Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

VOL. 19 NO. 9

APRIL 29, 1971

Data communication: here's how— combine the right hardware with the right transmission service for your particular application. Easy? No; the relative economic merits of various alternative schemes are often subtle and difficult to evaluate. To get help with your system-design problem, turn to the report beginning on p. C1

QPL/PDQ

from DALE

It's a fact that Dale can quickly supply more QPL resistors and trimmers than any other source. It's also a fact that we don't turn off the quality when we produce these same parts to fill your non-DESC needs. Wirewound or film, military, industrial or commercial, standard or special, we have a resistive capability that you can use to save time and money for your company. No bragging—It's a fact!

Write for more information including Dale's Military Resistor Identification Guide and QPL or phone 402-564-3131.

DALE®

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A subsidiary of The Lionel Corporation

POWER WIREWOUND

MIL-R-26E/MIL-R-39007B: RW20V to 24V, 29V to 33V, 35V to 38V, 47V, 67V to 69V, 70U, 74U, 78U, 80U, 81U.
RWR71, 74, 78, 80, 81, 82, 84, 89 (including both "S" & "W" suffixes).

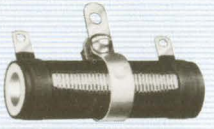
POWER WIREWOUND HOUSED

MIL-R-18546D/MIL-R-39009A: RE60, 65, 70, 75, 77, 80 (including both "G" & "N" suffixes); **RER**40, 45, 50, 55, 60, 65, 70, 75 (includes "F" suffix).

PRECISION WIREWOUND

MIL-R-93D/MIL-R-39005B: RB52CE to 56CE, **RB**71CE; **RBR**52 to 55.

ADJUSTABLE POWER WIREWOUND



MIL-R-19365C: RX29V, 32V, 33V, 35V, 36V, 37V, 38V, 47V.

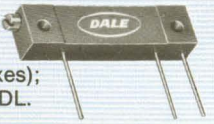
FIXED FILM

MIL-R-10509F/MIL-R-55182D: RN50 (C&E), 55 (C, D, E), 60 (C, D, E), 65 (C, D, E), 70 (C, D, E, F), 75 (B), 80 (B).
RNR, RNC & **RNN**50, 55, 60, 65 (H, J, K), to "R" failure rate.

FIXED FILM INSULATED

MIL-R-22684B: RL07S, 20S.

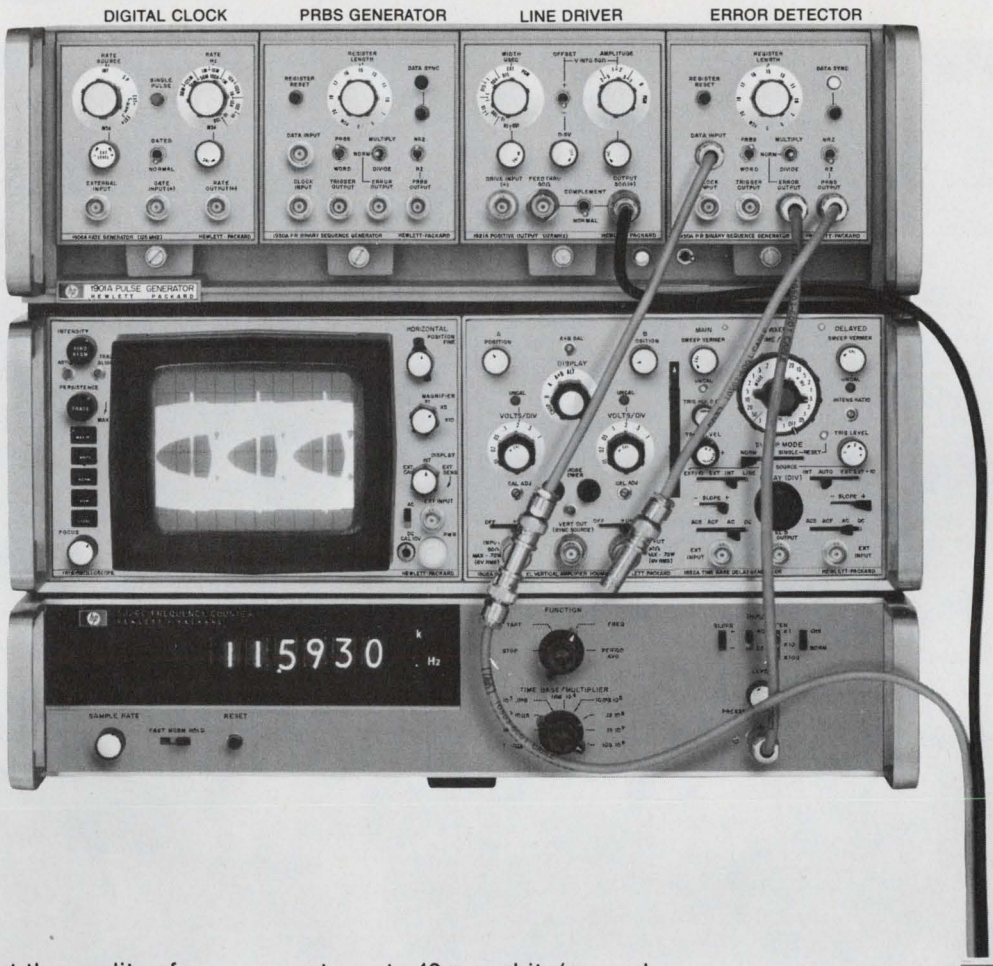
VARIABLE WIREWOUND



MIL-R-27208C/MIL-R-39015A: RT10, 11, 12 (C2P, C2L suffixes); **RT**22, 24, (C2P, C2L, C2W, C2X suffixes); **RTR**12DP, **RTR**12DL.

INFORMATION RETRIEVAL NUMBER 181

The new way to measure bit error rate: HP's pseudo-random binary sequence generator



081/6

How do you test the quality of a digital transmission system? By feeding in data, and comparing what comes out with what you put in... right?

You can do this by hooking up a scope to the output, and looking at the "eye" pattern. The accuracy of your results depends on the randomness of your signal, however ... and even at best, there's still an element of estimation involved.

That's why HP has developed the 1930A—a new plug-in for the 1900 Pulse Generator System. The 1930A is designed specifically to solve digital system testing problems. It enables the 1900 System to generate over 70,000 different apparently-random binary sequences ranging in length from 7 bits up to 1,048,575 bits... at any desired rate up to 40 megabits/second. And this means a better "eye."

The 1930A's capabilities don't stop there, however. By using two synchronized 1930A's, one at each end of your transmission system, you can **directly** compare output with input. Every time there's a discrepancy between the pattern coming in over the transmission line and the pattern being generated by the 1930A at the receiving end, the "receiving" 1930A sends out an error pulse.

Add a counter, and you're measuring bit error rate **digitally**. No more guesses.

Another use for the 1930A's is to scramble and unscramble data where security is important. Data can be coded in over a million different ways and no complex synchronization is required to unscramble.

The 1930A is digitally programmable, as is the entire 1900 System. Price of the 1930A is only $1200. For applications where a 16-bit word generator will suffice at the transmitting end, HP's 1925A may be substituted for the 1930A, at a savings of $350.

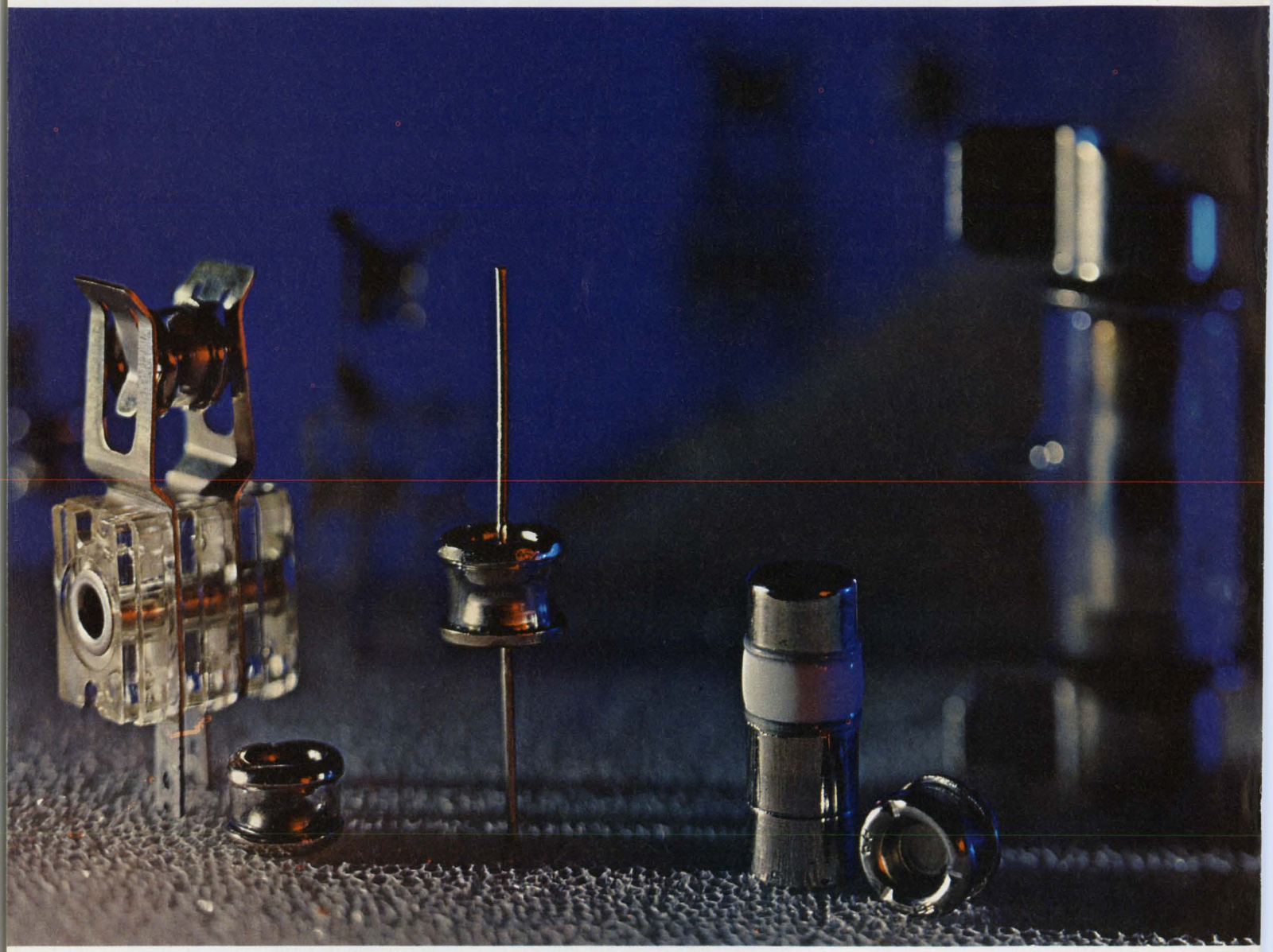
For further information on the 1930A, or on any aspect of the 1900 Pulse Generator System, contact your local HP field engineer. Or Write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

SIGNAL SOURCES

INFORMATION RETRIEVAL NUMBER 2

Siemens



Low-cost SVP™ devices can save your valuable equipment from destruction by voltage transients.

You can no longer overlook the need for protecting your circuits. New sources of transients are cropping up every day. And any one of them might cause operational failure of your equipment.

Now there is an easy low-cost way to protect your circuitry from these transients. It's a simple little gas-filled surge voltage protector. We call it an SVP. Only this Siemens SVP offers high-current capability (up to 50 kiloamps) in such a small package and a high impedance when not conducting (10^{10} ohms, 1 to 6.8 pF depending on model).

Siemens is the world's largest manufacturer of surge voltage protectors. More engineers are using them every day. You can benefit by doing the same.

Siemens Corporation, 186 Wood Avenue South, Iselin, N.J., 08830. (201) 494—1000.

Siemens. A three billion dollar name in quality products.

SIEMENS

INFORMATION RETRIEVAL NUMBER 3

Electronic Design

VOL. 19 NO. 9

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 29, 1971

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover: Designed and photographed by Art Director Bill Kelly.

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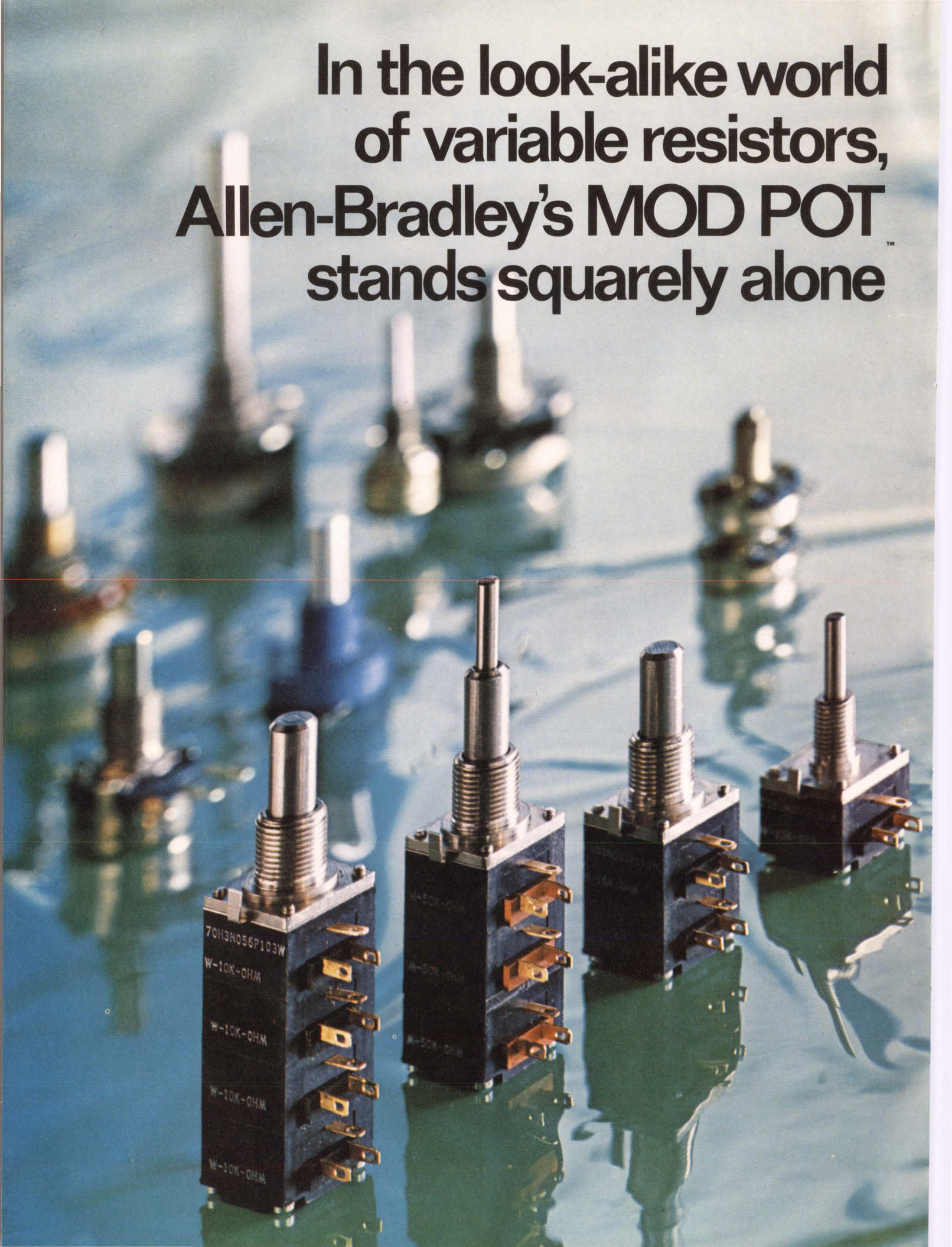
82,501 copies this issue.

In the look-alike world of variable resistors, Allen-Bradley's MOD POT™ stands squarely alone



MOD POT: the most versatile 5/8″ square potentiometer available today.

Series 70, designed for the 70's. There are a multitude of basic combinations. Potentiometer, switch and vernier drive modules combined to form single, dual, triple or quadruple section controls. With single or concentric shafts. But that's only the beginning.

Resistance modules come in cermet or hot-molded composition. Cermet, 100 ohms to 5 megs. Composition, 50 ohms to 10 megs, available in five standard tapers and also special tapers.

Switch modules in push-pull, momentary or rotary styles with actuation at the beginning or the end of rotation.

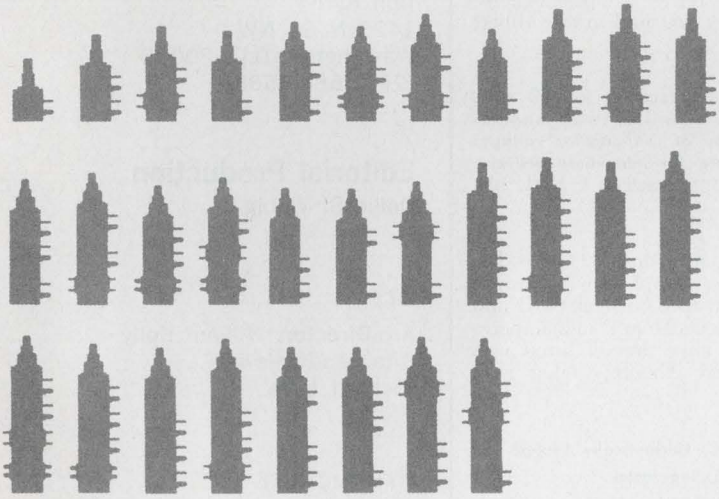
All standard options are available, including: two different shaft diameters, sixteen lengths with plain, slotted or flatted ends; bushings in two lengths and two diameters with your choice of plain or shaft lock styles. Marked with your part number, or ours.

Add together all the modular variations and you have thousands of possible combinations. Each backed by Allen-Bradley's unrelenting pledge of quality and dependability.

But suppose you need something more. Something unique and special. We're ready. Because the Series 70 is more than a product, it's a dynamic concept that will grow and change to meet your needs. Add our years of experience with variable resistors, and the design of "specials" is simple. Give us the chance to tackle your next unusual requirement.

MOD POT, the new look in pots. Solve your problems with its versatility.

Call your A-B appointed electronics distributor, or write: Allen-Bradley, Electronics Division, Milwaukee, Wis. 53204. Export: Bloomfield, N. J. 07003. Canada: Galt, Ont.



NEW DIMENSION ELECTRONICS

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letters

'Closed shop' in U. S. public schools decried

Sir:

You have put down in words what I have been saying for years —that in our antiquated public school system, no matter how many degrees you possess, you cannot teach unless you have a specified number of how-to-teach credit hours [see "Don't Waste Our EEs —Put Them in Classrooms," an editorial, ED 5, March 4, 1971, p. 39].

You stated that some systems allow exceptions. Sure, but this is on a temporary basis and only if the political bosses allow. You can have a Ph.D. and teach students who will become teachers, yet you cannot teach in the public schools. Private schools, yes; public schools, no, as a full-time teacher.

How wonderful it would be, if everyone had the right to teach. We criticize our labor unions for closed shops, yet the educational system is authorized to practice a closed shop.

You talk about the unemployed engineer bringing valuable knowledge to our future generation. How about the retired who would be glad to donate their services to the public?

I am an electronic engineer, employed for 22 years.

Michael Yurescko
3817 Pearson Ave.
Philadelphia, Pa.

Sir:

Concerning your editorial of March 4 on the subject of EEs teaching math (or any other suitable subject) in the classrooms: The problem, in Texas at least, is not just a lack of education courses. One must also have taken the specific technical course numbers approved by the state education agency for that particular specialty.

I investigated this matter two years ago and was informed that most of my math courses were not "applicable," since many math courses I took were taught through the engineering school under engineering course numbers, rather than those numbers used for essentially the same course content for math and education majors. Thus nearly all of my math courses would have to be repeated to obtain state approval for permanent teaching purposes.

Apparently the only way I could obtain other than provisional approval in Texas would be to go back to school as a freshman and spend another four years taking an "approved" course of study. Since I hold two degrees in electrical engineering, I decided that such an approach was not acceptable, in view of the pay level I could expect after obtaining this additional "education."

I contacted the state education agencies of four other states, and judging from the contents of their information pamphlets, it appears that the same situation also exists in these states.

K. R. Tipple
11112 Staffordshire
Dallas, Tex.

Accuracy is our policy

In the article "Designing active filters with less effort" (ED 1, Jan. 7, 1971) the capacitor value, C_1, for the low-pass filter was incorrectly given as $C_1 = 1/\zeta^2 C_2$. The value should be $C_1 = (1/\zeta^2)\ C_2$.

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, 850 Third Ave., New York, N.Y. 10022. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

As portable data recorders go, the three you see below leave all the others behind.

Surprisingly versatile for their size, they're yours for the taking whenever and wherever there's a need to record or reproduce analog signals.

Part of the broad line of TEAC instrumentation products, which have come a long way in worldwide business and industry over the past ten years, these portable systems are now set to go places in this country.

The smallest of our get-up-and-go trio is the low-priced R-70 Series using Philips-type instrumentation cassettes.

You can select direct or FM on any one of its four channels with a flip of a switch, or add any spoken data needed. And a light goes on to tell you when you've come to the end of your tape.

Rugged and reliable, the R-70 will operate on self-contained batteries, or on external AC or DC.

The R-200 Series Direct/FM recorder is another fine idea that you can never carry too far. In the field or laboratory, it gives you four independent record/reproduce channels, built-in calibration source, input/output level meters and a direct-drive closed-loop capstan. It performs well under mobile conditions on AC or DC and takes voice messages on one channel when desired.

It'll even follow your directions via a remote control unit. Which guarantees your always having everything well in hand.

The mightiest of our lightweights, (only 67 pounds), the R-250 Series, is made to IRIG standards. Using an FM system, it will record and reproduce analog signals from DC to 5kHz, on its ½" tape.

You can take your choice of using one or more of its seven independent channels plus one edge-track voice channel.

While a bit heftier than the R-70 and R-200, it's worth its weight in dependability, whether you're on the move or not.

For additional details on these portable recorders and other TEAC systems, write or call Ken Williamson, Director of Marketing, Technical Products, TEAC Corporation of America, 2000 Colorado Ave., Santa Monica, CA 90404. Telephone: (213) 394-0240.

You'll see why there's a good reason to go TEAC.

Take your TEAC® and go.

R-250 SERIES

R-70 SERIES

R-200 SERIES

truly remarkable

25-MHz BANDWIDTH

DELAYING SWEEP

3% ACCURACY

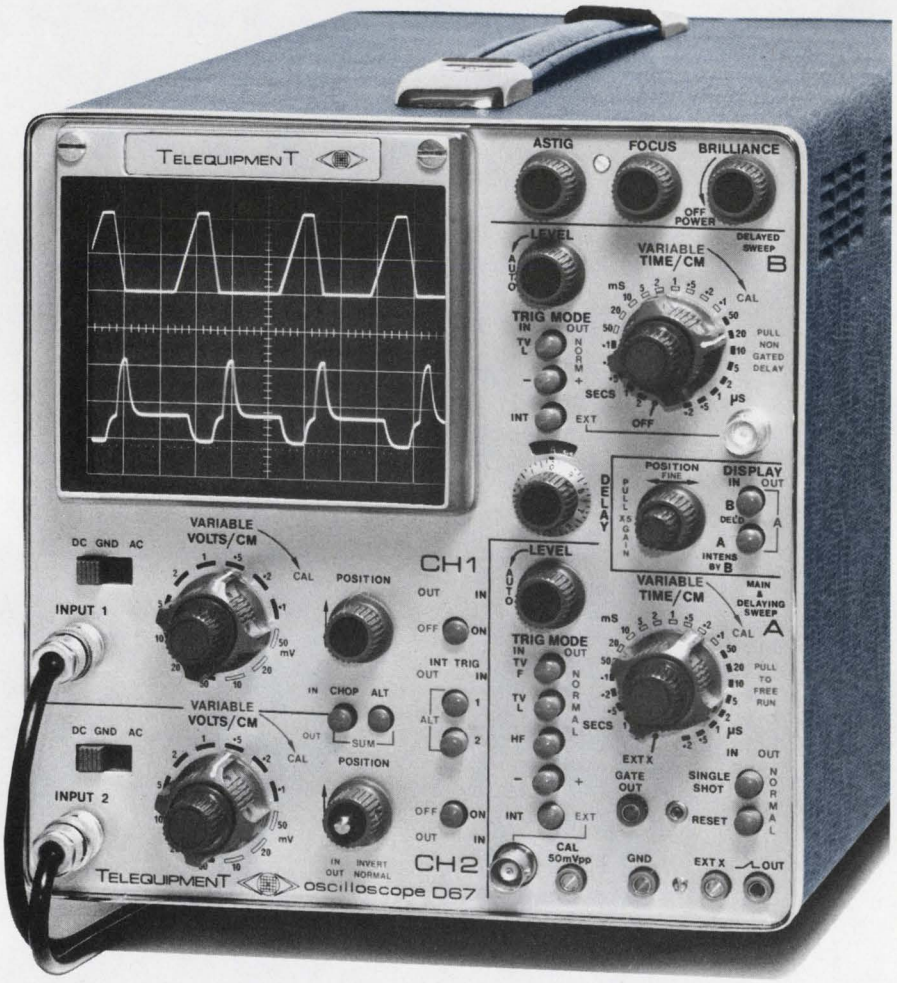
10-mV SENSITIVITY

DUAL TRACE &

SIGNAL DELAY LINE

ALL FOR ONLY .....

$975



The new Telequipment D67 Oscilloscope offers the performance you have always desired at a price that is several hundred dollars lower than any other comparable model.

In addition to its impressive array of specifications, the D67 has other features not usually found in low-priced scopes: regulated power supplies, FET inputs to keep vertical trace drift to a minimum, fully solid-state design to improve reliability, transistors in sockets to make servicing easier and faster.

Bright displays are obtained by using 10-kV high voltage on the rectangular 5-inch CRT which has a big 8 x 10 cm display area.

A wide range of sweep rates from 2 s/cm to 0.2 μs/cm (40 ns with X5 magnifier), delayed sweep, 3% accuracy and 14-ns risetime, make the D67 ideal for high resolution analysis of pulse sequences. And if some of the pulses are jittery, that won't be a problem because the delayed sweep can be triggered. Those who have a need to view television signals will be pleased with the D67's ability to trigger at TV field and line rates. This feature allows viewing a selected line in a field.

Even if portability is not a prime consideration, you are certain to like the D67's lightweight—it weighs only 25 lbs.

Telequipment Oscilloscopes are marketed and supported in the U.S. through the Tektronix network of 57 Field Offices and 30 Service Centers. The instruments are warranted against defective parts and workmanship for one year. For more information call your nearby Tektronix field engineer or write: P. O. Box 500, Beaverton, Oregon 97005.

Telequipment Oscilloscope prices start as low as $245.

U.S. Sales Prices FOB Beaverton, Oregon

TELEQUIPMENT ..... a subsidiary of TEKTRONIX®

INFORMATION RETRIEVAL NUMBER 9

INFORMATION RETRIEVAL NUMBER 10 ►

Until today, you put high value components on cheaper epoxy boards taking a chance with their costly 10% failure rate.

Now you can specify General Electric's new GEMON L Polyimide Prepreg for your boards and save. Both dollars and customers. That's the bread board idea.

You see, M/L boards of GE's GEMON L Polyimide Prepreg are so reliable they suddenly make epoxy boards expensive. For example, they're twice as dimensionally stable as epoxy. So you have no ruptured plating after temperature cycling. No blistering. No delamination. And no outgassing at 500°F solder bath temperatures. Perfect for your high component density designs.

Laminates made from GEMON L Polyimide Prepregs exhibit less warpage than epoxy for easier automated assembly. They process as easy as epoxies at 350°F and 200 psi.

And since GEMON L is a thermosetting resin, 150°F more stable than epoxy, it eliminates smear. No chemical etchback required.

How's this for class? GEMON L meets NEMA FR-4, -5, G-7, -10 and -11. And comparable MIL P 13949D and 55617A classifications.

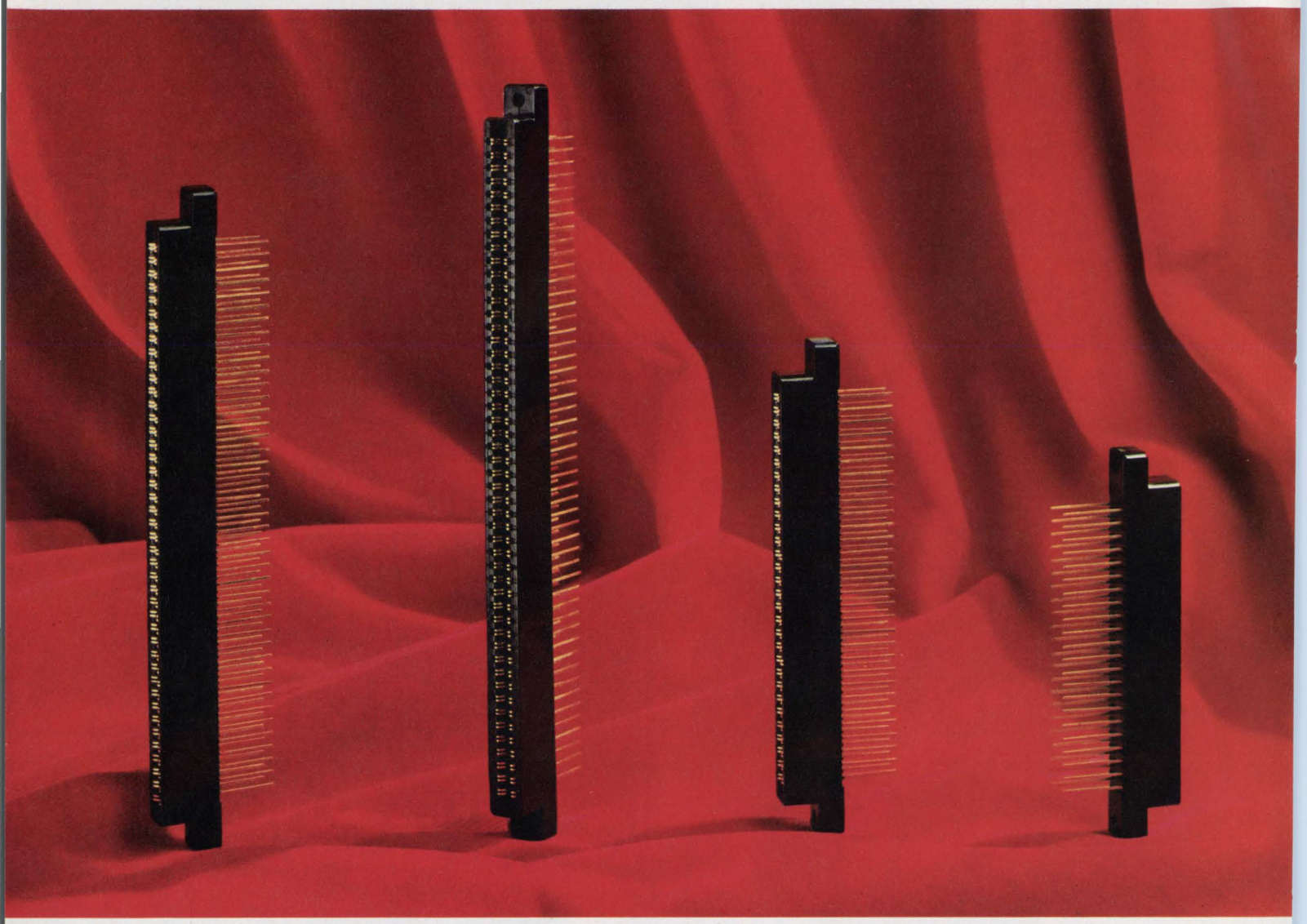
Let's talk about new GEMON L. Just write General Electric Company, Insulating Materials Department, Composites Operation, 1 Campbell Road, Schenectady, New York 12306. 846-56

GENERAL ELECTRIC

New GEMON® L Polyimide Prepregs cut multilayer board scrap loss by 50% or more

THE BREAD BOARD

A new cost-saver...



to wrap your wires around.

Here's a new family of miniature pc connectors from Amphenol for wire wrapping applications. They cost you less because we've engineered new industrial grade materials into these connectors, yet retained all the same features found in military connectors.

Contact spacing is on a .100 X .200, or .125 X .250 grid and the connectors are available in 22-, 30-, 43- and 50-position models with either grid spacing.

These new 225 Series connectors have bifurcated bellows contacts for smooth, positive, 2-point mating action no matter how irregular the board surface. The bellows exert firm pressure on the pads even under extreme vibration and shock conditions. You get thousands of insertions and withdrawals without a failure.

We can also give you this new low-cost connector with solder terminations on .156 centers. And there's a QPL version to MIL-C-21097B, too.

Call your Amphenol salesman or distributor; he'll show how inexpensive it is to wrap your wires around a great connector. Or write us. Amphenol Industrial Division, The Bunker-Ramo Corporation, 1830 South 54th Avenue, Chicago, Illinois 60650.

BUNKER RAMO AMPHENOL

designer's calendar

JUNE 1971						
S	M	T	W	T	F	S
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6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

June 2-4

Conference on Laser Engineering & Applications (Washington, D. C.) Sponsors: IEEE et al. D. E. Caddes, Sylvania Elec. Systems, Electro-Optics Div., Mountain View, Calif. 94040.

CIRCLE NO. 413

June 14-16

International Conference on Communications (Montreal, Quebec, Canada). Sponsor: IEEE. W. C. Benger, Northern Elec. Co., Ltd., POB 3511, Station C, Ottawa 3, Ontario, Canada.

CIRCLE NO. 414

June 27-30

Consumer Electronics Show (Chicago). Sponsor: EIA. Alfred L. Perkins, Harshe-Rotman & Druck, Inc., 108 N. State St., Chicago, Ill. 60602.

CIRCLE NO. 415

JULY 1971						
S	M	T	W	T	F	S
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18	19	20	21	22	23	24
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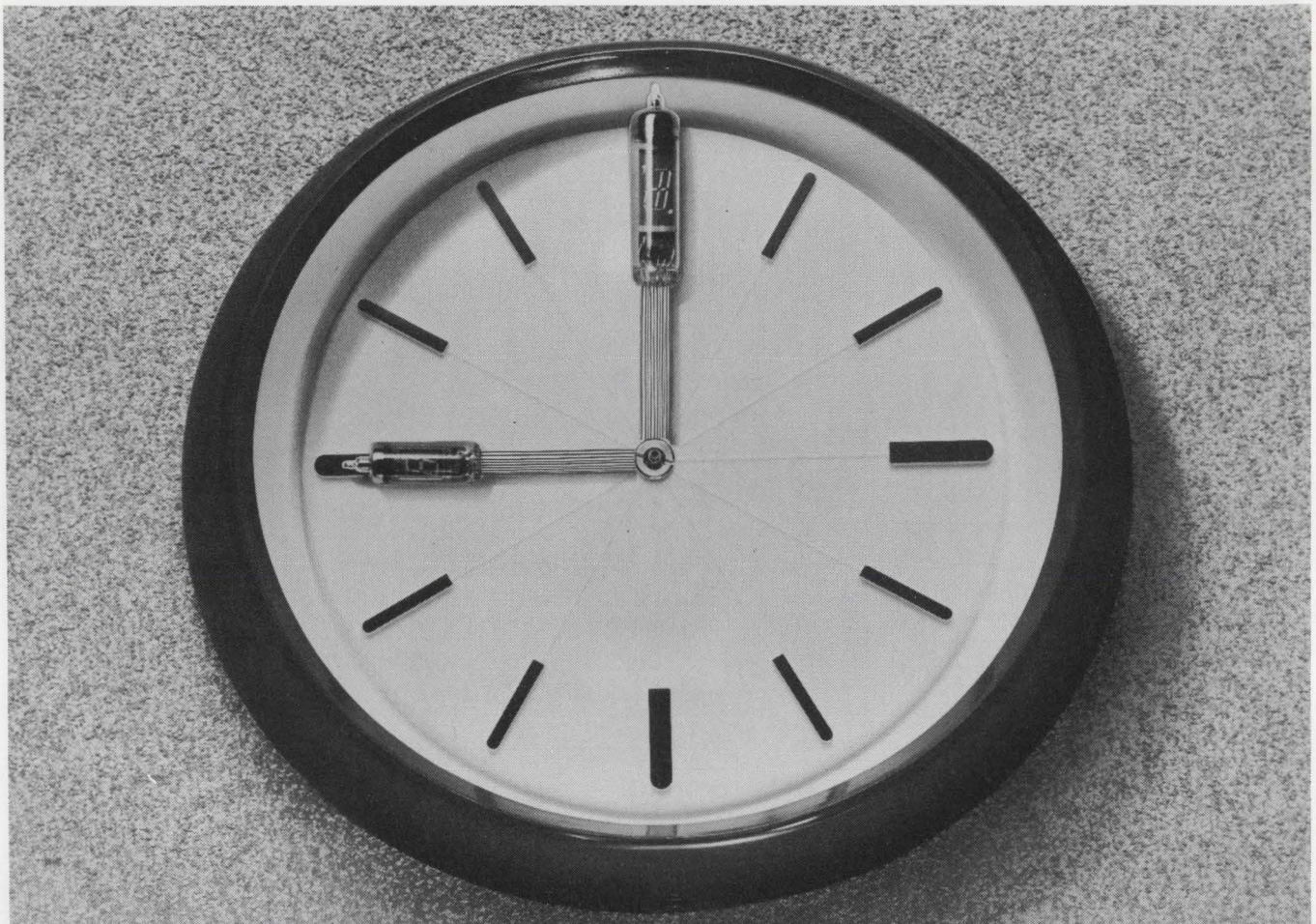
July 13-15

International Symposium on Electromagnetic Compatibility (Philadelphia). Sponsor: IEEE. Ralph Showers, Moore School of EE, Univ. of Pennsylvania, Philadelphia, Pa. 19104.

CIRCLE NO. 416



IT'S TIME···
TO SEE THINGS IN A NEW LIGHT

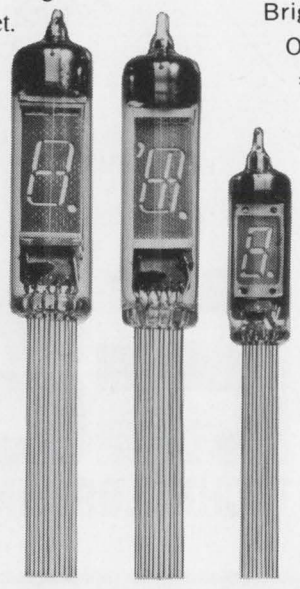
When multi-faceted display problems dictate 9 to 9 work days, it's high time you saw things in a new light, on a single plane with no "dancing" digits and with no eye strain.

Legi DG 12C numerical indicator tube segments are an eye-easy phosphor green for a readout as bright and clear as day, legible at distances over 35 feet. These tubes offer low-voltage, low current drain, and high stability advantages so definitive and pack a performance punch so large, you can't afford not to afford to examine full particulars. They fit to the "T" perfectly portable and circuit-board mounting applications and are available at mass production prices. Look at these important particulars, then write for comprehensive data that show display tube performance in an entirely new light:

LEGI DG 12C

Filament voltage at 95 mA ..... 0.85 volts ± 10%
Phosphor segments & control grid ..... 20 Vdc
Brightness ..... 80 foot-lamberts
Operating temperature ..... −10° to +70° C
* Dynamic life expectancy ..... 200,000 hrs.

U.S. PATENT 3508101



DG 12H DG 10A

Legi Sole U.S. Distributor:

Legi Electronics Corporation

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Phone: RE 3-4508, 733-9105

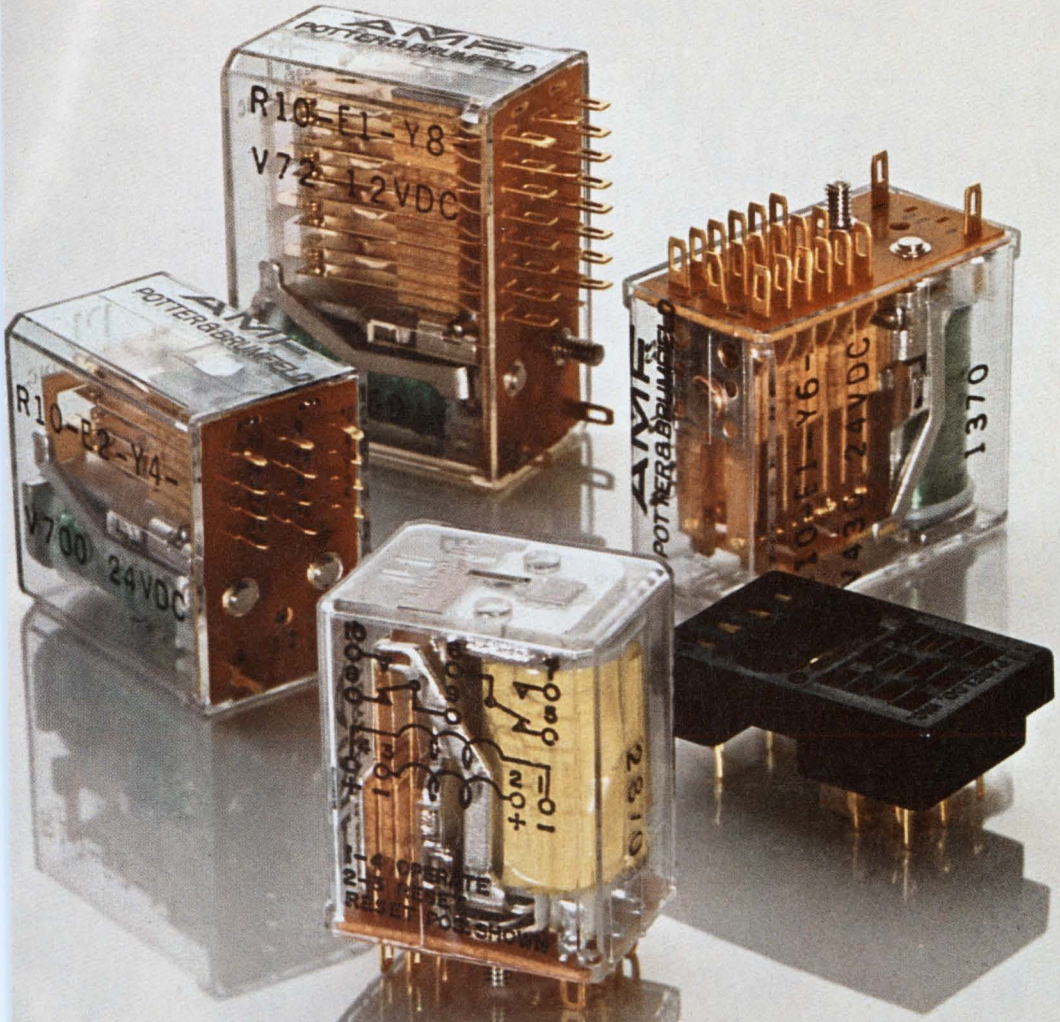
ISE Manufacturer:

Ise Electronics Corporation

P.O. Box 46, Ise City Mie Pref., Japan Phone: Mie (059627)-26

INFORMATION RETRIEVAL NUMBER 13

INFORMATION RETRIEVAL NUMBER 14 ►



R10: Our compact, multi-purpose relay.

You might say P&B designed it to be many things to many people.

Copiers, computer peripherals, business machines, precision instruments—you'll find our R10 in a multitude of applications requiring a compact, reliable, multi-pole relay. That's because it probably gives you more design options than any other single relay.

Consider these choices: Contact arrangements up to 8PDT. Ratings from dry circuit to 10 amperes. Six styles of contacts, including bifurcated. Sockets with solder or printed circuit terminals including one for mounting the relay horizontal to a printed circuit board—all with or without grounding provisions.

Mechanical life up to 100 million operations. Electrical life ranges from 100,000 to 100 million operations depending on load and voltage. Coils for DC operation from 3.0V to 115V can be supplied. AC-operated R10 relays to 2 Form C are also available. R10 relays have Underwriters' Laboratories' Component Recognition, File 42810.

The single lot price for a 4PDT, 2 amperes R10 relay is only $3.60. Quantity discounts apply.

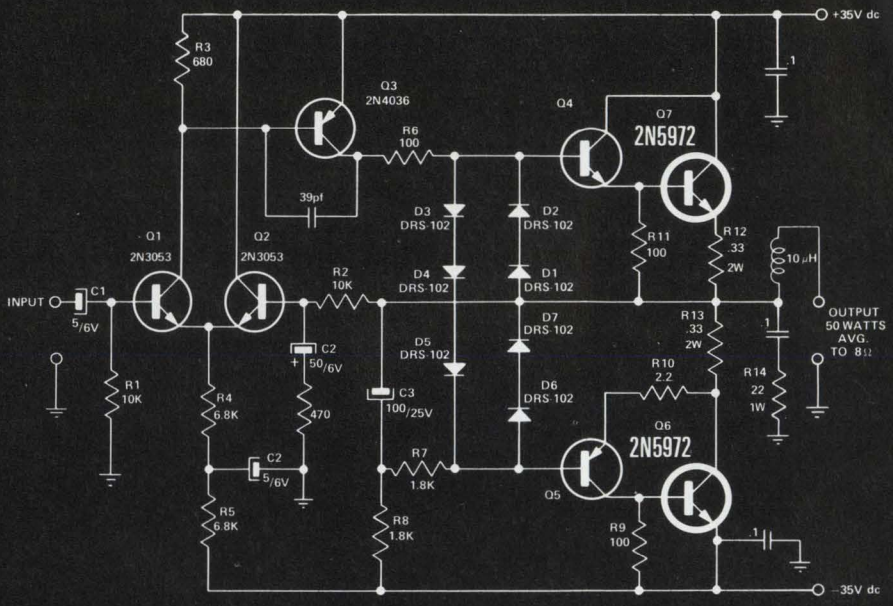
Order R10 relays from leading electronic parts distributors or call your P&B representative. For a complete, 194-page relay catalog, write Potter & Brumfield Division of AMF Incorporated, Princeton, Indiana 47570. Telephone: (812) 385-5251.

AMF
POTTER & BRUMFIELD

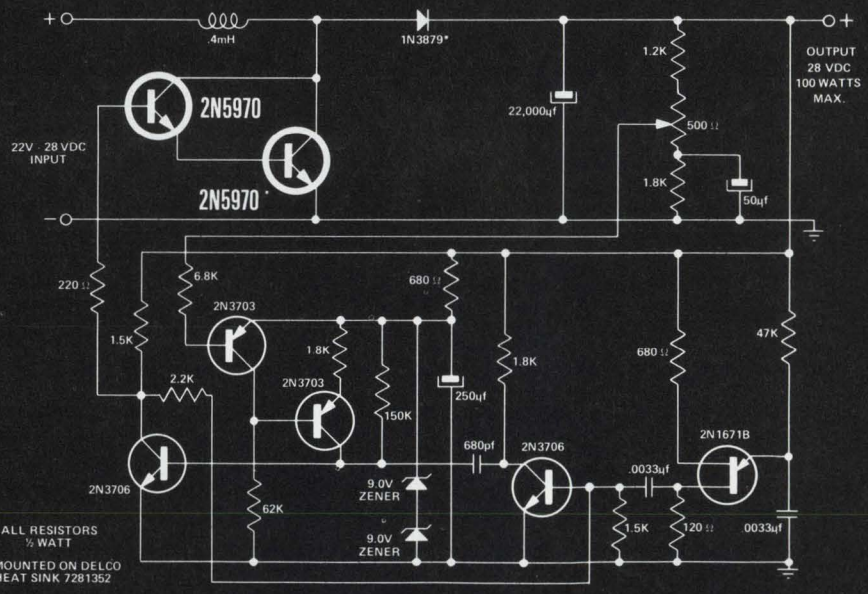
P&B performance. Nothing else comes close.

High Energy Silicon for the 70's.

For Audio Amplification.



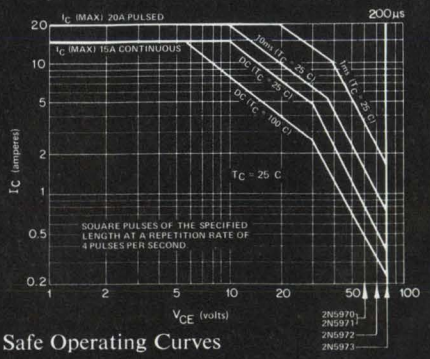
For Switching.



TYPE	I_C Cont. Amps.	I_C Pulsed Amps.	V_{CEO} Volts	V_{CEX} Volts	$V_{CEO}(sus)$ Volts	h_{FE}(min.) @ I_C=5A	h_{FE}(min.) @ I_C=15A	V_{CE}(sat.) Volts @ I_C=10A, I_B=1A
2N5970	15	20	60	80	60	20	10	2.0
2N5971	15	20	60	80	60	50	20	1.5
2N5972	15	20	80	100	70	25	10	1.8
2N5973	15	20	100	120	80	25	10	1.8

Pulse Energy Test — @ V_{CE}=40V, I_C=4.5A, t_p=10 ms, duty cycle ≤ 4% ALL TYPES=1.8 Joules

NPN Triple diffused silicon power transistors in TO-3 Solid Copper cases.



Safe Operating Curves

Delco's New 2N5970 Series Transistors: 15 Ampere, Medium Voltage Fast, Versatile, Strong.

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Application Notes 42 and 43 provide the data on the circuits.

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DIVISION OF GENERAL MOTORS CORPORATION, KOKOMO, INDIANA

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INFORMATION RETRIEVAL NUMBER 15

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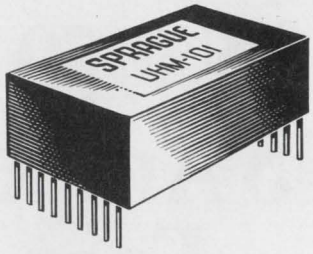

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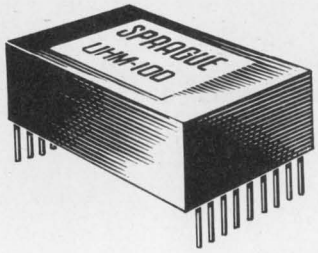

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These systems convert a binary input into a pulse whose ratio of on time to period is proportioned to the input word. This pulse can then be averaged out to a d-c level.

Extremely versatile, these systems can be used in servo mechanisms, D/A testers, plotters, and other low to medium speed, high accuracy applications.

For the name of your nearest stocking distributor, call or write to Bill Campbell or Bill O'Connor, Functional Electronic Circuits Operations, Sprague Electric Co., 115 Northeast Cutoff, Worcester, Mass. 01606. Telephone 617-853-5000, Ext. 314, 270, or 313.

For Engineering Bulletins 29,040 and 29,041, write to Technical Literature Service, Sprague Electric Co., 347 Marshall Street, North Adams, Massachusetts 01247.

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INFORMATION RETRIEVAL NUMBER 16

news scope

APRIL 29, 1971

Commerce Dept. predicts happy days through '80

The U. S. Dept. of Commerce says the electronics industry's economic decline has just about halted and business should pick up through 1980. In an optimistic forecast, "U. S. Industrial Outlook, 1971," the department sees shipments for 1971 totaling $23.9-billion, up 6% over 1970. By 1975, it says, this figure should hit $31.2-billion, and by 1980, $44.3-billion. This would mean a growth rate for the 10-year period of 7%.

Projected increases in specific categories include the following:

- Consumer shipments will rise 6% in 1971 to slightly more than $3.5-billion. A total of $145-million of these shipments will be to foreign customers, partly compensating for the decrease posted in 1970, when exports dropped 7% below the 1969 total of $140-million.
- Approximately 5.2 million color television receivers will be shipped in 1971, compared with nearly 4.8 million in 1970.
- Telephone and telegraph equipment will bring in $4.32-billion in 1971, an increase of 8% over the $4.06-billion estimated for 1970. This expansion will continue at a rate of 8% a year to reach $6.4-billion in 1975. By the end of the decade, shipments will amount to $10.4-billion.
- Electronic component shipments will rise 3% in 1971 to $6.28-billion. By 1975 component shipments may reach $7.1-billion, and by 1980, $8.1-billion.
- Electronic exports will hit $1.6-billion, with imports at $590-million, by 1980, making a favorable trade balance of over $1-billion.

The report is on sale at $5 a copy from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

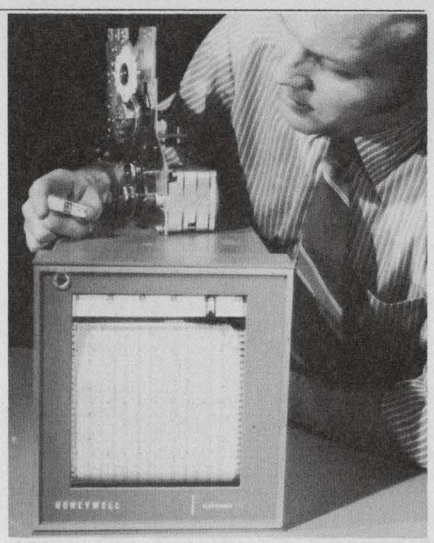
LSI replaces gears in process instrument

Described as the first use of LSI in an industrial process instrument, a single MOS LSI chip performs the timing and provides the programming logic in a new line of servoed, self-balancing potentiometers, or recorders.

