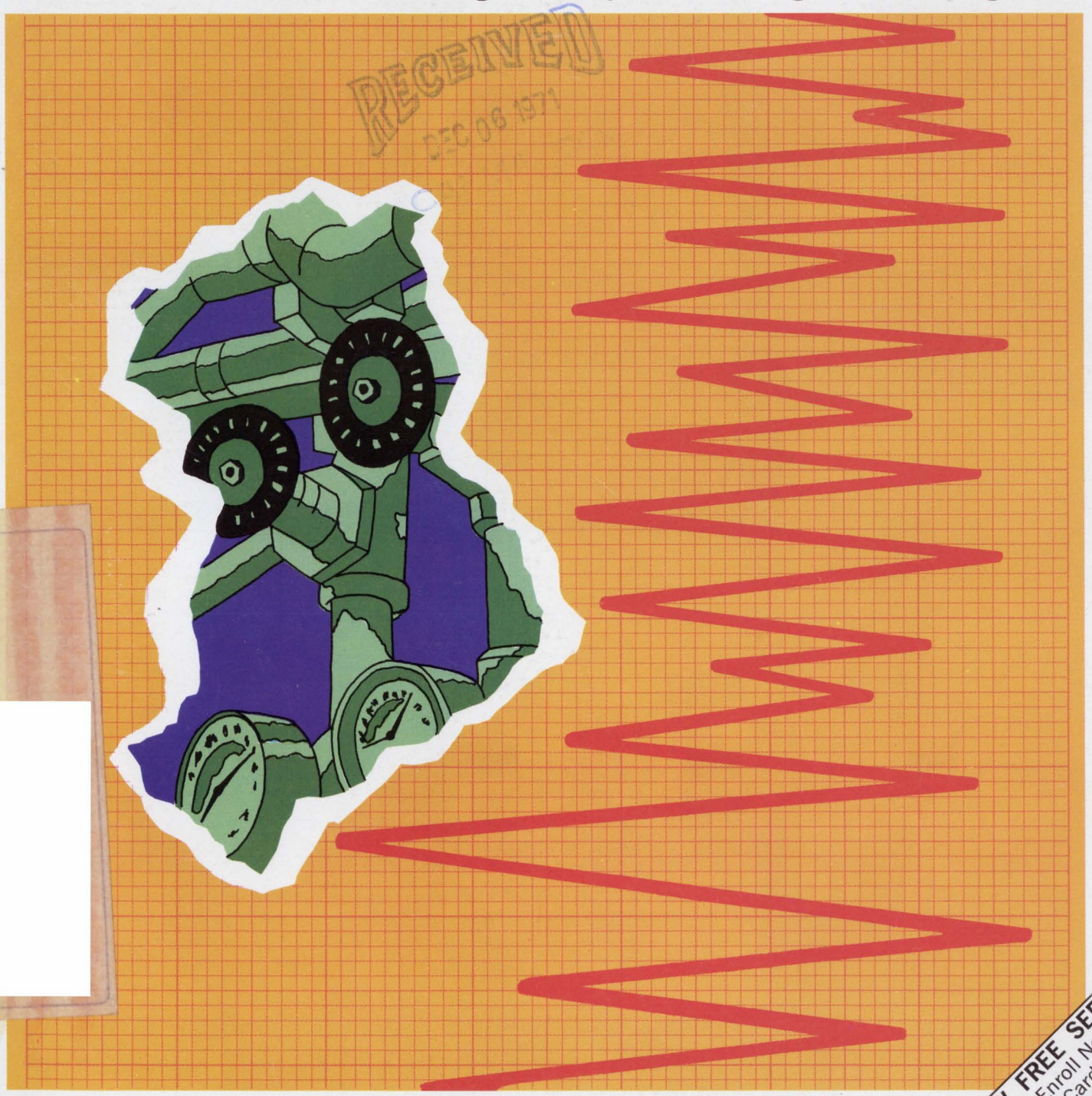
VOL. 19 NO.

Electronic Design 25

FOR ENGINEERS AND ENGINEERING MANAGERS

DEC. 9, 1971

Industrial chart recorders can be used to monitor almost anything —from manufacturing processes to environmental pollution levels. The trick is to choose the right recorder for the job. Should you use a galvanometric recorder or a potentiometric unit? Forced-fluid writing or a heated stylus? For help in deciding, turn to page 48.



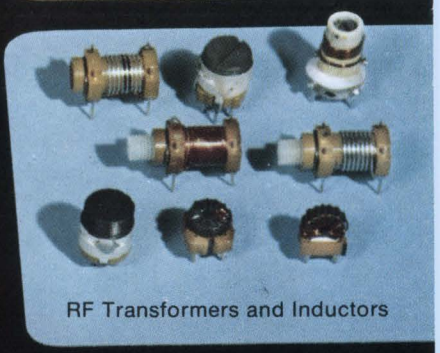
Custom Toroids

DALE®

COIL COUNTRY

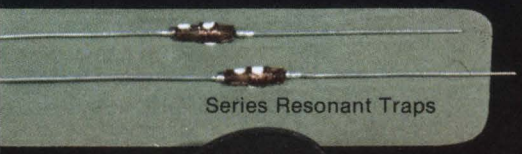
Custom Bobbin Coils

Variable Pitch Inductors

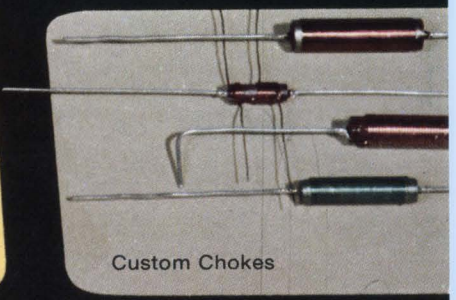


RF Transformers and Inductors

A good inductor source... just got better!

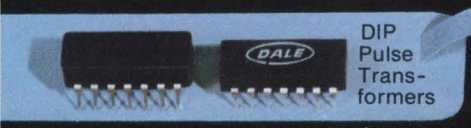


Series Resonant Traps

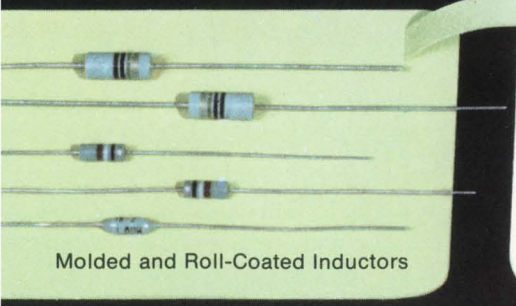


Custom Chokes

PC-Mount Toroids



DIP Pulse Trans-formers



Molded and Roll-Coated Inductors

Dale is moving quickly to qualify as your preferred inductor source. In recent months we have:

DOUBLED our line of standard PC mount toroids (Mil-T-27C, Type TF5SX20ZZ). Standard inductances now available from .05 μh to 20h, in a wide selection of Q vs frequency ranges.

ADDED Pulse Transformers in DIP configurations. Machine and hand insertable models (14,16 pins) are available containing up to four pulse transformers. Inductance range: 1 μh to 2 mh; Tolerance $\pm$20%; Leakage inductance: As low as .2% of total inductance; Interwinding capacitance: As low as 3 pf ; ET product: Up to 10 volts-μsec.

EXTENDED the values and frequencies available in molded inductors (Mil-G-15305D, Grade 1, Class A,B) and roll-coated chokes. Inductance: .10 μh to 1000 μh. Selt-resonant frequency: 680 to 3.5 Mhz.

This increased ability to supply standard inductors (many direct from stock) balances well with our custom capabilities in bobbins, rf transformers, chokes and toroids. For a fast quote or immediate design help get in touch with Dale—***lots of people are!*** *Call today: 605—665-9301*

INFORMATION RETRIEVAL NUMBER 241

DALE ELECTRONICS, INC., East Highway 50, Yankton, South Dakota 57078

A subsidiary of the Lionel Corporation

Take the price you'd normally pay to measure one nanosecond and 550 MHz.

Now divide by two.

Now for less than half the price of alternative solutions you can measure frequencies up to 550 MHz and time intervals from 0.15 nanoseconds to 10^9 seconds. You get the best resolution too, <50 picoseconds. Only HP's unique type of time interval averaging permits these measurements with such economy.

And you get all the other functions you expect in universal timer/counters. Features such as totalizing, period, ratio and conventional time interval measurements. They're the most programmable counters of their type as well.

This series also includes the only counters with built-in digital voltmeters. So you can set trigger levels digitally and better than an oscilloscope can for accurate time interval measurements. Use the DVM to check out dc voltages too, or add an HP 11096 probe for ac.

For more accurate measurements you can option for a high stability time base of 5 parts in 10^{10}/day. Or to measure low level signals, we can offer input sensitivities as high as 25 mV.

The HP 5327 Series is ideal for testing logic timing, cable delays, low-power circuits, and crystal oscillators—as well as calibrating frequency and pulse generators. Prices of the three models in the HP 5327 Series range from only $1495 to $2150. Or, if a 50 MHz will do your job, there's the companion 5326 Series from just $950 to $1595.

Sound too good to be true? Ask your local HP field engineer about these outstanding counter values. Or for more information, write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

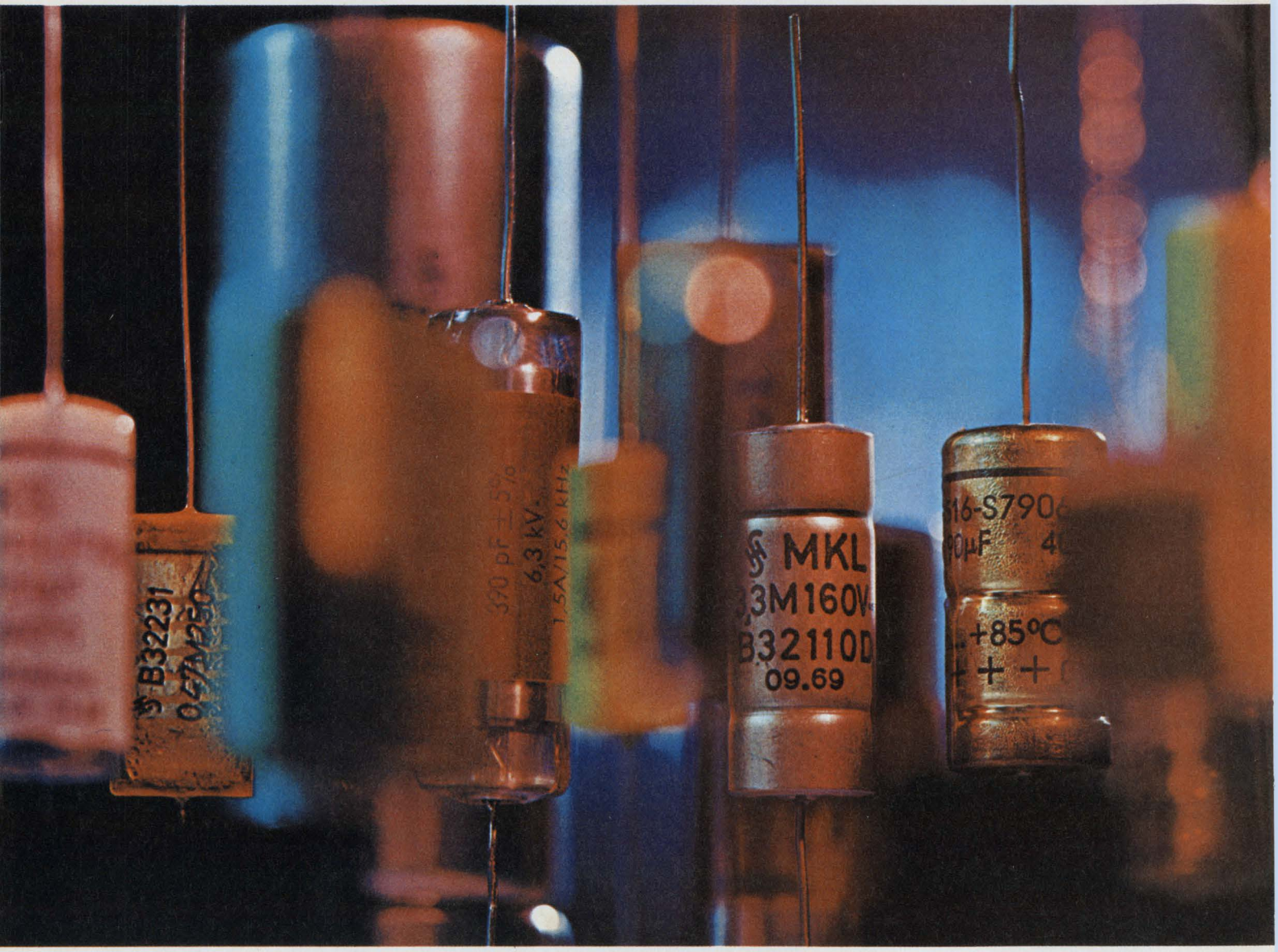
02117

INFORMATION RETRIEVAL NUMBER 2

HEWLETT hp PACKARD

ELECTRONIC COUNTERS

Siemens



Our MKL metallized lacquer capacitors handle peak voltages four times their rated voltages.

And that means you can use a much smaller capacitor for any given application. This is just one of many Siemens innovations. Our double anodized foil aluminum electrolytics are 30% smaller than competitive units. And our unique MKM metallized polycarbonate construction makes possible a dramatic reduction in the size of film capacitors.

Our capacitor line is one of the most extensive available. Film and metallized film dielectrics of paper, lacquer, polyester, polycarbonate, polypropylene and polystyrene. Tantalum and aluminum electrolytics. All for immediate delivery.

More and more engineers are designing in Siemens capacitors. 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

VOL. 19 NO.

Electronic Design 25

FOR ENGINEERS AND ENGINEERING MANAGERS

DEC. 9, 1971

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover: Designed by Art Director, Bill Kelly

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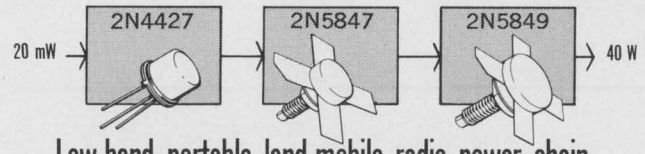
We Must Communicate

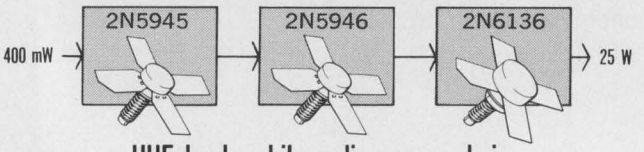
. . . on land!



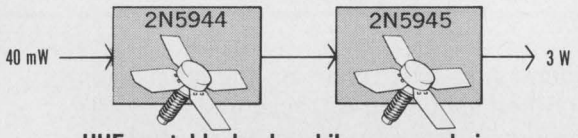
Low-band, portable land-mobile radio power chain.
25 to 50 MHz, 12.5 V.

Send for data sheets and AN282: "Systemizing RF Power Amplifier Design" and AN502: "A 40 W, 50 MHz Transmitter for 12.5 V Operation."

INFORMATION RETRIEVAL NUMBER 211



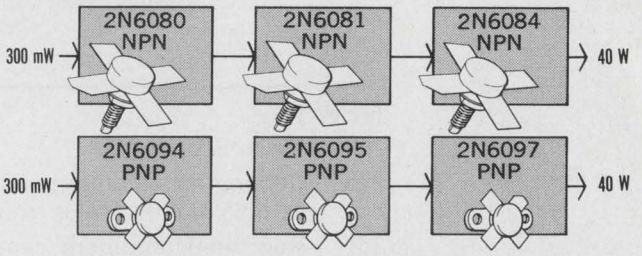
UHF land-mobile radio power chain.
470 to 512 MHz, 12.5 V.



UHF portable land-mobile power chain.
470 to 512 MHz, 7.5 V.

Send for data sheets and AN548: "Microstrip Design Techniques for UHF Amplifiers."

INFORMATION RETRIEVAL NUMBER 212



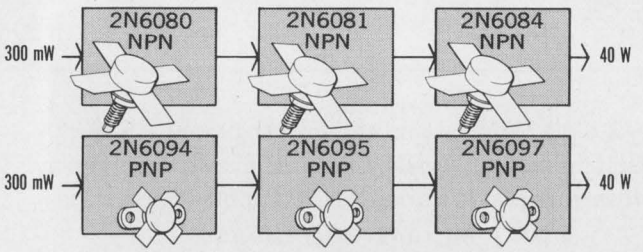
High-band, portable land-mobile radio power chain.
150 to 175 MHz, 12.5 V.

Send for data sheets and AN282: "Systemizing RF Power Amplifier Design" and AN495: "A 25 W, 175 MHz Transmitter for 12.5 V Operation."

INFORMATION RETRIEVAL NUMBER 214

Land-mobile radio, covering 3 distinct frequency ranges, requires significantly different devices in each band. Other design techniques are required for UHF devices than low or high-band. Data sheets and application notes examine these differences with UHF types even characterized at 7.5 V for portable operation. Motorola has them all!

. . . at sea!



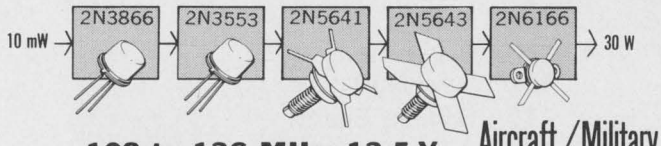
Marine radio power chain.
152 to 162 MHz, 12.5 V.

Send for data sheets and AN282: "Systemizing RF Power Amplifier Design" and AN495: "A 25 W, 175 MHz Transmitter for 12.5 V Operation."

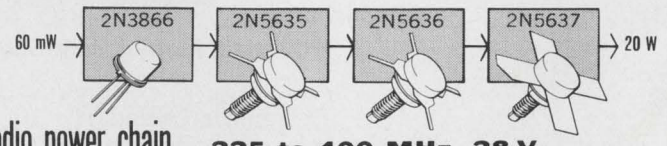
INFORMATION RETRIEVAL NUMBER 215

Marine radio falls into the same frequency range as high-band land-mobile with the same type of modulation and voltage required. Both PNP and NPN chains are available from Motorola for your designs!

. . . in the air!



108 to 136 MHz, 13.5 V.



Aircraft/Military radio power chain. **225 to 400 MHz, 28 V.**

Send for data sheets and AN481: "A broadband 4 W Aircraft Transmitter;" AN503: "A 25 W Broadband Aircraft Transmitter" and AN507: "A 13 W Broadband AM Aircraft Transmitter."

INFORMATION RETRIEVAL NUMBER 213

INFORMATION RETRIEVAL NUMBER 216

Typical AM systems are shown. Devices capable of 25 W and 50 W output for 225 to 400 MHz range are available on special request. And they're Isothermal-rugged!

With You At Once

. . . by cable TV!

CATV Device	Gain (dB)	Cross Modulation Distortion	Noise Figure (dB)	Case
2N5109	11 Typ	−70 dB Typ[1]	3.0 Typ	
2N5943	11.4 Typ	−67 db Typ[2]	3.4 Typ	
2N5947	11	−60 dB Typ[3]	3.8 Typ	
2N6135	11	−62 dB Typ[3]	4.8 Typ	

[1] 2 channel with +54 dBmV output level
[2] 12 channel with +40 dBmV output level
[3] 12 channel with +50 dBmV output level

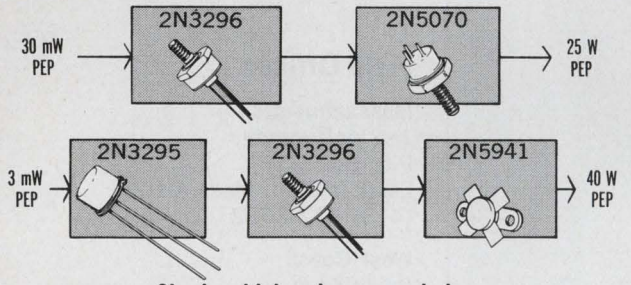
CATV. **5 to 300 MHz**

Send for data sheets with complete characterization for broadband CATV operation including distortion specs, noise figures and Y & S parameters . . . they're unique with Motorola!

INFORMATION RETRIEVAL NUMBER 217

Hybrid circuits offer important performance, reliability and space advantages. Both upstream and downstream hybrid designs are available from the factory.

. . . on single sideband!



Single sideband power chain.
2 to 30 MHz, 28 V.

Send for data sheets and AN546: "Solid-State Linear Power Amplifier Design."

INFORMATION RETRIEVAL NUMBER 218

The problem of linear amplifier design, including a technique for temperature compensation utilizing only passive devices can be solved. The block diagrams show output capability at two of the most popular power levels with 150 W PEP outputs easily obtainable with multiple devices.

. . . without noise!

