profit-robbing failures.

The displays are more reliable (and more readable) because there are no "loose" elements inside.

High quality components, superior workmanship, and wide-safety-margin designs combine to reduce failures, too.

We're so sure we have the answer, we've extended our WARRANTY for **ONE FULL YEAR!**

It won't take you that long to find out how much money you're saving with the 4000 series on your panel.

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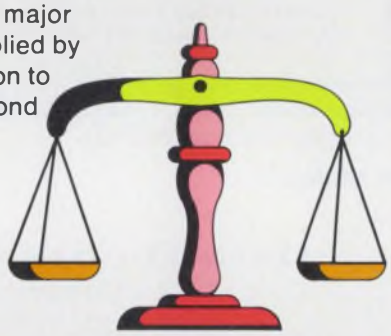
INFORMATION RETRIEVAL NUMBER 14

SPEED vs.

The one-nanosecond conundrum.

Schottky or ECL 10,000? How should you commit your engineers, your plant, your production, to get the faster logic that your next system will require?

It's a tough choice. Both major logic families volume-supplied by Signetics can be counted on to boost speed levels far beyond standard TTL. With each offering its own unique advantages, each with built-in drawbacks (sometimes more psychological than real).



PARAMETER	TYPICAL VALUES	
	74S/82S	ECL 10,000
Propagation Delay (per Gate)	3ns	2ns
Power Dissipation (per Gate)	20mW	25mW
Positive Volt. Supply (+V)	+5V	0V
Negative Volt. Supply (−V)	0V	−5.2V
Logic "1" Level	+2.7V	−.9V
Logic "0" Level	+0.5V	−1.8V
Output △V/△T	1V/ns	.25V/ns

Hands down, ECL 10,000 beats out Schottky 74/82 in performance—delivering the best high speed/low power trade-off yet. But the crucial question facing users: just how critical to your individual designs is that one extra nanosecond knocked off by ECL?

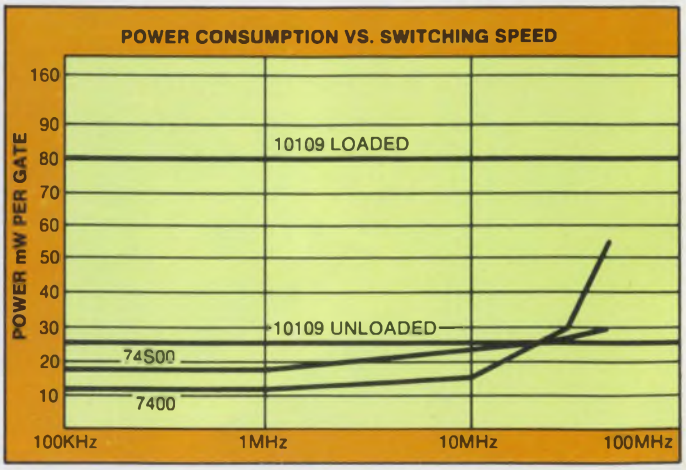
Unless you're into super scale or large scale computers, which have always utilized ECL's maximized performance, there's no pat answer to the question. You have to balance where you've been, and where you're going, with a careful probing of both technologies.

For all practical purposes, 74/82 Schottky is third generation TTL enhanced to allow the designer to increase his system speed by replacing present TTL circuits with their Schottky equivalents. Signetics uses a 3 micron epitaxial film thickness to produce extremely small geometries. Combining small geometries with Schottky diode clamped transistors results in optimized T^2L performance plus remarkable high-density MSI capability. Since gold doping is no longer required, you get higher betas—making PNP transistors available for innovative circuit ideas. All Signetics 82S circuits use PNP transistors to reduce input loading, to insure that fan-out rules are not violated when upgrading existing systems.

Schottky TTL is compatible with standard TTL circuits, with logic rules familiar to the vast majority of engineers. That's the good news.

The bad news: wiring rules may become more stringent due to the sharper signal edges of Schottky TTL compared to standard T^2. Careful attention must be paid to PC board geometries and line terminations, as with 74H type circuits. And, of course, there is that one nanosecond difference in gate delay.

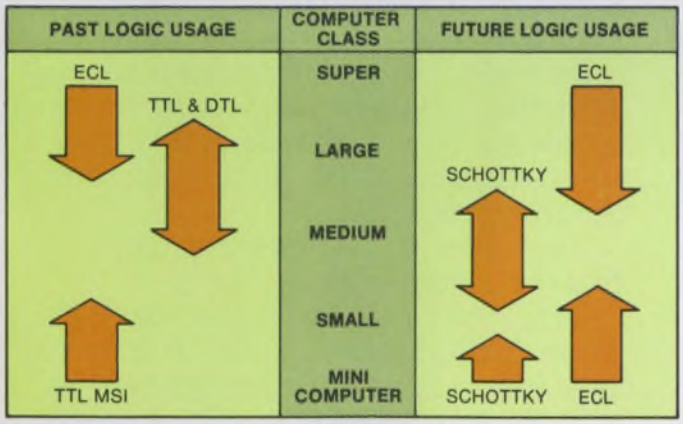
ECL 10,000 will drop propagation delay from 3 to 2ns per gate. With MSI frequently twice as fast. But it takes more than speed to make 10K so desirable.



SPEED

The constant current nature of ECL 10K is obvious. Properly loaded ECL gates show very flat power dissipation. This flat power curve means greater ease of power distribution. And the difference between loaded and unloaded curves offers termination freedom: this choice of resistor helps immensely in reducing internal dissipation to allow higher functional densities. ECL combines remarkable design/function flexibility with significant savings in gate and package count.

A fear of the unknown appears to be the key stumbling block to ECL. Probably the prime concern is the relative unfamiliarity with the NOR/OR logic. The system engineer or manufacturer often feels he has enough on his hands mastering the new usage techniques of 74/82 Schottky, where the basic logic is still TTL. Learning to cope with the sharp edge speeds of faster logic is one thing. Being forced to learn a whole new logic besides... that's often the last straw. Is one extra nanosecond worth it? Only you, the user, can tell.



Put yourself in this picture. Match usage to computer category. Match speed requirements to your own best interests, recognizing that the entire industry is trending toward ever-higher speeds. And before you commit to either Schottky TTL upgrading, or a switchover to ECL, consider both alternatives carefully.

74/82 Schottky. Or ECL 10,000. Signetics gives you both ways to go.

SCHOTTKY 82S MSI

82S30/31/32	8-Input Digital Multiplexer
82S33/34	2-Input, 4-Bit Digital Multiplexer
82S41/42	Quad Exclusive-OR/Quad Exclusive-NOR
82S50/52	Binary-to-Octal/BCD-to-Decimal Decoder
82S62	9-Bit Parity Generator and Checker
82S66/67	2-Input, 4-Bit Digital Multiplexer
82S70/71*	4-Bit Shift Register
82S90/91*	Presettable Decade/Binary Counter

SCHOTTKY TTL 74S

74S00	Quad 2-Input NAND Gate
74S03	Quad 2-Input NAND Gate (Open Collector)
74S04	Hex Inverter
74S05	Hex Inverter (Open Collector)
74S20	Dual 4-Input NAND Gate
74S22	Dual 4-Input NAND Gate (Open Collector)
74S112*	Dual J-K Edge-Triggered Flip-Flop
74S113*	Dual J-K Edge-Triggered Flip-Flop
74S114*	Dual J-K Edge-Triggered Flip-Flop
74S40*	Dual 4-Input NAND Buffer
74S140*	Dual 4-Input NAND Line Driver

ECL 10,000

10101*	Quad 1-Input OR/NOR Gate
10102	Quad 2-Input NOR Gate
10105*	Triple 2, 3, 2-Input OR/NOR Gate
10106*	Triple 4, 3, 3-Input NOR Gate
10107	Triple 2-Input Exclusive OR/NOR Gate
10109	Dual, 4, 5-Input OR/NOR Gate
10110	Dual 3-Input 3-Output OR Gate
10111	Dual 3-Input 3-Output NOR Gate
10112	Dual 3-Input 1-OR/2-NOR Gate
10113*	Quad Exclusive -OR Gate/Comparator
10115*	Quad Differential Line Receiver
10116	Triple Differential OR/NOR Line Receiver
10117	Dual 2-wide 2, 3-Input OR-AND/OR-AND Invert Gate
10118	Dual 2-wide 3, 3-Input OR-AND Gate
10119	4-wide 4, 3, 3, 3-Input OR-AND Gate
10121*	4-wide 3, 3, 3, 3-Input OR-AND/OR-AND Invert Gate
10131*	Dual D-Type Master-Slave Flip-Flop
10161	1 of 8 Demultiplexer/Decoder (Low)
10162	1 of 8 Demultiplexer/Decoder (High)
10170*	9 + 2-Input Parity Circuit
10171*	Dual 1 of 4 Demultiplexer/Decoder (Low)
10172*	Dual 1 of 4 Demultiplexer (High)

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☐ Send parts lists, pricing and data sheets on both lines.

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ANALOG DEVICES

An ECM crisis in Vietnam reported by ex-combat pilot

North Vietnam's downing of a U.S. Air Force EB-66 on April 1 with a surface-to-air SAM missile —the very weapon system that the EB-66 is elaborately equipped to render ineffective—undoubtedly has the Pentagon worried about the effectiveness of its electromagnetic airborne countermeasures (ECM) equipment.

Was the loss of the plane a fluke, or is our ECM equipment relatively ineffective?

A bold appraisal of American ECM has been given to ELECTRONIC DESIGN by a former Air Force captain who piloted F-4s and F-105s in Vietnam and RB-47s and U-2s in Turkey. He is an engineer and an expert on ECM. He prefers anonymity so he can comment freely.

"If the military doesn't move fast," he warns, "particularly the Air Force, we're going to find ourselves in the same dangerous and costly position we were in in 1964. Ordered to bomb targets in North Vietnam, neither the Air Force or the Navy had adequate ECM to protect their fighters and bombers from radar-guided missiles. The result was a crash program that the Navy called Shoe Horn, pointing out how the ECM equipment would have to be squeezed into already-crowded aircraft.

"The result was equipment that could have been much better had we had more time—and it could have been built much, much cheaper."

The problem, as he sees it firsthand, is that the North Vietnamese have learned to cope with American ECM, both by adaptation of existing ground-fire equipment and design changes.

"Two other EB-66s were lost to SAM missiles before this one," reports Col. George Hennrikus, an Air Force information officer in New York, "and eight have been lost due to other causes since we started bombing the North on Aug. 5, 1964. Total losses of all kinds of aircraft to SAM missiles since 1964 come to 105."

These figures do not include the planes that SAM missiles have forced down to lower altitudes, where a lethal bed of antiaircraft artillery fire awaited them—a new trick the North Vietnamese SAM radar operators have learned. Nor do the figures include losses incurred since the renewed air war began April 1—statistics the Pentagon will not disclose at this time.

The solution?

"A mixed bag," the former Air Force captain says, "putting all our assets together, because the more confusion you create, the better."

Better equipment urged

He recommends:

- Development and deployment of new kinds of ECM equipment—optical and infrared—and receivers and transmitters to analyze and jam frequencies in the X-band region and beyond.
- A dedicated ECM aircraft equipped with its normal ECM gear plus the above to accompany fighter-bombers.
- Improved defensive ECM pods on combat aircraft that automatically sense when the aircraft is being tracked by ground radar and automatically jams the radar.

Discussing shortcomings in present ECM equipment, the ex-combat pilot notes the following:

- When a U.S. pilot jams a North Vietnamese ground radar that is measuring his aircraft's azimuth, elevation and range, the North Vietnamese operator merely adjusts the radar antennas to measure the direction of the jamming noise. From this, he gets the plane's azimuth and elevation. He cannot determine the range, but he doesn't care; if the missile keeps going in the right direction, it will eventually arrive at the correct range and blow up the U.S. plane.
- The North Vietnamese can get their missile-launching information from a burst of radar energy that is so brief that U.S. planes don't have time to jam.
- The North Vietnamese often dispense with the SAM's ground radar altogether and use an optical sight, feeding azimuth and elevation angles from it into the SAM computer. "Needed by U.S. forces is some kind of countermeasure to put those optical sights out of commission—perhaps a laser to blind the operator," the former Air Force officer says.

Soviet radars altered

As for equipment changes, he says that Soviet radars in North Vietnam have had their frequency spreads extended. If the spread covers 200 MHz, for example, and the airborne jamming pod is capable of putting out only 500 W, the effective radiated power is 2.5 W per 1-MHz increment—not enough to do much damage. "To jam properly you need about 1000 W," the ECM expert says.

The Navy is in better shape than the Air Force, he asserts. Its fighters are protected by a newer ECM aircraft, the EA-6A, and by July it will have a follow-on plane, the EA-6B.

But even the EA-6B will not be equipped with optical or infrared devices or jammers that operate in X-band and higher.

The Air Force has only the EB-66, 16 years old and designed originally as a bomber. Although the service denies it officially, rumors have the EB-66 in mothballs by spring.

The Air Force has examined the EA-6B and reportedly likes the ECM equipment but considers the aircraft too slow and without enough range.

In a supplemental budget request for fiscal 1972, the Air Force asked for $10.2-million to convert two F-111s to EF-111 ECM planes, but Congress turned down the request.

"New equipment is needed, not in Vietnam alone—the war in

Vietnam could soon be over—but elsewhere," says the ex-Air Force captain. "The Russians have far better ECM in the Middle East than they have in Vietnam. We have no airborne ECM equipment operational today, for example, that can cope with the Soviet SA-3 missile system now set up in Egypt. For it, we'd need all we have now in Vietnam plus a lot more."

New rubbery material has switching uses

A new conductive, rubber-like material, now available, can be formulated for use as a power switch, power connector contacts or a circuit breaker.

The elastomer, called Pressex, is being offered by Essex International, Inc., of Fort Wayne, Ind., and it can be either spongy or firm. It goes from an essentially open circuit in an uncompressed state to a closed circuit when it is sufficiently compressed. Travel to obtain this on-off action ranges from 0.001 to 0.125 inch.

While applications for the material are still being developed, Essex sees its prime use in automobiles. Initially it will be fabricated as terminal contact material in special terminal block connectors, with switch applications to follow.

Testing of Pressex terminals has been completed in some 2600 cars. Essex says that studies to date show that the connections have about one-half the voltage drop of comparable contacts. The operating force varies from about 3 pounds on a typical 18-gauge wire connector to 50 pounds for multiple-terminal connectors.

Developed originally in the search for a solid-state circuit breaker, the material can break an electrical overload in about 400 μs, according to its inventor, Gideon A. Durocher, director of advanced design at Essex. As soon as the overload ceases, he says, the material again becomes conductive.

New processor gives instant microfiche

To read out information from computers onto microfilm, the film usually is exposed by a cathode-ray tube, and then developed by a wet process that takes about 20 minutes. But a new film developed by the 3M Co. of St. Paul, Minn., and a new laser readout system developed by Datalight, Inc., of Bloomfield, Conn., permit the reading out of a page of data and processing in less than a second.

Originally developed for 3M's electron-beam readout microfilm system, the new film, known as a dry silver type, is developed by heat instead of chemicals and is relatively insensitive to light.

Because of its lack of sensitivity, a very-high-intensity light must be used to expose the film, says Walter Crofut, vice president and general manager for Datalight. Thus, he explains, his company developed a low-cost, reliable helium-neon laser system that focuses a beam to a point and writes on the film like a pencil writes on paper. The film is then passed through a heat chamber, where it is developed, and the microfilm is available almost instantaneously.

Called Datawrite, the new microfilm system will be available from Stromberg Datagraphix of San Diego, which has an exclusive agreement to sell it.

The new system, Crofut reports, while competitive in price with existing systems, prints directly on microfiche at a rate of between two and four pages a second. Present systems use roll film that must be developed for 20 minutes and then cut to microfiche size.

Another application to the Datawrite system is in phototypesetting and composing machines. This application, which uses a heat-sensitive paper, will be available exclusively through Photon, Inc., of Wilmington, Mass., and will be part of that company's latest phototypesetting machine, according to Crofut. Datawrite will replace the xenon light source presently used in these machines and will eliminate the need for processing the exposed paper with chemicals. In addition, lower operating costs are expected, because the dry silver paper is cheaper.

Semi show looking for doubled attendance

While general electronics trade shows like the IEEE are declining in attendance, this week's Semicon II show at the San Mateo County Fairgrounds in California expects 8000 visitors—double last year's figure.

The show, being held May 24-26, is designed exclusively for the semiconductor manufacturer—and specialization appears to be the key to higher attendance these days. All exhibitors at Semicon II are manufacturers of materials, equipment and services for the semiconductor industry in the Bay Area.

Howard Moss, president and chairman of the Semiconductor Equipment and Materials Institute, Inc., of Palo Alto, Calif.—sponsor of Semicon II—says there are 196 booths this year, compared with 120 in 1971.

Technical sessions will be held on semiconductor processing, testing materials and assembly, ion-implantation processing, circuit technology, n-channel silicon-gate and other semiconductor technologies.

News Briefs

The first microwave rf power transistor to operate in the linear mode is being developed by RCA's Solid State Div., Somerville, N.J. Under a contract from the Air Force Avionics Laboratory, RCA is designing a 10-W linear uhf power transistor that will operate in the 1.7-to-3.4-GHz range. All present uhf and microwave rf power transistors are intended for use in the nonlinear Class C mode.

Development of the world's most powerful radio transmitting tube —a two-million watt output tetrode with 17-dB stage gain—is reported by Varian Associates Eimac Div., San Carlos, Calif.

A National Quadraphonic Radio Committee has been established by the Electronic Industries Association Consumer Electronics Group. The purpose? To report to the Federal Communications Commission on the technical aspects of providing commercial four-channel broadcasting. An FCC go-ahead for quadraphonic broadcasts could come within a year or two, EIA predicts.

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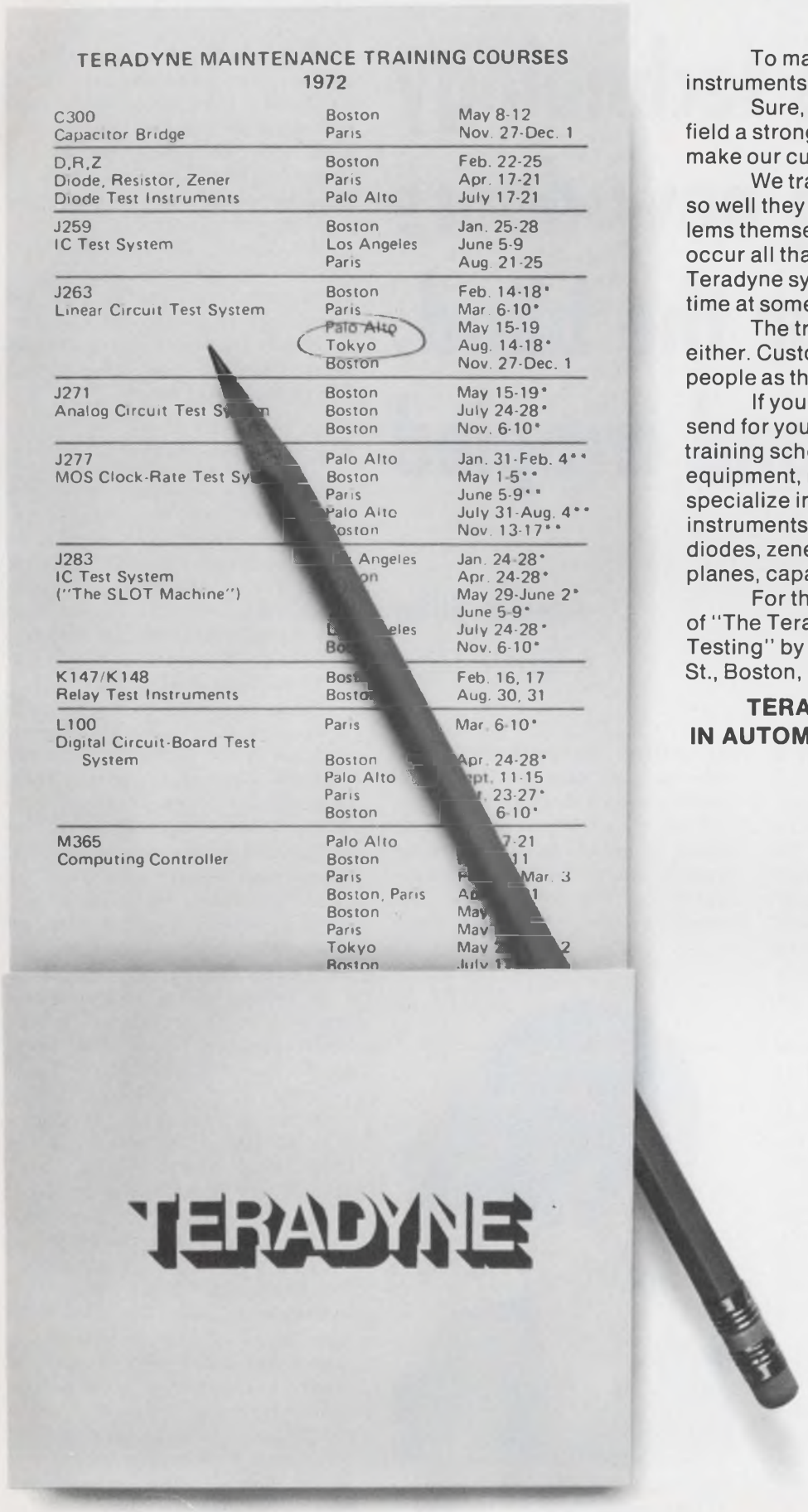

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INFORMATION RETRIEVAL NUMBER 17

Space-age technology opening new doors for the blind, deaf and crippled

Jules H. Gilder
Associate Editor

In 1968, Prof. G.S. Brindley, a physiologist at the Institute of Psychiatry, Maudsley Hospital, South London, England, implanted 80 tiny radio receivers and 80 miniature electrodes in the brain of a blind woman. Using transmitters to stimulate those electrodes, he was able to cause the woman to see phosphenes—flashes of light generally produced by stimulation of the retina.

As a result of this preliminary work, Brindley believes that it is possible to develop a sensory aid that will enable blind people to see.

This is only one example of the increasing application of highly sophisticated electronic technology to restore physical functions to the handicapped. Besides visual aids, improved electronic systems are being used to help the deaf and hard of hearing and to assist or replace human limbs.

One system to aid the deaf is an electrotherapy device that improves speech discrimination in people who have a sensorineural hearing loss—more commonly known as nerve deafness. Preliminary results indicate that more than 50% of the patients treated with this device had at least 15% improvement in speech discrimination.

Work in assisting or replacing human limbs has borrowed heavily from NASA projects. Switches operated by the eye, tongue and breath are some of the technological spinoffs from the space program. A special Biomedical Applications Team has been organized at the Southwest Research Institute, San Antonio, Tex., to apply NASA technology to the solution of everyday problems. Dr. David Culclasure, head of the team, says that complete engineering information on products developed by the group is often available free to manufacturers who wish to produce them commercially.

Night-vision goggles developed by ITT help overcome night blindness.

The common denominator in all of these applications is the need for ingenuity on the part of the design engineer. Devices designed originally for nonmedical functions must nearly always be modified for physiological use.

Electronic eye studied

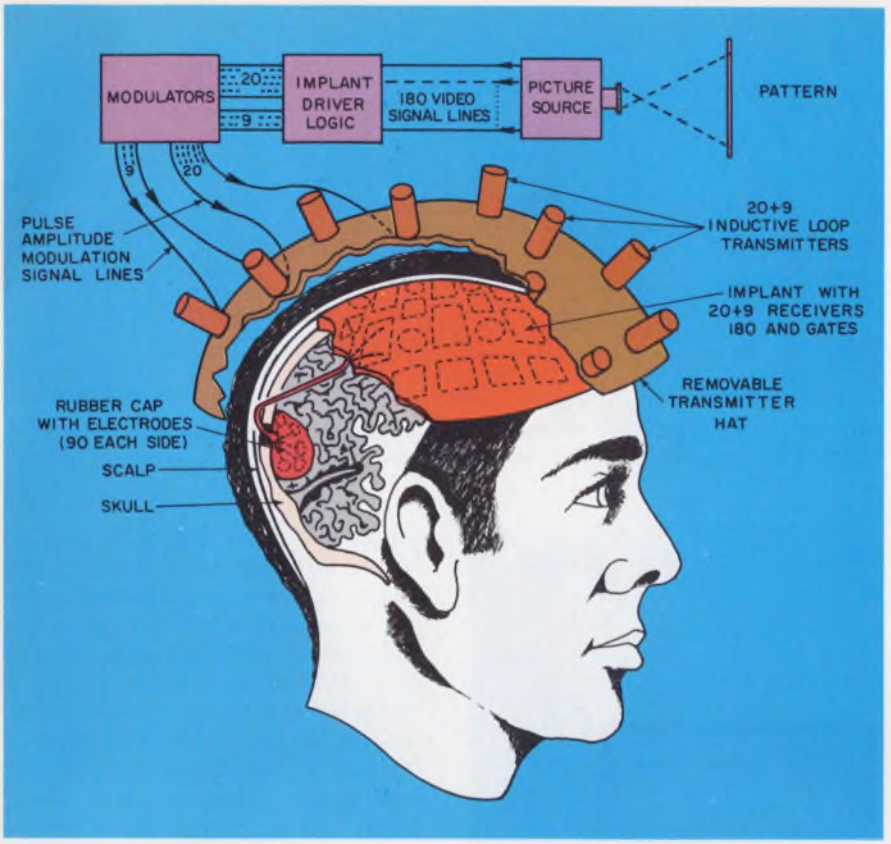
Spurred by Brindley's work on a visual prosthesis, the National Institutes of Health has decided to study the feasibility of an electronic eye. According to Dr. Terry Hambrecht, assistant project officer, a total of seven universities, hospitals and companies are directly involved in the study.

There are many problems with brain implants, says Hambrecht, and the participants in the study will try to clarify them and indicate possible solutions. While Professor Brindley has already tried his technique on a human subject, Hambrecht reports that the National Institutes of Health will require extensive animal studies before the technique is tried out on a human.

In normal vision, electrical impulses from the retina of the eye are transmitted by the optic nerve to the visual cortex of the brain, where an image is formed. Blindness can be caused by a malfunction of either the retina or the optic nerve, resulting in a loss of stimulation to the visual cortex.

The theory behind Brindley's work is to stimulate the cortex to produce phosphenes. By stimulating selected portions of the visual cortex, he believes it is possible to organize the phosphene patterns to enable a blind person to see obstacles in his path, or even to read.

Encouraged by his earlier work, the British professor has developed an improved implant, now being tested. The new unit (see illustration) consists of 180 points on



A visual prosthesis now being tested contains 180 implanted electrodes. Because of the bulkiness of available electronic circuitry, only 90 of the implanted electrodes can be stimulated.

the visual cortex—90 on each side of the brain. The 180 points, Brindley says, are sufficient to convey information on the shape of an object and the light and dark features associated with it.

Many problems to be solved

In the U.S., work on a visual prosthesis is progressing at a slower rate. While Brindley has solved some of the initial problems, there are still many that must be overcome before a practical device emerges.

The biggest problem, according to Hambrecht, is that of interfacing an electrode with the neural tissue in the brain. Not only must the electrodes be held in place without damaging the tissue, but a way must be found to convert the electron flow in the electrode into an ion flow in the conducting fluid that surrounds the brain. This must be done, Hambrecht notes without producing toxic products or changing the pH of the body fluids.