Developed by Honeywell's Industrial Div., Fort Washington, Pa., the chip replaces a mechanical timing mechanism that contains gears, levers, cams and pulleys, according to Thomas R. Sergeant, division marketing manager.

"The mechanical device required a lot of maintenance," says Sergeant.

"It had a mean time between failure (MTBF) of between 5000 and 10,000 hours. The chip has a predicted MTBF of 150,000 hours."



LSI package held by Honeywell engineer replaces the mechanical assembly shown on top of the process recorder case.

The chip is packaged in a ceramic 40-pin, dual-in-line package designed by Honeywell's Industrial Div. in connection with other divisions. It contains the equivalent of more than 600 discrete components and performs all the functions necessary to time, advance and trigger operations of the printing solenoids of the multipoint recorders. The device also provides the impulse for stepping the selector switch and assures synchronization of the print head. Five recording formats are selected by a rotary switch that is used along with the chip.

Another unique feature of the multipoint recorders is a fiber optic light pipe that transmits and digitally displays the point identification of the operating channel. This number, illuminated, appears at the upper left front of the recorder door.

System lets doctors see human heart in action

A doctor can now watch a three-dimensional movie of a patient's heartbeat. He can, in a sense, "walk around the heart," viewing it from any angle he likes. He can examine dead spots or scar tissue in the heart wall, aneurysms (bubble-like projections of the heart muscle), and any other malfunctions. If he likes, he can stop the display at any point of heart expansion or contraction and play the picture back.

An electronic system manages to accomplish all this by combining the capabilities of X-ray movies and a computer that is stored with the results of extensive research in heart configurations and dimensions. The system has been developed and is being refined by scientists and doctors from the National Aeronautics and Space Administration's Ames Research Center, Mountain View, Calif., and the Cardiology Div. of Stanford University Medical Center, Palo Alto, Calif.

To prepare a movie, X-ray contrast dye is injected into the particular heart chamber of the patient that the doctor wants to examine. Two two-dimensional X-ray movies are then taken at right angles to each other at 60 frames per second.

The entire sequence of movie frames, each containing the heart

chamber outline, is traced on a computer input screen and retained in the computer memory. The computer program then mathematically constructs a three-dimensional image that is also stored in the computer memory for analysis and display. The result is seen in lines of light on a computer display screen, similar to a television screen.

The system's animated display is exact enough to show dead sections of the heart wall about the size of a nickel (two centimeters), details of large malfunctions and holes between heart chambers.

Since the animated displays are a form of computer readout, they can be transmitted to doctors at distant points by telephone line and recreated on a computer display screen.

Costs are coming down for low-voltage CMOS

Would you believe an electronic wristwatch accurate to within five seconds a year for only $30? It's a possibility, some manufacturers are saying, because custom LSI circuits using CMOS technology and operating off power supplies of 1.2 to 1.4 V can now be built as cheaply as CMOS designed for 3 V and higher.

Although 1.3-V CMOS has been available in the past from several sources, it has been more costly to manufacture than the higher voltage types (see "With the Price Right, CMOS Is Headed for New Applications," ED 8, April 15, 1971, p. 32). This is because of difficulty in setting n and p-channel threshold levels with great precision.

Developments at the Hughes Aircraft Co. Semiconductor Div. in Newport Beach, Calif., and Intersil, Inc., in Cupertino, Calif., are leading the way to such products as highly accurate electronic wristwatches that, according to one Intersil spokesman, will sell for about $30 in about five years.

Hughes has achieved low-cost CMOS at a minimum supply voltage of 1.2 V, with aluminum gates, through the use of ion-implantation technology. According to Carroll Perkins, assistant marketing manager at Hughes: "With our technology, we can set the n and p-channel thresholds at 0.6 V with great precision. This is the ideal case for 1.2-V operation."

Perkins notes further: "If we went to self-aligned gates and ion-implanted junctions, rather than aluminum gates and diffused junctions, we could increase our circuit density by from three to four times and our speed performance by a factor of five."

When very low supply voltages were desired in the past, back bias was frequently introduced to set the n-channel threshold at the proper level.

Intersil says it has solved this problem. David Bingham, manager of low power devices, points out that the company has developed a technique of doping that allows extremely precise setting of the threshold levels. However, with the Intersil method, aluminum gate technology can be used down to only 1.3 V. To achieve 1.2 V, silicon-gate technology becomes necessary.

Small mercury batteries of the type designed for wristwatches put out 1.2 V. Circuits requiring 1.3 to 1.4 V call for silver-oxide batteries. There is considerable disagreement in the industry as to whether mercury or silver-oxide batteries are better in small battery-driven applications.

A great tape developed; All it needs is a machine

What comes first, the tape or the recorder? According to Graham Magnetics, Inc., of Graham, Tex., the answer is the tape. The 3M Co. in St. Paul, Minn., on the other hand, feels that the machine takes precedence.

Graham has just announced development of a new high-energy magnetic material that, it claims, allows an increase of at least 400% in the recording densities of magnetic recording tapes. Called Cobaloy, the material differs from conventional tape coatings in that it is a metal alloy—not an oxide.

Cobaloy has a coercive force of 1000 oersteds and a saturation magnetization of 980 EMU/cc. This compares with 300 oersteds and 389 EMU/cc for gamma iron oxide—the most common tape coating in use today.

But the trouble with Cobaloy tapes is that very few machines today can use them effectively. The tapes provide longer playing time and improved S/N ratio only when used with new or modified machines that have the tape speed, bias level and head design that are optimum for the new material. Graham believes that developing the new tape was the best way to get the new machines built.

At 3M a different philosophy prevails. 3M's new cobalt-doped iron oxide tapes (see "New Oxide Boosts Tape Output and Clarity," ED 8, April 15, 1971, p. 35) were developed especially for compatibility with existing machines. They have a coercive force of about 500 oersteds and a saturation magnetization of about 350 EMU/cc. According to a 3M spokesman, Clark Duffey, the company's new tapes can be supplied with any coercive force up to 1000 oersteds. The company hasn't made a big issue of its ability to produce 1000-oersted tape, he says, simply because there seems to be no demand for it.

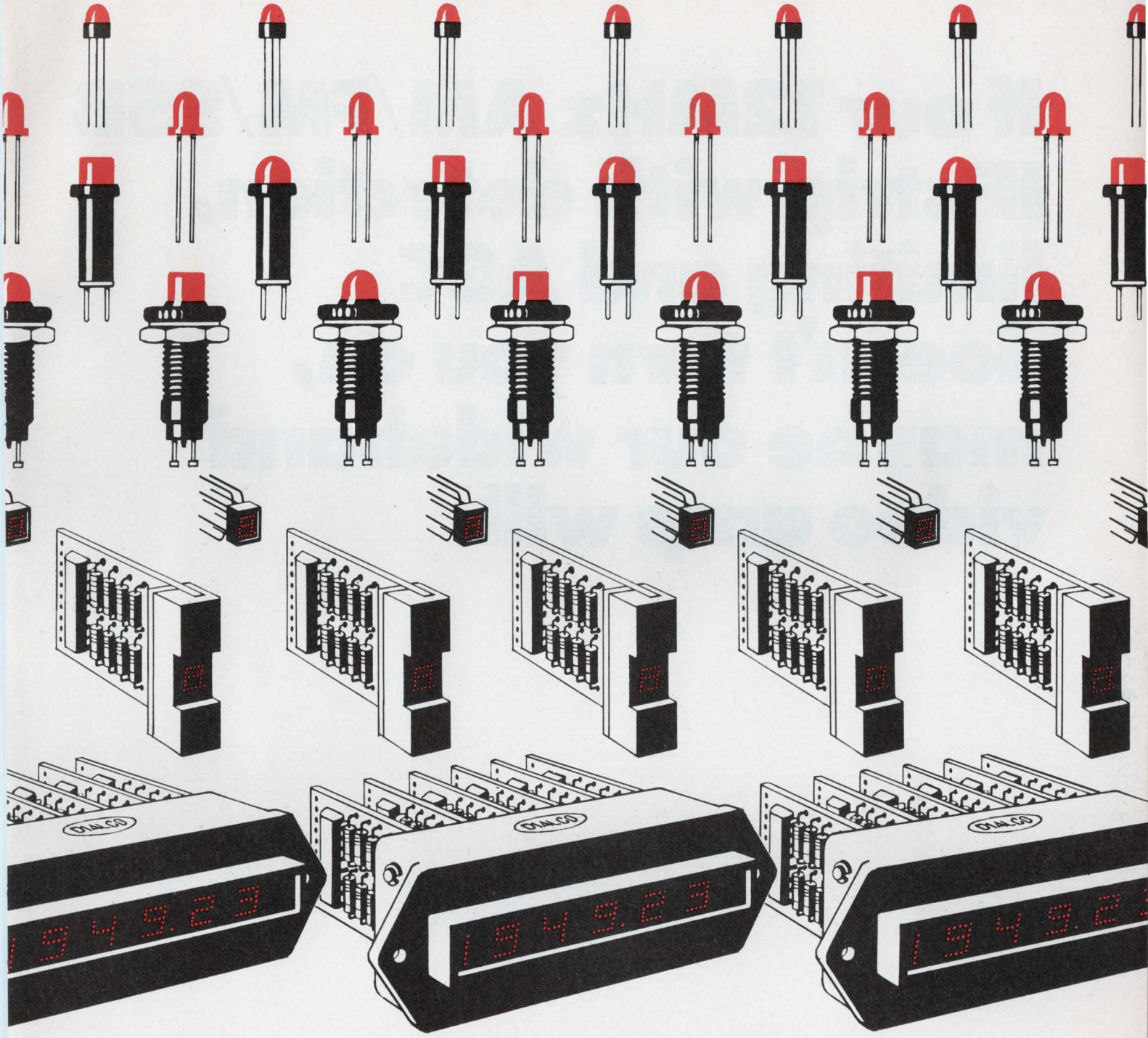
Chrome photomasks in mass production

Chrome photomasks are now being mass-produced for the integrated-circuit industry. Formerly they were made only for custom high-cost, high-reliability jobs. In mass production, most companies have used emulsion photomasks.

Bell & Howell Co., Pasadena, Calif., is making the chrome photomasks in quantity, and it credits "improved chemical processing" and automated techniques, for its success.

Robert D. Burr, product manager in the Electronic Materials Div. of Bell & Howell, says: "Whereas an emulsion mask might be typically used for 10 exposures, a chrome mask will last about 150 exposures. In addition the typical defect level in emulsion masks is 10 to 15%, but in chrome masks it is below 5%."

Typical defects in masks include pinholes, scratches and opaque spots. A lower defect level means higher yields and therefore lower costs.



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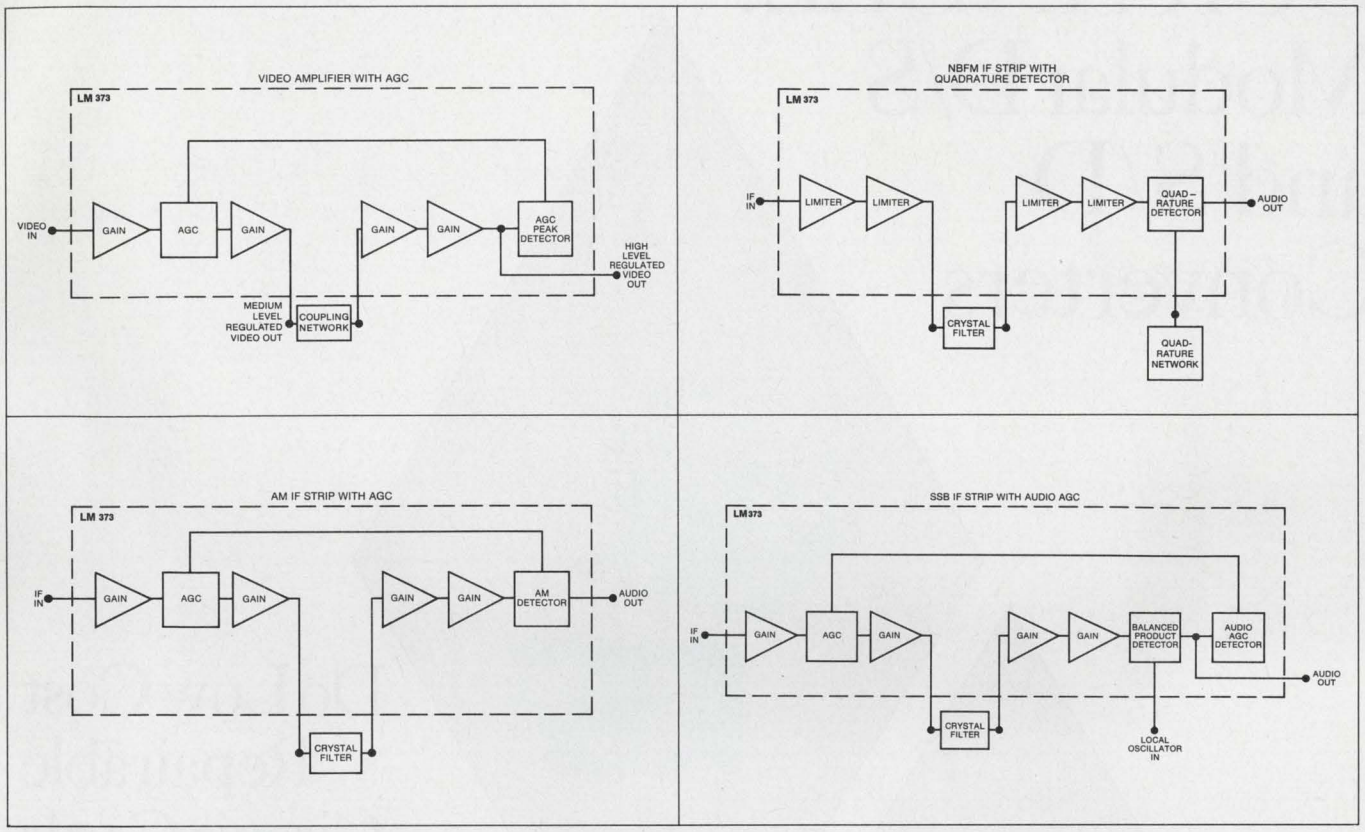

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For data sheet and application details, write or call National Semiconductor, 2900 Semiconductor Drive, Santa Clara, California 95051. Phone (408) 732-5000 TWX: (910) 339-9240. Cable: NATSEMICON.

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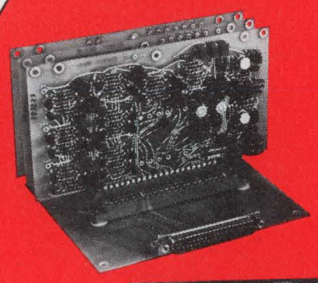
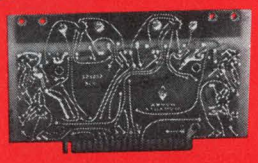
INFORMATION RETRIEVAL NUMBER 18

OUR ANGLE: Modular D/S and S/D Converters





Do Low Cost Repairable Circuit Cards Make Sense from Your Angle?

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These new converters are available to meet a wide range of systems needs. The 701 D/S has selectable accuracies of 9 or 12 bits with resolution of 8 through 14 bits, transformer output isolation and short circuit protection, operation at 60 Hz or 400 Hz with 1VA or 10VA output. The 711 S/D has 0.05° accuracy, 13 bit resolution with input transformer isolation, and continuously tracks 400 Hz synchro data to 1000°/second.

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INFORMATION RETRIEVAL NUMBER 19

Digital design gets a star role in solving television problems

Digital technology—from multiplexing to minicomputers—emerged at the recent National Association of Broadcasters Convention in Chicago as a prime cure for a gamut of problems in the television industry. Significant problems are found in remote sports pickups, automatic control of station operations and video tape editing.

For remote TV sports pickups, networks use field color cameras and standard cables that have 82 conductors and weigh one pound per foot. Golf matches use two or three mobile vans with as many as 16 cameras, each camera with up to 2000 feet of cable. The cable, because of its bulk and weight, needs a separate truck for transportation. For easier handling the cable is made up in 200-foot sections.

Last year LaVerne Pointer, director of broadcast engineering for the American Broadcasting Co., told ELECTRONIC DESIGN (see "Electronics Scores in Sports," ED 11, May 24, 1970, p. 41):

"A much smaller and lighter cable, possibly with the use of a multiplexing scheme or some other reliable method of camera-to-van transmission, is needed."

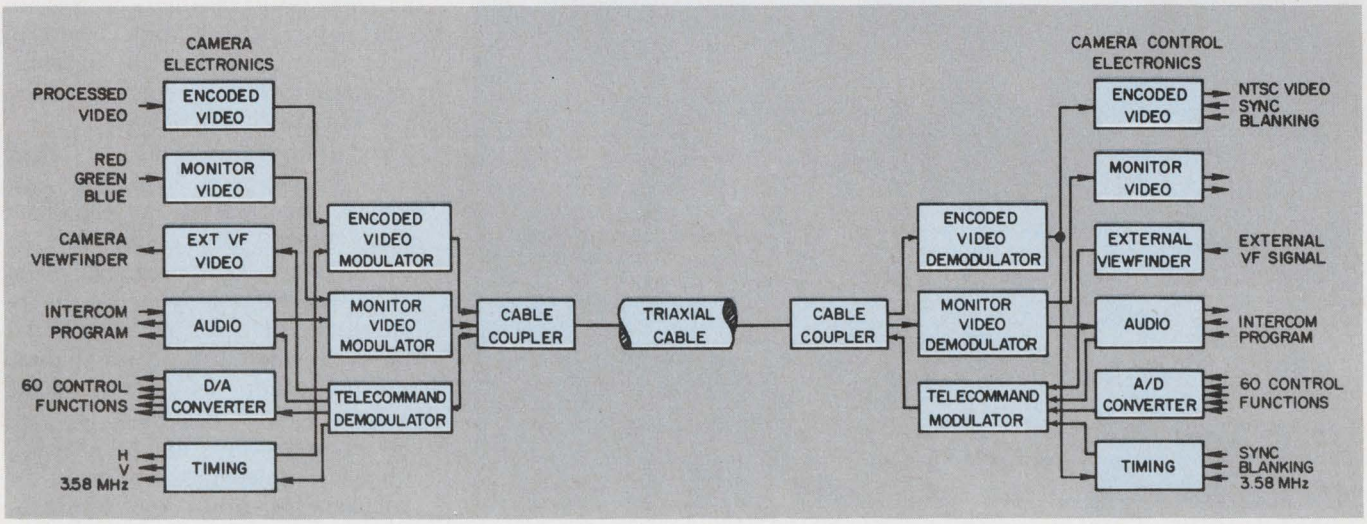
Jim McDermott
East Coast Editor

New design answers need

One answer to Pointer's comment was displayed at the broadcasters' convention: a digitally controlled camera that uses multiplexing techniques to transfer information between the remote camera and the van (or other) camera control centers. Multiple channels of data are multiplexed onto a three-eighth-inch triaxial cable (it has a center conductor and two concentric, individually insulated shields.) The new cable weighs less than 1/10th what the cable with 82 conductors does and at 75 cents a foot, it costs about 1/25th as much.

Under development for the past three and a half years by the Philips Broadcast Equipment Corp., Montvale, N. J., a division of North American Philips, the Norelco PC-110A camera is the first fully digital camera to be marketed in the U. S. John S. Auld, president of Philips Broadcast Equipment, noted that whereas 5000 feet of standard 82-conductor cable weighs over 4000 pounds, the same length of triaxial cable is only 333 pounds.

In commenting on this new development, ABC's Pointer told ELECTRONIC DESIGN that one cost advantage to the networks would be in cable repair. Triaxial cable connectors can be changed in a few minutes, he noted, while it requires one man-day to replace the 82-connector cable. Another big saving with the smaller, lighter cable will come in manpower and transportation costs. One thousand feet of triaxial cable can be reeled



1. **Transfer of information between a remote color-TV camera and a field or studio control station** is effected by this multiplex system, by Philips. The system uses lightweight, triaxial cable to carry some 60 control functions and other video and audio signals, as well as camera monitoring information.

on a three-foot cable drum.

For the camera system itself, three basic channels of data are multiplexed between the center in the van and camera-head electronics (Fig. 1). These channels are:

- A command channel to transmit operating, registration and set-up signals from the control center to the camera.
- A video channel to send encoded video from the camera to the control center.
- A monitor channel to send monitor signals in the video processing chain to the control center.

The command-channel control system consists of an analog-to-digital converter at the camera control site plus digital-to-analog converters in the camera electronics. The control data is transmitted in eight-bit digital form, and each function is sampled four times for each camera field, or 240 times a second.

For the video channel, the video electronics produces an encoded signal that modulates a 27-MHz subcarrier. For horizontal sweep timing, a pulse is inserted in the video blanking interval. This horizontal timing pulse is extracted at the camera control station and compared with the studio horizontal sync signal.

For monitoring purposes, camera video signals are picked off at critical points in the camera chain by a video switcher that is controlled through the data control link. During the blanking interval, intercom signals are applied to a pulse-width modulator, whose output is added to the monitor video.

Vhf stations go remote

The recent announcement by the Federal Communications Commission permitting remote control of the nation's 503 commercial and 200 noncommercial vhf TV stations, starting April 30, stirred interest at the broadcasters' convention in computer-controlled automation systems. They could be adapted for partial or fully automatic station operation.

The Chrono-Log Corp. of Broomwall, Pa., demonstrated an all-solid-state digital system designed to automate the most critical and potentially profitable on-the-air period—the station break. During this brief time, a station's technical director performs many switching functions rapidly and, hopefully, precisely. At a commercial station, switching errors result in advertising revenue losses besides disrupting broadcasts.

Arthur Freilich, Chrono-Log's president, explained that one problem a station operator had with some systems of this nature was learning a specialized program.

To avoid this, the Chrono-Log system was designed so that the five to seven technical operations that normally occur during a station break are programmed visually. This is done by insertion of pins through a paper template on a pinboard that can handle up to 16 station operations. For example, during a station break the programmed pinboard of the Chrono-Log system controls:

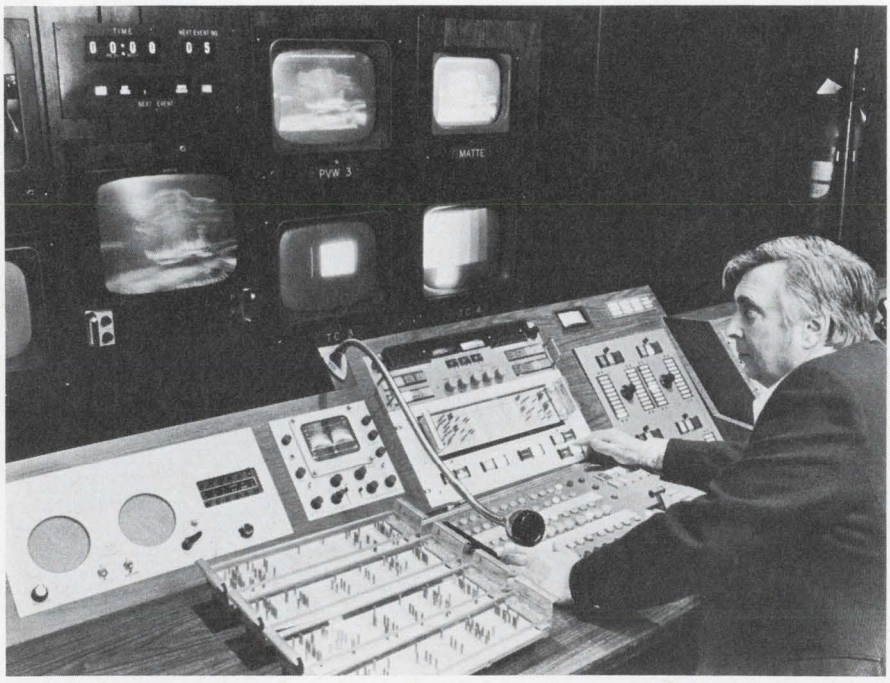
- The starting and stopping of film projects and video tape machines.
- Video audio switching.
- Sequences of film slides.
- Fades, wipes, superimpositions or lap-dissolve video transitions.
- Return of the video and audio to the network or other program source at the end of the break.

Station automation appears

Control of all studio operations with 80-column IBM data cards was demonstrated by the General Electric Visual Communication Products Dept., Syracuse, N. Y. The GE BAC-100 system, as it is called, uses GE's PAC-30 minicomputer, with a capacity of 60-K characters of core memory. Only 16-K characters were used for the demonstration setup at the broadcasters' show.

G. F. Eustis, GE project engineer, explained that the system had a closed-loop subsystem that made corrections, enabling it to put the right program input on the air even before the station operator could sense an error. The automation system can also correct a fade or a wipe that is in error.

A Digital Equipment Corp. PDP-18 computer, with an 8-K memory, was featured at the show by the Grass Valley Group, Inc., of Grass Valley, Calif., as the basis for a building-block approach to full station automation. Dr. Donal Hare, president of Grass Valley, indicated that while the basic equipment was designed to provide error-free station breaks and automatic teleprinter logging of programs to fulfill the FCC requirements, it could be expanded to provide for data used by the station's other departments.



A large number of switching operations must be performed with split-second timing during TV station-breaks. To avoid mistakes, this Chrono-Log Corp. system uses programmed peg boards to control switching.

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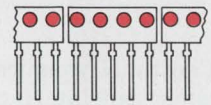
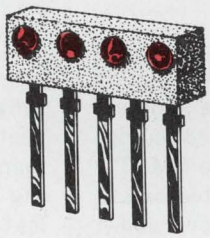


.10" Center to Center
Actual Size



The four-in-one MV5040

Four times the indicating ability for your diagnostic or panel light needs. The MV5040 is actually 4 LED's in one easy-to-handle, easy-to-mount package.

It is ideal for array mounting with .10 inches center-to-center when stacked end-to-end.

Brightness is a high 1,000 ft-L (typ.) and it features the same long life, small size and ruggedness you have grown to expect from Monsanto GaAsLite products.

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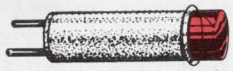

Plug an LED in your socket.

The Monsanto MV9000 series cartridge lamps will fit your indicator needs - from 4 to 30 volts. These long lasting LED's are mounted in a standard black aluminum case and are offered with red, green or amber clear plastic lenses.

The NEVER-REPLACE-REPLACEMENT features a projected life of 10^6 hours and requires only 10 to 50 milliamps to operate.

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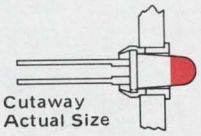

Cutaway
Actual Size

Panel indication is a SNAP - with the MV5020 Series

This series of four panel lights will fit right in to your 1/16 or 1/8 inch panel. They are available in four lens types and are supplied with a dual purpose snap-in clip for easy mounting. The MV5020 offers 750 ft-L (typ.) brightness. Plenty of light for most ambient conditions.

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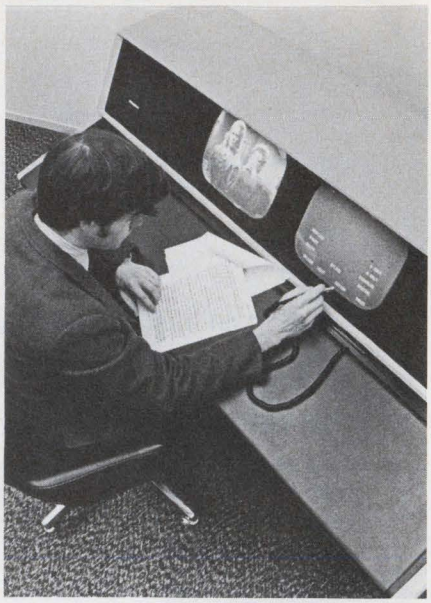
INFORMATION RETRIEVAL NUMBER 20

The latest advance in electronic editing of video tape is represented in these new time-code editing systems, from RCA. Each editing panel, the one on the left shown being operated, controls one tape machine.



Use of a light pen places edited scenes on a disc pack for storage in this CMX Systems tape editor.

Editing of magnetic tape video recordings—taking separate segments of action from one or more tapes and combining them into one master tape with smooth video and audio continuity—has been a difficult, time-consuming and costly procedure. It used to require at least two, and sometimes more, $100,000 "quadruplex" video tape recorders. In early editing setups, the editor ran the tape to be edited back and forth, studying the action in normal, fast or slow speeds, or even in still frames. But without some automatic means of identifying and stopping at precise points in the tape, smooth insertion of the edited portions onto the master tape was difficult.

An obvious solution for identifying the precise point desired on the tape was to record a BCD serial time code on the cue tracks of all tapes. But among the several manufacturers who did this work —Electronic Engineering Co. of California, Ampex, RCA, Datatron, and Central Dynamics, Ltd., of Canada—each had its own incompatible time code.

Standard time-code adopted

To avoid TV industry chaos, manufacturers and TV industry representatives met under the guidance for the Society of Motion Picture and Television Engineers, and last June an SMPTE standard 80-bit BCD time code was adopted.

New computer-controlled equipment designed around the SMPTE time code was demonstrated or announced at the broadcasters' show. A time-code editing system, designed for RCA by the Electronic Engineering Co. of California, Santa Ana, uses a panel-operated Unit Programmer for master control of the editing functions. Designed for use with a single, twin-reel tape machine (see photo), the system computer stores up to four 26-bit words in a semiconductor memory.

According to Ronald E. Taylor, electronic engineer at Electronic Engineering, the system records the time of day down to a single frame. Using this data, the operator can command the system to search for a scene and stop. Control is through switches on the Unit Programmer panel.

Another new editing system using the SMPTE code and capable of controlling several tape machines was demonstrated by Central Dynamics, Ltd., Pointe Claire, Montreal, Quebec. The system, placed in a master control console, uses a Data General Nova 1200 minicomputer.

The computer is teamed with a dynamic, interactive CRT display that uses a light pen to select all operating functions and to initiate control sequences. Kenneth P. Davies, manager of product planning for Central Dynamics, says that the system can interface with many types of equipment, including both expensive quadruplex and less costly helical video recorders, as well as audio recorders and live studio equipment.

Whereas the RCA and Central Dynamics equipment works directly with tapes, CBS and Memorex, through their CMX Systems venture in Sunnyvale, Calif., announced a new editing system that stores discrete video frames on computer disc packs. Although not displayed at the broadcasters' show, Kenneth I. Taylor, technical director of CMX Systems, said that the equipment separates the editor's decision and assembly process, in that he can select and store the material he wants on disc packs, and can also pick and store the eventual tape location identifications.

The system, controlled by a PDP-11 minicomputer, does not play back the disc-recorded material directly; instead it uses the disc storage to control the actual tape-to-tape editing. Operator control of the Memorex System is also through an interactive CRT display that uses a light pen.

Each disc pack stack is capable of storing up to five minutes of video data, and provisions are made in the system for using up to 12 packs for one hour of storage. ■■

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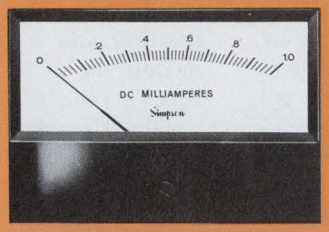

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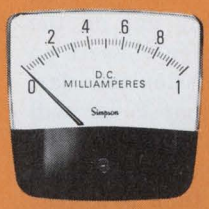

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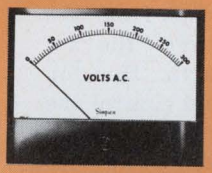
round style available



RUGGED SEAL
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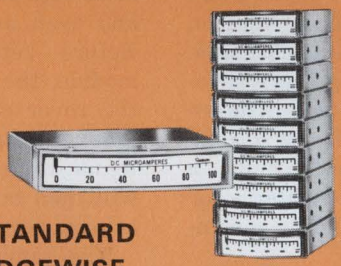

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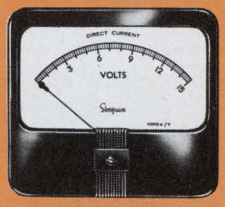

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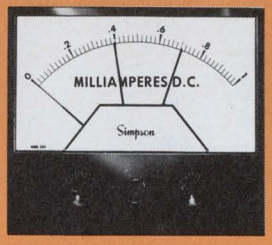

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A great TV show is lined up for that car trip on the moon

The Apollo 15 astronauts, scheduled to lift off for the moon on July 26, will probably put on the best show for television viewers on earth of any lunar mission thus far.

A four-wheeled lunar rover will enable both astronauts to explore the moon in style, covering 28 square miles—more than twice the area they could cover on foot—and it will permit them to carry a lot of equipment they couldn't carry on foot, including a color television camera. The camera will televise directly to earth the short walks they take out from the rover to explore and pick up rocks, and it will record their lift-off from the lunar module to rejoin the command module for the trip back to earth—an event not witnessed by television audiences before.

The TV camera will operate only when the rover is stationary and the antenna directed toward the earth.

Besides the TV camera, the rover will be equipped with a two-way voice and telemetry radio that will operate while the vehicle is moving; other cameras; a lunar drill to measure the temperature 10 feet below the surface; magnetometers and an automatic dead-reckoning navigation unit.

Powered by two 36-V silver zinc, nonrechargeable batteries, the rover will be able to make many sorties, up to a cumulative distance of 40 miles. No sortie will extend more than three miles from the lunar module, in case something should go wrong with the vehicle and the astronauts are forced to walk back.

The rover is about 10 feet 2 inches long, slightly more than 6 feet wide and 45 inches high. It has a 7.5-foot wheelbase. It weighs 480 pounds and can carry 1000 pounds (each astronaut with his life-support equipment weighs 400 pounds, and the scientific experiments, tools and lunar rocks will weigh 200 pounds). The vehicle's top speed is about eight miles an hour on a smooth surface.

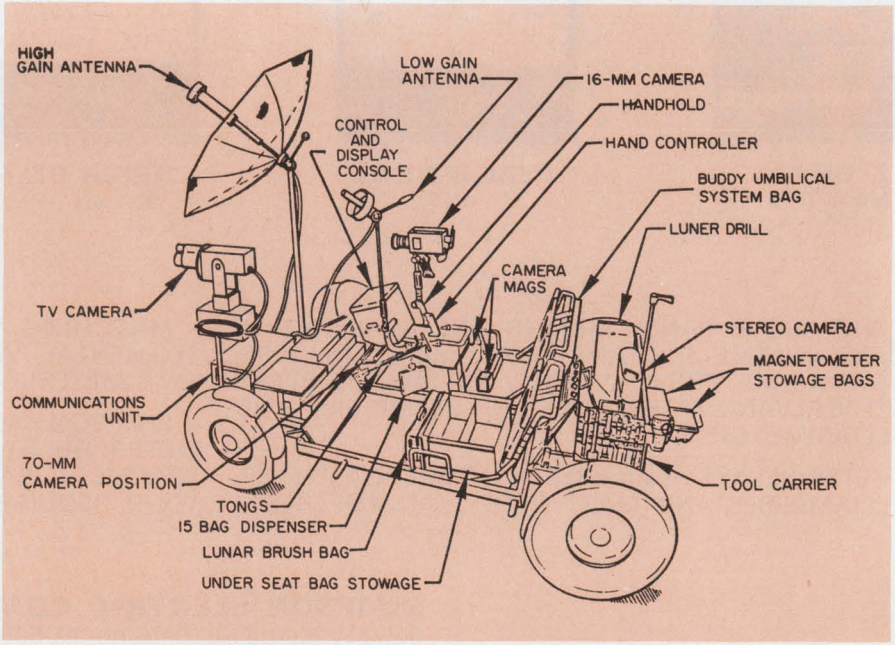
The dead-reckoning navigator consists of a directional gyroscope, which will be set up by alignment with the sun just prior to the start of an excursion, and odometers on each wheel that will transmit nine magnetic pulses during every revolution, to measure the distance traveled. There is also a signal processing unit—essentially a small solid-state computer for working navigation and trigonometry problems.

With the direction and distance traveled fed into the computer, all the navigational information the astronauts need to know will be displayed in dials on the rover's dashboard. The dials will show heading and distance to the lunar module at all times, as well as the rover's velocity.

The TV camera and the briefcase-sized communications set will be controlled by the Manned Spacecraft Center in Houston, Tex. Controllers there will turn the camera on and off, pan it around, raise and lower it, zoom in or out and even adjust the light control. Before returning to the lunar module, the astronauts will station the rover some 300 feet from the lunar module and direct the antenna toward the earth. Houston will then take over and control the camera for televising the lift-off.

The camera has been built with RCA's silicon intensifier tube, which can transmit color pictures under levels of lunar light from dawn to high noon. It is also im-

John F. Mason
Military-Aerospace Editor



Color TV and audio signals will be transmitted directly to earth from the lunar rover. The vehicle was built by the Boeing Co.'s Aerospace Group.

mune to damage from bright light, even when pointed at the sun.

The lunar communications relay unit will transmit telemetry and voice signals, as well as the color TV, directly from the moon to earth. It will also receive transmissions from earth. The unit measures 5 by 13 by 21 inches and weighs 50 pounds—or nine pounds on the moon.

The unit has two antennas—a 38-inch-diameter, umbrella-like device that can be opened and folded for transmitting TV, and a smaller T-shaped antenna for voice and data exchanges.

The TV camera will be connected to the communications relay unit by cable. The astronauts' voice and telemetry—including their heartbeat rates and data on critical spacesuit systems—will be transmitted to the vehicle unit from their backpack radios.

The backpack radio will transmit to the vehicle unit via vhf (259.7 MHz). The vehicle unit then will convert the astronauts' vhf signals to uhf, combine them with the TV signals from the camera, and transmit the voice, telemetry and TV to earth-based receiving units on an S-band carrier of 2272.5 MHz. The signals will then be relayed from the receiving sites, via radio links, telephone lines and satellites, to Houston. There the TV signals will be converted to commercial standards and released to the networks for broadcast.

Transmissions from the earth to the vehicle unit on the moon will be at 2101.8 MHz, and from the vehicle to the astronauts at 296.8 MHz.

Design and development of the vehicle has been under the direction of the NASA's-Marshall Space Flight Center, Huntsville, Ala. The Boeing Co.'s Aerospace Group at its Kent Space Center, near Seattle, built three rovers for an estimated contract cost of $37.8-million. General Motors' Delco Electronics Div. Laboratories at Santa Barbara, Calif., acted as prime subcontractor. The communications and television systems were built by RCA. ■■

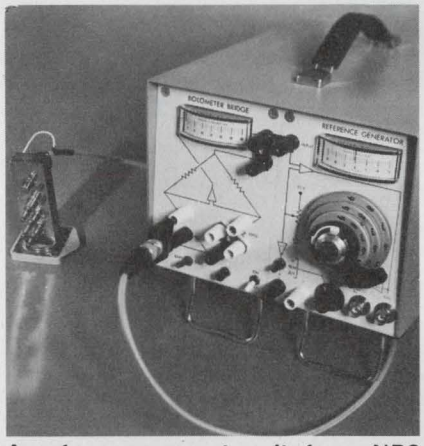
Rf measuring unit offered by NBS

Do you dream, as some engineers do, of owning your own electronics business? Here's a possibility:

The National Bureau of Standards is offering the complete design package for an rf power-measurement system that it says is seven times more accurate than any commercially available unit.

The complete package is available for less than $150 from the bureau's Electromagnetics Div., Boulder, Colo.

NBS will grant a royalty-free license to produce and sell the unit,



An rf measurement unit from NBS

on which patents are pending. The bureau estimates that the system could be manufactured for less than $2000 per unit.

Weighing 12.5 pounds, it consists of a self-balancing bolometer bridge and a reference voltage generator.

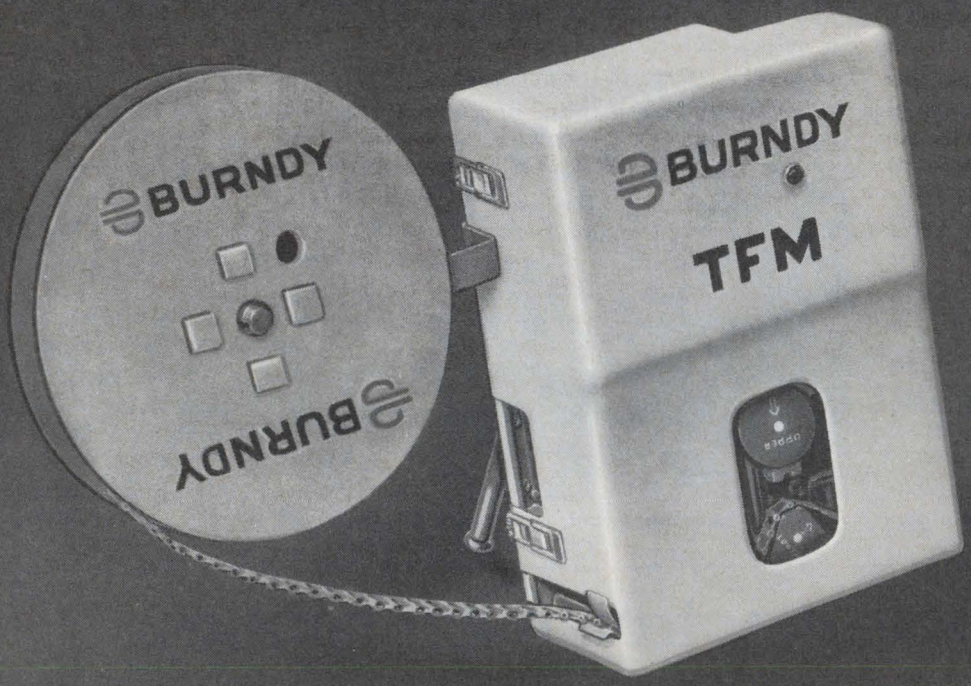
Its accuracy, when used to make a substituted dc power measurement with a 200-Ω thermistor, is ±0.0169% at an rf power level of 10 mW. Designated the NBS Type II Power Measurement System, the unit produces less than 0.05 μW of noise. ■■

Computer aids electron microscope

A scanning electron microscope coupled to a computer is able to move its scanning beam over discrete points of a specimen. Usually the specimen is moved by a motor under the beam. The new technique allows analysis of more defined areas, with finer resolution. The microscope magnifies an object more than 50,000 times.

Signatures of discrete points in the specimen are stored in the memory of an IBM System/360 Model 44 computer and can be recalled by the operator for further study.

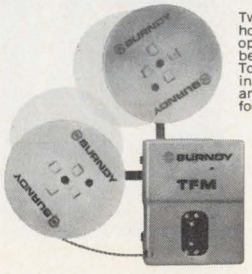
The system was produced by IBM's System Development Div. Laboratory, Poughkeepsie, N. Y.■■



Our little TFM Crimper

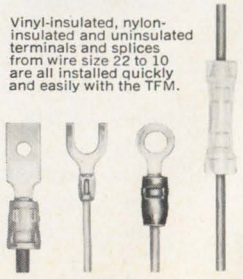
No matter what you're using, you can't afford not to use this new Burndy machine for installing terminals and splices on wire sizes 22 to 10. Designed to take all types—vinyl-insulated, nylon-insulated and bare—the TFM does all the work of several competitive machines. And beats all others on the basis of installed cost, ease of use and maintenance.

No die changing. Multi-position die turrets adapt the crimp to all types, all sizes. Just a twist of the

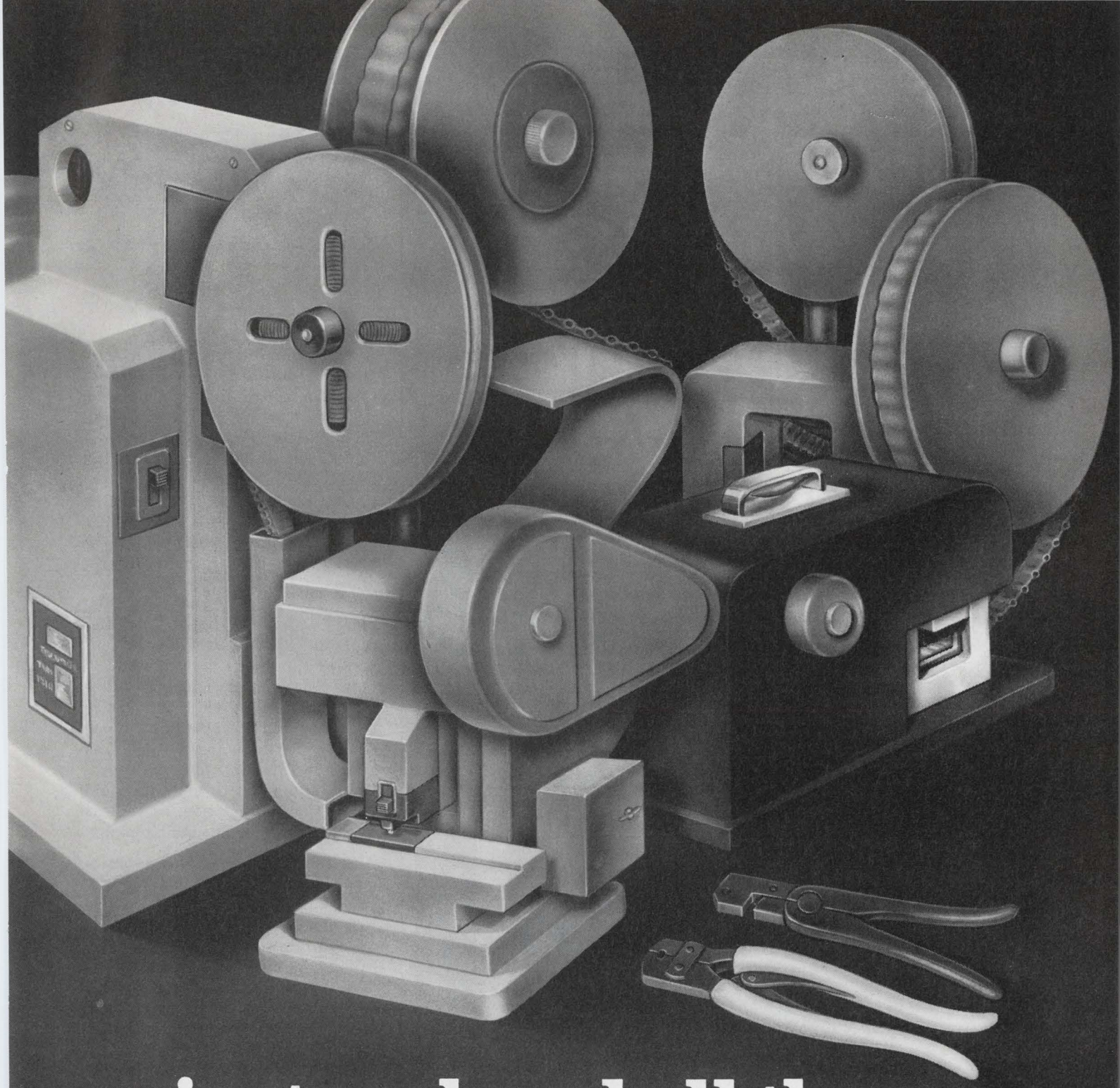


Two-position reel holder allows optimum use of bench space. To operate, just insert the wire and press the foot pedal.

Rear tilt stand is adjustable from 60° to horizontal. Suitcase type handle makes it easy to carry the lightweight TFM to any area.



Vinyl-insulated, nylon-insulated and uninsulated terminals and splices from wire size 22 to 10 are all installed quickly and easily with the TFM.



just replaced all these.

wrist rotates the control. In 30 seconds flat, an operator can change reels, terminals and dies.

The TFM offers other important advantages: It's fast. 1500 to 2000 crimps per hour. It's quiet. Powered by air as well as electricity, it cuts the noise by 80% compared with all-electric machines. It's safe. The small opening accepts only wire. A non-glare cover reduces eye fatigue. And because it is lightweight, it can be carried like a suitcase to any bench.

A two-position reel holder adapts to available bench space, and Burndy terminals and splices, mounted on low-cost Mylar, come wound on lightweight, easy-to-handle cardboard reels.

The TFM, available on lease, saves space, inventory and money on all the tooling it replaces.

BURNDY
Norwalk, Connecticut 06856

INFORMATION RETRIEVAL NUMBER 22

technology abroad

A custom microcircuit that carries out most of the logic functions for a five-digit panel meter has been completed by Integrated Photomatrix of Dorchester, Dorset, England. The MOS circuit—produced for two meter manufacturers, Evershed and Vignolles of Chiswick, London—is 137 × 117 mils. Containing over 1000 MOS transistors, the microcircuit replaces some 20 TTL MSI packages. Five decade counters, four binary counter stages, 20-shift-register stages, 12 set-reset bistable flip-flops and about 70 gates of various complexity are integrated on the chip. The entire logic package, including Nixie drivers, is now being marketed as a kit in Britain. The chip provides automatic over-range and under-range indication, as well as display-tube anode multiplexing.

A withdrawal from the avionics manufacturing field, "due to the contraction of the market open to British makers and the high cost of maintaining high technology in this field," has been announced by Standard Telephones and Cables of England. Its products have included aviation communications equipment, airborne navaids, radio altimeters, intercom systems, ILS, precision-approach radar, ADF and VOR. The company now will concentrate on its main line of telecommunications and components manufacturing.

Soon to be introduced by ITT Semiconductors is an ultra-small light-emitting dot-matrix display, developed at STL Laboratories, Harlow, Essex, England. The display, comprised of a single monolithic chip of gallium arsenide phosphide, has a 5 × 7 array of light-emitting junctions diffused into its surface. Each of the dots can be X and Y addressed to pro-

duce characters that are a maximum of 4 mm high. Although this is much smaller than comparable Monsanto, Texas Instruments or Motorola displays, the new display is aimed at a different market: the labeling of computer key controls. The function and the label of any computer key can then be changed to suit its position, which frequently varies in the computer program. The compact display package has a three-dimension connection matrix that brings the connections from the chip out to the back of the package.

A novel, 32-bit static shift register with a length that can be changed by electrical addressing was displayed by Sescosem, the French semiconductor subsidiary of Thomson-CSF, at the Paris Components Show. This register is considered ideal for use as a delay line of variable length, operated in conjunction with standard shift registers.

A seven-inch color electronic attitude-director/indicator will be demonstrated by Thomson-CSF, Paris, at the International Air Show in Paris, May 27 to June 6. The demonstrator will display green and yellow runway diagrams, but it's expected that red will be added to the system by mid-summer. A display tube with two different phosphors produces the red and green primary colors, while amber is obtained from a combination of the two. Simulation test trials are scheduled to begin in September in the Concorde SST simulators at Toulouse, France.

An integrated circuit to replace electromechanical relays in television crossbar-switch distribution systems has been developed by Siemens of Munich, Germany, to meet an in-house requirement. The IC, particularly suitable for switching tasks, consists essentially of two emitter followers. The signal path between the two is connected or blocked by diodes. The emitter followers ensure high-input impedance and low-output impedance. In addition they provide high decoupling attenuation and low transmission loss, together with good linearity.

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INFORMATION RETRIEVAL NUMBER 25

washington report

DON BYRNE, WASHINGTON BUREAU

Inflation endangers F-14 program

The Grumman Aerospace Corp. has told the Navy that "extraordinary inflation," higher material and procurement costs, and a decrease in its business base have made it "commercially impractical to complete delivery on the Navy's $8-billion F-14 fighter program. In a letter made public reluctantly by the Navy, Grumman said that it had warned the Navy as long ago as 1969 and again in 1970 that costs were rising and that something should be done about the existing contract. But the Navy in December 1970 denied in a Pentagon press conference that there were any cost problems with the aircraft. In all, the contract calls for 710 aircraft at a price of $11.5-million each. Grumman will be able to deliver the first 38 of the aircraft at that price without any difficulty but seeks a reworking of the contract for the other 672 aircraft. There are also reports that there are difficulties with the aircraft's Phoenix missile fire control system made by Hughes Aircraft. Pentagon sources would say officially only that the test program of the F-14 has been delayed. The Navy has a $1.035-billion request in the current proposed budget for 48 of the aircraft.

FAA charts 10-year traffic control program

The Federal Aviation Administration has unveiled to the industry its latest 10-year plan for the nation's air traffic control system. It hopes to have Congress approve $1.1-billion in R&D and $3-billion in facilities and equipment through 1981.

Included in the program are plans for procurement of microwave instrument landing systems at 84 larger airports and 370 smaller ones. An FAA five-year plan for these systems is expected to be announced shortly.

The FAA's R&D request this year is for $81-million. This is scheduled to climb to $135-million by 1975 and then average off at $100-million for the following six years.

Imports soar as U. S. employment drops, study shows

An estimated 107,000 jobs were lost in the U. S. electronics industry and the value of shipments declined by 7% in 1970, a Commerce Dept. study shows. At the same time, according to the findings, imports continued to climb, and at the end of the year the unfavorable balance of trade stood at $266-million, or more than twice what it was just five years ago.