Low-Noise Device	Noise Figure (max)	Frequency	Case
2N5179	4.5 dB	200 MHz	
2N5031	2.5 dB	450 MHz	
2N2857	4.5 dB	450 MHz	
2N5829 (PNP)	2.5 dB	450 MHz	
2N4957 (PNP)	3.0 dB	450 MHz	

Low Noise Designs.

Send for data sheets and AN215: "RF Small Signal Design Using Admittance Parameters;" AN419: "UHF Amplifier Design Using Data Sheet Design Curves" and AN421: "Semiconductor Noise Figure Considerations."

INFORMATION RETRIEVAL NUMBER 219

These low-noise devices excel in receiver front-end designs and have excellent noise figures at frequencies other than those listed. Design in Motorola quietness!

. . . and a word about ruggedness in RF.

Few semiconductors are subject to as severe treatment as RF devices. Load mismatching — by far the largest single cause of transistor failure — has largely been curtailed with the introduction of Motorola balanced emitter technology . . . BET* . . . and most recently, Isothermal* fabrication techniques. The latter has furnished an important new level in RF device ruggedness on many Motorola types with heat buildup reduced 50% through use of an asymmetrical emitter-resistor path design which apportions heat evenly over the entire chip surface.

Choose from more than 150 standard — and rugged — Motorola types . . . with frequency ranges to 2 GHz . . . power outputs to 100 W . . . in 18 optimized package styles. And you can customize device performance and testing merely by letting us know your particular needs. Write for data sheets and let's communicate.

*Trademark of Motorola Inc.

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— Get The Message.

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Editors

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50 Essex St.
Rochelle Park, N.J. 07662
(201) 843-0550
TWX: 710-990 5071
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Editor: George Rostky
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Associate Editors:
Roger Allan
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Field Offices

Massachusetts
Jim McDermott
P.O. Box 272
Easthampton, Mass. 01027
(413) 527-3632

West Coast
David Kaye
2930 Imperial Highway
Inglewood, Calif. 90303
(213) 757-0183

Washington
Don Byrne
1111 S. Army Navy Drive
Arlington, Va. 22202
(202) 296-8982

Editorial Production

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Art

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Peggy Long

letters

Hospital engineer joins call for better devices

Your article in the Oct. 28 issue on "Defects in Medical Electronics Draw Heavy Fire From Hospitals" (ED 22, pp. 22-26) is timely, true and revealing.

The hospitals should be blamed for not giving much attention to the problem. This, however, is changing rapidly, as is the case in our facility. But, the major share of the problem lies with the manufacturers. It seems that some manufacturers do not understand, nor are they willing to accept, the hospital environment. When electronic equipment is built to fly to the moon, it is designed accordingly; there is no reason why electronic equipment designed for the hospital should not be made for the hospital environment.

Allan Belgard [president] of Electrodyne may be only partly correct in his statement. Some of Electrodyne's equipment, which is only about one year old, lacks the most basic service considerations, and there is still a mess of wires in the new pressure monitor, Model PR-15. For example, PC boards do not show component references, workmanship is marginal and replacement of an indicator light on a monitor requires a major effort. These problems are not new to the electronics industry—I have been in this field for over 15 years. So what is Electrodyne's excuse? Or what is the excuse for not having a good instructional manual with accurate schematics?

The hospitals need to accept and learn about proper equipment care. But, more important, the manufacturers need to design and build quality instruments. The hospital, or anyone else, cannot inspect quality into an instrument; the quality must be built-in in the first place.

Mort Arditti
Senior Biomedical Engineer
Computer Sciences and
Bioengineering Facility
Department of Cardiology
Cedars-Sinai Medical Center
Los Angeles, Calif. 90054

A manufacturer's view

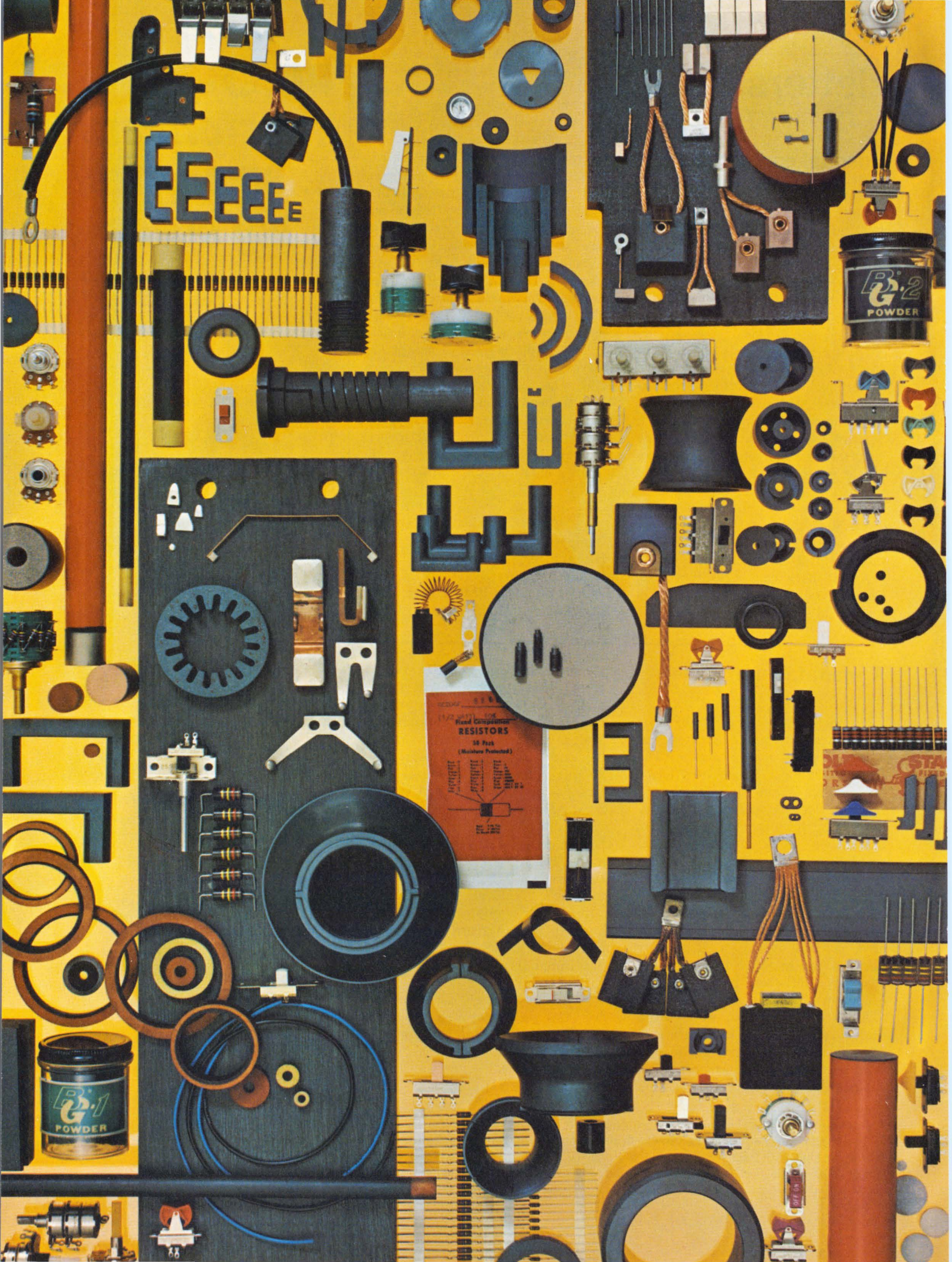
As the leading manufacturer of meter relays, I would like to comment on your Oct. 28 article "Defects in Medical Electronics Draw Heavy Fire From Hospitals."

First, let me express my sympathy for the plight of the doctors and other users of medical electronic equipment. I am sure that one of the world's most frustrating experiences must be the failure or malfunction of electronic-support equipment in the middle of a critical operation. Especially aggravating must be the discovery that the failure was in some simple (to them) low-cost component.

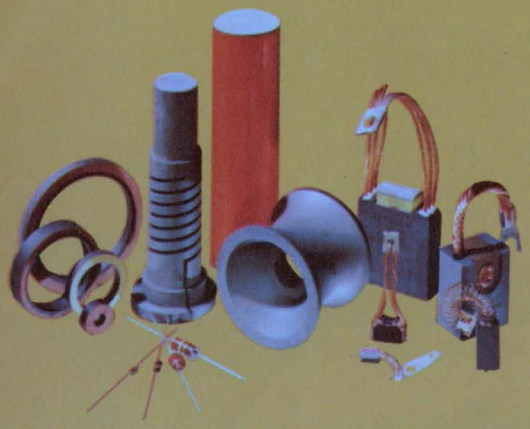
Since the article mentioned meter relays as high failure-rate components, I would like to say that the meter relay is a complex component. Our company (LFE's recent acquisition, API Instruments) has devoted much money and effort to educate the prospective user to the advantages and design pitfalls of meter relays. Nevertheless there have been cases of misapplication. Whenever they have come to our attention, we have worked with the manufacturer, either in correcting this circuit or in making changes in the meter relay, until the misapplication problem was solved. As Electrodyne's president, Alan Belgard, points out, equipment that was built 10 and 15 years ago is often being used as a basis for present-day complaints, and this just isn't rational.

John D. Saint-Amour
Senior Vice President
LFE (AUI Instruments)
LFE Corp.
1601 Trapelo Rd.
Waltham, Mass. 02154

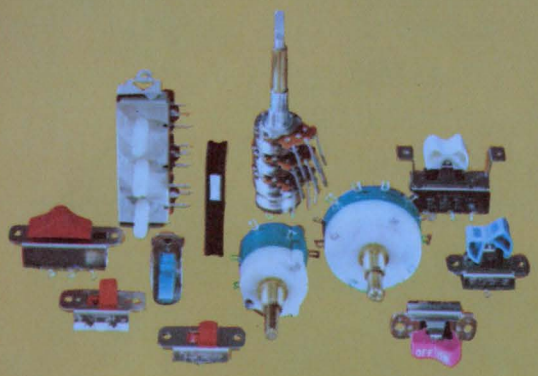
Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St., Rochelle Park, N. J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.


RG-2
POWDER
Fixed Composition
RESISTORS
50 Pack
(Moisture Protected)
RG-1
POWDER

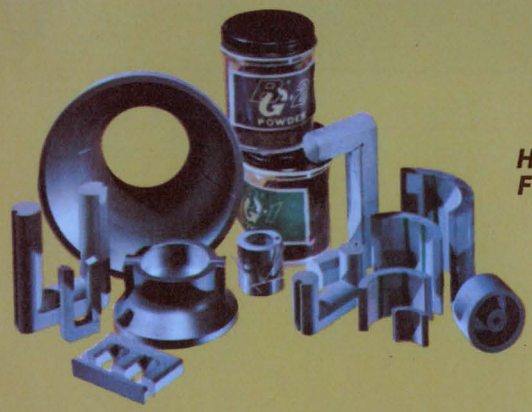
Our part in your product is value



Carbon and Graphite Products



Electro-Mechanical Components



Hard and Soft Ferrites

The items shown are produced by Stackpole's Carbon Division, Electronic Components Division, Magnet Division and Stackpole Components Company.

We make a lot of things at Stackpole. Components by the millions. Materials by the ton. But what really makes us different is our philosophy.

Stackpole believes in producing the best possible product, for the lowest practical price, delivered on time and backed by service. Simple? Sure. Perhaps even old-fashioned. But true. And certainly no small task.

Ours is a manufacturing technology. A capability to produce. In volume. To your specific needs.

For sixty-five years, Stackpole has served virtually every industry. To many, we are the known, respected leader. Others in emerging technologies are coming to know the special skills, imagination, experience and quality uniquely Stackpole.

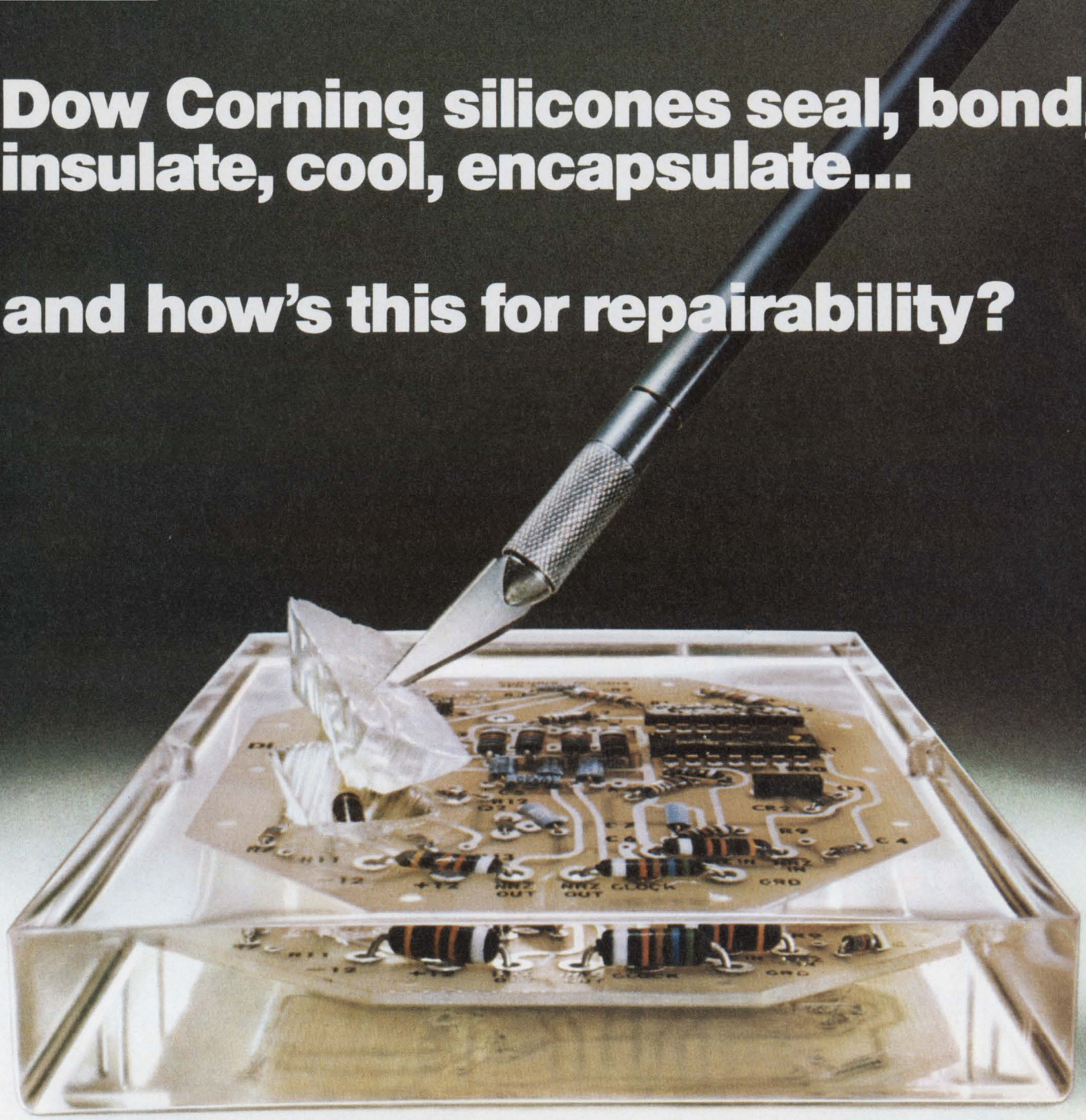
Value. It's determined in performance. For products and companies alike. Let us be a part of your production team.

Stackpole Carbon Company,
St. Marys, Pennsylvania 15857.

STACKPOLE

Dow Corning silicones seal, bond, insulate, cool, encapsulate...

and how's this for repairability?



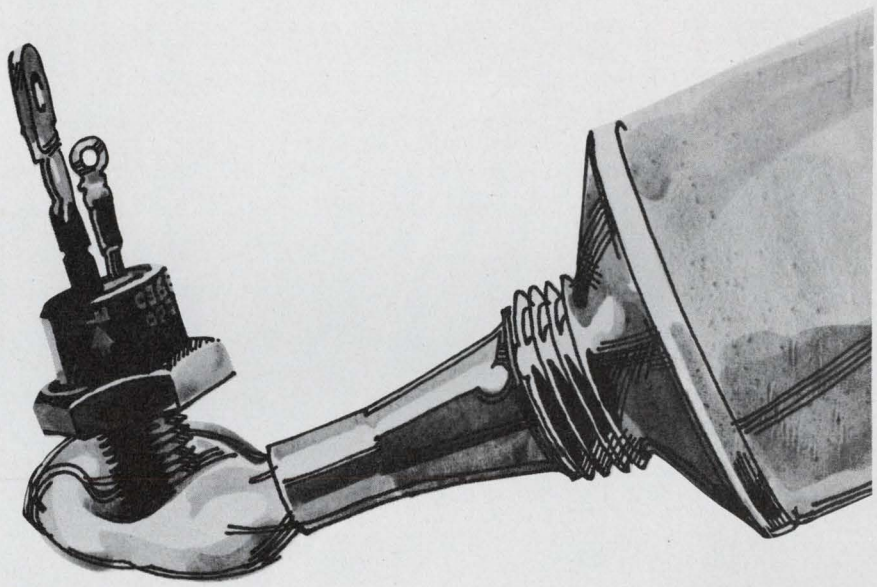
See-through silicone package speeds repair. Encapsulation of microcircuits with a clear resilient Sylgard® brand resin pays off with more than just protection. When circuits are under development, the encapsulant can be cut away to expose components for testing and modification. And, if fast field repair is a factor, defective components are more quickly located and replaced. Voids are merely filled with the silicone resin and protection is again intact. Sylgard resins also eliminate cure shrinkage associated with other encapsulants. They easily meet the most exacting shock, vibration, temperature and moisture resistant requirements. Circle Information Retrieval Number 821.

Silicone materials are unusually versatile. But whether they are used to seal, bond, insulate, impregnate, encapsulate or cool—their one basic function is to protect. And they protect better because of inherent silicone resistance to change—regardless of environment. When electronic equipment must function reliably in hostile atmospheres, look to silicones from Dow Corning to shut out trouble. Described here are a few ways our materials can ensure the integrity of your designs. Many others are described in our Silicone Electronic Materials brochure available from your Dow Corning distributor. His name appears on the following page. Or write Dept. A-1220, Midland, Michigan 48640.

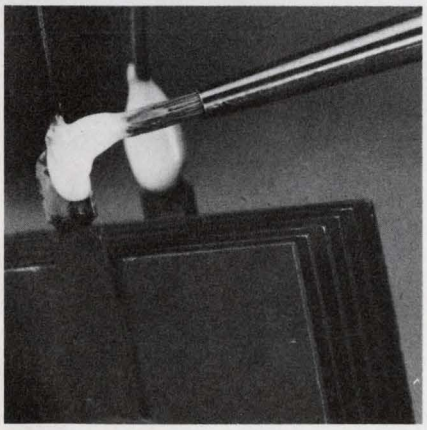
Electrical / electronic materials from

DOW CORNING

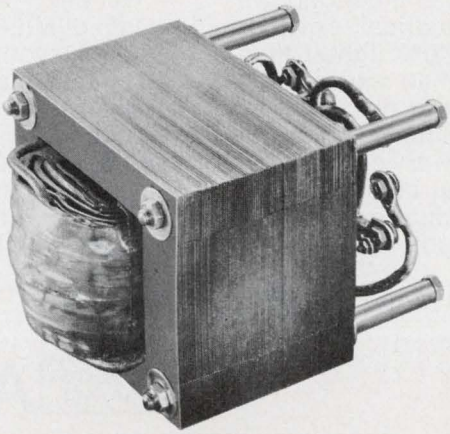
DOW CORNING



Noncorrosive silicone sealants. For critical electronic insulating requirements on corrosion-sensitive materials. Four noncorrosive, acid-free curing silicone sealants are available from Dow Corning—two are pourable, self-leveling liquids for conformal coatings; the other two are nonslump materials for sealing, mounting and bonding. All are ready to use, cure at room temperature and are serviceable over a wide temperature range. Circle Information Retrieval Number 822.