Another big problem, he says, is placing enough electrodes on the surface of the brain to produce a usable phosphene map, or image. The number of electronic components required in the implant is directly proportional to the number of electrodes used. Since the amount of space available is limited, some method of decreasing space requirements must be found.

Optical radar system to guide the blind can be mounted on glasses.

Brindley has attempted to solve this problem by arranging the electrodes in a 9 by 20 matrix and by using hermetically sealed integrated circuits. But the sealed packages tend to be bulky, Hambrecht notes. A way must be found to build ICs that can operate reliably for years in a warm bath of saline body fluid, without the need for bulky hermetic packaging.

A problem that may already be moving toward solution is the development of a TV input sensor for the prosthesis. Recent work by RCA and Bell Telephone Laboratories with charge-coupled devices has shown that it is possible to use solid-state technology to reduce drastically the size of television cameras. Further reduction will undoubtedly result from a new $3-million charge-coupled-device research program sponsored by the Navy.

The Navy's interest in charge-coupled devices can be attributed, at least in part, to the desire to simplify and reduce the size of low-light-level television systems. High-quality TV cameras using charge-coupled devices that cost about $100 are envisioned.

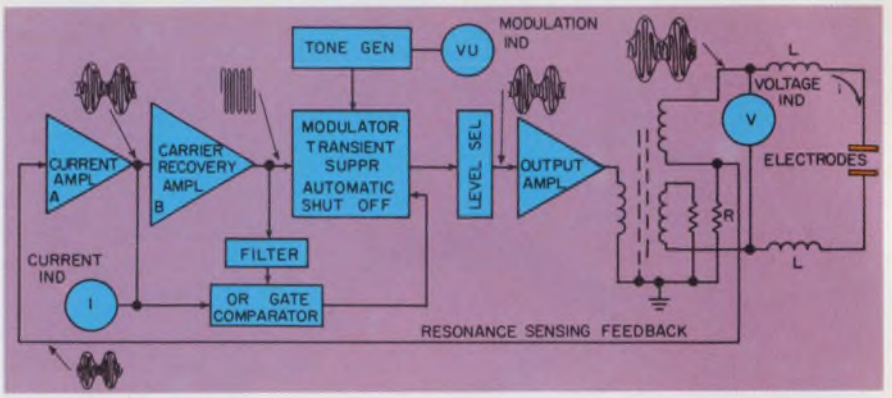
Sensing with the abdomen

In a related development, the Reticon Corp. of Mountain View, Calif., recently announced a 32-by-32 self-scanning photodiode array that can be mounted on a pair of eyeglasses with a light source and a small lens.

Dr. Carter C. Collins, associate professor at the University of the Pacific's Smith Kettlewell Institute of Visual Science, San Francisco, plans to use the Reticon device in a sensory aid that he has had under development for eight years.

In his system an image is sensed on a photosensitive array. Each point on the image array corresponds to an electrode placed on an individual's abdomen. A lens focuses the image to be viewed onto the array. Elements of the array are illuminated, and electrical pulses are transmitted to the corresponding electrodes. Intensity information is transmitted by varying the width of the pulse. Thus by feeling where pulses are applied

Bell's Code-Com set can enable the deaf to see or feel coded messages.



How the Intelectron transdermal therapy device works. A modulated signal is coupled to the patient's head via electrodes.

Portable home-therapy device maintains hearing improvement obtained through treatment with TD 100.

Intelectron's TD 100 professional therapy unit has improved hearing in patients with nerve deafness.

and their intensity, a blind person can sense an image.

Collins is presently using a 256-bit photosensitive array produced by Fairchild Semiconductor, Mountain View, Calif. This provides the blind person who uses the aid with a 5-to-10-degree field of vision. Collins' new aid, using the Reticon array, is expected to be operational by the summer and to provide about a 20-degree field of vision. Both aids, he says, will be used by the blind to read, but neither will provide a sufficient field of vision to allow a person to walk.

For walking, Collins says, a 40-to-50 degree field of vision must be provided. "We hope to do that with a 4096-bit photoarray that Westinghouse has developed for NASA," he adds.

Placement of the electrodes for Collins' sensory aid has been a problem; they occasionally break away from human skin, with consequent loss of electrical contact. However, after talking with textile manufacturers, he is hopeful that this can be overcome by weaving the electrodes into a special garment. The idea is novel and may find use in other applications, such as patient-monitoring systems.

When asked about Brindley's work, Collins said it was very interesting and he wished him "luck," but he asked: "If you were a blind person, looking for a sensory aid, what would you rather do, have a brain operation or slip on a girdle-like garment?"

Night blindness overcome

In another recent development, a pair of night-viewing goggles developed originally for the Army by the Electron Tube Div. of International Telephone and Telegraph has been adapted as an aid to night travelers whose rod vision has deteriorated. The rods of the eye are the main sensors in night vision.

In operation, the lenses in the goggles focus the scene before the viewer onto a miniature image-intensifier tube, where it is converted to an electronic image. The image is then amplified and displayed on a phosphor screen in the goggles, in much the same manner as a TV picture is displayed on a cathode-ray tube.

Tests carried out by Thomas Coursey of the Western Blind Rehabilitation Center, Palo Alto, Calif., indicate that the night-vision goggles may be a significant aid to people who suffer from night blindness. But image-intensifier tubes are expensive, and before this device can become widely used, the cost must be brought down—a set of goggles costs $11,600. In addition the packaging of the unit must be changed to make it cosmetically appealing.

A device intended as a mobility aid—not a visual aid—for blind people was recently developed by Forrest M. Mims, a technical consultant in Albuquerque, N.M. The unit is essentially an optical radar system that uses light-emitting diodes. Light produced by the diodes is reflected from objects that intersect the emitted beam and the field of view of a sensitive receiver. The received signal is used to control an oscillator that produces a tone, which the user can hear. Variations in the tone indicate the presence or absence of obstacles.

The system has low current consumption, and the entire device can be mounted on a pair of eyeglasses. While it is simple, practical and economical, the device is not yet being manufactured by anyone.

The basic system has many other applications, such as automobile "radar," an intrusion alarm

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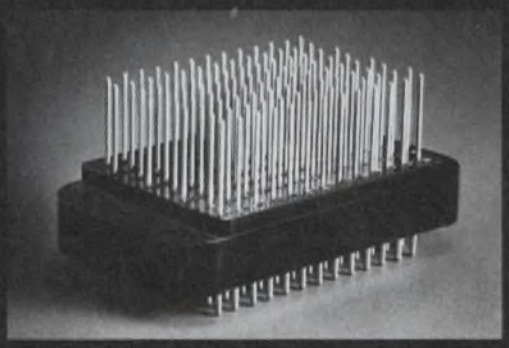

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GTE SYLVANIA

An artificial arm, with an electric elbow was developed at Ranch Los Amigos Hospital.

and an industrial counting system. With an increase in the diameter of the lens, a range of several hundred feet can be attained, making the system useful as a range detector for automobiles and future automated highways (for technical details see "Use LEDs, Not Lasers, in Ranegfinders," p. 48, this issue).

Systems to enable blind people to read do not have to be big and complex. A small battery-operated optical-to-tactile convertor, known as Optacon, can help the blind "read" conventional print in books and newspapers. Developed by Dr. James C. Bliss and Prof. John G. Linvill at the Stanford Research Institute, Optacon uses a 144-element, light-sensitive array to scan printed material. Each element of the array corresponds to a tiny metal pin set in a finger-sized depression in the device. As the reader scans a letter, the pins vibrate in the shape of the letter. Optacon is being manufactured by Telesensory Systems, Inc., in Palo Alto, Calif.

While the application of electronics to optical aids is relatively new, electronic hearing aids have been used for years by deaf people. Hearing aids have traditionally been in the forefront of medical electronic technology, says James H. Johnson, president of the Zenith Hearing Aid Sales Corp. in Chicago.

"When the transistor first came out in the 1950s, we were the first industry to use them," he notes. "And when integrated circuits became available in the early 1960s, our industry was again the first to use them."

Present efforts by Zenith to improve hearing aids include special audio ICs that contain compression and automatic-gain-control circuits, together with amplifiers, in one package; a new miniature cardioid microphone, and an implantable hearing aid. The first two developments will almost certainly find application in other branches of electronics, such as communications, Johnson says.

Electrotherapy aids nerve deafness

An electronic system that is designed as a therapy device has been developed by the Intelectron Corp., New York City. The unit, a professional instrument available only to doctors, couples rf signals

An experimental visual aid impresses TV images on the abdomen.

Patient's tongue controls an electric wheelchair by operating a proportional-control system that has strain gauges mounted on cantilever beams.

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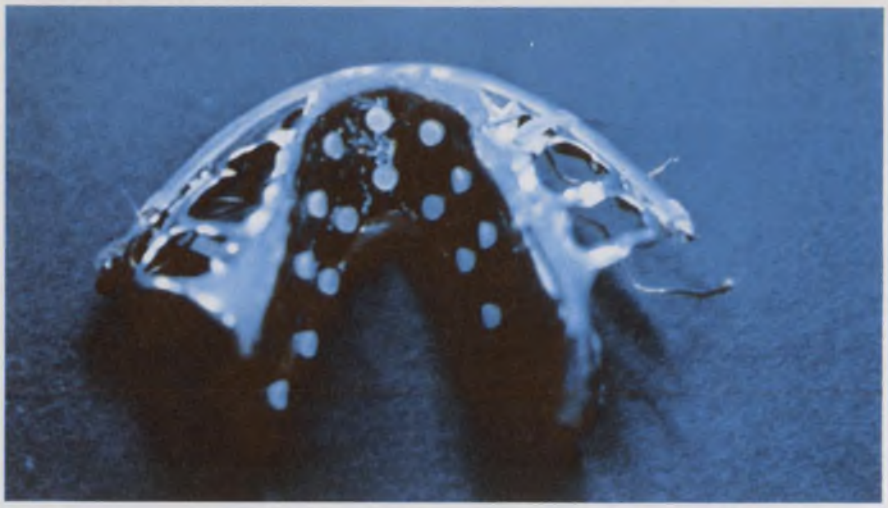

Intra-oral tongue switch under development at Rancho Los Amigos Hospital is activated by pressure on one of the strain-gauge elements.

A voice-controlled telephone dialer being developed by Bell Telephone may someday allow handicapped people to dial by speaking into a microphone.

through the skin to nerves in the head. Thus the term "transdermal" has been coined to describe the system.

Richard S. Dugot, Intelectron's vice president of engineering, reports that tests show at least a 15 point gain in speech discrimination for more than 50% of the patients with sensorineural loss who have received transdermal treatments. However, to maintain the hearing improvement, patients must continue therapy, he cautions. This can be done with the TD 200, a special home unit, and it requires only a few hours of treatment each week.

"We don't know exactly how it works," Dugot comments, "but it does work." The system is presently being evaluated by independent otologists, and plans to investigate the physiological mechanism involved are being formulated.

Two researchers—Dr. James Martin, associate professor of psychology, and Dr. Paul Michael, professor of environmental acoustics, both at Pennsylvania State University—report that preliminary findings of a double-blind program show significant statistical correlation between transdermal therapy and improvement in word discrimination.

The idea for a transdermal therapy device came to light as a result of Intelectron's earlier work on a hearing aid to be housed in two false teeth. While working on that project, company researchers discovered that a thin metal probe, when attached to the output of an audio amplifier fed by a sound source, could be heard by a normal-hearing person if the probe was placed directly behind one ear and if another probe—to complete the circuit—was in contact with the body at any other point.

This was soon followed by the discovery than an amplitude-modulated carrier, when capacitively coupled to areas around the head by electrodes, could permit intelligible hearing.

Realizing that this phenomenon might be applied in the form of a hearing aid, the developers tested it. As weeks passed, it was found that patients using the new aid were responding to a wider band of pure tones and that their hearing was improving. Tests showed that the device was capable of enhancing speech discrimination.

The electrodes in the system are attached to the patient's head and act as a capacitor, which, with the series inductors, form a resonant circuit (see block diagram). Under electrostimulation, the tissue capacitance of the head changes from one to four times its initial value. To maintain the series resonance during therapy, the generator's frequency must change continuously to follow the changing value of the capacitor.

This requirement led to the development of a novel circuit known as a self-resonating oscillator. This oscillator senses the current in the resonant circuit by measuring the voltage drop in resistor R. In resonance, this voltage and the current in the resistor are in phase, and thus the voltage can be used as the positive feedback.

An electrotactile sound detector that enables deaf persons to detect and localize sounds is being developed by Frank A. Saunders at the Smith-Kettlewell Institute. With a technique similar to the one being used by Collins to aid the blind, Saunders is using the skin to detect pulses, whose magnitude and location convey information as to the site of the sound source and the strength of the sound.

(continued on page 32)

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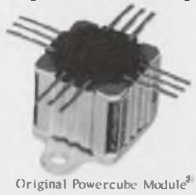

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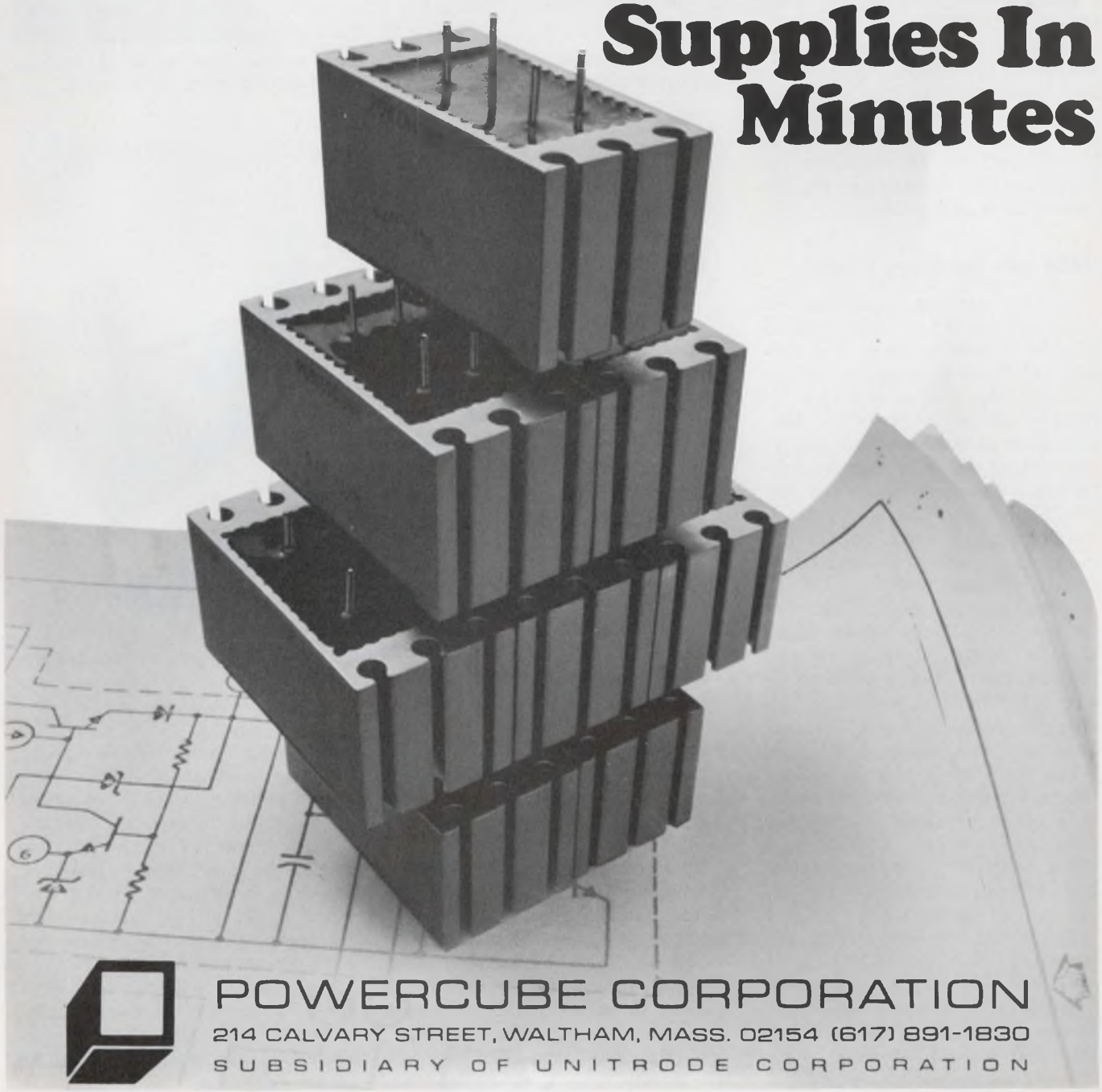

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INFORMATION RETRIEVAL NUMBER 20

(continued from page 30)

The electrotactile sound detector is a portable, battery-operated device mounted on a headband. Signals from bilateral microphones are converted to electrical pulses, which are used to stimulate the skin. The magnitude and frequency of the pulses are proportional to those of the original sound. Sounds originating to the left of the person activate electrodes on the left side of the forehead. The same thing is true for the right side.

Tests with deaf patients show that they are capable of responding to sudden sounds, such as a shout, horn or other warning signal, Saunders says. In addition, a person using this device soon learns to recognize the rhythmic patterns of certain sounds, such as doorbells, the crying of a child, telephones, etc.

Another important feature of this device, Saunders reports, is that it provides the feedback for a deaf person to regulate the intensity level of his voice.

NASA aids paralyzed people

In other electronic aids for the handicapped, NASA has been a valuable source of ideas and support. With an eye-operated switch developed for NASA by Hayes International of Huntsville, Ala., paralyzed patients are now able to move about on their own by controlling a motorized wheelchair. Researchers at the Rancho Los Amigos Hospital, Downey, Calif., have designed a chair that can be operated with the switch.

In addition the same switch can be used to perform other tasks, such as dialing a telephone and turning lights and appliances on and off. The switch operates by directing a low-intensity beam of light into the white of the eye. When the eye is moved, so that the darker iris intersects the beam, a sudden decrease in reflected light is sensed by a photodetector and a switching pulse is generated. Control logic determines which device will be operated.

But while the eye switch has increased the self-sufficiency of paralyzed patients, it also causes irritations of the eyes when the cornea is exposed to the light for extended periods of time. Thus an alternative switching system has been perfected—a complete control system that can be actuated by a person's breath, or a puff of air directed against a paddle connected to a microswitch.

A breath-operated switch and control system developed by NASA enables paralyzed patients to operate appliances by simply blowing on a switch.

Head, foot and hand switches can also be used with NASA's control system. They offer a choice for the less severely handicapped.

The breath switch was suggested by NASA's Langley Research Center in Norfolk, Va. With designers from the Southwest Research Institute, NASA engineers have built a system that permits a patient to operate any one of six devices in this way. Extensive testing has proved the feasibility of the system, and patient response has been favorable, NASA reports.

NASA also is supporting research relating to the development of prosthetic devices. An electric arm, developed by James R. Allen at Rancho Los Amigos Hospital, has been constructed with a tongue-operated switch developed by the space agency. The switch consists of 14 microswitches that can be operated by moving any one of seven levers with the tongue. A more sophisticated intra-oral switch is now being developed by Allen. ■■

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INFORMATION RETRIEVAL NUMBER 21

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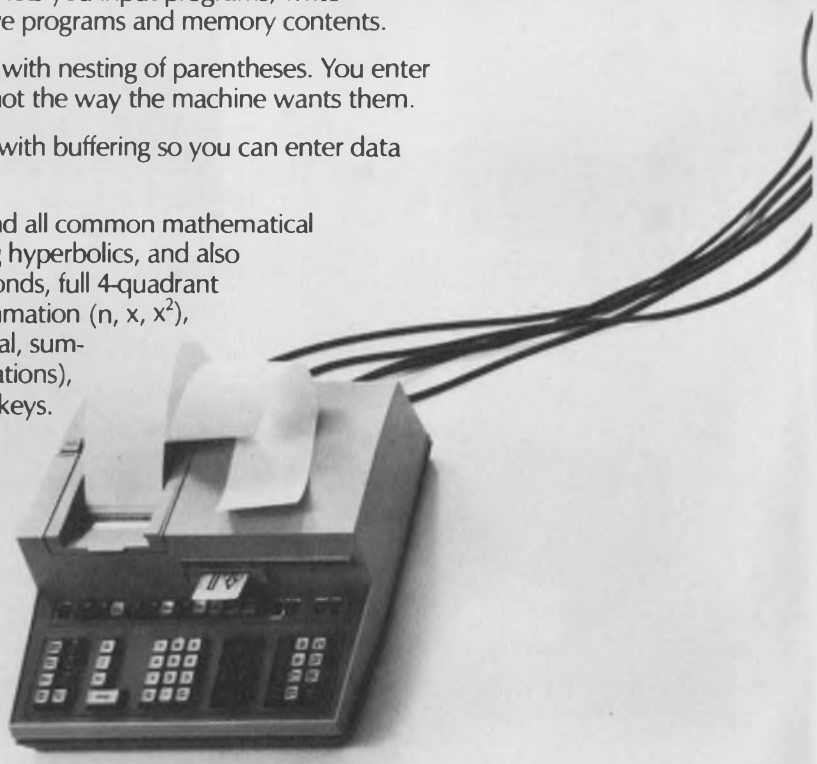

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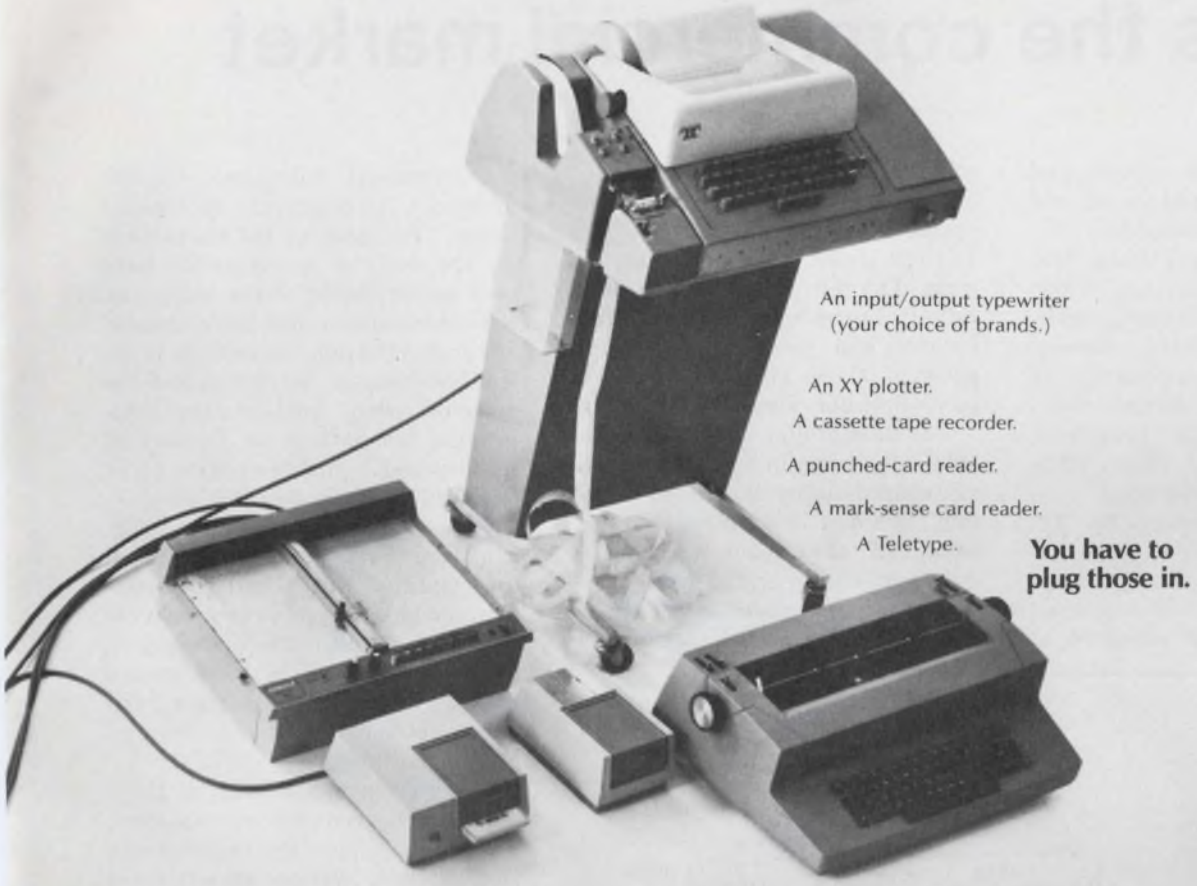

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INFORMATION RETRIEVAL NUMBER 22

Low-cost holographic ROM cracks the commercial market

The first low-cost commercial version of a holographic read-only memory has been developed.

Designed by Optical Data Systems, Inc., of Mountain View, Calif., for the point-of-sale, credit-verification market, the memory is expected to find application in such areas as minicomputer look-up tables, diagnostic programs, archival storage and other large data-based ROM applications.

Known as Holoscan, the 12-megabit store has an average access time of 1.5 seconds. Bit error rates are reported to be better than one part in 10^7. It is expected to sell for around $1500.

Les Brock
Western Editor

In operation, a he-ne laser generates a hologram pattern of 4 by 14 bits from a holographic film strip. The bit pattern is focused at infinity in the hologram, and a lens focuses and reconstructs the bit pattern in the plane of a 4-by-14 photo-detector array.

The 35-mm film strip consists of 5000 holograms in 40 channels that are spaced across the width of the film. The film is mounted in a cassette and takes about 3 seconds to run from end to end. A lead-screw-driven mirror selects one of the 40 channels and runs the entire channel past the laser beam.

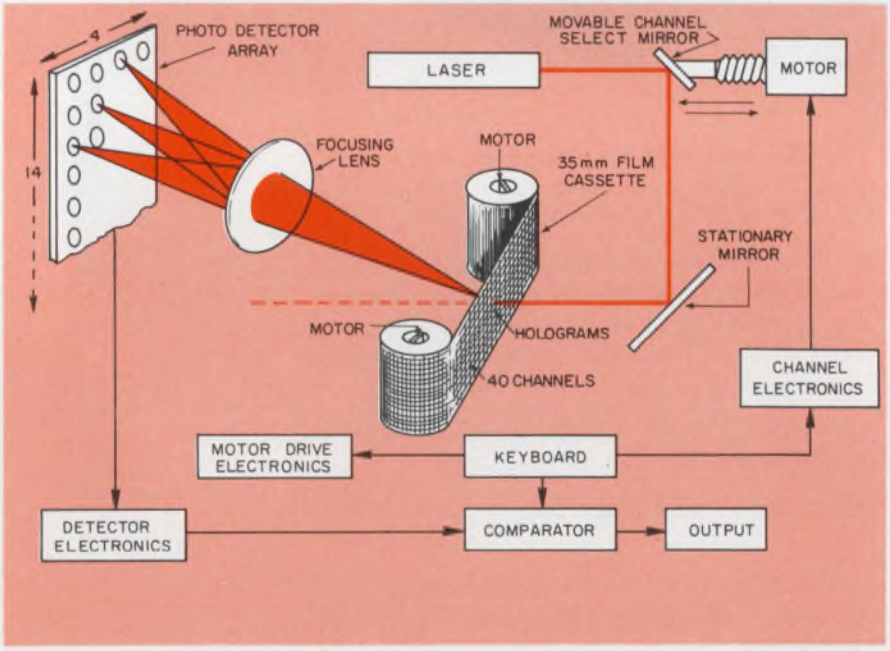
The key to the low-cost system lies in minimizing critical mechanical alignment tolerances in the memory. A company spokesman notes: "Focusing of the bit pattern on the detector array could have been accomplished in the hologram. However, this would have created a significant frame-alignment problem between the hologram and the detector array. Instead, the holographic bit pattern is focused at infinity and a lens is used to focus the data onto the detector array.