The study shows that in the consumer product field the unfavorable balance of trade has climbed 600% in five years, with imports now accounting for 30% of the domestic U. S. market. Japan was the leading supplier of electronics from abroad last year, accounting for 58% of the imports. Canada, West Germany and Britain were next, in that order.

Electronic components, commercial, industrial and military electronic systems and telephone equipment showed favorable balances of trade. The report warns, however, that there is "evidence of rapidly rising imports of Japanese telephone equipment, which could in the near future make serious penetration into the domestic telephone equipment industry, especially those independent equipment manufacturers who do not have the advantage of high-volume production."

Army sets August test for new 'electronics division'

The Army's First Cavalry Division went into training at Fort Hood, Tex., this month as the first of the Army's planned "electronic divisions." The divisions incorporate a triple capability—armor, airmobile infantry and air cavalry—and lean heavily on a network of common communications systems feeding computers. The computers decide where forces are to be placed and even make tactical decisions. The training and field tests, which start in August, are part of an evaluation of equipment and techniques for the "electronic battlefield" of the future.

Electronic failure dims Navy Lamps program

The Navy has canceled scheduled procurement of an existing helicopter as the new Light Airborne Multipurpose System (Lamps) because of failure to develop suitable electronic sensors for the helicopters. This represents a major revision in the program, because the Navy had been expected to issue requests for proposals in June to buy 369 helicopters. The craft are to be placed on all destroyers with air capability for anti-submarine warfare, missile-relay, decoy, early-warning and line-of-sight communications. Kaman, Bell, Boeing, Vertol and Sikorsky had been expected to submit proposals in June; now, no proposals are expected much before mid-1973.

With regard to the electronic equipment delay, the Navy declined to state specifically where the hangup was, other than to say it involved sensors. To fill the gap, the Navy has ordered its 115 Kaman HH-2DS helicopters to be equipped with off-the-shelf avionics, and it is seeking $38.5-million in the current budget for further electronics development.

Capital Capsules: The Bureau of Radiological Health of the Dept. of Health, Education and Welfare has come up with **a cheap and efficient testing device for microwave ovens.** The kit can be put together, the bureau says, by just about any repairman for about $150, as opposed to current equipment that costs around $800. Federal leakage standards on the ovens become effective Oct. 6. . . . Rep. Robert Tiernan (D-R. I.) has introduced **a bill that would strip Comsat's board of directors of both common-carrier members and White House appointees.** The corporation should be strong enough now to go it alone, says Tiernan. . . . **The Apollo 15 program is running right on schedule,** says NASA. The moon shot is scheduled for July 26. . . . The three major television networks have told the Federal Communications Commission that the proposed **communication satellites of Comsat, RCA Global Communications and Western Union appear to be the best to meet broadcasting needs for the future.** As expected, the nets declined their own proposal for a satellite system.

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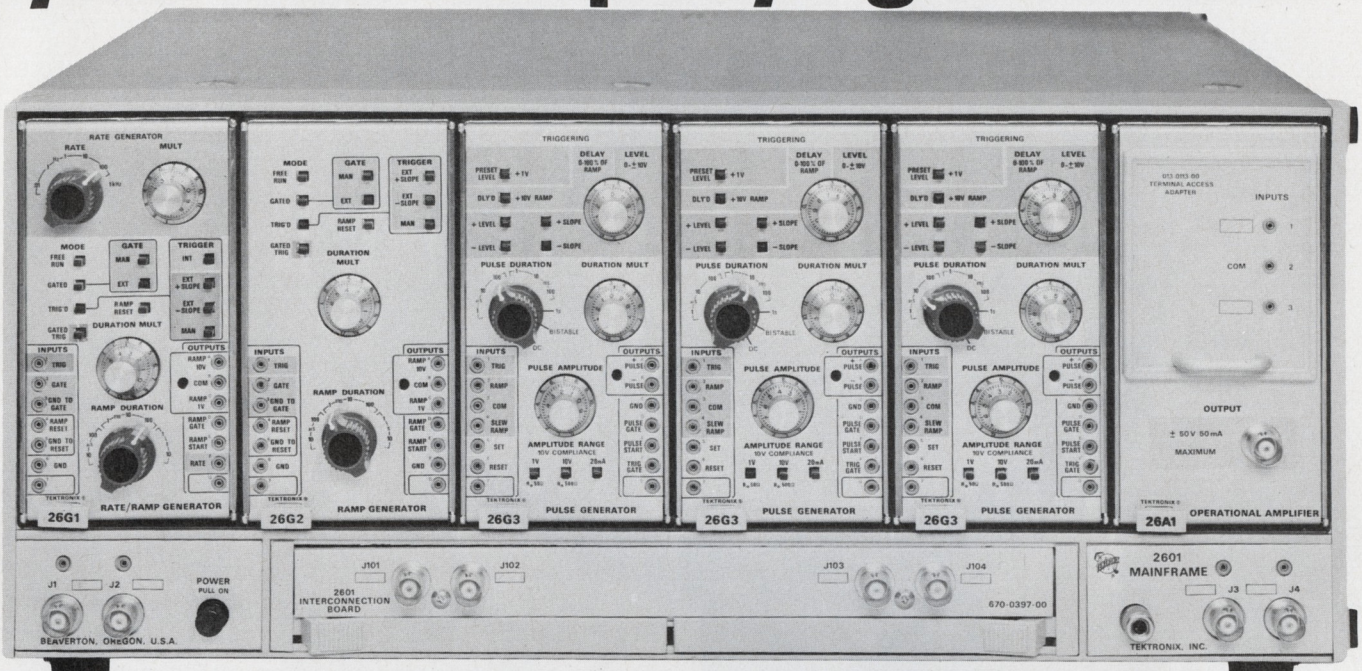

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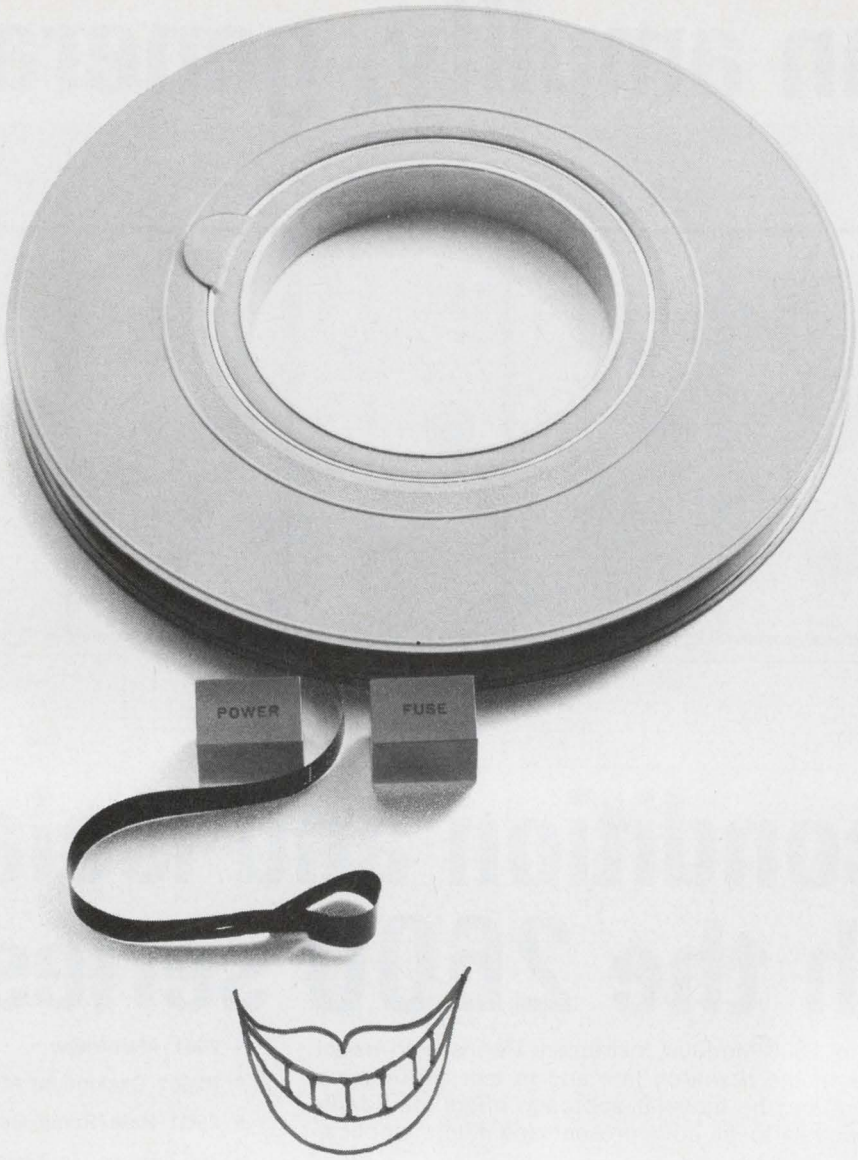

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A designer's guide to data communications

by Michael J. Riezenman, Technical Editor

Photograph courtesy of American Telephone and Telegraph Co.

Once upon a time—before the now-historic Carterfone decision—data communication was a relatively simple business from the user's point of view. He merely called Ma Bell, told her his problems, did what she told him and lived ever after.

He didn't always live happily ever after, but there wasn't much he could do about it, unless he was very rich. In that case he could build his own private transmission system.

Nowadays, as a result of the Carterfone case, things are different. Ma Bell (and her kid sisters) are not the only companies who may manufacture terminal equipment for use on the nation's dial-up telephone network. And although they still dominate the data transmission field, it is not as obvious as it once was that this will always be the case.

Microwave Communications, Inc. (MCI), for example, is currently constructing a common-carrier microwave system to provide private-line services between Chicago and St. Louis. The company expects to be ready to serve its first customers this June, according to Gerald H. Taylor, assistant to the president of Microwave Communications of America, an MCI affiliate. Furthermore a Federal Communications Commission decision opening the way for greatly increased private-line, common-carrier competition is expected to be announced next month.

What do these developments mean to the user? They hold forth the promise of better and more varied data communication services. But they also mean that the user will have to accept the responsibility for designing his own system. This, in turn, implies that he will have to know a lot more about the technical characteristics of transmission systems and terminal gear than he did in the past, or he may wind up with a system that only the Rockefeller brothers can afford to operate—when it operates at all.

What sorts of things must the designer of a data-communications system worry about? In addition to the all-important job of planning the layout of the system, four important items come immediately to mind:

- Choice of a common-carrier service.
- Error control.
- Throughput.
- Economy.

Let's briefly glance at each of these areas to see what they are and why they are important.

Choosing a common carrier is easy—now

At present it's easy to choose a common carrier: Just go to your local telephone company. But starting in June, people in the Chicago-St. Louis area will have a real choice. And it is likely that competition will spread over the rest of the country in the not-too-distant future.

What would be the advantages of choosing to use MCI rather than AT&T for a particular data link? For one thing, MCI claims that its transmission system will introduce only one error in every 10^7 bits. For another, its pricing structure allows you to pay for only the amount of channel capacity you need—with its service you need not pay for a full 3-kHz voice channel if you only want to send 1200 b/s.

On the other hand, the MCI system is strictly private. If you want to be able to reach any of the more than 110 million telephones in the country, the switched network is the only way to go.

Error control is essential

Like them or not, errors will always be with us. The question is: What are we going to do about them? Ignoring them is not recommended when you're dealing with a computer. So you've basically got to decide what type of error control to use and how thoroughly you should use it.

There are three basic error-control procedures: error detection, error correction and a combination of the two.

An error-detection system spots errors and then asks the sender to retransmit the block of information with incorrect bits. This is called ARQ, for automatic repeat request.

As the name implies, an error-correction system not only detects errors, it corrects them as well. It does this in a binary system by detecting the location as well as the presence of the errors in a block, and then flipping the offending bits over (from ZERO to ONE or vice versa).

Since no error-control scheme is perfect, it is sometimes a good idea to combine forward error control (error correction) with an error-detection system. The result is an ARQ system that asks for a retransmission much less often than it would without the forward error control.

In addition the system designer must decide how good the error control should be. Simple parity checks work well enough in low-error-rate environments, but they fail if used with the switched telephone network, where errors tend to come in bursts. The more sophisticated codes that can deal with burst errors may wind up adding so many extra bits to your message that your effective transmission rate of useful information is severely reduced.

Probably the best way to decide how much error control to use is to make sure that the added cost of the error control does not exceed the costs you would incur if the error had not been caught.

Throughput and data rate are not the same

Given a systems requirement to transmit useful information at the rate of 2000 b/s, the data-communications novice might blithely proceed to specify a 2000 b/s line and a 2000 b/s modem. He would then be rudely surprised to find that his system would be hard pressed to deliver, say, 1400 b/s under rather favorable conditions.

What he forgot to do, of course, was to allow for the bits that are used up by the error-control system and the time that is taken up by the ARQ procedure, if one is used.

Just how many bits are used to detect or correct errors and how much time an ARQ system uses up depends upon many factors: block size, channel error rate, type of channel (full or half duplex), type of modem (some new ones can make a half-duplex dial-up line do the job of a full-duplex leased line) and the error rate that is acceptable for the system under consideration.

To look at just one of these areas a bit more closely, let's say that a standard half-duplex dial-up line is being used with the standard stop-and-wait ARQ system. This means that after each data block is transmitted, the line must be reversed so that the sender can be told whether to send the next block or retransmit the last one.

Turning around a standard telephone channel can take over 100 ms if it has an echo suppressor in it. Hence over 200 ms are wasted during the transmission of each block of data.

Last but not least: cost

In data-communications system design, as in any other engineering problem, the best solution is the one that does the required job for the least money. How to do this is not always clear.

Sometimes it is possible to save money by using an expensive modem, because the high-priced device lets you send your data in a shorter time, thus reducing your phone bill.

Sometimes the cheapest way to send a lot of data is to load a bunch of magnetic tapes onto a truck and ship them.

No procedure is best for all situations, but this report should help you find the best answers to your problem. ■■

Eenie, meenie, minie, mo-- Which carrier service?

In choosing a common carrier, one must consider many factors—bit rate, noise performance and pricing structure, to name just a few. But one point is almost comically obvious: You can't use a common carrier unless it exists. Therefore, in most cases, the question at present is not which common carrier to use but which Bell System service to employ.

These services fall into two basic groups: private-line and switched. And into three speed ranges: low (up to 150 b/s), medium (voice grade) and high (50 kb/s to about 250 kb/s).

The private-line services have the advantages of freedom from busy signals, fixed monthly charges regardless of usage and the availability of conditioning for enhanced data-transmission performance.

The switched services, of course, have the advantage of being able to connect the user with any one else who subscribes to the same switched service. Another plus is that they are more reliable in the event of failure of a transmission facility, because the switching equipment will automatically route a call through an alternate link, whereas the private-line connection must be manually rerouted.

The ubiquitous switched network

Bell no longer offers a switched low-speed service. The teletypewriter exchange service (TWX) was turned over to Western Union on the first of this month. However, Bell does offer a rather well-known switched voice-grade service and a still-experimental switched 50 kb/s service known as DataPhone 50.

Since the switched voice network already reaches anywhere a user may want to go, why would someone use any other voice-grade service? In addition to being a "dedicated" service—that is, one always available for your private use—a private line may also provide cost savings if you plan to transmit a lot of traffic.

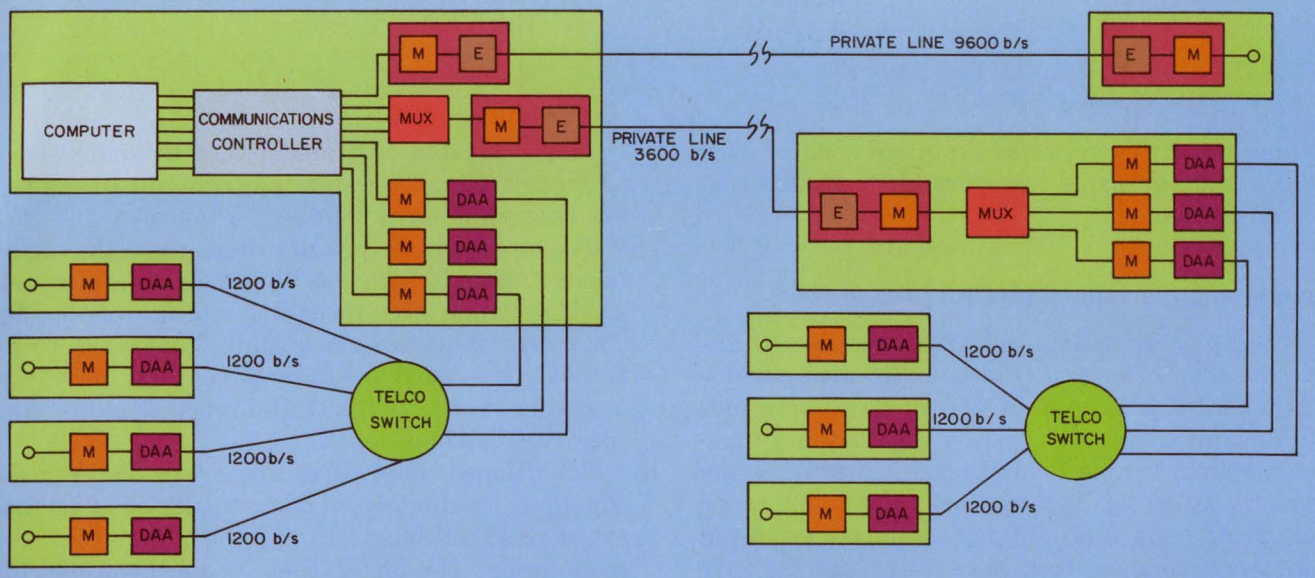
And there are also three major technical drawbacks of the switched voice network:

- Its delay distortion is not constant.
- It is noisy.
- It is only available in half-duplex circuits.

These factors are not as important as they used to be, because sophisticated terminal equipment can lessen their effects to a great degree. Nevertheless they should be taken into account in any system design.

Delay distortion is probably the major factor that limits transmission speeds over telephone channels. It is a nonlinear effect that causes different frequencies to be delayed by different amounts as they pass through the system. Thus a narrow pulse containing many frequency components will be spread out in time, because each of its components will be delayed by a different amount. Transmission speed must be reduced—that is, the pulse length must be increased—until the effects of delay distortion cease to cause adjacent pulses to run into each other.

Until comparatively recently the only way to combat delay distortion was to use a fixed equalizer. This is a filter that can be adjusted to cancel



Private lines and switched services can be mixed for maximum flexibility. Note that a data access arrangement (DAA) is required between customer-provided modems and telephone-company switches. Equalizers (E) are usually built into the modems, while multiplexers (MUX) are not.

most of the delay distortion in a line. Unfortunately adjusting an equalizer is a fairly lengthy and tedious process. And since each call placed on the dial-up network results in a circuit with different delay characteristics, it is not practical to use a manually adjusted equalizer in this application.

Recently automatic and even adaptive equalizers have been developed. These can measure the delay characteristics of a line and then equalize it automatically in a few seconds. The adaptive units will even monitor the line's performance and compensate for the small variations that occur with time. They do this by monitoring the actual data that is being received and adjusting the equalizer filter whenever the statistics of the received signal deviate from the norm.

Telephone noise is not random

The switching machinery in the switched voice network still contains a great number of electromechanical switches. Because of this, the network is plagued by much so-called impulse noise, which differs from thermal noise in that it comes in bursts. Thus, when the dial-up network is used for data transmission, it will usually be found that errors tend to occur in groups, making parity checks and other simple error-control methods largely ineffective.

More powerful error-detecting and correcting schemes, such as convolutional coding, are effective against burst errors, but they require sophisticated coders and decoders, and they add bits to the data stream without adding to its message content.

A final point to be made about the switched voice network is that it is only available for half-duplex operation. This means that the circuits cannot provide simultaneous, independent transmission in both directions. This is not a problem in voice communications, since people can't talk and listen at the same time anyhow. But in data transmission it means that two computers that want to exchange data cannot do it simultaneously.

The problem goes even deeper. The most common mode of operation in data communications today—that employed by IBM series 360 machines, for example—is the ARQ (automatic repeat request) error-control scheme. In this mode of operation, the data is transmitted in blocks. After each block is sent, the receiver tests it for errors and sends a control signal back to the sender: ACK (acknowledged) to indicate satisfactory reception, or NAK (not acknowledged) to ask for a retransmission.

On a full-duplex line, data can zip along in one direction while ACK/NAK signals flow the other way. But in a half-duplex circuit, the line must be turned around after the data is sent, and then turned around again after the control signal is returned.

Turning a line around can seriously reduce the effective rate at which data is transmitted. The reason is that there are echo suppressors in long-distance telephone lines that insert a high loss in the channel's reverse direction. It takes about

100 ms to reverse an echo suppressor, so at least 200 ms will be wasted for every block of data that is transmitted.

Suppressing the suppressors isn't the answer

When placing a data call, it is possible to disable the echo suppressors in your circuit by transmitting a 2.1-kHz tone of appropriate amplitude and duration. This will greatly cut the line's turn-around time, but, as Paul Muench, an engineering manager at AT&T in New York, points out, when you disable the echo suppressors, you get what they were designed to suppress—echoes. So then you have to wait for the echoes to die out.

The echoes will die out in less time than it takes to reverse an echo suppressor, so disabling the suppressors does improve things. But it doesn't really help very much because of yet another factor: equalization time.

All of the factors we have been discussing are only important when data is being transmitted at fairly high rates. (At low rates you don't worry about turn-around times, because they're only a tiny fraction of the total transmission time.) When transmitting data at high rates over the dial-up network, it is almost certain that you will be using an automatic equalizer. And every time you reverse the channel, the equalizer will have to readjust itself, again seriously lowering the effective data rate.

It is possible to overcome some of the disadvantages of half-duplex operation by using frequency separation to create two independent channels. This requires some rather sophisticated terminal equipment.

The only switched data service available that uses circuits with more bandwidth than a voice channel is DataPhone 50. This service is only offered between New York City, Chicago, Los Angeles and Washington, D. C. It is a dial-up service operating at speeds up to 50 kb/s, and it is only being offered on a trial basis at present.

Designing a system with DataPhone 50 is easy, because all of the communications terminal gear used with it must be supplied, installed and maintained by the Bell System.

Private lines can be conditioned

The private-line services available from the Bell System vary in speed capability from 30 b/s to 250 kb/s. However, all in-between speeds are not available.

The low-speed lines are simple unconditioned channels capable of transmitting dc mark-space or binary signals at speeds up to 150 b/s. They are not suitable for sending ac tones.

The voice-grade private lines use the same transmission facilities as the switched voice network, yet they offer three important advantages: They are quieter, because they don't have to go through the noisy switching centers; they are available in four-wire, full-duplex circuits; and they can be conditioned.

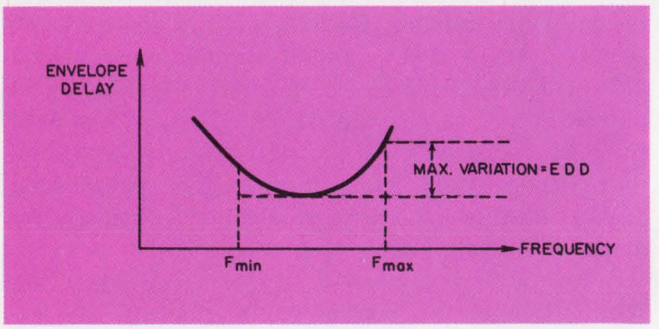
Conditioned lines are lines that have been equalized by the telephone company to a certain set of specifications. As the specs get tighter, the costs go up. The phase (delay) specifications for unconditioned lines and the three most common types of line conditioning are shown in Table 1.

The delay distortion parameter, Envelope Delay Distortion, is the maximum difference in envelope delay over the specified frequency band (Fig. 1). Note that the maximum difference is not necessarily obtained at the frequency extremes.

The MCI private-line concept

Since Microwave Communications, Inc., expects to begin providing private-line communications services between Chicago and St. Louis this June, and other companies have petitioned the Federal Communications Commission for permission to operate similar systems in other areas, we may ask: What are the advantages of using an MCI type of carrier for data communications?

The most significant feature of the MCI concept is its pricing structure. The company plans to lease lines in a very wide range of speeds, so that the user need pay only for the communications capability he needs. The company will offer 20 different data channels covering the range of 75 b/s to 19.2 kb/s (Table 2). Each channel will be sold on a one-way basis, so that a customer



1. **Envelope delay distortion (EDD)** is the maximum variation in a line's envelope delay over a specified band.

Table 1. Delay-distortion specifications of conditioned lines

	3002 Channel	C1 Conditioning	C2 Conditioning	C4 Conditioning
Envelope delay distortion (EDD)	Less than 1750 μs over band from 800 to 2600 Hz	Less than 1000 μs over band from 1000 to 2400 Hz Less than 1750 μs over band from 800 to 2600 Hz	Less than 500 μs 1000 - 2600 Hz Less than 1500 μs 600-2600 Hz Less than 3000 μs 500-2800 Hz	Less than 300 μs 1000-2600 Hz Less than 500 μs 800-2800 Hz Less than 1500 μs 600-3000 Hz Less than 3000 μs 500-3000 Hz

can have, for example, a 3600 b/s channel in one direction for data transmission and a 75 b/s channel in the reverse direction just to handle control signals.

It should also be noted that the company is charging for its lines on a data-rate basis, not on the basis of bandwidth.

Another important pricing feature is the availability of a reduced rate for part-time use. This makes it possible for the company to offer wideband services at low cost to customers who are willing to do their data transmission at night.

Since the Bell System was not designed for the transmission of digital signals, it does not specify an expected error rate. And indeed the actual error rates that are encountered can vary by several orders of magnitude, depending upon whether you get a noisy circuit or a quiet one. Despite the lack of hard data on the subject, most people in the business generally describe the voice network as having a typical error rate of 1 in 10^3 or 10^4.

By contrast, MCI's data channels are designed for a mean error rate of 1 in 10^7. This can result in reduced costs, by allowing the user to send more data over a given line. This comes about in two ways: First, fewer bits in each block need to be reserved for error-control. And, second, the blocks can be made longer without increasing the probability of a need for retransmission. This saves on the overhead bits needed to establish synchronization at the start of each block.

Table 2. MCI's 20 data rates (b/s)

75	1200	6000
110	2400	6600
134.5	3000	7200
150	3600	9600
200	4200	14,400
300	4800	19,200
600	5400	

A switched digital network is proposed

MCI, it should be emphasized, is a private-line common carrier. As such, it will offer no competition to the Bell System's dial-up network.

The Data Transmission Co. (Datran) of Vienna, Va., is a horse of an entirely different color. This subsidiary of University Computing Corp. has filed an application with the FCC for permission to construct a nationwide switched communications network, to be devoted entirely to data transmission. The proposed network would be completely digital and would have an expected error rate of 1 in 10^7.

The Datran concept includes a broadcasting capability, with which a subscriber could send the same message to several other subscribers simultaneously. And the company estimates that the time required to establish a connection would be less than three seconds 99% of the time.

Since many data calls—those of the simple inquiry-response type—are very short, Datran proposes to base its charges on a minimum call of six seconds. This feature alone could make the system very attractive to many users. But before potential users get carried away by Datran's plans, they should be warned that the system would not be ready to serve any customers before 1975, assuming that it gets the FCC go-ahead right away. And it's by no means certain that the proposal will be approved. ■■

Beware the pitfalls in picking from a maze of terminal gear

In direct contrast with the common-carrier situation, in which the user's present options are very limited, the problem in selecting terminal gear is to choose the best from a vast array of available hardware. Multiplexers and line concentrators are not needed for every application, but modems are. And this is probably the most confusing area of all.

Modems are available in a wide range of speeds, with and without equalizers, and with and without built-in error-control circuitry. Some operate synchronously, while others are asynchronous units. Some provide a reverse channel, others do not. And last, but not least, they vary considerably in cost—from thousands of dollars for some high-speed units, to below $100 for the new all-IC models that work at teleprinter speeds.

How, then, do you go about selecting the best modem for your job? The starting point is your data-rate requirement. At the low speeds associated with teleprinter transmission (about 150 b/s), a simple asynchronous FSK (frequency-shift keying) modem is all that is required for transmitting data over the switched telephone network. Such a modem converts the digital input signals it receives from the teleprinter into audio tones. These are sent to the receiving end, where they are converted back into digital logic levels by another modem.

Errors are not much of a problem in low-speed transmission, because each bit has such a long duration that it is very difficult for a noise burst to cover it up. As bit rates increase, however, errors become a matter of great concern, and so do several other factors.

Simple modulation schemes such as FSK cannot be used, because they waste too much bandwidth. And equalization must be employed to prevent delay distortion from causing intersymbol interference.

Bandwidth conservation is important

When FSK is used, the transmitted signal goes through several alternating cycles at each tone frequency (Fig. 1a), thus wasting a great deal of bandwidth. Since the bandwidth of a standard voice-grade telephone channel is limited to about 3 kHz, higher-speed modems must employ modulation techniques that make more efficient use of the available spectrum.

The two most popular approaches in use today, according to Clay Tatom, marketing manager for communications at Motorola Semiconductor Products, Inc., in Phoenix, are DPSK (differential phase-shift keying) and VSB-AM (vestigial sideband amplitude modulation). Both of these modulation methods achieve high rates of information transfer by transmitting signal elements as fast as they can, while trying to get each signal element to carry as much information as possible.

In differential phase-shift keying, each signal element is a change in the phase of the carrier with respect to its previous phase angle. If the DPSK system is designed so that the carrier can assume only two different phase angles, then each change of phase (signal element) carries one bit of information—that is, the bit rate equals the baud rate (see box). But if the number of distinguishable angles is increased to four, then two

Bits and bauds

Much confusion still seems to exist about the difference between the words "bit" and "baud."

A bit (or binary digit) is the smallest amount of information that can be transmitted.

A baud is a measure of the signaling speed of a communications system. One baud equals one signal element per second.

Let's see how bauds and bits are related in a binary asynchronous telegraph system. Each character in such a system will typically begin with a single start bit, followed by the eight-bit American Standard Code for Information Interchange (ASCII) for the character and ending with two stop bits. Therefore the system must send 11 code elements in order to transmit eight bits of useful information.

Clearly then, to send information at a rate of 80 b/s, this system would have to operate at a rate of 110 bauds. The baud rate in this case, exceeds the bit rate.

The opposite situation occurs in a high-speed synchronous transmission system using, say, four-phase differential phase-shift keying (DPSK). Since there are four possible phase states, each change of phase represents two bits of information. Thus, if the phase modulation rate is 2000 bauds, the system will be transmitting 4000 b/s.

Obviously if two-phase DPSK is used, the bit rate and the baud rate will be the same.

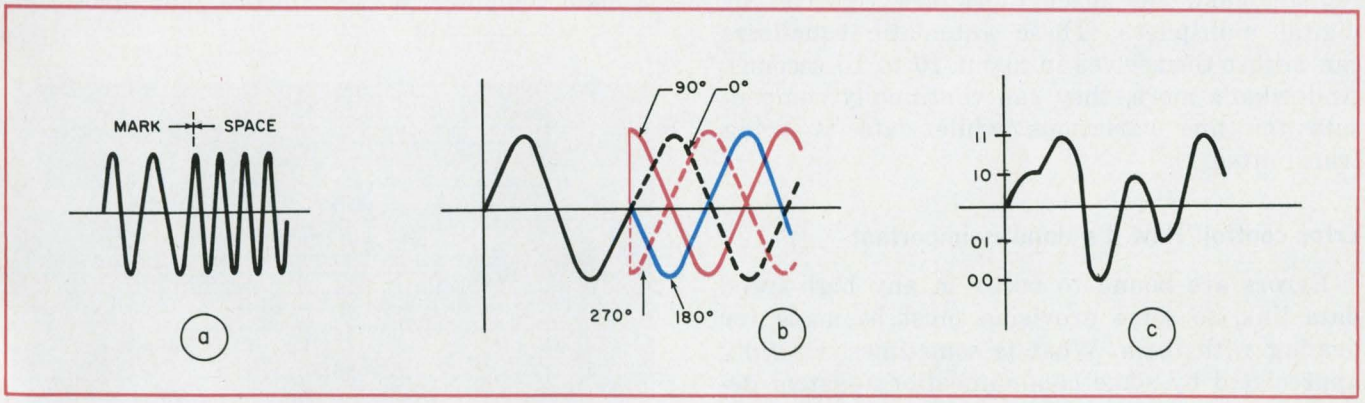
bits of information can be encoded into each signal element (Fig. 1b). An eight-angle system would thus carry three bits per baud, and a 16-angle system would carry four, and so on.

However, this game can only be played so far; as the number of angles increases, the system's susceptibility to noise increases as well. The noise characteristics of the telephone system (its phase jitter in particular) limit the number of angles that can be reliably distinguished to eight.

A disadvantage of DPSK is that it cannot take advantage of single-sideband techniques. Its two sidebands do not contain the same information; hence both must be transmitted for the signal to be detected. A more efficient modulation approach, according to Karl I. Nordling, director of product management for the Paradyne Corp., Clearwater, Fla., is vestigial sideband AM. As he points out, in AM the sidebands are completely redundant, so one of them can be omitted, and only the other sideband and the carrier need be transmitted.

If VSB-AM is used, the information is contained in the signal's amplitude, not its phase. As in the DPSK case, the communications-channel noise limits the number of signal levels that can be reliably distinguished. The practical working number for today's equipment, according to Nordling, is about four levels, or two bits per baud (Fig. 1c).

Since the VSB-AM modulation scheme has twice the signaling rate of the DPSK scheme and can pack two-thirds as many bits of information into each signal element, it winds up having a 4-to-3 advantage in the efficiency with which it utilizes the available bandwidth.



1. **FSK (a) is simple and effective.** Unfortunately, it wastes bandwidth, so it's only used in low-speed systems. Both DPSK (b) and amplitude modulation (c) make better use of the available spectrum. In the cases illustrated here, each signal element can assume one of four values, hence each baud transmits two bits of information.

Theoretically a channel with a bandwidth of W hertz is capable of transmitting 2 W pulses per second without any intersymbol interference. This theoretical result is based on the assumption that the channel in question is linear. As was mentioned in the preceding section, however, the phase characteristics of telephone channels are not linear at all. In fact, it turns out that delay distortion limits the signaling speeds on telephone lines to values much lower than bandwidth considerations would lead you to predict.

The fastest you can expect to go over on unconditioned, unequalized line is about 2000 b/s; whereas a highly conditioned C4 line working with a high-speed modem can operate at about 9600 b/s.

Clearly, then, delay distortion has got to go. In private-line systems, delay distortion can be greatly reduced by having the common carrier condition the line. On the dial-up network, or when the available conditioning isn't good enough, an equalizer must be included in the modem.

Delay distortion causes the different frequency components of the transmitted signal to arrive at the receiver at different times. To correct this form of distortion, the equalizer contains a tapped delay line with a variable attenuator on each tap and a network to sum all of the weighted delayed output signals (Fig. 2). By an appropriate adjustment of the attenuators, the equalizer can be made to (almost) compensate for the channel distortion by introducing an equal and opposite distortion of its own.

The adjustment of an equalizer is a very slow and tedious business, if it is done manually, so it is not practical to use manual equalizers on dial-up lines. If they were used, the first 10 or 15 minutes of each data call would be spent in adjusting the equalizer.

Fortunately modern digital ICs have made it possible to build low-cost automatic equalizers in which the incoming signal is sampled and digitized, the delay line is replaced by a shift register, and the attenuators are replaced by digital multipliers. These automatic equalizers can adjust themselves in about 10 to 15 seconds. And what's more, they can continually compensate for line variations while data is being transmitted.

Error control: How it's done is important

Errors are bound to occur in any high-speed data link, so some provision must be made for dealing with them. What is sometimes not fully appreciated by some communications system designers is that the method of error control that is chosen can profoundly affect the system's throughput—the amount of useful data that the system can actually transmit.

In most cases, an ARQ type of error-control system will be used. On full-duplex dedicated lines, where there is no necessity to turn the lines around, this presents no problems. But as was explained in the last section, full-duplex operation is not available on a dial-up line, and turnaround delays cannot be tolerated in a high-speed system.

One effective, but expensive, way around this problem is to place two phone calls, thus establishing a full-duplex link. Since a primary responsibility of the systems designer is to keep costs down, this approach is not recommended.

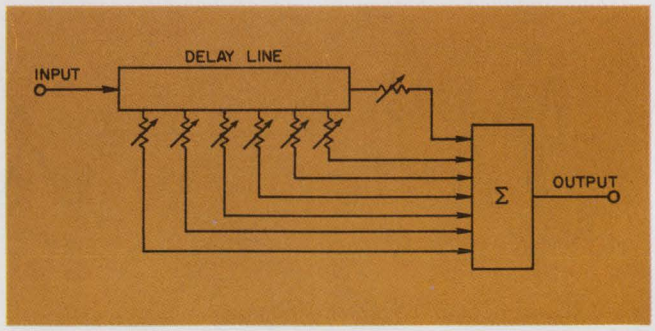
A better way is to use a modem that provides you with a reverse channel on a single half-duplex line. This is done by breaking the channel into two frequency bands of unequal bandwidth, the wider one used for transmitting data and the narrower one for control signals.

This technique sounds like the best solution to the problem, but often it is no solution at all. The trouble is that in almost all data-communications systems, the error-control function is performed by the data-processing gear, not the communications gear. And the existing hardware and software are not designed to make use of a low-speed reverse channel. So you must either get a modem with its own built-in error-control logic, or modify your data-processing machine's error-control procedures.

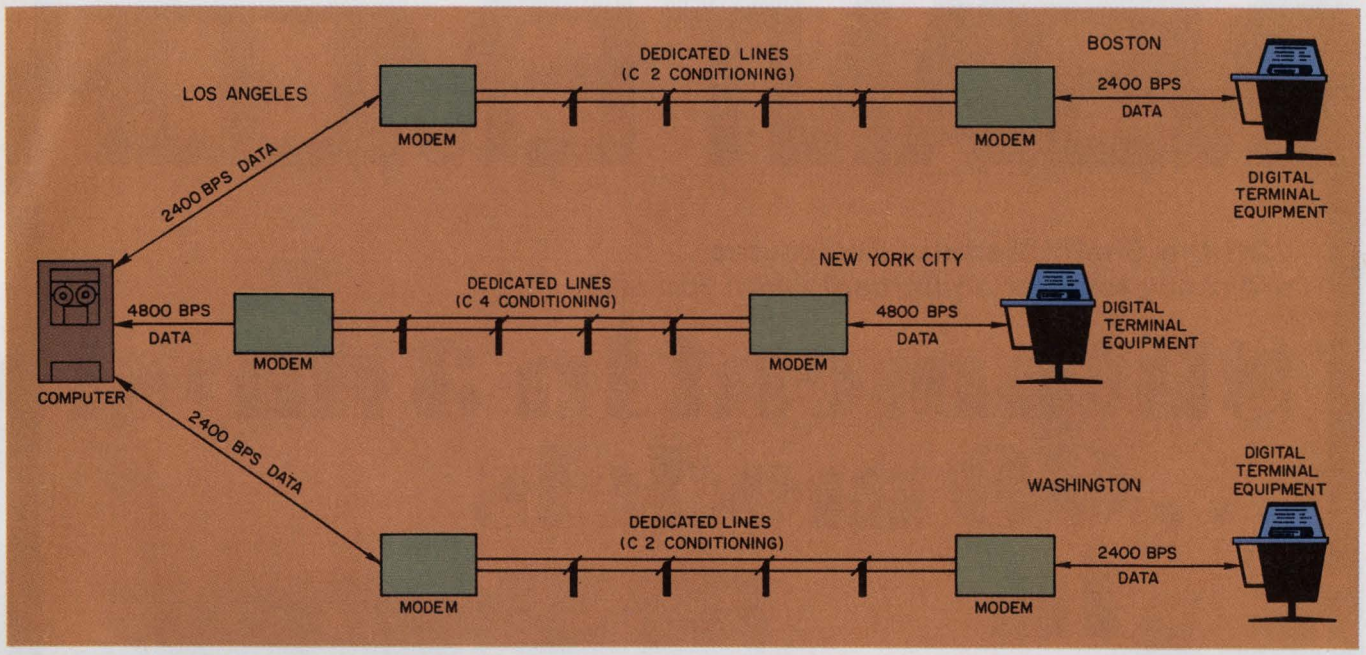
Naturally, before doing any of this, you'll want to make sure that the added costs of this more sophisticated equipment will justify themselves by cutting your phone bill sufficiently.

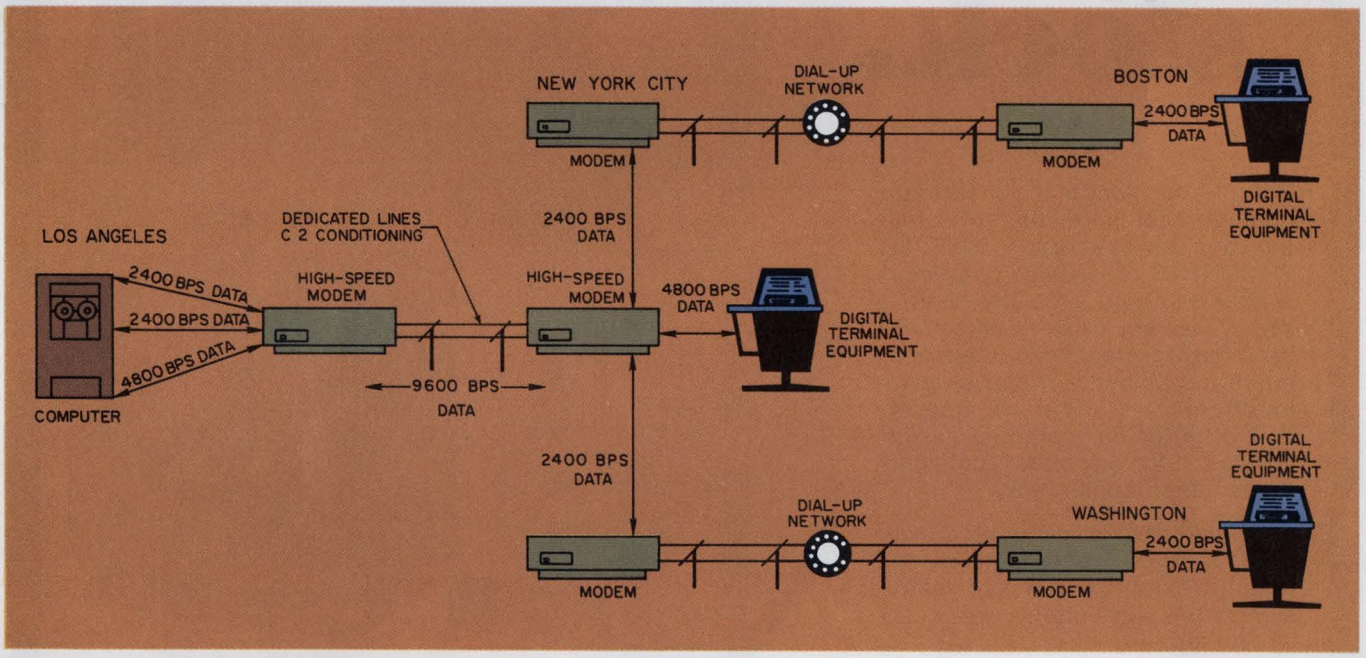
Keep the costs down

The way to evaluate any piece of equipment or operating procedure is to assess its effect on the total system costs. For example, Fig. 3 (top) shows a system that might be set up by an insurance or brokerage firm with offices in Boston, New York and Washington communicating with a main computer in Los Angeles. The operation



2. **Transversal equalizers can reduce envelope delay distortion** if the attenuators are properly set. To do this quickly, the equalizer must be made self-adjusting.





3. **This cross-country data communications system (top)** uses two C2 conditioned lines and one C4 line to connect four offices. The suggested lower-cost system (bottom) uses only one dedicated line to handle 9600 b/s, and relies on the switched telephone network to distribute low-speed signals. Obviously, the designer has calculated that the costs of the high-speed modems will be more than offset by the savings in line charges.

is a multi-speed (2400 b/s, 2400 b/s, and 4800 b/s) multi-channel cross-country configuration.

A way to cut the costs of operating this system, suggested by Richard A. Borysiewicz, a senior engineer at International Communications Corp., Miami, Fla., is shown in Fig. 3 (bottom). In the new configuration, two 9600 b/s modems route the multi-speed information between Los Angeles and New York City over a single C2 conditioned line. At New York, the 4800 b/s data is processed and the two 2400 b/s data streams are routed to Boston and Washington via 2400 b/s modems and the dial-up network.

By reconfiguration of the operation, one C4 and one C2 cross-country line have been eliminated. However, reduction of the operation to one cross-country C2 conditioned line has a disadvantage. If the line or the high-speed data sets should fail, all three facilities would be out of operation until the problem was solved. To assure full-time, noninterrupted operation, many data communication systems are being designed with redundant lines or dial back-up capability, and sometimes even back-up modems. With such an arrangement, the cost of one C4 cross-country line would be saved. ■■

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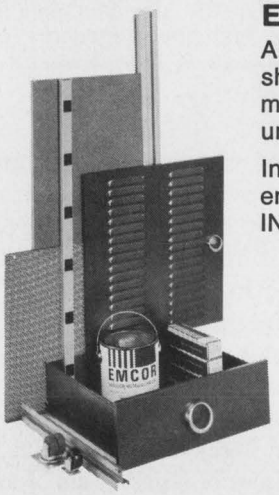

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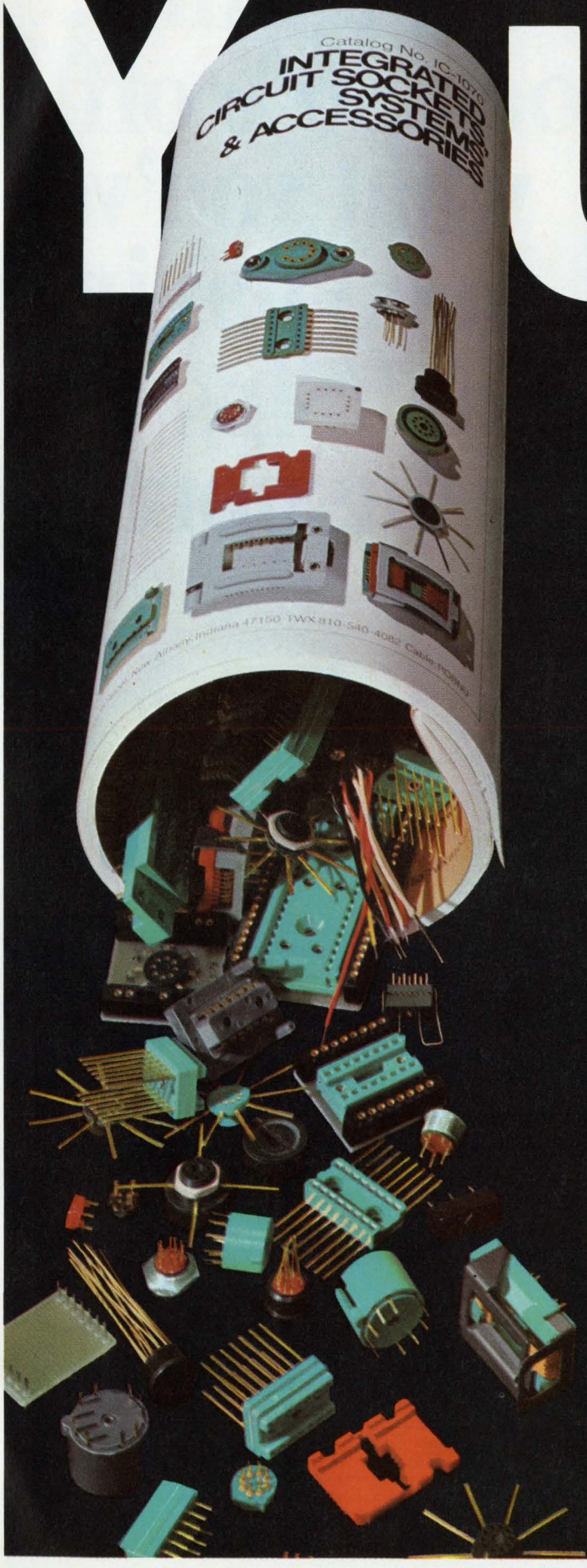

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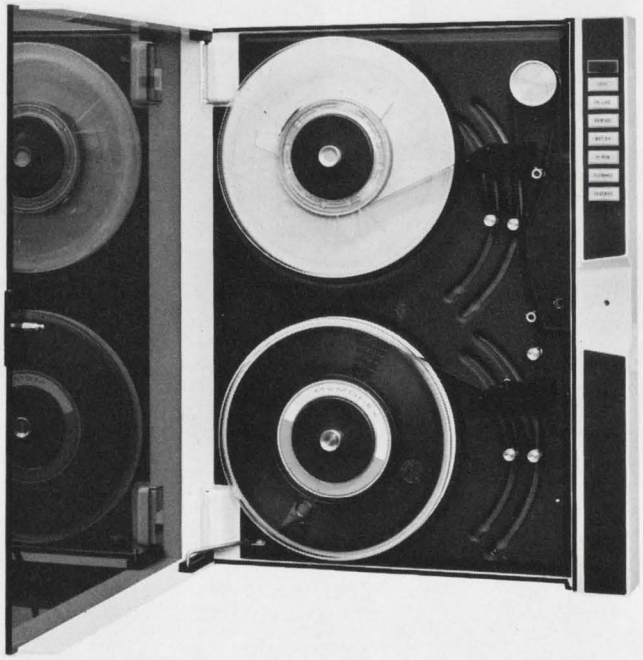

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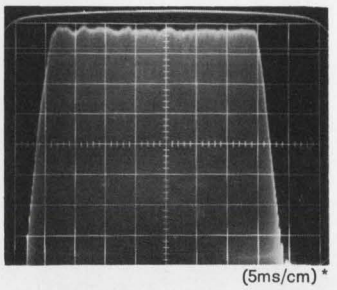

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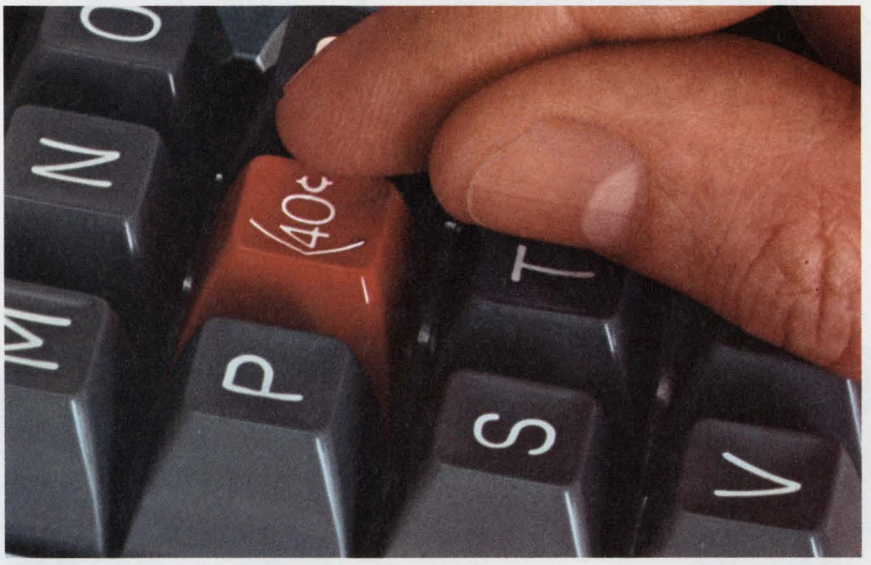

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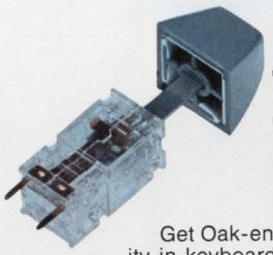

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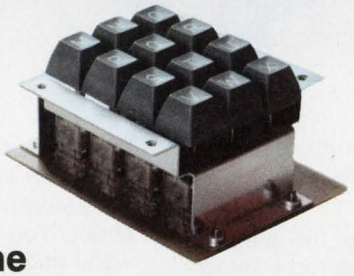

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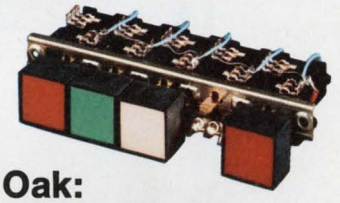

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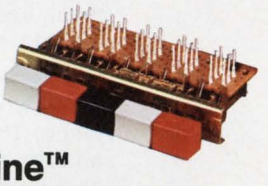

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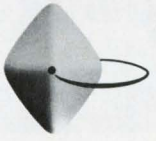

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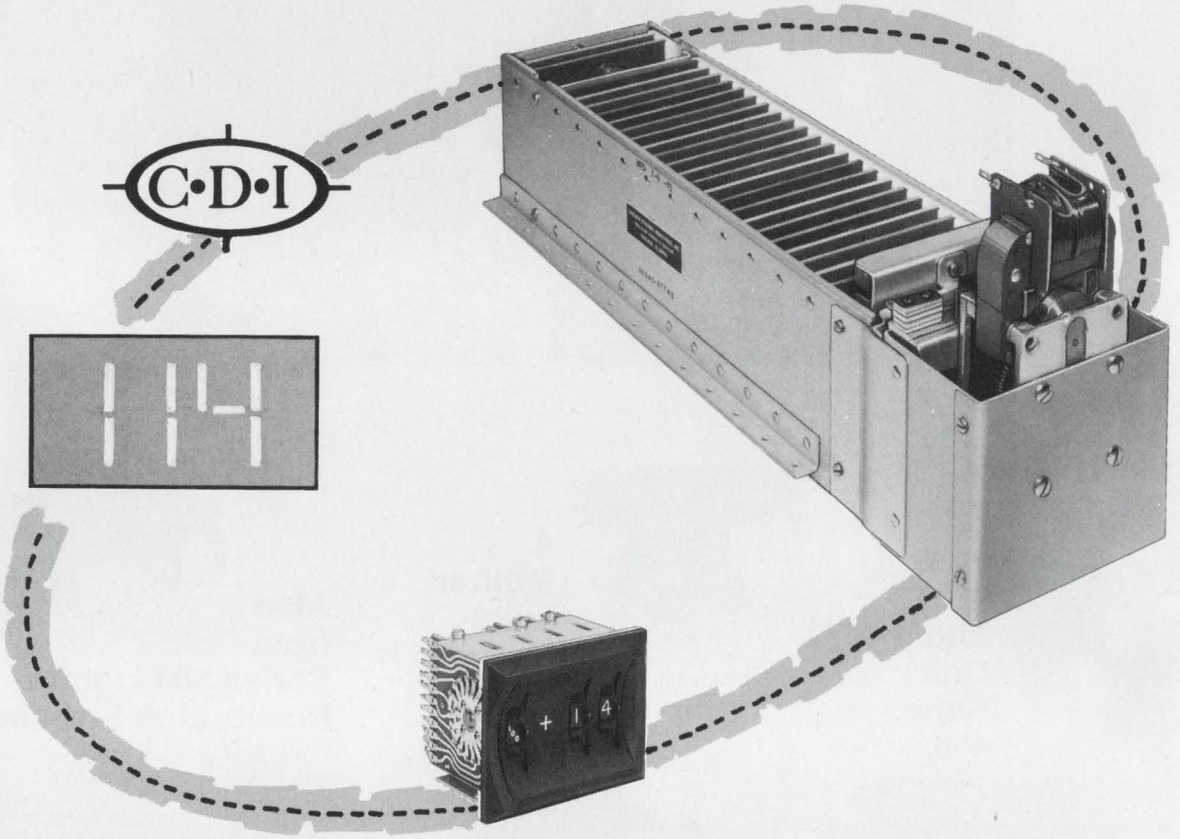

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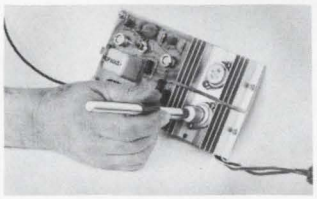

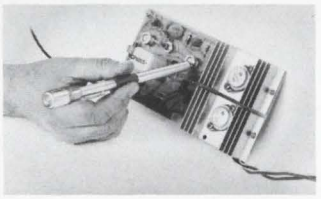

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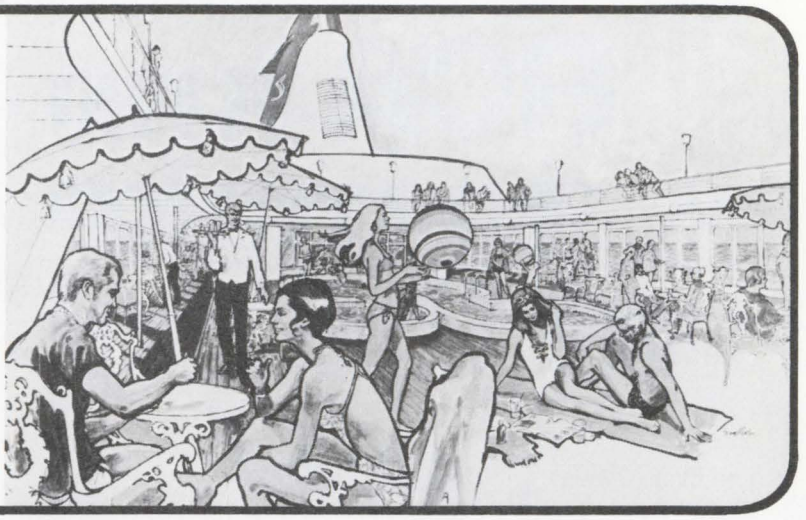

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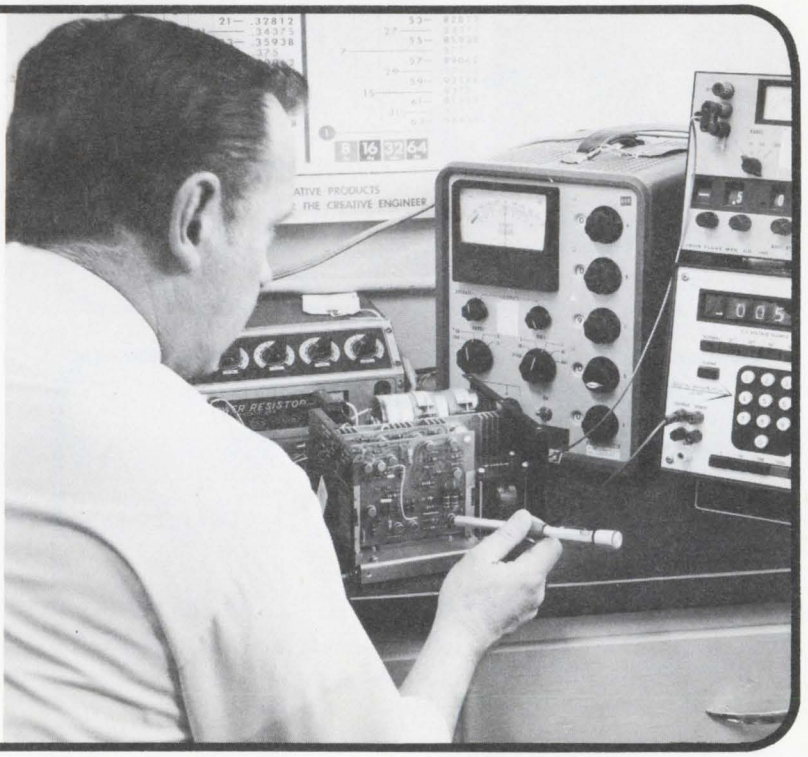

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Like any other engineering problem, you have to know your requirements and be able to evaluate a mini's performance in terms of them. In addition to the hardware specifications and costs, software implications are just as important. Software may cost as much or more than hardware.