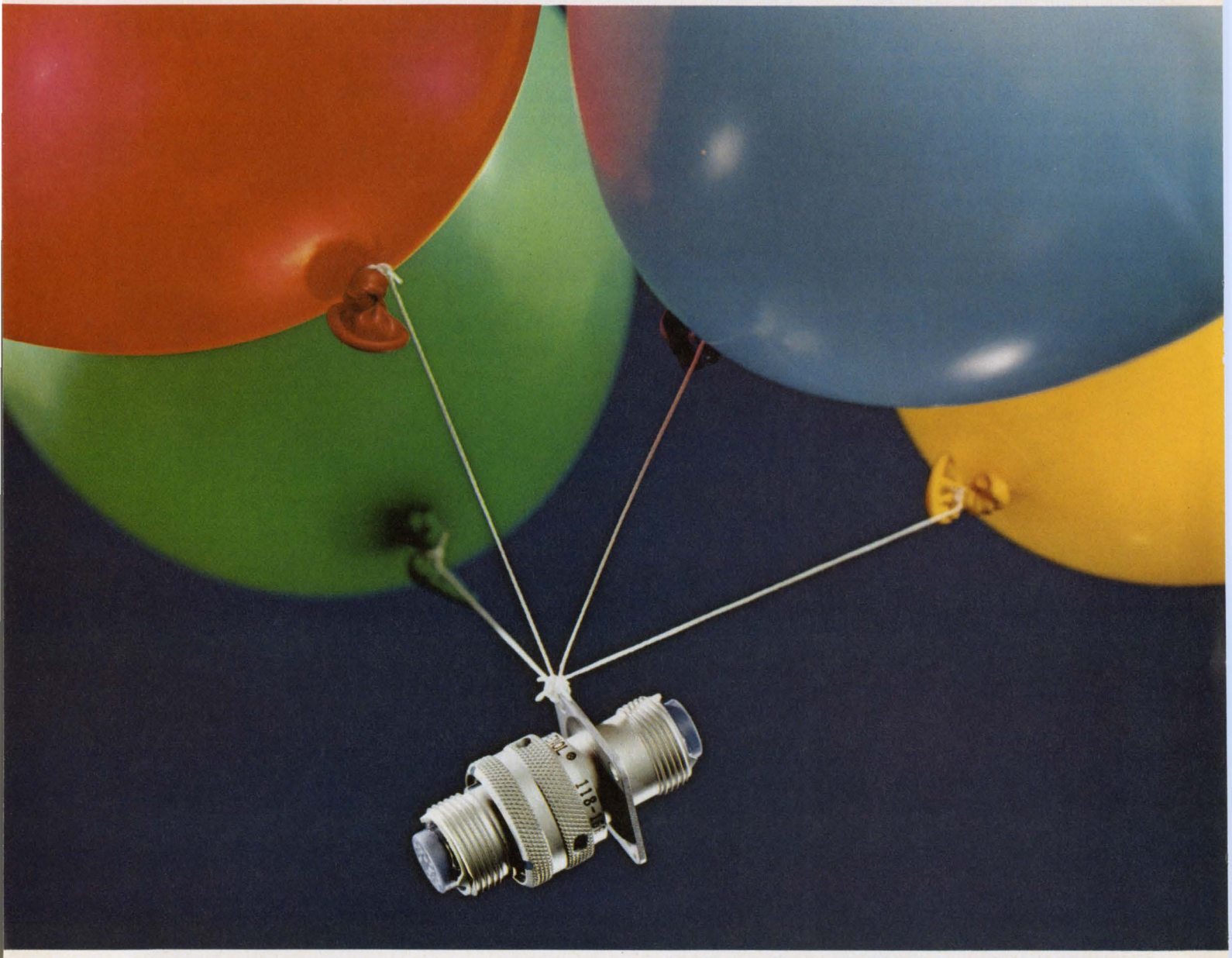


Dissipate heat fast with silicones. You can use silicone materials to protect from heat, or to get rid of it. A Dow Corning® brand heat sink compound helps cool components such as transistors, diodes and rectifiers by transferring operating heat to heat sink or chassis. Thermal conductivity is effective as high as 200 C with this noncorrosive, metal-oxide filled silicone material. Ask about silicone fluid coolants also. Circle Information Retrieval Number 823.



Silicone varnish aids miniaturization. When operating temperatures of new spacesaving power supplies such as transformers hit the 200 C mark, protection with Dow Corning® brand silicone impregnating varnishes ensures performance. These materials are the most reliable insulating resins available. And they are easy to apply. Stators, chokes, coils, solenoids and other electronic equipment are protected by simply dipping, brushing, flooding or impregnating. Circle Information Retrieval Number 824.

The new Merlin 1® connector.



40% lighter than anybody else's.

Through the magic of Amphenol engineering we now bring you a rear-release, cylindrical, environmental connector that is not only 40% lighter than competition, but ½-inch shorter than most.

A one-piece thermoplastic retention disc, molded of tough Astrel 360* replaces the individual metal retention clips common in heavier connectors. Therefore, a 61-pin Merlin configuration has one retention disc instead of 61 individual metal clips. The result is a lot less useless weight. And, without all those parts, more reliability.

Adds a little magic to cost-cutting, too.

Our new Merlin exceeds all performance requirements of MIL-C-83723, MIL-C-26482 and NAS-1599 and is fully intermateable and intermountable with all three of these types.

Shell sizes are available in the eight most popular configurations with your choice of straight plug and both wall-mounted or jam-nut receptacles.

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BUNKER RAMO AMPHENOL

INFORMATION RETRIEVAL NUMBER 6

designer's calendar

JANUARY 1972

S	M	T	W	T	F	S
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16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Jan. 25-27

Symposium on Reliability, (San Francisco), Sponsor: IEEE, J. H. Simm, Beckman Inst. Inc., 2200 Wright Ave., Richmond, Calif. 94804

CIRCLE NO. 422

Jan. 30-Feb. 4

Power Engineering Meeting, (New York City), Sponsor: IEEE, J. W. Bean, AEP Service Corp., 2 Broadway, New York, N. Y. 10004

CIRCLE NO. 423

FEBRUARY 1972

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Feb. 8-10

Aerospace & Electronic Systems Winter Convention (WINCON), Los Angeles), Sponsor: IEEE, Gerry Goldenstern, L.A. Council Office, 3600 Wilshire Blvd., Los Angeles, 90010

CIRCLE NO. 424

Feb. 16-18

International Solid-State Circuits Conference (Philadelphia), Sponsor: IEEE, A. V. Brown, T. J. Watson Res. Ctr., Box 218, Yorktown Heights, N.Y. 10598

CIRCLE NO. 425

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To prove our commitment is no card player's bluff, we're inviting you to pick *one* of the following nine thyristors, all direct replacements* for those listed, to receive free.

Then just "Plug It In And Try It."

**Although these devices have comparable specifications, in some instances they may require slight modifications for the specific application before being considered "direct replacements."*

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100 V 800 mA TO-92 packaged SCR

If You're Using

B01051, B01052, B01071, B01072, C122G, C122B, TA7404

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A1001, A1002, A1021, A03001, A03002, 2N5755, 40430

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B05041, B05042, C30B, C31B, C35B, C36B, C37B, C38B, C135B, TCR1520, TCR2020, TI3039, TI152, 2N685, 2N6845, 2N1845A, 2N1845B, 2N1846, 2N1846A, 2N1846B, 2N4317, 40742, 40754

Pick Motorola's FREE 2N3897

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I_V = 4.0 mA (min) TO-18 packaged UJT

If You're Using

A01061, A01101, A01141, SC141B, SC146B, 40668

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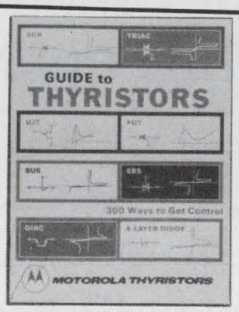

TOPS IN THYRISTORS †Trademark Motorola Inc.

I've picked a card! Send me the circled thyristor card (one only, please) including device, data sheet and "Plug It In And Try It" button along with my "ace-in-the-hole": Motorola's Guide To Thyristors.

SCR'S	2N5062	2N4442	2N3897	
Triacs	2N6071	2N6151	2N6139	2N6160
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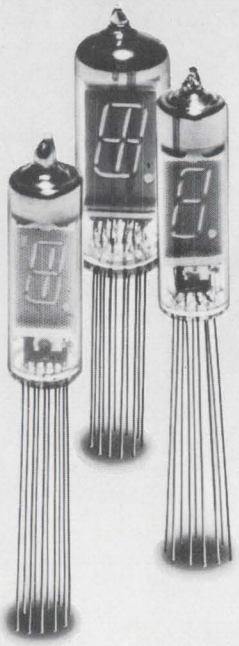

SPECIFICATIONS (pulse operation)

TYPE	Filament Current I_f	Filament Voltage e_f	Phosphor Segment Voltage e_p	Control Grid Voltage e_g	Phosphor Segment Current I_p
DG12M	85	*1 0.8 ± 10%	50	*2 50	4
DG12H	85	*1 0.8 ± 10%	50	*2 50	3
DG19E	95	*1 1.7 ± 10%	55	*2 55	4
Unit	mA	Va. c	Vd.c	Vp-p	mAp-p

TYPE	Control Grid Current I_g	Phosphor Segment Cut-off Voltage e_{pco} (MAX.)	Control Grid Cut-off Voltage e_{gco} (MIN.)	Brightness
DG12M	19	0	−4	150
DG12H	18	0	−4	150
DG19E	22	0	−4	150
Unit	mAp-p	V	V	Ft-L

*1 Effective Value at 50 or 60 Hz A.C
*2 Pulse condition— Duty Factor 1/16 pulse width 60 μsec.

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INFORMATION RETRIEVAL NUMBER 102

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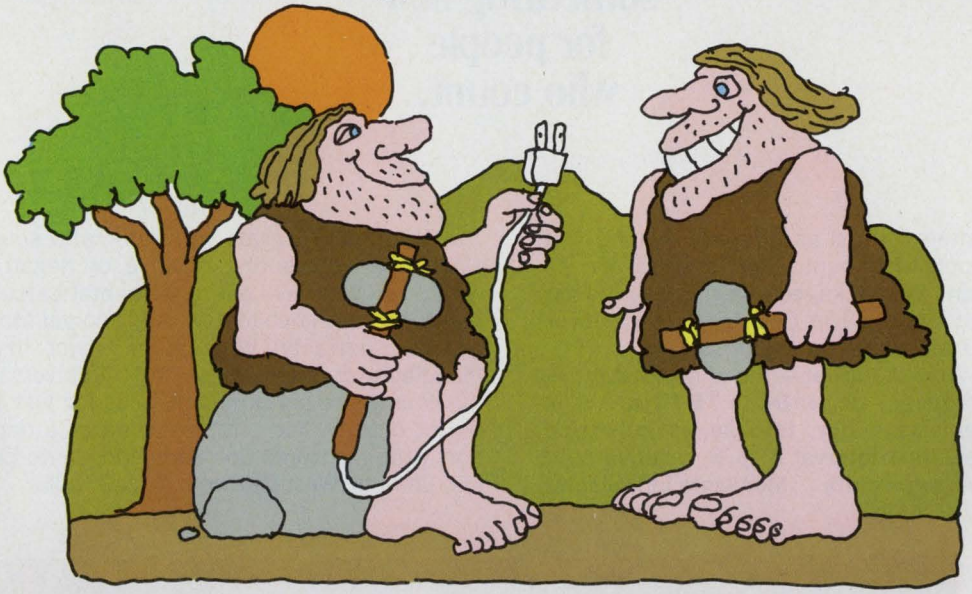

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APPLICATION	SOLUTION
Precision digitizer for disc, tape and drum systems. Digital communications receiver. Signal conditioner. Bidirectional transition detector. Frequency doubling.	**8T20 New Bidirectional One-Shot.** Combines linear comparator, one-shot and logic all-in-one. Functions as a zero-crossing detector with an input threshold of 15 ±4mV and positive or negative edge triggering, or both.
To meet compatibility requirements of IBM System 360 I/O interface specs, channel to control unit. When tying on any peripheral equipment such as core memory, discs, graphic terminals, etc.	**8T23 Dual Line Driver.** **8T24 Triple Line Receiver.** The first and only interface driver/receiver pair proven totally compatible with IBM 360. Replaces discrete components.
To conform with EIA-Std-RS232, MIL-Std-188 and CC-ITT-V24 specs, when transmitting and receiving digital data.	**8T15 Dual Line Driver.** **8T16 Dual Line Receiver.** EIA/MIL communications devices.
Digital data transmission and receiving, using coaxial cable, twisted-pair, or other low impedance lines. Party-line data transmission. Schmitt trigger. One-shot.	**8T13 Dual Line Driver.** High current driver with short-circuit protection and DOT-OR capability. **8T14 Triple Line Receiver.** High input impedance receiver with Hysteresis.
Data transfer in bus-oriented systems. Modular systems design. Minicomputer design. Multiplexing.	**8T09 Quad Bus Driver.** Tri-state logic configuration to increase system performance. High speed (10ns) and high current (40mA) capability. **8T10 Quad D-Type Bus Flip-Flop** Tri-state outputs with input and output disable. 50MHz typical toggle rate.
Driving seven-segment numerical displays, LEDs or incandescent lamps.	**8T04, 8T05, 8T06 BCD-to-Seven Segment Decoder/Drivers.** For driving almost any type of display — LEDs, Numitron, etc.
Low voltage (+5V) to high voltage (40V) level translation.	**8T80 Quad 2-Input NAND Gate.** **8T90 Hex Inverter.** Low-to-high voltage interface gates.
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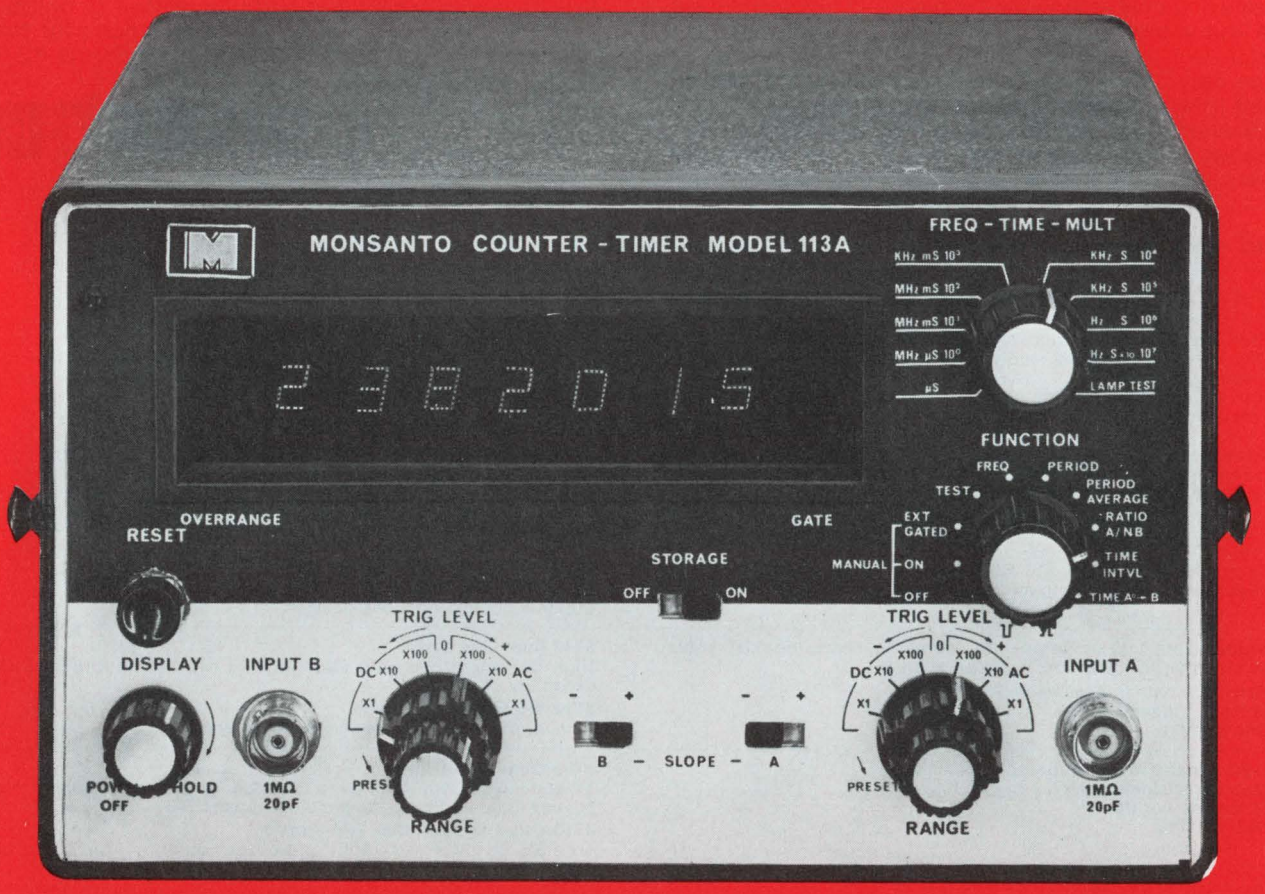
Take a quick look at some of its outstanding features... **Frequency range: DC to 75 MHz... 8 operating modes: frequency, totalize, ratio, period, period average, time interval A to B, positive pulse width, negative pulse width... Monsanto LED display.**

The Model 113A gives you automatic selection of slope when measuring positive or negative pulse widths, so you have one less mental calculation to make, one less knob to turn. And you get Monsanto's two-year warranty. What other major instrument manufacturer offers you that? All this versatility, all this four-figure performance, sells for just $895 for 5-digit display. For complete data or a demonstration, write Monsanto Company, Monsanto Electronic Instruments, West Caldwell, N. J. 07006.



Monsanto

news scope

DECEMBER 9, 1971

Cable TV pact expected to open up huge market

The recent compromise agreement between the cable and broadcast television industries is seen by cable TV system operators and hardware suppliers as opening the door to a market that may eventually run to several billions of dollars. Microwave and studio equipment are expected to be in heavy demand.

Formulated by the Office of Telecommunications Policy at the White House, the new agreement—which is more restrictive than the original Federal Communications' proposed rules on CATV earlier this year—is expected to be adopted by the FCC in March of 1972.

The agreement requires the cable TV operator to pick up and distribute all network and independent station programs within a 35-mile radius of his location. If this coverage does not provide the cable customers with at least the three major network programs plus those of two or three independent stations, the CATV operator can then supply the signals of stations beyond the 35-mile radius to fulfill minimum service requirements.

Another requirement that will affect future hardware demand is the need for cable TV operators to provide "two-way capacity" between the CATV station and the customer.

As a result, according to a spokesman from Jerrold of Philadelphia, the largest U.S. manufacturer of cable-TV distribution equipment, the principal cable-TV building block will be a distribution system with two-way capability. Along with this will be development of consumer-oriented terminals with data capabilities, as well as computer systems with the intelligence to implement the terminals.

A spokesman for TelePrompter Cable TV Corp. of New York City, the nation's largest CATV system operator, said the new agreement would be good for the industry. But he emphasized that the pickup of distant signals is not too important in the long run since new services, other than TV station programs would be the eventual primary source of income.

Some of these services, he noted, would be local television pickups for merchandising, delivery of certain classes of government mail, burglar alarm systems, fire alarm systems, and remote meter reading.

As a result, he predicted there will be a large demand for studio equipment as well as for more sophisticated terminal-type equipment that would allow the subscriber to communicate with the CATV studio and perhaps print out pages of data.

But most important, he felt that the larger firms, such as Westinghouse and General Electric, would jump into the hardware market. As an example, he pointed out that Hughes Microwave Division is already in partnership with TelePrompter, owning 49% of the system in New York and 50% in Los Angeles.

Hughes principal contribution is in microwave systems that TelePrompter uses in both New York and Los Angeles. Originally run experimentally on the GHz band, their equipment is now operative in the 12.7 to 12.95 GHz band, set aside by the FCC for cable television.

A.M. Sereng, planning manager for Sylvania cable TV systems, Waltham, Mass., feels that the principal use of microwaves is primarily in the larger cities such as New York, Chicago, where it is too costly to run cables.

Ira Kamen, president of Laser Link Corp., Woodbury, N.Y., which has frequency-division multiplexed FM microwave systems that put 18 TV channels on one carrier—in contrast to Hughes' amplitude modulated link—says that the rules open up wide new markets, particularly for local microwave distribution systems.

Laser Link, he says, has a backlog of $10 million in letters of intent for 23 filings with 18 new ones coming in anticipation of the FCC approval of the new agreement.

Daniel Mezzalingua, president of Craftsman, a Magnavox cable TV subsidiary, says that the new agreement can only help the equipment manufacturer.

However, he notes that the immediate problem for the industry is to obtain the funding for system construction. They're going to need vast amounts of money to build some of the system franchises that have been held for the last few years, he argues. But he's confident that the chances of raising the money are now considerably better.

Conference will feature charge-coupled devices

The second anniversary of charge-coupled devices will be celebrated at the Solid-State Circuits Conference in Philadelphia from Feb. 16 to 18 in what appears sure to be two of the most popular sessions there, according to a conference spokesman.

In the first session, "Charge-Transfer Devices," several papers will be presented on recent developments in the field, including two that will describe the application of charge-coupled devices to analog delay lines (for more information, see "Bucket-Brigade Device Said to Cut Audio Delay-Line Costs Drastically," ED 24, Nov. 25, 1971, p. 34).

Perhaps of more interest, however, will be a panel discussion, "The Impact of Charge-Control Technology," which will evaluate progress to date, and future applications of charge-coupled devices.