Both holograms and microfilm can store digital, as well as analog, information. But whereas microfilm images are relatively easy to record and difficult to retrieve, holograms are difficult to record and very simple to retrieve. Far more retrieval systems are required than record systems.

The storage capabilities of Holoscan can be reduced or expanded, depending upon the application. Optical Data Systems says it plans to introduce in the first quarter of next year two new Holoscan systems. Holoscan II will store only 10^6 bits, but it will have an average access time of about 100 ms and sell for about $500. Holoscan III is expected to store 10^8 bits, sell in the $2500 range and have a 1.5-second access time.

Previous work on holographic memories has been largely experimental. In 1968, RCA developed a feasibility model of a holographic read-only memory for the Army Electronics Command. It consisted of four holographic pages containing 26 bits of ROM information. A solid-state gallium-arsenide diode laser was used to construct or read the holograms onto a photo-detector array.

RCA is presently working on a random-access read/write holographic memory for NASA that consists of 1024 liquid-crystal holograms of 1024 bits. This RAM system will cost about $200,000. ■■



Retrieval of digital information from a holographic ROM in a 35-mm film cassette is done with a laser, two mirrors, a lens and a photo-detector array. One of the mirrors is adjusted by a lead-screw mechanism to position the laser beam on one of the 40 channels across the width of the film. The reconstructed spot-pattern image from the hologram is focused by a lens onto the detector array. The cassette motor-drive system scans the entire film strip past the stationary laser beam, successively reading out each of the tiny holograms along the chosen channel.

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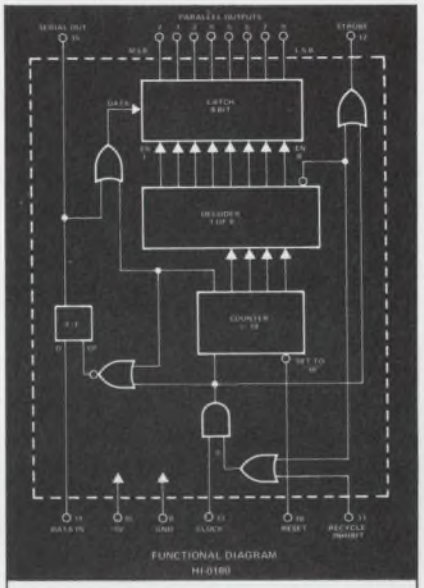

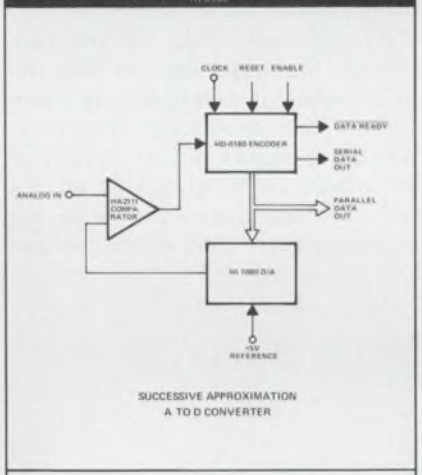

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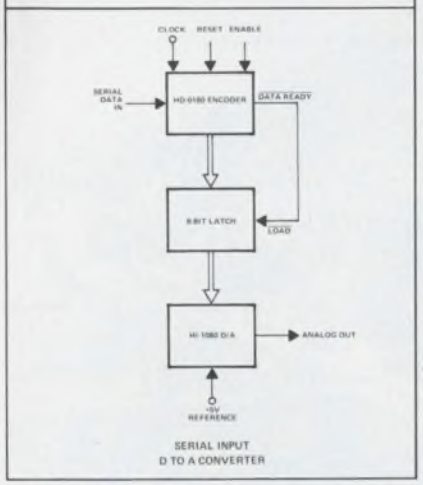

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INFORMATION RETRIEVAL NUMBER 25

Ferrite phased-array radar developed for smaller planes

For pilots of small, single-engine aircraft, a weather radar to guide them through stormy weather has long been a hope rather than reality. Weather radars were only for bigger planes. They were prohibitively expensive—and, besides, a single-engine plane had no place to mount a rotating radar dish, which generally has been installed in the nose of the plane.

Now, as a result of a new ferrite phase-shifter design, the small-plane owner can have a weather radar that, its manufacturer says, is even better than the present systems in some of the big general-aviation planes. The price of the new radar is expected to be about $5000 fully installed—still fairly high for many single-engine plane owners but only half the cost of presently available units.

Jules H. Gilder
Associate Editor

The new radar is a phased-array system that can be mounted in the wing of the plane. It has no moving parts, and thus offers higher reliability. It uses meander-line, nonreciprocal phase shifters and stripline construction, which results in the 50% cut in costs, according to David Stanislaw, project engineer for the Aradar Corp., Plymouth Meeting, Pa., the manufacturer.

Another advantage of the new system, Stanislaw says, is that the radar scans at a rate that is much higher than eye-flicker frequency. What this means is that instead of the image being presented in discrete frames, the display is a continuous picture that shows changes instantaneously. Also, regular cathode-ray tubes are used instead of the more expensive high-persistent types.

Ferrite phase shifters used

Phased-array radar systems have been around for some time. They can use either solid-state or ferrite phase shifters. The solid-state, while capable of several kilowatts, are very expensive. Ferrites on the other hand, while inherently cheaper to fabricate, operate at typically, only a few hundred watts, Stanislaw notes.

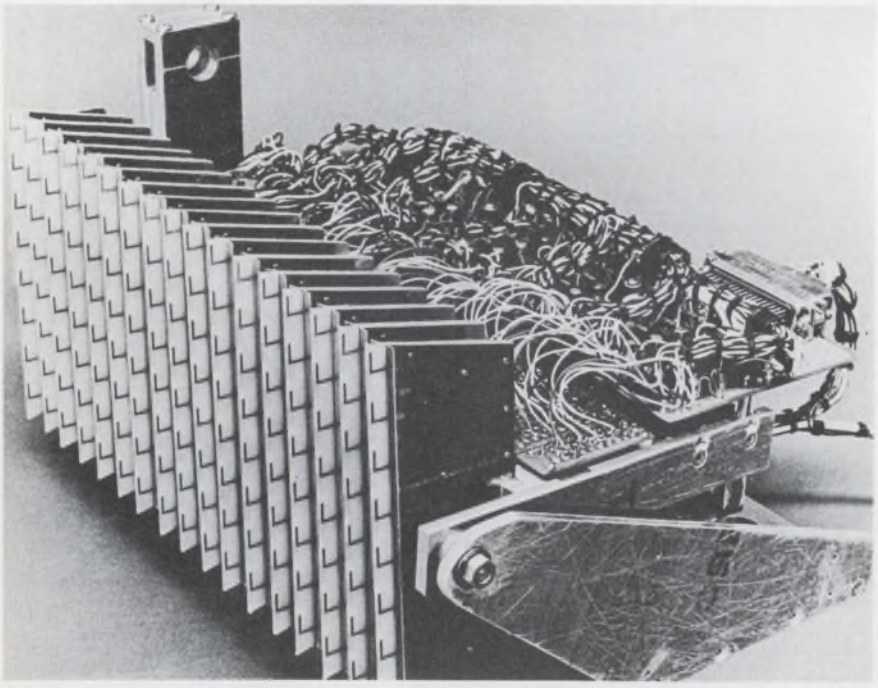
"Our new ferrite phase shifter, however, can operate at a power level of 10 kW—higher than any other ferrite phase shifters," Stanislaw reports. He's not saying how he is able to do this, though, because patents are still pending.

Based on military technology

The early development work on Aradar's ferrite phase shifters was done by the Syracuse University Research Corp. in New York State. Syracuse was chosen because of extensive work that it did on ferrite devices for the Navy and the Air Force.

The radar system operates in X-band and has a range of 90 miles. It can be mounted in the leading edge of an airplane wing, with lower installation costs than for present nose radars.

Although still in the prototype stage, Stanislaw says that production of commercial units will start by the first quarter of next year. He estimates that the system will sell for about $3000, with $2000 required for installation. This contrasts, he says, with present systems selling for $7000 and requiring $3000 for installation. ■■



Phased-array weather radar system can be mounted in the wing of an airplane. A fiberglass radome, the same shape as the wing, covers the array.

technology abroad

The use of low-cost base-metal compounds in thick-film hybrid microcircuit resistors is under study by Britain's Electrical Research Association. The association's work has so far demonstrated that some conductive base-metal compounds, such as molybdenum boride, possess desirable properties and are relatively easy to process. In the latest phase of the program, the association is making differential thermal analyses of the phase changes and related effects that occur in the materials at up to 1500 C in a controlled atmosphere.

CIRCLE NO. 441

New pyroelectric crystals that can detect a one-degree change in a black body at 300 K may replace the costly and bulky nitrogen-cooled detectors in night-vision systems. The new proprietary crystals, which have already been fabricated as the target of a conventional vidicon camera by Thomson-CSF in France, are only an order of magnitude less sensitive than the nitrogen-cooled devices. The new camera has a temperature resolution of 1 C, spatial resolution of 2 mrad and a frame rate of 10/s.

CIRCLE NO. 442

A low-cost digital-to-analog conversion technique eliminates ladder networks and reduces the components to a simple MOS integrated circuit plus a resistor-capacitor integrator. It was developed by the French firm Alsthom, a manufacturer of process controls. The output of a 10-bit random number generator is compared with the digital signal, and the difference is applied to the RC network. The average value of the RC network output has a linear relationship to the digital input. A 10-bit converter, using the simplified technique, has been produced. The French circuit designers say that an analog-to-digital conversion is also possible. The circuit, produced under an Alsthom license, is being marketed by General Instrument in Europe.

CIRCLE NO. 443

A hybrid IC that can control loads of 5 or 6 kW when triggered by a standard TTL gate has been developed by International Rectifier in England. The device measures 1 inch by 2-3/4 inches by 1-1/4 inches. Packaged onto a beryllia substrate are encapsulated SCRs, rectifier diodes, zeners and an optical decoupling circuit to isolate the input fully from the output. The two SCRs are connected in inverse parallel, and they switch in the 'zero-voltage' mode. This gives full ac control up to 25 A at either 110 or 240 V without generating radio-frequency interference.

CIRCLE NO. 444

An experimental laser system to measure wind speed, and possibly air turbulence, is being tested by Britain's Royal Aircraft Establishment. The laser beam illuminates particles in the air, and the doppler shift in back-scattered light gives an indication of the particle airspeed. This velocity is displayed on a chart recorder. The present system uses a single laser beam. However, equipment with multiple beams or a scanning system is proposed for constructing wind profiles in real time. Such equipment might be used to detect and investigate turbulence patterns in the wake of large aircraft like the 747 jumbo jet.

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Monsanto

INFORMATION RETRIEVAL NUMBER 27

washington report

Don Byrne
Washington Bureau

White House action opens research funds to industry

Administrative action by President Nixon has assured industry of getting more than it usually does of the National Science Foundation's applied research money this year. Acting on a 1968 amendment to the National Science Foundation Enabling Act, President Nixon decided last month that it was "in the national interest" for the foundation to allow organizations "other than academic institutions" to carry out applied research on national problems.

The total money budgeted for 1973, of which industry will have a bigger share, amounts to $120-million. The entire foundation budget amounts to $674-million—$28-million more than was sought by the agency and $55-million above current spending.

One area in which industry might see more grants or contracts is the Experimental Technology Incentives Program, which will consist of $40-million divided between the foundation and the National Bureau of Standards. This program was designed to encourage industry to put more dollars into research, especially in cooperation with colleges.

More Federal support planned for industrial technology

In its own bid to aid industry, the NSF's National Science Board has asked in its recent annual report for a national policy statement that by 1974 would free more Government funds to underwrite work by scientists and engineers to solve society's growing needs.

Board member J. Ross MacDonald, vice president of corporate research and engineering of Texas Instruments Inc., says that Government supported research, development and demonstration on problems such as transportation are the innovative keys essential to providing these services to society.

Daniel E. Drucker, Dean of the University of Illinois College of Engineering, said in the report that a "dramatic turn for the worse" is taking place in American industrial technology. "We are deeply concerned," he said, "when our own plants become non-competitive, not on cost alone, but on quality and versatility of their output."

Most oppose FCC's limited entry plan

The majority of the eight applicants and 24 other interested parties are finding some kind of fault with the FCC's proposed "limited entry" plan for a domestic satellite communications system. The plan, drawn up by the FCC's Common Carrier Bureau, would authorize several sys-

tems to be operated by cartels created by the eight applicants.

Western Telecommunications Inc., approved of the FCC's Common Carrier Bureau position on the satellite system. But the Office of Telecommunications Policy, the Justice and Defense Departments all urged major revisions. OTP favored a complete open entry policy permitting any viable applicant to do anything. Defense, as it has stated before, disagrees with the Common Carrier Bureau position on AT&T. The Bureau only wants to allow AT&T to provide long distance and wide area telephone service (WATS) but be precluded from offering private line services which compete with other carriers. Defense buys most of its private lines from AT&T. Verbal arguments in the case will conclude this month.

How to beat foreign competition without subsidies

A low bid of $91.6-million by Rohr Industries for 60 computer-operated subway cars for the Washington, D.C., subway system now under construction has headed off a prospective battle in Congress. Protectionist, tariff-minded Congressmen feared that Toshiba International Corp. of Japan would be the low bidder and were set to fight for a "Buy American" policy. Happily, Toshiba was the highest bidder of them all—$142.9 million. Other losers were Vought Aeronautics, bidding $103.14-million and General Electric with a $103.13-million bid. Present plans for the capital system call for a total of 300 cars.

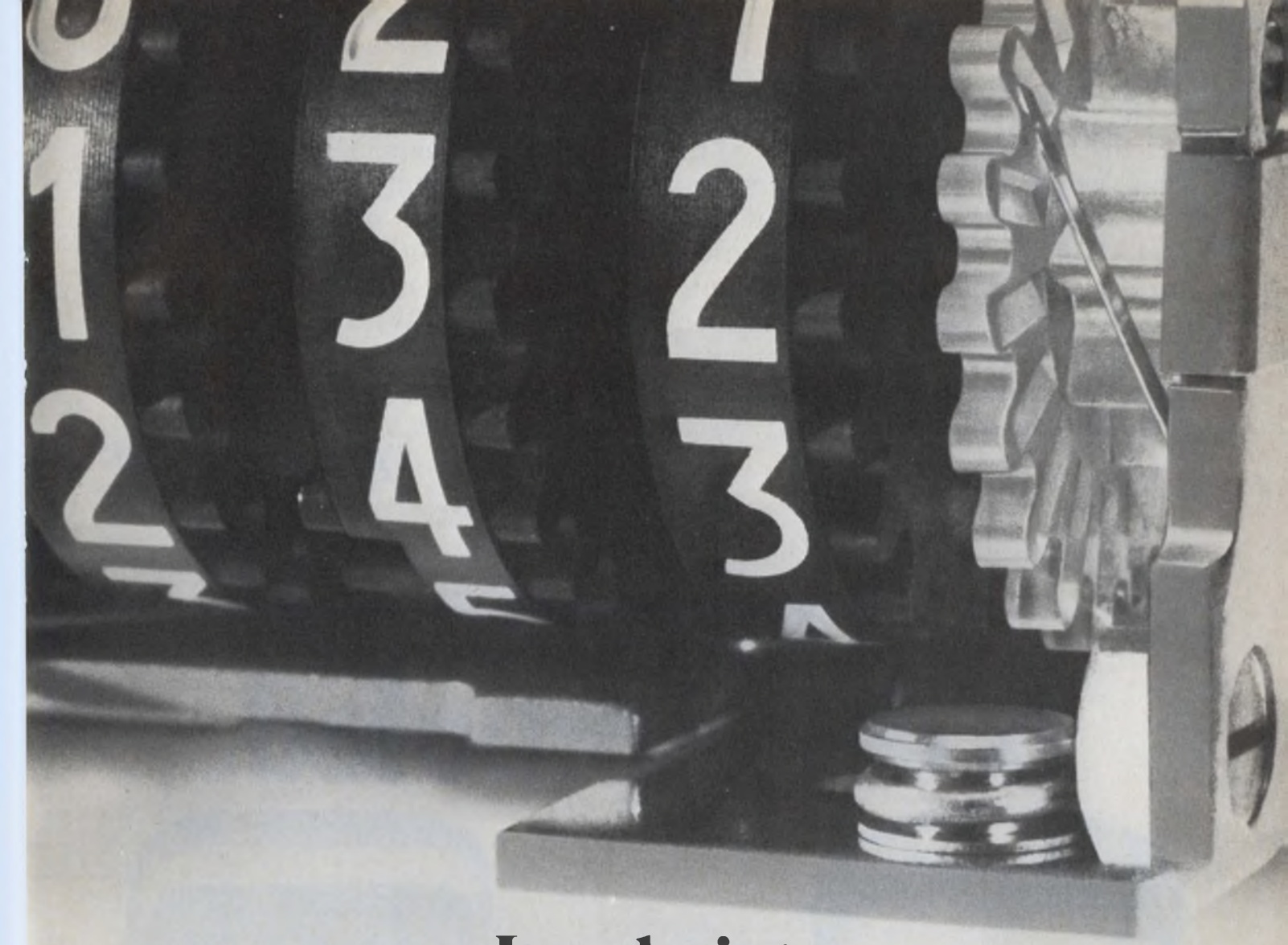
EIA data shows magnitude of 1971 semi slump

Figures just released, somewhat belatedly, by the Electronic Industries Association affirm what most in the industry have known for the past two years, namely, that the semiconductor industry has been in a severe recession. Data show that U.S. factory sales of solid state industry products totaled $1.155-billion during 1971, a 4.5% decline over 1970 sales of $1.209-billion. Unit sales for 1971 were placed at 2.9-billion while comparable 1970 sales reached 3.1-billion. The total IC market was placed at 482.1-million units (up 14.7%) worth $534-million (up 19.7%). Discrete device sales reached 2.5-billion units during 1971, off 6.9%, with dollar volume put at $621.2-million, off 9.4%.

Although year-end sales were down, considerable improvement was noted during the last few months of 1971, according to the EIA.

Capital Capsules:

The Commerce Dept. reports that **export of electronic measuring instruments dropped 15% last year to $226.3-million.** Imports were also down 13% to $68.6-million. . . . **The Air Transport Association has told Congress that the $26-million budgeted by the Federal Aviation Administration** for navigation aids, landing systems, radar, towers and weather services this year **"is far too small."** The association has asked Congress to appropriate $131.35-million for a long-overdue catch-up effort. . . . **Boeing will build in-house most of the avionics package for the Air Force B-1 bomber.** It will provide the weapons-delivery system, the low-light-level TV, the controls and display and the computer software. Boeing will buy the airborne computer, and the Government will furnish the navigation system.



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INFORMATION RETRIEVAL NUMBER 29

editorial

If you want to be a pro, try morality and guts

We're all aware of the almost universal specmanship game that manufacturers play to make their equipment look good. But there's a related problem that receives little publicity: the data-juggling game played by engineers to qualify—or hide—an out-of-spec device or instrument.

Just how widespread is this practice? It's almost impossible to come up with a reliable figure, but one case, reported in a pull-no-punches article in the April issue of *Harper's* dramatically points to the practice.

The article describes a cover-up of the under-design of a fighter aircraft brake. The designer, testing personnel and top management of the company are implicated. During tests, according to the article, the brake overheated and disintegrated. Despite repeated failures with a variety of friction materials, the brake was delivered to the Air Force—but not until both the tests and the test data were manipulated to make the brake appear to have qualified. What followed is obvious: The first pilot who tried to stop his plane upon landing had a rude awakening. Fortunately no lives were lost.

While this is an extreme case involving threat to life, the practice of letting a bad unit go by seems to be more common than most engineers care to admit. How many can recall cases similar to the brake story in their careers? And isn't yielding to pressure to ignore an out-of-spec unit or a marginally performing one immoral, even if no lives are at stake?

In the long run, if engineers want to earn the much-deserved respect of management, they'll stop worrying about their jobs and start realizing their moral responsibilities—to themselves, to their profession and to the public. Until they do, they can't call themselves true professionals.

Stanley Runyon

Stanley Runyon
Associate Editor

Use LEDs, not lasers, in rangefinders

for a range of just a few yards. LED rangefinders can even provide 'eyes' for the blind.

Optical rangefinders can be built without lasers. LEDs can be used instead—especially in battery-operated portable equipment and when long range and extreme accuracy are not the most important considerations.

With LEDs, you can construct a lightweight optical rangefinder with a range of a few yards, and it has many potential applications—for example, as a mobility aid for the blind. Such a device can be packaged in less than 25 cubic centimeters with a total weight of less than three ounces.

In an optical radar system, a beam of pulsed near-infrared radiation is emitted by a transmitting unit. The reflections from objects intersecting the emitted beam and the field of view of a sensitive receiver are detected. The output from the receiver can be converted to an audible tone. A block diagram of one possible arrangement is given in Fig. 1.

Use of optical-frequency radiation allows effective use of low-power signals, thus simplifying the drive circuitry for the LED or laser. Thus the use of optical frequencies contributes to meeting the important design criteria for portable systems—namely, low power consumption and compact circuitry.

LEDs eliminate portability problems

Injection lasers can generate much more output power than LEDs. In a laser, quasi-coherent radiation is emitted by a narrow junction region into a beam of restricted divergence. This allows collection of nearly all the emitted radiation with a simple f/1 lens. But the high current requirements of injection lasers make transmitter design cumbersome and the required narrow driving pulses make receiver design complicated.

Use of a LED eliminates these problems, since it can be driven with simple pulsers that operate at very low current levels. However, the broad beam width and large emission area of LED chips, together with their low power output, work against efficient collection and collimation of the emitted radiation.

Forrest M. Mims, 6901 Zuni SE A-12, Albuquerque, N.M. 87108

Design of transmitter and receiver units is governed by a set of optical-radar range equations. Factors that influence the range and performance of a rangefinder include target variations—the diffuse or specular nature of the target, reflectance and the size of target with respect to that of the transmitted beam—the collection area of the receiver optics, the transmitter output power and the receiver sensitivity.

Most detected objects are diffuse reflectors—they scatter the incident radiation. The maximum range capability for a diffusely reflecting target large enough to intercept the beam completely is expressed by the equation

$$R_{max} = \sqrt{\frac{P_o A_{rec} \rho \tau}{P_{th} \pi}}, \qquad (1)$$

where P_o is the peak power of the transmitted beam,
P_{th} is the threshold power of the receiver,
A_{rec} is the area of the receiver aperture,
ρ is the target reflectance,
τ is the transmissivity of the receiver optics.

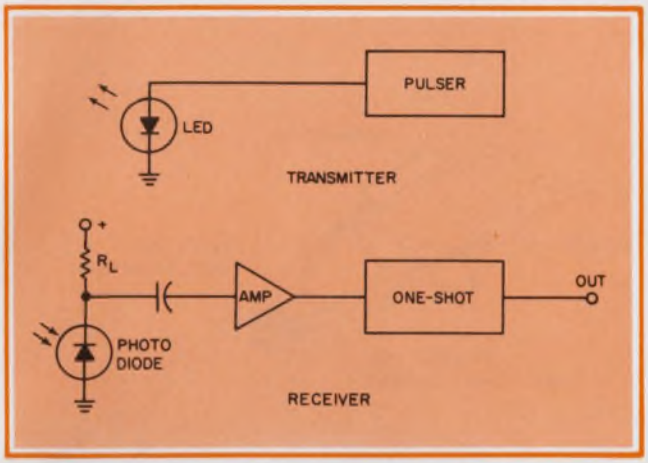
The maximum range capability for diffusely reflecting objects that do not intercept the entire beam may be expressed by the equation

$$R_x = \sqrt[4]{\frac{P_o A_o A_{rec} \rho \tau}{p_{th} \Omega_o \pi}}, \qquad (2)$$

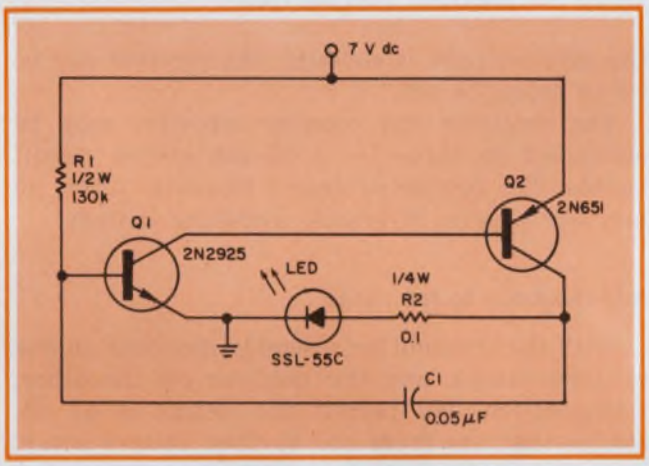
where A_o is the illuminated area of the object intercepting the beam and
Ω_o is the transmitted beam divergence in steradians.

The ratio of power output to power threshold (P_o/P_{th}) appears as a critical factor in both equations. Using Eq. 1, with a detection range R_{max} of one meter, a reflectance ρ of 0.1 and a receiver lens A_{rec} of 10 mm, we see that the result for P_o/P_{th} is about 5×10^5. A GaAsSi LED, when driven with current pulses of several amps in amplitude, will emit a peak power P_o of up to 100 mW. A threshold power P_{th} of 200 nW would be required of the receiver.

Such a sensitivity is not unreasonable for a



1. **Transmitter and receiver units** of optical rangefinder that can be used as an aid for the blind. To help reduce noise, an AND gate may be connected between the receiver amplifier and the one-shot, with one input of the gate tied to the pulser output.



2. **Transmitter generates infrared radiation** from the LED, which is pulsed by transistors Q1 and Q2.

LED. A GE SSL-55C is a suitable choice. It has high power efficiency because it has a built-in miniature reflector. This LED emits a narrow wavelength band of radiation centered at 950 nm. The flux from the LED is collected by a f/1.17 lens, 12 mm in diameter, and collimated into a beam whose divergence is adjustable to a minimum of 70 mrad.