Software characteristics, like hardware, affect the decisions of a prospective minicomputer user, but from different perspectives. The OEM purchaser seeks a minicomputer with programming capabilities matched to his application. High-quality, vendor-supplied software minimizes his own applications software development costs.

The end-user, on the other hand, often wants to use the computer in a stand-alone mode for off-line, general-purpose programming applications. He is often concerned about the ease with which his own programming staff can modify and extend the supplied software.

Minicomputer processing generally falls into one of the following categories:

- Data manipulation, requiring the minicomputer to receive, manipulate and output significant volumes of data. This processing is a major factor in such applications as telecommunications; data and text editing and format conversion; analog data acquisition and conversion; and information retrieval.
- Computational processing, requiring the minicomputer to perform nontrivial calculations, such as solving control equations. Such processing is critical in process control; on-line, real-time data reduction and signal processing, and computer graphics, among other applications.
- Control processing, requiring the minicomputer to sense rapidly status conditions—usually keyed to sampled input values—and to implement various procedures, such as initiating outputs when conditions are in certain prescribed combinations. This type of processing is represented in such applications areas as direct digital control and computer-aided design.

Estimate your applications

In judging the impact of minicomputer programming and software characteristics, the prospective user should first estimate the relative role that each of the three types of processing will play in his application. If a high degree of uncertainty exists, he should select a machine from a family of machines, so that when the actual use pattern emerges, the machine's cost and performance can be optimized through the use of options or by moving to a higher or lower speed processor within the same family of machines.

Among the more obvious hardware specifications to consider are these:

- CPU capability—logical and arithmetic operations and data handling.
- Word length—the number of bits in the computer word.
- Memory capacity—the total storage capacity of a basic machine for both instructions and data.
- Speed—the time required for a CPU to cycle through an instruction step, access memory or perform an I/O operation.
- Input/Output capability—manner in which peripheral devices may communicate with the CPU.
- Interface—the mechanical complexity of interfacing, and the tools, including documentation, provided by the manufacturer.

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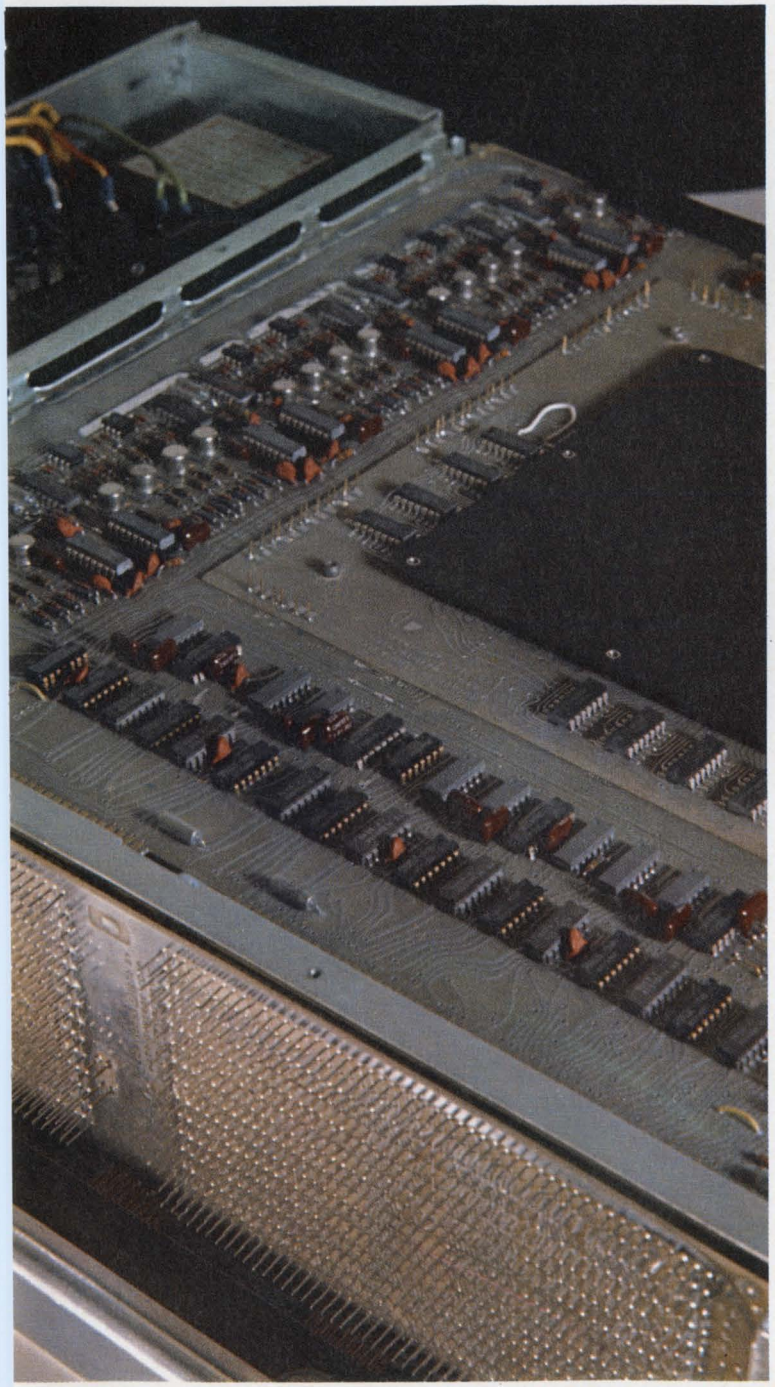
Equally important are some less obvious characteristics of the minicomputers. These are more difficult to evaluate and are often not recognized until some "hands-on" operation time has been logged by the user. Among this group of specifications are:

- CPU organization—parallel or serial, synchronous or asynchronous.
- Data/Instruction format—operation code, modifying and addressing fields.
- Diagnostics—the availability of programs for use in maintenance.
- Reliability/Maintainability—the expected MTBF and the effort required to repair and maintain the machine.



- Human factors—layout of the operator's control console, size and access to internal hardware.
- Peripheral availability—the types of off-the-shelf peripherals and controllers available.

Central processor unit organization

In the conventional computer system, the central processor unit (CPU) controls all peripheral input/output equipment, performs all arithmetic, logical and data-handling operations, provides memory storage of data and program, and sequences the program stored in memory.

Figure 1 shows a typical computer architecture. In this system the control unit and the memory are central, and the over-all performance of the system is keyed to the performance of the memory. This architecture normally results in synchronous timing and rather straightforward analysis.

When synchronous timing is used, execution of each instruction is controlled by a clock-signal. This can cause time delays if the machine has to wait for the next clock signal.

The application of MSI and LSI has led to more sophisticated CPUs, together with many attempts at adapting the basic architecture to satisfy particular application needs. One such variation is the "bus" organization (Fig. 2). This highly modularized technique makes it relatively simple to tailor a basic machine to a specific application. This type of machine tends to have a more complex control system and asynchronous timing. With asynchronous timing, different operations occur simultaneously in separate modules. This means that for two machines with the same cycle time, the one with asynchronous timing will execute programs faster than the one with synchronous timing.

Word length affects three other things

Computers operate on binary bits of information. The number of bits in a sequence that are treated as a unit and that can be stored in one computer location is known as a word length.

The trend has been toward use of word lengths that can be handled readily by peripherals. Thus most minicomputers contain core memory of 8, 12 or 16 bits (not including parity bits).

The word size affects three important characteristics: speed, memory size and cost. Speed—or machine cycle time, as used here—is the time

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Choosing the right minicomputer for your application—whether this Nova 1200 by Data General Corp., Southboro, Mass., or another—requires more than just evaluating hardware specifications. Software costs may equal or exceed the hardware costs.

required to execute an instruction rather than the time to access or cycle core memory. Machine cycle time generally increases as the word length decreases, because short word length leads to double-word instructions, which in turn requires more memory capacity. With double-word instructions, two memory accesses are required to obtain the full instruction word. This increases the machine cycle time by at least one memory cycle time. Some of the 16-bit minis also use double-word instructions extensively.

Also affected by word length is the data-transfer rate from peripheral equipment. Transfer of word lengths exceeding the capability of a single memory word reduce the effective I/O transfer rate by the ratio of the CPU word length to the data word length.

Therefore, in determining the word length for a given need, the user must not only satisfy the immediate need to handle data but also consider the impact upon speed, memory size requirements and arithmetic precision.

Memory: Two main factors to consider

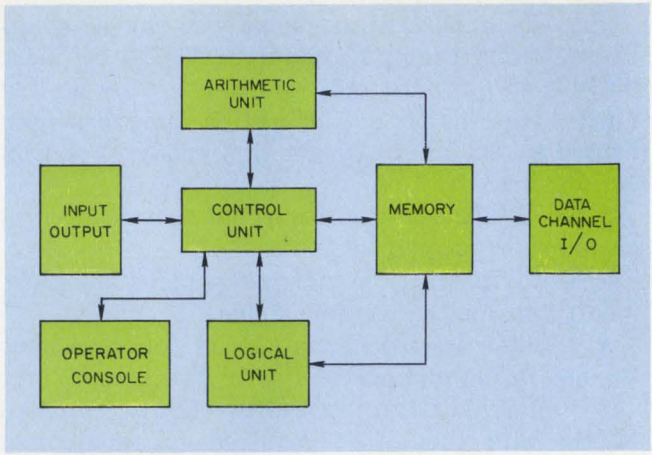
The main factors to consider regarding memory are the speed and maximum memory capacity of the basic CPU. The memory cycle time is, in most cases, the specification cited to indicate the CPU speed. As noted earlier, however, this can be a misleading specification, since the CPU must execute the instruction after it has been obtained from memory. Memory speed is important, since it largely determines the maximum instruction and I/O throughput rate.

The quoted memory speed is generally the full cycle time and includes the time required to read a word from memory and to restore the word, since a read operation from a volatile core memory destroys the contents of the location read. Also, in a store operation, the memory cell of interest must be cleared prior to storing new data in that location. Typical full cycle times range from 750 ns to 3 μs. Be careful. Make sure the cycle is clearly defined.

Volatile does not necessarily imply that the contents of core are destroyed in routine power-on sequencing. Most manufacturers implement interlocks to insure that the contents of the core memory are not modified by normal start-stop operations.

As usual, you can't get something for nothing. While the dollar cost of the fast memory may be reasonable, and in some cases about the same as for a slow memory, problems such as system noise susceptibility become very serious. Reduced noise immunity of the memory shows up as dropped and picked-up bits.

Noise leads to another consideration—that of memory parity bits. In general, the moderate-to-slow-speed computer memory systems do not contain memory parity bits. The manufacturing techniques used in producing magnetic cores and memory systems have led to highly reliable systems. However, because of the noise susceptibility of the faster core memories, serious consideration should be given to the availability of memory parity. On many minicomputers, memory parity is an available option.



1. **The system performance is keyed directly to the memory's operation** in minicomputers typically organized with a centralized memory and control unit.

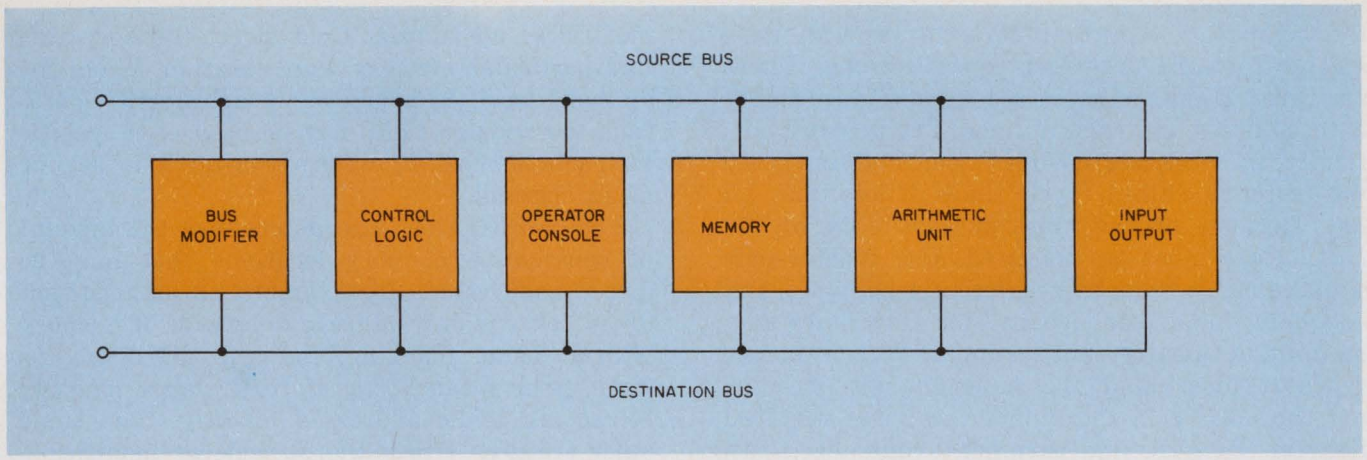
Another memory media is the read-only-memory (ROM). This is a nondestructive readout memory that is faster than core. ROM does not have the noise susceptibility of core, since its contents may not be accidentally altered once it is programmed. ROM cycle times range from 150 to 300 nanoseconds and can improve the CPU execution time proportionally. However, since the ROM's contents cannot be electrically altered easily, it can be used only to store programs of a permanent nature.

The price of solid-state semiconductor memories has dropped dramatically, and minicomputers organized around these ultra-high-speed memories with cycle times less than 300 ns are appearing in the marketplace. The solid-state memory is usually volatile. Its contents are lost when power is removed; it can be read out without re-writing, and it can be overwritten without having to be cleared.

Unless the minicomputer architecture exploits the higher speed of ROMs or IC memories, the actual processor speed may not be enhanced proportionally.

Speed is difficult to judge

Machine speed varies according to the operation being performed. This accounts for memory speeds quoted as a measure of the CPU speed. In general, those operations involving memory access take approximately twice as long as the



2. **A bus-organized architecture is one approach** for achieving greater flexibility in modern minis. Nonessential function modules may be omitted. Asynchronous timing reduces the time required to perform operations that are usually performed sequentially with a centralized architecture as shown in Fig. 1.

memory speed. However, some computer organizations take full advantage of memory access time (the time required before a memory word is available after addressing the word in read mode) to execute a large portion of the instruction cycle.

Speed also affects the complexity of interface controllers and system noise susceptibility. The interface controllers for external peripherals will be required to generate and handle higher speed control signals. This will require the interface designer to guard against radiated and coupled noise on the data and control lines. Speed, as with other characteristics, should be considered with the application in mind. Much grief and expense can be avoided by not chosing CPUs with speeds faster than those required by the application.

Input/output communication with CPU

There are two normal ways peripherals communicate with CPUs: by way of a programmed I/O channel, or a direct memory access channel. The programmed I/O channel requires an instruction execution for each data transfer, which for low data rate is not a problem. It represents a fairly straightforward and usually inexpensive method of data transfer. For high data rates, the direct memory access (DMA) is very useful.

DMA may be referred to as a data channel or a memory channel. The DMA allows a peripheral device to communicate directly with memory, using a minimum of CPU time. Data transfers are on a cycle-steal basis—that is, data is transferred between CPU instruction executions. This allows peripheral data transfers to operate concurrently with program execution. DMA is normally used for high-speed devices, such as magnetic tape, communications controllers and discs. Since the interface is directly with memory, more attention must be given to noise susceptibility.

High speed is not the only criteria for determining the applicability of direct memory access, because considerable software overhead can be absorbed by a relatively simple and slow-operating DMA controller.

Two types of DMA interfaces are common in today's minicomputers: those which employ basically the same data and address lines as the programmed I/O, and those which have an autonomous set of buses. The DMA interfaces operating on a time-shared basis over the standard I/O structure tend to be slightly more complicated than the programmed I/O controller. Because the interface is directly with memory, fast signals are involved and some additional consideration should be given toward insuring electromagnetic compatibility. The DMA interfaces which operate over a separate port tend to be more complex and costly since a completely different set of logic and controls is required.

In most minicomputers, both the programmed I/O and DMA systems operate on a priority interrupt basis. The programmed I/O has the capability of being controlled by the CPU.

The priority interrupt system typically has fixed priorities assigned according to the physical location on the I/O bus for single-level priorities or according to the level for multiple-level priorities. The number of priority levels specified by a manufacturer is generally not an effective measure of the mini's interrupt system capability.

The application will determine the importance of the priority interrupt and I/O capability. High-speed data acquisition systems will require high-level interrupts and fast data channels, whereas industrial control systems require more internal CPU data handling capability and can lower the speed of the I/O capability.

The complexity of the interface is governed by the need of the user and the organization of

the computer. Minicomputers, in general, have straightforward interface specifications. There are three groups of interface signals to consider: data, address and control lines. The greatest difficulty in interface design is encountered with the faster machines (cycle times of less than 1.5 μs), because of the noise susceptibility of the CPU. Care must be exercised. Use twisted-pair signal lines, adequate grounding techniques and adequate line-driver circuits. The data lines may be unidirectional or bidirectional. Both interface types require about the same amount of logic, but they differ in the number of wires required between the CPU and peripheral controller. Unidirectional data lines require twice as many interconnecting data lines as a bidirectional interface does. The address lines may be used by the CPU to address a particular peripheral and to identify an interrupting peripheral in a single-level interrupt system. In some systems the address lines are shared with the data lines, but this construction complicates the interface and usually slows data transfer. Address lines may also be unidirectional or bidirectional.

The complexity of the control lines is a function of the CPU construction and the type of channel interface. The DMA channel requires a more complicated interface than the programmed I/O channel, since the CPU does not act as an intermediary betwen memory and the peripheral. Where the application speed or peripheral device permits, DMA interfaces should be avoided to minimize the complexity of the interface design and susceptibility to noise. In either interface configuration, programmed I/O or DMA, care should be taken to minimize the load that an interface line must drive, and proper terminations on all lines to match the source and drive point impedances are critical. Large loads or unmatched lines can contribute radiated noise caused by reflected signals into other data or control lines. Proper grounding techniques are also essential to prevent ground loops.

Data instruction format sets machine speed

Word format, word length, CPU speed and memory capacity are all very closely related. As the demand for a more sophisticated instruction set becomes apparent, the word format will normally tend toward a longer word length, which, in turn, affects memory capacity and the instruction execution time.

The word format can be broken into three fields: the operation code (op code), the address modifier and the address field. The op code specifies the type of operation to be performed—for example, memory, logical or arithmetic operations. When the op code specifies memory, the address modifiers and address field direct the operation to a particular memory word location. When the op code specifies a logical or arithmetic operation, the address field may be used as a specific instruction sub-code within the op code set, or as an operand.

The address field size determines the amount of consecutive memory locations that may be directly addressed. For example, an eight-bit address field can only address 256 words of memory without using indexing, indirect addressing or some other means. Therefore, if large memory blocks are to be addressed directly, then some other feature—either the op code or modifier—must give up some capacity.

A final word about instruction word and address field formats: On occasions it may be desirable to code in ONES and ZEROs, and it is handy if the processor operation codes, addressing mode, address and I/O control fields form orderly, contiguous bit fields. Most minicomputer users and end users generally don't care whether the bits are splattered entirely across one or more instruction words, so long as they are provided with a good assembler and debugger. Nevertheless, if extensive console debugging by inexperienced personnel is anticipated, considerable weight should be given to the orderliness of the instruction word format.

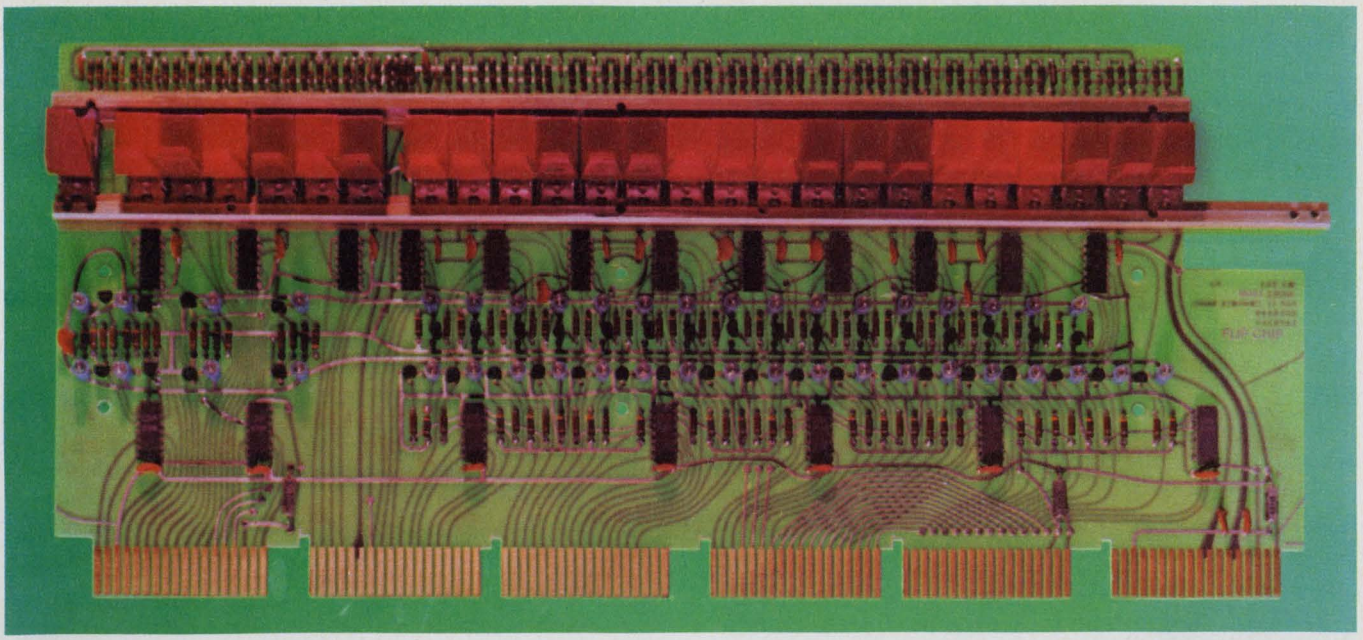
Registers: How many and what kind?

Most of what happens in a minicomputer program gets done in registers. As a general rule, all arithmetic, logical and indexing operations are either register-to-register or register-to-core. In some machines the registers are divided by class—arithmetic registers, index registers, status registers—while in others, registers are multipurpose. In most applications, the efficiency (speed $\times$ size) of programs is related directly to the number of registers. This results from the fact that register-to-register operations are almost always faster than those involving core locations. In addition, when only a few registers are available, intermediate results must often be stored temporarily in core to free a register—a costly operation in terms of execution time and core storage overhead.

It should be noted that registers, as used here, refer to program-accessible dynamic storage units. Some manufacturers include a large number of status bits and temporary, non-accessible registers in their total register complement.

Three different addressing modes

In most minicomputers, instructions such as LOAD and STORE reference core locations by



The first step in the selection of a minicomputer is to determine the system requirements. This task is all too often overlooked. Circuit modules—such as this unit for a programmer console and control panel made by Digital Equipment Corp., Maynard, Mass.—must be designed specifically for the end use of the system.

various addressing modes. In other words there are different ways of computing the address of the location referenced. The common addressing modes are direct, relative and indexed modes.

In the direct addressing mode, the address is a bit field of the instruction word itself. Direct addressing modes are either one-word or two-word. In the one-word direct mode, the address is usually formed from seven to eight bits of a single-word instruction. In this mode only a restricted area of core can be referenced. This is overcome in the two-word direct addressing mode, where the address is extracted directly from selected bit fields of a two-word instruction. In this manner any location in core can usually be referenced.

In the relative addressing mode the address is a positive or negative displacement from the address of a particular status register, such as the program count register or a specified page register. The absence of the relative addressing capability in a particular machine may restrict the ease of generating relocatable code (programs executable with any arbitrary area of memory). But relocatable programs are usually less efficient than their absolute counterparts.

The operand address in an indexed mode is contained in a register that is set up before the instruction is executed. Index registers usually have automatic incrementing and decrementing features. These are useful in sequentially accessing arrays of data in memory buffer areas.

In most computers these addressing modes can be modified to operate indirectly. One-word direct and relative addressing modes are usually the least time-consuming, but they limit the area of core that can be referenced. Their primary impact is on control processing programs, and in any program where core storage space or execution time is critical, the low core and execution time of these two modes can be a great advantage.

Although somewhat slower than the direct mode but usually faster than the indirect mode, the indexed mode allows any location in core to be addressed. Its primary impact is on applications programs involving data manipulation processing. Because registers can be incremented or decremented faster than core locations, the indexed mode is efficient for accessing sequential addresses.

Indirect addressing often has an impact on time-critical programs, since one indirect addressing instruction can often perform an operation requiring two instructions in a machine without indirect addressing. In most applications fetching the indirect address once or twice will suffice.

The absence in a machine of one of the addressing modes will have a definite impact on programming efficiency in applications where storage or execution time is critical.

Instruction repertoire is very important

Every computer comes with its own set of instructions that will interpret and execute directly. The manufacturer will usually list the number of instructions and the execution time for each. But since each machine operates differently, you can't just assume that the machine with the biggest instruction set is best.

The best way to compare minicomputer instruction sets is to code benchmark routines in each and make the comparison on the basis of total execution time and the number of instructions required. The benchmark routines used should be related to the proposed minicomputer application.

Suggested benchmarks are as follows:

Data manipulation processing

1. Interchange the contents of two arrays in core.
2. Generalized byte fetch procedure. (For 12-bit and 16-bit machines, load the lower half of a register with a half-word byte, either upper or lower, of a core location. The upper half of the register should be zero at the end of this operation.)
3. Count the number of one-bits in a register and leave the result in another register.

Computation processing

1. Add the contents of two arbitrary core locations and store the results in a third location.
2. Perform a fixed-point multiplication with software.
3. Arithmetically compare (less than, greater than or equal) the contents of two registers and branch to one of three locations, depending on the results of the comparison.
4. Perform a double precision right shift of two registers—the lower bits of one register shift into the upper bits of the other—with the number of shifts being specified in a third register.

Control processing

1. Search a list of values whose starting address is in a core location, to find the list value equal to the contents of a register.
2. Branch to one of four different arbitrary addresses, depending on the value of two adjacent bits in a register. The bits should not be the low-order or high-order bits.

Interrupt processing takes time

Interrupt latency is one of the most crucial elements of real-time programming applications. It is the time required for the computer to sense an external interrupt condition and to transfer control to a processing sub-program for that condition. The functions involved to carry this out are usually performed by a mixture of hardware and software processing, depending upon the computer. These functions include:

- Terminating normal CPU operation once the machine has completed the instruction it is executing.
- Disabling the interrupt system temporarily.
- Determining the source of the interrupt.
- Saving the current contents of all registers.
- Enabling a portion of the interrupt system in accordance with a priority level schedule.
- Transferring control to a subprogram to service the interrupting device.

Few quoted latency figures include all of these steps, but all of the steps contribute to the actual latency of a minicomputer. The service demands of the various system components should be measured against this actual latency. The real-time user is particularly concerned with minimum latency, conservation of core and flexibility. In other systems, a particular device may be time-critical, even though the application is not.

Floating-point arithmetic improves precision

Minicomputer architecture seldom includes floating-point arithmetic capability in the hardware. In some process-control and computation applications, the numerical dynamic range and precision afforded by floating-point arithmetic is required. In such applications, time requirements usually permit use of software-implemented floating-point procedures.

Two approaches to software-implemented floating point are subroutines and interpreters.

In the subroutine approach, the minicomputer seller usually supplies a set of floating-point subroutines that may be called by user programs.

In the interpreter approach, the seller supplies one basic routine: the floating-point interpreter. The interpreter can examine sequential core locations and "interpret" their contents as floating-point instructions, thus simulating the operation of a CPU with floating-point hardware.

The main advantage of the interpreter approach is tremendously increased programmer convenience, since floating-point instructions can usually be coded naturally in sequence with normal hardware instructions. However, the interpreter approach usually takes longer than the subroutine approach. When software approaches prove too slow for the application, check for the availability of floating-point hardware.

Software supplied may not be adequate

The software supplied by today's minicomputer manufacturers generally falls into one of two classes: development and general-purpose. Development software—such as assemblers and loaders—is of primary concern to OEMs, since it provides the basic software tools for producing applications programs. General-purpose software

packages, such as compilers and manufacturer-supplied application packages, are often of more concern to the end-user, who requires some special programming capability.

Virtually all mini manufacturers supply the following development software packages:

- Assembler: This allows the programmer to code in a symbolic language that is usually in one-to-one correspondence with the actual machine instructions. Minicomputer assemblers usually produce program listings on a teletypewriter and object tapes on a paper tape punch.
- Loader. This loads the object tapes produced by the assembler.
- Editor. This allows the programmer to update source tapes by inserting or deleting lines and characters.
- Arithmetic and utility routines. These give the programmer often-used functions, such as single and double-precision fixed-point arithmetic binary-BCD conversion.

This development software, especially the assembler, can have a dramatic impact on application program preparation by significantly reducing labor required to produce large minicomputer programs. The elements to be considered in evaluating assemblers are as follows:

- Assembler size. If a minimum sized minicomputer (4 k) is used for software systems development, it is extremely important that the assembler operate on a fairly large source program in the 4-k environment.
- Assembler operating procedures. Most minicomputer assemblers will require three passes of the source program if the sole I/O device is a Teletypewriter. In the first pass the assembler creates a symbol table. A source listing on the page printer and an object code tape on the punch are then produced in separate passes. The two latter passes can, and should, be combined if separate listing and primary output devices are available. Assemblers requiring more than three passes to produce a listing and object tape should be approached with caution.

The amount, and nature, of general-purpose software provided by minicomputer makers varies widely. The end-user, who is concerned with using such packages as minicomputer FORTRAN, BASIC, COBOL and seller-developed application packages, should examine the efficiency and operating procedures of the packages. A FORTRAN compilation, for example, may require too many source tape passes in a 4-k minicomputer/Teletype configuration. The prospective user should judge efficiency by running benchmark programs and evaluating the results, based on run time and code storage consumption.

Software is normally provided by the manufacturer to help diagnose and maintain the processors and interface controllers that he supplies. The construction of the controller dictates the amount of sophistication needed in the software. If a mother-board technique is used, the diagnostic software must pinpoint the component that may be bad. Otherwise it can be very expensive to replace the entire controller board, since it may well contain other controllers. If the construction is modular in approach, using plug-in printed-circuit boards—which individually are not very expensive—the software need only identify the suspect board.

If the manufacturer does not offer a complete line of peripherals, then the designer must plan on writing his own diagnostic software, or else have competent people provide the maintenance. Either way, this can be expensive.

Reliability vs maintainability

Reliability is often overlooked in evaluating minicomputers. Technological advances have produced extremely reliable components, but reliability figures are still difficult to obtain, because in many cases only estimates will be available until the machines have had an extended operating history. If the reliability estimate is not high, or if the application is critical, then maintainability becomes very important. Do the construction techniques and the furnished diagnostic aids facilitate fast repair of the machine? Physical inspection of a demonstration unit may be helpful in finding the answers.

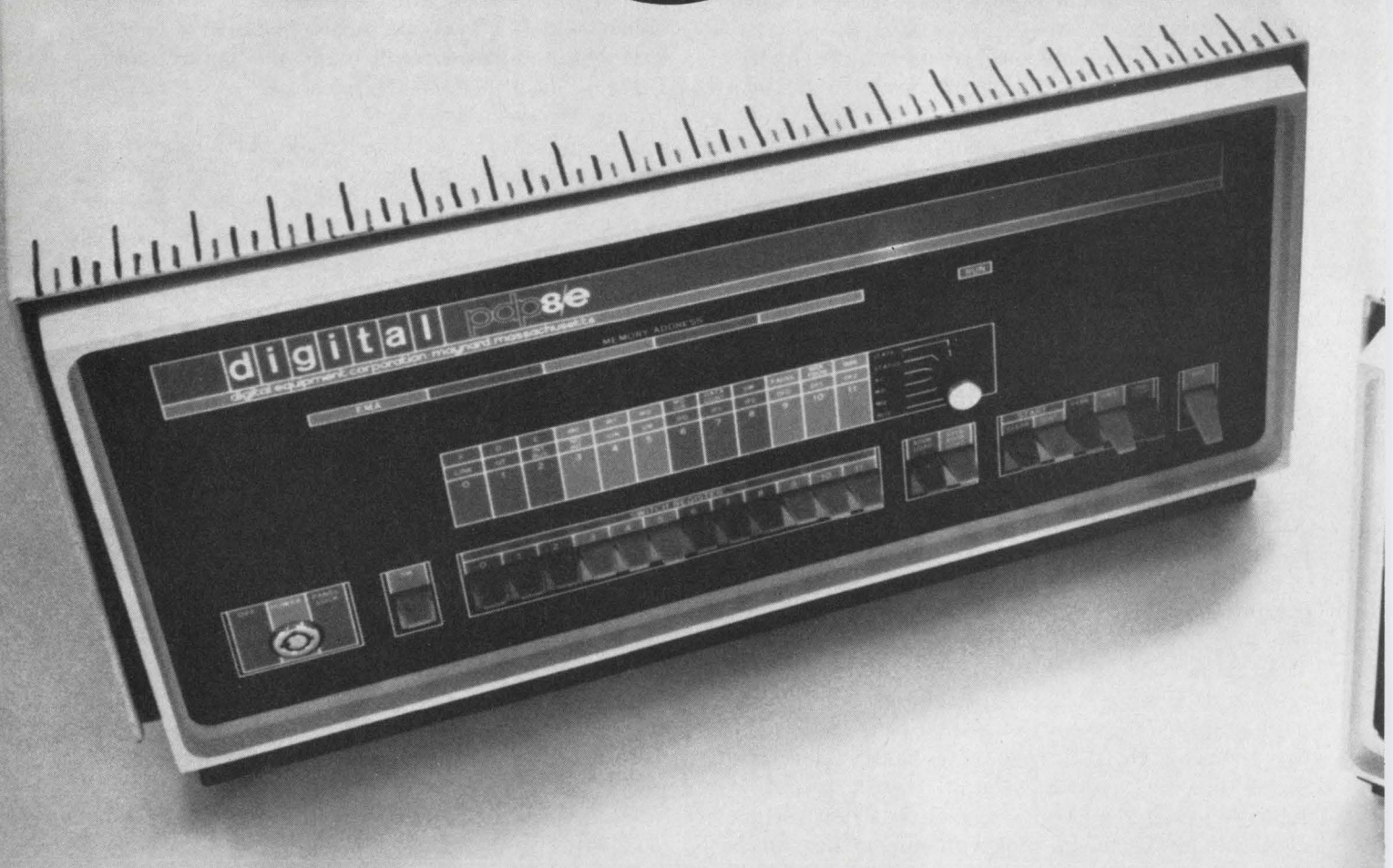
Don't forget the human factors

The layout of the operator's console—the switches and display and their configuration—can affect the operator's efficiency. The size of the CPU mainframe and the construction concept may create system packaging problems that can be costly to overcome. The evaluator should determine if his mainframe is a complete system or if extra modules will be necessary to provide memory and power. Another point to consider is the ability to install interface controllers inside the basic mainframe.

Finally, the buyer should be conscious of at least the following other factors: the terms of the contract under which the equipment is to be purchased; and the arrangements for maintenance and spare parts.

Warranty, service and field-upgrade policies vary widely from manufacturer to manufacturer. There is no perfect contract, and standard policies are hard to change. But you never get what you don't ask for. Above all, the contract should be thoroughly understood and reviewed before it is signed. ■■

The Yar



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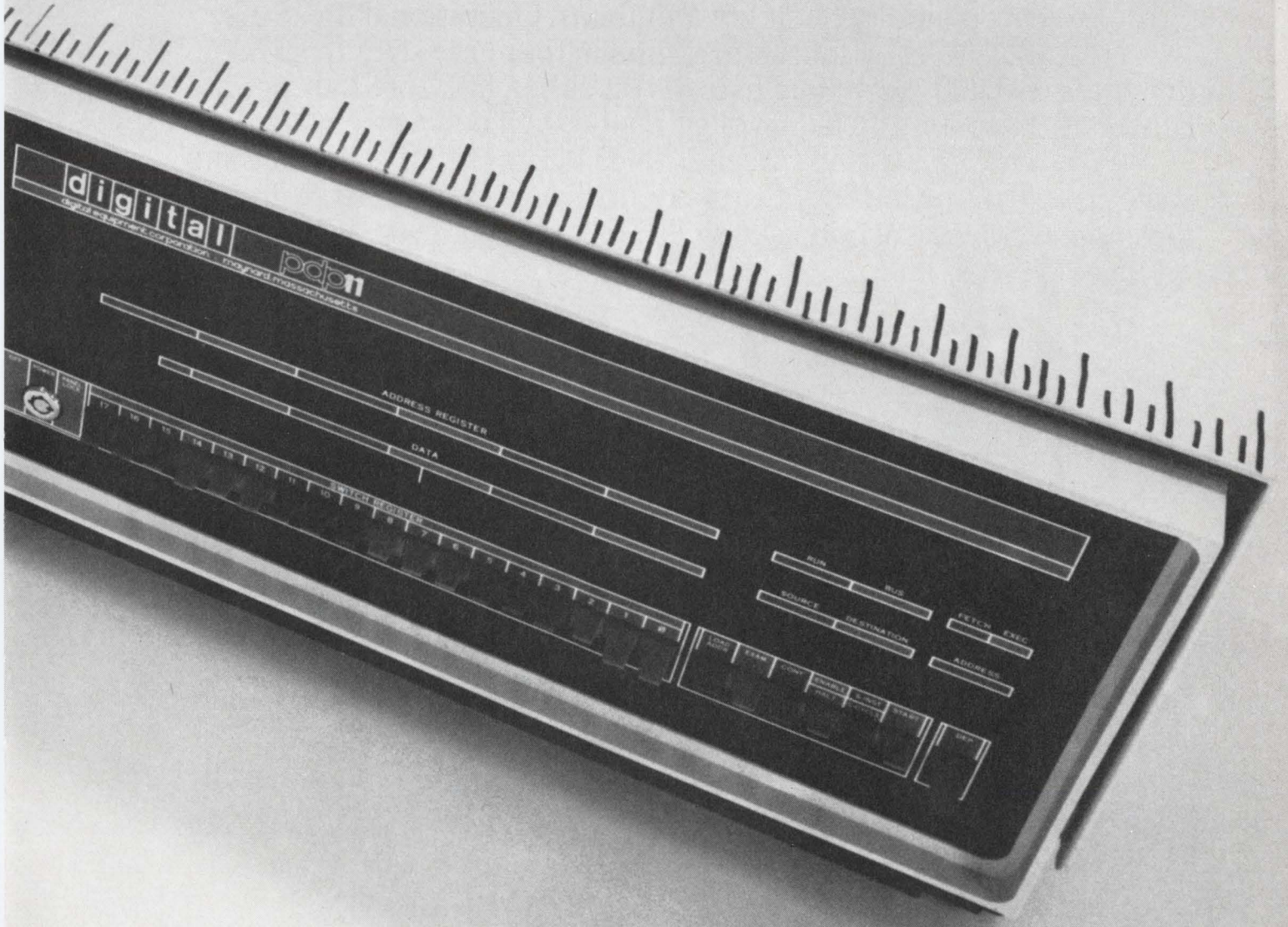
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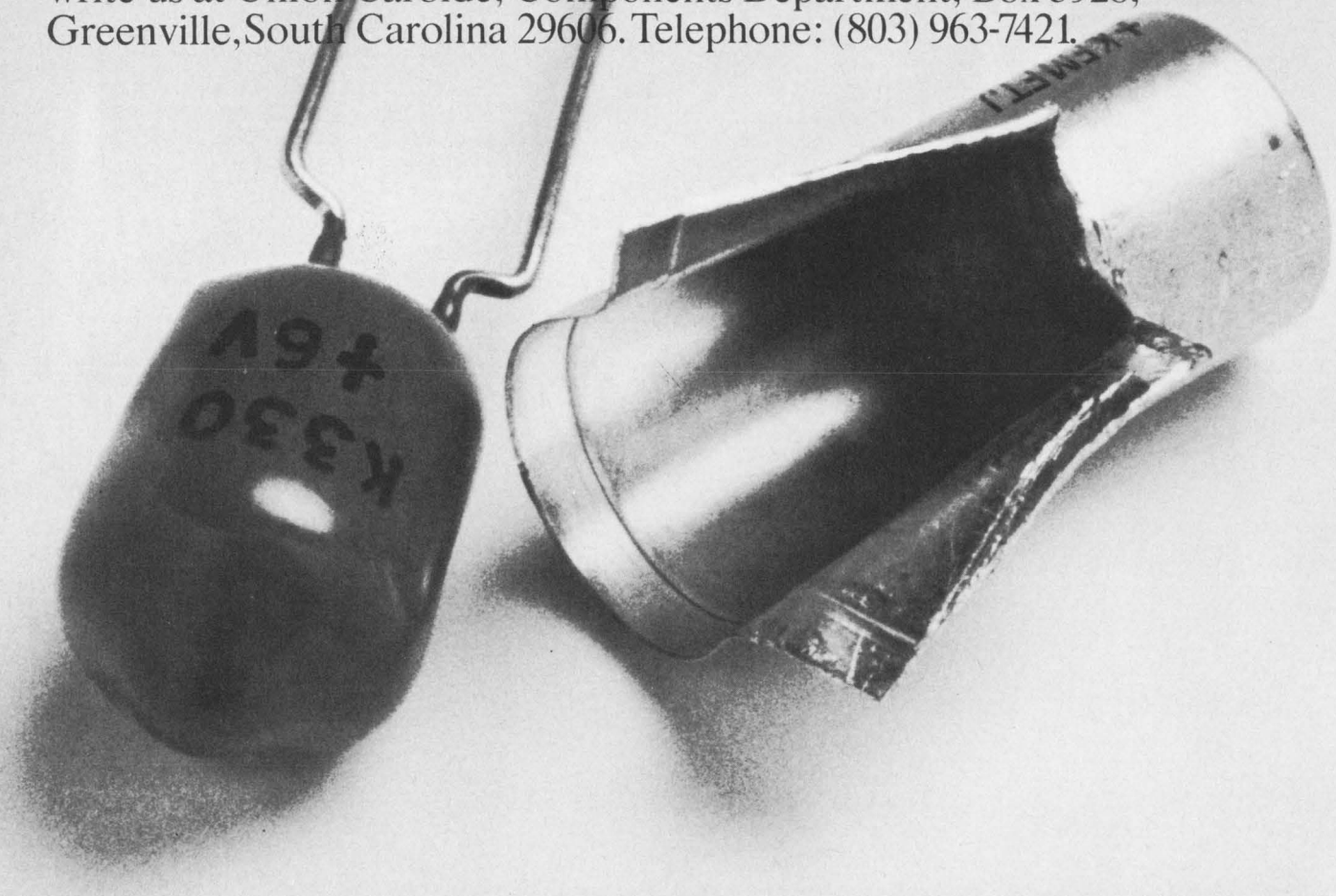

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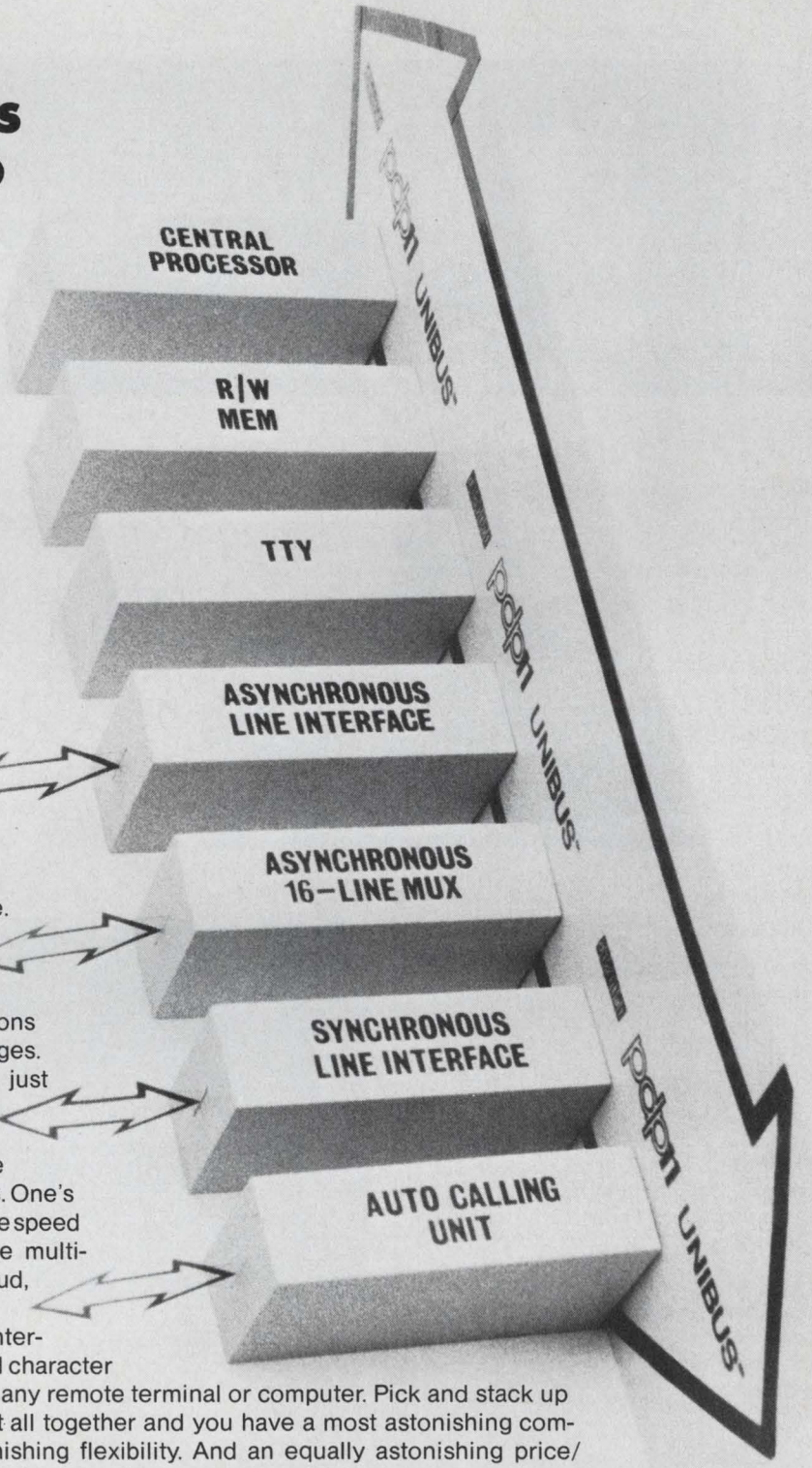
UNION CARBIDE COMPONENTS DEPARTMENT

The PDP-11 family grows on. This month: Communications hardware that lets data come and go as you please



Just follow the arrows. Pick out the hardware you need, plug it in, and you have a data communications system. Fast. Easy. And less expensive than you might expect.