Xerox copiers to get electronic logic

Xerox copying machines of the future will look much the same as today's, the company says, but a

revolution is under way inside.

"We're embarking on a very strong trend to replace mechanical logic with electronic logic," says James Donohue, electronics designer in Xerox Corp.'s Research and Engineering Div., Webster, N.Y. The changeover is going to be *painful*, as any big switch in procedure is, but it will be worth it, he says.

The reasons for the new trend: cost and performance requirements. "We're no longer able to meet the production performance requirements with relay mechanical logic, and we see that the low cost of integrated circuits makes electronic logic cheaper," Donohue says. The IC generation has arrived at Xerox, he adds, without the company's having to go through the transistor stage, except for power transistors.

The 4000 series is the first Xerox copier to use any significant electronics. "It's roughly halfway there," Donohue says. "ICs will be the key electronic component in the 4000. They will be zener offset DTLs, the HNIL (high noise immunity logic) IC made by the Amelco Div. of Teledyne. "In the future the IC most likely to be used," Donohue says "is the 5474 TTL series made by many companies."

Over the next five years Xerox will go very heavily into MOS LSI, he notes. "For the present, we'll use DTL-TTL. Later, more TTL, and eventually full MOS LSI."

Xerox will always remain a bipolar MOS house, Donohue says, because of the frequent need to bring its machines up to date. "The constraints on changing an MOS design are just too severe at this stage," he explains. "However, when someone builds a $15 processor with a read-only memory, to fulfill the logic requirements of a particular machine, then that's a different ballgame." Donohue believes such a data processor will be available by 1976.

An electric commuter car passes all road tests

An electrically powered commuter car can be built today with available hardware at a cost of about $3896 per car, according to Tom N. Thiele, electronic and control technology director of Allis-Chalmers Corporation's Advanced Technology Center, West Allis, Wis.

Addressing a session of the Electric Vehicle Council's symposium and exhibition held recently in Atlantic City, Thiele described his experience with an electric powered Karmann Ghia. Driving the car almost 10,000 miles in a 10 month period, Thiele said that the car demonstrated a number of important things. Among these were reliable transportation, no vehicle breakdowns, and a maximum range of 65 miles at a speed of 60 miles per hour. For city driving at lower speeds, Thiele continued, a considerably greater range is possible.

The car contains an efficient direct current drive configuration in which a 27-hp direct-current shunt wound motor with field control is coupled through a standard transmission and clutch to the differential and driving axle. Speed is controlled by a low power chopper.

This electric commuter car developed by Allis-Chalmers Corp. uses a standard clutch and transmission.

However, the day of the mass-produced commuter electric car is still off in the distant future. In a recent session on electric cars held at the Transportation Conference at Nerem '71 in Boston, R.D. Thornton of the Massachusetts Institute of Technology predicted that only a thousand electric cars will be on the road in this country by 1975. The reason for this relatively small number of vehicles can be attributed to the lack of interest in development exhibited by major U.S. automobile companies.

According to Thornton, the evolution of electric cars continues to follow a somewhat surprising path with the major automotive companies in the U.S. abandoning all serious development efforts. Thus the only development being carried out here is by two or three battery companies and a few smaller non-automotive organizations.

In contrast to this, the Japanese have been quite active in this field. Major Japanese electronics and automotive companies such as Toyota, Nissan, Mitsubishi, Hitachi, and Sanyo to name a few, are presently collaborating in a government sponsored program to develop an electric car. In addition to being aimed at Japan's need for short range low emission vehicles, the Japanese are also considering the potential overseas market left to them due to lack of interest by U.S. manufacturers.

3-D image technique could replace X-rays

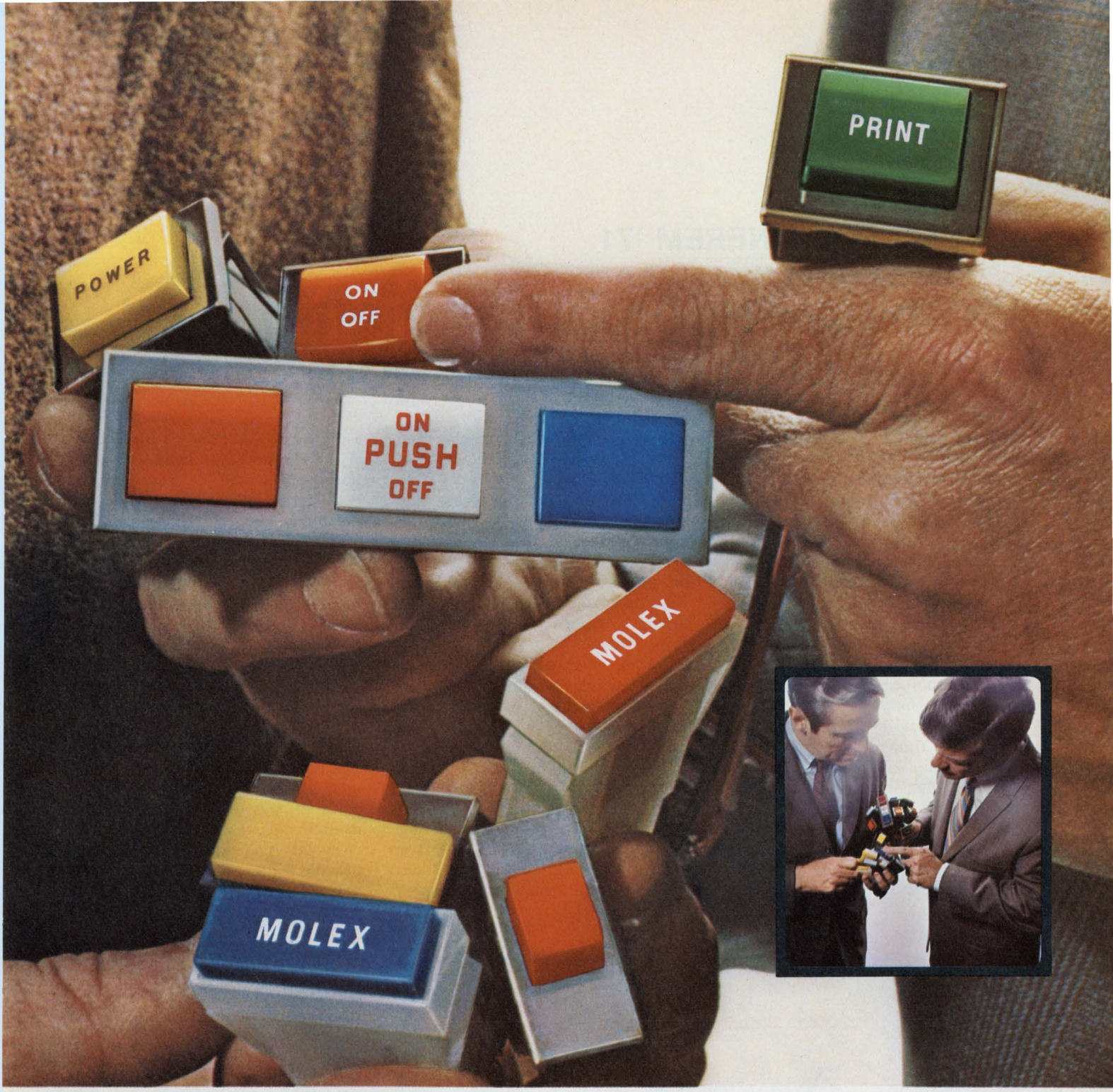
A new research project that will combine holography with ultrasonics to aid in the diagnosis of early cancer signs and heart disease was announced by Dr. George W. Stroke, head of the electro-optical sciences laboratory at Stony Brook University, N.Y.

The technique is known as sonoradiography and was first conceived of by Dr. Dennis Gabor of CBS. The technique described by Stroke will enable physicians to take three-dimensional pictures of internal body organs without the dangers normally associated with X-ray techniques presently used.

In actual operation, a broad wave of ultrasound would permeate the entire organ. A three-dimensional "map" would then be produced by the impression of the echoed sound wave onto a hair-thin mirror-like plastic membrane. Laser light and other optical and holographic techniques would then be used, continued Stroke, to convert these deformations of the membrane into a hologram.

Dr. Stroke said that a working model of the instrument could be ready within three years.

The project, a joint venture of Stony Brook University and CBS Laboratories is being funded by a $200,000 National Science Foundation grant, and is part of the foundation's increasing emphasis on practical research to combat national problems.



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INFORMATION RETRIEVAL NUMBER 11

M159A

news

REPORT FROM NEREM '71

Coming in computer memories: semis plus magnetic domains

Semiconductor and moving-magnetic-domain technologies—one a mature and the other an infant technology—will team up and play a dominant role in computer system memories of the next decade, according to experts who gathered at the 1971 Northeast Electronics Research and Engineering Meeting (Nerem) in Boston.

They called at a technical session for a variety of storage technologies to increase the efficiency of future computer systems and said this could be achieved mainly through a higher degree of organization. The session was entitled "Future Memory Systems: Architecture and Technologies."

Mainframes, the experts said, will use increasingly bipolar and MOS memories capable of subnanosecond speeds. The rest of the computer system, where bulk storage is important, will be using memory blocks of moving-magnetic-domain storage, capable of providing high-density storage with microsecond access times at prices competitive with current core, disc and drum memories. Two types of magnetic-domain storage will be employed, the session was told: domain-tip (DOT) and bubble (see figure for a cross-section of a DOT memory).

Roger S. Allan
New Products Editor

Growth in semiconductors seen

Despite the present maturity of semiconductor technology, further growth was predicted by Dr. Richard F. Elfant, manager of packaging at IBM, East Fishkill, N.Y. By 1975, he said, most computer mainframes will be made almost exclusively of semiconductor bipolar and MOS storage elements.

At present IBM does use all-semiconductor mainframes on two of its systems—the 370/135 and 370/145. Two of its newest models —the 370/155 and 370/165—use a combination of core memories and semiconductors.

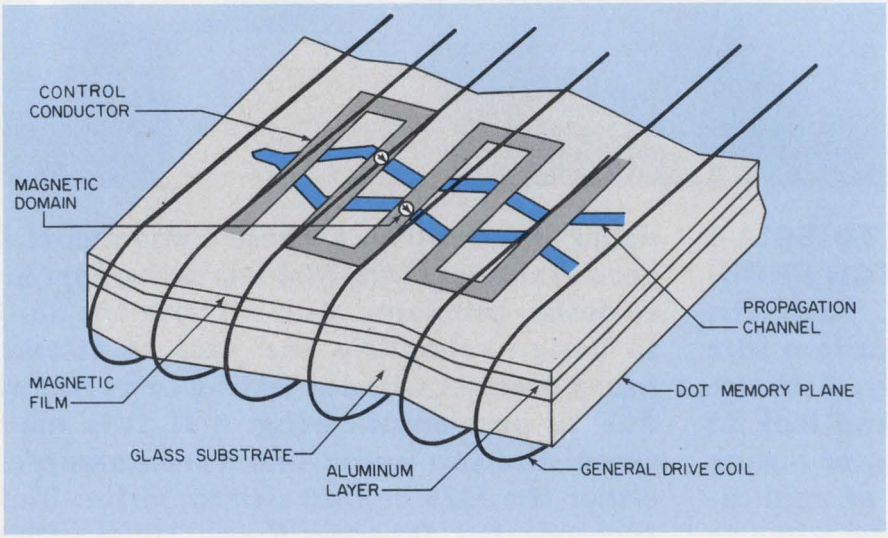
"The key factors in the realization of all-semiconductor computer mainframes will be future improvements in photolithographic and semiconductor-processing techniques," Elfant said.

As he saw it, future small and medium-capacity computer memories will use LSI ICs that will provide high operating speeds with gate delays in the picoseconds. They will take up less space, he said, becasue of small chip sizes, with typical chips housing all the supporting electronics—decoding and sense amplifiers. Costs in the range of 0.6¢ to 1¢ per bit are expected.

Elfant predicted a twofold to threefold shrinkage in the size of IC chips, resulting in bit/chip density increases of 10 to 50 times, by 1975.

"Without projecting too far out in time," he said, "by the early 1975s we can see densities on the chip level to 64k bits per chip on chips measuring no more than 200 mils to a side. Densities of one million bits per inch can certainly become a reality."

Despite these higher densities, the expected use of pulsed power, instead of steady power, and static, instead of dynamic memory cells will cause total chip power dissi-



Cross-section of a DOT memory shows propagation channels etched into the storage plane. Overlaying conductors are excited to control the shifting of moving magnetic domains (arrows indicate direction of the motion). Data blocks are selected by applying a current to the drive coil.

Chances are you're paying up to 30% too much for this kind of breaker.

Unless you're already using Heinemann's new Series AM1.

It's our low-priced, direct replacement for AM12-type breakers that have been so popular everywhere.

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HEINEMANN

4975

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pation to remain at least at the same levels, Elfant said.

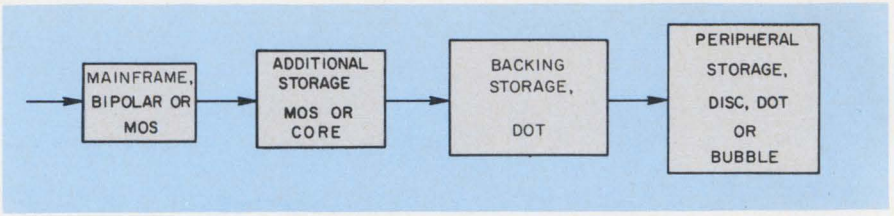
The challenge of DOTs

"Magnetic-domain storage elements—particularly DOT types, which use polycrystalline magnetic-film mediums—will offer very fast mass-memory blocks at low cost and power dissipation and with high reliability," Joseph Kruy, president of Cambridge Memories, Newton, Mass., told ELECTRONIC DESIGN. He attributed the low costs to the excellent yields that DOT memories can provide—much better than semiconductor yields. However, he would not elaborate with any specific figures. Kruy was chairman of the session.

He did not see magnetic domain DOT and bubble memories competing with semiconductors, but rather complementing them in hierarchial computer structures. Semiconductors will be used in the computer's fast-memory section, he said, and DOT and bubble in the mass-storage section as backing-storage systems (see figure).

Dr. Robert J. Spain, director of research for Cambridge Memories, told the session of specific DOT advantages over current bulk disc, drum and core memories. He pointed out that DOT memories can have block access times of less than 1 μs, compared with 10 to 20 ms for fixed-head disc and drum memory blocks. Speed of 1 μs is competitive with cores. "The average DOT word access time is only 0.5 ms," he explained.

And because disc and drum memories use moving mechanisms, which are subject to mechanical wear, DOTs with nonmechanical operation offer more reliability, Spain pointed out. As for cost, less than 0.1¢ per bit within a year, compared with about 0.25¢ at present—at least an order of magnitude cheaper than semiconductor and core, and competitive with disc and drum memory prices.



Semiconductors are expected to be used in the computer's fast memory section, while magnetic domain and DOT bubble memories will be used in the mass-storage section as backing storage systems.

Spain explained further that DOT memories offer low power consumption in the standby mode. A typical 1-megabyte memory block consumes only 10 W—less than 1 μW per bit. And like core memories, DOTs are nonvolatile—a feature that is very important for mass-memory users.

Still another reported advantage of DOTs over disc and drum memories is that they can be synchronized to any frequency, which simplifies memory interfacing.

Spain said that present densities of 6000 bits per square inch are available in DOT technology, with densities of 50,000 bits per square inch achieved in the laboratory.

Cambridge Memories, Inc., is reported making a 2.5-megabit, 18-bit-word mass DOT memory that should be available by early next year.

Bubbles of the future

The outlook for bubble memories was outlined by Andrew H. Bobeck, supervisor of propagation-domain devices, Bell Telephone Laboratories, Murray Hill, N.J. Bubble memories are similar to DOT in operating principles; both use moving magnetic domains for storage. They differ, however, in that bubbles use single crystals for storage mediums, whereas DOTs use polycrystalline magnetic films.

Although bubble memories are not yet commercially realizable, Bobeck believes they will be soon and will leave all other types of memories, including DOTs, far behind in density and cost advantages.

Present densities of 10 megabits per square inch can be designed easily and evaluated, Bobeck said. "Work is already going on," he noted, "to increase this density to 100 megabits per square inch—the highest density of any existing storage technology." As for cost, Bobeck saw prices as low as 0.001¢ per bit by the mid 1970s.

He reported on the design of a 15-megabit memory, now in progress. "Based on a 100-kHz, in-plane field rate," he said, "the average access time to any of the 1328 word blocks is 1.25 ms. This speed makes bubble very competitive with disc and drum type memories."

Large-capacity, high-density experimental shift registers that use bubble techniques have been designed and evaluated by Bobeck. Specifically, 10,000-step shift registers have been operated in memories that were only 100 mils square in area. He reported on even more recent experiments in which 100-step shift registers with densities of 10^7 bits per square inch were achieved. ■■

How minis can unknot communications

The use of minicomputers as digital controllers could increase the capacity of present communication systems by 100%, a session at Nerem '71 was told.

Jules H. Gilder
News Editor

The same session discussed new uses of the mini in health care.

In a presentation to the session —"Why a Minicomputer?"—Ed Rearick of Sanders Associates, Nashua, N.H., described a municipal communication network to show how minicomputers could improve both communications capacity and functions.

Because present communication systems are heavily loaded with voice, the over-all efficiency is greatly reduced, he said. In an attempt to overcome this, he noted, municipalities are now looking to

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Note: MM42xx refers to −55°C to +125°C temperature range devices; MM52xx to −25°C to +70°C

National

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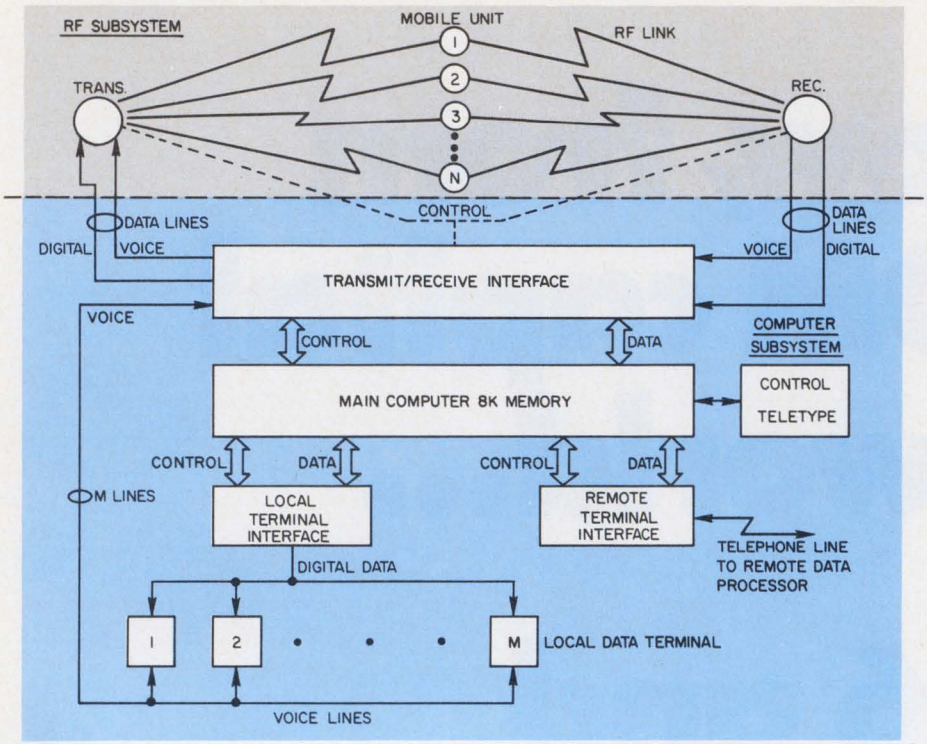

Multimode communication system uses a minicomputer to control the base station transmitter and receiver. Mobile units are automatically polled for status and location.

the installation of vehicle location systems, in-car teletypes and other techniques to reduce voice communications.

To implement these additional systems, it ordinarily would be necessary to use another communication channel, thus necessitating the purchasing of additional tranceivers at about $1000 apiece. For small systems, this may be the best solution Rearick said. However, for larger applications—40 or more mobile units—a minicomputer system that might cost less than $20,000 to implement would be a much more practical approach, he contended (see figure).

The minicomputer, he explained, could improve the response of the system by using the "dead" time, which normally is present in voice systems, to interleave digital data that is automatically sent to and from vehicles to determine their status and location. According to Rearick, the status of 40 mobile units could be determined in 120 ms, while their location could be resolved to within 500 feet.

The proposed system would use existing communication equipment, with only minor changes in circuitry required. These changes would include a modification on the receiver to disable the transmitter whenever the frequency was in use and to permit the mobile unit to respond only when the unit's digital identifier code was received. This would give the base station the ability to choose one or more mobile units.