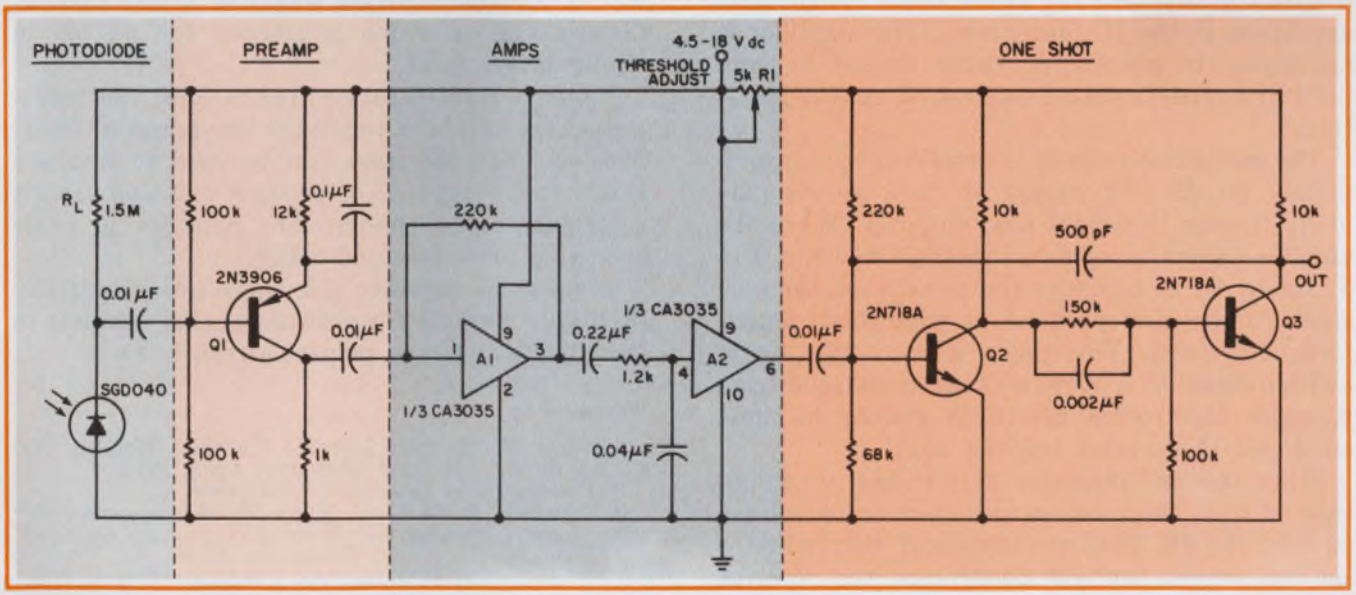
Design of the circuitry

A two-transistor pulse generator (Fig. 2) modulates the LED. The pulser delivers a 20 μs current pulse with an amplitude of 2.7 A and draws 4 mA from a 6.8-V mercury battery when the pulse repetition rate is 100 Hz. The LED emits 90 mW of infrared when driven by the pulser, but only about 45% of the flux is collected by the lens. All of the flux can be collected by an appropriate lens. Miniaturization requires use of a small diameter f/1 lens which will only collect 45% of the flux.

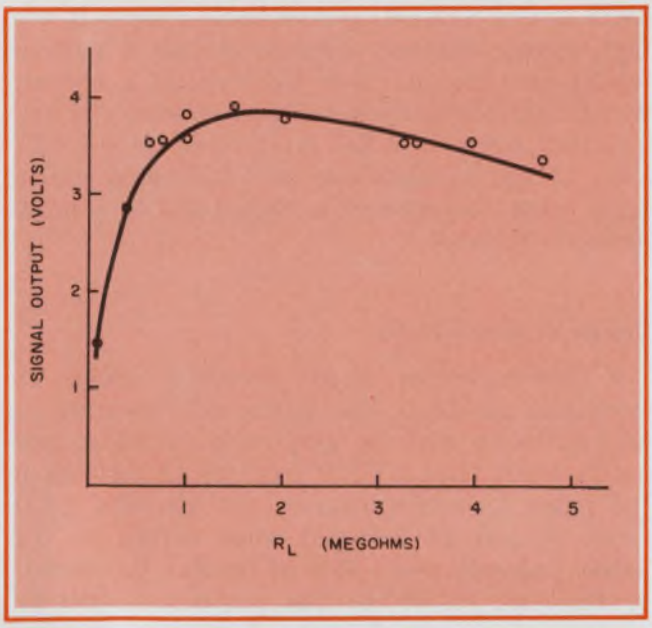
In the pulser circuit of Fig. 2, transistors Q1 and Q2 modulate the LED at a frequency determined by R1. The pulse width may be narrowed by reducing the value of capacitor C1.

The 0.1-Ω resistor R2, used to monitor the circuit, may be omitted if the current does not exceed the maximum allowable for the LED.

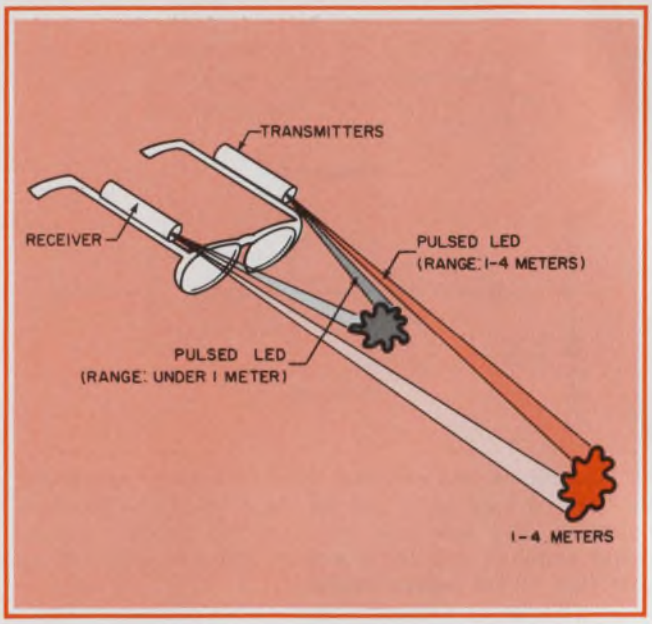
The design of the complete receiver involves choice of a detector, design of a high-gain amplifier and selection of an audio output transducer. Phototransistors feature sensitive response to near-infrared radiation and low cost, but usually their response is sufficiently nonlinear to cause saturation in the presence of sunlight. While an optical filter may alleviate the phototransistor sunlight problem, a better solution is



3. **Receiver circuit features** a maximum sensitivity of 3.5 × 10^{-8} W for 950 nm radiation.



4. **Experimental plot** for a 20 μs pulse width shows that maximum signal output occurs at a photodiode load resistance of 1.5 MΩ.



5. **Optical ranging** in a mobility aid is achieved by triangulation. A second LED source allows detection of obstacles that are closer than one meter.

to use a PIN photodiode. One such device—the EG&G SGD-040—exhibits a response to optical radiation that is linear over seven orders of magnitude. An f/1.17 lens, 12 mm in diameter, increases the collection area of the photodiode by a factor of 140.

A reverse-biased silicon photodiode serves as a detector of infrared radiation. The R_L resistor in series with the photodiode acts as a load. The optimum value of the load resistor can be experimentally determined by substituting various resistors into the circuit and monitoring the output of the receiver, while illuminating the photodiode with the pulsed LED. As can be seen in Fig. 4, the optimum value of R_L is 1.5 MΩ.

Preamplification is provided by transistor Q1, and high-gain amplification results from series-connecting two (A_1, A_2) of the three independent amplifiers in the IC linear amp. The amplifier is ac-coupled to prevent dc shifts caused by sunlight and other ambient sources of optical radiation.

The photodiode signal is amplified by approximately 80 dB and passed on to a monostable-multivibrator threshold discriminator. When the amplified signal exceeds a threshold value of 0.15 V, set by R1 to be above the noise level, the one-shot triggers and produces a wide, high amplitude, 5-V pulse. This pulse is converted to an audible signal by a subminiature transducer (e.g., Knowles Electronics BK-1612) similar to those employed in eyeglass hearing aids.

Since the multivibrator output has an amplitude of 5 V, the receiver has an over-all voltage gain of 110 dB. With the threshold discriminator set for bright sunlight conditions, the receiver will detect a minimum signal of 62 nW. When the ambient light is subdued, the receiver can be set to detect 35 nW.

The amplifier and receiver circuitry may be assembled on three 10 × 25-mm etched circuit boards. The completed device measures 13 × 90 mm and weighs 78 grams, including battery.

Add flexibility to the range

With the transmitter assembly mounted on one eyeglass temple and the receiver on the other, triangulation will permit the detection of obstacles that are from one to four meters away. But what about obstacles at 0.5 meter?

A possible solution—whereby a second LED, operating at a different repetition rate from the first, detects very close obstacles—is shown in Fig. 5. Another solution would be to use two detectors, one of which is aligned for an 0.5 m triangulation point.

While in limited-range applications, the infrared source can be a relatively low-powered, inexpensive LED, the laser can be used to improve range at the expense of greater cost and circuit complexity. Few changes are required in basic operating principles and optics.

Besides the mobility aid, there are potentially profitable markets for optical ranging systems in cars, boats and even private aircraft. ■■

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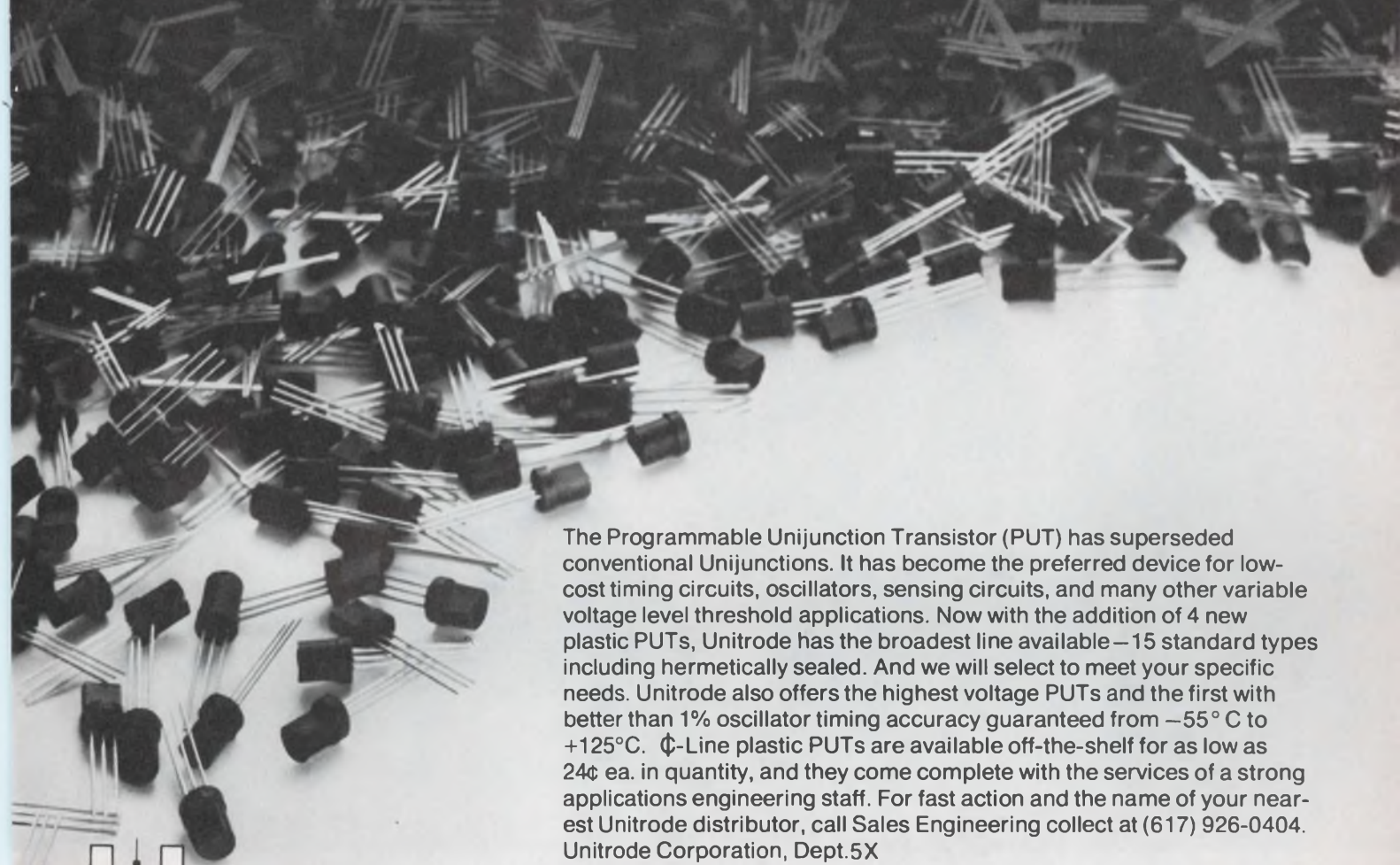

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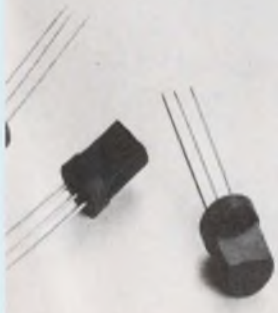

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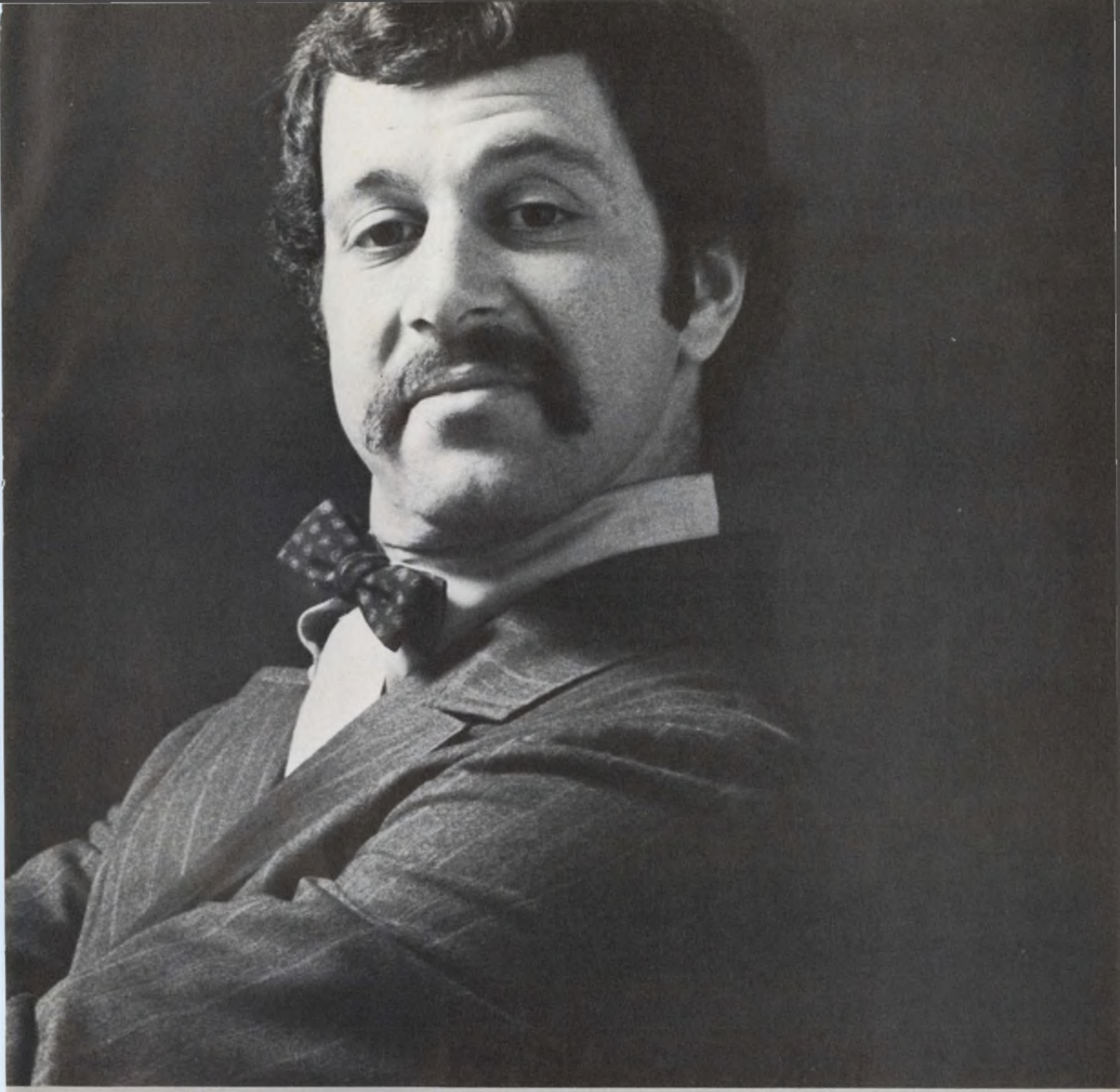

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INFORMATION RETRIEVAL NUMBER 31

Speed computer-aided circuit design

by using random-number inputs to get optimized values. The loss in accuracy is acceptable in most cases.

ECAP, SCEPTRE NET-1, RFAMP . . .

Ever used any of these computer programs to design a circuit? Or other programs like them? If you have, you'll probably agree that unless the input variables are in the right format, you'll end up spending considerable time modeling the problem to derive usable input data.

You can cut programming time and effort drastically by using random numbers as the input data. Then, with a straightforward numerical analysis, circuit values can be optimized by minimizing a function that expresses the desired performance criteria. For example, criteria like these:

- Minimum amplifier output impedance.
- Minimum circuit turn-on time.
- Maximum frequency response.

Some of the different methods for minimizing a function include Fletcher-Powell, steepest descent and conjugate gradient. All these, and other techniques, make use of the function derivative to find the minimum.

Let's consider minimization, rather than maximization, since a function can be maximized by minimizing its negative. Here is why:

Referring to Fig. 1a, let

$$f(x) = \sin x, \qquad (1)$$

where $0 \leq x < \pi$.

The minima of $f(x)$ within the limits spelled out in Eq. 1 are at $x = 0$ and $x = \pi$. To determine the maximum by means of minimization, let

$$g(x) = -f(x) = -\sin x, \qquad (2)$$

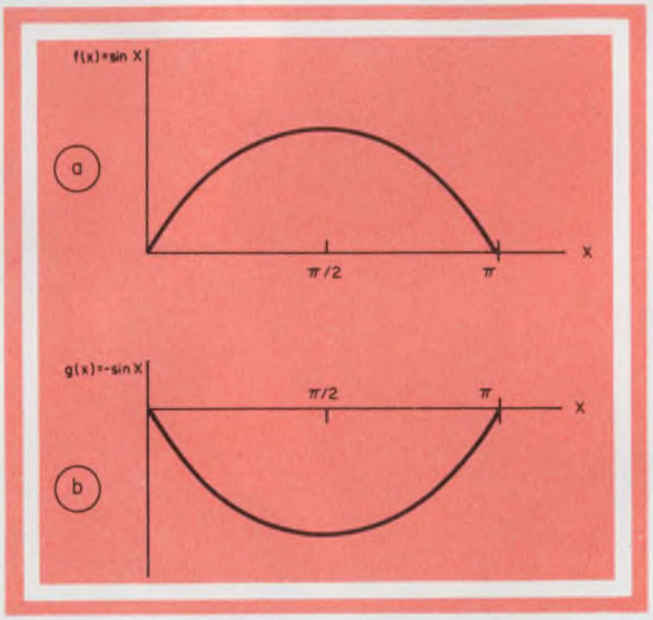
limited to the same range as in Eq. 1.

The minimum of $g(x)$ occurs at $x = \pi/2$. In this simple case, we can see by inspection that this minimum value of $g(x)$ is the maximum point of $f(x)$.

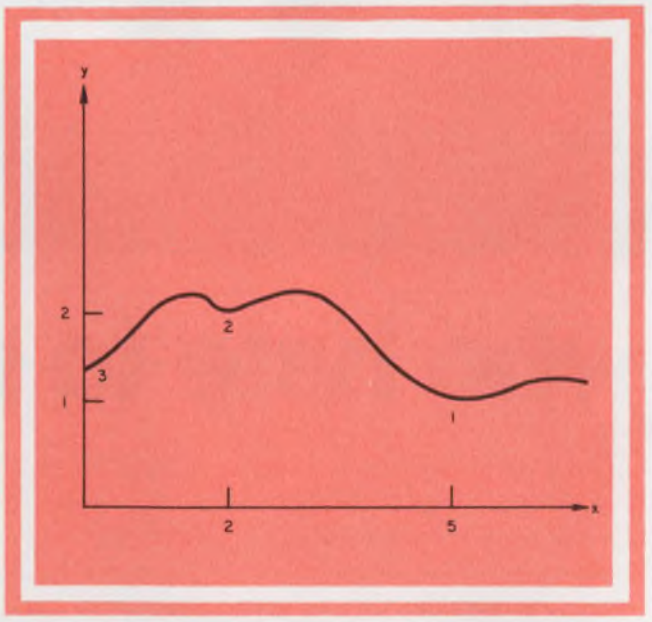
Minimizing with random numbers

Random numbers used in a computer program come from a random-number generator. For simplicity, we will use only positive numbers, thus

Ralph D. Taylor, Senior Engineer, Bendix, Kansas City Div., P.O. Box 1159, Kansas City, Mo. 64141.



1. **Minimizing is the same as maximizing** a negative of a function. Here the maximum for the curve in "a" is found by determining the minimum of the curve in "b."



2. **The right minimum value of a function** will be determined if proper definition of the minimum is used. Otherwise any of the possible minimum values may be selected by the minimization program.

```
      B3=10.**6
      IX=75773
      DO 8 J=1,500
      WRITE(3,4)A1,A2,B
    4 FORMAT(  20X,31E18.8)
      CALL RANDU(IX,IY,A)
      IX=IY
      A1=10.*A
      CALL RANDU(IX,IY,A)
      IX=IY
      A2=10.*A
      X=0.
      B=0.
      DO 7 I=1,10
      X=X+0.1
C
    7 B=(((EXP(-A1*X))- (EXP(-A2*X)))-
     2((EXP(-X))- (EXP(-10.*X))))**2 +B
      IF(B.GT.B3) GO TO 8
      B3=B
      B1=A1
      B2=A2
    8 CONTINUE
      WRITE(3,33)B1,B2,B3
   33 FORMAT(3E18.8)
      STOP
      END
```

3. **Extremely simple programming** is the big advantage of the random-number optimization technique over several other existing methods. This program was used to optimize the values for the active-filter circuit depicted in Fig. 4.

The Fletcher-Powell method

The Fletcher-Powell method makes use of a gradient that, for a three-dimensional function, is

$$f(x,y,z) = [\delta f(x,y,z)/\delta x]a_x + [\delta f(x,y,z)/\delta y]a_y + [\delta f(x,y,z)/\delta z]a_z,$$

where a_x, a_y, a_z are unit vectors indicating directions. To optimize a function, an iterative program must be written to calculate the gradient of the function. Then this gradient is used, together with the previous values of the gradient, to obtain a new estimate of the minimum. This procedure is repeated until the estimates of desired accuracy are obtained.

All variables are free to assume values anywhere from minus to plus infinity. It can be shown that with the proper choice of starting variables, the method will always yield an answer.

To prepare a FORTRAN program for determining a minimum with the Fletcher-Powell method, the mathematics becomes complex. In addition the program preparation requires a thorough understanding of both the mathematics and the programming. A typical program may have five subroutines and a total of 200 to 300 statements.

performing a "constrained" minimization. This is not a limitation, since the variables in electrical problems are normally passive elements; resistors, for example, are real positive-valued elements.

The random-number approach is a brute-force one with a digital computer. It consists of choosing a set of values for the variables and checking to see whether or not the values satisfy all constraints. If all constraints are satisfied, the function is evaluated. If not, another set of values is chosen and again checked against the constraints. This process is repeated until the function has been evaluated several times and only the minimal value is retained.

Referring to Fig. 2, we see a simple function with several minima. It also demonstrates that the nominal minimum value of a function often depends on the definition of the minimum. In the figure, for instance, if the minimum is defined as the sign change in the first derivative, then there are three minima: at x=0, x=2 and x=5. Yet there is only one absolute, or global, minimum of y(x): at x = 5.

If we use a gradient approach, one minimum can be found for a starting point. Then more information is needed before we start the search for other minima. With the random-number approach, no prior information is needed, because there is an equal probability of hitting any particular minimum.

A saving in computer time

With a method similar to the Fletcher-Powell, memory in excess of 30-k bytes on an IBM S/360

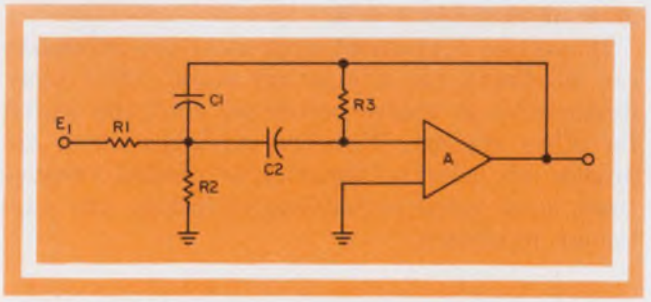
Comparison of Fletcher-Powell and random-number technique

Characteristic	Fletcher-Powell	Random Number
Starting values	Requires a starting value of accuracy dependent on type of function. Not always possible to predetermine accuracy prior to starting search.	None required.
Program complexity	Iterative gradient search. Technique fairly complex.	Call random number, generate and evaluate a function. Technique easy.
Execution time	Several minutes for short problems (five variables or less), longer as number of variables increase.	1 min or less for 3 digit accuracy of 5 variables or less.
Accuracy	Limited by machine accuracy. 16 digits double precision for S/360.	Limited by machine accuracy and how many guesses one wishes. Three or four digits most possible.
Language	Any.	Any. Can be programmed for an interactive terminal to search a region.
Prior knowledge of minimums before programming	Need good estimates for starting values.	Need to know minimum within several order of magnitudes or make repeated passes.
Programming knowledge required	Considerable. Must be able to program an iterative constrained search in variables.	Little. Must be able to evaluate function and keep least value.
Time to obtain an operable program.	Three to four weeks	Two or three days or less.
Repeatability	Same for each attempt.	Varies, depending on number of random numbers chosen.

501 might be required, against 1 k needed with the random-number programming. Furthermore program debugging time for a program such as the Fletcher-Powell might run as high as 40 hours. With this random-number method, no debugging is necessary, because of the simplicity of the program (Fig. 3).

Computational time increases rapidly with an increase in the number of variables in the optimizing function. In the case of random numbers, the time depends on how many guesses must be made. For example, for a five-variable function with six constraints, answers within 5% of Fletcher-Powell results were obtained in only 45 seconds with random numbers. The Fletcher-Powell method, by contrast, required two minutes on an IBM S/360 501.

While Fletcher-Powell's results will be accurate to eight decimal places, accuracy to four decimal places should be expected when random numbers are used. Beyond four digits additional accuracy is obtained at the cost of more computer time.



4. **Optimum values for this active filter** were obtained with a random-number optimization program, and the total programming took only one day while the running time was one minute.

Designing an active filter

The random-number technique evolved after considerable time was spent trying to design an active bandpass filter with the Fletcher-Powell method. The problem was to choose suitable component values for an active filter (Fig. 4), to minimize the filter's sensitivity to environmental and manufacturing changes. The performance

criterion for minimization was the sum of the sensitivities.

By definition, the sensitivity of the Kth element is given by

$$S_k = [e_k/(E_2/E_1)] \mid \delta(E_2/E_1)/\delta e_k \mid , \quad (3)$$

where

e_k = the value of the Kth element
(E_2/E_1) = the transfer function.

For the circuit of Fig. 4, the sum of the sensitivities becomes

$$S = S_{R1} + S_{R2} + S_{R3} + S_{C1} + S_{C2}. \quad (4)$$

The minimization was carried out subject to the following constraints:

$$e_k \geq 0,$$
$$2 \leq (E_2/E_1) \leq 5. \quad (5)$$

Solving this problem with the Fletcher-Powell method took about 20 working days of programming and debugging, then about five minutes on computer.