How so? It all begins with the architecture of the 16-bit PDP-11. A whole new way to build computers. So every device is independent. Pluggable. And can communicate directly with other devices.

That's because of the UNIBUS™. A common communications path that handles 8-bit bytes and 16-bit words with equal ease. It's asynchronous. Bidirectional. Acts just like a multiplexer.

It plugs right into any device you have now. Any device you'll want to add in the future. And that's just half the story.

We've done the same thing with software. Come up with a modular, expandable, communications-oriented multi-task executive (COMTEX-11). It's a data-transparent front end for your applications programs. With terminal applications packages. Interrupt service routines. It's pluggable, just like the hardware. To give you a good head start on any communications program.

And now we've added four new interface units. Two are asynchronous line interfaces. One's a single-line unit with both programmable line speed and character size. The other is a 16-line multiplexer that handles data rates up to 1200 Baud, and can be stacked to handle over 200 lines. We've also got a synchronous line interface that'll program both sync character and character size. And an auto calling unit for dialing up any remote terminal or computer. Pick and stack up what you need, then add your data. Pull it all together and you have a most astonishing communications systems package. With astonishing flexibility. And an equally astonishing price/performance ratio. Just what you'd expect from Digital. After years of experience in data communications. After delivering over 10,000 mini-computers. After building more types of computers than anyone else. Anywhere. Our PDP-11 communications systems package is a big idea. You really ought to read up on it. Write for the brochure. Next month still another member will join the PDP-11 family. Digital Equipment Corporation, Main Street, Maynard, Mass. 01754 (617) 897-5111.

digital

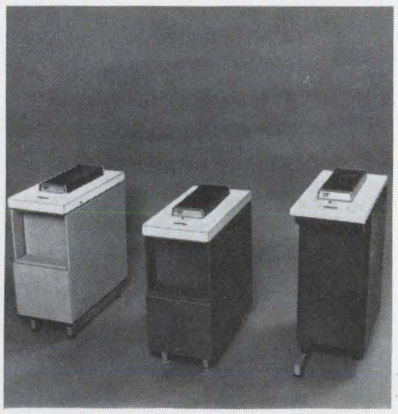
INFORMATION RETRIEVAL NUMBER 129

It's true.

After helping a jillion feet of paper tape wind and unwind its way through communications systems everywhere, Teletype announces the addition of magnetic tape data terminals.

There are some basic advantages in both mediums. But as you are well aware, the medium that's right for a system depends a lot on the application criteria.

The new magnetic tape data terminals have many operational features that make life less complicated for the operator.



New, modular line of Teletype® 4210 magnetic tape data terminals.

For example, take a look at the tape cartridge, which was specifically designed for reliability required for data transmission.

Its vital statistics are: 3″ x 3″ x 1″.

It contains 100 feet of ½″ precision magnetic tape.

It will hold 150,000 characters of data, recorded at a density of 125 characters per inch. The equivalent of a 1000 foot roll of paper tape.

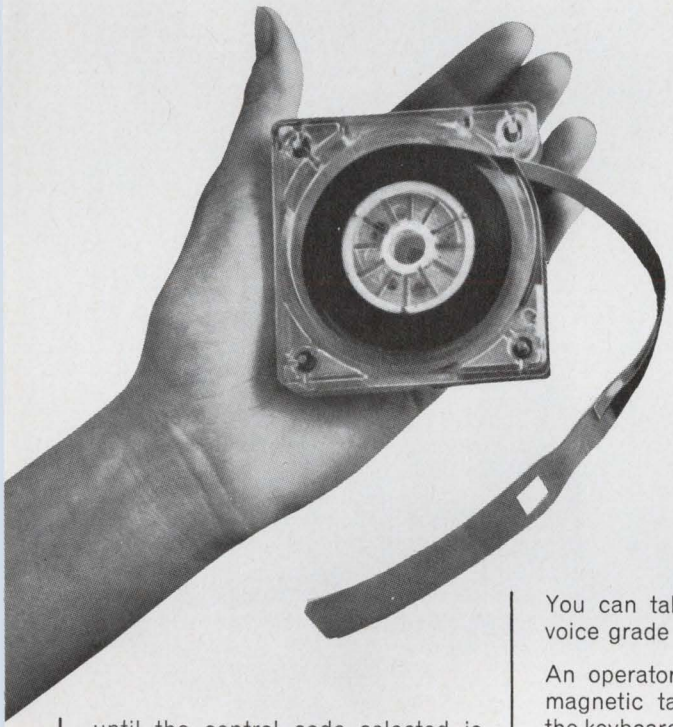
This means that your data is easier to store, easier to handle, easier to work with than ever before. And it's reusable.

Teletype is a trademark registered in the U.S. Pat. Office.

The units have a "fast access" switch which will move tape forward or reverse at a speed of 33 inches per second. A digit counter provides a reference point to help locate various areas of the tape.

Four ASCII control code characters can be recorded in the data format to aid character search operations. When the terminal's "search" button is pressed, tape moves at the rate of 400 characters per second until the control code selected is detected. Then the terminal stops the tape automatically.

A "single step" switch is also provided which enables you to move the tape forward or backward one character at a time. In editing or correcting tape, you can send a single character using this feature.



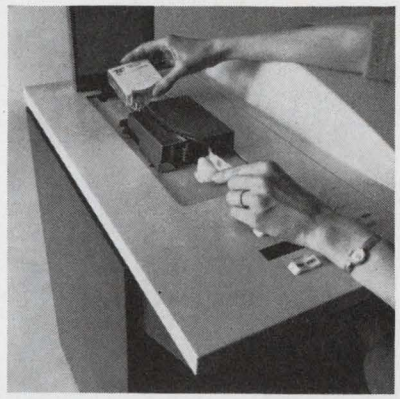
Also magnetic tape adds high speed on-line capability to low speed data terminals.

You can zip data along the line at up to 2400 words per minute. For example: Take a standard speed Teletype keyboard send-receive set, and a typical typist. Add a new magnetic tape unit to this combination and the on-line time savings can pay for the magnetic tape terminal in short order.

You can take better advantage of voice grade line speed capabilities.

An operator can prepare data for magnetic tape transmission using the keyboard terminal in local mode. Then send it on-line via the magnetic tape terminal up to 2400 words per minute.

These new modular magnetic tape data terminals offered by Teletype are perfectly compatible with model 33, model 35, model 37 and Inktronic® keyboard send-receive equipment.



Straight-through threading makes tape loading and unloading exceptionally easy.

They can send or receive at high or low speed. Or can be used independently as stand-alone terminals on-line.

If you would like to know more about this new line of Teletype magnetic tape data terminals, please write Teletype Corporation, Dept. 89-15, 5555 Touhy Avenue, Skokie, Illinois 60076.

Teletype 4210 magnetic tape data terminal with 37 keyboard send-receive set.

TELETYPE

machines that make data move

INFORMATION RETRIEVAL NUMBER 130

DATA GENERAL MAKES OUTRAGEOUS CLAIMS.

OUTRAGEOUS CLAIM #3.
Big Configurations: We promised we could put main frames, peripherals, and software together at prices as low as our main frames, and we're delivering.

OUTRAGEOUS CLAIM #2.
Nova 1200, Nova 800, Supernova SC: we promised three fast new mini computers, and we're already delivering ahead of schedule.

OUTRAGEOUS CLAIM #1.
Nova and Supernova: we promised the best small computers in the world, and we've delivered on that promise more than 1,000 times.

OUTRAGEOUS CLAIM #4.
Software: We promised the biggest single package of mini computer software ever, and we delivered FORTRAN IV, ALGOL 60, Time Sharing BASIC, Disk Operating System, and lots more.

True.

It's always been this way.

Ever since we said that our first 16-bit multi-accumulator mini computer, the Nova, was the best small computer in the world.

That we'd back everything up with software, peripherals, and world-wide sales and service. That we'd become a high volume manufacturer in a hurry.

Well, we've delivered on all counts.

With one very interesting result: We still make outrageous claims. But with our delivery record, people simply refuse to be surprised by anything we say.

For instance, we introduced three new members of the Nova line, featuring LSI, MSI and all-monolithic memory, at the 1970 Fall Joint, and the only people to get nervous were the competition.

We told everybody that the Nova 1200, the first mini computer to take advantage of large- and medium-scale integration to achieve maximum speed and reliability, was the least expensive multi-accumulator 16-bit computer on the market.

Did we shake anybody up?

No, we just wrote orders.

And then, to cap it off, we delivered the Nova 800 a month ahead of schedule, and the Nova 1200 two months ahead of schedule (which is really outrageous in this business).

At the same time, we introduced the Supernova SC.

Here we are, the cocky young kid on the block, introducing the first all monolithic memory in a mini computer and people didn't just accept it. They expected it.

Now we're telling people that it's not enough to love us for our low main-frame prices. They should love us for the way we can put main frames, software and peripherals together in configurations that meet real-world computing requirements at the lowest prices possible.

Reaction? Disk Operating Systems, Real-Time Operating Systems, Time Sharing BASIC Systems, all kinds of systems, are installed and running. Right now.

Sure we make outrageous claims.

But with more than 1000 computers, and all kinds of software, peripherals, and systems installed all over the world, it's getting harder.

Because people are simply buying everything we say.

DATA GENERAL

Southboro, Mass. *(617) 485-9100* / Hamden, Conn. *(203) 624-7010* / Commack, L.I., New York *(516) 368-3304* / Rochester, New York *(716) 235-5959* / Saddlebrook, N. J. *(201) 843-0676* / Bryn Mawr, Pa. *(215) 527-1630* / Washington, D.C. *(202) 296-0380* / Atlanta, Georgia *(404) 458-0118* / Orlando, Fla. *(305) 425-5505* / Chicago, Ill. *(312) 539-4838* / Cleveland, Ohio *(216) 486-5852* / Houston, Texas *(713) 622-2820* / Dallas, Texas *(214) 233-4496* / Denver, Colorado *(303) 758-5080* / Manhattan Beach, Cal. *(213) 376-7917*/ Palo Alto, Calif. *(415) 321-9397* / London, England *01 499 7735* / Munich, W. Ger. *0811 29 55 13* / DATAGEN OF CANADA LTD.: Hull, Quebec *(819) 770 2030* / Montreal, Quebec *(514) 341 4571* / Toronto, Ontario *(416) 447 8000* / Vancouver, British Columbia *(604) 731 2711.*

INFORMATION RETRIEVAL NUMBER 131

Hard-copy unit interfaces displays

Tektronix, Inc., Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $3750; 60 days.

The new 4601 hard-copy unit produces paper copies from CRT displays of the following Tektronix products: the T4002 graphic computer terminal, the T4005 graphic display and the 611 11-in. storage display unit. Upon receipt of a manual or computer-controlled command, the 4601 produces an 8.5 by 11-in. reproducible copy within seconds at 8¢ per copy.

Booth No. 2501 *Circle No. 256*

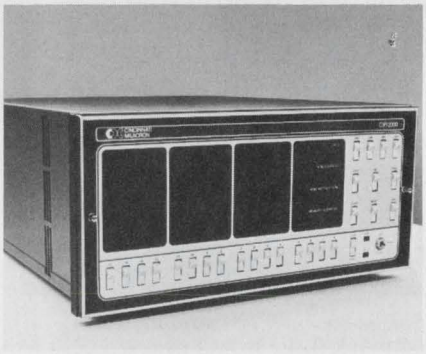
29-ms disc drive stores 58 megabits

Information Storage Systems, Inc., 10435 N. Tantau Ave., Cupertino, Calif. Phone: (408) 257-6220. P&A: $14,500; June, 1971.

A new disc drive with an access time of 29 ms and track-to-track access of 7 ms offers a storage capacity of 58 million bytes. The 715 uses 406 cylinders on a standard 2316 disc pack. It is compatible with a variety of computer equipment and is adaptable to controllers handling a 312,000-byte/s data rate.

Booth No. 1239 *Circle No. 284*

8-bit minicomputer cycles in 1.1 μs



Cincinnati Milacron Co., Lebanon, Ohio. Phone: (513) 494-1200. P&A: see text; 30 days.

The CIP/2100 is an 8-bit minicomputer with a 1.1-μs cycle time, designed for real-time systems applications by OEM users. A wide variety of processors and peripheral equipment options are available. The minicomputer is available with a single IC ROM board. Prices begin at $4565 for a basic CIP/2000 with IC ROM and 4k-by-8-bit core memory.

Booth No. 1759 *Circle No. 276*

Silent MOS/LSI terminal is completely portable

Texas Instruments, Inc., Digital Systems Div., 12203 Southwest Freeway, Stafford, Tex. Phone: (713) 494-5115. Availability: 30 days.

The new model 725 silent and portable data terminal for time-sharing users features a built-in acoustic coupler packaged in a luggage-type carrying case. It contains MOS/LSI ICs, standard printing speeds of 10, 15 or 30 characters/s, half or full-duplex operation and adjustable print contrast. Transmission is at 110, 150 or 300 baud over telephone lines.

Booth No. 1505 *Circle No. 296*

4k 16-bit minicomputer prices down to $5400

Varian Data Machines, Irvine, Calif. Phone: (714) 833-2400. P&A: see text; June 1971.

The 620/L minicomputer, a new lower-cost successor to the popular 620/i, features a 16-bit 4k processor that is 100% software and peripheral compatible with the 620/i, for just $5400. The basic configuration is memory expandable in 4k-word increments for only $2300 each. Features include 4096 words of core memory, a party-line I/O bus, direct memory access and a power supply.

Booth No. 2619 *Circle No. 257*

Graphic display system complements computers

Lundy Electronics & Systems, Inc., Glen Head, N. Y. Phone: (516) 671-9000. P&A: $60,000 to $100,000; 3 to 6 months.

System 32 is a high-performance computer interactive graphic display system for use with large and minicomputers. Its capabilities include high capacity of line drawings and alphanumerics, orthogonal projection of 3-dimensional data with rotation and use of circle/ellipse generators. A choice of interactive manual-input devices is available.

Booth No. 2436 *Circle No. 261*

New! Fail-safe N-key rollover

This new Licon® N-Key rollover keyboard eliminates transmission of false codes.

Thanks to a unique new design approach, Licon now offers perfected N-Key rollover. Available right now. Each key transmits its signal in the sequence in which it is struck, *regardless* of the condition of preceding keys . . . whether still depressed or in return travel. It's "failsafe". That's typical of the complete Licon keyboard. Example? Candidly, everybody's electronics exhibit about the same level of reliability. The critical element is the key itself. And Licon's is based on a reliable, low-cost ferrite core. Solid-state, but simple!

Essentially immune to temperature change, vibration, voltage variations, etc. "Bounce"-free. Requires very little power, yet provides high level output, with outstanding signal-to-noise ratio. Encoding can be changed without touching the electronics. For service, buttons and PC cards simply snap out, snap in. Interface with your equipment is a simple plug-in connector, and we'd like to give you a plugged-in demonstration on your equipment. Send for brochure or demonstration. **Licon, Division Illinois Tool Works Inc., 6615 W. Irving Park Road, Chicago, Ill. 60634. Phone (312) 282-4040.**

VISIT US AT SJCC IN BOOTH 2142

itw LICON

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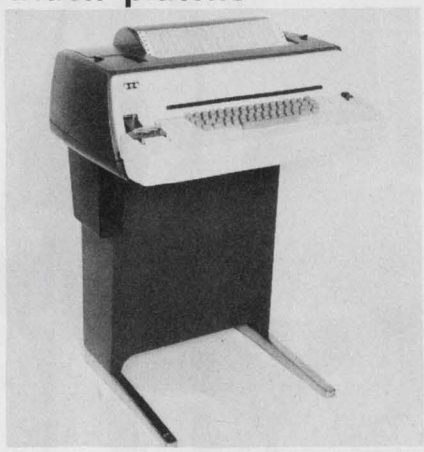
Teletype terminals widen platens

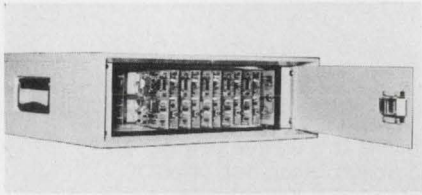


Teletype Corp., 5555 W. Touhy Ave., Skokie, Ill. Phone: (312) 982-3133. Availability: 2nd quarter, 1972.

The new family of Teletype 38 receive-only KSR and ASR terminals widen the versatility of the model 33 units. They employ the same concepts as the 33 line except they have upper and lower-case print-out and a wide platen for a 132-character line at 10 character/in. All model 38 units operate at 10 characters/s.

Booth No. 1145 *Circle No. 283*

Low-cost multiplexers handle many channels



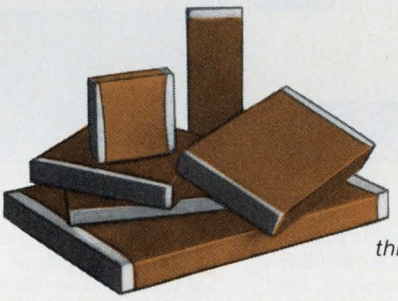
ComData Corp., 7544 W. Oakton St., Niles, Ill. Phone: (312) 692-6107. P&A: from $1440; stock.

The low-cost series 200 multiplexers provide multiple-channel drops at various points along a private-line path, busy-out control of remote dial-up data sets and loop-back test features with manual and computer control. Twelve 110-baud channels are available for unconditioned lines and 16 for conditioned lines. Data rates of 110, 134.5, 150 and 300 baud can be mixed.

Booth No. 1721 *Circle No. 293*

INFORMATION RETRIEVAL NUMBER 134 ►

Chips. Price, delivery, service.



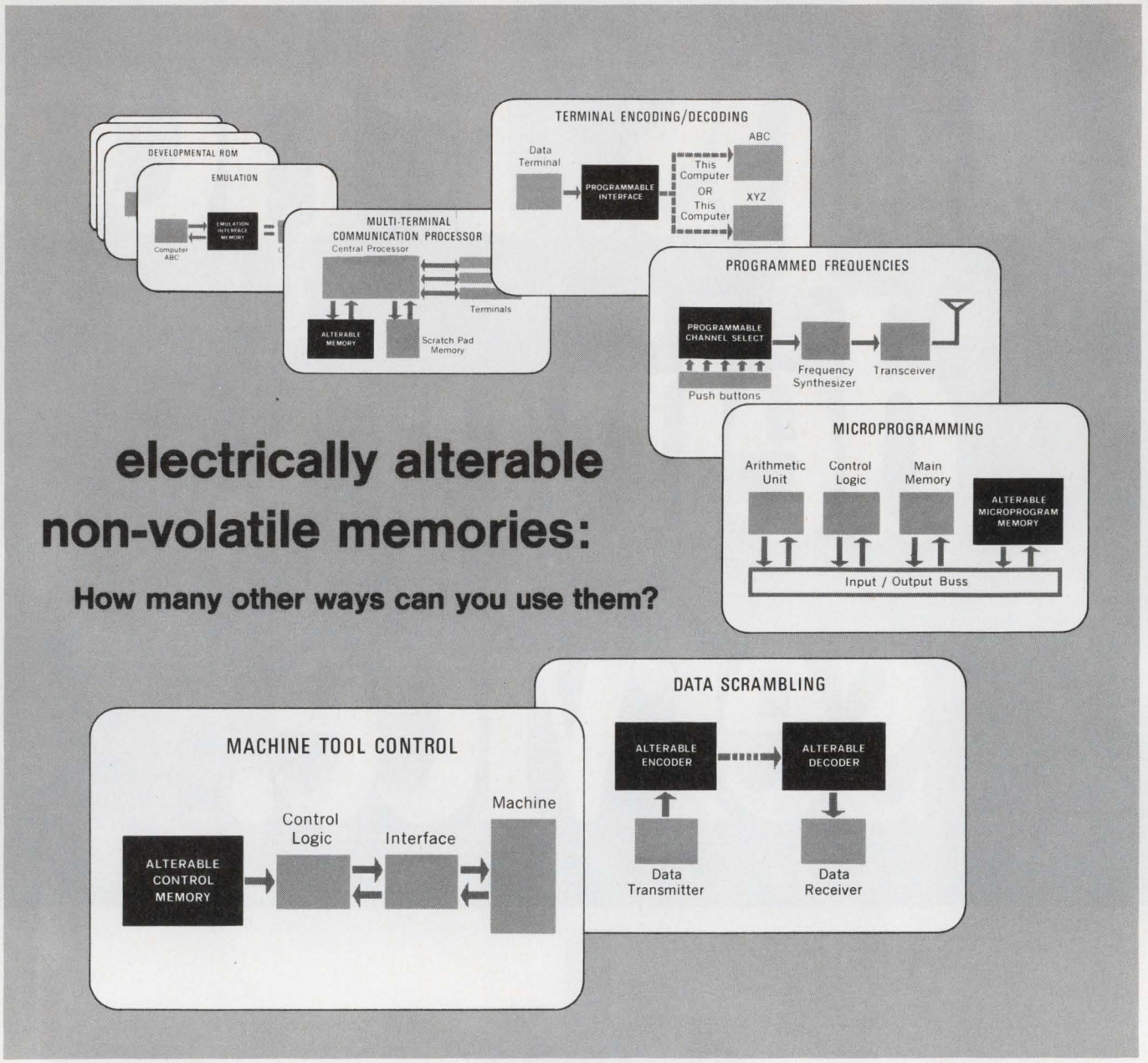
Leading the way to lowered chip prices through advanced automation production

Electro Materials® monolithic ceramic chip capacitors provide extremely high values of lumped capacitance per unit volume. They are ideal components for hybrid electronic circuitry demanding high volume efficiency. Their only drawback was price. Now Electro Materials has made them practical for use throughout the consumer electronics, computer and general communications fields. In the same high quality level developed for the aerospace/defense industry. Available in 25-, 50-, 100- and 200-volt ratings in capacitance values of 0.47pf to 15.0 mfd, Electro Materials in-depth stocks assure right-now availability of most items. And for custom solutions to capacitance problems, we can "tailor" the electrical, environmental reaction and mechanical characteristics as you need. Chip capacitors are designed for direct attachment to substrates, headers or printed circuit boards with silver, silver-alloy or gold-alloy terminations.

Even pre-tinned in production quantities. Free. Just call or write for free samples and information to: **Electro Materials, Division Illinois Tool Works Inc., 11620 Sorrento Valley Road, San Diego, Cal. 92121. Phone (714) 459-4355. TWX 910-322-1130.**

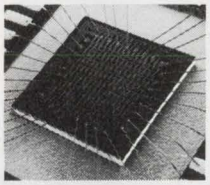
itw ELECTRO MATERIALS

The Innovating Electronic Group of ITW... ELECTRO MATERIALS • PAKTRON • LICON



electrically alterable non-volatile memories:

How many other ways can you use them?



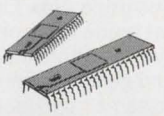
Up until now you've had to settle for non-volatility *or* electrical alterability in a semiconductor memory system. One or the other; not both together.

Today, we're glad to say, you can have your cake and eat it too. Because the best of both have now been combined in a single device: our new 256-bit Read-Mostly Memories (RMM).

Key to their unique characteristics is the use of amorphous and silicon semiconductors integrated in a 16x16 matrix on a monolithic chip, with a diode-isolated Ovonic Memory Switch (OMS) at each cross-point. What makes them alterable and non-volatile, too, is the fact that the OMSs are, in essence, bistable resistors. They can be reversibly switched between their high resistance (300k Ω) and low resistance (500 Ω) states by the application of controlled current-time pulses. And they're also capable of remaining in either state indefinitely, even when power is removed.

Add to these exclusive features non-destructive readout plus read speeds of 150 nsec access and 200 nsec cycle time (including decoding delay) and you've got yourself a versatile memory element that's readily adaptable to a host of applications beyond those diagrammed above.

Availability? Off-the-shelf! At prices ranging from $120 each in quantities of 1 to 9, $75 each from 10 to 99, and $60 each for 100 or more. Application engineering assistance is available upon request without obligation. Write or call for complete information today.



OVONIC

RMM

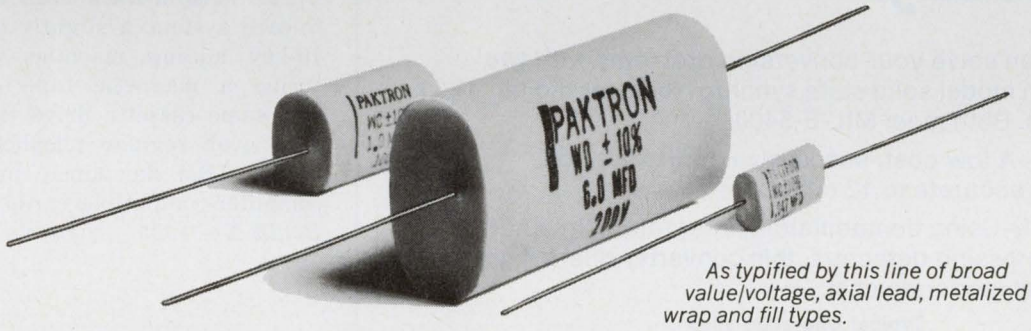
Energy Conversion Devices, Inc.

1675 WEST MAPLE ROAD • TROY, MICHIGAN 48084 • 313/549-7300

INFORMATION RETRIEVAL NUMBER 135

INFORMATION RETRIEVAL NUMBER 136 ►

Low cost reliable film caps.



As typified by this line of broad value/voltage, axial lead, metalized wrap and fill types.

Paktron employs the most highly mechanized film capacitor plant in the country to insure economy, availability and consistent quality throughout its entire line of film capacitors. Which includes a selection that virtually guarantees the ideal and economical choice for almost any application. Choose from the Paktron® film foil and metalized Mylar*, polypropylene, and metalized polycarbonate parts. Epoxy coated, wrap and fill, molded and epoxy dipped construction. Radial and axial leads. Special close-tolerance types, temperature stable types and extra compact shapes like low-profile and wafer thin models. All designed to advance the universal trend to miniaturization and the current state of solid-state electronics. For samples and data on the finest in quality domestic capacitors, contact your Paktron representative, or call or write: **Paktron, Division Illinois Tool Works Inc., 1321 Leslie Ave., Alexandria, Virginia 22301. Phone (703) 548-4400. TWX 710-832-9811.**

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itw PAKTRON

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SJCC PRODUCTS

Efficient multiplexer interleaves 32 channels

Timeplex, Inc., 65 Oak St., Norwood, N. J. Phone: (201) 767-1650. P&A: from $4300; 45 days.

The SMC-200 synchronous data multiplexer efficiently bit-interleaves up to 32 synchronous or isochronous data streams. Input rates to 400 kbits/s may be multiplexed up to group-band, T1, Telpac or megabit microwave transmission rates. Any low-speed channel rates can be also accommodated.

Booth No. 1664 *Circle No. 288*

Cassette-to-card unit enscribes magnetic tape

Customized Data Systems, Inc., Box 3146, Corpus Christi, Tex. Phone: (512) 882-2971.

The Adapta-Data 5210 cassette-to-card system, a slightly modified 10-key adding machine, can enscribe a magnetic tape cassette. The same cassette drive transmits data over regular telephone lines to an IBM keypunch producing computer-compatible cards.

Booth No. 1525 *Circle No. 290*

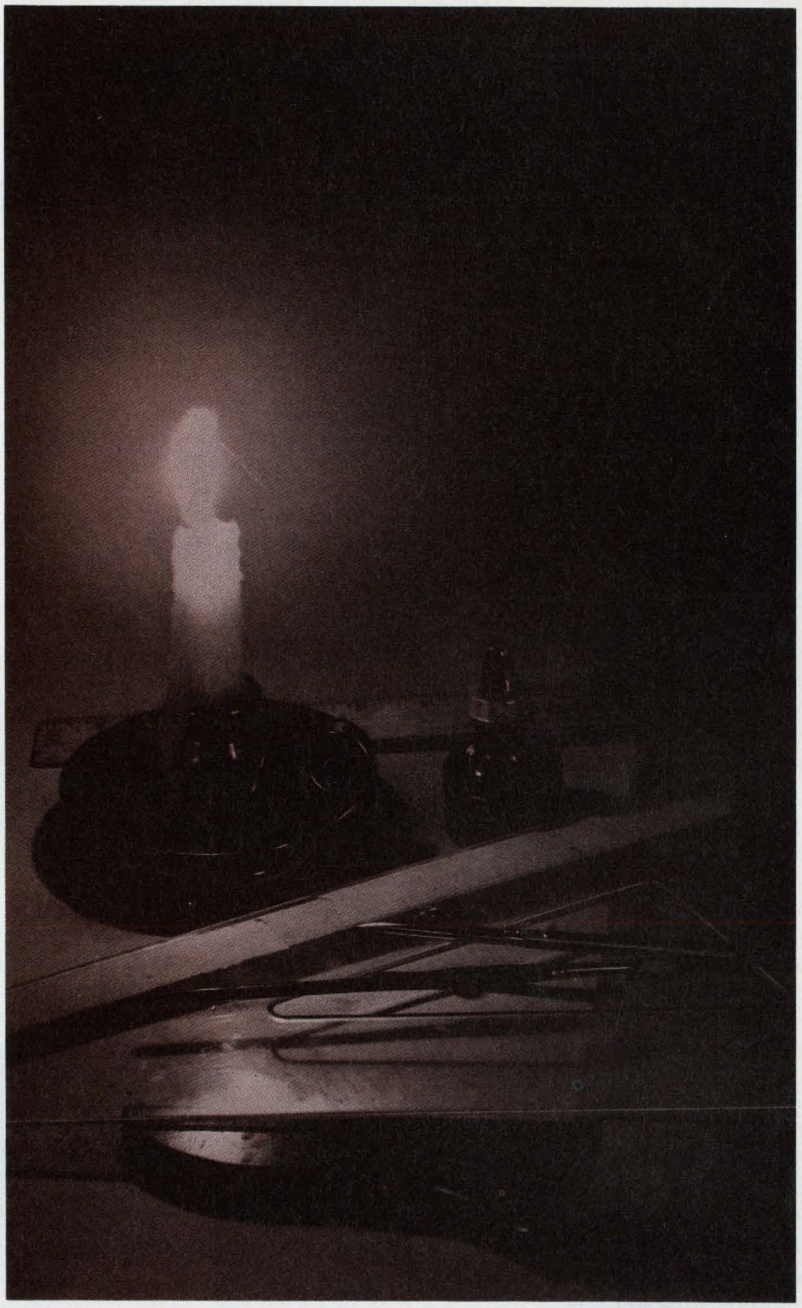
Plotter/digitizer processes paper tape

Bendix Computer Graphics, 2385 Freeway Park Dr., Farmington, Mich. Phone: (313) 477-3700.

The new Datagrid X-Y plotter/digitizer for interactive design accepts input data via a paper-tape reader and outputs the plotter's digitzer portion of an ASR-33 teletypewriter with a paper-tape punch. A magnetic-tape input is also available.

Booth No. 1213 *Circle No. 273*

Buckbee-Mears has the world's fastest, most precise artist locked in a dark room.



This artist even speaks EIA computer languages.

We call the artist BMAPS. The initials stand for Buckbee-Mears Automated Plotting System. It's really a Gerber 532 plotter directed by a Univac 418 Computer, and it can do things no artist or draftsman ever dreamt of.

Designs impossible to achieve by hand, such as exotic encoders or spiral patterns, can be drawn easily by BMAPS. The system is 20 times faster than a draftsman and draws three to four times as accurate.

We use BMAPS to plot precision artwork directly onto photosensitized film or glass in the production of photo-etched and electroformed parts. We also rent out BMAPS to firms who just want to use the artwork, making it the only precision plotter available on a commercial basis.

Until recently BMAPS instructions had to be written in a special BMAPS language. Now we have a translator program, which means we can take any standard EIA computer language and convert it to BMAPS. The system will take either 80 column cards or magnetic tape.

BMAPS is extremely accurate. The 4′ x 5′ plotting table holds tolerances to ±.0009″ at speeds up to 70″ per minute. A special 12″ high precision area has a tolerance of ±.0004″.

BMAPS is the latest advancement by Buckbee-Mears in the field of photomechanical reproduction. Since we invented the business, we feel obligated to keep offering you the best service in the world.

If you need precision etched or electroformed parts, or if you just want to rent time on BMAPS, call or write Industrial Sales Manager, Bill Amundson in St. Paul. The number is 612-227-6371.

• PRECISION METAL ETCHING AND STAMPING • GLASS ETCHING • ELECTROFORMING • FLEXIBLE CIRCUITS • PULSE TRANSFORMERS • SCREENS & MASKS FOR HYBRID CIRCUITRY • AUTOMATED DESIGN

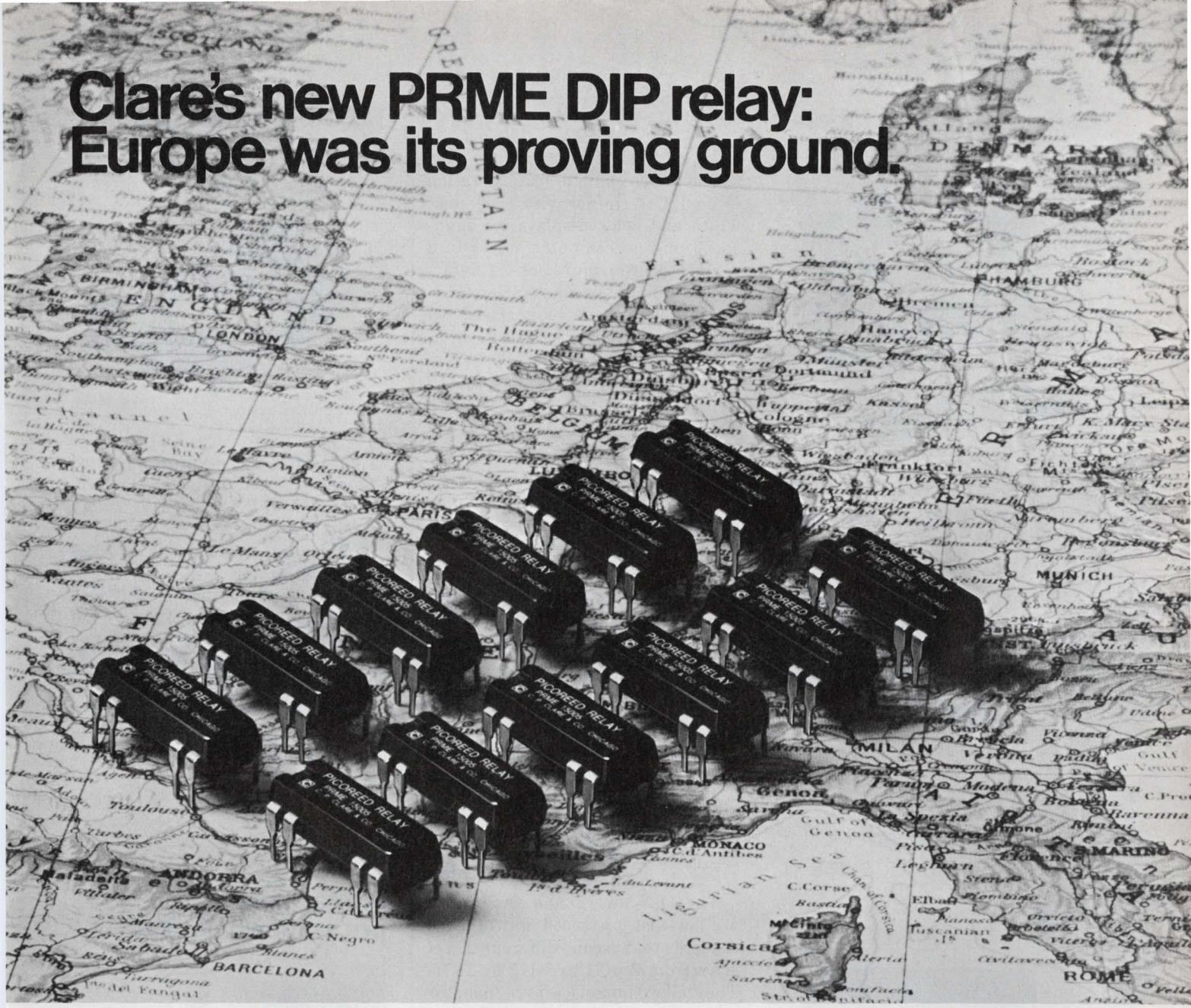
bmc

BUCKBEE-MEARS COMPANY

SAINT PAUL, MINNESOTA 55101

INFORMATION RETRIEVAL NUMBER 138

Clare's new PRME DIP relay: Europe was its proving ground.



True electrical and physical compatibility with DIP-packaged IC logic families plus the Clare Picoreed capsule.

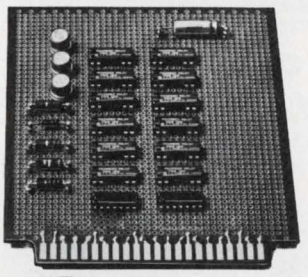
France. Italy. Germany. Belgium. The Netherlands. This microminiature sealed-contact relay has been built by Clare International, and has proved itself over most of Europe in data process and process control applications. The users? Some of the biggest names over there. Now Clare's new PRME DIP Relay is ready for you.

Check its credentials. Electrically and physically compatible with DIP-packaged IC logic families. Drive the 5-volt model directly from most DTL/TTL standard gates without power NANDS or external driver/buffers. Total DIP package compatibility also. That means IC DIP dimensions, epoxy molding, automatic machine insertability.

And here's a big plus: The PRME is built around Clare's own Picoreed capsule, basis for the inherent reliability of Clareed relays.

Some other points. Available for 5, 6, 12 and 24-V dc operation. Operates within 500 μ seconds, releases within 100 μ seconds. Sensitivity: 35 mW with ICs—45 to 130 mW with other circuit types. Switch 500 mA, 100 V, 10 VA max; carry 2.0 A max. Internal diode-coil suppression and electrostatic shield options.

Care to know more about the new Clare relay that is already a sensation on the Continent? Circle the Reader Service Number now.



CLARE®

C. P. Clare & Co.
Chicago 60645 and worldwide.
A General Instrument company.

INFORMATION RETRIEVAL NUMBER 140

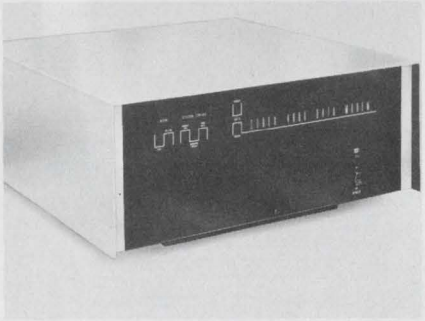
Communication station has color displays

Computer Communications, Inc., 5933 W. Slauson Ave., Culver City, Calif. Phone: (213) 390-7777.

The CC-30 communication station is an I/O terminal with black-and-white and color displays for high-speed on-line computer access in a variety of configurations. Characters can be entered on its screen in one of four colors: blue, green, red and yellow. Color selection is specified by control codes entered from the keyboard or transmitted by the computer.

Booth No. 2537 *Circle No. 294*

4800-bits/s data modem equalizes lines 2 ways



Codex Corp., 15 Riverdale Ave., Newton, Mass. Phone: (617) 969-0600. P&A: $5575; 30 days.

The 4800 voice-band data modem features automatic and adaptive equalization and operates at 4800 bits/s over unconditioned telephone circuits. It uses a modulation technique which combines both phase and amplitudes. Carrier and timing recovery are data-derived, eliminating the need for separate pilot tones and assuring no phase jitter.

Booth No. 1153 *Circle No. 263*

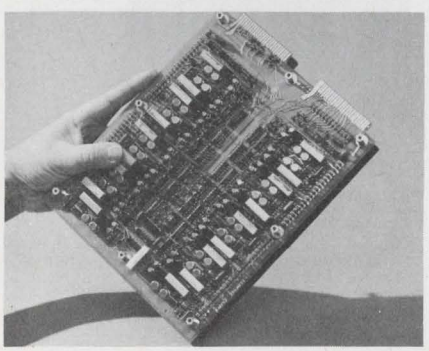
Optical mark readers scan many sheet sizes

Optical Scanning Corp., Newton, Pa. Phone: (215) 968-4611. P&A: see text; July, 1971.

The OpScan 12 and OpScan 17 are low-cost low-speed optical mark readers that scan different sheet sizes from 2 by 4 to 8-1/2 by 11 in. They allow numerics to be hand or pre-encoded on forms and then scanned. The OpScan 17 can be used as a data station component. It costs $5000 and rents at $195/month. The OpScan 12 costs $3500 and rents for $125/month.

Booth No. 1838 *Circle No. 259*

7-kbit core memories occupy 1-in.² areas

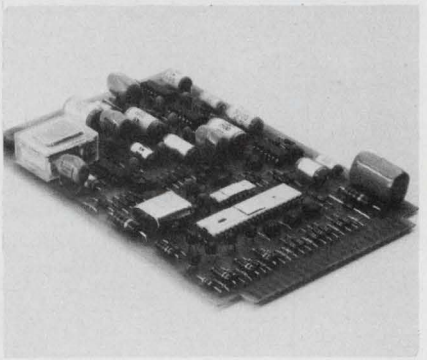


Ampex Corp., 9937 W. Jefferson Blvd., Culver City, Calif. Phone: (213) 836-5000. P&A: 2¢ bit; 60 days.

A new line of low-cost modular core memories store 7000 bits (18-mil cores) in 1 in.² of board area. The 1800 series offers cycle times of 650 and 900 ns in sizes ranging from 8192 words by 18 bits to 131,072 words by 36 bits. The 8192-word by 18-bit model measures 8-in. high by 10-in. deep by 2.2-in. wide.

Booth No. 2217 *Circle No. 262*

1200-bit/s LSI modem fits on a 4-in.² card

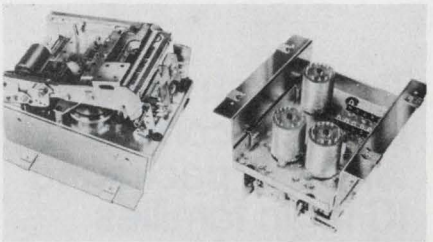


Penril Data Communications, 960 Thompson Ave., Rockville, Md. Phone: (301) 881-8151. P&A: $400; 30 days.

Employing MOS/LSI, a new data modem provides 1200-bit/s transmission from a single PC card measuring 4 in.² The 1200/-5-150 is online compatible with Bell 202C-6 modems. Other features include reverse-channel compatibility of 150 bits/s, crystal-controlled tone frequencies and reverse-channel on-off keying from 0 to 5 Hz.

Booth No. 1345 *Circle No. 277*

Digital tape deck prices down to $96



Scovill Auricord Div., 35-41 29th St., Long Island City, N. Y. Phone: (212) 361-7400. P&A: see text; stock.

The CAS-20 digital cassette tape deck features single-direction read/write from 1.5 to 15 in./s with dual-direction search from 40 to 400 in./s at a sample price of $276 and a production quality price of $96. The CAS-20 has cassette in-place and file-protect sensors. Prices include a 2-track head but not the electronics.

Booth No. 2424 *Circle No. 285*

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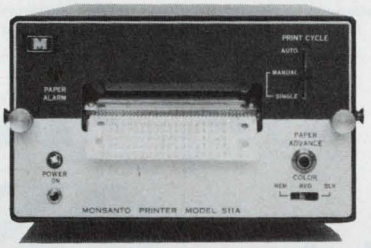
105A 9 digit.....$1,670
105A-111 .....$1,725
105A-111 9 digit.....$1,845



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- ☐ 106A, Up Down Counter-Timer.....$775
- ☐ 107A, Computing Counter.....$1250
- ☐ 109A, Dual Limit Counter.....$975
- ☐ 110B, 150 MHz Counter-Timer.....$1585
- ☐ 114A, 150 MHz Freq. Counter.....$995
- ☐ 120A, 512 MHz Auto/Programmable C/T.....$2195
- ☐ More coming.

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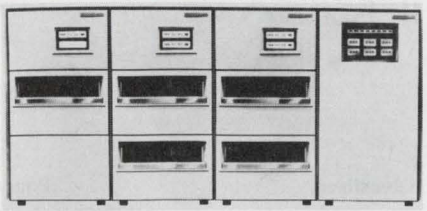
INFORMATION RETRIEVAL NUMBER 141

Controller/disc drive has 400 channels/disc



California Computer Products, Inc., 2411 W. La Palma Ave., Phone: (714) 821-2541.

A new controller and disc drive combination system, that uses existing IBM 2316 or equivalent disc packs, provides 400 information channels per disc surface. The new system is composed of the model CD 1015 disc controller and the model CD 215 disc drive unit. It is plug-to-plug compatible with IBM 360 computers and requires no software change.

Booth No. 2411 *Circle No. 287*

Key-to-tape device inputs data via phone

General Computer Services, Inc., 444 Executive Center Blvd., El Paso, Tex. Phone: (915) 544-2700. P&A: leasing from $65 to $80/month; 2 to 4 wks.

The Translator is a device for keyboard systems that allows the user to input data directly onto tape via any remote Touch Tone telephone. It enables the user to skip, duplicate, error-correct, and enter data with the keyboard.

Booth No. 2418 *Circle No. 268*

Software package processes payrolls

Computer Sciences Corp., 9841 Airport Blvd., Los Angeles, Calif. Phone: (213) 641-3810. Price: see text.

Designed for operation under OS/COBOL, the Payroll software package can process payrolls alone or with labor functions. It can process supplemental calculations for expenses. Licensing fees are $12,000 and $20,000 for payroll only and payroll with labor distribution processing, respectively.

Booth No. 2231 *Circle No. 295*

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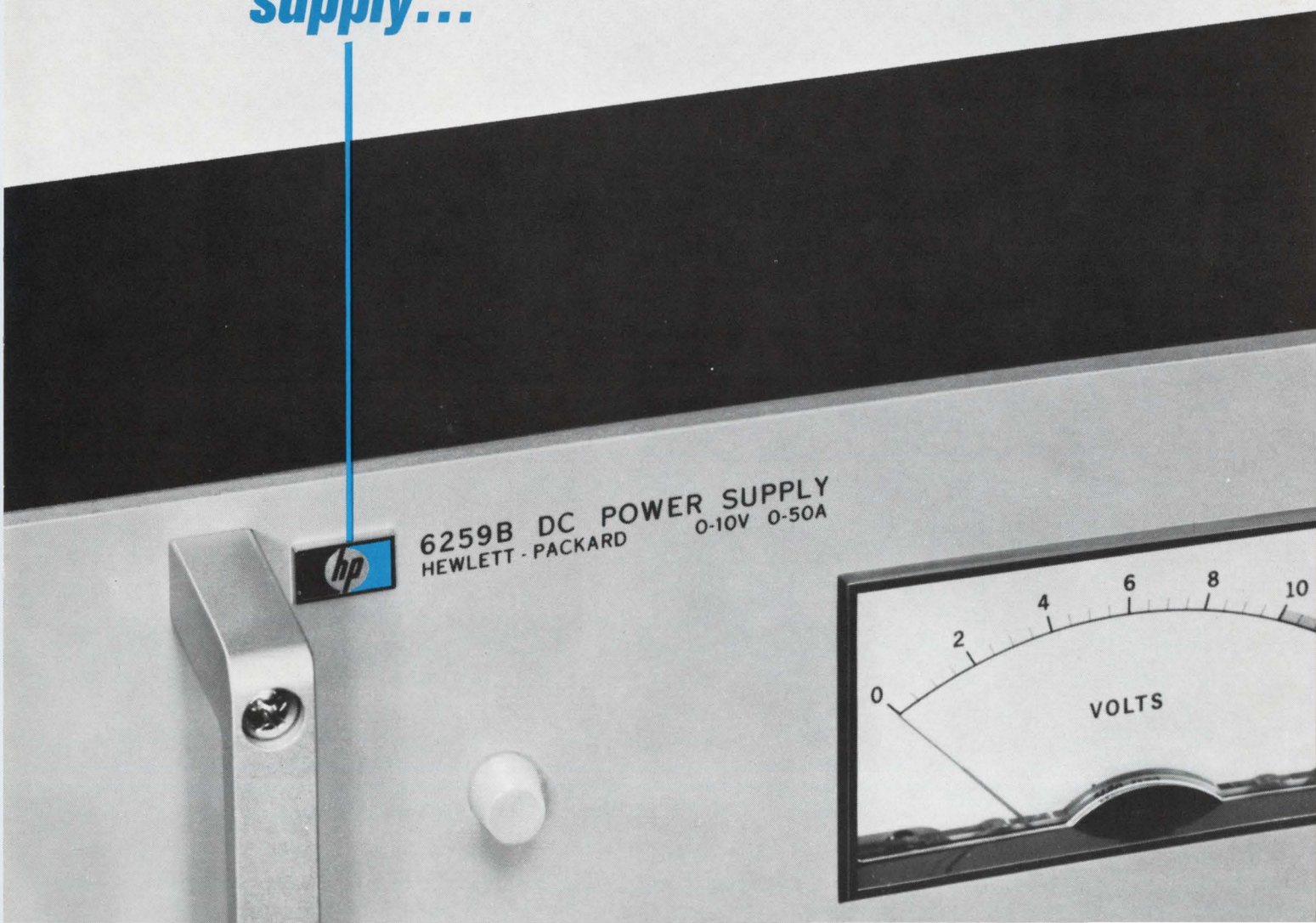

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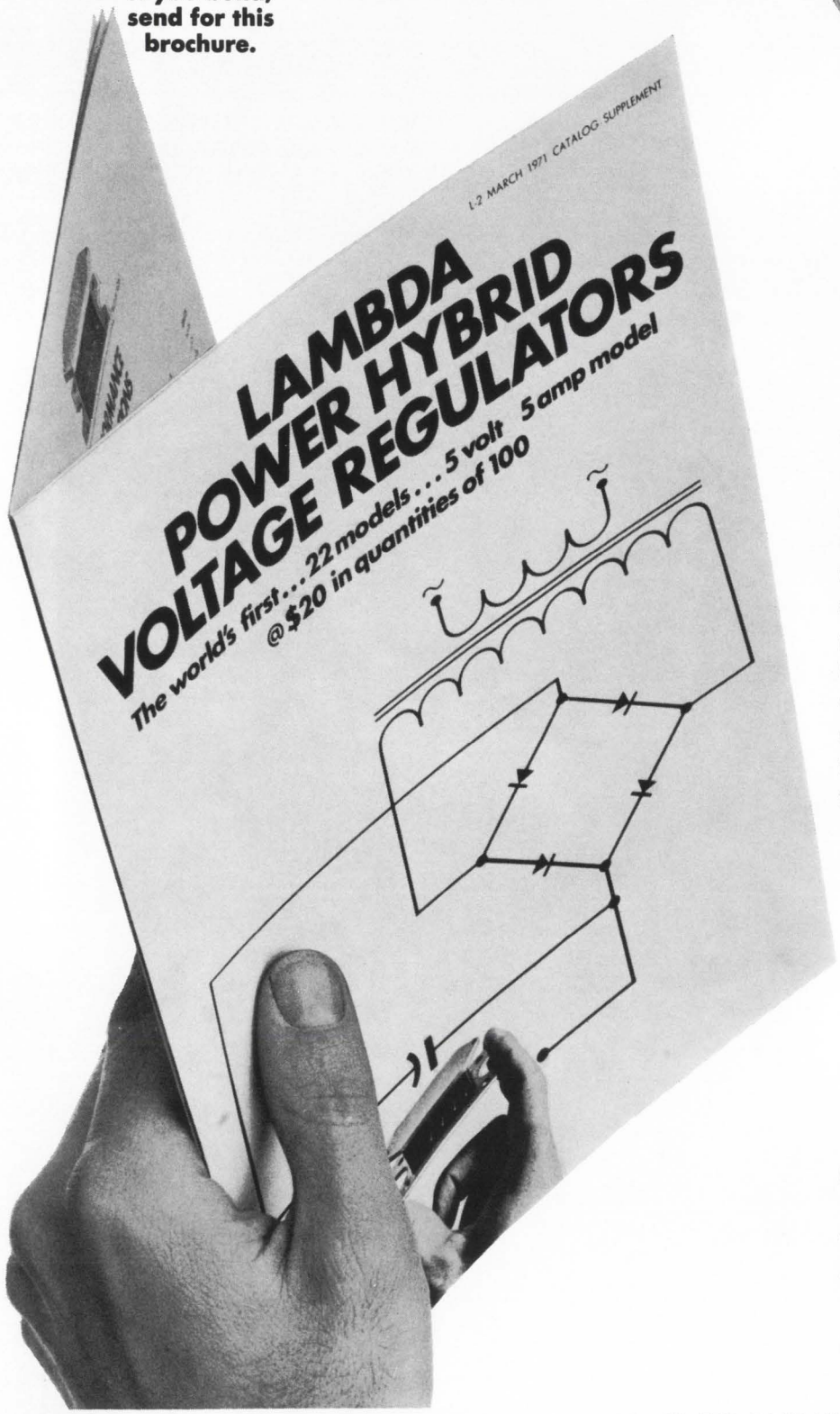

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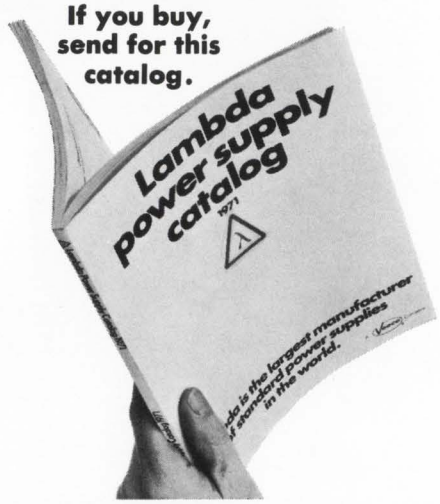

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INFORMATION RETRIEVAL NUMBER 149

editorial

What's a show without the semiconductor boys?