With the minicomputer, voice transmission could be limited to "mission-oriented" information only, Rearick said, and even then only to selective mobile units.

Hospitals turning to minis

On the medical front, minicomputers are gaining a strong foothold in hospital systems, the Nerem session heard. Since hospital applications are easily grouped by function, dedicated minicomputer systems have been developed as a counter-trend to integrated systems, which require large-scale computers, Cody Webb of Arthur D. Little Co., Boston, told the conferees.

Webb grouped the mini's hospital functions into five categories:

1. Automated clinical laboratory.
2. Communications and admissions.
3. Scheduling and inventory.
4. Multiphasic testing.
5. Computer-aided diagnosis.

Because minis are relatively inexpensive, he said, it is feasible for each of these functions to have its own computer. In addition the use of minis eliminates the problems inherent in large computer installations, such as access time and down time of the entire system because of failure in a small part. Minis allow each department of the hospital to retain its autonomy, Webb said. ■■

A substitute proposed for vacuum deposition

For over a hundred years, manufacturers of glass and ceramic tableware have been using organic solutions of gold to apply decorative coatings to their products. Since the manufacture of modern microwave integrated circuits is largely concerned with the same activity—depositing thin films of precious metal onto a ceramic substrate—why don't microwave engineers study this almost-ancient technology?

The question is raised by Ralph T. Hopper of the Hanovia Liquid Gold Div. of Engelhard Industries, Inc., East Newark, N.J. He told ELECTRONIC DESIGN in an interview that metallo-organic compounds offer three big advantages over the commonly used vacuum-deposition approach: They're cheaper; they provide films with much better adhesion, and they're much more versatile.

One problem with such vacuum-deposition techniques as evapora-

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The new military standard for 1.5 watt power zeners is Unitrode's double pin bonded design.

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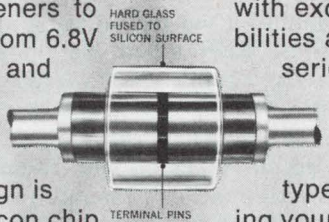

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tion and sputtering, Hopper notes, is that they coat not only the object being treated but the inside of the entire vacuum chamber as well. This leaves you with the choice of wasting gold or going through the expense of recovering it.

Because the films in question are extremely thin (typically on the order of hundreds or thousands of angstroms) the waste of gold is probably of less economic significance than the cost of the capital equipment used in vacuum deposition.

When someone talks about setting up a vacuum-deposition facility, he is usually talking about spending more than $100,000. By contrast, a four-ounce bottle of formulated metallo-organic solution containing about 25% gold costs about $16 and need only be fired in air at about 800 C to produce a high-quality coating on a ceramic substrate. A production conveyor furnace costs approximately $5000 more.

Briefly, a formulated metallo-organic compound is a mixture of metallo-organic resinates with small amounts of fluxes and other additives. The resinates are formed by the reaction of noble-metal salts with organic acids or mercaptan and dissolution of the resulting compound in organic solvents, such as toluene.

These formulated compounds can be made in varying concentrations and typically have the appearance and consistency of varnish. When the compounds are applied to a glass or ceramic surface and fired slowly in air, all of the organic components are volatilized or burned away, leaving behind a metal film.

Because the formulated compounds contain special fluxes and other additives, they produce brilliant, conductive metallic films with excellent adhesion to the substrate, Hopper says. And since they are thermally deposited, the films are heat-stable and will not delaminate under the thermal stresses of, say, soldering operations—a major problem with vapor-deposited films.

Perhaps the most outstanding feature of these metallo-organic preparations, Hopper points out, is that they can be applied by any of the methods commonly employed in the graphic-arts and surface-coatings industries. No special equipment is needed. Brushing, dipping, spin-coating, spraying, roller-coating and decalcomania transfer are standard methods that can be used.

Spin-coating is particularly attractive in the electronics field, since it is already widely used as a method for applying photoresist solutions in the photolithographic manufacturing of integrated circuits. Thus the same spin-coating equipment that applies the photoresist could be used to apply the metal coating, if this method of manufacture is used.

One interesting possibility mentioned by Hopper is the development of photosensitive metallo-organic compounds. This is not feasible when the more common thick-film deposition methods are used, since they employ inks or pastes that are essentially suspensions of finely powdered metal. The metal particles would scatter the light used to expose the photosensitive material, and would make high-resolution etching impossible.

The metallo-organic preparations, are true solutions and present no such problems. ■■

Slotted coax breaks an rf barrier

A new slotted coaxial cable known as Radiax provides two-way "wireless" communication in buildings, tunnels, subways and other problem areas where propagation characteristics are severely limited.

Designed by the Andrew Corp. for Motorola, the cable can radiate and receive rf signals. The slots in the cable shield allow the cable to function as a continuous antenna, permitting a controlled portion of the transmitted rf signal to radiate along the entire length of the cable. Conversely, a signal transmitted near it will couple into these slots and be carried along the cable.

According to J. S. Brown, director of cable and rf component engineering at the Andrew Corp., the cable opens up possibilities for the manufacturers of pocket paging systems. With Radiax, low-power transmitters of approximately 1 W could be added to pocket paging units to provide a talk-back capability. In addition, if Radiax is connected to a roof-mounted antenna, the pocket pager would also be able to communicate with mobile or other distant units.

Contrary to twin lead, which is commonly used in radiating applications, Radiax can be installed directly against any surface, including grounded surfaces, with conventional hardware and only a negligible effect on both radiation and attenuation. Insulators and standoffs are not required, and accumulated dirt, oil, and moisture have no appreciable effect on attenuation, the manufacturer says, as they do with twin lead. The reason for this is that while twin lead is a balanced line whose attenuation increases enormously with the slightest imbalance, Radiax is designed as an unbalanced line and exhibits the qualities of a poor coaxial conductor.

In recent evaluation tests of Radiax in the Lincoln Tunnel at New York City, Art Schneider, staff services engineer of the Port of New York Authority said that it performed very well and that, pending final evaluation, it might be installed in the PATH subway tubes and the underground sections of the World Trade Center in lower Manhattan. Comparing the costs of twin lead and Radiax, Schneider said that the installed costs of Radiax were at least half those of twin lead.

Radiax is presently available in commercial quantities. It is designed for use in the 30, 150, and 450-MHz bands. ■■

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'Instant' holograms produced with a new thin-film material

A new, optically sensitive thin-film material—arsenic trisulfide—can produce holographic images in 10 seconds or so without any film processing.

In contrast with the conventional method of exposing special film and then developing it, the vacuum-deposited arsenic trisulfide film produces holograms directly when exposed to the green beam of a 15-mW argon laser. The images are read out with the red beam of a helium-neon laser. The arsenic trisulfide film is insensitive to the radiation at this wavelength.

The technique was discovered by RCA Laboratories in Princeton, N.J., during research aimed at providing high-speed, large-capacity optical memories for data processing.

In operation, the arsenic film is exposed to the green beam, and while the holographer watches, the image develops. He then turns the beam off when the image reaches the desired intensity. At this point the image is ready for use.

Initial tests have indicated that the hologram is permanent, provided it is not further exposed to read out beams of green or blue laser light.

The new technique was developed by Scott A. Keneman, a member of the RCA staff, under the direction of Dr. Jan A. Rajchman, vice president of information sciences. It uses standard evaporation methods for depositing the film. Consequently it is potentially a low-cost method for rapid holography.

When the new film is exposed in a standard holographic setup, the optical pattern created by the interference of the object and reference beams causes the atomic absorption edge of the arsenic trisulfide to shift. This, in turn, changes the index of refraction of the material. The intensity of the change is proportional to the exposure.

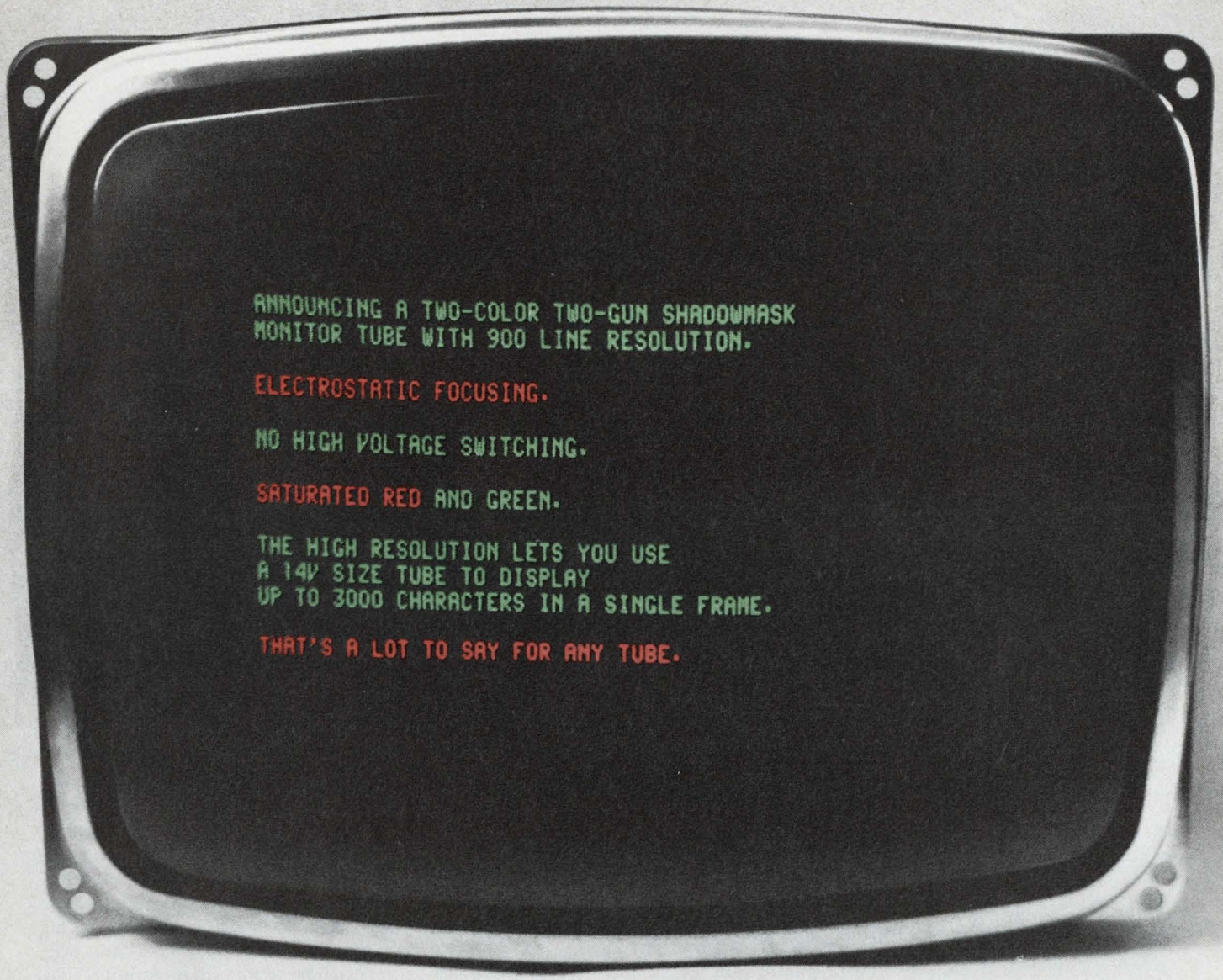
The holographic interference pattern is therefore recorded in variations of the refractive index of the material. Consequently the hologram can be read out with the red beam. There is, however, some image distortion with the red illumination, says Robert Lohman, head of information sciences and systems at RCA.

Diffraction efficiencies of several per cent—more than adequate to produce an excellent hologram—can be produced by exposing the arsenic film to the beam of a 15-mW argon laser for 10 seconds. Scattering of the readout beam is exceptionally low in the arsenic trisulfide. As a result, resolution in the hologram is unusually high.

Holograms with a resolution of 2860 lines per millimeter have been recorded in a 2-μm film, with no signs of approaching the resolution limits of the arsenic trisulfide, Keneman says. ■■

Jim McDermott
East Coast Editor

Almost simultaneous exposure and readout of holographic images occurs with a technique that does not require chemical development. Here, Scott A. Keneman of RCA watches the image of a letter as it is projected from an asenic trisulfide thin film that is exposed to an argon laser.



Sylvania Electronic Components, Seneca Falls, N.Y. 13148

GTE SYLVANIA

Powerful laser communicator put in 3-lb binocular package

A laser communications system has been put into a binocular-like package that weighs only three pounds, to make one of the most powerful, lightweight, compact laser communicators built (also see "Laser Rangefinder Built in Binocular Form," ED 23, Nov. 11, 1971, p. 23).

Powered by one 500-mA-hour, 6-V nickel cadmium rechargeable battery, the transceiver uses a gallium-arsenide semiconductor laser. The wavelength of the laser output is 0.9163 μ, and the peak power output is 10 W. Each light pulse has a time duration of 100 ns.

Developed by the Santa Barbara Research Center, a subsidiary of the Hughes Aircraft Co. in Santa Barbara, Calif., the transceiver has a range up to four miles in clear weather (visibility of 10 miles or greater). The range is cut by haze and precipitation.

Norman Rigby, product manager for infrared special systems at the Santa Barbara Research Center, notes that signal transmission is accomplished by pulsing the laser and frequency-modulating the pulse repetition rate with the voice signal inputs.

Rigby points out: "A p-i-n silicon photodetector is used to receive the transmitted light pulses through a 2.5-inch receiver aperture. The infrared energy received is then processed, using current-mode preamplification to enhance the signal to noise ratio. The pulses are then amplified and the repetition rate demodulated to convert the received pulses into audio or data signals."

The transmitter current consumption is approximately 100 mA during transmission, and receiver consumption is less than 3 mA.

Rigby's group has made these transceivers with both two and three-degree beam divergences. He says that because of its wide-angle transmitter beam design, the communicator can be used under any conditions that allow the use of binoculars.

Under normal operation, the two people communicating would first view each other through the alignment telescopes contained within one ocular of the binocular. After alignment, communication is merely a question of pushing a button and talking into a microphone. Listening is done through a small earphone set that plugs into the binocular. ■■

David N. Kaye
West Coast Editor

Laser communicator, weighing three pounds and looking like a pair of binoculars, contains a gallium arsenide infrared laser and has a range of up to four miles in good visibility.

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MOS technology today includes varied approaches to structure and processing techniques. Some are converted to high volume production capabilities, others are in advanced development and offer great promise for improved performance and early implementation, and still others are experimental. All must be evaluated carefully for potential advantages.

P-Channel MOS Is Readily Produced

P-channel MOS isn't the most advanced, the fastest, the lowest power, nor the most versatile approach, but it is familiar and at several companies is in high-volume production. Hence, it is the prevalent MOS form for both standard and custom circuits. Achievable speeds are, conservatively, about 2 MHz — reconcilable with the requirements of many data-processing applications. Power dissipation, down to 0.5 mW/gate, presently is about the same as the lowest-power bipolar line, higher than other MOS forms, yet low enough for some really large-scale integration. The MCM1131L 2240-bit character generator, for example, has a maximum power dissipation of only 400 mW.

Representative PMOS circuits available now are MSI/LSI parts, with simple gates and flip-flops conspicuously absent. Why? Typical PMOS technology loses its price advantage as circuit complexity is reduced, giving way to the widely available, broad-line bipolar families. Since MOS generally is more appropriate for MSI/LSI, the more creative complex designs are usually in custom programs. Established PMOS process variations permit custom tailoring of circuits, even to the point of making them functionally compatible with bipolar logic. The two digital forms can be used together without extensive interface circuitry.

Two High Threshold PMOS Power Levels

Two power levels, medium ($P_D = < 1.7$ mW/gate) and low ($P_D = < 0.45$ mW/gate), are available with high threshold (V_T) PMOS. A 20% saving in active on-chip cell area is also achieved in the low power line, but the tradeoff is speed. It is some four times slower, at 300 ns typical propogation delay per logic level, than the medium power line. Nevertheless, where performance is adequate, this represents the quickest, least expensive, and least troublesome technology. High threshold logic offers the designer the advantage of high noise immunity, with turn-on voltages on the order of 3.5 volts making it relatively secure from noise spikes and spurious signals.

Low Threshold PMOS Has Advantages

Low-voltage MOS is faster and more economical in the system because of the lower power-supply voltage. It is compatible with the most popular bipolar logic forms such as TTL and DTL whereas the outputs of bipolar types are simply too low to turn on the high voltage PMOS devices. Of the methods used to lower the threshold, the <100> crystal orientation achieves good reduction of the threshold voltage and power supply requirements, but speed and packing density are not improved.

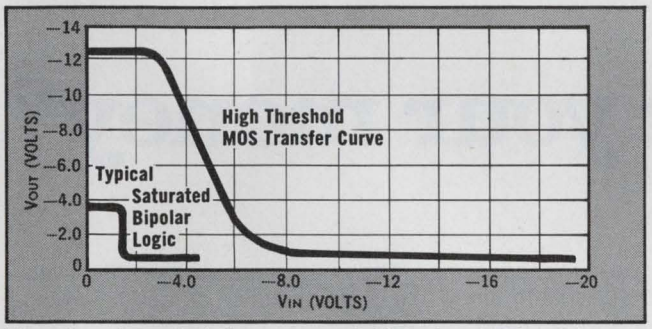
Another method, the Silicon Gate process, is preferred at Motorola. Not only is the threshold voltage reduced to an extremely low level, but circuit speed is increased, packing density can be increased, and manufacturing efficiency is greater. This technology has matured rapidly, and an impressive number of products is available off-the-shelf.

What About NMOS?

Everyone eagerly awaits the ready availability of NMOS for its speeds, potentially two/three times as fast as conventional high threshold PMOS. The Silicon Gate process is applicable too, and it considerably increases the packing density potential. NMOS yields generally aren't good enough yet to make this eagerly awaited technology available at viable prices.

CMOS — Developing Rapidly

Any MOS circuit exhibits significantly lower power dissipation than bipolar capability permits, but far and away the greatest power miser in sight is complementary MOS circuitry, known as McMOS at Motorola. In fact, with complementary MOS dc power dissipation can be reduced virtually to zero – enviable where battery operation or battery backup is a requirement.



Transfer characteristics curve of high threshold MOS compared with that of typical saturated bipolar logic lines. Clearly, bipolar lines cannot cause turn-on of high threshold logic, while the output of the latter would damage the bipolar devices.

Matching comparable simple examples, a single-channel circuit draws current from the power supply during the entire "on" portion of the input signal. With the CMOS circuit, power dissipation occurs only during input signal transitions. Extreme low power designs are practical when frequency is less important, say for 100 kHz operation. Speeds in excess of 10 MHz also can be designed at the expense of some power dissipation increase due to the higher rate of signal transitions. Generally, the high speed and low power drain make CMOS a significant factor in the future of MOS technology, and by most indicators, a major logic form.

MOS PROCESS	THRESHOLD VOLTAGE	SUPPLY VOLTAGE V_{DD} (V_{GG})	PROP. DELAY (ns/gate)	FREQ. (min.)	POWER DISS. PER GATE	RELATIVE CHIP COMPLEXITY	NOISE MARGIN "1"	NOISE MARGIN "0"
P-CHANNEL MOS								
High Threshold	−3.5 TO −5	−17 TO −27					3	1.5
Medium Power			75 ns	2 MHz	1.7 mW	1		
Low Power			300 ns	500 KHz	0.45 mW	1.2		
Low Threshold <100> Silicon Gate	−1.5 TO −2.5	−12 TO −17					2	0.7
			70 ns	2 MHz	1.0 mW	1		
			60 ns	5 MHz	1.0 mW	1.3		
Ion Implant, Depletion Loads	−1.5 TO −5	−12 TO −27	35 ns	5 MHz	1.5 mW	1.3	1.5	1
N-CHANNEL MOS								
Metal Gate / Silicon Gate	1 TO 2	5 TO 20		10 MHz	1.0 mW	1.3 / 1.6	1	1
COMPLEMENTARY								
Metal Gate	(±)1.5 TO (±)2.5	3 TO 18	40 ns	20 MHz	50 nW	0.3	$V_{DD}/2.2$	
Silicon Gate	±0.5 TO ±2.5	1.2 TO 15	25 ns	25 MHz	50 nW	0.4		
BIPOLAR LINES								
TTL		5.0 V +20% −10%	10 ns	60 MHz	15 mW*	40	1.2	1.2
ECL		5.2 V +20% −10%	<1 ns	400 MHz	25 TO 35 mW	20	0.4	0.4
DTL		5.0 ±10%	30 ns		8 mW	20		
RTL		3 ±10% OR 3.6 ±10%	24 ns		12 mW	10		

*A Special Low-Power Line (54/74L) Has Power Dissipation of ≈ 1 mW/Gate

COMPARISON OF MAJOR CHARACTERISTICS OF MOS PROCESS AND BIPOLAR LOGIC LINES

Numerous manufacturers have announced standard CMOS products, custom capability, or both, and Motorola has invested heavily in this area. Lower cost, because of the basically simpler process, greater circuit density, and lower power dissipation, suggest CMOS will prosper at the expense of TTL. Penetration of the consumer market is anticipated in areas such as watches, clocks, various automotive applications, appliance controls, and even toys. Features such as high noise immunity, operation from an unregulated power supply, microwatt power dissipation, and low noise-generation are expected to make the industrial market another big CMOS user.