After that the random-number approach was tried. It took only one day to program and debug the program and only one minute of computer time. The program shown in Fig. 3 was used. This resulted in answers with five-digit accuracy.

The following component values were determined:

C1 = 0.022 μF	R2 = 580 ohms
C2 = 0.01 μF	R3 = 1.2 MΩ
R1 = 2.2 kΩ	

Was this the best answer? Perhaps not. The best of all answers was not found. The method merely tested a group of variables and determined and retained the best answer from that group. But the engineering objective was reached quickly and inexpensively. ■■

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STABILITY (Temperature Coefficient in PPM/°C	Characteristic A - 200 ±30				Characteristic C ±200		
	B 0 ±100	−120 ±30	Varies to ±350	+1150	D ±100	0 ±30	+180
	C 0 ±50				F - 0 to +70		
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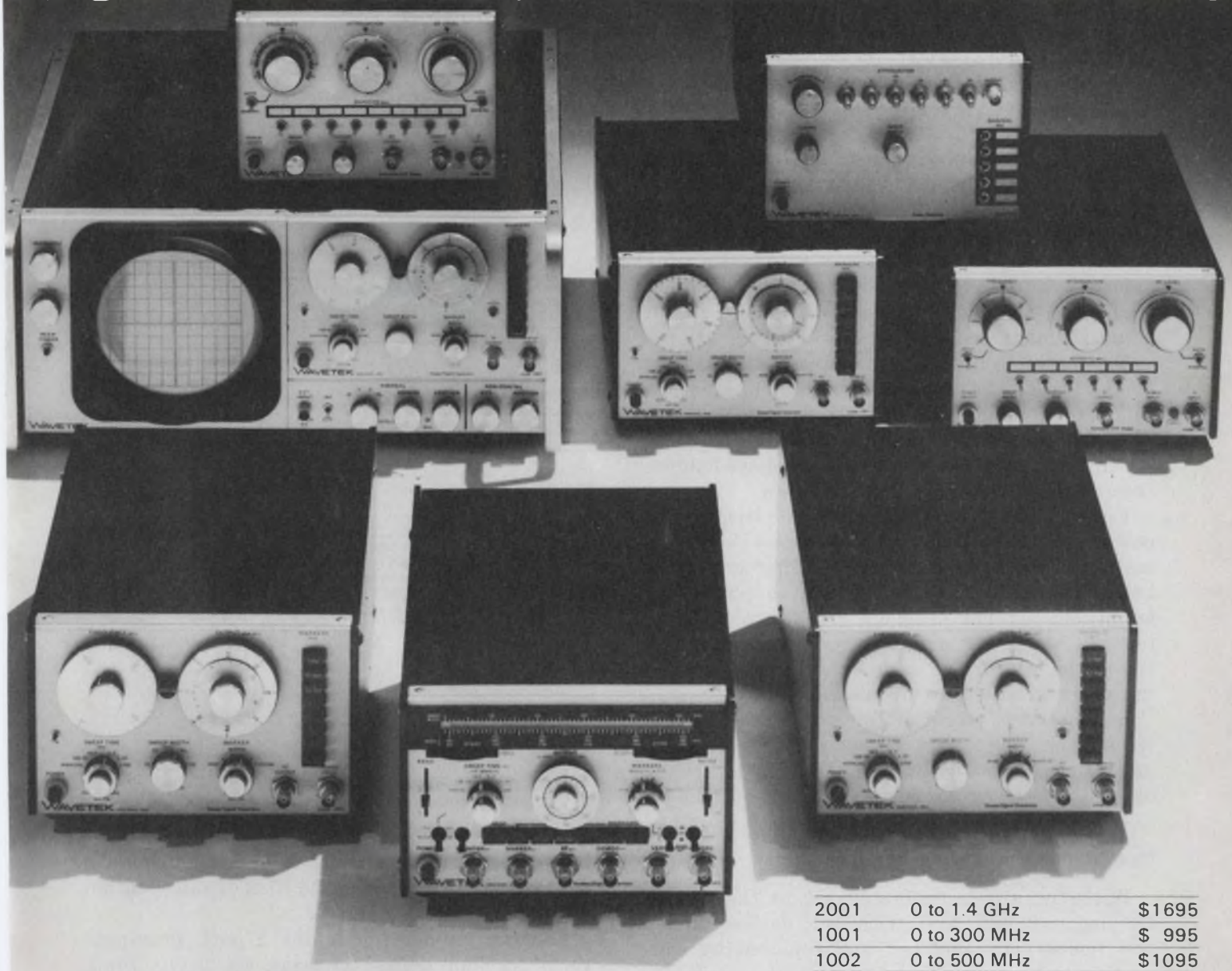

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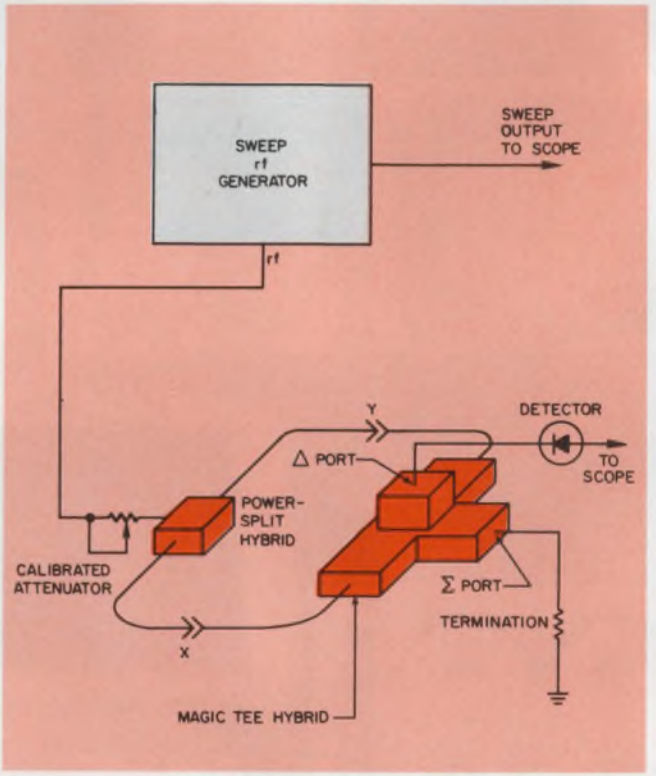
The basic technique works over a wide frequency range. It has been used at vhf (with a commercial broadband hybrid) to tune lumped-constant phase-tracking filters, and at Ku-band (with waveguide magic tees) to phase-balance receiver-protector (TR-limiter) tubes.

Fig. 1 shows the basic bridge circuit. The power-split hybrid can be any type—such as a magic tee fed at its sum port—so long as it gives two outputs that are equal both in phase and amplitude. At low frequencies even a resistive tee will work, but some degree of isolation between the two bridge arms is desirable to minimize errors caused by mismatches.

Symmetry is essential for proper calibration. Keep such accessories as adapters, transitions and flanges the same in both arms of the bridge, or you won't get a broadband calibration null.



1. **Test configuration uses a bridge and magic tee** to detect phase unbalance in the two devices under test.

Measurement procedure has four steps

With the sweep generator set to the proper frequency range, and with the devices under test temporarily removed and replaced by connecting links, follow these steps:

1. Check the bridge symmetry by detecting a null at the Δ port, with the Σ port terminated in a load. For this step, set the calibrated attenuator to minimum attenuation and the scope to maximum gain. The amplitude of the scope trace at null should be negligible when compared to the calibration level that will be used in Step 3.

2. Refer to the CALIBRATE curve of Fig. 2. Find the attenuation value that corresponds to the phase-unbalance specification and set the calibrated attenuator to this value. For example, ±5° tracking corresponds to 27.2 dB attenuation on the CALIBRATE curve.

3. Place the detector at the Σ port, terminate the Δ port and adjust the scope sensitivity for a convenient trace. If no base line exists, square-wave modulate the rf and mark the base and calibration lines. If the amplitude of this calibrate trace is not much greater than the null trace of Step 1, then the bridge arms must be more carefully balanced.

4. Change the detector and termination back to the ports indicated in Fig. 1 (i.e. reverse them). Remove the same amount of attenuation set in Step 2 from the attenuator. Insert the phase-tracking devices at X and Y in Fig. 1 and watch your scope trace. Any detected level of less than the calibration indicates a phase match, or unbalance, better than your specification.

John C. Deriso, 11659 North Shore Drive, Reston, Va. 22070.

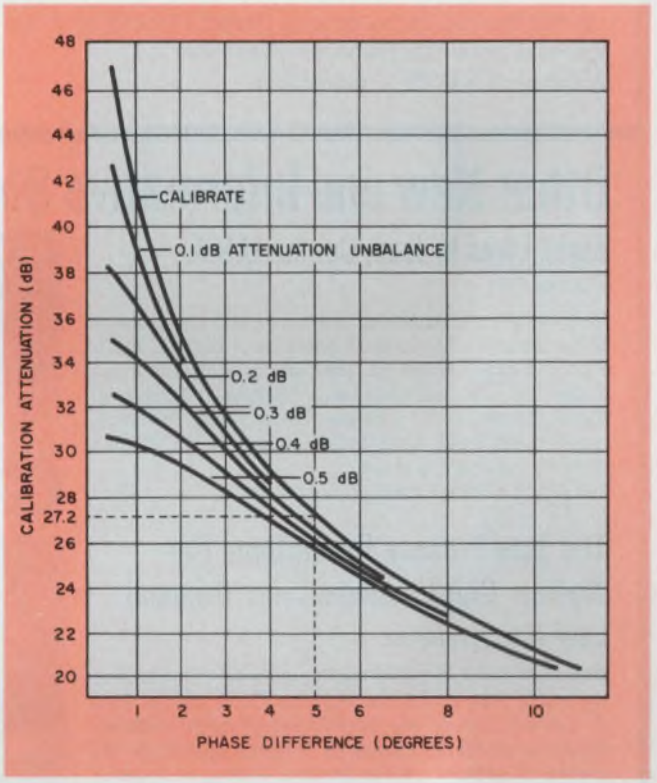
Note that phase unbalances that yield trace levels of greater than the calibration level can be measured by attenuating the rf until the observed and CALIBRATE traces align. For example, 6 dB of attenuation must be added to bring an observed trace down to the level set for the ±5° unbalance. Referring to Fig. 2, and using 27.2 − 6 = 21.2 dB, we see that the phase unbalance is ±10°.

Amplitude unbalance causes errors

A word about measurement uncertainty: the technique described here depends on small differences in the bridge arm attenuations—particularly for small phase unbalances. The auxiliary curves of Fig. 2 point out the degree of uncertainty of phase measurement for devices that have up to 0.5 dB of amplitude unbalance. For instance, an amplitude differential of 0.5 dB could make a "true" phase balance of ±4° yield a scope trace equivalent to ±5.2°. In any event, the CALIBRATE curve will give the worst-case condition, so that if two devices do have an amplitude unbalance, the true phase difference will be less than that observed.

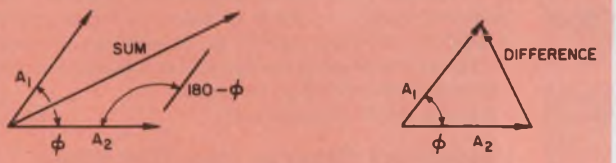
Note also that since only one detector is used, this is not a true differential measurement. If active devices—those having gain—are to be measured, the total circuit gain must be kept identical to that used in the calibration step.

For example, to check the phase balance of two amplifiers, each with 15-dB gain and each having a phase balance specification of ±5°, the calibration is made at 27.2 dB, as in Step 2, but the variable attenuator must be set at 27.2 − 15 = 12.2 dB during the actual measurement. ■■



2. **Curves are used to calibrate the test set-up** and to determine errors caused by unbalanced bridge arms.

Derivation of calibration curves



Let a_1 and a_2 be the magnitudes of voltages A_1 and A_2, respectively.

$K = a_2/a_1$ = voltage ratio

$$(\text{Sum})^2 = a_1^2 + a_2^2 + 2a_1 a_2 \cos(180-\phi)$$
$$= a_1^2 + K^2 a_1^2 + 2Ka_1^2 \cos(180-\phi)$$
$$(\text{Difference})^2 = a_1^2 + a_2^2 + 2a_1 a_2 \cos(\phi)$$
$$= a_1^2 + K^2 a_1^2 + 2Ka_1^2 \cos(\phi)$$

$$\textit{Isolation} = 10 \log \left[\frac{a_1^2 + K^2 a_1^2 + 2Ka_1^2 \cos(180-\phi)}{a_1^2 + K^2 a_1^2 + 2Ka_1^2 \cos(\phi)} \right]$$

$$= 10 \log \left[\frac{(\text{Sum}^2)}{(\text{Difference})^2} \right]$$

$$= 10 \log \left[\frac{1 + K\,[K + 2\cos(180-\phi)]}{1 + K\,[K + 2\cos(\phi)]} \right]$$

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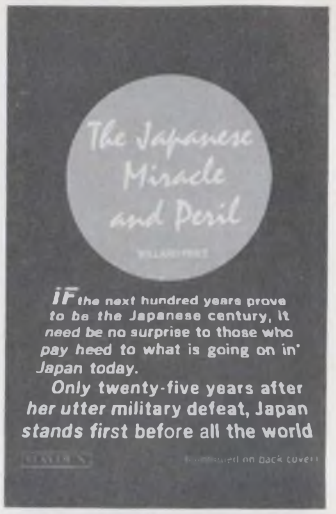

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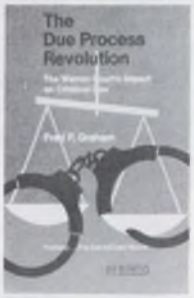

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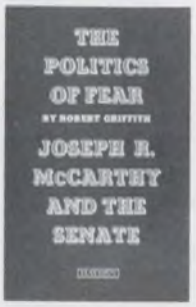

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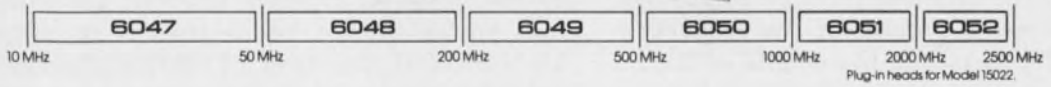

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Rick Spofford, Manager of Converter Products Engineering, Analog Devices, Inc., Norwood, Mass. 02062

Making the adjustment from bench engineering to management has got to be the biggest challenge of my career. I think that move is an important milestone in every engineer's career, because once he goes into management, he more often than not has reached a point of no return. If he doesn't make good as a manager, his career could go downhill from then on, and the door to the managerial office could be slammed shut forever. And that's only half of it. Once an engineer has decided to become a manager, he'll probably find, too, that it's very difficult to return to bench engineering.

The toughest problem for me in making the adjustment to management was learning how to organize and oversee about 20 projects at the same time. Where, as a project engineer, I was responsible for three or four simultaneous projects, I'm now responsible for five engineers, who are responsible for three or four simultaneous projects each. My organizational viewpoint has gone up by a factor of five.

One adjustment a new manager finds he must make is to take immediate action on whatever comes up, instead of deferring it for a couple of days as he could have done when he was an engineer.

Some of the project products have originated from common components, which makes them fairly easy to oversee. But, generally, I have to keep track of five different product categories. So the first problem I had when I became a manager was to try to come on board the projects at roughly the same level as the project engineers themselves were. It was sort of like jumping on a fast-moving train. Time was the problem. I had to find out as much information about the projects as I could in the shortest possible length of time. I had to review the status of the products' developments and understand the details of their technical innards.

I had known what everyone was working on before I was promoted, because we communicate well in the department, but I had to attain a deeper understanding of all projects: So I had each project engineer fill me in on each of his projects—what he's doing, where he's at with it, what's going into it and where his difficult areas are. I had each show me his schedules and all the drawings that were pertinent to his projects, and I asked each: "What kind of 'new components' is the company about to purchase? What are the long-lead parts procurement items that'll show up in the product's development cycle?"

It took me about two months before I really "weighed anchor" with all the projects under way. I had thought it would take me about a month to pull even, but I hadn't counted on the technical depth of the projects.

Keeping up with five engineers and 20 projects requires me to keep straight in my mind which problems go with what projects. So I commit everything to paper: where I ought to be, what commitments I've made and have been made to me. If I write it down once, I've got it locked in my mind. I call this record a "chase sheet." It's a listing of everything that has to be done in the next two weeks. It helps me to keep the projects on course.

Another way to keep pace is to take action immediately on whatever comes up. You can't afford to jot a problem down on your calendar and pick it up again in two or three days, as you did when you were an engineer.

A manager shouldn't feel that to motivate his people he must be more technically competent than any member of his staff.

The second problem I had in adjusting to management was motivating a group of engineers I'd worked with before I was promoted. I got to know them and their work on a peer level, and then suddenly I was giving them their quarterly review. It's a lot different knowing the work of a man you've worked beside than it is comparing his work with the work of other engineers.

I think my toughest assignment as a manager is appraising my men. I tell each man that it's

RICK SPOFFORD

Education: BSEE, Syracuse University (1961).

Experience: design engineer; applications engineer; supervisor (linear integrated circuit designs); marketing engineer; project engineer; engineering manager.

Patents and Papers: Three patents; application notes; technical conferences; magazine articles. Most recent is NEREM paper—"High Speed Versatile D/A Quad—Current Switch."

Personal: Age, 32; married, three sons. Sports include tennis; skiing; skating. Hobbies are carpentry, and various home electronics projects.

Employer: Analog Devices, Inc., Founded in Cambridge, Mass., in 1966, to produce operational amplifiers. The company now also makes d/a and a/d converters; integrated circuits; and a new line of digital panel meters. Sales have risen from $500,000 the first year to $12,300,000 in 1971. The company moved to a 65,000 square foot facility in Norwood, Mass., last year; it also maintains manufacturing facilities in Wilmington, Mass., and Santa Clara, Calif., and has 400 employees world wide.

my review as well as his. If his review is bad, I ask him to tell me if I'm standing in his way, keeping him from performing well. We review the engineer for his past three months and set up goals (management by objectives) for him to meet in the next quarter.

I don't think a manager, to motivate his people, should feel that he must be more technically competent than any member of his staff. My strong point as a catalyst is that I can bring the experiences of engineers I've known together with the experiences of my staff and point out the similarities of the problems. My years in marketing as an applications engineer have helped to broaden my background in that regard. If my career course had not included a couple of passes at marketing, my development as a manager might have been slower.

Also, I believe that an engineer's work should be varied. I don't think any engineer should be kept on any one product line for extended periods of time. Even though one may be the most qualified for the product, we're continually turning over new project responsibilities to all our engineers in the hope that they'll eventually get a smattering of problems in different areas. As the engineer becomes available, he picks up the most pressing product needed at that point in the development cycle. This doesn't run entirely open loop; at the beginning of every year we review a total product plan for the following fiscal year and match know-how with projects.

I think designers should be encouraged to think broadly, instead of vertically or elegantly. I ask them to explore, say three alternatives to the design problem before they start. A designer can make the mistake of starting with one particular approach to a problem, pursue it further downstream, believing it to be the ultimate approach to solving the problem, and come to that point in time when he should be completing that phase, only to be left with an elegant solution that doesn't quite work on a production basis. If the engineer has alternatives, chances are one of them will be more producible. What works best for me is to leave the judgment of which design to pursue to the project engineer. But following the breadboard phase we hold a formal design review on the circuit. It's crucial that changes from this point on be in the component area and not in the basic technique.

I try to convince the engineer that his solution isn't the only one. I try to get him to work laterally with his peers on the same project, so he'll profit by other points of view. We take definite steps to make sure we're communicating on each other's projects. We have formal biweekly presentations given by the project engineer on the breadboard phase of a product's developments. At that time engineers have a chance to point out specific design changes that they've made—and which ones could be used for the product being presented.

I like to think that I know my men well, and that I'm continually sensitive to their personal problems on and off the job. I try to find out what motivates each man, what excites and interests each, and gear his work effort to that.

One reason engineers fail as managers is their fear that administrative duties will strip away their bench time and stifle their creative ability, and turn them into paper shufflers.

And the third problem of adjusting to management is probably the adjustment itself. I think just finding out how the people at the management level function and how they communicate and fit into the company picture is as important a single factor to learn as any other. Basically that problem has been handled for me because people communicate openly here. When I first became a manager, I attended formal management meetings at this level on a weekly basis, and it gave me a chance to see how the other departments function.

New managers can succeed by communicating openly with the other departments of their company. But I've known engineering managers who think that their time is much too valuable to talk to a marketing man or a salesman about generalities, or even about a $100,000 order.

But perhaps the most prevalent reason for the engineer's failure to come to terms with his adjustment is fear—his fear that management responsibilities will strip away his bench time, stifle his creative ability and turn him into a paper shuffler.

I think that the fear is unfounded. My own technical experience has broadened considerably since I was an engineer, because as a manager I've been constantly exposed to all projects at once, instead of just one or two at a time. ■■

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INFORMATION RETRIEVAL NUMBER 36

ideas for design

Three-LED circuit indicates ac or dc and polarity

Here's a circuit that can be added to a digital voltmeter to indicate whether the input signal is ac or dc. In the case of dc inputs, the circuit also indicates polarity. Three LEDs act as indicators, and a μA741 op amp functions as a voltage comparator.

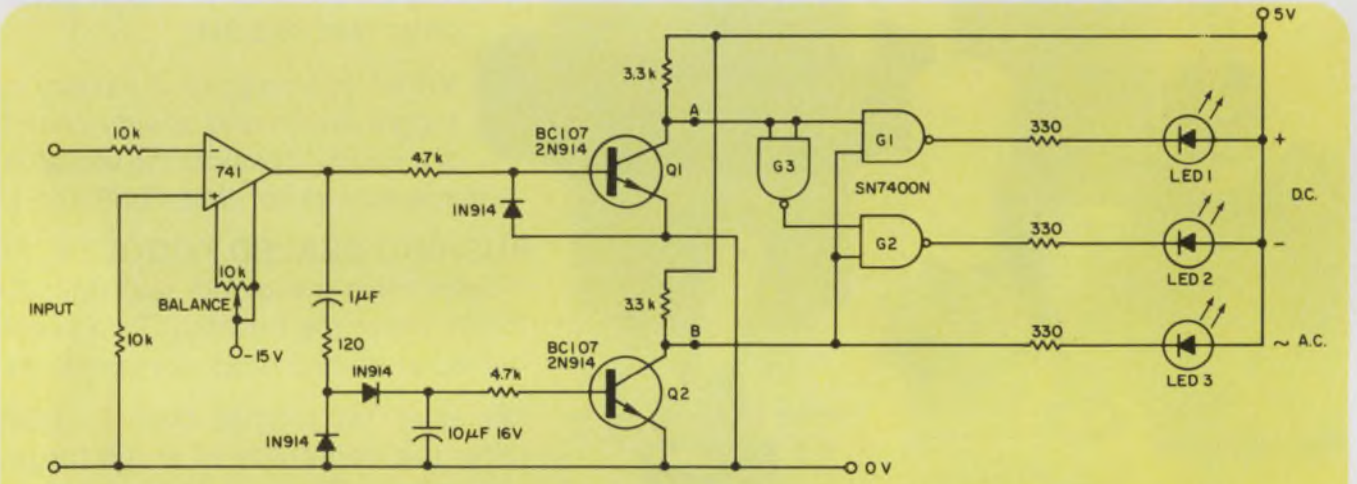
When the input is negative dc, transistor Q1 saturates and its collector (point A) goes LOW. Since transistor Q2 remains turned OFF, its collector (point B) stays HIGH. The output of NAND gate G1 is thus HIGH, while the output of G2 is LOW, and only LED 2 will glow.

For positive dc inputs, transistors Q1 and Q2 both remain turned OFF and both collectors (points A and B) stay HIGH. The output of G1 is thus LOW, while the output of G2 is HIGH. Under these conditions only LED 1 will glow.

Transistor Q2 saturates only for an ac input. Its collector (point B) then goes LOW, and LED 3 glows. Because point B is LOW, the outputs of G1 and G2 are HIGH, so that LEDs 1 and 2 will not light.

T. J. Steen, Pres. Kennedylaan 36, Roosendaal, The Netherlands.

CIRCLE NO. 311



LED 1 glows for positive dc input, LED 2 for negative and LED 3 for ac in this polarity indicator.

CMOS logic expands use of variable duty cycle oscillator

The nearly infinite input impedance of a CMOS logic gate offers negligible loading to the RC frequency-determining network of a cross-coupled oscillator. This allows large-valued resistors and relatively small capacitors to produce long oscillation periods (three minutes with the component values shown). The following equation defines the oscillation period:

$$t = 3t_d + RC$$

where $t = \frac{\text{period}}{2}$

t_d = delay of each gate
C = capacitance in farads
R = resistance in ohms for either charge (OFF period) or discharge (ON) path.

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803	X		+21 to +32			30
804		X	+20 to +32			35
853	X		−21 to −32			30
854		X	−20 to −32		±0.05%	35
805	X		+3 to +9		±0.1%	30
806		X	"		"	35
855	X		−3 to −9		"	30
856		X	"	Up to 0.5 amp	"	35
807		X	+30 to +60	0.150 amp	±0.05% at −20° to +125°C ±0.1% at −55° to −20°C	30
808		X	+60 to +120	"	"	30
809	X		+5 to +28	0.75 amp	0.003%/mA	8.95
859	X		−5 to −28	"	"	8.95
828A		X	+5 to +30	500 mA	Line: ±0.01%/V Load: ±0.01%	50
838A		X	−5 to −30	"	"	50
844			Dual ±12 to ±20	0.3 amp	Line: ±0.005%/V Load: ±0.005%	20

Low Cost Series 809 and 859 voltage regulators are small (1″ x 0.5″ x 0.170″ high), complete, fully sealed and compatible with flat pack and dual-in-line packaging. The 809 and 859 circuits consist of a series pass stage, an error amplifier with built-in reference, and a precisely adjusted output voltage sense divider. In addition to being complete voltage regulators, the Series 809 and 859 have the following add-on capabilities: current limiting, load capability to over 10 amps, and adjustable output.

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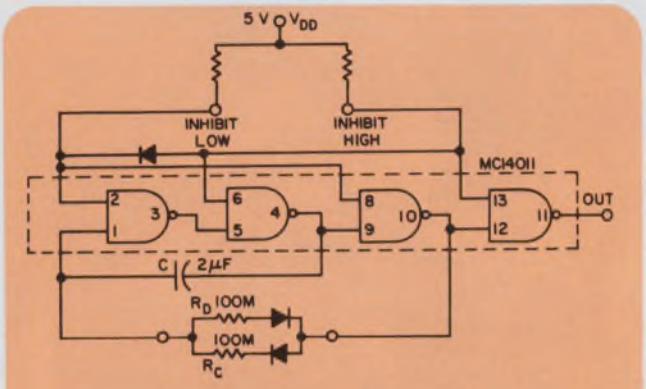
INFORMATION RETRIEVAL NUMBER 37



Duty cycle of this oscillator can be varied over a range of around 10.000:1 by alteration of the values of R_C and R_D.

The diodes in series with R_C and R_D provide two different charge and discharge paths, to generate a nonsymmetrical waveshape. If the resistors R_C and R_D are made variable, the HIGH and OFF states can be controlled independently to provide whatever combination of frequency and duty cycle are desired.