The exhibitors at this year's Spring Joint Computer Conference may be fewer in number than last year, but they still represent a good cross-section of what is commonly termed the computer industry. Manufacturers of large computers, medium-sized computers and minicomputers are all there, together with component, software and peripheral companies.

Although this is a rather trite observation, it takes on relevance when compared with what one encounters at the yearly IEEE Convention in New York and Wescon show in California. These are the "general" shows of the electronics industry, just as the Spring and Fall Joint Computer Conferences are the general shows of the computer industry.

But whereas products from just about all areas of the computer industry are shown at the two computer conferences, both the IEEE and Wescon shows have a serious void in their exhibitor make-up.

That void, as anyone who has been to these shows in recent years knows, is the absence of semiconductor manufacturers. In the early days of semiconductor technology, they were all there, contributing much to the liveliness and interest of the show. But about five years ago they began dropping out, and the exodus has continued to the point where there are now virtually no semiconductor exhibitors at the IEEE and Wescon shows.

The reasons semiconductor companies cite for their refusal to exhibit are generally based on sound business judgments. Who can argue when a company is able to prove that the cost per sales lead obtained at these shows is too high, compared with other sales and promotion techniques? And who can dispute that every engineer knows what a dual, in-line package or TO-5 can looks like? So what can they get from a manufacturer's booth that they can't get from the manufacturer's literature?

But in spite of such logic, the fact remains that the semiconductor segment is the most dynamic part of the electronics industry, as well as the most pervasive. And a general show cannot be considered truly representative of the industry if it doesn't contain a good cross-section of semiconductor companies.

How do we get semiconductor manufacturers back into the IEEE and Wescon shows? Surely not by following the present trend. In time this would lead to an even greater proliferation of specialty shows and the demise of the general shows.

What is needed is innovative thinking by the managements of IEEE and Wescon—thinking that will result in plans to make the shows attractive to semiconductor manufacturers, even if for participation on a limited scale. This may result in special inducements to one portion of the electronics industry. But when that portion is as significant as semiconductors, we think it's worth it.

Frank Egan

FRANK EGAN

Prevent damage to loads and supplies

with these protective circuits. Don't allow component breakdown or human error to compromise entire systems.

First of two articles

Power-supply protection is not the place to cut corners when designing delicate electronic equipment. In computers, for example, 50 to 70% of the material cost is in solid-state logic that can be easily destroyed by a power-supply failure.

Anthony Annunziato, Research Section Supervisor, Mail Station A-37, Sperry Gyroscope Div., Sperry Rand Corp., Great Neck, N. Y. 11020.

Field-effect devices are also extremely sensitive to overvoltage.

Economy, therefore, demands that the power supplies used in such equipment be designed with load protection as well as with circuitry to prevent load faults from damaging the supply.

Common to most dc supplies is the series regulator (Figs. 2 to 9). Should the series-pass transistor in this circuit short, the supply's output voltage will rise unchecked if protective circuits

Table 1. How damage is caused.

Fault	Damage		Major causes	Magnitude (approximate)	Typical protective circuit
	Load	Power supply			
Overvoltage applied to load	X		■ Series pass transistor fails short.	■ 30% to 100% of rated voltage.	■ SCR crowbar and fuse decoupling (Fig. 2).
	X	X	■ Several power-supply outputs are interconnected (bridged) by common circuits, and one power supply fails to turn on.	■ 30% to 100% of rated voltage.	
	X	X	■ External power cable (ac or dc power lines) touches power-supply output terminals (technician trouble-shooting).	■ For ac lines 115 V-208 V; for dc lines 15 V to 300 V.	
Reverse voltage applied to load	X	X	■ Positive and negative power supplies are bridged together by common circuits, and one power supply fails to turn on.	■ 30% to 100% of rated voltage.	■ Reverse diode is connected across the power-supply output terminals (Fig. 2).
Power supply subjected to overcurrent		X	■ Partial load circuit failures (short circuit). ■ Pinched cables. Decoupling capacitors short-circuit (electrolytic failures). ■ Troubleshooting results in shorted power-supply output terminals.	■ 10% to 300% of rated load.	■ Crowbar and fuse decoupling (Fig. 2) or automatic resetting. Turn-off circuits (Figs. 8 & 9) or line-toggling reset (Fig. 4) or current-limiting (Figs. 1 & 5).

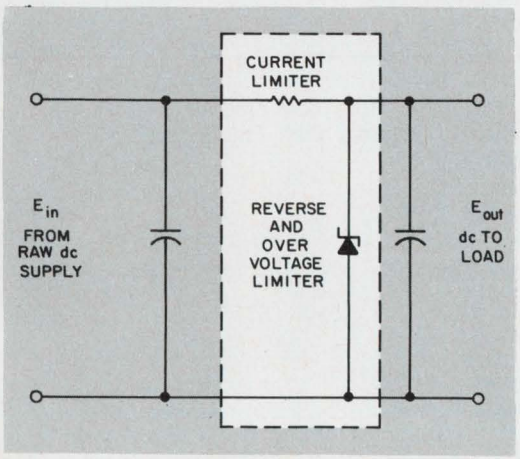
are not employed. Operating requirements on output adjustment, input line tolerance and input ripple mean that the uncontrolled voltage produced by a shorted transistor can be 50% to 100% above the nominal output level. Special supplies designed for large input line variations may exceed the rated output by 200% with series pass breakdown. Table 1 summarizes the faults caused by power-supply failures, operating errors and overloads.

Various schemes for preventing extensive load or supply damage (regardless of where the failure originates) are outlined in Table 2. Some circuits provide a single corrective feature while others offer combined protective functions.

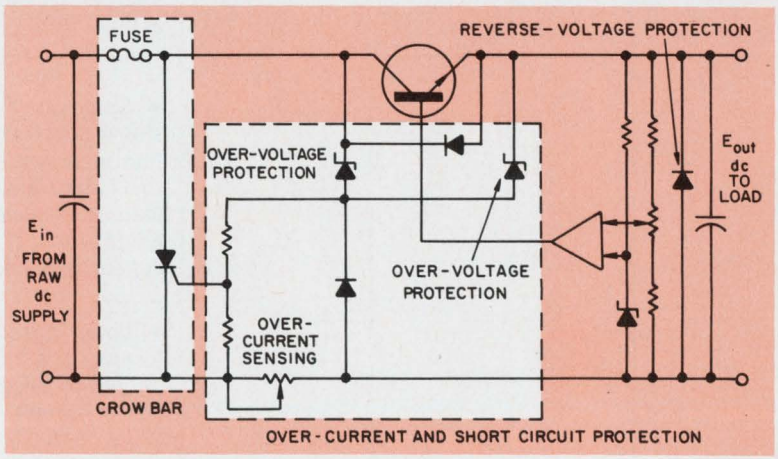
Practical designs usually group several of these circuits together as a dependable barrier against shorts, overvoltage, reverse voltage and overload. The cost for this protection, though substantial, is easily justified as insurance on any large investment in delicate on-line equipment. ■■

Table 2. Select the protection that suits your needs.

Figure	Protection			Advantages	Disadvantages
	Over-voltage	Reverse voltage	Overload or short circuit		
1	X	X	X	■ Simple, reliable and low-cost. ■ Automatic recovery.	■ Used only for low power outputs (not a practical approach above 10-W loads). ■ High-power losses.
2	X	X	X	■ Simple and reliable.	■ Fuse blowing. ■ Broad trip-point tolerance with temperature variations. ■ Resistor sensing lowers power-supply efficiency.



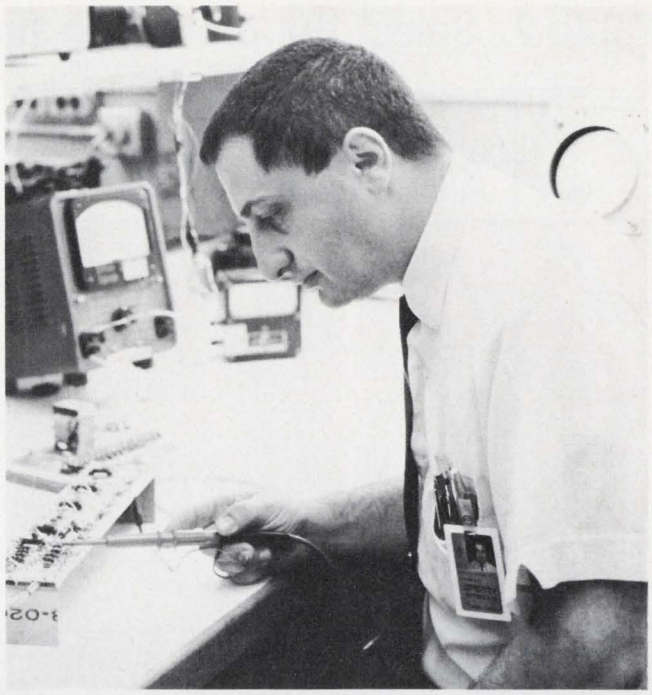
1. Shunt regulator



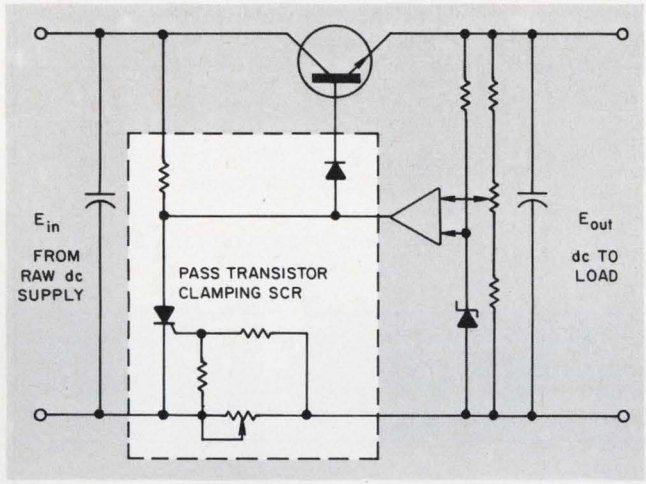
2. Fused crowbar

Table 2. Select the protection that suits your needs.

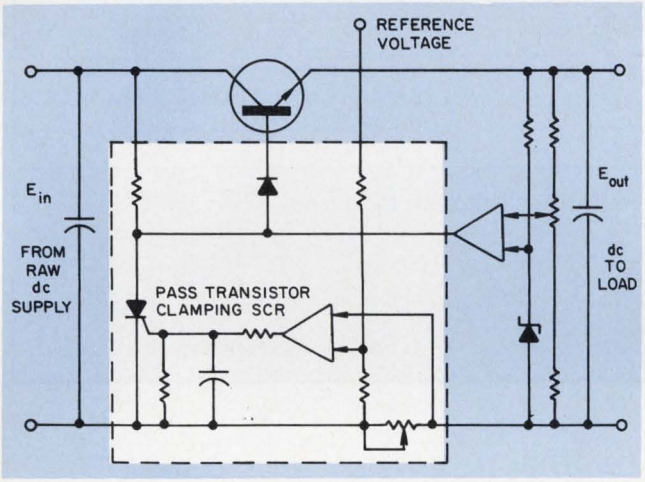
Figure	Protection			Advantages	Disadvantages
	Over-voltage	Reverse voltage	Overload or short circuit		
3			X	■ Simple, reliable and low-cost. ■ Line-toggle recovery.	■ Broad trip-point tolerance with temperature variations. ■ Resistor sensing lowers power-supply efficiency.
4			X	■ Accurate trip-point setting. ■ Simple, reliable and low-cost. ■ Line-toggle recovery.	■ Temperature sensitivity minimized at the cost of an extra operational amplifier. ■ Auxiliary power supplies. ■ Resistor sensing lowers power-supply efficiency.
5			X	■ Simple, reliable and low-cost.	■ Broad trip-point tolerance with temperature variations. ■ Pass transistor must absorb all load power when load is fully short circuited (may increase size and cost of power supply). ■ Resistor sensing reduces power-supply efficiency.
6			X	■ Same as Fig. 5 except sharper current limiting action.	■ Same as Fig. 5
7			X	■ Same as Fig. 5 with sharp cutoff and reduction in power absorbed in the pass transistor as load resistance diminishes to zero. (This is called foldback.) ■ Lower pass transistor losses, and smaller overall power supply compared to current limiting (Figs. 5 & 6).	■ More components, hence less reliable than Fig. 5.



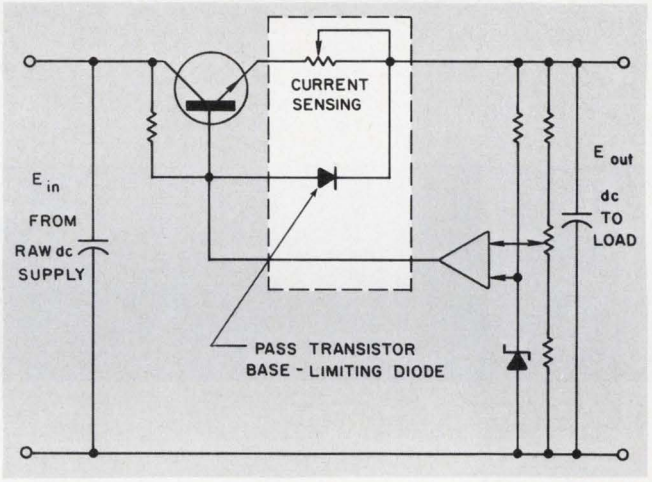
Bench tests verify component choices and circuit layout, once a protective scheme has been selected. Author Annunziato has recently decided to produce a full-length volume on the design of power supplies.



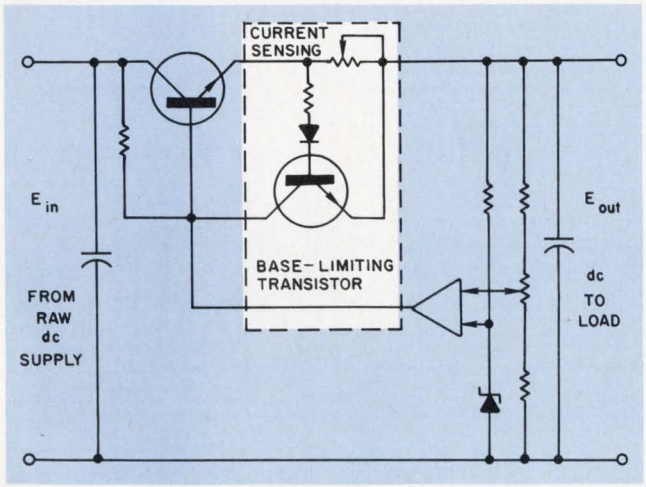
3. Line toggle reset



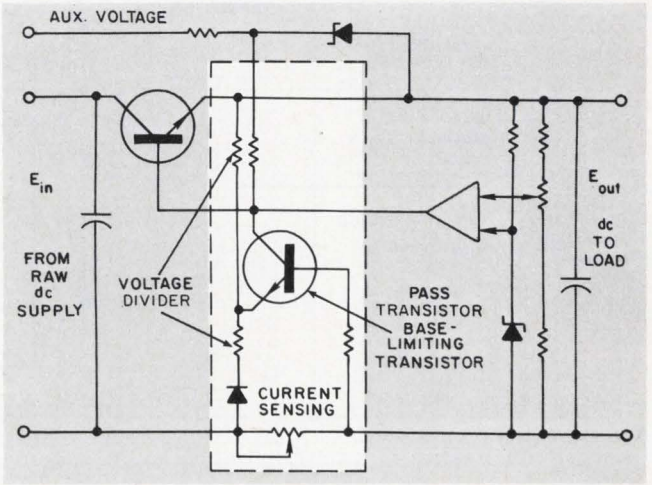
4. Line toggle reset with fine adjust



5. Diode current limiting



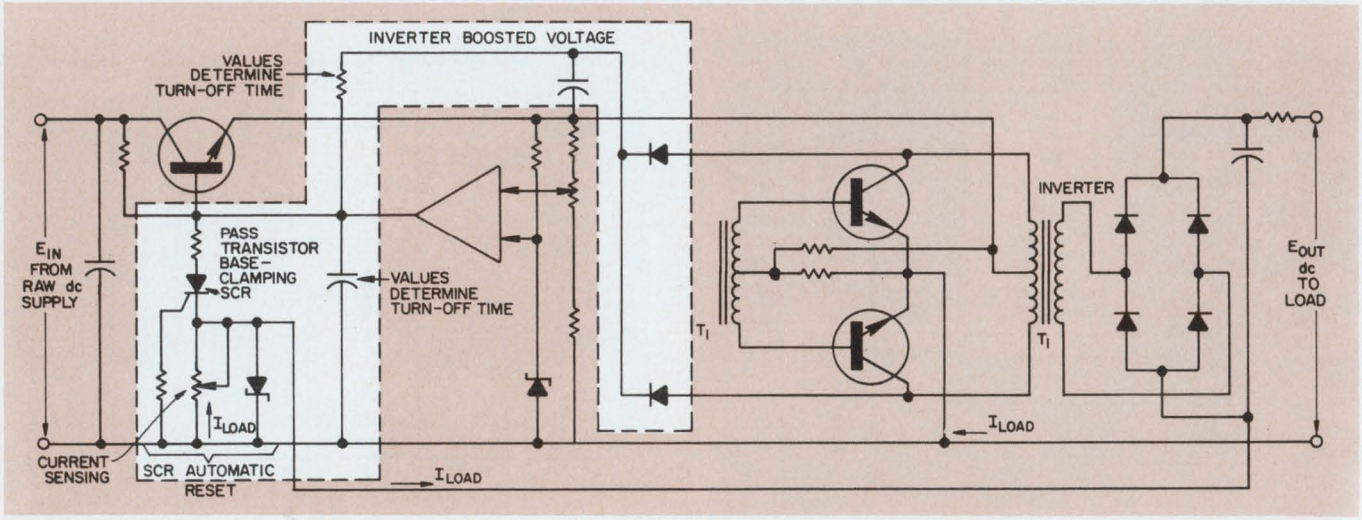
6. Diode-transistor current limiting



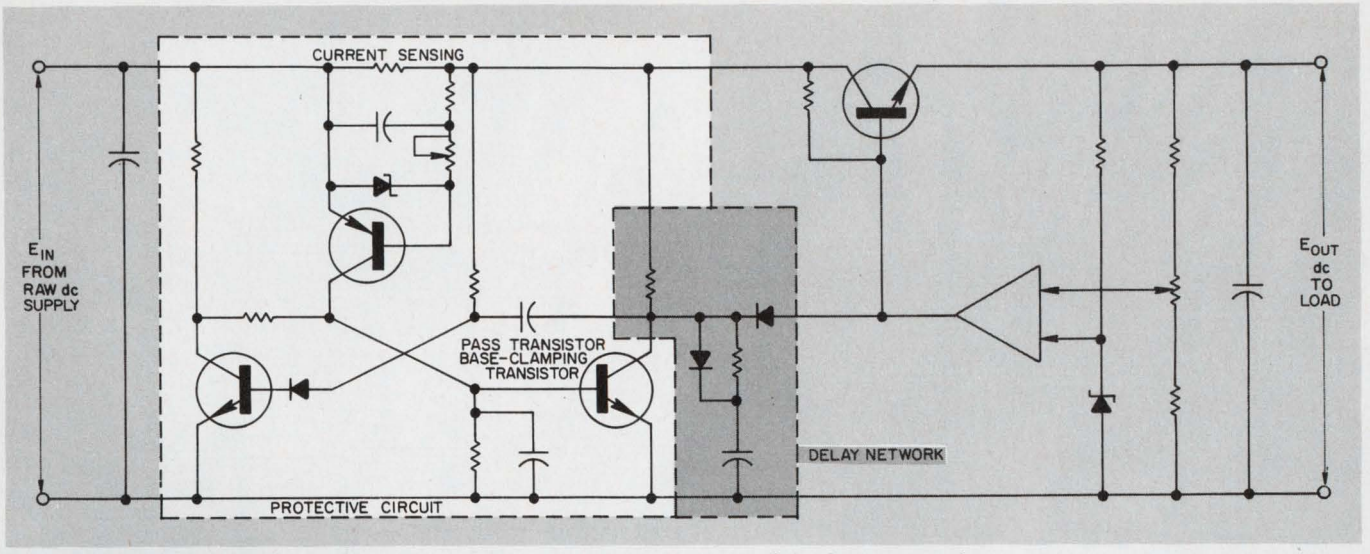
7. Foldback automatic reset

Table 2. Select the protection that suits your needs.

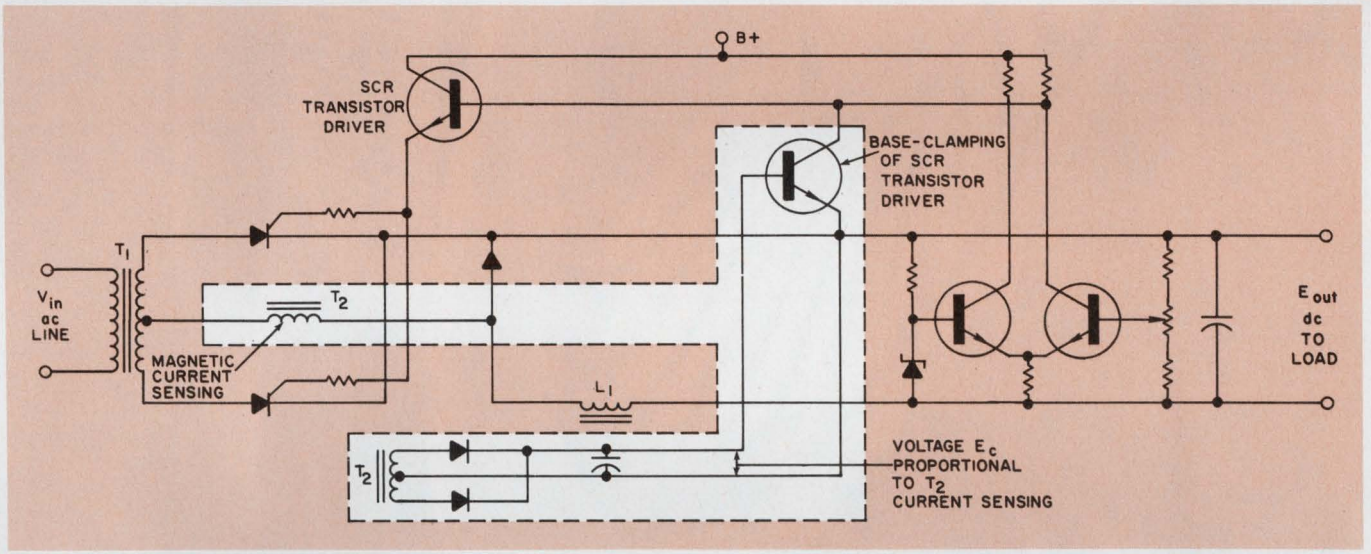
Figure	Protection			Advantages	Disadvantages
	Over-voltage	Reverse voltage	Overload or short circuit		
8			X	■ Automatic recovery. ■ Lower pass-transistor power losses compared to current limiting techniques.	■ More components, less reliable than preceding schemes. ■ Requires inverter transformation stage. ■ Large trip-point variation with temperature changes. ■ Resistor sensing reduces power supply efficiency.
9			X	■ Same as Fig. 8 but does not require the inverter stage.	
10			X	■ Simple, reliable. ■ No sense-resistor power loss. ■ Automatic recovery.	■ Can only be used with ac inputs. ■ Expensive. ■ Slow response between load overcurrent and actual shutdown of the SCR circuit.
11			X	■ Faster response to load faults (dc current sampling); otherwise same as Fig. 10. ■ Automatic recovery.	■ Expensive. ■ Half-cycle response time.



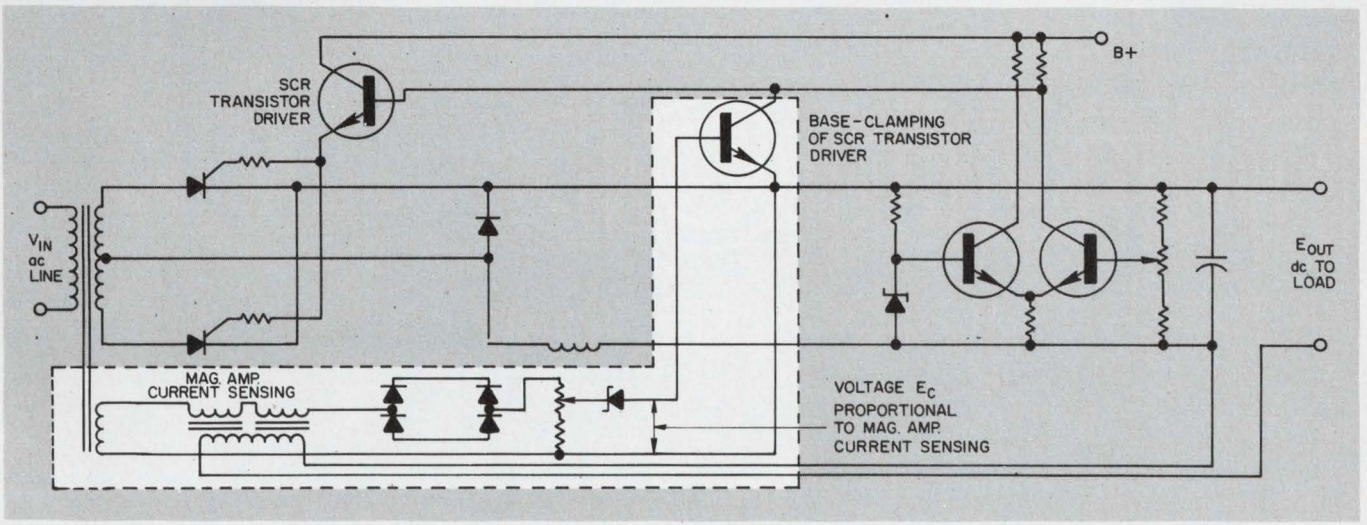
8. Automatic turn-off and turn-on



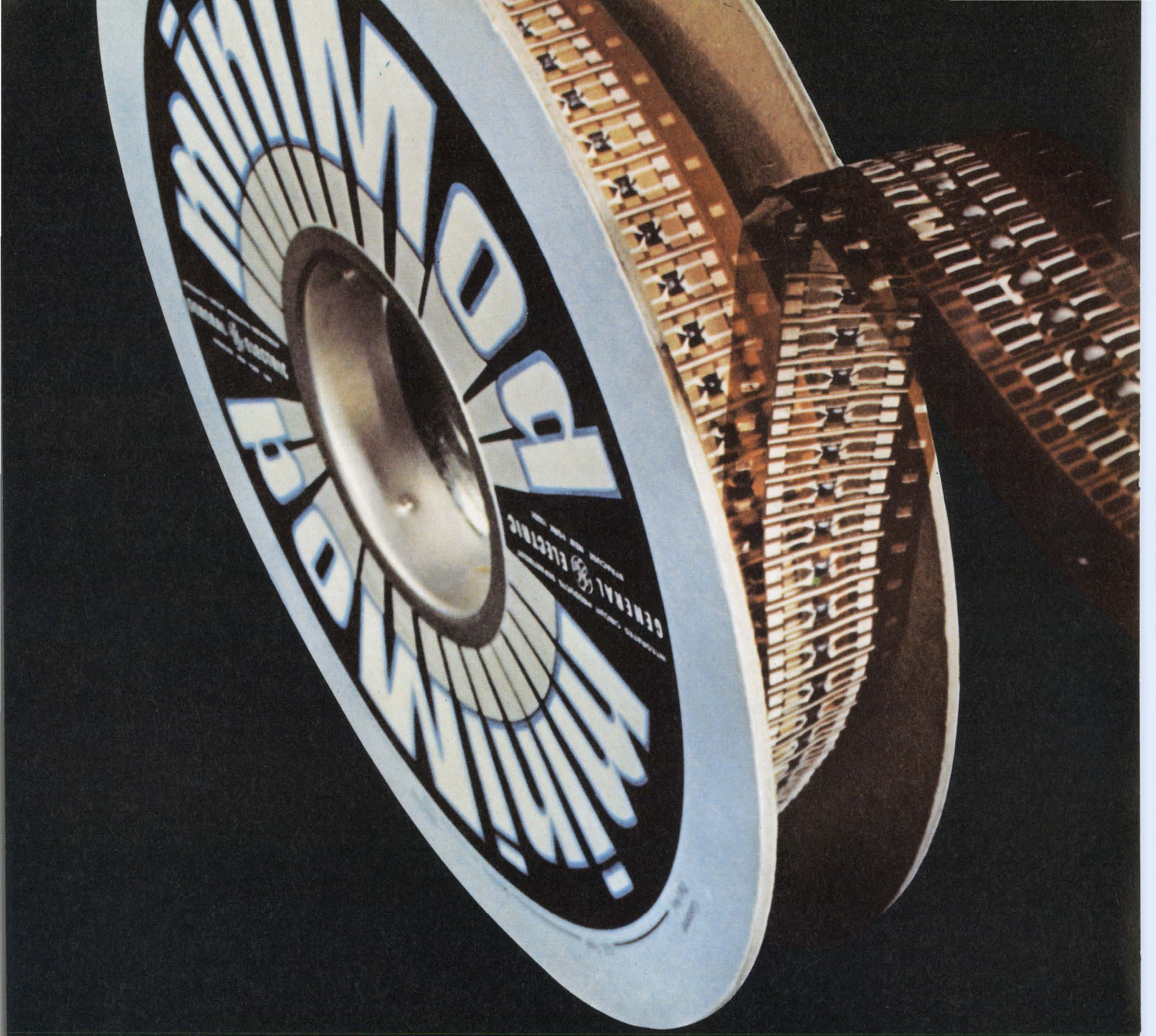
9. Automatic resetting using monostable multivibrator and delaying network



10. SCR switching regulator using magnetic (transformer) sensing



11. SCR switching regulator using magnetic (mag. amp.) sensing with automatic recovery



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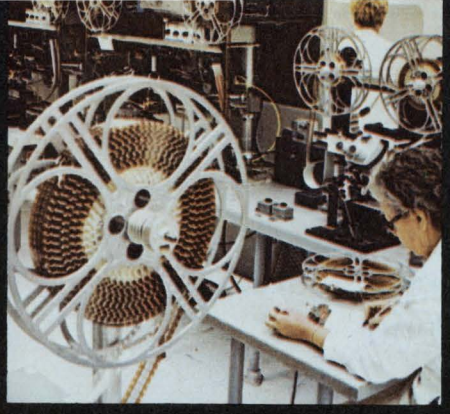

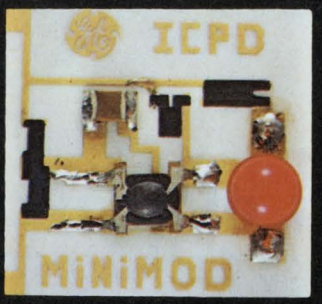

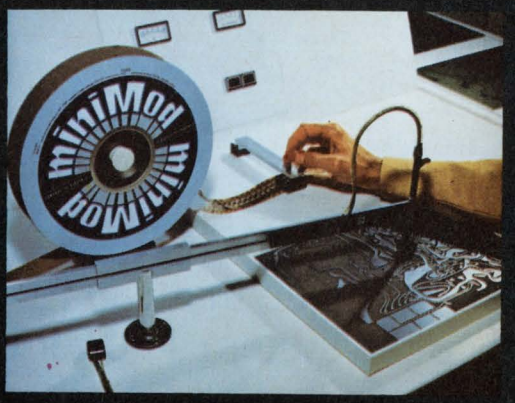

packaging concept for integrated circuits. Inside the miniMod package, the IC chip and its metallized lead pattern are supported on a strip of 35 mm polyimide film. Chip, leads and film are then encapsulated to form a tiny, rugged integrated circuit that is available individually or on reels. That's right—reel-to-reel IC's for the high-volume user.

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For more information about GE's new miniMod IC's or how to use them, write General Electric Company, Integrated Circuit Products Department, Section 770-01, P.O. Box 131, Liverpool, New York 13088.

GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 246

Strobing multi-digit displays is a valuable design technique that can reduce display costs and enhance the system's power efficiency.

As every good designer now knows, light emitting diodes are ideal when it comes to designing a compact display system that will not require special power supplies. But what some designers, used to gas discharge tubes, may not know is that strobing is usually a more advantageous driving technique than non-strobing when the decoding function is performed outside the display module.

The choice of driving technique depends on the driving hardware available, the number of packages in the system, the number of digits in the display and how much you want to spend on the display cost and give better power efficiency.

Light-emitting-diode readouts have either a segmented or a dot-matrix character format. The seven-segment version is the most popular and the one that we will consider here.

In strobed operation, the decoder is time-shared by the digits in the display, which are illuminated one at a time but fast enough so that they appear flicker-free. For non-strobed operation, each digit in the display is continuously illuminated, usually with one decoder per digit.

Count the digits, then decide

Generally, cost-per-digit and interconnection considerations indicate that strobing is more attractive as the number of digits in the display increases. The strobed device, for example, requires far fewer interconnections between the display and the driving hardware than the non-strobed device. Typically for a four-digit display, three times as many leads are needed for non-strobed operation as for strobed.

Let's take a closer look at the trade-offs between strobed and non-strobed operation. Figure 1 illustrates the cost-per-digit and the power-per-digit requirements of a display as a function of the number of digits. As the curves show, if there are more than three digits in the display, it is more economical in terms of IC cost to use a strobed technique rather than a non-strobed one.

David Giuliani, Applications Engineer, Hewlett-Packard Co., 620 Page Mill Rd., Palo Alto, Calif. 94304.

A block diagram (Fig. 2a) of a typical non-strobed four-digit display shows that each digit or character has its own seven-segment BCD decoder. In addition there are individual segment lines for each character.

Figure 2b illustrates a typical strobed display that uses a four-digit solid-state indicator. It has eight segment enable lines (seven for the character segments and one for the decimal point), and four character enable lines.

A closer look at strobing

In strobed operation, the appropriate segment enable lines are activated for the character to be displayed, and the proper character enable line is then activated for the character desired. The strobe now progresses to the next character, activating its character enable line and the appropriate segment enable lines for that character position.

The brightness of the display is proportional to the time-averaged forward current through the segments. Thus, if N characters are to be displayed so that there is no dark time (time during which no character is activated), the peak current of the display is N I_{avg}, where I_{avg} is the average forward current per segment.

The peak current limits the number of digits that can be strobed. If I_{avg} is 3 mA, and the maximum peak current rating for the display is 150 mA, then the maximum number of digits that can be strobed in one sweep is 50.

If the character refresh rate is high enough, the display will appear flicker-free to the observer. In most applications a freqeuncy of 100 Hz is adequate. However, vibration of the display may result in visible intermodulation between the vibration and the strobe. For vibrations in excess of 0.005 inch, it is best that the strobing rate be greater than three times the maximum vibration frequency expected.

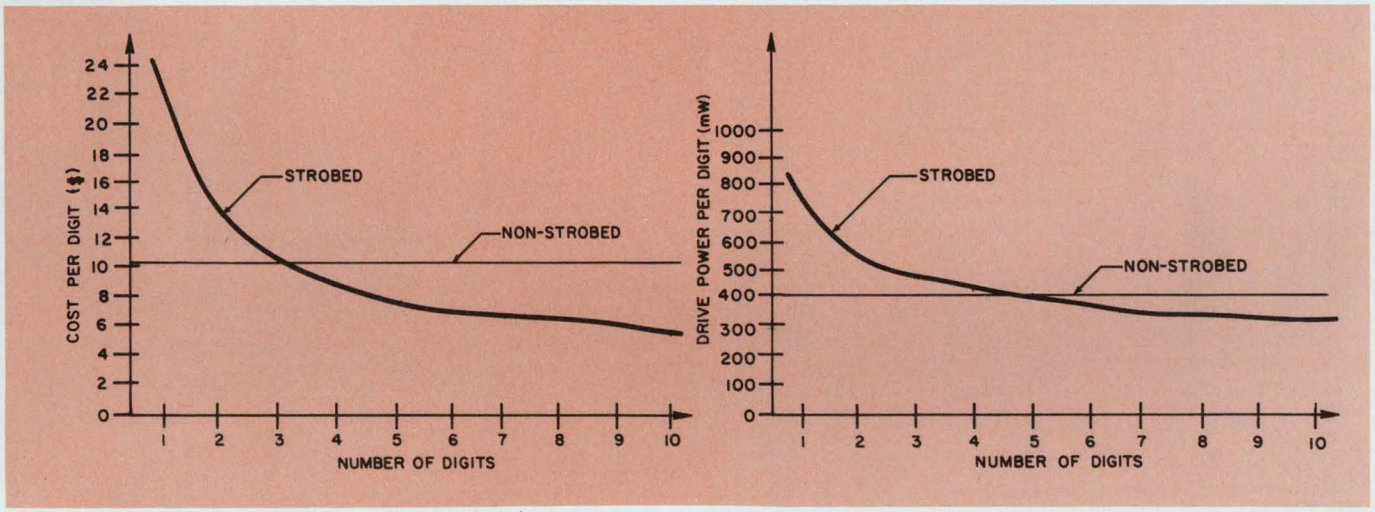
In strobing, the eight segment enable lines, which are connected to the segment anodes, must be activated successively for each character. The eight-bit segment word applied to the segment enable lines is usually generated by a decoder.

The decoder translates data from an input code (usually four-line BCD) into a seven-bit word for the character, with the eighth bit for the decimal point being supplied by another source.

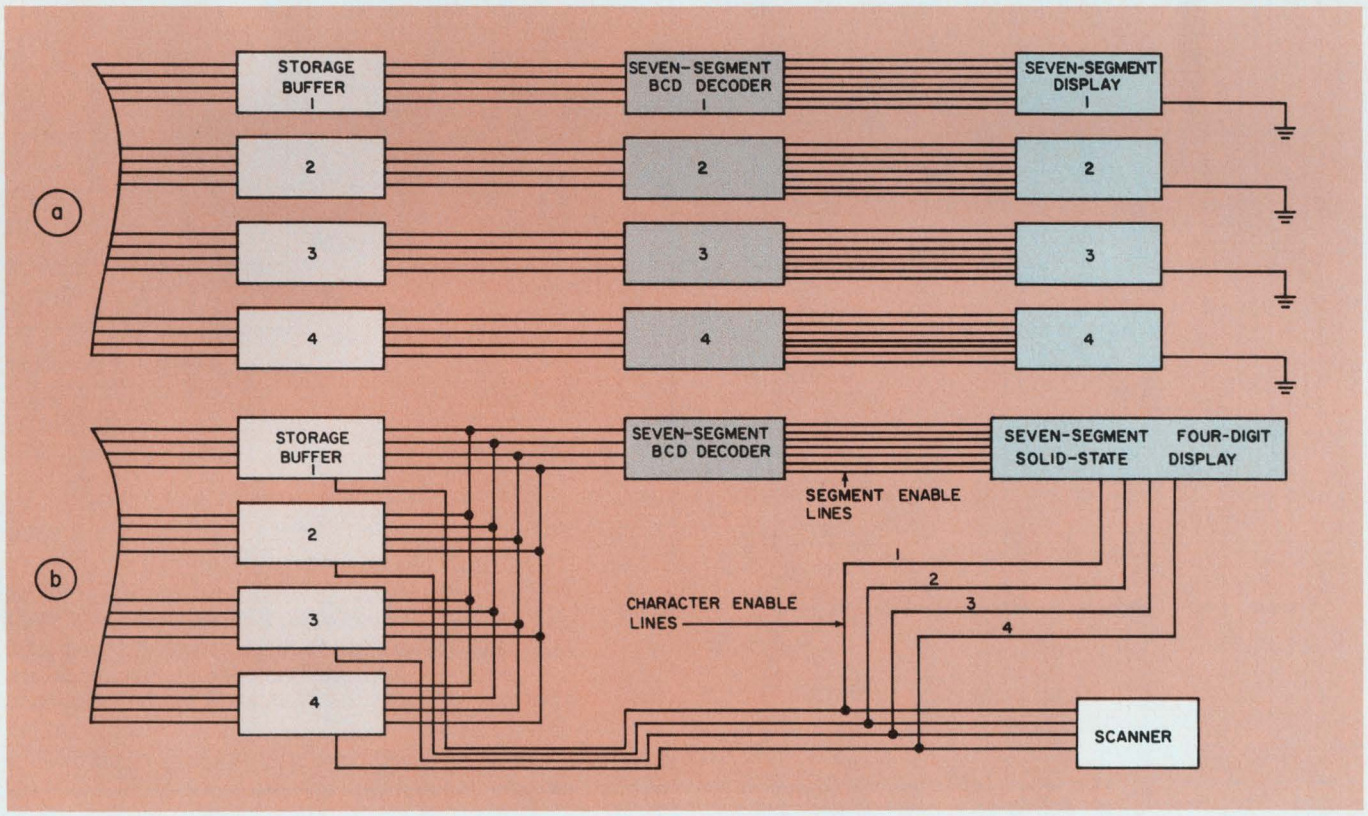
Choose the right strobing technique

There are two commonly used methods for periodically applying the character segment status words to the segment enable lines. One involves decoding and storing the segment status word into registers that are accessible to the segment enable lines. The second requires storing the input data in its original format and then decoding the data each time a segment status word is needed

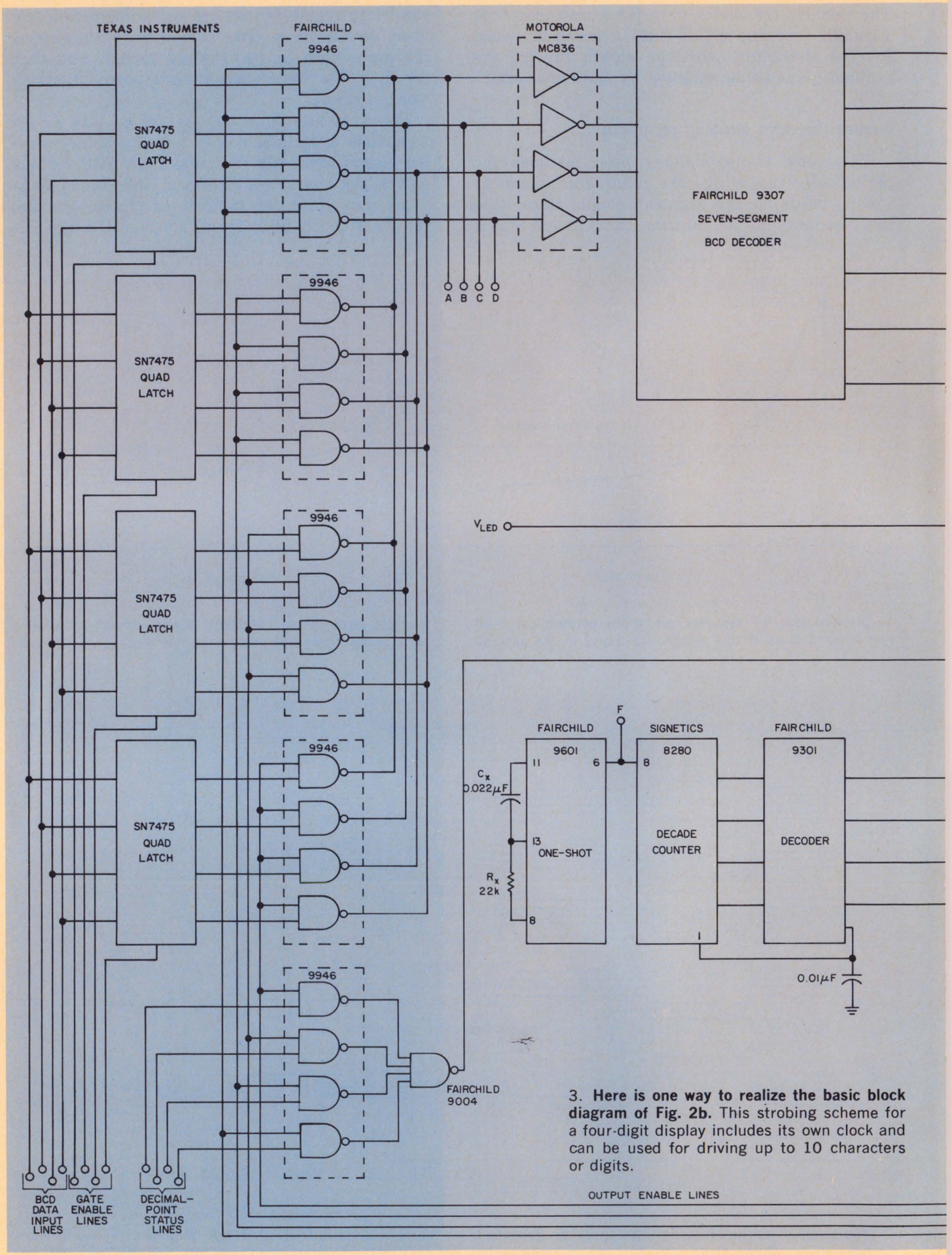
The first technique requires seven bits (eight to include a decimal point) per character, while the second uses only four bits (five with decimal point) per character. However, the second technique may limit the number of characters that can be strobed because of propagation time in



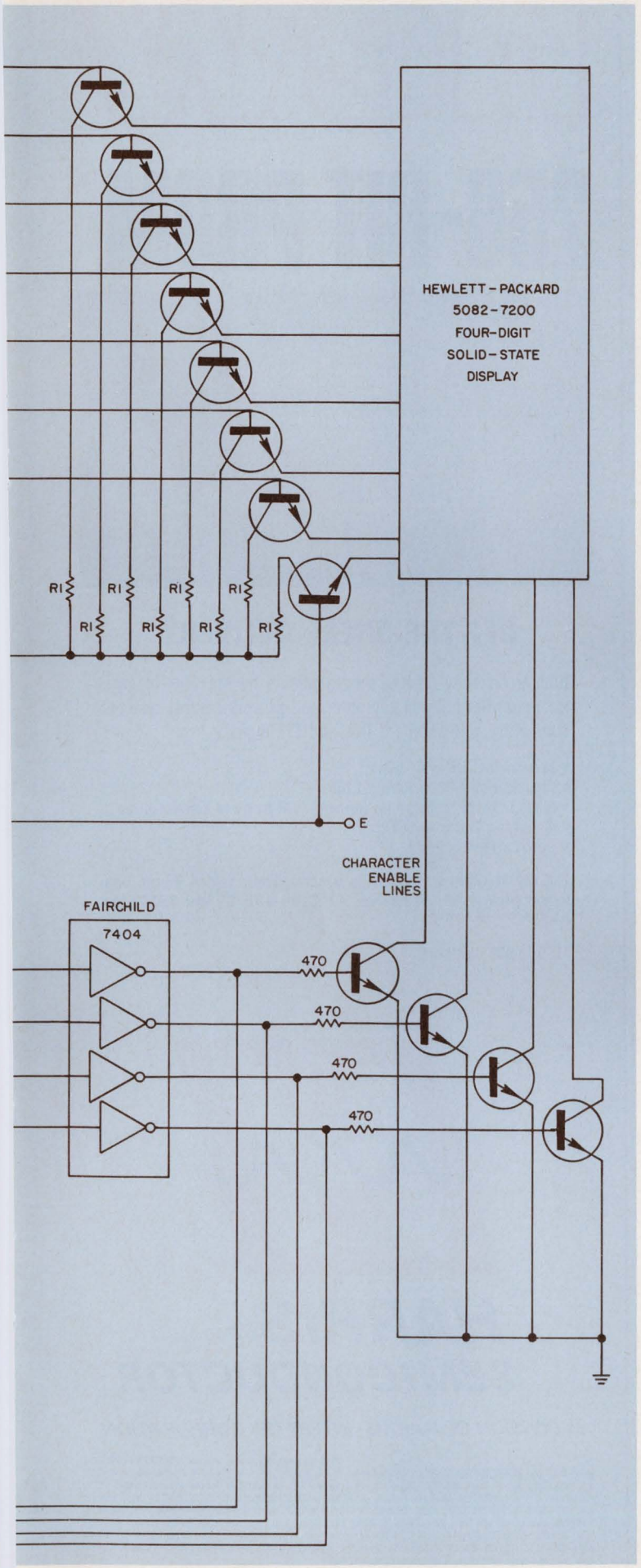
1. **Strobed display systems are more economical than non-strobed ones** if the number of digits in the display is more than three. Strobed power efficiency is also better when there are more than five digits.



2. **Non-strobed segmented displays require individual decoders** (a), while strobed units can time-share the same decoder (b). Both block diagrams represent four-digit display systems that use four-line BCD logic.



3. **Here is one way to realize the basic block diagram of Fig. 2b.** This strobing scheme for a four-digit display includes its own clock and can be used for driving up to 10 characters or digits.



the decoder.

The schematic of a strobed driver for four digits (Fig. 3) is a realization of the basic block diagram of Fig. 2b. It includes its own clock and accepts decimal-point information from four-line positive logic. Some power and ground connections are not shown.

Here's how a strobe works

Quad latches are used with wired-OR DTL NAND gates to perform data storage and multiplexing for the display. During operation the output enable lines are activated one at a time to gate the appropriate buffer into the decoder. They also gate the proper decimal-point data onto a common line. As an alternate, decimal-point data can be stored in buffers and gated like the BCD data.

Both the latches and the NAND gates can be eliminated if the data is already organized bit-parallel and character-serial, with a character rate that is consistent with the display. The NAND gates alone can be eliminated if the latches have OR-tieable gatable outputs.

The decoder/driver accepts positive BCD inputs and generates active high outputs. The OR-tied scheme requires one inversion to be compatible with the decoder. Additional pull-up resistors can be used if the decoder does not positively saturate the discrete drive transistors.

Resistances R_1 and R_2 control the peak current that passes through the light-emitting diodes of the display. For a 5-V supply, their appropriate values are:

$$R_1 = 3/N\ I_{avg} \text{ and}$$
$$R_2 = 15/N\ I_{avg}.$$

The scanning circuitry

The scanner provides one-out-of-N current sinking for the light-emitting diodes as well as active high outputs to enable the output gates on the storage buffers. Other techniques can be used for the scanner function, but the one shown is useful for up to 10 digits, and is less expensive than other methods. A shift register with one active high bit that recirculates is an alternate technique.

A retriggerable monostable multivibrator is used to implement a negative-going clock. In practice, the clock may be derived from an existing clock in the system. The clock rate must be N times the character rate, or a minimum of N 100 Hz. The circuit illustrated generates a clock pulse with a period of about 210 μs. In general, the period is approximately

$$T = 0.36\ R_x\ C_x.$$

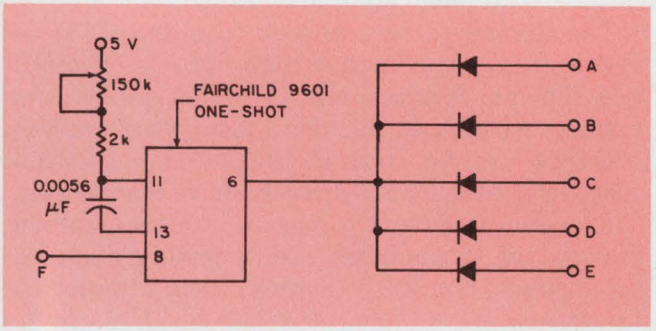
The clock, which drives a decade counter, is followed by a one-out-of-10 decoder and an in-

verter. The inverter's outputs are active, high, mutually exclusive drive lines, which enable the NAND gates that control the input data flow onto the decoder bus.

The NAND gates also drive the switching transistors for the character enable lines. These transistors must be able to carry a peak current of 8 N I_{avg} and an average current of 8 I_{avg}. The value of the 470-ohm resistors is nominal, since it is a function of transistor h_{FE}, N and I_{avg}; it should be selected to place the transistor well into saturation.

Display brightness can be controlled

Display intensity can be varied with an amplitude or pulse-width modulation (PWM) technique. The latter is recommended for wide-range brightness control, because it has the advantage of reliable tracking between segments as the brightness is decreased and also allows the light-emitting diode to operate with a high peak current for good efficiency.



4. **Use pulse-width modulation to vary display brightness.** You can change display intensity from full brightness to complete blanking by adjusting the potentiometer of this diode-coupled circuit.