Summarizing, Silicon Gate PMOS shapes up as a leading MOS form with CMOS maturing rapidly to take its place as the second dominant approach, essentially extending PMOS capability rather than replacing it. NMOS will be built, but for the near term probably will not be widely available. How to evaluate suppliers? Published specifications probably speak for themselves in respect to standard products. For custom designs, consider carefully the total MOS capabilities of a prospective supplier. Those with many faces are probably the best bet.

This is the second in a series designed to present a realistic, objective analysis of MOS technology in a dynamic, competitive industry. For an examination of this and other aspects of the MOS technology in greater depth than is permitted here, circle the reader service number or write to Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, AZ 85036.

MOTOROLA MOS
Directions in digital designs

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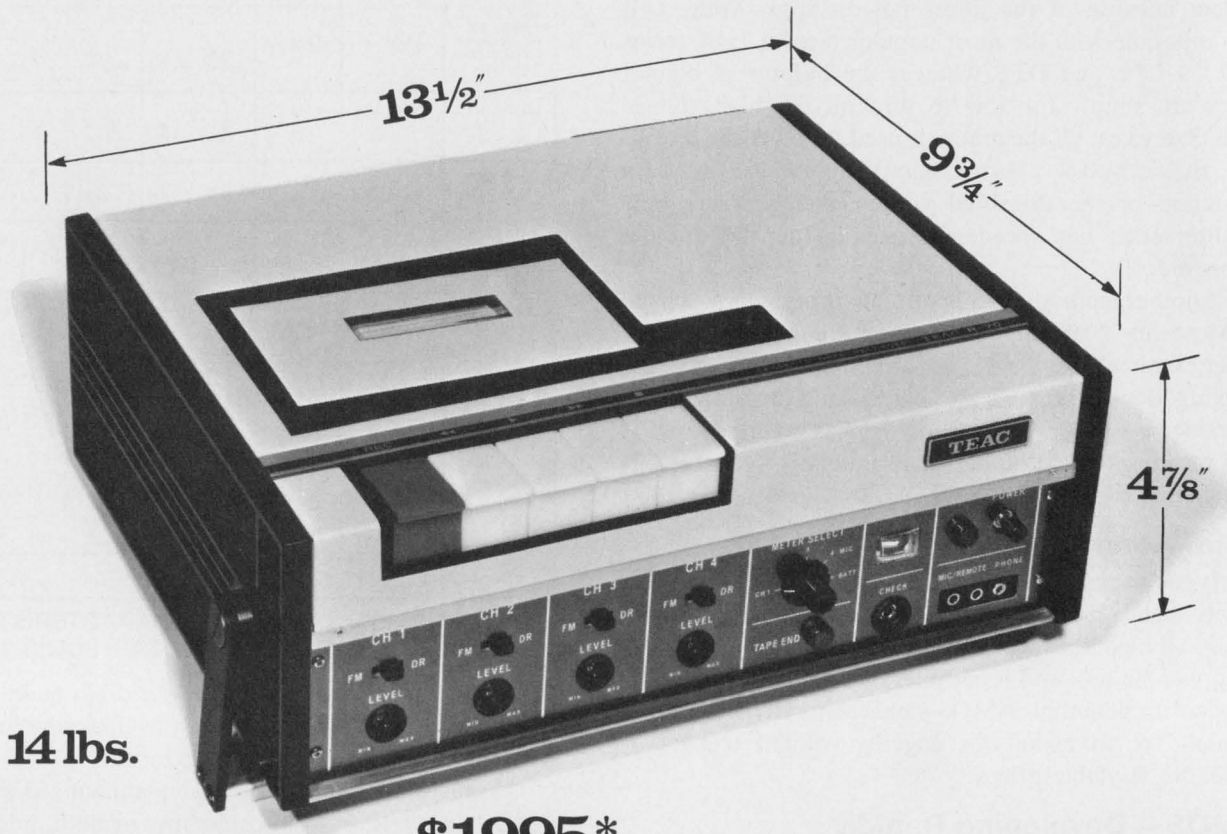

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If you judge superiority by size and worth by weight, the looks of our R-70 cassette data recorder may be deceiving.

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For more of the fine points on this or other data recorders in our line, write or call Ken Williamson, Director of Marketing, Technical Products, TEAC Corporation of America, 7733 Telegraph Rd., Montebello, CA 90640. Telephone (213) 726-0303.

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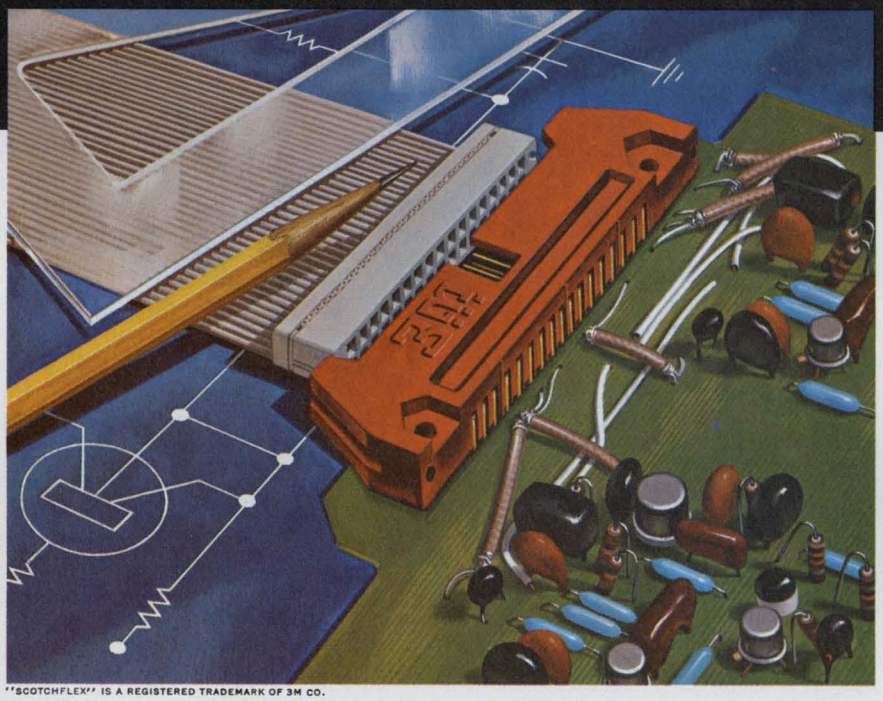
*Price includes these accessories: TEAC CT-60 tape cassette; memo announcement microphone; monitoring earphone; input-output cords; fuses and lamps; AC power cord; DC power cord; check terminal cord; cleaning kit; vinyl cover; adjustment screwdriver; operating manual.

INFORMATION RETRIEVAL NUMBER 19

For built-in reliability, design with "Scotchflex" Flat Cable/Connector Systems.



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There's built-in reliability for your circuit inter-connects. Our flat, flexible PVC Cable has up to 50 precisely spaced conductors. The gold plated U-contacts are set into a plastic body to provide positive alignment. They strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

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For full information on the "Scotchflex" systems approach to circuitry, write to Dept. EAH-1, 3M Center, St. Paul, Minn. 55101.

3M COMPANY

INFORMATION RETRIEVAL NUMBER 20

technology abroad

An electro-optical light-beam deflection system being developed at the Central Research Laboratory of Thomson-CSF of France uses polarization commutation and a dual refractive system. Consisting of six cells assembled in series and successively crossed by a light beam, the prototype system is capable of deflecting the beam into 64 positions. The first application will be in an ultra-rapid optical printer able to feed one million characters per second into a computer optical memory core. The deflection system will also be used in numerically operated photocomposing machines. Another long-term application is in telephone switching.

CIRCLE NO. 440

Hybrid techniques are applied in a new 300-MHz frequency meter produced by Racal Instruments of Windsor, England. Thick-film circuits, designed in-house, provide a latched, eight-digit display with overspill and an automatically positioned decimal point. Resolution is 1 Hz up to 300 MHz with a one-second timing gate. Sensitivity is 10 mV. The internal frequency standard has a stability of better than one part in 10^9 per day.

CIRCLE NO. 441

An alternative to the air bags under investigation by auto safety experts in the United States is a new ultrasonic system being jointly developed in England by Mullard and the Ford Motor Co. The new system consists of seat belt interlocks that prevent the starting of the car until the belt has been fastened in place. When this happens, a fan-shaped ultrasonic beam from a transducer fitted to one of the diagonal shoulder straps strikes an ultrasonic sensor in the roof. In addition a

seat switch makes contact when the driver climbs in. When both the ultrasonic beam and the seat switch are operative, the ignition circuit is completed and the driver can start the car. If a driver unbuckles the belt, audible and visible alarms occur, and the ignition is cut off. Mullard believes that the equipment would add about $25 to the price of seat belts.

CIRCLE NO. 442

An ultrasonically operated remote-control TV channel changer is being produced by Grundig of West Germany. In addition to channel selection, the viewer can adjust the color contrast and the brilliance. A microphone in the TV set picks up signals from this channel change unit, and conventional TTL circuitry then transforms each ultrasonic channel signal. These voltages control a voltage-variable capacitor that is part of the TV tuner circuit. The capacitor automatically selects the correct channel.

CIRCLE NO. 443

An ion laser with a 10-W output is being produced by use of a plasma jet instead of a conventional cathode. Developed by Laser Associates in England, the new laser is formed by striking an arc in the gas that is made to lase. The resulting conductive plasma then forms the cathode in the gas laser system. Other advantages claimed for this type of laser are its ruggedness and its maintainability. The system is open and a rotary vacuum pump maintains the necessary low pressure conditions for the plasma jet.

CIRCLE NO. 444

A simple magnetic switch that can signal the theft of documents or banknotes is being marketed by Siemens of West Germany. The device uses a thin, flat magnet that can be concealed within a bundle of paper. If the bundle is lifted from its normal resting place, a magnetic switch fitted under the drawer or compartment initiates an alarm. The alarm contact can actuate a concealed camera for filming the scene.

CIRCLE NO. 445

GOODBYE SOLID STATE.

Hello better switching alternatives.

Until today, solid state was the only approach to logic or power switching you considered. But there's another way.

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When you need a simple decision-making or interlocking circuit, why bother with a 5-volt supply, filter capacitor, ground plane pc board and logic packs? Clare general purpose relays can accomplish the same function at a fraction of your design time. You don't have to worry about line transients, overvoltages, lead capacitance, ambient temperature, etc.

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Our thirty years of relay experience helped develop a general purpose relay line with all the features we know you want—a simplified design so there are fewer parts to go wrong, a combustion-proof, virtually unbreakable Lexan* cover, the highest UL motor control recognition, and a wide choice of terminals and sockets.

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washington report

Don Byrne
Washington Bureau

Lockheed and Grumman lead defense contractors

The Lockheed Aircraft Corp. and Grumman Aerospace Corp. dominated Defense Dept. contracting in fiscal 1971, a new Pentagon report shows. For the third straight year, Lockheed led the top 100 companies in receiving prime contracts of $10,000 or more. Grumman led the research and development contractors.

Lockheed received $1.50-billion in Government work and was followed by General Dynamics, with $1.49-billion; AT&T, $1.2-billion; Grumman, $1.1-billion, and General Electric, $1.04-billion. In all, the top 100 companies accounted for $21.5-billion in fiscal '71 awards, or 72.1 per cent of the $29.8-billion awarded to U.S. concerns.

In R&D and test and evaluation, Grumman led all companies with $569.1-million in awards. McDonnell Douglas was second with $385.8-million and Lockheed third with $333.7-million, followed by Hughes Aircraft Co., $323.3-million, and Western Electric, $318.8-million.

AT&T extends protection tariff a year as meetings continue

The American Telephone & Telegraph Co., acting on a Federal Communications Commission request, has agreed to put off for one year imposing fees on customer-owned equipment. Meetings between the commission staff, telephone company representatives and other manufacturers and users on what kind of standards should be set for the customer-owned PBXs—private branch exchanges—are continuing meanwhile.

In another PBX development, the FCC has responded to the National Association of Regulatory Utility Commissioners by saying that a federal-state board will indeed be set up to handle questions on customer-owned communications equipment, as suggested by the association.

With contract overruns rising, AIA asks guidelines

Sen. William Proxmire (D-Wis.) says a General Accounting Office survey of 45 major weapons systems shows overruns of $35.2-billion in development costs—more than the overruns in the same programs last year. Last year the overrun figure was $28-billion, he said. Meanwhile the Aerospace Industries Association has asked Congress to set broad guidelines for Government procurement.

The association said that many of the industry's problems were caused by a lack of guidance in procurement. An AIA study noted that "there

are 4000 statutory provisions, scores of executive orders and circulars, hundreds of court decisions, innumerable policies spread through various agencies and thousands of procurement regulations procedures, management systems and reporting requirements" affecting the Government's dealings with private industry. Among the association's recommendations to Congress were some calling for the Government to abide by the same business principles that govern others, to avoid the use of monopolistic leverage to exact unfair contracts and to offer a reasonable profit commensurate with the risks assumed.

Broadcasters and cable TV reach compromise

The boards of directors of the National Association of Broadcasters and the National Cable Television Association have reached a tentative accord on a plan to govern television operations. The plan, which hinges on rules for the importation of distant signals and copyrights, was worked out by Dean Burch, chairman of the Federal Communications Commission, and Clay T. Whitehead, director of the Office of Telecommunications Policy. The major impact will come in the smaller cities in which more channels will be permitted to be piped in via microwave from distant points. Copyright legislation will also be sought. The House Interstate and Foreign Commerce Committee says it is not planning any hearings on CATV at this session of Congress or the next, so presumably the new FCC regulations for expanding the CATV market will go into effect in March, as planned.

Capital Capsules:

The House has rejected an effort to kill the F-14, the Navy fighter being developed by Grumman. The motion came as the House was debating the defense appropriations bill. **Rep. Jonathan Bingham (D-N.Y.) tried to cut the $800-million for the F-14, saying the program was headed for disaster in overruns.** The Appropriations Committee chairman, George Mahon (D-Tex.), argued that removing the $800-million would allow a new contract to be renegotiated, with Grumman adding $1.4-billion to the program. The committee said the Navy would probably have to restructure the program. . . . NASA is seeking bids for proposals to use space-related technology to solve problems in air and water pollution, waste management and clinical medicine. . . . FCC Commissioner Charlotte Reid has been appointed Defense Commissioner of the FCC to replace Robert Wells, who resigned from the commission to run for Governor of Kansas. **She will handle emergency communication matters and represent the FCC on interagency defense matters.** . . .The Postal Service's facsimile mail transmission is now in operation between New York and Washington, and the service says it is aiming for a total delivery time of four hours between the two points. . . . A NASA computer program is being used by the Ford Motor Co. to help design light trucks and cars. **Ford reports a 60% improvement in predicting the behavior of components under stress and a two-thirds reduction in the time needed to arrive at such calculations.** The NASA program—Nastran—is one of several hundred developed for space use and now available to any U.S. company for the "nominal cost of evaluation, processing and distribution." Information is available from NASA's Computer Software Management and Information Center, Barrow Hill, University of Georgia, Athens, Ga. 30601. . . . House action has killed once and for all the Army's Main battle tank program. **The cost of the "economy" version of the elaborate and trouble-plagued XM-803 had soared to almost $1-million per tank.**

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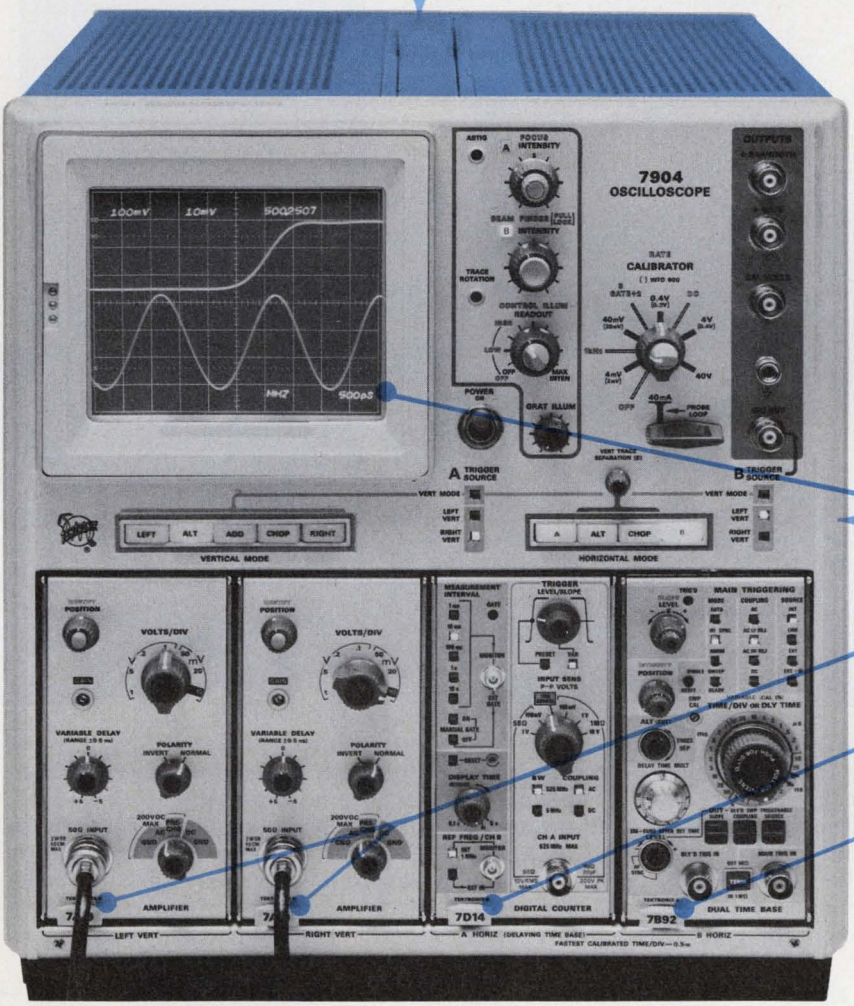

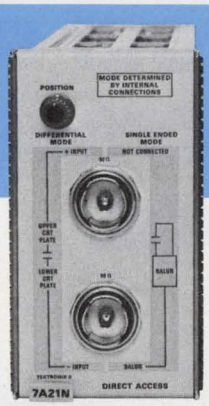

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INFORMATION RETRIEVAL NUMBER 24

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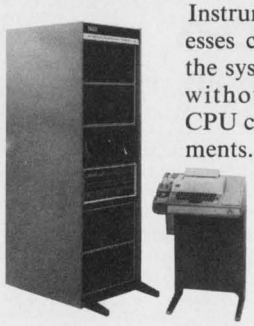

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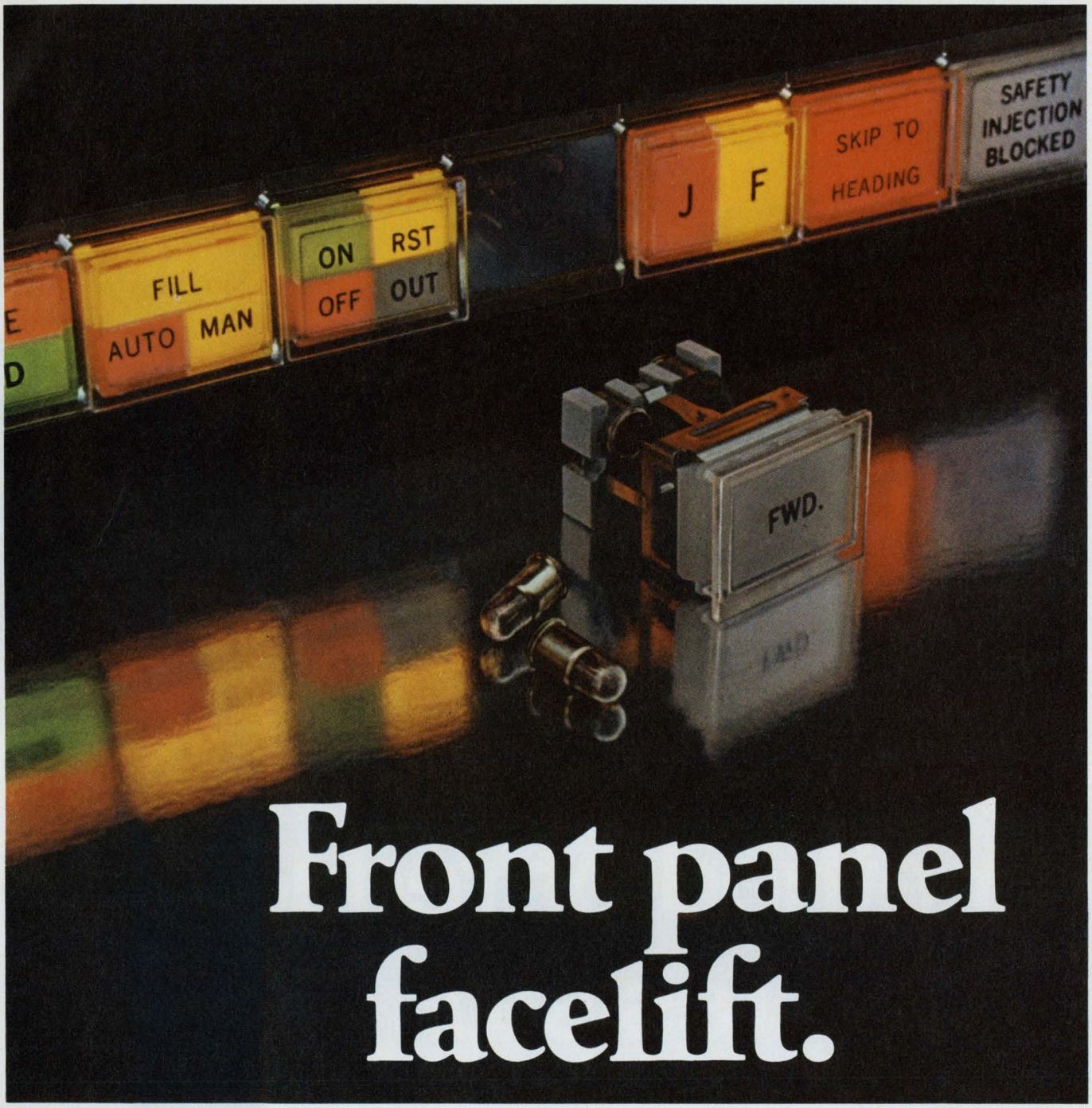

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ALLEN-BRADLEY

A-B QUALITY

editorial

Further confirmation of a changing industry

The "10-year Forecast of Government Markets" presented by the Electronic Industries Association at last month's EIA Fall Conference in Los Angeles (see ED 23, Nov. 11, 1971, p. 28) may have put a final damper on any remaining speculation that the U.S. is about to embark on a new round of defense spending.