Grounding of the Inhibit HIGH or Inhibit LOW terminals permits oscillation to be stopped in either state, if the oscillator phase is of interest. The low inhibit does not affect timing accuracy. The diode connected between pins 2 and 6 of the gate insures 10% accuracy for even the first half cycle after removal of a HIGH Inhibit command.

Jim Barnes, Senior Applications Engineer, Systems Engineering, Motorola Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz. 85008.

CIRCLE NO. 312

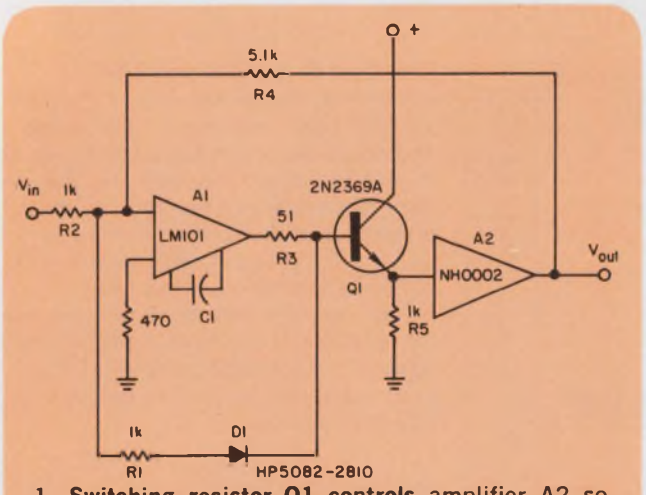
Clamp negative outputs without introducing spikes

A simple op-amp circuit (Fig. 1) provides linear amplification with positive outputs, but it quickly clamps to zero if the output tries to go negative. The clamping action is accomplished with a distinct absence of switching spikes. Total offset amounts to only the few millivolts of offset inherent in an NH002 op amp. The input-ouput characteristics are shown in Fig. 2.

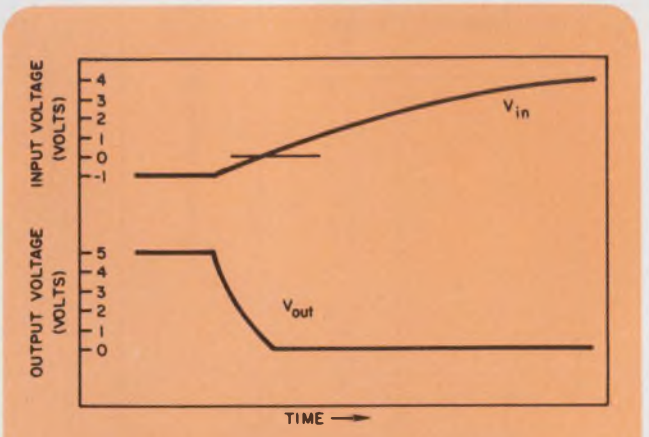
For negative inputs, the loop is closed around A1, Q1 and A2. The inverting input of A1 is at virtual ground. When the input goes positive, the negative output of A1 turns off Q1. Because of the low output impedance of A2, the output is effectively clamped at zero. Hot-carrier diode D1 and resistor R1 prevent the loop around A1 from opening and causing a latch-up when Q1 turns off. These components also allow rapid return to linear operation when the input signal again goes negative.

Mike Black, Texas Instruments, M.S. 257, P.O. Box 6015, Dallas, Tex. 75222.

CIRCLE NO. 313



1. **Switching resistor Q1 controls** amplifier A2 so that the circuit provides linear amplification of positive inputs and clamps negative signals at zero.



2. **Input-output voltage characteristic shows** circuit operation for positive and negative inputs.

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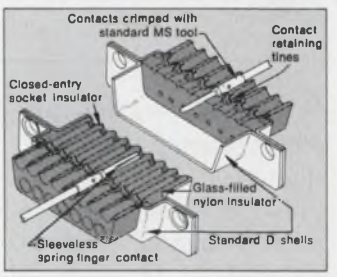


CANNON ITT

INFORMATION RETRIEVAL NUMBER 38

Divide two pulse rates with TTL logic

The ratio of two pulse rates can be determined continuously for both periodic and stochastic inputs with two NAND gates and two flip-flops (Fig. 1). Errors can be minimized to less than 1% for periodically distributed pulses, but they will be higher for random distribution. The input pulse rates, with mean values N1 and N2, must satisfy the condition that between two N1 pulses at least two N2 pulses occur.

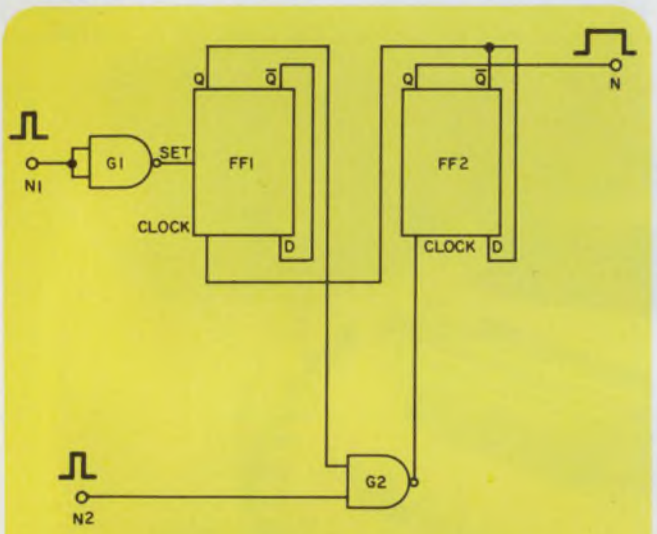
Each N1 pulse produces one output pulse with a width equal to 1/N2. If this output pulse train is externally integrated, the resulting level will be proportional to the ratio of N1/N2.

The N1 pulse enters gate G1, and its leading edge sets flip-flop FF1 so that Q is HIGH. When FF1 has Q LOW, the N2 pulses cannot pass gate G2 because the other input is LOW. When FF2 has its Q output LOW, two successive N2 pulses pass G2 and switch FF2—first, so that Q is HIGH, and then to its initial position with Q LOW—on the trailing edges of the first and second N2 pulse.

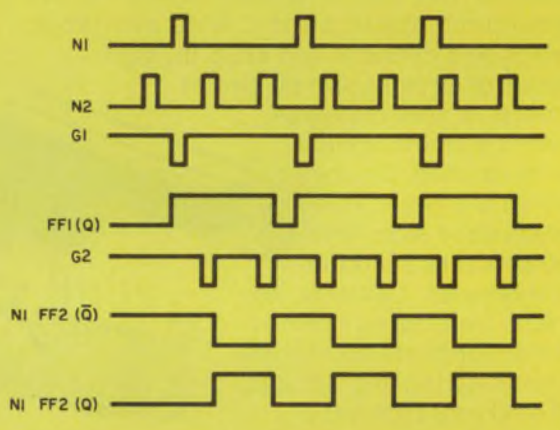
The timing diagram (Fig. 2) shows the sequence of operation. The resulting train of N pulses can then be fed into an external integrator from output Q of FF2.

Josef Seda and Jozef Sabol, Faculty of Nuclear Science and Physical Engineering, Technical University of Prague, Prague 1, Brehova 7, Czechoslovakia.

CIRCLE. NO. 314



1. **TTL pulse-ratio circuit uses half of a quadruple two-input NAND gate** and two D-type, edge-triggered flip-flops.



2. **Timing diagram shows input pulse trains N1 and N2** and resultant output from Q of FF2. The outputs of the gates and FF1 are also given.

IFD Winner of January 20, 1972

Jim Wyland, Linear IC Applications Dept., Signetics, 811 E. Arques Ave., Sunnyvale, Calif. His idea "Phase-locked loop decodes narrow bands" has been voted the Most Valuable of Issue award.

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Feedback to bridge regulates scope high voltage

A simple circuit, used in the Ballantine Laboratories Model 1066A oscilloscope, regulates CRT high voltage by adjusting the ac transformer secondary voltage from which the HV is derived.

Most scopes use an expensive dc/dc converter/regulator to generate, and minimize fluctuations in, the high voltage. The converter usually switches at rates between 10 and 100 kHz—frequencies that can lead to troublesome electromagnetic interference problems. Ballantine avoids this, and saves money, by using the circuit shown in the figure. Regulation is accomplished at line frequency, simplifying the requirements for internal shielding and decoupling and also minimizing EMI.

By connecting the secondary winding of the power transformer to ground through the bridge, the designers have held the regulation to ±0.5%. The voltage across the bridge opposes the unwanted variations in the ac line voltage.

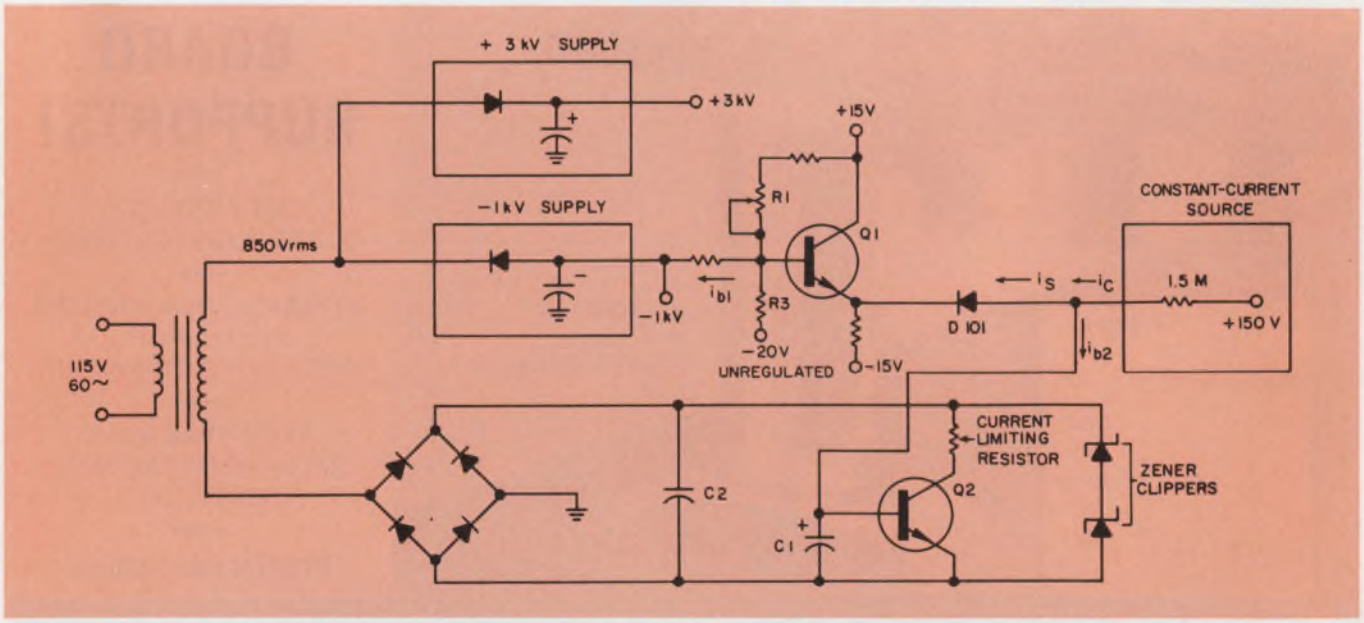
The voltage dropped across the bridge is essentially the V_{ce} of Q2, which is controlled by the base current of the transistor; any increase in the current pumped into the base causes Q2 to conduct more, thereby lowering the collector-emitter drop.

Changes in the line, and hence the HV, are sensed by sampling the −1-kV supply and by using any variations in the sample to control the conduction of emitter follower Q1, which acts as a current sink. Variations in the HV cause Q1 to conduct more, or less, thereby controlling the base current of Q2. C1, at the base of Q2, is charged through D101, which conducts for the positive half-cycle only. In effect, C1 integrates any variations over several cycles.

The potentiometer R1 is set to give full power-line tracking of the regulating bridge, so that the −1 kV can actually fall anywhere between −940 and −1050 V.

Additional compensation for line changes is obtained by connecting R3 from the unregulated low-voltage supply to the summing junction at the base of Q1. This assists the main feedback path.

CIRCLE No. 319



Bridge regulator reduces scope shielding and decoupling requirements by operating at line frequency. The cost savings is passed on to the scope buyer. The technique also minimizes EMI.

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		55°C	60°C	71°C	RMS (4V)	P-P (mV)	RMS	Voltage	Current		Ohms/Volt (±.5%)	Volts/Volt	Ohms/Amp (±10%)	mV/Amp	
SRL10-25	0-10	25	22	16.7	350	20	10mA	0.01% or 2mV	0.02% +4mA	150	200	1	40	20	$450
-50	0-10	50	44	33.5	300	10	20mA		0.02% +4mA	150	200	1	20	8	$650
-100	0-10	100	88	67	300	20	30mA		0.02% +6mA	150	200	1	10	2.5	$825
SRL20-12	0-20	12	10.5	8	200	20	3mA		0.02% +4mA	70	200	1	80	80	$435
-25	0-20	25	22	16.7	300	20	10mA		0.02% +4mA	150	200	1	40	20	$525
-50	0-20	50	44	33.5	500	40	10mA		0.02% +4mA	150	200	1	20	8	$775
SRL40-6	0-40	6	5.3	4	200	20	0.5mA		0.02% +1mA	70	200	1	150	150	$435
-12	0-40	12	10.5	8	300	20	1mA		0.02% +4mA	150	200	1	80	80	$525
-25	0-40	25	22	16.7	500	10	10mA		0.02% +4mA	150	200	1	40	20	$630
-50	0-40	50	44	33.5	700	40	10mA		0.02% +4mA	150	200	1	20	8	$850
SRL60-4	0-60	4	3.5	2.68	300	20	0.5mA		0.02% +1mA	70	200	1	250	250	$450
-8	0-60	8	7	5.36	300	20	1mA		0.02% +1mA	70	200	1	125	125	$580
-17	0-60	17	14.9	11.4	500	10	3mA		0.02% +4mA	150	200	1	50	40	$690
-35	0-60	35	31	23.4	700	40	10mA		0.02% +4mA	150	200	1	25	15	$970

*Selectable: write for Sorensen performance note, PAN-1.

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INFORMATION RETRIEVAL NUMBER 41

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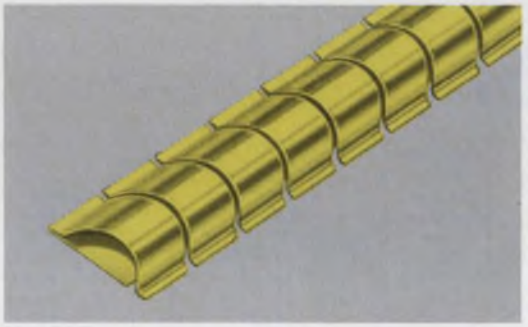

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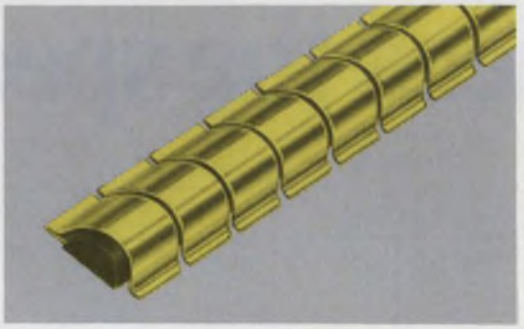

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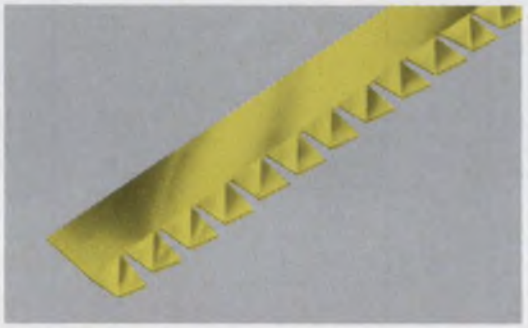

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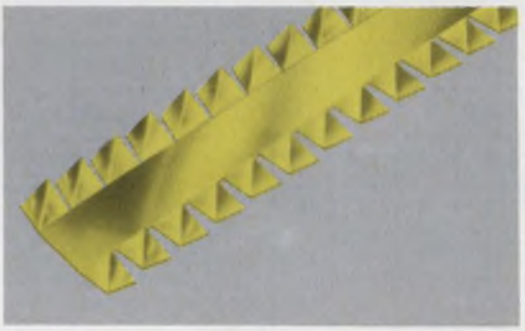

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INFORMATION RETRIEVAL NUMBER 42

new products

Self-test, 5-digit DMM helps alleviate uncertainty

Hewlett-Packard Co., Loveland Instrument Div., P.O. Box 301, Loveland, Colo. (303) 667-5000. $1650. July.

At the flip of a switch, HP's 3490A digital multimeter sequences itself through 10 tests that check timing signals and auto-ranging circuits, validate the performance of 70% of the logic-circuit ICs and check the six-digit LED display. These tests, and others provided by six additional, front-panel switches, cut calibration cost and time, reduce the number of external standards required and assure a user that his DMM is ready to make accurate measurements.

In a few seconds, a user can measure the zero offset of the dual-slope integrator, isolate thermal-voltage errors, check the reference voltage, locate offsets in the ratio amplifier, calibrate all dc-voltage ranges with only a single, 10-V source, and check the power supply for the ohms function.

Test results on the LED display can be compared with the "right answers" on a pull-out chart. If there's a discrepancy, the user can refer to the operations manual (and, if he likes, an accessory video tape) to help him localize faults to major circuits. Then, to isolate faulty components, he can use something like HP's $295 logic comparator, Model 10529A, which uses a clip-on probe to test in-circuit DIP ICs with up to 16 pins.

If the user doesn't want to look at charts, he can store the right answers in a calculator or computer and use a simple software routine for the comparisons. This suggests, of course, that future DMMs could contain complete diagnostic routines that would not only interrogate all key points in the instrument but also guide the user to faulty components.

The unique self-test features in the 3490A stem from a microprogram in a 4096-bit IC ROM, designed and manufactured by HP. These features supplement the normal functions one might expect in a fine meter. There are five full digits, with a sixth to show 20% overrange on all but the 1000-V range.

The fully guarded instrument has five dc ranges from 100 mV to 1000 V, four ac ranges from 1 to 1000 V (with a maximum HzV product of 10^7), and six four-wire resistance ranges from 100 Ω to 10 MΩ. Input resistance is 10^{10} Ω for the 100-mV-to-10-V ranges and 10 MΩ for 100-V and 1000-V ranges. Input impedance for ac is 2 MΩ, shunted by 75 pF without rear terminals, and by 100 pF with them. The reading rate is five per second for dc voltage, and for resistances in the ranges from 100 Ω to 100 kΩ, it's four per second for resistances in the 1-MΩ range, two per second for the 10-MΩ range and one per second for ac voltages.

Accuracies, specified for 30 days at 23 C ±5 C, range from ±(0.008% rdg ±0.002% f.s.) for 1 to 1000-Vdc ranges to a worst case of ±(0.75% rdg +0.05% f.s.) at 100 kHz to 250 kHz in the 1-V and 10-V ranges.

Options include digital output, remote control, single-bus, ASCII-coded data-control and data-output and ratio measurements. The instrument uses a dot-matrix LED display, rather than the more common seven-segment display, to minimize the ambiguity that can result from failure of a single diode.

CIRCLE NO. 252

Electrostatic voltmeter ignores source distance

Trek Inc., 8460 Ridge Rd., Gasport, N.Y. 14067. (716) 433-6779. $1875 w/o probe; 30 days.

The Model 300 electrostatic voltmeter is a 0.05%, 200 Hz bw instrument used to make noncontacting electrostatic voltage measurements in the range of ±0.05 V to ±3000 V ac or dc. This technique presents a load impedance of 10^{20} Ω to the voltage source. The instrument features a ±0.75% meter as well as high accuracy recorder outputs. Drift is less than 0.1 V/hr and tempco is less than 0.1 V/°C. Output noise, referred to input, is 0.1 V max. or 0.003% F.S.

CIRCLE NO. 253

Digital-readout sig gens battle on price, accuracy, stability and modulation

LogiMetrics: Five-digit readout; 0.05% accuracy; 1.0 V rms output.

Singer: 3-1/2 digit readout; 0.008% accuracy; 2.2 V rms output.

LogiMetrics, Inc., 100 Forest Drive, Greenvale, N.Y. 11548. (516) 484-2222. $2575. 90-120 days.

It started in late 1968, when LogiMetrics introduced the first line of digital-readout signal generators. Singer followed in 1970 with its SG-1000, which covered frequencies to 512 MHz, more than double the 230-MHz top frequency in the LogiMetrics line. Now LogiMetrics bounces back with the Model 750, which extends the frequency range to 520 MHz and offers the user challenging tradeoffs.

While the frequency ranges (9.5 to 520 MHz for the LogiMetrics 750; 7.75 to 512 MHz for the Singer SG-1000) are similar, the price of the 750 is significantly lower—$2575 vs. $4250. Further, the 750 offers a full, five-digit readout, while the SG-1000 has 3-1/2 digits, with a X100 expansion for higher resolution. Pushing a button moves the two most significant digits off the display to the left and adds two least significant digits.

Both manufacturers offer variable resolution. But LogiMetrics defines variable resolution as "blanking out the digits you don't need," while the Singer unit switches the decimal point with changes in frequency setting.

The maximum error of the LogiMetrics display is 0.05% while Singer specs its worst-case at 0.008%.

Frequency stability is one parameter where the two units crash head-on. Singer specifies a "typical" drift of 10 ppm/10 minutes after a one-hour warmup and a tempco of 50 ppm/°C, while LogiMetrics doesn't specify. And while the SG-1000 claims a residual FM of 0.25 ppm *peak*, the spec sheet for the 750 lists a more liberal residual FM of 0.25 ppm +50 Hz *rms*.

The absence of stability figures can probably be traced to LogiMetrics' method of generating the output: the Model 750 heterodynes the outputs of two cavity oscillators—one fixed and one variable—and amplifies the beat frequency to obtain the output. While this offers the advantage of performing all the modulation functions on the fixed oscillator only, instabilities or drifts in the frequency of either oscillator show up in the beat frequency, often magnified by a large factor.

The SG-1000, on the other hand, uses a binary chain to divide down the output of a cavity-tuned oscillator. Use of the binary chain also permits output-frequency band-switching over six octave-bands. The LogiMetrics unit uses a continuous crank to tune the desired frequency.

The peak FM deviation of the Model 750 can be varied from zero to ±300 kHz at rates from dc to 100 kHz. Further, one can read the deviation on a front-panel meter. This is especially convenient when the operator changes the output frequency: no re-calibration of deviation is necessary.

In contrast, setting the peak deviation, which is limited to ±0.5% of range, on the Singer unit involves a calibration process whereby the reference frequency is first set. An internal reference voltage is then adjusted until the frequency (as read on the display) is shifted by the desired amount.

While this technique gives a typical deviation accuracy of 1%, as opposed to the 5% of full-scale attained with the 750, the deviation resulting from applying an external modulating voltage must be calculated from the Hz/volt gradient obtained in the calibration process.

A comparison of other key specs of the two generators shows:

For the 750:

- In FM, a maximum distortion of 0.5% at 75 kHz deviation.
- In AM, a maximum distortion of 1% at 30% AM and 3% at 70% AM.
- A pulse modulation on/off ratio of 40 dB, minimum.

For the SG-1000:

- In FM, a maximum distortion of 0.5% at 0.1% deviation.
- In AM, a maximum distortion of 2% at 30% AM and 5% at 70% AM.
- A pulse modulation on/off ratio of 60 dB up to 200 MHz and 40 dB up to 512 MHz.

While the LogiMetrics unit provides a big rf output range of +13 to −127 dBm into 50 ohms, the Singer engineers have stretched their output by 26 dB to give an even bigger range of +20 to −146 dBm. Don't be surprised, though, when the output level meter drops 6 dB when switching to AM: the range for this mode is +14 to −146 dBm.

For more information:

From LogiMetrics CIRCLE NO. 250

From Singer CIRCLE NO. 251

TRAKATRON

The Whereabouts Machine

Today we can track astronauts all the way to the moon, but we can't locate them instantly in a building on earth. Trakatron closes this communications gap.

Trakatron stands for "tracking people electronically." Trakatron is available in three modes — manual (Trakapen), semiautomatic (Trakascan) and fully automatic (Trakafone).

With the basic manual Trakapen system, operation is manual through a standard touchtone keyboard which indicates on a readout the location of any person at any instant.

The semiautomatic Trakascan system automatically and continuously scans multiple numbers of people and displays their whereabouts on a TV-like (CRT) terminal.

Trakafone is a completely automatic mode in which the room sensors and other interface equipment are incorporated in the telephone system. This system automatically "searches" and rings the phone nearest to where a person being called may be at a particular moment. Trakafone also has a built-in memory which indicates when a person being called is not available, and notifies the caller automatically when the party becomes available.

Here's how one mode, Trakascan, works: a processor holds a list (see diagram) of all people tracked by the system and their Trakatron pen numbers. At specific time intervals, the processor sends a coded message, on private or telephone wires, to all ultrasonic transmitter-receivers (sensors) installed throughout a building, or buildings. In the room, or designated areas of this building, the pen code addressed by the processor will respond with its own coded signal to the receiving sensor in that particular room, or area.

That receiver will then send a coded message to the processor which identifies the area of the coded pen. The processor now places the room number, phone extension, or other code opposite the name of the person in the list and then moves on to locate the next coded person. By scanning the list, a complete directory of people is ultimately built up and is kept current by constant repetition of the scanning process.

TV monitors placed at strategic locations throughout the building can display the contents of the list continuously, thus making the current information immediately available to interested parties.

As people move from one area to another, the Trakascan system locates and displays their present location. If a person is unavailable, or has left the building, it will also report that fact. Personnel may be added, or deleted at any time.

Trakatron systems are designed to incorporate a number of options; digital synchronized clocks in any room sensor; after hours intrusion alarm; fire detection; provision for Trakavision internal video picture phone interface (the same screen can scan and display data on location of personnel and display actual live pictures of the person talking on the phone).

The versatility of the Trakatron system makes it possible to incorporate other features such as Penlok access control which permits a doorlock to "recognize" the pen of an individual without any conscious personal human involvement, insuring access only by cleared personnel.