One PWM technique (Fig. 4) makes use of a monostable multivibrator triggered by the display clock to control the duty cycle of character illumination. The voltage, V_{LED}, should be 5 V for constant brightness and PWM intensity control. If a variable voltage source (up to 5 V) is used, intensity can be adjusted over a small range.

In the PWM brightness control of Fig. 4, terminals A through F are connected to the corresponding terminals in Fig. 3. Diode coupling is used in the circuit to give a blanked output. A diode also controls cutoff of the decimal-point drive transistor so the decimal point can be dimmed. Some power and ground connections are not shown.

Brightness is dependent on resistance. When the 150-kΩ potentiometer is shorted, the circuit provides about 2 to 3% intensity reduction; with a full 150-kΩ resistance present, the display is completely blanked. ■■

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RADIATION MICROELECTRONICS HAS CHANGED ITS NAME TO HARRIS SEMICONDUCTOR

INFORMATION RETRIEVAL NUMBER 29

Trade shows are great—or are they? Every year electronics companies ask themselves questions like this. Here are answers that some of them have found.

Richard L. Turmail, Management Editor

Every year many of the 16,000 electronics companies in this country spend large amounts of time, talent and money to exhibit their wares at one or more of the industry's trade shows. And every year more than one company management wonders if the effort has been worth it.

As an engineer or engineering manager, you may have considered questions like these: Should my company exhibit or not? With so many trade shows to choose from, does the company have a logical formula or policy to determine which show to exhibit in? What should it expect to gain from exhibiting at trade shows?

What other companies do

For comparison, ELECTRONIC DESIGN asked a sampling of electronics companies why they did or did not exhibit at trade shows—and if they did, how they gauged their successes or failures at them. Their answers were as varied as the companies themselves. Some companies never let a year pass without exhibiting at one of the shows; others have stopped exhibiting completely. Some companies that participate in shows expect very little immediate gain from them, while others fully expect their exhibition to more than pay for itself.

Aside from the obvious politics of exhibiting at a trade show because the competition does, a company's size often determines why and how it will exhibit. Small companies, for instance, generally use a show to advertise their name in the industry, while large companies use the opportunity to introduce one or more new products. According to ELECTRONIC DESIGN's survey, the six reasons most often given for exhibiting at trade shows are:

- To establish company presence.
- To sell products and/or kick off a major marketing campaign.
- To introduce new products.
- To stimulate new business.
- To meet the customer in person.
- To size up the competition.

Here's how a few electronics companies explain their trade show policy—or their lack of one:

A spokesman for Hughes Aircraft says that originally the company exhibited at the two largest shows (IEEE and WESCON) to tell users that it produced more than aircraft. Every year the company's aerospace and commercial divisions were exhibited together in one central 40-to-50-foot booth at IEEE and WESCON—a mix of microelectronics, semiconductors and missiles.

When the trade shows became more commercially oriented, Hughes decided to stop exhibiting at the large trade shows in favor of military-oriented shows, including ones sponsored by the Army United States Association, Air Force Association and the Navy League. Next year the company's aerospace division will also be represented at a new air show to be held at Dulles International Airport in Virginia. The commercial division of Hughes exhibits at the large commercial shows only when it has an important new product to introduce.

Hewlett-Packard exhibits at all the major trade shows, including IEEE, WESCON and the Spring and Fall Joint Computer Conferences, according to a company spokesman. H-P exhibits at IEEE because it sees it as the major national electronics show where the newest products can stimulate the most interest and business. H-P considers WESCON to be more regional in character, but it exhibits there because the western market is important to the economy and because it takes pride in supporting a western show. Since computers are a new business for the company, it exhibits at the Spring and Fall Joint Computer Conferences mainly to establish its presence in the market.

Shows have changed with the industry

For the first time since IEEE started, there was no Texas Instruments booth at the show this year. A TI spokesman says the company hasn't exhibited at WESCON or at the computer conferences for about a year and a half. The shift in the company exhibition policy was brought

Show	Year	Attendance	Exhibitors	Total Space Contracted	Booths or Equivalent Space	Location
IEEE	1966	63,450	731	115,410	1282	New York
	1967	59,196	722	121,790	1353	New York
	1968	63,749	680	121,777	1353	New York
	1969	60,543	618	115,208	1280	New York
	1970	47,738	587	106,443	1183	New York
WESCON	1966	47,440	670	113,244	1416	Los Angeles
	1967	45,290	610	99,630	1245	San Francisco
	1968	48,480	659	109,402	1368	Los Angeles
	1969	45,068	610	108,540	1357	San Francisco
	1970	36,811	604	90,230	1128	Los Angeles
SJCC	1966	Figures Not Available				
	1967	13,200	124		348	Atlantic City
	1968	18,300	146		460	Atlantic City
	1969	35,525	172		427	Boston
	1970	28,713	350		960	Atlantic City
FJCC	1966	Figures Not Available				
	1967	24,124	142		443	Anaheim
	1968	24,576	152		415	San Francisco
	1969	25,600	368		997	Las Vegas
	1970	22,083	250		814	Houston

The 'big four' statistics for the past five years: Show organizers say that although a majority of IEEE exhibition visitors are from the east, a large number of attending engineers and managers, as well as exhibitors, come from all parts of the country. WESCON officials report that 65% of the exhibitors come from the midwest and the east, and 80% of the attendees hail from a 300 mile radius of the show. The majority of exhibitors are tapping the western market. A spokesman for the computer conferences said that both the fall and spring editions of the show are generally attended by those who reside within 100 to 200 miles of the conference site.

about by changes in the semiconductor industry and in the trade shows themselves.

He explained that in the days when the electronics industry was coming into its own, wave after wave of new devices were presented at IEEE; every year exhibitors were showing a whole new line of products. But now that the electronics industry has matured, there aren't as many new products to be shown. The big product trade show is waning, and many companies are exhibiting for reasons other than new-product presentations. But TI is of the opinion that the broad trade shows fail to convey the message of company diversity.

This year the company is concentrating its marketing activity on a specific area of its broad product line by exhibiting at both the West and East Electro Optical Systems Design Show. Company business was brisk there last year, the spokesman said, mainly because most of the attendees were interested in the products that were shown.

Teradyne, on the other hand, an eastern producer of test instruments, says it contracted for a 60-foot booth at IEEE this year mainly because it has a broad line of equipment to exhibit. Inquiries, a company spokesman says, are the yardstick by which exhibit success or failure is judged, but the total number of inquiries can be misleading. The company's product system is high-priced and five paying customers, rather than 300 interested customers, can make a show a success.

According to the spokesman, the larger and more well known a company is, the less value the show has for it. A large semiconductor company, for example, with a single product line would gain less from exhibiting at a major show than a small but diversified company, he says.

Teradyne thinks that NEPCOM WEST has been a good show for it, because applied systems are featured there. The spokesman says that a very practical group of people attend that show. They are potential customers who, for the most part, are looking to buy solutions to their problems—and that means more prospects.

Burndy, a connector company that has participated with fair regularity in IEEE and other large shows, dropped out of the IEEE exhibition this year, mainly because of the economic crunch, according to a company spokesman. The company has found that there's a lot of "waste" in the audience for it at the major shows. It has exhibited at NEPCOM WEST and EAST with some success. A spokesman says that connectors aren't just connectors—other products are involved in making up a complete system—and the company wonders if perhaps it should be exhibiting more at machine-design and appliance shows. It realizes the importance of having the potential customer see, touch and select the product first-hand, and, on occasion, it has sent a product demonstration trailer (a converted bus) around the country to introduce its products.

Show costs have risen

An exhibiting company should not interpret the show in terms of gains or losses, according to a spokesman for Systron-Donner. It believes, however, that it would lose business if it dropped out of shows. It uses the WESCON and IEEE shows as a platform for new-product introduction, to size up the market and the competition, and to meet its customers.

The company's formula for the amount of booth space it contracts for each year is to assign so many feet per product line. It cut its IEEE booth space from 115 feet to 80 feet this year, because it felt that it could present itself better in a more compact area. Systron-Donner introduced 18 new products at the IEEE show this year.

According to the spokesman, the company carries the same exhibit to WESCON, with the emphasis on different products or applications. Many companies build new exhibits each year, but Systron-Donner has refurbished the same basic exhibit for the past eight years with success. Show costs have soared in that time, the spokesman notes. Booth space has risen in price 30% to 40%, and trucking, booth construction and other services have risen 30% to 100%.

Subtle reasons to consider

In addition to all of the usual reasons for "showing or not showing" at trade shows there are some less obvious influences that should be seriously considered. Frank Burge, vice president of marketing for Data Technology, offers the following for your consideration:

1. *Timing new-product introductions to trade shows.* Too often new products are introduced at major trade shows before the development is complete. The new product makes a big splash, the sales force and customers get turned on—only problem is, you can't deliver. As time passes, your customers and your salesmen turn sour to your false promises. As a result, the false start costs you market position and a loss in credibility in the marketplace.

It is difficult and expensive to recover from such a false start. Even worse is the problem of reliability. With customers and salesmen screaming for products, the pressure is often so intense that products seem to get shipped before receiving a thorough going-over by quality control. Again, disaster results when the product has field problems. In some cases you find that you can't economically meet the original published specifi-

The go/no-go trade show test

Many companies would like to know what gains they can expect if they exhibit at a trade show.

Bruce La Centra, director of communications at Iomec, Inc., Santa Clara, Calif., has devised a formula to help his company determine what the cost per prospect will be for exhibiting at shows. Here's his step-by-step analysis showing a typical example:

1. *Cost of exhibit.* Including planning time, floor space, booth construction and shipping, set-up and knock-down costs, electrical work, plus travel, food and lodgings for booth attendants $20,000
2. *Expected attendance* 10,000
3. *Subtract "waste" attendance*—those who have no say in the purchasing process; 40% is usually a safe figure for most big exhibits 4000
4. *Base attendance figure*..... 6000
5. *Subtract "disinterested" attendance.* Assuming that your product does not have universal appeal, many viewers won't have the slightest interest in it; 50% would be a good figure, although it will vary widely from product to product.... 3000
6. *Adjusted base attendance figure*... 3000
7. *Subtract "interested-but-not-in-the-market-now" attendance.* Include all those who do not plan to buy within a year; the figure will vary, but 75% is not unreasonable 2250
8. *Adjusted base attendance figure*—your target group at the exhibit 750
9. *Subtract half of the target group.* Most companies find they can reach only half of the target group at an exhibit.... 375
10. *Final base attendance figure*—real prospects that you will probably reach... 375
11. *Divide into total cost ($20,000) to get cost-per-prospect* $53.22

You may want to quit right here, but stick with it for a few more steps. First try to find out how much bonafide inquiries from other promotion sources are costing you. If your advertising is yielding good inquiries at $10 each, then:

12. *Divide exhibit cost-per prospect by 2 or 3* (we'll use 3). Assume that an exhibit inquiry is two or three times as valuable as an advertising inquiry because (a) You have had a chance to talk to the prospect face-to-face, and (b) You have most likely demonstrated your product to him. Neither of these advantages apply to most other forms of promotion..... $17.77
13. *Compare with cost-per-prospect of advertising inquiries* $10.00

Now you can decide not to go into this show. Your cost-per-prospect would be $7.77 higher than it would be for advertising-generated inquiries. If the figures came out about the same or in favor of the exhibit, then of course you would probably decide to participate.

cations—once again, embarrassment plus the expense of reprinting all those data sheets and brochures that are grossly incorrect.

2. *Hidden costs.* All companies add up the costs of the display booth, the air fares, the hotel bills, etc. But some costs are not so obvious. For example, add the cost of those engineers working up a clever display for the booth, when they could be designing products. And don't forget the time your marketing and management people spend on show planning, when they could be defining new products or developing new markets.

3. *Losing the competitive jump.* Most companies use trade shows to evaluate competition, and it is amazing how much can be learned. Sometimes the booth is manned by a design engineer or a new salesman, and once he starts talking, all the competitor has to do is listen. There are hundreds of cases where the competition got the edge simply because it spent a lot of time at your booth learning about your product and plans (including manufacturing costs and schedules). Although such information-gathering tactics may be frowned on, everybody does it. Ask yourself: Will display at a trade show hurt or help your competitive position?

You may find that trade shows are not a good investment. If you have a narrow customer base, private showings may be more appropriate.

A throwback to medieval trade fairs?

It's apparent that few companies exhibit at trade shows for the same reasons. Some companies do it for reasons they can't even explain.

La Centra at Iomec says: "In many respects, exhibits are a throwback to the medieval trade fairs, which were inefficient methods of communication.

"Why then put up with them? Because they can work if everything is right. They're often a gamble, but when you hit it, you hit it big. The lure is irresistable, and we're all gamblers at heart." ■■

ideas for design

Improve your curve plotting with SuperBASIC software

Computer costs and programming time can be reduced by using SuperBASIC[1] to do your curve plotting. It's an advanced BASIC language incorporating many user-oriented features, such as string manipulation, printout control and Boolean logic.

A graph routine written in SuperBASIC cuts composer costs because it is more efficient in program length and printout time than an equivalent BASIC routine.[2] The SuperBASIC routine also saves programming time, because it is more flexible and therefore easier to use.

Curve plots generated by the graph routine of Fig. 1 are shown in the printout of Fig. 2. Here gain (G) in decibels and phase (P) in degrees are plotted as a function of frequency. The lines connecting the data points are drawn in afterward to accentuate the curves.

Each value on the frequency scale is rounded to three places and printed as a number between 1 and 1000, followed by a symbol indicating the multiple of ten (i.e. G = giga = 10^9, M = mega = 10^6, K = kilo = 10^3).

The logical operation of the graph routine of Fig. 1 is quite simple. Lines 0 to 100 are a short main program to generate data points for the demonstration graph of Fig. 2. The graph itself is printed in two parts: The axes and scales are generated by the print statements in lines 110 to 140 and 240; the data points are generated by the J-loop in lines 150 to 230.

Data points for G and P are printed in a 37-row by 61-column matrix. The 37 rows are printed one at a time from top to bottom as J varies from 0 to 36. Within each row the 61 columns are accumulated in the string variable O, one character at a time from left to right, as I varies from −30 to +30.

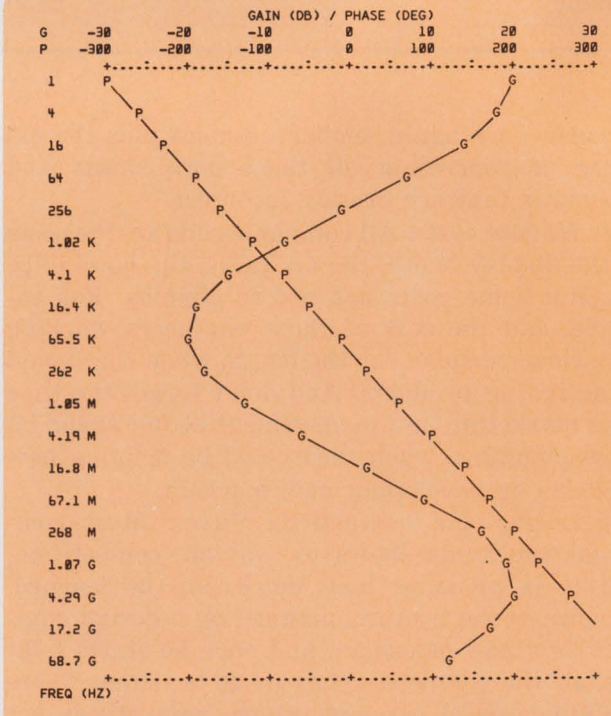
The first two characters in the string O are a frequency scale symbol and a space (generated by line 170). The remaining 61 characters in the string O are the G and P data points and intervening spaces (generated by lines 180 to 200). Although the string O is always 63 characters long, the computer skips trailing blanks during printout (in line 210) to minimize terminal time.

Line 170 uses the advanced logical and string capabilities of SuperBASIC to reformat the frequency values. The following arithmetic and string functions are used:

INT (x) = The largest integer in the number x.
ROUN (x) = The nearest integer to the number x.
LGT (x) = $\mathrm{Log}_{10}(x)$.
SUBSTR (S,x,y) = The substring of the string S, beginning with the xth character from the

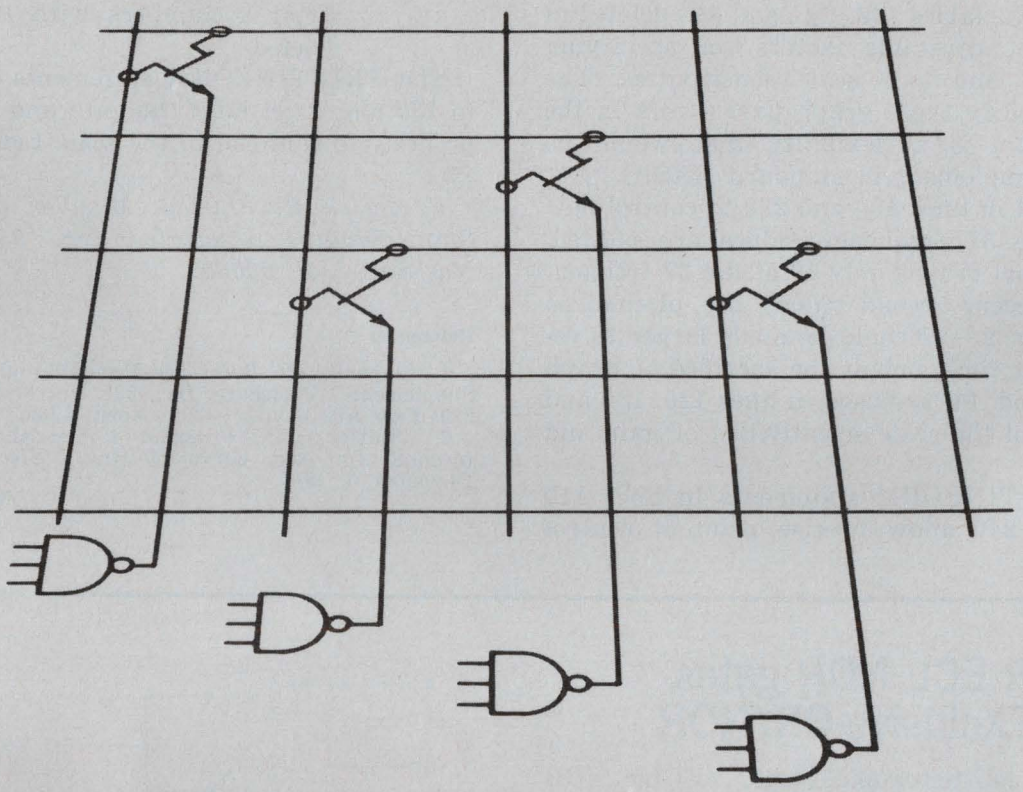
```
0 REM  GRAPH ROUTINE FOR SBASIC
10 REAL F(0:36),G(0:36),P(0:36)
20 F(K)=2^K,G(K)=20*COS(K*.2),P(K)=18*K-300FORK=0TO36
100 J0=2,G0=10,P0=100
110 PRINTINFORM"4/26B'GAIN (DB) / PHASE (DEG)'/":
120 PRINTINFORM"'G'3B7(5%5B)/":G0*J FOR J=-3TO3
130 PRINTINFORM"'P'3B7(5%5B)/":P0*J FOR J=-3TO3
140 PRINTINFORM"8B'+'6('....:....+')/":
150 FOR J=0 TO 36 STEP J0
160 G=ROUN(G(J)*10/G0),P=ROUN(P(J)*10/P0),F=ABS(F(J))
170 IF F<1E-18 THEN F1=0,O="  "ELSE F2=2-INT(LGT(F)),F3=INT(F2/3),
 F1=ROUN(F(J)*10^F2)/(10^(F2-F3*3)),O=SUBSTR("*TGMK LUNPFA",F3+6,1)+" "
180 FOR I=-30 TO 30
190 IF I=G THEN O=O+"G" ELSE IF I=P THEN O=O+"P" ELSE O=O+" "
200 NEXT I
210 PRINT F1:TAB(7):O:
220 PRINT FOR I=1 TO J0 IF J<36
230 NEXT J
240 PRINTINFORM"/8B'+'6('....:....+')/'FREQ (HZ)'4/":
```

1. **Optimize computer time** with 18-line SuperBASIC program for plotting curves.



2. **Comptuer-generated gain and phase curves** show frequency in conventional engineering units.

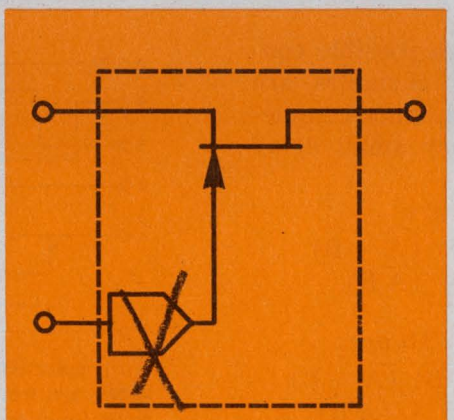
Drive FET analog switches from DTL without interface drivers?



Sure.

Where low cost is a prime requirement, such as in an audio crossbar system or other small digital multi-point switching system, control the Siliconix U306 directly from DTL logic.

Think of it. No interface drivers between analog switches and low level logic in many applications. This is just one example of how Siliconix products and applications know-how can save you money.



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left and continuing y characters to the right.

If F is very small ($<10^{-18}$) then F1 is set equal to zero and O becomes a two-character string of spaces; otherwise F2, F3, F1 and O are defined as shown. The variable F2 keeps track of the decimal place in F, F3 selects the scale symbol, F1 is the frequency value rounded to three places, and O is the scale symbol followed by a single space.

The three variables J0, G0, and P0 defined in line 100 are adjustable factors for specifying graph detail and axis scale sensitivities. The ability to modify these graph parameters in the main program is a flexibility that would be difficult to implement in standard BASIC.

J0 is used in lines 150 and 220 to control how many of the 37 frequency values are plotted. With J0 equal to two, only 19 of the 37 frequency values (every second value) are plotted, as shown in Fig. 2. J0 could be made larger to reduce printout time, but at the sacrifice of graph detail. G0 and P0 are used in lines 120, 130 and 160 to control the scale sensitivities of gain and phase.

The PRINTINFORM statements in lines 110 to 140 and 240 allow precise printout control with a minimum of programming. The information within the double quotes specifies the format for printing the values of the variables after the colon. The following conventions are used in the PRINTINFORM format:

'S' = Print the literal string S.
/ = Go to the next line.
x(y) = Repeat the y field x times.
xB = Print x spaces.
x% = Print x numbers with leading zeros deleted.

The PRINTINFORM statements in lines 120 to 130 align and label the gain and phase scales properly to conform to the scale factors G0 and P0.

Frederick R. Shirley, Member of Technical Staff, Sanders Associates, Inc., 95 Canal St., Nashua, N. H. 03060.

References

1. "SuperBASIC Reference Manual" and "SuperBASIC Supplement," Tymshare, Inc., 525 University Ave., Suite 220, Palo Alto, Calif. 94301, April, 1969.
2. Shirley, F., "Program a time-shared computer terminal for easy curve plotting," *Electronic Design*, December 6, 1969.

VOTE FOR 311

Wired-OR ECL NOR gates give an EXclusive-OR/NOR

Standard emitter-coupled logic (ECL) NOR gates can be wired-OR to produce an EXclusive-OR/NOR function.

Figures 1a and 1b illustrate two possible configurations when complementary variables are available. They are quite practical, since complementary signals usually have very small delay differences.

The logic equations for Fig. 1a are:

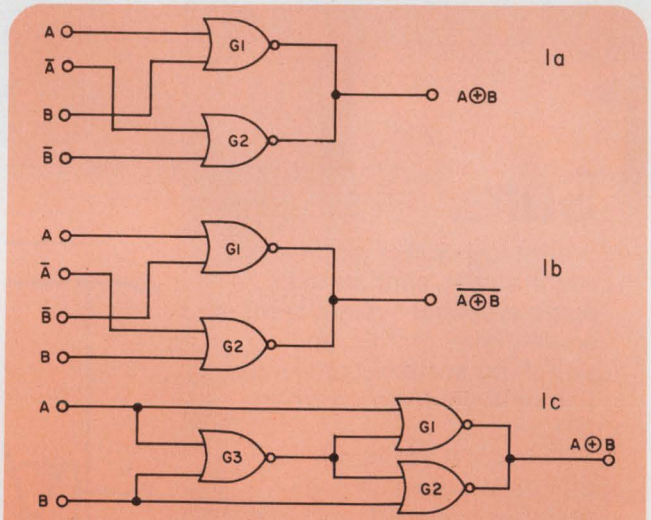
$$\overline{(A + B)} + \overline{(\overline{A} + \overline{B})} = (A + B)\,(\overline{A} + \overline{B})$$
$$= (A\,\overline{B}) + (\overline{A}\,B)$$
$$= A \oplus B.$$

Similarly the equations for Fig. 1b are:

$$\overline{(A + \overline{B})} + \overline{(\overline{A} + B)} = (A + \overline{B})\,(\overline{A} + B)$$
$$= (A\,B) + (\overline{A}\,\overline{B})$$
$$= \overline{A \oplus B}.$$

The addition of a third NOR gate (Fig. 1c) eliminates the need for complementary inputs, but introduces one or two gate delays, depending on the value of A and B. The equations for this configuration are:

$$\overline{[(\overline{A + B}) + A]} + \overline{[(\overline{A + B}) + B]}$$
$$= \overline{[(\overline{A + B}) + A]\,[(\overline{A + B}) + B]}$$
$$= \overline{(A+B)\,(\overline{A+B}) + A(\overline{A+B}) + B(\overline{A+B}) + (A\,B)}$$
$$= \overline{(A+B)} + (A\,\overline{A}\,\overline{B}) + (B\,\overline{A}\,\overline{B}) + (A\,B)$$
$$= (\overline{A+B}) + (A\,B)$$
$$= (\overline{A}\,\overline{B}) + (A\,B)$$
$$= A \oplus B.$$



With complementary inputs, only two ECL NOR gates are needed to implement the EXclusive-OR/NOR function. Adding a third gate reduces the inputs to only two, but at the price of gate delay.

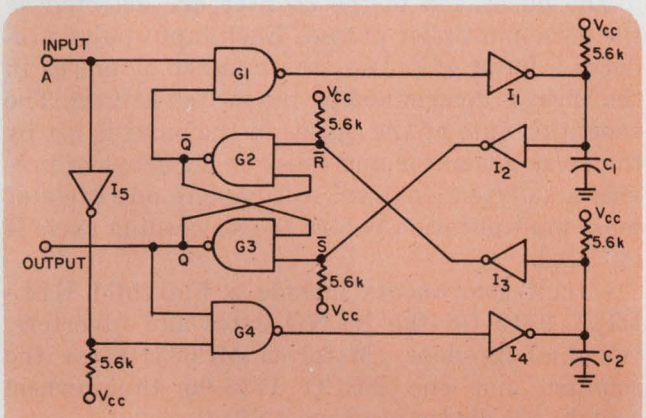
If B is ZERO and A is switched, the output of the tri-gate EXclusive-OR/NOR appears within two gate delays. If B is ONE and A is switched, the output appears within only one gate delay.

R. R. Osborn, Roberts Enterprises, 502 W. 113th St., New York, N. Y. 10025.

VOTE FOR 312

Digital IC noise eliminator lets you count clean pulses

In digital systems it is often necessary to count pulses from a noisy source. Noise can cause false counts by appearing on the input line as spikes of sufficient amplitude to trigger the counter or as discontinuities in the desired pulse. A circuit that eliminates noise by functioning as a dual pulse width discriminator consists of a quad two-input NAND gate (Texas Instruments SN7400) and a hex inverter (Texas Instruments SN7405).



Noise eliminator functions as a dual pulse discriminator for pulse-counting applications. The circuit uses only two digital integrated circuits—a quad dual-input NAND gate and a hex inverter.

With no input (point A to logic ZERO), the latch automatically assumes the reset state ($\overline{Q}$ at logical ONE). An input pulse causes C_1 to charge towards V_{cc}. If the input's duration is long enough for C_1 to charge to the switching threshold of inverter I_2, $\overline{S}$ of the latch is pulled low, causing the latch to change states.

Feedback from $\overline{Q}$ returns $\overline{S}$ to logical ONE. With the latch in this state, the input line is isolated from the network controlling $\overline{S}$ and is gated to the network controlling $\overline{R}$ after being inverted by I_5.

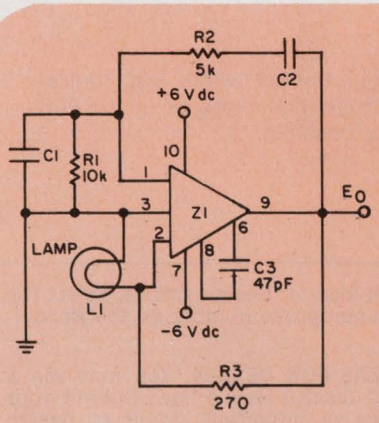
The output taken from Q of the latch will not return to the ZERO state until the input returns to the ZERO level for a period set by C_2. The use of open-collector inverters with external resistors provides a high input resistance, and therefore large time constants for a given C_1 or C_2.

Ronald E. Wysong, Project Engineer, R. L. Drake Co., 540 Richard St., Miamisburg, Ohio 45342.

VOTE FOR 313

$5 Wein-bridge oscillator is both stable and compact

For about $5, you can build a Wein-bridge oscillator that will give you performance comparable to those of circuits that cost five times more. This economical oscillator can drive load impedances of less than 10 ohms, as well as large capacitive loads.



FREQUENCY	C1=C2
1 Hz	33 μF
100 Hz	0.33 μF
500 Hz	0.065 μF
1 kHz	0.033 μF
10 k Hz	3300 pF
50 k Hz	650 pF
100 k Hz	330 pF

Stability and low distortion are main features of this compact Wein-bridge oscillator, in which a lamp provides automatic gain control. The table indicates various values for C_1 and C_2 over a range of operating frequencies.

Additional advantages include simplicity, compactness, low power dissipation, stability and low distortion. A complete test generator consumes only about 100 mW of power.

The amplifier, Z_1, is Motorola's MC1454, chosen because of its ability to drive low-impedance loads. R_1 equals the typical input impedance of the amplifier, while R_2 is equal to R_1 shunted by the amplifier input impedance. C_1 and C_2 have equal values and are the reactive components in a positive feedback configuration. C_3 is used to compensate the amplifier.

Automatic gain control is implemented by L_1, a No. 80 lamp from Lamps, Inc. R_3 provides the required negative feedback and also offers limited control over output amplitude.

The oscillator's output is stable at 2 to 8 V pk-pk over the frequency range of 1 Hz to 100 kHz. A slight amount of cross-over distortion is noticeable at the higher frequencies, due to the output stage of Z_1. The frequency of oscillation is $1/2\ \pi\ R_1C_1 = 1/2\ \pi\ R_2C_2$.

P. C. Lipoma/C28, Lockheed Electronics, 16811 Camino, HASR/671-11, Houston, Tex. 77058.

VOTE FOR 314

Switchable pulse multiplier delivers 10-to-1 pulse burst

A switch-selectable pulse multiplier provides an output pulse train that has from 1 to 10 pulses for each input pulse. The circuit is useful in many digital control systems—the driving of a stepper motor, for example.

It consists of a unijunction-oscillator pulse generator, a four-bit binary counter, a switch-selected gate to detect the counter's state, three signal inverters and a control gate. In operation, the UJT oscillator produces a continuous pulse train with a repetition rate of approximately 200 pulses per second for the component values shown. Circuit modifications, however, can bring the repetition rate up to 40,000 to 50,000 pulses per second.

The counter is normally at the count selected by the switch setting. At this setting, NAND gate G_2 is enabled. A ZERO output from G_2 disables NAND gate G_1.

A ONE input at the signal input terminal produces a ZERO at the output of the inverter I_3. This zero disables G_1 and resets the four flip-flops. With the flip-flops reset, the output of G_2 changes from ZERO to ONE to enable one input of G_1.

The second input for G_1 comes from the pulse generator through inverter I_1. This input is enabled at the pulse repetition rate. No output is obtained from G_1, because of a third disabling input from I_3. When the signal input returns to ZERO, the output of I_3 becomes a ONE and enables the third input to G_1.

Each pulse of the pulse generator now produces an output from G_1. This output is inverted by I_2 and then counted by the four-bit counter. When the number of pulses entering the counter is equal to the selector switch setting, G_2 is enabled and G_1 becomes disabled, preventing all succeeding pulses from passing through.

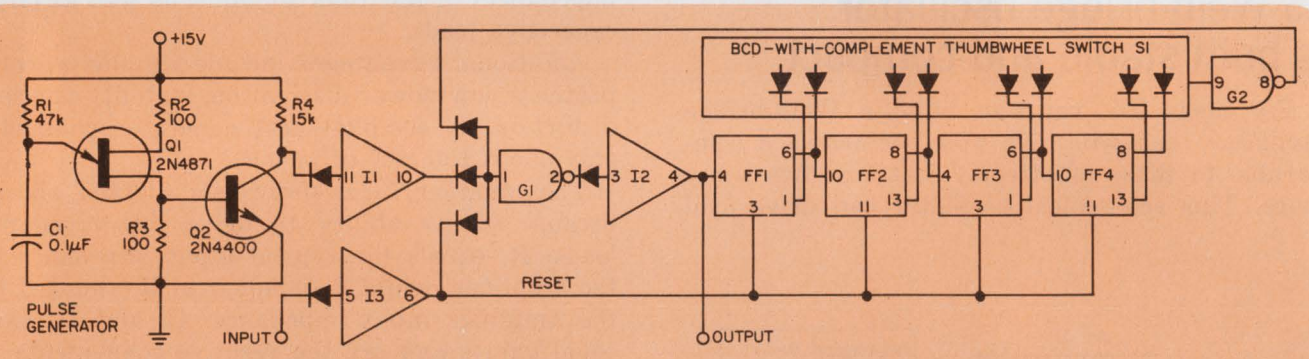
The pulses fed to the counter are detected as the pulse-multiplier output. Each input pulse produces a burst of pulses; the number of pulses in the burst is determined by the switch setting. The repetition rate of the pulses in the burst is set by the pulse generator and must be adjusted to provide a sufficient interval to complete one cycle of pulse multiplication before the succeeding cycle is initiated.

Circuit components include a Fairchild HLL-DTμL 9110 for the NAND gates and inverters, two dual flip-flops (Motorola MC663P) for the counter, and one EECO 1776-06 thumbwheel switch. All diodes are type 1N914.

This circuit concept may be extended to several decades by replacing the binary counter with several cascaded binary-coded-decimal counters and detecting the outputs with a corresponding number of thumbwheel switches.

Ernest A. Kussmaul, Kussmaul Engineering Co., 186 West Main St., Sayville, N. Y. 11782.

VOTE FOR 315



Get a train of up to 10 pulses from a single input pulse with this switch-selectable pulse multiplier. Basic circuit components are a UJT pulse generator, a binary counter, a thumbwheel switch and control gates and inverters. Repetition rates of up to 200 pulses per second are possible.

IFD Winner for January 7, 1971

Steven E. Holzman, Technical Staff Member, E. S. L., Inc., 495 Java Drive, Sunnyvale, Calif. His Idea "TTL-Compatible Analog Gate For Only $2 in Parts" has been voted the Most Valuable of Issue award.

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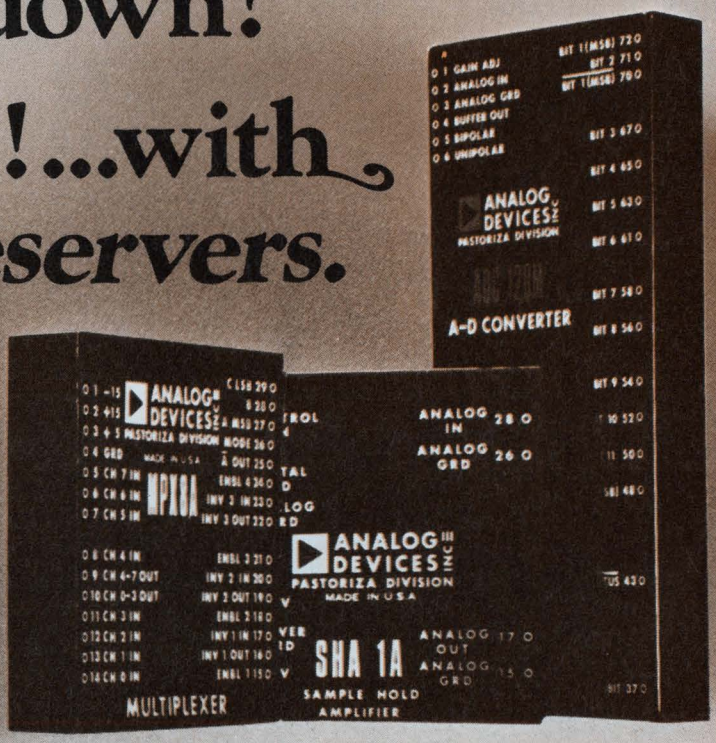

When you buy a good 12-bit A/D Converter, you want that 12th bit to *stay* good. But every time you add another element to the system, you lose accuracy. Multiplexers, data amplifiers, sample holds . . . each one nibbles away at the 0.02% limit of error you are protecting. Pretty soon, you've lost the 12th bit, and are sweating out the 11th.

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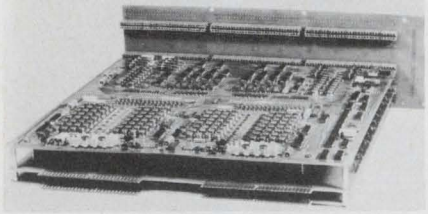
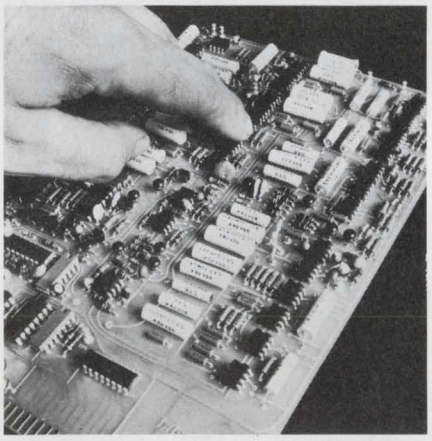


Computer Automation, Inc., 895 16 St., Newport Beach, Calif. Phone: (714) 642-9630. Price: see text.

A new concept in minicomputers is the Naked-Mini, a stripped down minicomputer starting with basic 8-bit 4k core memory for only $1700 (200 quantities). It's stripped of its power supply, console and metal chassis to lower its cost for OEM users. A 16-bit 4k unit costs just $2400. Up to 32 kbits of memory are available. The entire minicomputer is on a 15 by 15-in. module.

CIRCLE NO. 340

Integral data modems operate to 1800 baud



Intertel, Inc., 18 Adams St., Burlington, Mass. Phone: (617) 272-7436. P&A: under $200; stock to 90 days.

Series IN202 of medium-speed integral modems can be used over dial-up or private telephone lines at speeds up to 1800 baud. Four models are compatible with Western Electric 202 data sets. Models 2020 and 2021 are for use over dial-up lines. Models 2025 and 2026 are for two or four-wire private lines. All models allow operation at receive-signal levels of −50 dBm.

CIRCLE NO. 341

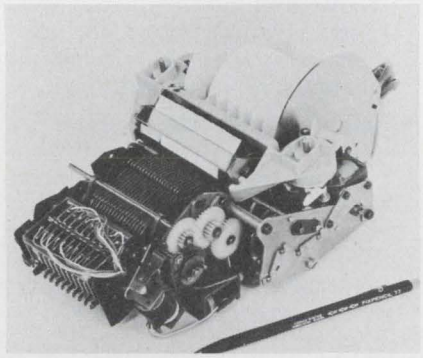
High-density display shows complex graphics

Tektronix, Inc., Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $7850; 3rd quarter, 1971.

The new T4005 graphic display is a high-speed computer peripheral designed for low-cost displays of high-density alphanumeric and complex graphic data. It is composed of a graphic-display controller and Tektronix 11-in. direct-view bistable storage display unit. Features include display scaling, zooming, augmenting and ability to drive multiple displays.

Booth No. 2501 *Circle No. 254*

Compact digital printer has 20-column capacity

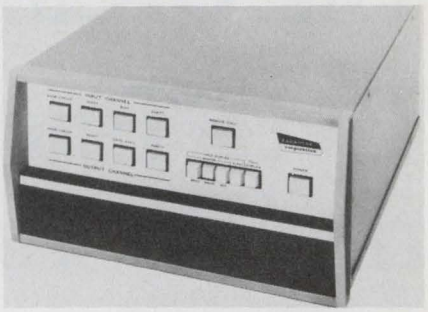


Facit-Odhner, Inc., Secaucus, N. J. Phone: (201) 866-5111.

A new digital printer, the 4501, is a compact device consisting of a solenoid, timing unit and printing unit that operates at 3.5 lines/s with a maximum capacity of 20 columns at 12 or 17 characters/column. It incorporates, as options, a ribbon mechanism or ribbon cassette, a paper feed mechanism and motor.

Booth No. 1943 *Circle No. 280*

600-byte/s extender eliminates hardware



Paradyne Corp., 2040 Calumet St., Clearwater, Fla. Phone: (813) 442-5126. P&A: $6000; 60 days.

Combining a modem, error-control system and an I/O channel interface, the PIX-600 600-byte/s parallel interface extender eliminates hardware as a controller, modems, data set adaptors and remote processors. It also eliminates software. Its speed is 4800 bits/s on dial-up lines and it can operate within tape and disc systems and as an on-site peripheral.

CIRCLE NO. 342

Tape-drive motor handles 200 in./s

Micro Switch Div. of Honeywell, Inc., 11 W. Spring St., Freeport, Ill. Phone: (815) 232-1122.

A new high-performance dc motor that can handle tape capstan drives as high as 200 in./s is available. Key to the high-speed 6VM3-1-C3 hollow-rotor motor is its aluminum wire windings, which nearly doubles the acceleration rate of copper-wired motors, and its low-volume high-velocity forced-air cooling. The 6-in.-dia 15-lb motor, which uses 36 V, has a torque of 155 oz-in.

Booth No. 1182 *Circle No. 267*

1024-character terminal accesses minicomputers

Mark Computer Systems, Inc., 2 Patterson Pl., Garden City, N. Y. Phone: (516) 746-5885. P&A: from $3995; 90 days.

The series DD-70 terminal provides operator access to a minicomputer by means of a 12-in. 1024-character CRT display with a keyboard. Character positions are operator or computer selectable and can be title and data fields.

CIRCLE NO. 343

Digitized design system speeds up analysis

Bendix Computer Graphics, 23850 Freeway Park Dr., Farmington, Mich. Phone: (313) 665-7766. Price: $20,000.

The completely electronic new Automated Design System permits an operator to feed digitized information quickly into a computer for rapid analysis and computation. It performs the routine checking and verification of engineering and design problems.

CIRCLE NO. 344

8-channel tape recorder reads 150 characters/s

Engineered Products, Inc., 290 Huyler St., S. Hackensack, N. J. Phone: (201) 488-4040. P&A: $160; stock.

Speeds up to 150 characters/s can be achieved with a new 8-channel starwheel sensing tape reader. The model 1200 is driven mechanically by turning a shaft at 15 degrees per character. Contacts are HTL, DTL, RTL and TTL compatible.

CIRCLE NO. 345

Teletypewriter coupler converts BCD to ASCII

Pivan Data Systems, Inc., 6955 N. Hamlin Ave., Lincolnwood, Ill. Phone: (312) 676-0790. Price: $500.

The 33ASR Dijitdriver coupler converts parallel-bit four-wire BCD data into a serial-bit ASCII format. It provides a convenient and low-cost means of recording the digital output of instruments on a 33ASR Teletypewriter.

CIRCLE NO. 346

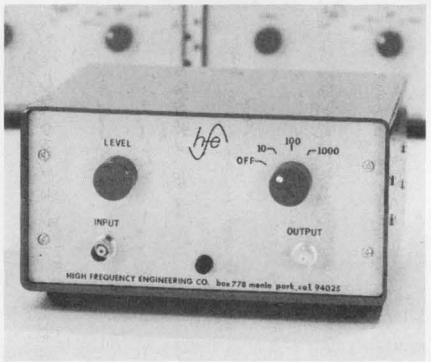
Compact $220 DPM has 1-second response

Triplett Corp., Bluffton, Ohio. Phone: (419) 358-5015. P&A: see text.

A new 3-digit single-polarity compact DPM with a single-plane 7-bar fluorescent wide-angle display, 1-s response and a sampling rate of 3/s has a $220 price tag. The model 4230-F measures only 2.359 by 4.14 by 4.846 in. and has full-scale readout of 999. Power drain is only 2 W, input resistance is 1000 MΩ and BCD is optional.

CIRCLE NO. 347

50-Ω pre-scaler extends to 300 MHz

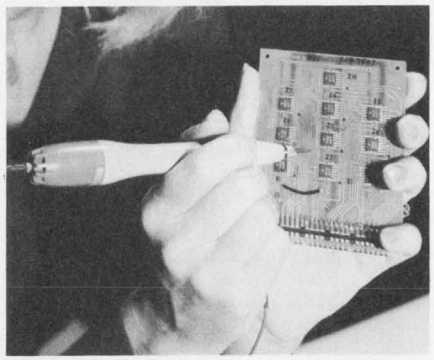


High Frequency Engineering Co., 123 Santa Maria Ave., Portola Valley, Calif. Phone: (415) 851-8108. P&A: $230; stock.

An upper limit of 300 MHz is possible with the model HFE300 pre-scaler which functions with digital counters to extend their range by scales of 1000, 100 or 10. Its maximum rf input voltage is 1 V rms. Typical input voltage is 150 mV rms. Output voltage is 1 V pk-pk and input and output impedances are 50 Ω, each.

CIRCLE NO. 348

Current-limited probe simplifies testing

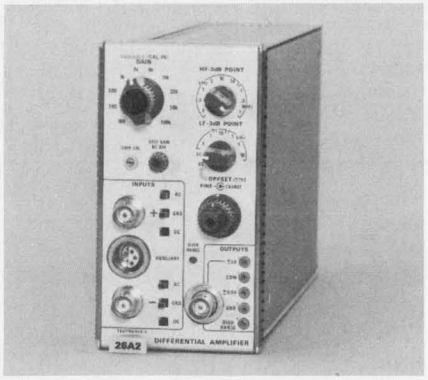


Western Technical Products, 13355 Saticoy St., N. Hollywood, Calif. Phone: (213) 765-4562.

No bigger than a penlight, the Toneprobe is a unique current-limited (1 mA) audible tester completely self-contained. While listening to the tone pitch (which increases with resistance), the user is able to sweep rapidly across circuits with complete eye and body freedom, unhampered by leads extending from fixed equipment. The probe uses two AAA batteries.

CIRCLE NO. 349

Amplifier plug-in gains from 10^2 to 10^5



Tektronix, Inc., Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $550; 11 wks.

The new 26A2 differential amplifier plug-in module features a gain switching range from 100 to 100,000, selectable high and low-bandwidth limits and dc offset. Front-panel power is available for active probes and transducer adapters. Two outputs are available: a low-impedance high-level ±5 V at ±20 mA and 5 Ω for a/d converters and recorders; and a 50-Ω ±0.5- V output for driving display monitors.

CIRCLE NO. 350

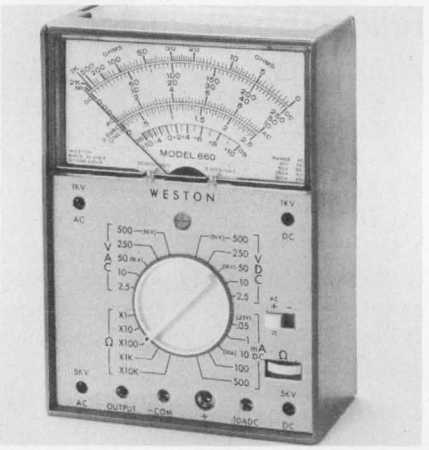
10 Hz to 12-MHz source is fully programmable

Progress Electronics Co. of Oregon, 5160 N. Lagoon Ave., Portland, Ore. Phone: (503) 285-0581. Price: $495 to $580.

The new model 101A digital test oscillator is a programmable instrument that covers 10 Hz to 12 MHz. It features facilities for AM and FM modulation, BCD remote programming digital frequency selection and constant output amplitude into 50 and 600 Ω. A multiphase output allows a 180° phase change in the output signal.

CIRCLE NO. 351

Ruggedized VOMs are drop proof

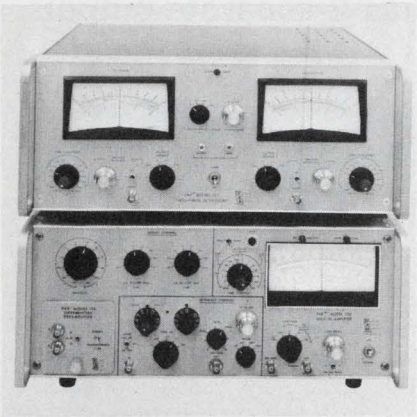


Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, N. J. Phone: (201) 243-4700. P&A: $76.50 to $132.50; stock.

The 660 series miniature VOMs offer drop-proof protection. They are warranted in writing to work after accidentally being dropped five feet and utilize a ruggedized taut-band mechanism. Five models in the series are available. Features include accuracy of 2% for dc and 3% for ac and sensitivity of 20 kΩ/V dc and 5 kΩ/V ac.

CIRCLE NO. 352

210-kHz lock-in amp measures 1-nV signals



Princeton Applied Research Corp., Box 565, Princeton, N. J. Phone: (609) 924-6835. P&A: $1995, $1895; 90 days.

Two new instruments measure phase and amplitude of low-level signals buried in noise. The 126 lock-in amp is designed for 1-nV signals and 1-μV sensitivity over 0.2 Hz to 210 kHz. The 127 two-phase lock-in accessory allows lock-ins to simultaneously measure phase and amplitude of the quadrature component of signals.

CIRCLE NO. 353

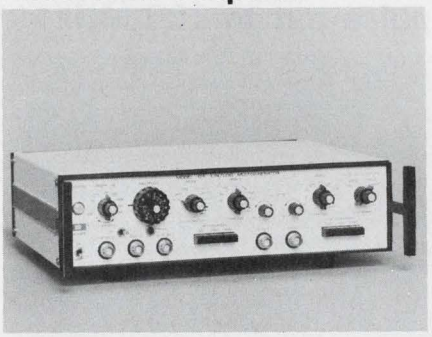
Sweep generator spans 5 to 1000 MHz

Texscan Corp., 2446 N. Shadeland Ave., Indianapolis, Ind. Phone: (317) 357-8781. P&A: $1695; 6 wks.

Covering 5 to 1000 MHz in one band, a new sweep signal generator can be swept its full width while retaining sufficient stability for narrow-band circuit testing. Model VS-60 provides a full 10 mV of output power in both the cw and sweep modes. Other standard features include a sweep rate that is variable from 20 s per sweep to 16 ms per sweep, and built-in square-wave modulation.

CIRCLE NO. 354

Lin/log generator has twin outputs

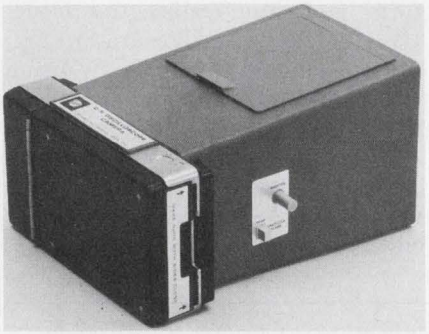


Exact Electronics, Inc., Box 160, Hillsboro, Ore. Phone: (503) 648-6661. P&A: $795; stock to 3 weeks.

A new multiple-purpose waveform generator called the model 125 Lin-Log Multigenerator features dual-output amplifiers—each with individual function selection—80-dB attenuation, two generators, 1000:1 internal or external voltage-controlled frequency and a frequency range from 0.1 Hz to 5 MHz on the primary generator.

CIRCLE NO. 339

Scope camera unit costs just $185

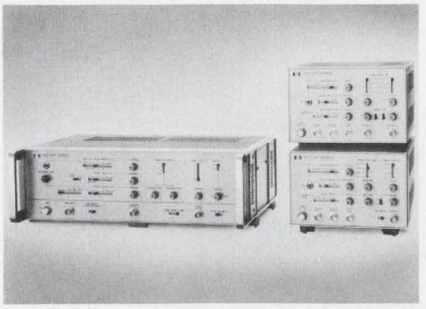


Tektronix, Inc., Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $185; 2nd quarter, 1971.

The C-5 trace-recording scope camera features fixed-focus and fixed-aperture design which simplifies waveform photography and costs only $185. The C-5 has a 60-mm, f/16 lens. Shutter speeds are 1/10, 1/25 and 1/50 of a second plus bulb and time. Object-to-image ratio is 1:0.68. A Polaroid Pack-Film back accepts 3000-speed film.