A consensus of predictions submitted to the association by 18 electronic companies, ranging from components manufacturers to large aerospace concerns, reveals even more pessimism about long-term defense spending than the 10-year outlook presented by the EIA last year. Total Defense Dept. procurement is expected to hang around the $20-billion level continuing to decline as a percentage of the total federal budget. The budget itself is expected to more than double in the next 15 years—to $450-billion by 1985.

Despite rumors of huge increases in defense spending after the Vietnam war ends, despite claims of a growing Soviet military threat, despite the predictions of some Congressmen, aerospace executives, military "experts" and stock-market speculators, it appears the unlimited spending days of the mid-60s are gone—if not forever, at least for the forseeable future.

The EIA survey confirms what this magazine has believed for some time—namely, that action will be in new markets and in the civionics sector. In fact, Government spending is expected to at least double in the next five years, with hundreds of millions to be spent on automatic train control systems, vehicular traffic control, justice communications and so on. Though still small when compared to total Defense Dept. and NASA figures, the relative growth of these markets *is* phenomenal.

As ELECTRONIC DESIGN has said so often in the past, times are changing, and particularly so in the electronics area. New markets call for new technology, and this will in turn create new opportunities for engineers.

Ralph Dobriner

RALPH DOBRINER
Managing Editor

FOCUS on Industrial chart recorders

Speed. It's probably the most important parameter to consider when you shop for an industrial chart recorder. The appropriate pen-drive mechanism, writing method, paper type and chart speed will all be determined primarily by the frequency of the signal you want to monitor. And these factors, in turn, will determine how much you're going to pay for the recorder and the paper it uses.

Industrial chart recorders differ from laboratory units; they're cheaper and less flexible. Typically they're purchased in large quantities, with each unit earmarked for a specific function. Lab recorders, on the other hand, are usually purchased singly, and they have the front-panel-selectable chart speeds and sensitivity ranges required by general-purpose instruments.

Because of the relative lack of flexibility of the industrial units, it's particularly important to be sure to specify all of the features you'll be needing when you place your order. The machine isn't likely to have any bells and whistles that you don't ask for.

First, decide how to drive the pen

By and large, there are two ways to move the thing that marks the paper: It can be attached to a galvanometer, or it can be driven by a motor that forms part of a potentiometer-feedback positioning system.

Galvanometers are the faster of the two. Writing instruments of this type can usually follow signals as high as 100 to 200 Hz.

In all other respects, however, the potentiometer-feedback approach is better. It allows larger chart widths, better resolution, better accuracy, less drift and lower price. Its speed, however, is limited to signals on the order of 1 to 2 Hz.

The first rule of chart-recorder selection, therefore, is to stick to potentiometer types, unless your speed requirements make a galvanometer necessary. And if a standard galvanometer isn't fast enough, you'll have to go to the subminiature light-beam galvanometer types or even the fiber-optics CRT approach.

The light-beam galvanometer approach uses a tiny galvanometer to which a low-mass mirror is attached. Movements of the mirror are used to deflect a light beam, which then writes on photosensitive chart paper. Because of the low mass of its moving parts, a light-beam galvanometer can usually handle signals as high as 5 kHz; some high-performance units, in fact, boast 3-dB bandwidths of dc to 10 kHz, and even slightly higher.

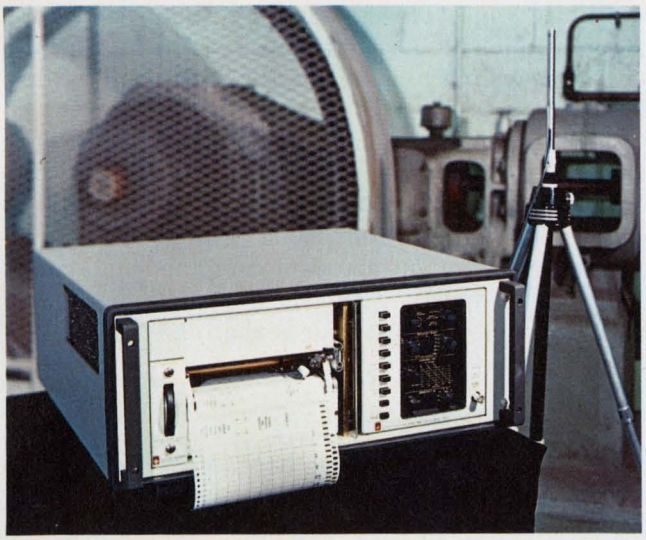
For the ultimate in chart-recorder speed, mechanical schemes must be abandoned completely. One way to do this is to use a cathode-ray tube to generate a moving spot of light, which is transmitted to photosensitive chart paper by a bundle of fiber optics. Honeywell's Visicorder recording oscilloscope uses this approach to achieve a 3-dB bandwidth of 1 MHz. But at $12,500 and 120 pounds, the instrument is much better suited to the laboratory than to industrial applications.

'Sensitivity' is a flexible word

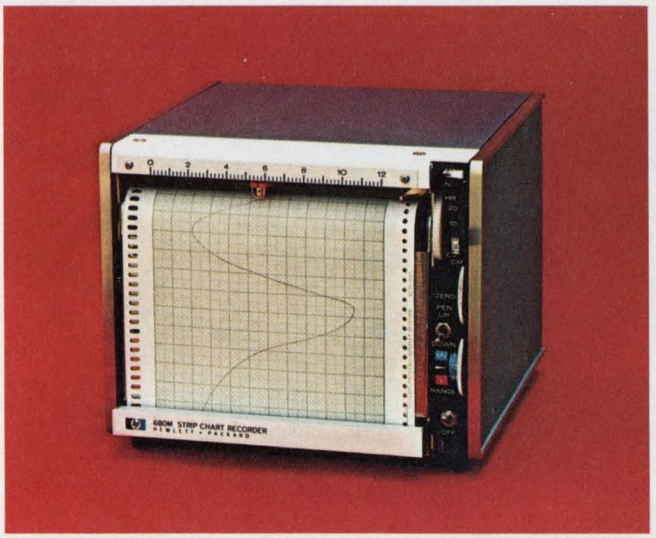
Since most industrial applications will not need the speed of light-beam oscillographs, let's concentrate on the two basic mechanical systems.

An important advantage of potentiometric recorders over galvanometric types is in sensitivity. However, as John Deans, advertising manager of Hewlett-Packard's San Diego division points out, the difference is not immediately obvious from a

Michael J. Riezenman
Technical Editor



General Radio's GR1523 Level Recorder operates fully automatically here, recording a one-third octave analysis of the noise generated by the nearby compressor.



Hewlett Packard's Model 680 potentiometric recorder is available with either capillary-ink or electric writing. Response time is a maximum of 0.5 s full scale.

casual glance at the spec sheets.

"By some old, unknown convention," he explains, "the sensitivity of a galvanometric recorder is specified like a scope: so many volts per division. A potentiometric recorder, by contrast, is specified like a voltmeter: so many volts full-scale. You could have one of each type recorder with '1-mV sensitivity,' but a 1-mV signal would move the pen 25 cm on a potentiometric unit but only 0.1 cm on the other."

Another area in which specifications are not handled in the same way for both types of recorders is speed. Potentiometric recorders are so slow that their speed is usually described in response time rather than bandwidth.

This response time is the time required for the pen to traverse the full width of the chart when a full-scale step input is applied. It is customary for the response-time spec to include settling time, but it never hurts to check.

One thing to watch when you compare response-time specs is the width of the chart. For example, HP specifies a response time of less than 1/3 s for its model 7123A/B and less than 1/4 s for its 7143A/B. The latter unit isn't really faster than the former; it merely has a five-inch chart width instead of a 10-inch width.

Some companies avoid this problem by specifying a slew rate instead of a response time. Thus Precision Standards Corp. characterizes its Series GP702 recorders as having a slew rate of 20 inches/s, which corresponds to a response time of 1/4 s for a five-inch chart.

Watch those bandwidth specs

Someone once said that a broadband isn't an all-girl orchestra. Sometimes it also isn't a frequency-response spec that looked pretty broad at first. And this is not a minor consideration.

For example, one manufacturer's spec sheet states that the galvanometric recorder in question has "response to 100 Hz." Further down the sheet it says "Frequency Response: ±1/2 dB dc to 80 Hz. -3 dB to 100 Hz. 10 Hz reference."

The proper interpretation of this spec isn't obvious, but it can mean that the response at 100 Hz is 3 dB below the response at 10 Hz, while the dc response is 3 dB above 10 Hz. Thus, over-all, the output at 100 Hz may be 6 dB below dc, without the numeral 6 appearing on the spec sheet.

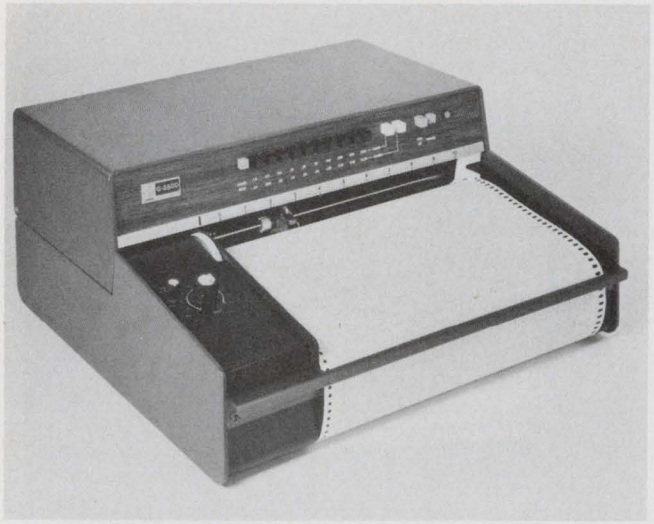
Another way you can go astray in interpreting frequency-response specs, according to C. H. Vaughan of General Scanning, Inc., Watertown, Mass., is to assume that the advertised frequency response of a recorder is for a large signal. It usually isn't.

The effect of this consideration can be profound. One particular recorder with a maximum output of 50 divisions peak-to-peak is 3 dB down at 80 Hz. However, if the dc signal is limited to 10 divisions, the 3-dB point moves out to 150 Hz.

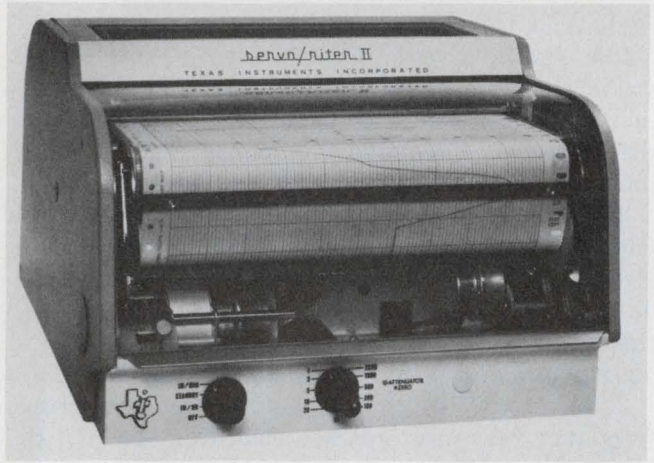
Rectilinear doesn't mean linear

Galvanometer recorders all have at least one problem in common: The normal movement of their pointers is along a curve—not in a straight line. A common way to deal with this problem is to use chart paper with curved-grid construction, in which the radius of curvature of the grid lines is the same as the effective radius of the pointer.

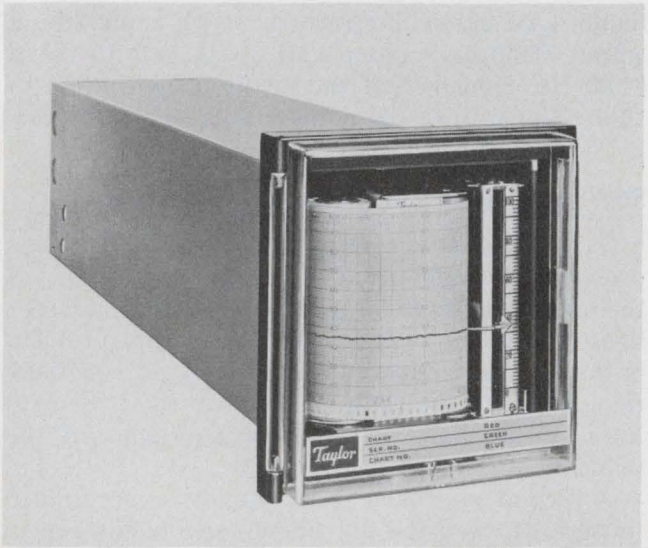
A second approach is to employ a mechanical linkage between the galvanometer and the pen to translate the curved swing into a linear motion. Sometimes—in the case of thermal writing systems, for example—the stylus-paper contact is



Varian's series G-2500 recorders feature 0.5-s pen response across a 10-inch usable chart width. The series has an accuracy rating of ±0.25%.



Texas Instruments' Servo Riter II series of potentiometric recorders feature an accuracy of ±0.25% of full scale or ±5 μV, whichever is greater.



Taylor's 800 J transistorized servo recorder operates at a standard chart speed of 1 inch/hour; other speeds are available as options.

at a knife edge. This guarantees that the chart presentation will be perfectly rectilinear, but it does not say anything about the linearity of the presentation.

Generally speaking, to get really good linearity from a galvanometer movement, you've got to use the same trick that's used with potentiometric recorders—position feedback. Using this approach, several manufacturers combine small contactless transducers with mechanical linkages to reduce linearity errors to less than 0.5%.

Drawing the line

It's hard to believe the many ways man has devised for drawing lines on paper, until you examine the writing methods used in various chart recorders. The methods include capillary ink, felt-tipped pen, pressurized ink, heated stylus, pressure-sensitive paper and electrosensitive paper. Which should you choose?

The answer, of course, is pick the cheapest one, unless there's a good reason for doing otherwise.

Your first choice, therefore, may be capillary ink. This system consists of a metal pen tip connected to an ink reservoir by a piece of tubing. Ink is fed to the pen tip, on demand, by capillary action. As the paper moves relative to the pen tip, it pulls ink from it at a rate determined by the viscosity of the ink, the size of the orifice in the pen tip and the speed of the relative motion between the pen tip and the paper.

In addition to being simple and inexpensive, capillary ink has three other advantages: It works very well on cheap, ordinary chart paper; it produces a thin dark line that is easily reproduced by conventional copiers, and it works well over a fairly wide range of speeds.

The disadvantages of capillary ink become obvious when you go to high-speed writing. To prevent skipping at high writing rates, it's necessary to use a low-viscosity ink and a large-diameter pen tip. This combination is an open invitation to flooding if you attempt to use the pen at low speeds or, heaven help you, if you let the pen rest on one spot on the paper.

Furthermore, at high speeds, it's usually necessary to use a fast-drying ink, so the chart will not smudge when the user is ready to handle it. These inks, unfortunately, can dry almost as quickly in the pen tip as on the paper. In some cases if the pen is left inoperative for only a few minutes, it can get clogged enough to become inoperative until it is cleaned.

Felt-tipped pens provide many parallel passages for the ink, and thus they are less susceptible to clogging than capillary pens. They are also able to write without skipping at reasonably high speeds. Their big disadvantage is that they

tend to bleed on the paper at low speeds and will deposit a pool of ink if left standing in one spot.

As fiber tips wear, they tend to make broader lines and thus lose resolution. Worn-out pens, it should be noted, can be cheaply and easily replaced. And they make good reproducible records on low-cost paper.

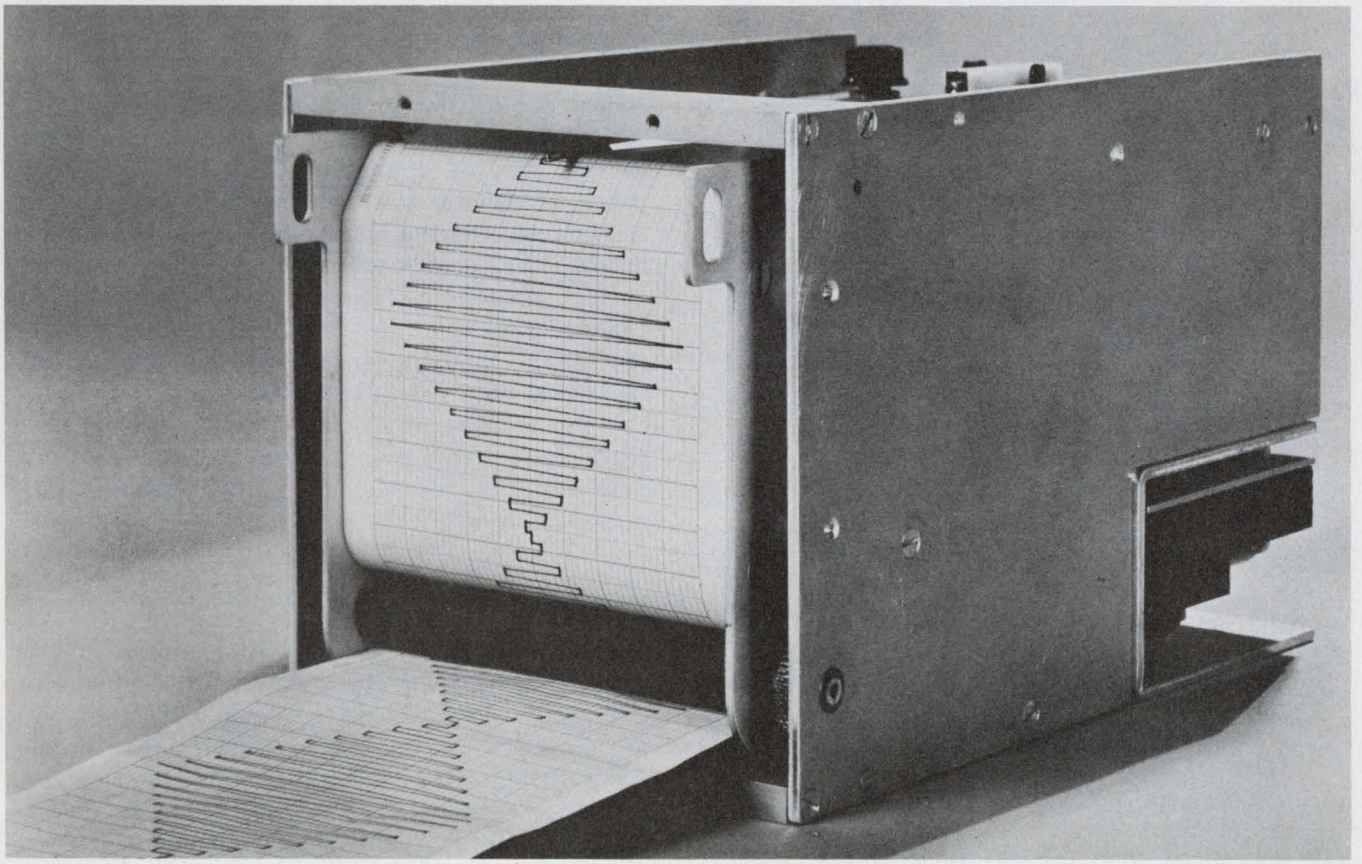
Putting on the pressure

For really high-speed ink writing, pressurized-ink is the way to go. A pressurized-ink system is a completely enclosed miniature hydraulic system, containing a pump and a pressure-control system that modulates the pressure on the ink as the pen speed varies. Because the pressure is always optimized for the particular chart speed and pen speed in use, this method of writing produces very uniform lines over a wide range of speeds.