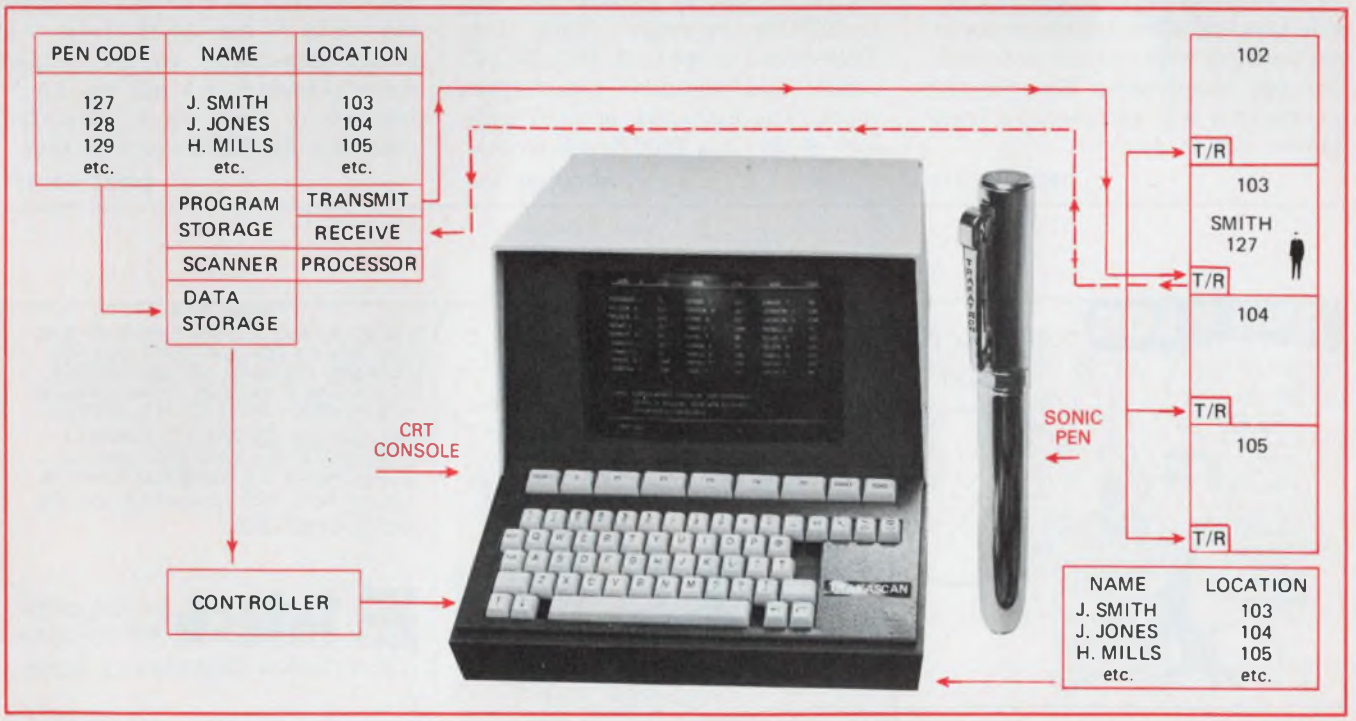
Trakatron — automated locating systems for medium and large corporations, institutions, terminal facilities, etc.

For more information on licensing, write:

R. W. Lester, President
Recognition Devices, Inc.
101 Park Avenue, New York, N.Y. 10017

Trakatron patents and trademarks Pend.

Recognition Devices Inc.



INFORMATION RETRIEVAL NUMBER 43

Portable, 4-1/2 digit DMM has single IC

Dana Laboratories, 2401 Campus Dr., Irvine, Calif. (714) 833-1234. $650; 30 days.

The 4300 weighs 5-1/2 pounds (7-1/2 with battery pack) and can operate from battery power for eight continuous hours. The unit then shuts off automatically. When the battery falls below an acceptable operating level, the readout is blanked out and the batteries are automatically disconnected. Five dc, four ac and five ohms ranges are provided, with 120 dB CM rejection. The unit has 100% overranging. Over-voltage protection is 1000 V on any ac or dc range and 250 V on any ohms ranges.

CIRCLE NO. 254

Non-contact sensor resolves a microinch

Mechanical Technology, Inc., 968 Albany-Shaker Rd., Latham, N.Y. (518) 785-2330. $1600 approx.; 4 wks.

The KD-100 uses a fiber-optic probe to measure displacement and motion of targets. It resolves movements of 1 μin. from dc to 100 kHz and is said to be very stable. The instrument features a 3-1/2 in. center-zero, meter, a calibration reference point, and a step/vernier light-intensity control. Interchangeable plug-ins allow a wide range of applications with various sensitivities and bandwidths. The KD-100 weighs only 8 lb and operates from 115 or 230 V ac.

CIRCLE NO. 255

Digital millivoltmeter resolves 1 μV

United Systems Corp., 918 Woodley Rd., Dayton, Ohio (513) 254-6251.

The Digitec Model 268 digital millivoltmeter offers 6 ranges, has resolution to 1 μV, and handles up to 1000 V dc. Features are: 4-1/2 digit LED display, accuracy of 0.02% of reading on 4 highest ranges, 0.05% of reading on lowest two ranges, guarded input and isolated BCD and system functions. Front panel controls include self-check zero and calibration.

CIRCLE NO. 256

Scope plug-in has 500 μV/div

Tektronix, Inc., P.O. Box 500, Beaverton, Ore. (503) 644-0161. 7A15A; $280, 7A15AN; $250; stock.

The 7A15A and 7A15AN plug-in vertical amp provide extended sensitivity to 500 μV/div. Features include: 500 μV/div at 10-MHz bw; 5 mV/div at 50-MHz bw; dc-to-50-MHz response (with Tek 7400-Series scope); 1 MΩ, 20 pF input; and selectable polarity on input. The units can be used with any of the Tek 7000-Series scopes.

CIRCLE NO. 257

IC tester sells for less

Macrodata Co., 20440 Corisco St., Chatsworth, Calif. (213) 882-8880. $34,520 and up; 30-60 days.

The MD-183 dc functional/parametric tester, is said to sell for about half the price of other computer-controlled systems. Sequential testing, binning, and logging are performed automatically; and the logging counters record all passes and failures, as well as actual test values. The system can be set up for either single-pin or multiple-pin tests, including stress, leakage, continuity, and threshold.

CIRCLE NO. 258

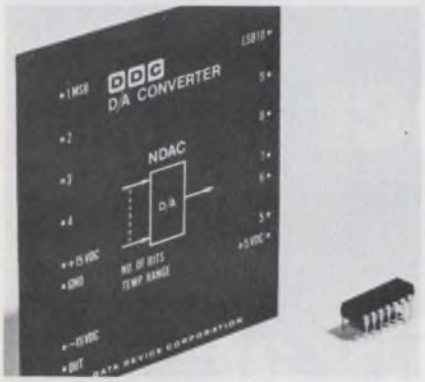
$495 pulse generator has 50 MHz rep rate

Chronetics, Inc., 500 Nuber Ave., Mt. Vernon, N.Y. (914) 699-4400. $495; stock to 30 days.

The Model PG-10 pulse generator provides positive or negative current or voltage pulses with variable baseline offset, single (delayed) or double (plus manual one-shot), normal or inverted (complement) over a rate range of 0.1 Hz to 50 MHz. It may be driven by the internal clock or be externally triggered from dc to 50 MHz. The unit may also be synchronously or asynchronously gated from dc to 25 MHz. In the current mode, output is $\pm$20 mA to $\pm$200 mA ($\pm$10 V into 50 Ω) from 1 k source impedance; in the voltage mode output is $\pm$5 mV to $\pm$5 V into 50 Ω from 50 Ω. Rise/fall times are fixed and are 5 ns max.

CIRCLE NO. 259

Plug-in d/a settles within 50 ns

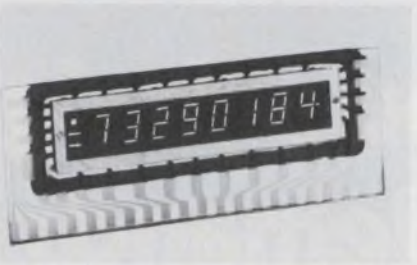


ILC Data Device Corp., 100 Tec St., Hicksville, N.Y. (516) 433-5330. $350 (0-70 C), $450 (−55 to +85 C); stock.

A d/a high-speed converter, designated the Model NDAC, provides a resolution of 10 binary bits, a settling time of 50 ns and accuracies of up to ±0.05%. The plug-in module measures only 2.6 × 3.1 × 0.6 in, yet drives a 50-Ω coaxial load. The unit provides an output power capability of 0 to 5 volts at 100 mA.

CIRCLE NO. 260

Numeric display panel features eight digits

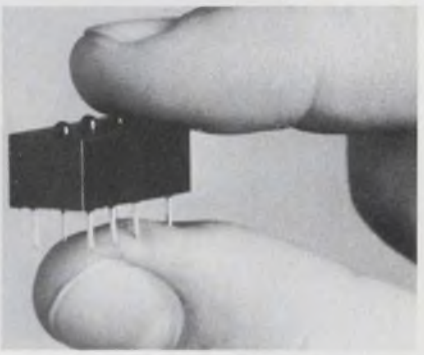


National Electronics, Inc., Geneva, Ill. (312) 232-4300.

The NDP 1252 is an eight-character numeric display designed to operate in the time-share mode. The cold-cathode gas-discharge panel features a seven-segment (.255-in. high) character with decimal points, and left-hand minus, overflow and dot symbols. Anode supply and cathode prebias voltages are 190 V dc and 115 V dc, respectively. Peak cathode currents range from 0.15 to 0.85 mA. Refresh rate is 75 to 750 Hz and character duration varies from 75 to 750 μsec. Overall size is 3.30 × 1.32 × 0.630 in.

CIRCLE NO. 261

Logic status indicator checks 4 bits, costs $4



Unique Devices Co., P.O. Box 70, Bountiful, Utah. (801) 295-4252. $3.99 (5000).

The LD-4 logic-status indicator lets you monitor your circuit continuously and inexpensively. Plugged in among the ICs, each LD-4 indicates status of 4 logic bits. It is housed in a DIP-like package. Indicator facilitates design checks and troubleshooting of individual circuits or complete systems. LEDs are mounted in 0.1 in. centers and require only 3 mA. Various models are available.

CIRCLE NO. 262

Two-quad d/a multiplies signals fast

Datel Systems, Inc., 1020 Turnpike St., Canton, Mass. (617) 828-6395. P&A: See text. Stock to two weeks.

A two-quadrant, multiplying d/a converter, the Model DAC-MI series, multiplies any dc or ac analog reference by up to 12 binary bits. The input can range from dc—2 MHz and can be a sine wave, ramp, sawtooth, or other arbitrary shape.

Other specs include a choice of input coding—straight binary, BCD, offset binary or two's complement. The analog input range is 0 V to +10 V and requires a source current of 1 ma. Full scale analog output can be either unipolar (0 to 2 mA @ 1.2 V) or bipolar (±1 mA @ ± 1.2 V) without the use of external components. Accuracy specs include ±1/2 LSB linearity, ±0.002%/°C temperature coefficient and ±0.01% full scale accuracy at 25 C.

Five models (8-12 bits, binary or BCD) feature typical output settling times of 150 nsec (250 ns, max.) for a full scale digital change, and 500 nsec (750 ns, max.) for a full scale reference voltage change.

The units also have a built in voltage reference (+6.2 V) which can be externally pin strapped for conventional d/a operation. DAC-MI series require ±15 V dc and are packaged in a 2 × 3 × 0.4 in. module.

Prices for the DAC-MI series are $100 for the 8-bit unit; $119 for the 10-bit unit; and $139 for the 12-bit module.

CIRCLE NO. 263

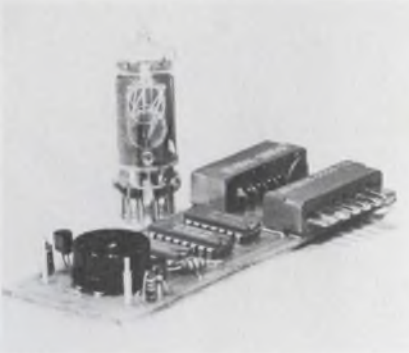
5 V dc supply is short-circuit proof

Melcor Electronics Corp., 1750 New Highway, Farmingdale, N.Y. (516) 694-5570. $15 ea; stock.

The model 2144 power supply provides an isolated, regulated 5 V dc from 115 V, 50-60 Hz. It offers 2% regulation for 10% line, 0 to 1 A load, and 0 C to +60 C temperature variations. The unit is equipped with built-in short circuit and foldback current protection. The compact unit measures only 6-1/8 × 3-3/4 × 2 in.

CIRCLE NO. 264

Decade counter gives modular plug-ins



Compton Electronics, P. O. Box 5326, Compton, Calif. $38.50 ea. with readout tube.

The DECAPLUG line of TTL counters/readouts can be plugged into each other, side-by-side, to obtain any number of digits for counter and numerical readout applications. The DEC-1A contains a counter, memory and decoder plus decimal point for right and left sides of number. Counting rate is 20 MHz.

CIRCLE NO. 265

High voltage CRT supply offers small package

Brandenburg Ltd., 939 London Rd., Thornton Heath, Surrey CR4 6JE, England. £ 15.

The model 512, a modular high voltage supply for CRTs, provides between 4 and 7 kV at a maximum of 120 μA. It can withstand an output short-circuit for up to 10 seconds without damage. The impregnated HV components are fully screened in a metal can only 2 × 1-1/2 × 4-1/2 in.

CIRCLE NO. 266

Portable data terminal has editing capability

Data Products, 6219 DeSoto Ave., Woodland Hills, Calif. (213) 887-8246. $1450; 90-120 days.

The PortaCom portable data terminal, with a magnetic tape cassette, has full editing capability. Its impact printer, produces letter-size printout with up to three carbons at a transmission rate of 30 cps. It also has a built-in acoustic coupler and alphanumeric keyboard. Over 50,000 characters can be stored on a single cassette.

CIRCLE NO. 267

Unit ties teleprinter to message-switching net

Pulse Communications, Inc., 5714 Columbia Pike, Falls Church, Va. (703) 820-0652. $1000 and up.

The Model 461-1 is a terminal control unit that interfaces standard private-line teleprinters with AT&T—85A1 message-switching systems. The line and terminal sides interface either current-operated or EIA RS-232-C circuits. Optical coupling isolates the current-operated input.

CIRCLE NO. 268

Wideband tape recorder stores visual material

Ampex Corp., 401 Broadway, Redwood City, Calif. (415) 367-4151.

An instrument tape recorder attains twice the bandwidth (12MHz vs 6MHz) of previous rotary-head recorders. One-inch-square areas of visual material are scanned and recorded on 2-inch-wide magnetic tape. Location of the material on the tape is noted digitally. Rotary-head recording uses four heads mounted on a rotating drum. The heads sweep across the longitudinally moving tape at right angles.

CIRCLE NO. 269

Tape unit features full remote-control

Techtran Industries, Inc., 580 Jefferson Rd., Rochester, N.Y. (716) 271-7953. $1650; 30-45 days.

The 4100 cassette tape unit is plug compatible with most data terminals and minicomputers. Features include switch-selectable speeds from 110 to 2400 baud, high-speed search, data-edit ability, and remote-control for unattended data station operation.

CIRCLE NO. 270

Stunt-box recognizes call code on party line

Logic Systems Corp., 1567 Cypress Dr., Jupiter, Fla. (305) 746-5181. Baudot: $335.

The Model 2028 remote selector a selective calling unit or "stunt box," permits selective control of remote equipment, such as a teleprinter, from a central location on a broadcast or party-line circuit on detection of a predetermined code. The selector operates on Baudot, typesetting or ASCII codes.

CIRCLE NO. 271

Expand mini memory with plug-to-plug add-on

Cambridge Memories Inc., 285 Newtonville Ave., Newtonville, Mass. (617) 332-3100. $4000 & up; 45-60 days.

ExpandaCore-11 is a self-contained add-on memory for PDP-11 computers with a basic size of 4 k expandable to 28 k words. A single enclosure is wired and powered for up to 16 k of capacity. Cycle time is 1.2 μs; 900 μs when interleaved.

CIRCLE NO. 272

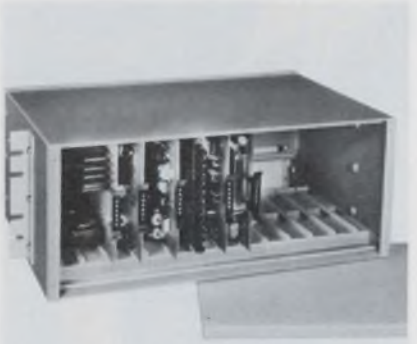
Three LSI chips contain logic for calculator

Singer, Business Machines Div., 2350 Washington Ave., San Leandro, Calif. (415) 357-6800. 1101: $595; 1201: $695.

The model 1101 and 1102 calculators have all logic in three packages. Both calculators use a floating input, fixed output decimal system with up to nine digit accuracy and provide a printed output. The 1102 is the same as the 1101, but includes a fully independent memory for more complex business problems.

CIRCLE NO. 273

Computer can dial numbers with this unit



G-V Controls Div., Sola Basic, 101 Okner Pkwy., Livingston, N.J. (201) 992-6200. $1160; 60 days.

The 907801 series of automatic calling units accepts BCD code and converts to serial digits for automatically dialing telephone numbers. There are several models with different EIA interfaces under RS-366 specifications. Some models can store a limited quantity of phone numbers. When large lists are necessary they are stored in the computer. All models are available in either pulse or tone dialing.

CIRCLE NO. 274

Optical reader can read marked or punched card

United Business Communications, 6405 Metcalf, Shawnee Mission, Kan. (913) 362-5300.

The MR-300 optical-mark, medium-speed card reader is plug-to-plug compatible with the PDP-8 and PDP-11. It can read keypunched cards, pencil-marked cards or a combination of both at rates up to 300 cards per minute. Its vacuum picking technique allows it to process damaged cards. The unit's read amplifiers automatically adjust to changes in card reflectivity.

CIRCLE NO. 275

Cassette data logger stores 10^5 8-bit words

Incre-Data Corp., 6405 Acoma Rd., S. E., Albuquerque, N.M. (505) 265-9575. $2000.

The 6000 Series Incre-Logger is a cassette recording system for the acquisition of data in digital form. Over 100,000 eight-bit words may be recorded on each track of a 300-ft Philips-type cassette. The unit is housed in a half-rack instrument case with height of 5-1/4 in. Data and channel number displays are provided. Other versions are available.

CIRCLE NO. 276

Accumulating printer accepts BCD input

Veeder-Root, 70 Sargeant St., Hartford, Conn. (203) 527-7201.

The series 7726 accumulating digital printer uses a conventional adding machine print mechanism and tape. Using IC electronics, it operates at up to 3 lines/s from parallel BCD data input. It is compatible with TTL, DTL or unloaded RTL. It has a 7-column print capacity and 8 columns for totalizing. Totals print in red. Though low cost is claimed, manufacturer gave no price.

CIRCLE NO. 277

Portable keypunch unit provides I/O functions

Varifab, Inc., 1700 E. Putnam Ave., Old Greenwich, Conn. (203) 637-1434. $975.

Model 403 Vari-Punch punches standard 80-column cards or card sets, from equipment such as badge/card readers, minicomputers, time clocks or its own keyboard. It can also control other devices, like adding machines, through self-generated output signals. Data are punched at 12 characters per second. Speed exceeds three cards per minute.

CIRCLE NO. 278

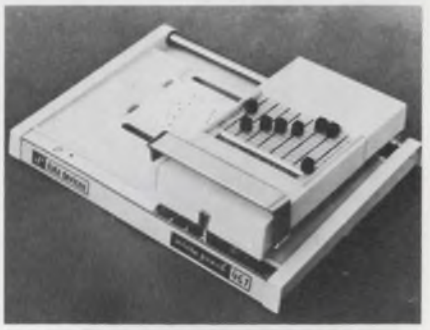
Personality card stores program for tester

Macrodata Co., 20440 Corisco St., Chatsworth, Calif. (213) 882-8880. $650.

"Personality cards" match the 1103-1 RAM and UAR/T control logic to the Macrodata memory tester, MD-100. Cards can also be obtained for most standard memory devices. Cards for new memory devices will be added to the line, as they appear. The company also offers a universal personality card, which may be configured by the customer. Each card has its own pass/fail indicators but needs a ROM to provide the specific test sequences.

CIRCLE NO. 279

Portable card punch enters data manually



Data Products, 6219 DeSoto Ave., Woodland Hills, Calif. (213) 887-8000. $395; 30 days.

A portable card punch for use in source data entry applications simultaneously punches up to eight columns of numerics on a standard 80-column tab card. It weighs less than eight pounds, and has printing and bar-program capabilities. The Micropunch 461 was previously marketed solely to end users rather than OEMs.

CIRCLE NO. 280

Op-amp cost plummets with introduction of 2 quads

Motorola Semiconductor Products, 5005 E. McDowell Rd., Phoenix, Ariz. (602) 962-2292. $1.75 (100). National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. (408) 732-5000. 75¢ (100).

Introduction of the industry's first quad op amps—by Motorola and National—brings with it the lowest-cost op amp available—from National. Unlike Harris Semiconductor's PRAM, which allows the digital selection of one out of four op amps, the Motorola and National devices include four independent, internally compensated op amps.

Motorola's device, the MC 3401P, sells for $1.75 in quantities of 100, while National's LM 3900 sells for 75¢ in the same quantities—which makes for the lowest-cost per op amp (less than 19¢ apiece). That's half to a third of the going price of 709s (which aren't internally compensated) and 741s (which are). The price gap between the Motorola and National quads suggests that an adjustment could be expected, especially since the devices appear quite similar.

Both are current amplifiers, rather than the usual voltage amplifiers. Both are single-ended, inverting amplifiers, but both provide noninverting inputs through the use of a "current mirror," where current equal to that entering the noninverting input is pulled out of the inverting input and shunted to ground.

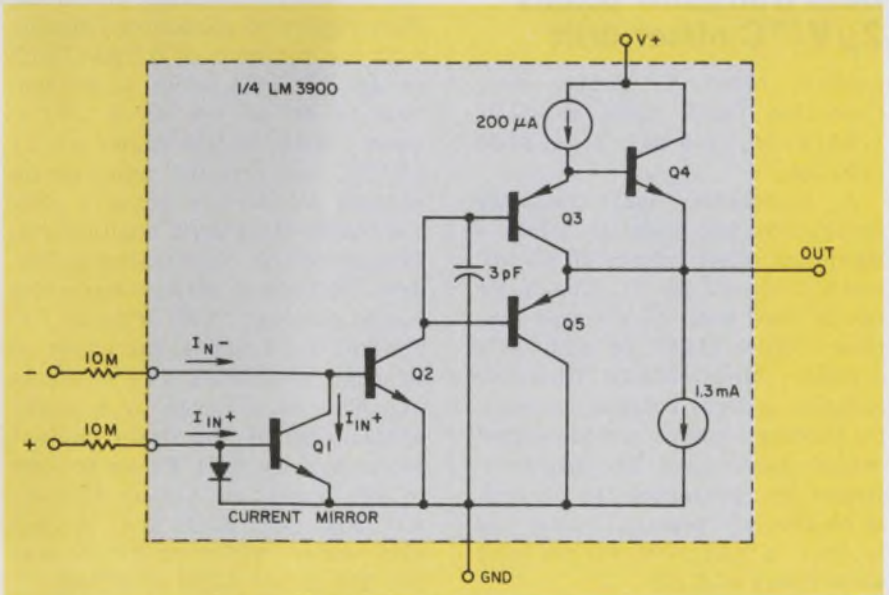
At 25 C, with a supply of +15 V, Motorola specifies a minimum low-frequency, open-loop gain of 1000, while National quotes 800. Typical unity-gain bandwidth in the inverting mode is 5 MHz for Motorola, 2.5 MHz for National.

Motorola quotes a typical slew rate of 0.6 V/μs (with a load of 5 k shunted by 100 pF and gain unspecified), while National quotes 0.5 V/μs (with load and gain unspecified, though National quotes output swing with a 5.1-k load).

Both units operate from a single supply (+5 to +18 V for Motorola, +4 to +36 V for National) and, though National's device can also operate with a dual supply, Motorola's unit cannot.

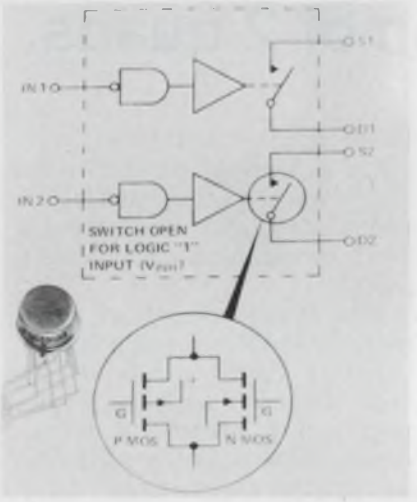
One big difference between the two quad op amps is that the National version contains an internal transient-sinking transistor (Q5 in the schematic) that can sink currents of over 40 mA. Motorola's device doesn't have this feature.

For Motorola CIRCLE NO. 300
For National CIRCLE NO. 301



By connecting GND to V− and adding 2 resistors LM 3900 operates as a 741.

CMOS analog driver/SW has ±15-V signal range



Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. (408) 246-8000. Stock.

A dual SPST analog driver/switch combination employing complementary MOS (CMOS) technology offers a ±15-V analog signal range when ±15-V supplies are used. Designated the DG200, the transmission gate features break-before-make switching action, and t_{OFF} and t_{ON} ratings of 500 and 1000 ns at 25 C. The ON resistance, r_{DS}, is less than 100 Ω over the full signal and rated temperature range. In quantities of 100, prices are $8.75 for the military version, $3.50 for the industrial version.

CIRCLE NO. 302

Dual transistor boasts 2 μV/°C offset drift

Intersil, 10900 N. Tantau Ave., Cupertino, Calif. (408) 257-5450. 115A, $4.50, (100 up); 114A, $5.50 (100 up).

A monolithic dual transistor using dielectric isolation offers a maximum offset voltage of 0.5 mV and a drift of 2 μV/°C. The device can be used with 45-V power supplies (Model 114A), or with 60-V supplies (Model 115A). Dielectric isolation reduces collector-to-collector leakage currents and associated output capacitances. The dual transistors are guaranteed by Intersil to be free of "popcorn" noise, and to have a maximum narrow-band noise figure of 2 dB.

CIRCLE NO. 303

ECL line compensates voltage and temperature

Fairchild Semiconductor Components Group, 464 Ellis St., Mountain View, Calif. (415) 962-3816. $1.80 (100-999).

On-chip voltage compensation as well as temperature compensation is now featured in the company's 95100 line of emitter-coupled logic circuits. The on-chip voltage compensation provides noise margins between devices with supply voltage differentials ranging from −4.7 to −8 V. Temperature compensation on 95100 ECL devices assures constant noise margins between devices at more than 50 C temperature differentials. The first devices in the new line are three SSI gates—the 95102, 95103 and 95104 dual, triple and quad OR/NOR gates.

CIRCLE NO. 304

Dual JFETs boast low bias, low drift

Analog Devices, Inc., Route 1 Industrial Park, Norwood, Mass. (617) 329-4700. Stock.

A line of monolithic dual junction FETs, termed Trakfets, feature extremely low bias currents and extra low input drift characteristics. The new devices are available in the AD 3954 series—optimized for 200-μA drain-current operation—and the AD 5906 and AD 830 series—optimized for 30-μA drain-current operation. In the AD 830 series, leakages are in the fentoampere to picoampere region, with the minimum at 0.1 pA. Drift in the AD 3954 series is guaranteed to be as low as 5 μV/°C (max.) with typical values of 1.1 μV/°C in certain temperature ranges. All devices boast a very low temperature-drift nonlinearity. Because of this close tracking, low-drift FET-input differential amps can be obtained. A 25 or 50 μV/°C Trafket, for example, can easily be adjusted to yield 1 μV/°C tracking. This is achieved by a slight unbalancing of the drain current of one-half the unit. Prices for 100 to 999 quantities are as follows: AD 3954 series, $2.25 to $7.70; AD 5906 series, $3.70 to $13.60 and AD 830 series, $4.50 to $22.90.

CIRCLE NO. 305

256-bit read/write memory in CMOS

Solid State Scientific, Montgomeryville, Pa. (215) 855-8400. $37.50 (100 up); stock.