CIRCLE NO. 355

Economy generators pulse out to 100 MHz

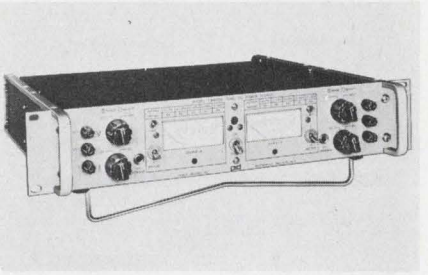


Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 493-1501. P&A: see text.

A new family of three economical pulse generators offers repetition rates to 100 MHz. Offered are: 8007A with a 100-MHz repetition rate and leading-and-trailing-edge transitions controllable from 2.5 ns to 250 μs at $1600; 8012A with a 50-MHz rate and transitions between 10 ns and 500 ms at $875; and 8013A with a 50-MHz rate and a fixed 3.5-ns transition at $625.

CIRCLE NO. 357

Multi-range supply has 2 separate outputs

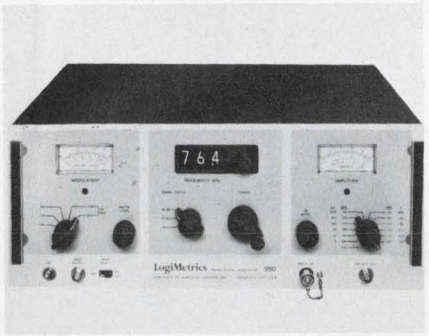


Power Designs, Inc., 1700 Shames Dr., Westbury, N. Y. Phone: (516) ED3-6200. P&A: $350; 30 days.

A new dual-output version of the Uniply multi-range dc voltage regulated power supply, the TW6050, is available. Each of its two sections has five output ranges: 0 to 7 V at 5 A, 0 to 15 V at 3 A, 0 to 25 V at 2 A, 0 to 50 V at 1 A and 0 to 60 V at 0.5 A. Each output can be operated independently, in series to provide 120 V at 0.5 A, or in parallel to 10 A. All ranges change automatically.

CIRCLE NO. 359

10 to 80-MHz generator reads out digitally

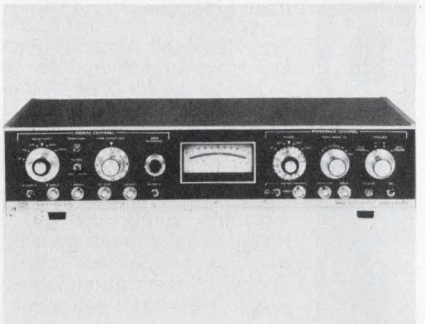


LogiMetrics, Inc., 100 Forest Dr., Greenvale, N. Y. Phone: (516) 484-2222. P&A: $1975; stock to 30 days.

A new digital-readout signal generator covers 10 to 80 MHz with calibrated internal and external FM, AM and cw outputs. The 950 has internal FM deviation adjustable from 0 to 20 kHz pk and AM adjustable from 0 to 30%. A 3-digit frequency counter provides a readout accuracy to ±0.002% at any setting over the generator's range.

CIRCLE NO. 356

15-kHz lock-in amp can also be tuned

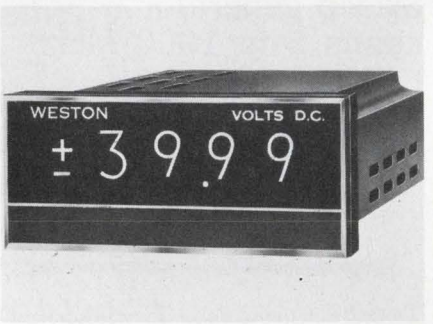


Keithley Instruments, Inc., 28775 Aurora Rd., Cleveland, Ohio. Phone: (216) 248-0400. Price: $1395.

The model 840 0.5-Hz to 15-kHz lock-in amplifier can be operated in wideband or tuned modes. It automatically tracks frequency and keeps signal phase shift constant when frequency changes. Using optional plug-in filter cards, it is capable of detecting signals 140 dB below noise level. Other features include 25-nV resolution to 1 V full-scale and optional 75-pV resolution.

CIRCLE NO. 358

Low-cost 4-digit DPM starts from $200

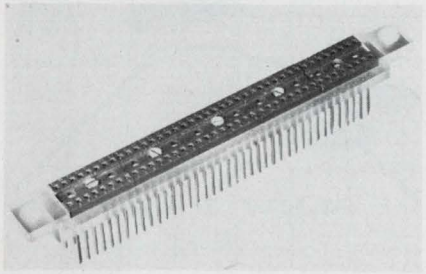


Weston Instruments, Inc., 614 Frelingsen Ave., Newark N. J. Phone: (201) 243-4700. P&A: see text; stock.

A new low-cost bi-polar DPM, model 1293, features a full-scale readout of ±3999, automatic out-of-range and polarity indicators, ±0.1% of full scale ±1 digit accuracy, and independent internal reference for positive and negative measurements and only costs from $200 to $300. Its minimum full-scale reading is 4 μA (3.999) or 400 mV (399.9).

CIRCLE NO. 360

Wirewrap DIP socket contains 80 pins

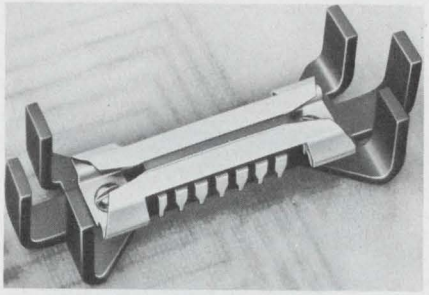


Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. Phone: (617) 491-5400. P&A: $5; stock.

IC socket assembly 703-1000-01-04-00 features 80 pins in two rows each positioned for up to five 16-pin DIPs. It consists of a rigid structural member of glass-reinforced diallyl phthalate with wirewrap posts and spring contacts held in place by four removable covers. It provides for collector supply-voltage and ground busses and needs no PC board for support.

CIRCLE NO. 361

Heat dissipator cools DIP ICs

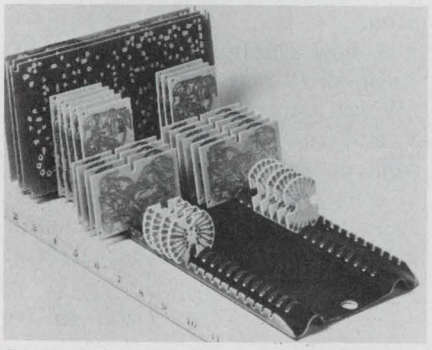


International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. Phone: (213) 849-2481.

A new aluminum heat dissipator especially configured for DIP devices is available. Developed for the Motorola MC1600 series of ICs, it is also applicable to a wide variety of other DIP circuits of various configurations. The LIC-14, which consists of a dissipator and a retainer clip, is available in 1/4 and 1/2-in.-high versions.

CIRCLE NO. 363

PC-board racks facilitate handling

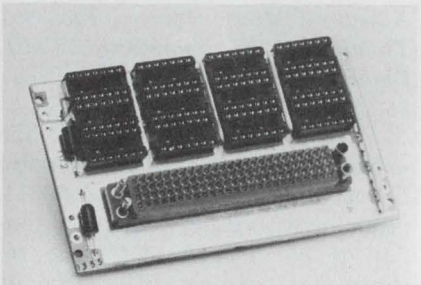


Lenkeit Industries, Inc., 258 Broadhollow Rd., Farmingdale, N. Y. Phone: (516) 249-8300. Availability: stock.

Transit Racks are patented racks made to facilitate the staging and handling of large to small printed circuit boards and assemblies. Available in aluminum and stainless steel styles, they retain boards of varying thicknesses. Aluminum racks are available in black, red, blue and orange. Stainless steel racks are chemically inert to most etchants.

CIRCLE NO. 362

100-pin-I/O board mounts 12 14-pin ICs

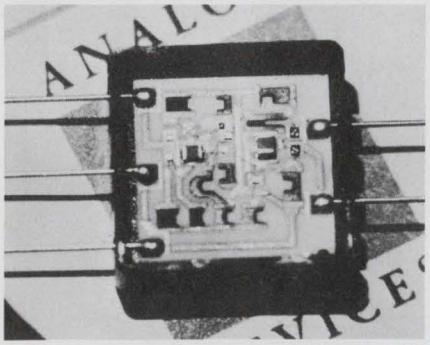


Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif. Phone: (714) 547-5501.

A new 2-D socket board, the model H-2923, is designed to mount twelve 14-pin dual-in-line ICs and one 100-pin I/O connector. It features power-connection flexibility with the use of a technique whereby power busses on the board are not connected to any specific pin on an IC socket. Another feature of the H-2923 is low-impedance power bussing.

CIRCLE NO. 364

$20 IC FET op amp replaces many hybrids



Analog Devices, Inc., Rte. 1 Industrial Park, Norwood, Mass. Phone: (617) 329-4700. P&A: $20; stock.

A new microcircuit FET-input op amp, model AD511, is a pin-for-pin replacement for many popular hybrids yet costs only $20. It has a 5-pA bias current, 10,000 CMRR, 1-mV offset voltage, 0.5 pA/°C current drift and 25 μV/°C voltage drift. It also has a 1-MHz small-signal bandwidth, 10^{11} input resistance and a ±10-V 5-mA output. Size is 0.6 in.^{2} by 0.25-in. high.

CIRCLE NO. 365

Dual monolithic FETs exhibit very low noise

Siliconix, Inc., 2201 Laurelwood Rd., Santa Clara, Calif. Phone: (408) 246-8000. P&A: from $2.65 to $8.10; stock.

A new family of six monolithic dual FETs, U280 through U285, feature equivalent-noise voltage of less than 70 nV/$\sqrt{\text{Hz}}$ at 100 Hz. Common-mode rejection ratio is over 100 dB (U280). Gate-source differential drift is 10 μV/°C.

CIRCLE NO. 366

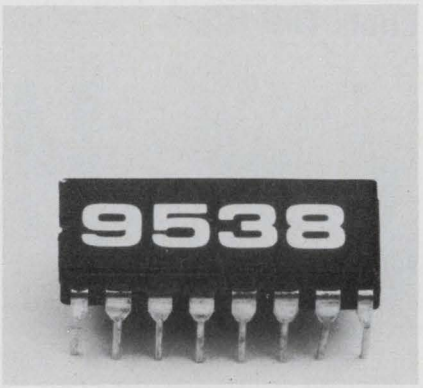
High-current thyristors handle up to 80 A

RCA Solid-State Div., Somerville, N. J. Phone: (201) 722-3200. Price: $25 to $45.

A new series of developmental-type thyristors with current-carrying capacity of 80 A are available. The devices, designated TA7757, are capable of handling power loads up to 22 kW at ac line voltages up to 277 V. They can block 200, 400 or 600 V.

CIRCLE NO. 367

One-of-eight decoder operates in 3.5 ns



Fairchild Semiconductor, 464 Ellis St., Mountain View, Calif. Phone: (415) 962-3562. P&A: $8.20; stock.

The new 9538 ECL/MSI decoder accepts three binary address inputs and provides one of eight mutually exclusive outputs with 3.5-ns through delay. Connecting a data source to its non-inverting enable input allows the 9538 to act as a high-speed demultiplexer. Its other enable line will then function as a data enable, while the three address inputs select the desired output.

CIRCLE NO. 368

Line driver/receiver enhances data interface

Advanced Micro Devices, Inc., 901 Thompson Pl., Sunnyvale, Calif. Phone: (408) 732-2400. P&A: $6.50, $8.50; stock.

A new quad single-ended line driver and a fail-safe receiver are now available. The driver, Am2614, is an inverting device with a fan-out of 25. The Am2615 line receiver can receive differential or single-ended data.

CIRCLE NO. 369

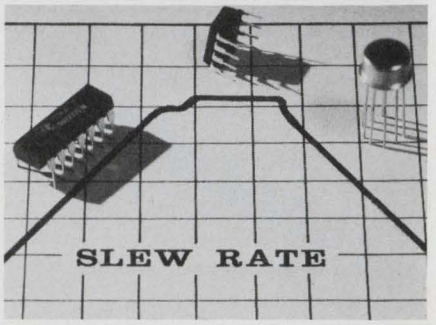
4-quadrant multipliers have low input errors

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. Phone: (408) 739-7700. P&A: $5 (N5595-A); stock.

Two new linear monolithic four-quadrant multipliers, the S5595F and the N5595A, feature maximum X and Y-input errors of 1 and 2% and 2 and 4%, respectively. Each has an input range of ±10 V.

CIRCLE NO. 370

Linear IC op amps need only 8 nA at input



Texas Instruments, Inc., 13500 N. Central Expwy., Dallas, Tex. Phone (214) 238-2011. P&A: $7.50; 2 wks.

High-gain transistors are used in two new linear IC op amps to achieve an 8-nA input current. The SN72770 and SN72771 op amps feature 5-mV input voltage, 15-nA input bias, output short-circuit protection and ±11-V common-mode input. Slew rate is typically 2.5 V/μs. The SN72770 is internally compensated while SN72771 is not, though it can be compensated.

CIRCLE NO. 371

10-MHz 64-bit registers dissipate 300 nW/bit

Solid State Scientific, Inc., Montgomeryville, Pa. Phone: (215) 855-8400.

A new family of CMOS 64-bit static shift registers combine 300-nW/bit low power dissipation at 12 V and 10-MHz shift rates in the same device. The SCI-51300 family is compatible with all logic levels from 4.5 to 15 V and have dynamic dissipation of 250-μW/bit/MHz at 12 V.

CIRCLE NO. 372

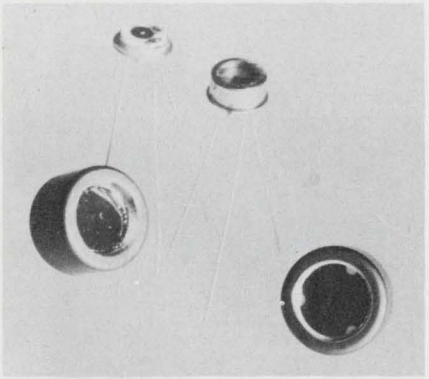
Fast power transistors gain up to 100 A

PowerTech, Inc., 9 Baker Court, Clifton, N. J. Phone: (201) 478-6205. P&A: $48.25 to $96.50; stock.

Series PT-5501 silicon power transistors feature turn-off times of 700 ns at 50 A, collector-emitter voltage (sat.) of 0.5 V at 50 A and guaranteed common-emitter dc forward gain at 100 A. Devices have collector-emitter ratings to 80 V and power to 200 W at 100°C.

CIRCLE NO. 373

Power phototransistors deliver 100 mA/mW/cm²



Solid State Products, Inc., 2261 S. Carmelina Ave., Los Angeles, Calif. Phone: (213) 478-0557.

New power phototransistors with a spectral response from 0.3 to 1.1 microns feature outputs of 100 mA/mW/cm² and a response time of 50 μs. Custom detectors are available with sensitive areas up to several square centimeters. The new devices, which operate from as low as 1.5 V ac or dc, achieve high outputs by being fabricated from high-purity silicon.

CIRCLE NO. 374

Hybrid receivers span 400-MHz band

International Microwave Corp., 33 River Rd., Cos Cob, Conn. Phone: (203) 661-5924.

By combining the operational flexibility of discrete components with the compactness of integrated circuits, a new line of semi-integrated receivers achieves i-f bandwidths of 400 MHz with i-f center frequencies of 1.4 GHz.

CIRCLE NO. 375

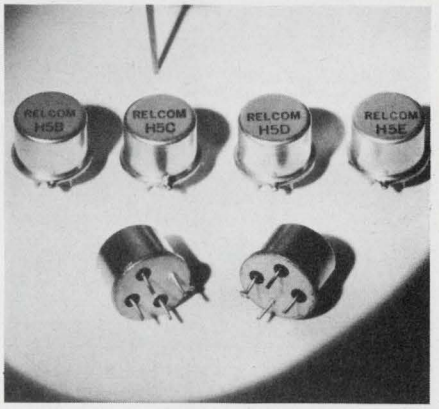
Low-noise photodiodes are ultra-sensitive

United Detector Technology, 1732 21st St., Santa Monica, Calif. Phone: (213) 393-3785. Price: $49, $35.

New ultra-low-noise p-i-n silicon photodiodes achieve high sensitivity between 8500 and 9000 Å. They give a noise-equivalent power of 6 $\times$ 10^{-15} W for UDT-020A with 20-mil active dia and a 1 $\times$ 10^{-14} W for the 40-mil active-dia UDT-040A.

CIRCLE NO. 376

$25 TO-5 dividers cover 10 to 600 MHz



Relcom, 2329 Charleston Rd., Mountain View, Calif. Phone: (415) 961-6265. P&A: $25; stock.

A new line of $25 miniature reactive power dividers operate in the 10 to 600-MHz frequency range. Packaged in TO-5 cases only 0.24-in. high, they weigh less than 1.2 grams each. Typical isolation between the output ports is 35 dB. Insertion loss is 0.2 dB; phase balance is 0.5 degrees and amplitude balance is 0.1 dB.

CIRCLE NO. 377

12-V vhf transistor changes 1/4 W to 140 W

Communications Transistor Corp., 301 Industrial Way, San Carlos, Calif. Phone: (415) 591-8921. P&A: $75; stock.

A new vhf 12-V transistor is capable of taking 250 mW and amplifying it to 140 W. Called the B70-12, the transistor is rated at 70 W and withstands infinite VSWR at its maximum rated power and supply voltage. It has a 5.5 to 10-dB power gain figure and is of single-chip construction. A 300-mW to 140-W amplifier can be constructed with only five B70-12s.

CIRCLE NO. 378

Microwave resistors have TCR of 250 ppm/°C

Midwest Microwave, Inc., 3800 Packard Rd., Ann Arbor, Mich. Phone: (313) 971-1992. Availability: stock.

A new line of thin-film microwave resistors using a pyrolytic carbon process for long-term stability and uniformity feature TCRs of 250 ppm/°C. Substrate material is aluminum or berylium-oxide and tolerance is 1%.

CIRCLE NO. 379

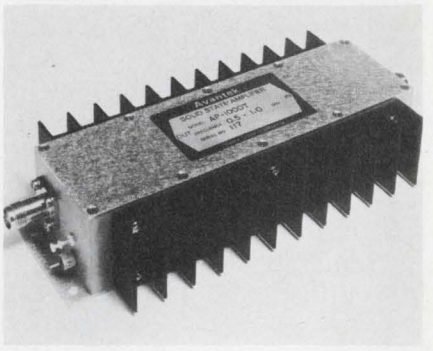
Argon laser pulses out 1 W

Britt Electronic Products Corp., 2944 Nebraska Ave., Santa Monica, Calif. Phone: (213) 371-6567. P&A: $4750 to $5940; 30 days.

A burst ion laser provides pulsed-argon average power of over 1 W. The 3000 series runs at 250 mW continuously in four configurations: basic high-power; custom-pulse; timed burst; and stroboscopic.

CIRCLE NO. 380

0.5 to 1-GHz amp delivers 1-W output



Avantek, Inc., 2981 Copper Rd., Santa Clara, Calif. Phone: (408) 739-6170. P&A: $990; 30 days.

Model AP-1000T amplifier offers 1-W linear Class-A power across 0.5 to 1 GHz. Its minimum gain is 30 dB at a maximum gain flatness of ±1 dB, the maximum noise figure is 10 dB and VSWR is a maximum 2.0:1. Input power is +15 V dc at 540 mA. For a 1-dB gain compression, the minimum output power is +29 dBm. The AP-1000T uses only silicon devices and it is encapsulated.

CIRCLE NO. 381

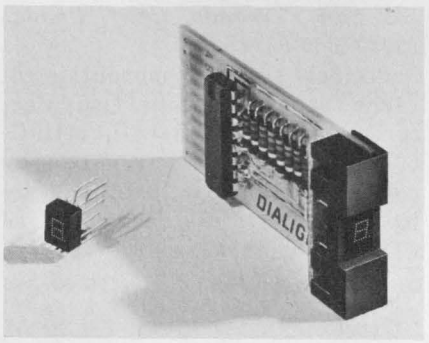
Digital comparators preset by thumbwheels

Newport Laboratories, Inc., 630 E. Young St., Santa Ana, Calif. Phone: (714) 540-4914. P&A: from $135; stock to 3 wks.

Series 270 digital comparators provide instantaneous warning signals whenever front-panel thumbwheel or remote electrical preset limits are exceeded. Models are available with 3 to 6-digit unipolar or 3 to 5-digit bipolar inputs and front-panel limit selection, or with 3 to 6-digit bipolar remote limit selection.

CIRCLE NO. 382

LED-readout module can house many digits

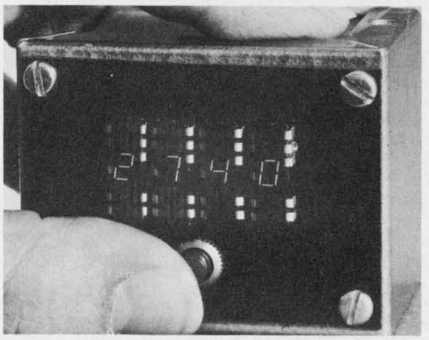


Dialight Corp., 60 Stewart Ave., Brooklyn, N. Y. Phone: (212) 497-7600. P&A: $12; stock.

A new digital-readout module, model 745, contains a GaAsP LED with a separate decimal point and is available in multiple-digit arrays. The LED is also available separately. Digit size is 0.125-in. high and 0.09-in. wide and is a 6-by-8 dot matrix connected for 7-segment driving. The 745 module is encapsulated and can be stacked horizontally or vertically.

CIRCLE NO. 383

Bright 7-segment LED drains 10 mA/segment

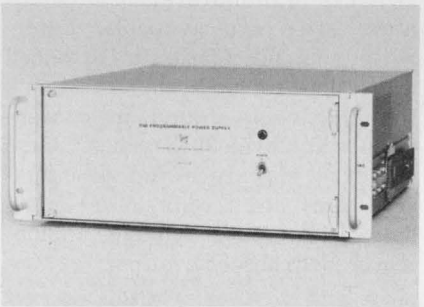


Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. Phone: (408) 257-2140. P&A: $7.50 (100-lot quantities); stock.

The MAN 4 is a new seven-segment solid-state display emitting 400 foot-lamberts at 10 mA/segment. It will operate with inputs as low as 1 mA and 1.65 V. Character height is 0.19 in. MAN 4 is a common-cathode device that has a built-in red lens. It is contained in a 14-pin DIP with 0.35-in. mounting centers.

CIRCLE NO. 384

Programmable supply provides five outputs



Tektronix, Inc., Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $5000; stock.

The new R1140 programmable power supply contains three ±40-V, one ±100-V and one current supply. BCD-programming format is TTL and no external programming resistance is required. Separate strobes and latching data inputs allow any of the five supplies to be reprogrammed independently, without disturbing others. Programmable voltage limits are on the current supply.

CIRCLE NO. 385

High-power amplifiers dissipate up to 600 W

Inland Controls, Inc., 250 Alpha Dr., Pittsburgh, Pa. Phone: (412) 782-3516. P&A: $500, $550; stock.

Two new direct-coupled wideband modular power amplifiers, models 60-IC-500 and 60-IC-600, continuously dissipate up to 500 and 600 W at 25°, respectively. Short-term dissipation for either can range up to 1500 W. Each unit requires ±60 V dc.

CIRCLE NO. 386

Noise squelcher compensates itself

Kahn Research Labs., Inc., 81 S. Bergen Place, Freeport, N. Y. Phone: (516) 379-8800.

A new self-compensating signal-to-noise squelcher operates directly on an audio signal to effectively squelch the signal whenever speech or other information is removed. An integral miniature signal analysis computer constantly monitors channel content.

CIRCLE NO. 387

Economy power supplies fill OEM applications

ACDC Electronics, Inc., Oceanside Industrial Center, Oceanside, Calif. Phone: (714) 757-1880. P&A: from $57 (quantities of 10); stock.

A new line of low-cost power supplies, specifically designed for OEM applications, is available with prices starting from $57. Called the OEM series, these new power supplies have voltages from 4 to 32 V dc at up to 36 A.

CIRCLE NO. 388

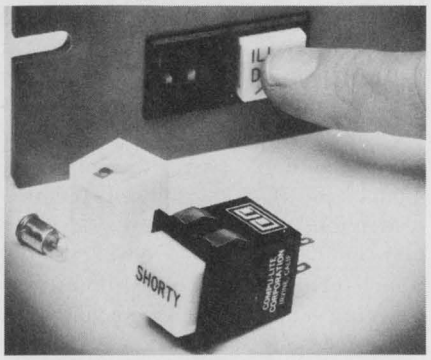
Multiplying 12-bit d/a has 0.015% accuracy

Analogic Corp., Audubon Rd., Wakefield, Mass. Phone: (617) 246-0300. P&A: $250; 2 to 4 wks.

The MP1012 Dacpac is a 0.015% accurate 12-bit multiplying d/a converter which is ideal for any application where the analog output must be a digitally scaled replica of the reference input. Reference may be dc to 50 kHz with any waveform.

CIRCLE NO. 389

Illuminated pushbutton is a bargain at $1

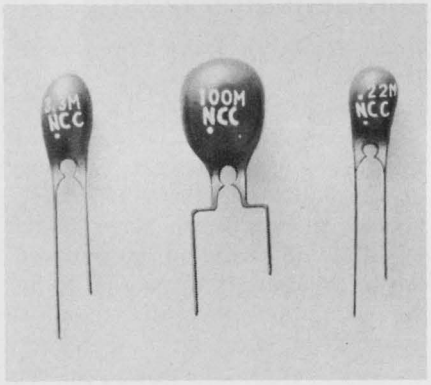


Compu-Lite Corp., 17795 Sky Park Circle, Irvine, Calif. Phone: (714) 546-3045. P&A: see text; stock to 2 wks.

A new computer-grade illuminated pushbutton switch, featuring a behind-the-panel depth of 7/8-in. and front relamping is available for under $1 (1000 quantities). Designated the Shorty, the 2pst switch is rated up to 1/2 A at 30 V dc or 117 V ac. It uses T-1-3/4 midget-base lamps and snap-locks into 0.75-in. square cutouts.

CIRCLE NO. 390

Tantalum capacitors retail as low as 10¢

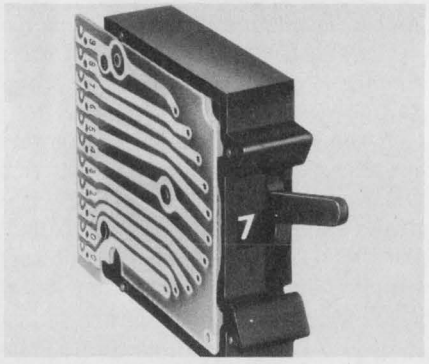


Matsuo Electric Co., Ltd., 3-5, 3-Chome, Sennari-cho, Toyonakashi, Osaka, Japan. P&A: see text, 4 wks.

New Blue-DT resin-dipped solid-tantalum capacitors feature small size and a low cost of 10¢ or less (1000-lot quantities). They can be easily inserted into PC boards and securely mounted by provided stoppers. Operating temperature range is from −55 to +85°C. Rated voltages are 6.3 to 35 V dc and capacitance values range from 0.1 to 100 μF.

CIRCLE NO. 391

Two-pole lever switches include 10 positions

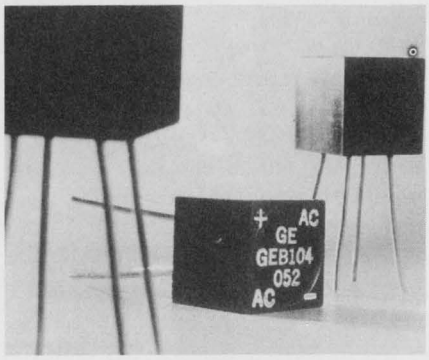


Cherry Electrical Products Corp., 1650 Old Deerfield Rd., Highland Park, Ill. Phone: (312) 831-2100.

Double-pole ten-position lever switches in miniature and subminiature sizes are available. Lever-wheel switches feature an extended lever that replaces the traditional thumb indents found in conventional thumbwheel switches. These standard miniature and subminiature sizes are totally interchangeable with other leading thumbwheel switches now in use.

CIRCLE NO. 392

Compact 1-kV bridges handle up to 1 ampere



General Electric Co., Semiconductor Products Dept., Electronics Park, Syracuse, N. Y. Phone: (315) 456-2298. Availability: stock.

A new series of compact hermetically sealed rectifier bridges is available for handling currents up to 1 A with voltage ratings up to 1000 V. GEB100 bridges are epoxy packaged single-phase full-wave rectifier units. They are compatible with standard printed circuit board layouts and have leads that are set on 0.25-in. centers.

CIRCLE NO. 393

3/4-in. rotary switch has 90° throw angle

Grayhill, Inc., 565 Hillgrove Ave., LaGrange, Ill. Phone: (312) 354-1040. P&A: $8.75; 2 to 10 wks.

Four-position (90-degree angle of throw) continuous rotation is the feature of a new rotary switch with a 3/4-in. and a 1/4-A 115 V ac rating. The series 9 switch has one or two poles per deck in multi-deck versions. Its life expectancy is 10,000 cycles of operation.

CIRCLE NO. 394

13-bit ladder network comes in a DIP case

Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. Phone: (617) 756-4635. P&A: $79; stock.

The MN120 is a 13-bit nickel-chromium ladder network available in a 16-pin hermetic DIP case. Its operating temperature ranges from −55 to +125°C, accuracy is 0.006% and temperature coefficient is ±50 ppm/°C. Temperature coefficient tracking is 1 ppm/°C.

CIRCLE NO. 395

Ceramic capacitor chips cover six sizes

San Fernando Electric, 1501 First St., San Fernando, Calif. Phone: (213) 365-9411.

Six new styles of monolithic ceramic capacitor chips, manufactured in accordance with MIL-C-55681, range in sizes from 0.08 by 0.05 by 0.2 in. to 0.18 by 0.25 by 0.04 in. They are designated as CD-01 through CD-06.

CIRCLE NO. 396

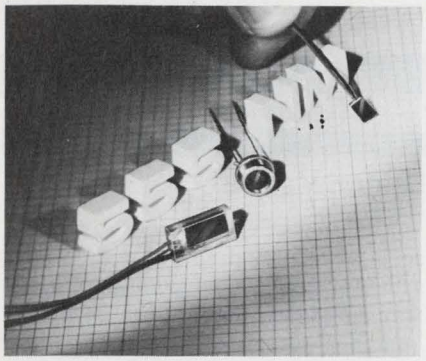
14-pin DIP delay line includes 10 equal taps

Allen Avionics, Inc., 224 E. 2nd St., Mineola, N. Y. Phone: (516) 248-8080. Availability: stock.

LC DIP is an ultra-miniature 14-pin dual-in-line lumped-constant delay line that incorporates 10 equal delay taps. Total delays are available in 50, 100, 150, 200, and 250 ns. Delay tolerance is ±5% or 4 ns whichever is greater and impedance is 100 Ω.

CIRCLE NO. 397

Photovoltaic cell peaks at 555 nm

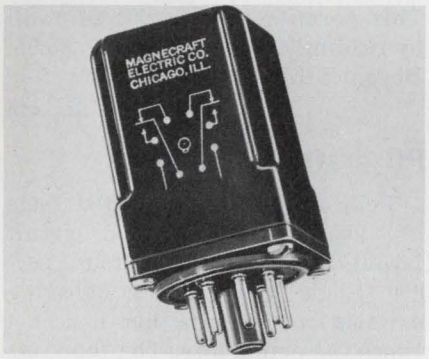


Sensor Technology, Inc., 7118 Gerald Ave., Van Nuys, Calif. Phone: (213) 781-2154.

The Sensor 555 photovoltaic cell has a response that peaks at 555 nm (corresponding to the human eye response curve) and drops off rapidly at 900 nm to one-third of its peak value. This silicon device is reported to provide a 300% higher output per unit area than selenium types. Standard units come in a variety of sizes, shapes and encapsulations.

CIRCLE NO. 398

Tiny time-delay relay occupies just 2-in.²

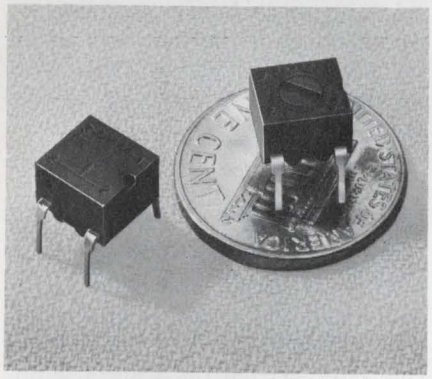


Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. Phone: (312) 282-5500. Availability: stock.

A new fully adjustable octal plug-in time-delay relay occupies less than 2-in.² of panel space. The class 214 CP solid-state (hybrid) relay has ±5% repeatability and convenient screw-driver adjustment at its top. Two timing ranges are available: 0.3 to 30 and 3 to 240 seconds. Operating voltage is 120 V dc and dpdt contacts are rated at 5 A.

CIRCLE NO. 399

DIP style trimmers come in square cases

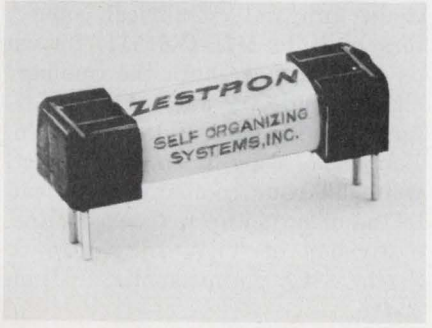


Dale Electronics, Inc., Box 609, Columbus, Neb. Phone: (402) 564-3131.

New square-style film-element trimmers are now available. Fastpack trimmers come in two series: 87 (single-turn) and 85 (12-turn). They are pin compatible with automatic DIP machinery. Both are rated at 1/2 W at 25° C. Resistances range from 10 Ω to 1 MΩ with standard tolerance of ±20%. Lower tolerances are available. Temperature coefficient is ±150 ppm/°C.

CIRCLE NO. 400

Miniature reed relay has a $1.45 price tag

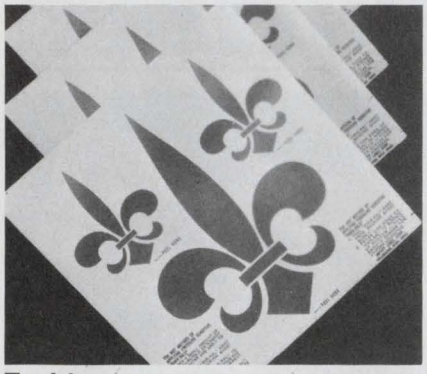


Self-Organizing Systems, Inc., Box 9918, Dallas, Tex. Phone: (214) 276-9487. P&A: see text; stock.

A new pico-sized open-frame reed relay sells for $1.45 (100 quantities). The Zestron 240 relay has over-all size of only 0.2 by 0.25 by 0.77 in. with pins brought out on a standard 0.1 by 0.7-in. pattern for PC board mounting. Contact rating is 250 mA 50 V dc, and 120 V ac. Closed-contact resistance is 0.2 Ω and offset is 100 μV.

CIRCLE NO. 401

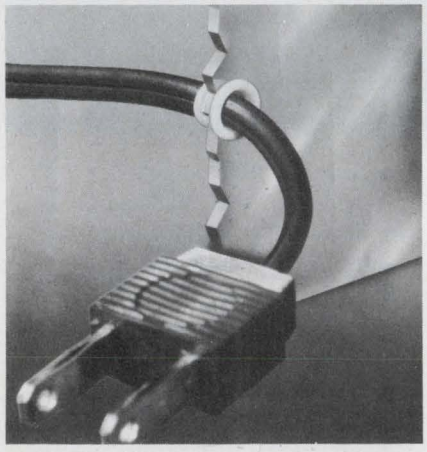
evaluation samples



Emblems

Pressure-sensitive emblems for application to glass doors or windows for identification or advertising purposes are available. There are three types: one is applied to the outside of glass surfaces; another for inside glass surfaces; and the third is for application to the inside of glass surfaces, but can be read from both sides of the glass. Details and samples are available. Impact Label Corp.

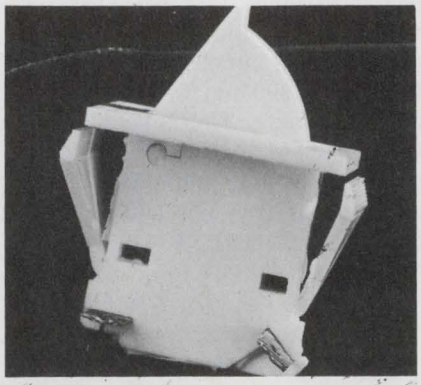
CIRCLE NO. 420



Snap bushings

Four new nylon snap bushings snap-lock into 5/16, 1/2, 5/8 and 3/4-in. panel holes. These miniature bushings require a minimum of depth clearance and have smooth inside diameters of 1/4, 3/8, 1/2 and 5/8 in. They snap into panel holes by little fingertip pressure for such applications as cables, hose and tubing as well as supports for push-pull rods and linkages. Samples for test and evaluation are available. Heymen Manufacturing Co.

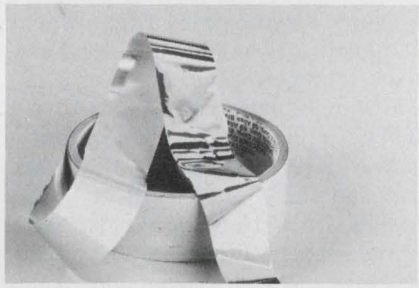
CIRCLE NO. 421



Rocker switch

A new type of rocker switch has been developed to adapt to many convenience and safety uses. The model 1977 includes a nylon housing that contains a mechanism of only six parts. It is rated at 150-W load (incandescent) for 1/2 million operations. Rated voltages are 125 and 250 V ac. Molded-in mounting ears allow the switch to snap-lock through a panel opening covered by a 5/8 by 1-1/4-in. flange. Normally open or normally closed styles are supplied. A free sample is available. Molex, Inc.

CIRCLE NO. 422

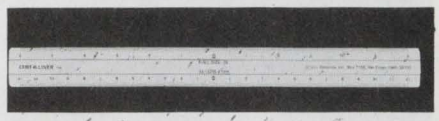


Teflon dielectric

Type CM metalized cast Teflon TFE film is an excellent material for use as an electret (fluorocarbon dielectric upon which metal is vacuum-deposited) for low-noise applications such as microphone discs. This new material has good sensitivity, high fidelity and reliability. It remains permanently polarized after being charged. One side of it is metalized under vacuum. Resistance is approximately 1.5 $\Omega/in.^2$ It is available as 1/4, 3/8, 1/2 and 3/4-mils thick at widths from 1/4 to 3 in. A free sample is available. Dilectrix Corp.

CIRCLE NO. 423

design aids



Drafting scale

The new Cent-R-Liner drafting scale is designed for working from a center line. It is graduated with zero in the center and numerals increasing outward from the center, both to the left and to the right. A full-size scale in 32nds of an inch is on one edge and a half-size scale to 16ths of an inch is on the other. This permits easy layout of radii by reading diameters. Cost is $5.95. Devonics Inc.

CIRCLE NO. 424

PC drafting templates

Four new drafting template sets are available for printed circuit layouts. Each of the four sets comes in three sizes allowing original layouts in either 1, 2 or 4 times the actual size. The four sets are called: the printed circuit layout template, the printed circuit layout template and drafting aid, the relay template and the universal component layout template. A complete set of the four sets which includes 12 templates in three sizes is available at a price of $70.70. HAPCO, Inc.

CIRCLE NO. 425

MIL connector chart

A convenient easy-to-read wall chart is available to provide a helpful aid in the selection of the exact MIL-C-81511 type cylindrical connector needed for a specific application. Illustrated on this 24 by 37 in. multi-color wall chart are 32 insert options and 10 shell styles available in the Astro/348 series connectors and cylindrical connectors built to MIL-C-81511. Shown on the chart are both the commercial and military part number designations for each style illustrated. For a free copy of the wall chart, write on your company letterhead to the manufacturer, Cinch-Nuline, a division of TRW Inc., 1015 S. Sixth St., Minneapolis, Minn. 55415.

application notes

High-density switches

Several high-density manual switching devices are described in a brochure. A graph included in the brochure compares the efficiency of patchboards, pinboards, matrix selector switches, shaft-type rotary switches and thumbwheel and leverwheel switches. It simplifies switch selection based upon application parameters. The problems of quick reset and the operator's decision-making time are also discussed. Cherry Electrical Products Corp.

CIRCLE NO. 426

Delay lines

The "Delay Line Buyer's Guide," developed to assist system and circuit designers in specifying high-performance minimum-cost delay lines, is a valuable source of information. It explains clearly their basic principles with the use of equations, formulas and illustrations, shows what the primary parameters are when specifying delay lines and contains a helpful glossary of terms. It also offers technical and cost application details. Edison Electronics Div. of McGraw-Edison Co.

CIRCLE NO. 427

Brushless dc motors

The construction and method of operation of brushless dc motors are described in a new three-page brochure. It discusses the construction principles involved in two-pole permanent-magnet rotors, electronically commutated dc motors, Hall generators, speed controls and magnetization and adjustment of rotor flux. Siemens Corp.

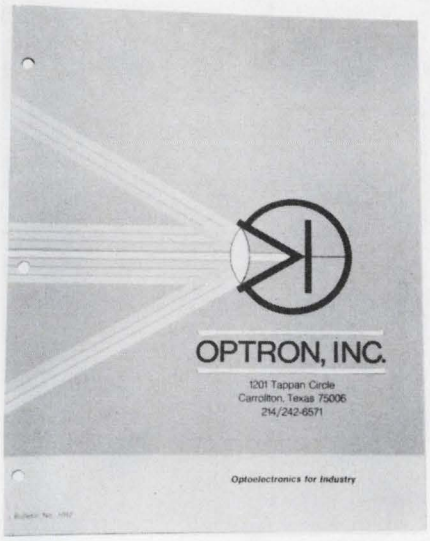
CIRCLE NO. 428

Timing circuits

Three application notes contain many circuit configurations that use an electromechanical capacitor known as the ESD for timing applications. Included are schematics that feature the use of the ESD with both linear and digital integrated circuits. Gould Ionics, Inc.

CIRCLE NO. 429

new literature



Opto-electronic products

A short-form catalog gives technical data on a full line of opto-electronic devices and products. The six-page catalog includes GaAs energy sources, Darlington and npn silicon phototransistors, GaAs couplers, reader and emitter source arrays, hybrid tape readers, monolithic arrays, sensor-LED encoder and mark-sense reader assemblies. Optron, Inc.

CIRCLE NO. 430

Fans/cooling devices

A new 12-page short-form catalog lists and describes a complete line of standard and premium-grade fans and cooling devices. Pamotor.

CIRCLE NO. 431

Hybrid microcircuits

A new loose-leaf brochure containing specification sheets and prices on a complete line of hybrid op amps and voltage regulators is available. Bell & Howell.

CIRCLE NO. 432

Wires and stampings

A new 24-page design guide is available to OEM designers who need formed and headed wires, stampings, connectors, welded assemblies and powdered metal parts. Emporium Specialties Co. Inc.

CIRCLE NO. 433

Logic handbook

The Designer's Choice Logic (DCL) handbook (Volume 1) provides readers with a software package that clearly explains the performance and use of the DCL series 8000 family. It covers basic logic elements including multivibrators, low-power, high-speed, ultra-high-speed and interface elements. Signetics Corp.

CIRCLE NO. 434

Power screwdrivers

A new catalog describes a line of miniature power screwdrivers. The Foredom Electric Co.

CIRCLE NO. 435

Ac/dc relays

A new family of low-cost general-purpose ac/dc 5 to 10-A relays in open and enclosed versions are described in a new bulletin. Oak Electro/Netics Corp.

CIRCLE NO. 436

Epoxy resins

A new information kit on epoxy resins includes a reference chart of 12 electrical encapsulation systems and an epoxy filter stability index. Epic Resins Div. of RTE Corp.

CIRCLE NO. 437

Lasers and accessories

A new 32-page catalog features helium-neon gas lasers and accessories for industrial, research and educational applications. Metrologic Instruments, Inc.

CIRCLE NO. 438

Centrifugal blowers

An illustrated, 76-page handbook describes a complete line of high-performance centrifugal blowers. It includes 13 pages of technical information complete with curves, systems designer and specifier. IMC Magnetics Corp.

CIRCLE NO. 439

Variable transformers

The Variable Transformer Selector is a handy condensed reference that lists by voltage and by increasing values of power and current, variable transformers. Staco, Inc.

CIRCLE NO. 450

Gear motors

A new catalog illustrates and describes a complete line of fractional horsepower gear motors. Electro Counter & Motor Co.

CIRCLE NO. 451

N-channel FETs

A preliminary data sheet is available on a new series of monolithic dual n-channel FETs. Teledyne Semiconductor.

CIRCLE NO. 452

LSI MOS memories

Field-inversion-protected LSI MOS read-only and random-access memories are detailed in a new catalog. Unisem Corp.

CIRCLE NO. 453

Digital plotter

A new digital plotter designed specifically to process time-share data from scientific instruments is featured in a four-page bulletin. Beckman Instruments, Inc.

CIRCLE NO. 454

Power supplies

A four-page illustrated data sheet details an expanded line of regulated power supplies. California Electronic Manufacturing Co.

CIRCLE NO. 455

Decals

A comprehensive 64-page catalog shows more than 162 different identification products and personalized items such as decals, signs and labels. Seton Name Plate Corp.

CIRCLE NO. 456

Picoammeters

Eight new data sheets describe a comprehensive line of solid-state analog and digital picoammeters and electrometers. Dynasciences Corp.

CIRCLE NO. 457

Reed relays

A new reed relay catalog gives designers complete mechanical, electrical and environmental data on all standard models. Douglas Randall, Inc.

CIRCLE NO. 458

Electric controls

An extensive review of low-voltage controls and line-voltage thermostats for electric heating is covered in a new bulletin. Singer Co.

CIRCLE NO 459

IC testers

A four-page short-form catalog describes six digital and linear IC testers. Microdyne.

CIRCLE NO. 460

Precision tachometers

A comprehensive application manual contains the latest design application data, in tabluated form, on precision motor tachometers. MPC Products Inc.

CIRCLE NO. 461

Tools

A 56-page catalog shows a line of assembly tools such as tweezers, pliers, soldering equipment and magnifiers. Electronic Tool Co.

CIRCLE NO. 462

FET-input IC op amps

A data sheet describes new IC FET-input op amps. GPS Corp.

CIRCLE NO. 463

Multiplier/digitizer

A 26-page brochure describes an analog signal multiplexer and converter. Xerox Data Systems.

CIRCLE NO. 464

bulletin board

of product news and development

Whether the envelope is shaped like a cylinder or a cube, packaging the electronics to fit should now become a great deal easier. So reports the Bunker-Ramo Corp.'s Electronic Systems Div., Westlake Village, Ill., in citing its **proprietary 3-D packaging technique called Planar Coax.** The technique is reportedly highly flexible because Z-axis interconnections are made with a standard array of through slugs on 50-mil centers. Each of the wafers used in the system is laid out using the 50-mil matrix, which provides for up to 400 Z-axis interconnections per square in.

CIRCLE NO. 465

Development of a new **triple micro-power operational amplifier for use in active filters** is announced by Canadian Westinghouse. Designated WC-788, the new device can be used for low, high and bandpass filters, particularly in low-frequency and high-performance applications. It has been specially designed to operate at very low power levels and on supply voltages as low as ±2 V.

CIRCLE NO. 466

KSC Semiconductor Corp. has added **five new pnp germanium power transistors** to their transistor line. Packaged in TO-36 cases, they range in unit-quantity prices from $4.50 to $15.

CIRCLE NO. 467

A new source for National Semiconductor LM105/205/305 voltage regulators is Teledyne Semiconductor. Their new LM105BE, LM-205CE and LM305DE units are pin-for-pin replacements of the National devices and are completely interchangeable.

CIRCLE NO. 468

Electronic Design

ELECTRONIC DESIGN'S function is:

- To aid progress in the electronics manufacturing industry by promoting good design.
- To give the electronic design engineer concepts and ideas that make his job easier and more productive.
- To provide a central source of timely electronics information.
- To promote two-way communication between manufacturer and engineer.

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- To publish prompt corrections whenever inaccuracies are brought to our attention. Corrections appear at the end of the Letters column.
- To refuse any advertisement deemed to be misleading or fraudulent.

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Editor
ELECTRONIC DESIGN,
850 Third Avenue,
New York, N.Y. 10022.

Design Data from

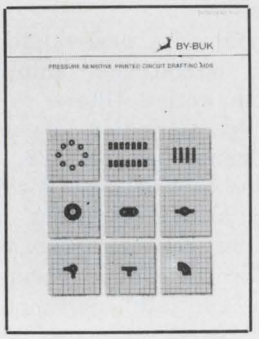
Free Catalog: New DC Lab Power Supplies

Power/Mate Corp. has introduced its new line of 87 **current and voltage** regulated laboratory and bench supplies — now described in this 4-page brochure. These 87 UniPower models collectively cover form 0 to 120 volts and currents up to 125 amps. They feature adjustable current limiting, low cost, high performance and Power/Mate's full five year warranty. The brochure covers complete specifications, model numbers, sizes, and prices. Write or call for your free copy.

CIRCLE NO. 174

Power/Mate Corporation
514 South River Street
Hackensack, New Jersey 07601
(201) 343-6294 TWX: (710) 990-5023

PC Drafting Aids Catalog



Thousands of time saving, cost saving artwork ideas are found in the By-Buk P-50 catalog of pressure sensitive printed circuit drafting aids. With the most practical artwork patterns for: TO cans, multi-pads, dual-inlines and flat packs featured. Donuts, connector strips, teardrops, ovals, tapes, tees, elbows, etc., by the hundreds are included in the most comprehensive list of sizes. Opaque black, transparent red and transparent blue materials for one and two-sided board designs. For a free copy and samples, write today.

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Instant Circuit Boards!™

Engineers at CIRCUIT-STIK, INC., have developed a complete family of circuit sub-elements and circuit materials designed to work together producing "INSTANT PROTOTYPE CIRCUIT BOARDS." Individual circuit boards can be assembled and tested from engineering sketches the same day. CIRCUIT-STIK's sixteen page catalog describes circuit sub-elements and materials that are pre-drilled, pre-plated, fluxcoated, and have pressure sensitive adhesive substrates ready for mounting and soldering of electronic components. (U. S. Patent #3,538,389 and other patents pending)

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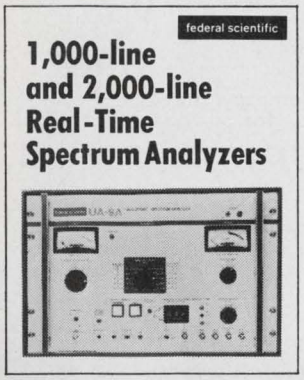
Telephone (213) 532-1450

Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-ServiceCard (Advertisement)

Highest Resolution in New Spectrum Analyzers



For the on-line processing of underwater acoustic signals, radar, sonar and other data where the maximum frequency resolution is always sought, new UA-9A series 1,000-line and 2,000-line Low Frequency Real-Time Spectrum Analyzers have been designed by Federal Scientific, originators of the Ubiquitous® analyzers.
High-speed versions produce complete 1,000-line spectra in 40 msec, and 2,000-line spectra in 160 msec.
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CIRCLE NO. 177

Federal Scientific Corporation
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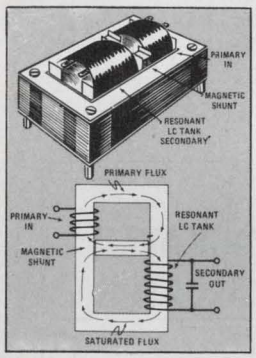
Ferroresonance is the Key to Simple Voltage Stabilization



In a new 6-page brochure, Kepco outlines the flux-oscillating stabilizer technique, applied to modern power supplies with special emphasis on the requirements of integrated logic systems.
High reliability, lack of overvoltage risk, exceptional line-noise isolation, inherent current limiting, these power supplies have what it takes at remarkably low cost.
The brochure describes the 58 different Kepco "PRM" stabilizers spanning the range from 4.5V to 240V d-c with ratings from 60W to 300W. There are charts and performance graphs plus complete mechanical installation data.

CIRCLE NO. 178

Kepco, Inc.
131-38 Sanford Avenue
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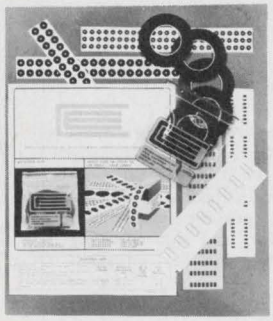
(212) 461-7000

Centron Precision Drafting Aids Catalog



The latest catalog in pressure-sensitive precision component matched artwork symbols and drafting aids. Completely opaque pre-cut symbols are printed on pressure sensitive .0015" matte acetate film accurate to ± .001". Featured are choices in packaging to the user which affords greater convenience and cost savings. Donut pads are offered in both roll and strip form and precision tape is packaged in air-tight zipper bags to preserve freshness even after use. SEND FOR YOUR FREE CATALOG AND SAMPLES.

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INFORMATION RETRIEVAL NUMBER 182

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