A 256-bit read/write memory, the SCL 5553, is fabricated in CMOS. The IC features a power dissipation of less than 200 nanowatts/bit (around 60 μW in the quiescent mode), supply range of 6 to 15 V and a typical access time of 100 ns (150 ns max). The memory is fully decoded and is organized as 256 words by 1 bit. A chip select strobe enables the memory array to be expanded in the word direction in increments of 256 words. Cycle times are less than 300 ns.

CIRCLE NO. 306

N-channel 1024-bit RAM has 85-ns access

Electronic Arrays, 501 Ellis St., Mountain View, Calif. (415) 964-4321. $25 (100 up).

An n-channel silicon-gate 1024-bit RAM, the EA 1500, has an access time of 85 ns—that's four times the speed of a typical p-channel RAM. In active operation, the new RAM dissipates only 160 mW—35% to 40% of p-channel dissipation. In addition, it can be logically brought to "standby" between accesses by bringing all inputs to logic ZERO. This reduces standby power dissipation to 35 mW. Any address input to a memory module will turn on the EA 1500 in several nanoseconds.

CIRCLE NO. 307

Glass-coated transistor chips for hybrids

Dionics, Inc., 65 Rushmore St., Westbury, N. Y. (516) 997-7474. Stock.

Glass-coated versions of the company's leading transistor-chip series are now available for hybrid circuit applications. The transistors being offered with glass coatings include the npn 2N2222A, 2N2484 and 2N3725 families, and the pnp 2N2605 and 2N2907A series. The glass coating is a 7000-Å-thick deposition of Pyrolytic Oxide over the metalization in the active top area of the chip. Only the aluminum bonding pads remain exposed.

CIRCLE NO. 308

4 × 8-bit RAMs in CMOS

RCA/Solid State Div., Route 202, Somerville, N.J. (201) 722-3200. $25 (1-99).

Two COS/MOS memories—the CD4036A for binary addressing, and the CD4039A for direct word-line addressing—are 4-word × 8-bit random access NDRO memories. Special features include memory bit expansion, memory bypass capability for all bits, buffering on all outputs and memory word expansion via Wire-OR capability. The memories are intended for use in digital equipment where low power dissipation and/or high noise immunity are primary design factors. The CD4036A and CD-4039A are currently available on a limited sampling basis in 24-lead DIPs.

CIRCLE NO. 309

CO laser believed a commercial first

Molectron Corp., 930 Thompson Pl., Sunnyvale, Calif. (408) 738-2661.

A CO laser system, the Model C200, is believed to be the first CO laser product supplied on a commercial basis. The complete system is capable of providing cw laser radiation at CO, CO_2 and N_2O emission lines. Stable single-mode output as well as multi-wavelength operation is available. The output is 20 W multi-line and 2 W single mode at the CO lines between 5 and 6 microns.

CIRCLE NO. 320

Optical components in variety of shapes

Applied Products Corp., 437 Caradean Rd., Horsham, Pa. (215) 675-1880.

Complex acrylic and polystyrene optical components with irregular configurations and complicated optical patterns can be custom machined in sizes from 4 to 78 inches × 10-1/2 inches thick. The acrylic lens shown is 13 inches in diameter × 13 inches high and has 53 internal axial flutes as well as 8 external perripheral facets. The complex lens is used as an infrared homing beacon for night operations.

CIRCLE NO. 321

Double balanced mixer operates at 0.01-4 GHz

Technical Research and Manufacturing, Inc., Kelly Ave., Grenier Field, Manchester, N.H. (603) 668-0120. $190 (1-5); stock to 3 wks.

The Model MD-101 double balanced mixer provides 6.0 dB typical conversion loss over the frequency range of 10 MHz to 4 GHz. The i-f range is dc to 3 GHz and port-to-port isolation is 20 dB minimum. With 50-Ω input/output lines, the mixer can handle 400 mW of power and 50 mA of i-f current (maximum values). The unit is available with BNC, TNC and SMA connectors.

CIRCLE NO. 322

YIG discriminators cover 500 MHz to 18 GHz range

Advanced Microwave Labs., 825 Stewart Dr., Sunnyvale, Calif. (408) 245-5770. 45 to 60 days.

A line of voltage-tuned YIG discriminators, the D2201 series, operates from 500 MHz to 18 GHz. These devices present a linear frequency discrimination window that can be positioned anywhere in standard octave-frequency ranges. The discriminator window is 15 to 40 MHz wide depending on the band. Tuning linearity is better than 0.1%.

CIRCLE NO. 323

Solid-state limiter good at 1 GHz

Raytheon Co., Micro State Products, 130 Second Ave., Waltham, Mass. (617) 899-8080.

The new solid-state limiter, designed for use as a receiver protector, operates at 1.0 to 1.2 GHz. Designated the RLH-5011, it has an rf input capacity of 1 kW peak and 25 W average. Pulse width is 10 μs. Isolation is 40 dB with insertion loss of 0.3 dB, and the input VSWR is 1.30. Excluding connectors, the RLH-5011 measures 3-1/4 × 1 × 1 inches. The operating temperature range is −50 to +70 C. Connectors are Type N male for input and Type SMA male for output. The new device was designed specifically for use as a receiver protector in TACAN systems.

CIRCLE NO. 380

PACKAGING & MATERIALS

Hot polyester offers new tradeoffs

General Electric Co., One Plastics Ave., Pittsfield, Mass. (413) 494-4803. In colors, 95¢/lb; natural, 85¢/lb. in truckloads; stock.

Combining high heat and flame resistance with fine moldability, lubricity, dimensional stability, solvent resistance and electrical properties, Valox 310-SEO includes no fillers (which make plastics more rigid but less ductile). The thermoplastic polyester meets UL's SE-0 requirements for self-extinguishment and no dripping after a flame is removed. It's thus superior to nylon, though slightly more costly. It's similarly superior to and more expensive than unreinforced, self-extinguishing polypropylene, which lacks heat resistance and toughness.

CIRCLE NO. 324

IC thick film packages offer hermetic sealing

Du Pont Co., 11444 Nemours Bldg., Wilmington, Del. (302) 774-2358.

A fully hermetic sealing system useful with silver/tin preforms satisfies MIL STD 883, Class A and promises to significantly reduce total package costs by as much as seven cents in lid and preform expense. Also, the first IC package ever to offer circuit elements on both sides of the ceramic substrate opens the door to more compact, lower cost hybrid circuitry.

CIRCLE NO. 325

Rubber heating blanket resists breakage

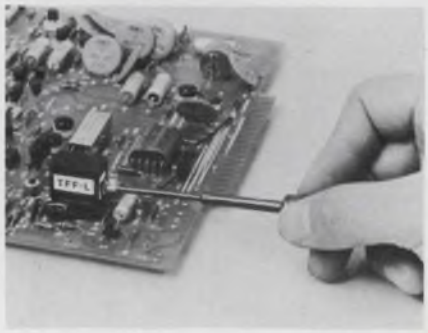
Tayco Engineering, Inc., 441 E. 4th St., Long Beach, Calif. (213) 427-0387. $5; 2-3 wks.

A rugged line of flexible, vulcanized rubber, electric heating blankets, Tay-Flex, defies breakage of the heating wire under continuous bending and flexing. This is attributed to the design of the resistance wire, which is wound around a core of fiber glass in a helix configuration, so the wire simply expands as a spring and relocates around the fiber glass core without kinking or fracturing.

CIRCLE NO. 326

COMPONENTS

Adjustable inductor fits DIP socket



The Five Friends, P.O. Box 7541, Stanford, Calif. (415) 326-3377. $22.00 (unit).

The TFF-L-V10/20 semiconductor plugs into a standard DIP socket for circuits that were previously impractical because of unrealizable L. Type V10 is adjustable over a 10% range and type V20 over a 20% range in sizes from 10 mH to 10 H. The unit, 0.78 × 0.56 × 0.49 in. weighs less than 10 grams, and operates from ±12 V to ±20 V, or +24 to +40 V unipolar. Setting may be manual, or automatic by voltage control.

CIRCLE NO. 327

Keyboard array offers many satellite clusters

Mechanical Enterprises Inc., 5249 Duke St., Alexandria, Va. (703) 751-3030. $87.15 (500 and up).

Ten types of alphanumeric arrays and over 100 combinations of satellite clusters designated, Unicluster, are offered. The assembly is mounted in a steel frame, and all outputs terminate at a single card edge. Keyswitches use a bounce-free, long-life, mercury switch sealed in a flexible tube. With MOS/LSI encoding logic, the assemblies provide two-key rollover and tri-mode or quad-mode shifting.

CIRCLE NO. 328

evaluation samples

Slide and rocker switches

UID slide and rocker switches are available with the new U.L. TV-1 and TV-2 listings. The company claims that this is the first time a TV-2 rated rocker switch has ever been offered in the very economical 24¢ price range. UID Electronics Corp.

CIRCLE NO. 329

Cable ties

A line of AMP-TY nylon cable ties incorporates dual stainless steel pawls to provide up to twice the bundling tensile strength of all-plastic cable ties. The ties are available in the four sizes to accommodate bundles from 1/16 to 4 inches diameter, with each size being infinitely adjustable within its range. AMP Inc.

CIRCLE NO. 330

Fastener components

A sample board contains physical samples of 24 popular fastener and holding components. The 10 × 14-in. board, which is suitable for wall mounting, includes such devices as PCB supports and guides, spacers, clamps, clips, bushings, perforated straps, wire ties, hangers, wire saddles, harness wrapping, grommets and idler pulleys. Richco Plastic Co.

CIRCLE NO. 331

Adhesive-backed material

Seventeen samples of adhesive-backed materials are presented in a new four-page catalog. The catalog presents specifications and information regarding the complete range of materials, adhesives and fabricating services available. Deccofelt Corp.

CIRCLE NO. 332

Coil bobbins

Coil bobbins of fiberglass laminated epoxy are molded in thousands of sizes from open stock tooling in thicknesses from 5 mil up. Lengths up to 18 inches are available. Stevens Products, Inc.

CIRCLE NO. 333

application notes

Tracking a/d converters

A new 8-page application note provides complete details on the design, construction and performance of a compact high-performance 8-bit tracking a/d converter. Operation in military applications may be obtained by simply specifying suitable military temperature range components. A complete components list and full size P.C. board layout is provided to enable construction in minimum time. Precision Monolithics, Inc., Santa Clara, Calif.

CIRCLE NO. 334

Phase jitter

A four-page applications note, "The Effect of Channel Noise and Other Additive Signals on the Measurement of Phase Jitter," presents a factual discussion of the various causes of channel noise and "T" carrier quantizing noise and the relationship of each to the measurement objectives. Hekimian Laboratories, Inc., Rockville, Md.

CIRCLE NO. 335

Filter response

"Phase and Amplitude Response of a Variable Electronic Filter" is the title of a new 16-page application note (IAN-101). A simple, general method for determination of phase and amplitude response of high-pass, low-pass, and band-pass filters is provided for four-pole Butterworth and Bessel Filters. Ithaco Inc., Ithaca, N.Y.

CIRCLE NO. 336

Measuring impedance

A two-page application note, AN-102, describes the use of two-phase lock-in amplifiers to measure the complex impedance of semiconductor junctions at specific frequencies. Use of the lock-in amps permit simultaneous determination of in-phase and quadrature components of junction impedance. Princeton Applied Research Corp., Princeton, N.J.

CIRCLE NO. 337

new literature

Time code references

A complete reference book of time code formats gives drawings and characteristics of about two dozen of the most commonly-used codes, including the IRIG standards, NASA, various range codes and special serial codes. All codes conform to Document 104-70. A glossary of terms, abbreviations and reference is included. Datum, Timing Div., Anaheim, Calif.

CIRCLE NO. 338

Test instruments

A 12-page catalog describes four lines of electronic test instruments. Descriptive copy, photos and specifications are given for a series of fully automatic counters, a series of universal counter/timers, two series of five-digit voltmeters, two series of four-digit voltmeters, a series of three-digit voltmeters, two series of data amplifiers and a series of frequency synthesizers. Dana Laboratories, Irvine, Calif.

CIRCLE NO. 339

Data storage

Application Note 133-3, "A Guide to Using Data Storage," describes the many advantages of a data storage option. Specific applications in three categories are discussed: A to D conversion, high-speed scanning and DVM measurement speeds independent of system speeds. Operation with various DVM plug-ins and advantages of sample-and-hold are discussed. This new 14-page booklet contains 30 illustrations. Hewlett-Packard Co., Palo Alto, Calif.

CIRCLE NO. 340

Transistor chips

A transistor chips catalog describes a series of standard chips including FETs, PNP and NPN switching transistors, integrated choppers and monolithic interface circuits. These chips can be supplied in the following forms: probed chips, 100% tested premounted chips and carrier-mounted chips. Teledyne Crystalonics, Cambridge, Mass.

CIRCLE NO. 341

Analog Devices guide

A 180-page guide provides descriptions and prices of converter, amplifier and linear ICs, digital panel meters, function modules and accessories. The guide also classifies products, presents extensive selection criteria and offers interpretative commentary relevant to optimum product choice. Analog Devices, Inc., Norwood, Mass.

CIRCLE NO. 342

TO-5, TO-18 sockets

Bulletin No. 7002 describes series sockets 131-55 for TO-5 and TO-18 devices. The bulletin contains material descriptions, line drawings, specifications and a photograph of the sockets. The sockets are usable on a wide variety of production applications. The series sockets 131-55 are designed to press fit into a double-D shaped chassis hole or dip solder to the top of a printed circuit board. The socket leads can be both hand or flow soldered. Barnes Div. of Bunker-Ramo Corp., Lansdowne, Pa.

CIRCLE NO. 343

Large core store

A brochure describes an extended core memory system capable of increasing the performance and lowering the cost of IBM's System/360 computer. The six-page brochure outlines the System/6000 large core store for use with IBM System/360, Models 50 and up. Data Products, Woodland Hills, Calif.

CIRCLE NO. 344

Digital tape unit

A 4-page brochure describes operations and specifications of the Model TMX digital tape unit. The TMX is a compact and reliable unit offering 7 or 9-track recording at speeds up to 25 inches per second for use with minicomputers, data terminals and acquisition systems. Ampex Corp., Redwood City, Calif.

CIRCLE NO. 345

Linear IC handbook

A new 304-page Linear Integrated Circuit Applications Handbook provides a fully indexed and cross-referenced collection of linear applications using both monolithic and hybrid circuits. Product areas covered include regulators, op amps, comparators, JFET amplifiers, analog switches, pin diode drivers and phase locked loops. Applications span a wide range of areas including instrumentation communications, consumer and high reliability military. National Semiconductor Corp., Santa Clara, Calif.

CIRCLE NO. 346

Opto-electronics guide

A 4-page selection guide contains information on LEDs, couplers and detectors. General Electric, Cleveland, Ohio

CIRCLE NO. 347

Coax components

A new 36-page booklet describes hundreds of components and accessories for high-frequency applications to 9 GHz. Included are complete and highly detailed specifications for general-purpose and precision 50-Ω and 75-Ω connectors, adapters, attenuators, terminations, 2 and 3-port coupling elements, cables, air lines and a unique broad-band directional coupler. General Radio, Concord, Mass.

CIRCLE NO. 348

GaAs and GaP lamps

A 4-page brochure describes gallium arsenide and gallium phosphide solid-state lamps. Application concepts and specifications are given. General Electric, Cleveland, Ohio

CIRCLE NO. 349

NEW LITERATURE

Transistor references

A completely revised 64-page "Semiconductor Cross Reference and Transistor Data Book" contains over 35,000 listings, including 10,000 types not previously shown. Types included are transistors, diodes, zeners, capacitors, rectifiers and SCRs. Specifications, electrical characteristics and outline drawings are given for the line of silicon and germanium transistors. The cross reference book features new "computer logic" sequencing of listings, which makes it faster and easier to use. International Rectifier Corp., El Segundo, Calif.

CIRCLE NO. 350

Data conversion

A 14-page short form catalog contains electrical and mechanical information on dc amplifiers, dc power supplies, dc-dc converters plus a/d and d/a converters. The hardware described forms the basic building blocks for many forms of data acquisition, data analysis, data reproducing and graphic display equipment. Datel Systems, Inc., Canton, Mass.

CIRCLE NO. 351

Lasers

An illustrated catalog shows seven laser models—including a new modulated laser—and a wide range of accessories to extend their use for education and research. The catalog describes low-cost education kits which capitalize on laser light to teach optics and light theory. Other pages carry descriptions of holographic equipment, laser kits, accessories and optics bench equipment. Metrologic Instruments, Inc., Bellmawr, N.J.

CIRCLE NO. 352

Quartz crystal filters

A revised catalog brings within one compact volume information on the extensive range of SEI quartz crystal filters. Salford Electrical Instruments Ltd., Manchester M30 OHL, England.

CIRCLE NO. 353

Solid-state pushbuttons

A 16-page brochure describes the company's full line of solid-state pushbuttons. Product brochure SN lists features, typical applications, switching concept, operating characteristics, reliability, performance parameters, electrical data and general calculations for interfacing. It describes lighted and unlighted direct printed circuit board mounting modules and panel mounted modules, button varieties (shapes, legends and colors) and ordering information. Micro Switch, Freeport, Ill.

CIRCLE NO. 354

Heat sinks

The 1972 short-form catalog of heat sinks and dissipators for transistors and ICs presents concise information including thermal test curves on the broadest line of such devices in the industry. The edition features a variety of new models specially configured for DIP packages, double DIP, square metal packages and many other new ICs and hybrids. International Electronic Research Corp., Burbank, Calif.

CIRCLE NO. 355

Epoxy FETs, bipolars

A new catalog listing operating parameters of more than 100 types of epoxy-encapsulated field-effect and bipolar transistors is available. The catalog also covers plastic semiconductors produced by Siliconix, Inc. and Ledel Semiconductors, Inc. The catalog contains a detailed FET cross-index, in addition to data on general-purpose, switching, RF FETs and NPN/PNP bipolar devices. Siliconix Inc., Santa Clara, Calif.

CIRCLE NO. 356

New Teledyne quarterly

A quarterly magazine contains technical articles and new product information pertinent to the field of analog switching. RF tuning and low noise amplification. Also included are application stories and a short circuits department. Teledyne Crystalonics, Cambridge, Mass.

CIRCLE NO. 357

MOS testing procedures

A 4-page application note describes test procedures used on the MK4006P and MK4008 MOS RAMs. The tests are all performed under worst-case address change, refresh, and other applicable conditions. Mostek Corp., Carrollton, Tex.

CIRCLE NO. 358

Used computer prices

The spring issue of the "Computer Price Guide," the Blue Book of Used Computer Prices, lists current market prices for all classes of used computers. While a large number of its 28 pages are devoted to IBM equipment, computers of every major manufacturer are represented. TBI Equipment Div., Elmsford, N.Y.

CIRCLE NO. 359

Microwave devices

A 24-page catalog describes a broad line of octave and multi-octave solid-state switches, limiters and switch and limiter modules. Both single and multi-throw switches, as well as a series of TTL compatible switch drivers are included in the new catalog. Crown Microwave, Inc., Burlington, Mass.

CIRCLE NO. 360

Computer terms glossary

A revised and updated pocket size Glossary of Computer Terms includes definitions of computer acronyms frequently encountered in the computer industry. General Automation, Inc., Anaheim, Calif.

CIRCLE NO. 361

Data communication tips

An illustrated 14-page brochure entitled "Mr. Datafella's Dilemma and How the Man from Tran Tamed the Trunk Dragon" provides the vehicle for a fun trip through one man's data communications nightmare and his awakening. The booklet probes seven common data-distribution problems and demonstrates networking techniques that eliminate "on-site" data sets and provide unlimited expansion capabilities and data communications for all kinds of low, medium and high-speed terminals. Computer Transmission Corp., Los Angeles, Calif.

CIRCLE NO. 362

National MOS/LSI

The 280-page MOS/LSI data catalog provides complete specification data for all MOS RAMs, ROMs, shift registers, clock drivers, analog switches, character generators, code converters and logic elements. The catalog also contains application notes and briefs for a variety of MOS functions. National Semiconductor Corp., Santa Clara, Calif.

CIRCLE NO. 363

Solid-state publications

The Solid-State Technical Publications, Form No. SMF-109, describes the broad range of technical publications on solid-state devices. These publications include the new Databook series, technical manual series, a reference handbook on solid-state power circuits and a variety of catalogs and brochures. They provide information on the theory of operation, mounting and handling techniques, circuit applications and definitive ratings and characteristics. RCA Solid State Div., Somerville, N.J.

CIRCLE NO. 364

Power modules

A comprehensive 56-page catalog describes and illustrates complete lines of power modules and has complete electrical specifications, operating parameters, dimension charts and prices. Three types of power conversion are covered in the catalog for military, aerospace and commercial applications. They are ac to dc, dc to ac and dc to dc. Abbott Transistor Labs, Inc., Los Angeles, Calif.

CIRCLE NO. 365

Burroughs newsletter

Readout, a monthly newsletter, is designed to open another communications link between the display manufacturer and the OEM building displays into his equipment. Readout will describe interesting or novel applications selected to stimulate ideas and to give others an opportunity to see how application problems are solved. Product line changes, new products and general news items will be included. Readout, Burroughs Corp., Plainfield, N.J.

CIRCLE NO. 366

bulletin board

The Electronic Components Group of **GTE Sylvania Inc.** has added several new families of solid-state devices, designed for industrial applications, to its **ECG semiconductor replacement line.** The added industrial families include: ECG 5000 series of zener diodes ranging from one-half to 50 W; ECG 5400 series of SCRs from a sensitive 800 mA unit to a rugged 35 A device; ECG 5600 and 5700 series of triacs having current ratings from 2.5 to 40 A; ECG 5800 series of axial lead rectifiers varying from 50 to 1000 V peak reverse voltage, stud-mounted rectifiers ranging from 3 to 70 A with reverse polarity basing construction, and ECG 6400 series which comprises special devices such as silicon unilateral, bilateral and asymmetrical switches; diacs, programmable and non-programmable unijunction transistors.

CIRCLE NO. 367

Price reductions

General Instrument Corp. has reduced the price, by up to 33%, of its **Discstor Model 500 FR,** a 19-inch, RETMA, rack-mounted fixed-disc memory. New prices will range from $2400 to $4300 per unit in OEM quantities.

CIRCLE NO. 368

Inselek has announced a general price reduction in its **silicon-on-sapphire wafer products.** Standard products, 1 μ SOS films with tight control on doping density, can now be purchased in quantity for less than $15.00/wafer.

CIRCLE NO. 369

vendors report

Annual and interim reports can provide much more than financial-position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

Sprague Electric Co. Capacitors, semiconductors and ICs, resistors, network assemblies.

CIRCLE NO. 370

Zenith Radio Corp. Consumer-electronic equipment, acousto-optic components.

CIRCLE NO. 371

Amp, Inc. Connectors and interconnection systems, programming systems, power supplies.

CIRCLE NO. 372

Belden Corp. Wire and cable.

CIRCLE NO. 373

National Cash Register Co. Business computers and data terminals.

CIRCLE NO. 374

Burroughs Corp. Computer systems and subsystems, terminals, encoders.

CIRCLE NO. 375

The Bunker-Ramo Corp. (Amphenol) Connectors and interconnection systems, lighted pushbutton switches, keyboards, trimming resistors and potentiometers.

CIRCLE NO. 376

Analog Devices, Inc. Function modules and ICs.

CIRCLE NO. 377

The Foxboro Co. Process-control instrumentation (pneumatic and electronic).

CIRCLE NO. 378

CTS Corp. Variable resistors, selector switches, loudspeakers, thick-film hybrid networks, quartz crystals.

CIRCLE NO. 379

Electronic Design

ELECTRONIC DESIGN's function is:

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- To provide a central source of timely electronics information.
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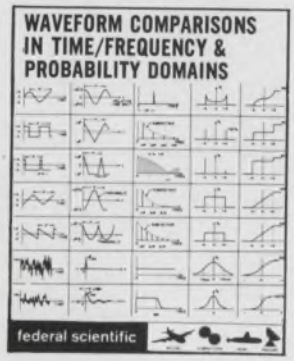

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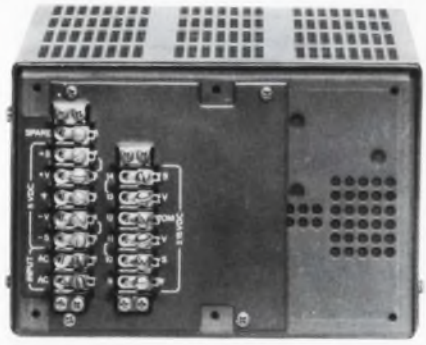

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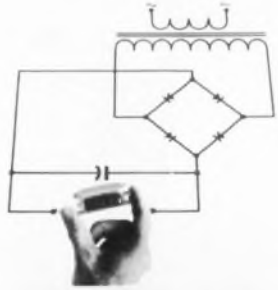

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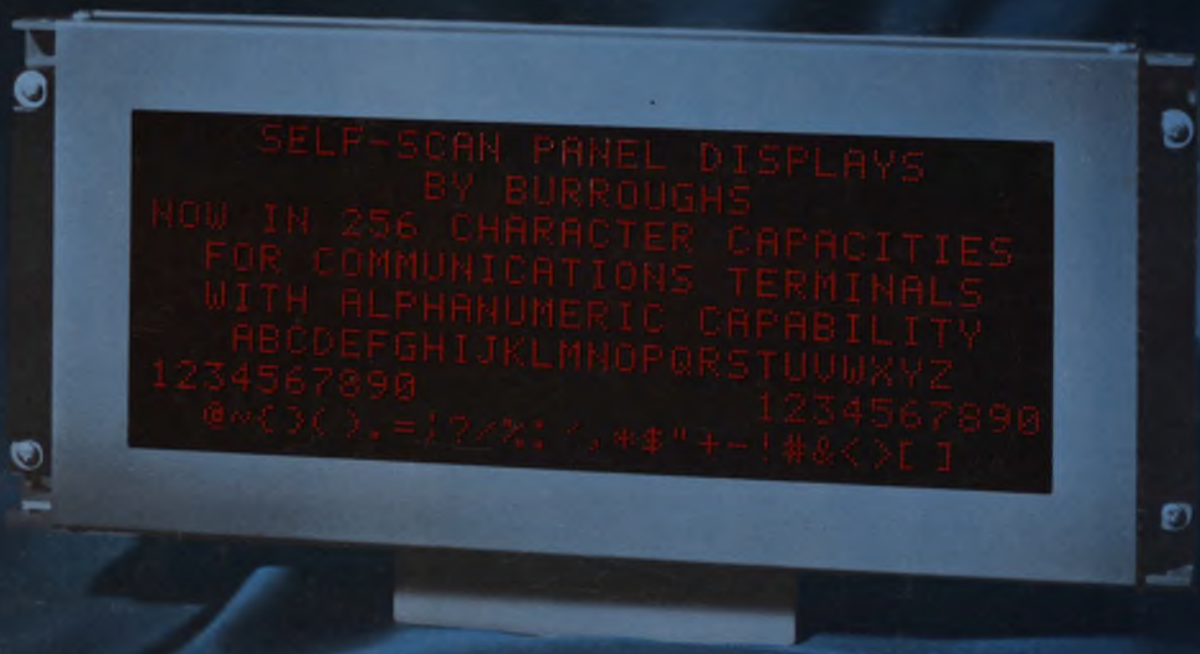

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