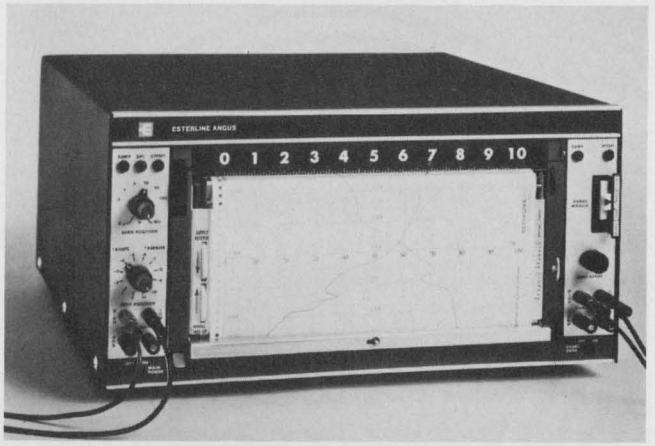
The main disadvantage of the pressurized-ink approach is economic—it costs more than the capillary-ink and felt-tipped-pen approaches, and it uses a more expensive type of chart paper. The paper must have a special coating on it that lets the pen make a liquid seal with the paper. The coating must also promote rapid drying of the ink once it is deposited.

An unusual type of pressurized-ink system—one that does away with the pen—is used in the Siemens Oscillomink liquid-jet recorder. This recorder, with a 3-dB bandwidth of 1000 Hz, has a writing speed of 150 ft/s—claimed by Siemens to be the fastest ink writing system ever developed.

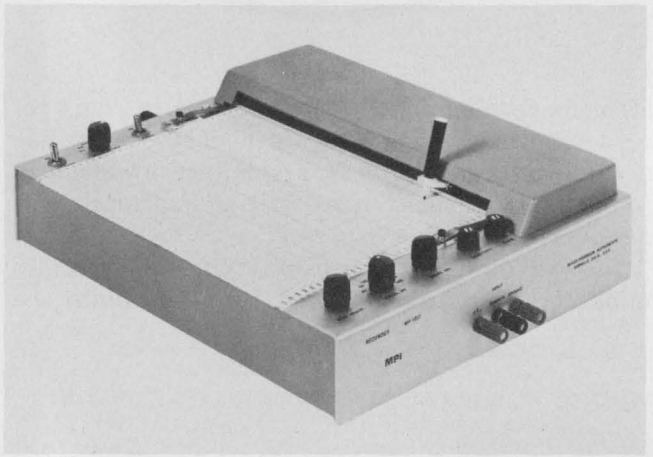
Instead of using a pen or stylus, the Oscillomink recorder directs a fine jet of ink onto the



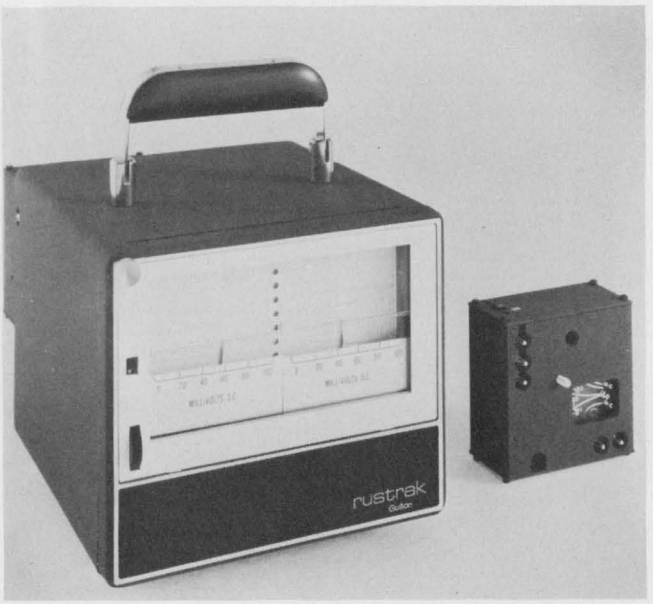
General Scanning's GR-1701 is claimed to be the fastest 100-mm strip chart recorder on the market. The unit has a 3-dB full-scale response of 20 Hz and uses a heated stylus recording.



The latest from Esterline Angus is the Speed Servo II series of 10-inch recorders, featuring response time below 0.3 s and over 240 different models.



McKee-Pedersen Instruments' Model MP-1027 come in two standard models: a 1 to 100-mV model and a 10 to 1000-mV version. Both have eight ranges.



Rustrak's Model 3400 new miniature two-channel potentiometric recorder utilizes a pressure-sensitive strip chart. Chart width is 2-5/16 inches per channel.

chart paper. Among its other advantages, this permits high-speed ink recording of overlapping traces.

Writing without ink

If the thought of ink-stained fingers and clothes makes you shy away from an ink-writing system, you may want to consider one of the many dry-writing systems available. In general, these schemes use rather costly special papers on which a special stylus can make a mark by applying either heat, pressure or electricity.

The traces produced by these methods usually lack the contrast of a good ink record, and the chart papers are often easily marked in casual handling.

Two of the most common dry-writing systems in use today are the pressure-sensitive and heat-sensitive types. Both use chart paper that is made by coating a black paper base with tiny spherical wax beads. This gives the paper surface a white appearance.

In the pressure-sensitive approach, a stylus is pressed against the paper, causing the wax beads to flow and become transparent thereby exposing the black base.

Heat-sensitive papers are almost identical in construction, but they use a harder wax with a low melting point. With the thermal approach to writing, a heated stylus is employed. It melts the wax, causing it to flow, and thus produces a mark in the same way that a pressure stylus does.

Pressure-sensitive writing systems find their widest application in low-speed recording situations, where unattended operation is important. In this type of application the consumption of paper is usually low, so the materials cost is reasonable. And the high reliability of the method makes it preferable to a capillary-ink approach.

Heat-sensitive papers are not immune to mechanical pressure, but they are less likely to be marked accidentally in normal handling. Since the stylus does not have to press heavily against the paper, thermal-writing systems can be used with high-speed galvanometers to produce clean, high-contrast records of high-frequency phenomena.

How about electric writing?

Probably the oldest and most common type of electric writing involves the use of carbon-impregnated electrosensitive paper. These papers are marked by a high-voltage stylus that breaks down a light-colored coating material, thus uncovering the carbon-filled base material.

During the marking process, carbon is blown from the coating, leaving a residue on the paper and in the machine. RFI is also an important

problem; the machine can interfere with nearby equipment if the recorder is not properly shielded. In addition carbon-impregnated papers are susceptible to accidental marking in normal handling.

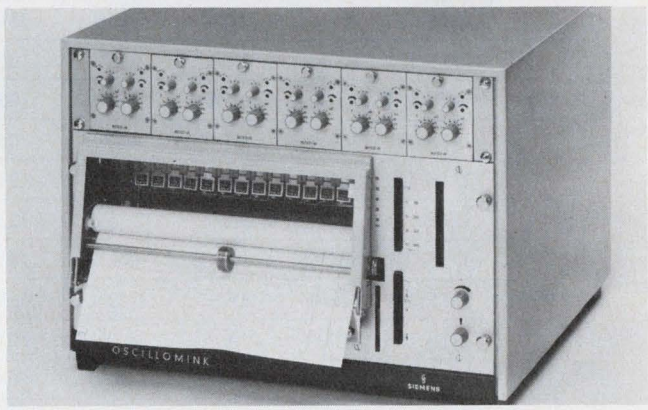
An improved form of electrosensitive paper is Hewlett-Packard's zinc oxide chart material. This low-voltage writing method is based on the reduction of zinc oxide to free zinc. The paper is covered with a thin sheet of aluminum foil, which is coated with conductive zinc oxide dispersed in an organic binder. Passing a current through the coating reduces the oxide, thereby leaving a mark.

Records made on this type of paper do not have quite as much contrast as a good ink record, but they are rugged and reliable, and the paper cannot be marked by heat, pressure, light or moisture.

Take care of your chart paper

Some accuracy specs aren't worth the chart paper they're printed on. And this isn't because the recorder manufacturer is trying to fool you, but because all chart papers expand and contract with changes in temperature and humidity. The papers are manufactured and tested under controlled conditions that will probably never be duplicated in the paper's future history. This is far from a trivial consideration. In fact, a spokesman for the Brush Instruments Div. of the Clevite Corp., Cleveland, estimates that temperature and humidity effects can introduce recording errors up to 2% because of their effect on the chart paper. This is pretty impressive in a 0.01% machine. ■■

Industrial chart recorders



Siemens' Oscillomink liquid-jet recorder has a 3-dB bandwidth of 1000 Hz and a writing speed of 150 ft/s. This pressurized system is claimed to be the fastest ink-writing system ever developed.

Need more information?

Products cited in this report have, of necessity, received only cursory coverage. They've been selected for outstanding or unique qualities, though other specifications, not discussed, may limit or enhance their value in specific applications. Readers may wish to consult the manufacturers, listed here, for further details.

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Fischer and Porter Co., Warminster, Pa. 18974. (215) 675-6000. (Joseph H. Mayer, Sales Promotion Editor).

General Radio, 300 Baker Ave., Concord, Mass. 01742. (617) 369-4400. (E. G. Rahaim, Sales Promotion).

General Scanning, Inc., 80 Coolidge Hill Road, Watertown, Mass. 02172. (C. H. Vaughan).

Hewlett-Packard Co., San Diego Div., 16399 W. Bernardo Drive, San Diego, Calif. 92127. (714) 487-4100. (John Deans, Advertising Manager).

Honeywell, Inc., Industrial Div., 1100 Virginia Drive, Fort Washington, Pa. 19034. (215) 643-1300. (William W. O'Hara, Instrument Editor).

McKee-Pedersen Instruments, P.O. Box 322, Danville, Calif. 94526. (415) 937-3630. (Richard G. McKee).

Precision Standards Corp., 1701 Reynolds, Santa Ana, Calif. 92705. (714) 546-0431. (E. Zimmer).

Rust Corporation, 168 Tremont St., Everett, Mass. 02149. (617) 389-3380. (Sal Fulchino, President).

Rustrak Instrument Div., Gulton Industries, Inc., Municipal Airport, Manchester, N.H. 03103. (603) 623-3591.

Siemens Corp., Measuring Instruments Div., 186 Wood Avenue South, Iselin, N.J. 08830. (201) 494-1000 (Martin Bauer).

Taylor Instrument Process Control Div., Sybron Corp., 95 Ames St., Rochester, N.Y. 14601. (716) 235-5000. (Robert M. Waples, Advertising Dept).

Texas Instruments, Inc., Digital Systems Div., P.O. Box 1444, Houston, Tex. 77001. (713) 494-5115. (Charles D. Newman, Recorder Marketing Manager).

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DTS 804	1400V	5A	800V	100W	
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2N2583	500V	10A	325V	150W	
2N3079	200V	10A	200V		
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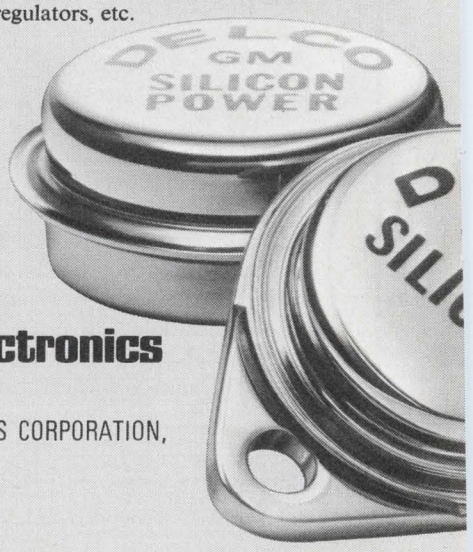

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Start logic designs with flow diagrams.

A properly drawn diagram helps you eliminate repetition, simplifies implementation and corrects malfunctions.

The design of logic systems can be torturous if the designer approaches the job circuit by circuit. The possible problems include circuit redundancy, overly complex logic and complicated debugging procedure. But all of these obstacles can be avoided if a complete logic flow diagram is used.

The diagram—a block-form representation of AND and OR circuits—is the blueprint from which the logic drawing is made. In the diagram, all passive circuits are left out.

The components omitted include inverters, driver blocks, counters and triggers. Although this is a tremendous simplification, every function of the machine is described graphically and specifically as to time, condition and execution. And that's all the information needed to draw control logic.

A flow diagram is developed from design specs. Let's see how.

Assume the specifications for a simple counter function are that the counter have these properties:

1. Is stepped by an oscillator with a basic frequency of 100 Hz and an output that is a symmetrical square wave.
2. Starts when a manual start switch is activated.
3. Steps from 0 to 5, then resets to a count of 3.
4. Resumes stepping from the count of 3 to a count of 4, then resets to 7.
5. Is then stepped from 7 to 5, backward.
6. Stops and signals that it is ready to start again.

The flow diagram based on these specs is shown in Figs. 1 and 2. In Fig. 1 the start counter sync control—essentially a sequence-oriented flow diagram—is shown. Beginning with a start block at the top, the first decision that is interrogated is the condition of the start switch.

In this application the common requirement for a no-bounce start switch is avoided for design simplicity. Instead, a bounce-suppression latch is specified. If the start switch is inactive, the bounce latch is cleared.

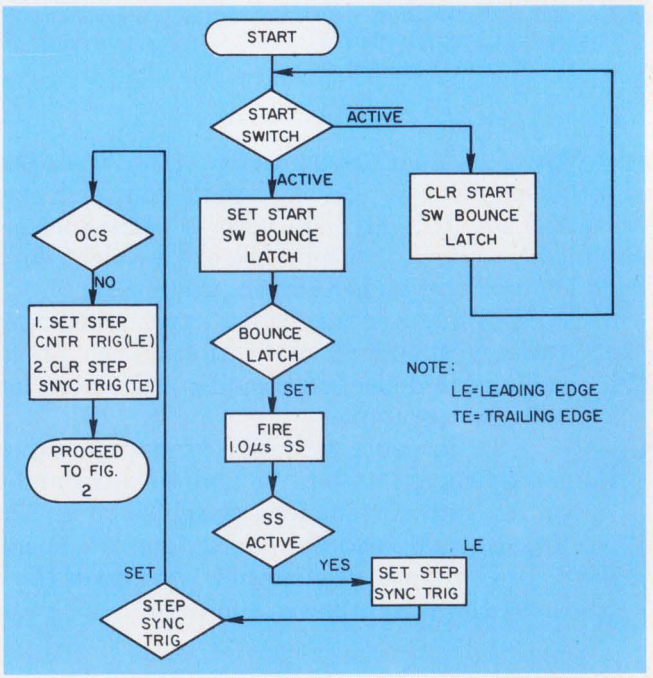
Tony N. Criscimagna, Systems Development Div., International Business Machines Corp., Kingston, N.Y. 12401

As soon as the start switch is activated, the bounce-suppression latch is set and a 1-μs single shot is fired. Then the step-sync latch is set, the negative alternation of the oscillator is specified as NO and the step-counter trigger is set on the leading edge.

Control counter stepping

The flow diagram continues with the step-sequence control in Fig. 2. Let's assume that the logic has been reset before this circuit is started. Now, with the step-counter trigger set, the oscillator on its first positive alternation, the counter not equal to 4 or 5 and sequence 2 trigger clear, the counter is stepped +1 on the pulse trailing edge.

The flow diagram shows a line going down to the left and back up to the top. The step-counter trigger, oscillator and counter are interrogated



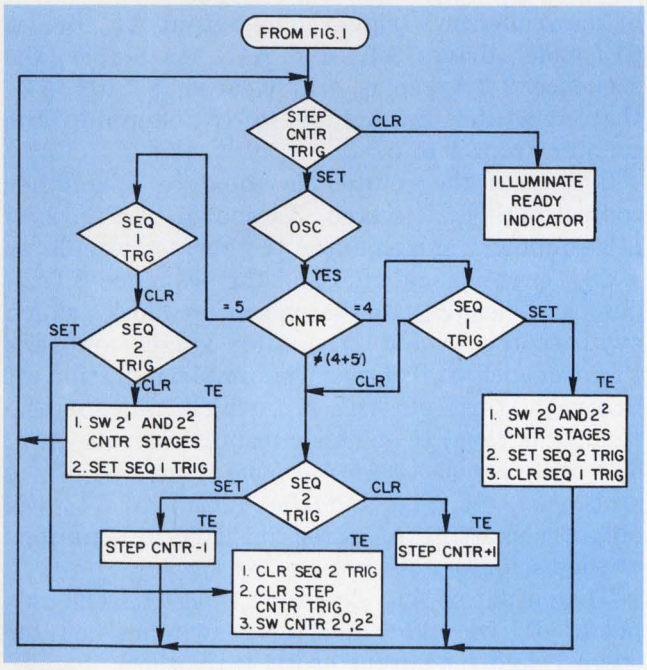
1. **A start-counter sync control, as a flow diagram,** shows all machine functions for this phase of the design, even though the passive circuits are left out. Initial and final blocks specify timing, rhombic blocks indicate conditions and rectangular boxes provide the executions.

again. Since the counter is still not equal to 4 or 5, and the sequence 2 trigger is still cleared, the counter is stepped up again to 2.

Consecutive oscillator pulses continue in this way, stepping the counter until it reaches 4. Now, with the step-counter trigger set, the oscillator on a positive alternation and the counter equal to 4, the sequence 1 trigger is interrogated and found to be clear. This returns the control path to a point where it is ORed with the counter not equal to 4 or 5, and since the sequence 2 trigger is still clear, the counter is stepped to 5. At this value and with the sequence 1 and 2 triggers clear, the 2^1 and 2^2 stages of the counter are switched, or complemented, and the sequence 1 trigger is set. Again, these functions are performed on the trailing edge of the oscillator pulse. Since the counter was at 5, complementing the 2^1 and the 2^2 counter stages switches it to 3, and control is returned to the top of the page.

The counter is stepped to 4 with the next positive alternation of the oscillator, since the counter is equal to 3 and the sequence 2 trigger is still cleared. Again, the control is returned to the top of the flow diagram. With the oscillator YES and the counter equal to 4, the sequence 1 trigger is again interrogated.

This time, however, it is found to be set. On the trailing edge of this pulse, the 2^0 and 2^1 counter stages are switched, or complemented, the sequence 2 trigger is set, and the sequence 1 trigger is cleared. Complementing the 2^0 and the 2^1 counter stages when the counter is equal to 4 switches the counter to 7. Again the control is returned to the top of the flow diagram.



2. **The step-sequence control diagram** provides for stepping a counter. The sequence of events is as follows: the counter steps from 0 to 5, resets to 3, steps to 4 and then resets to 7. It's then stepped backward from 7 to 5, stops and signals it's ready to restart.

In the next sequence of events—with the oscillator YES and the counter equal to 7—the sequence 2 trigger is interrogated and for the first time is found to be set. This time the counter is stepped backward to 6. The next time through, the counter is stepped to 5, with the step counter trigger set and the oscillator YES. The functions performed at this time are clearing the sequence 2 trigger, clearing the step-counter trigger and switching, or complementing, the counter stages 2^0 and 2^2. Since the count was equal to 5, this switching returns the counter to a 0 state.

Clearing of the step-counter trigger stops the gated oscillator pulses from stepping the counter. Clearing the sequence 2 trigger clears the last control trigger in the logic, thus stopping the sequence. A ready light is illuminated when the step-counter trigger is cleared. All control triggers and counters have been reset, and the counter is ready to start again when the start switch is depressed.

Implement the flow diagram

From the complete flow diagram, a logic drawing can be detailed directly. This is shown in Fig. 3. Through normally closed contacts of the start switch, a signal is applied to gate $A1_2$ to keep the bounce latch clear. When the start switch is activated, a signal is applied to $A1_1$, setting the latch. As long as the start switch does not exhibit any cross-contact bounce, the bounce latch will remain set until the start switch is released.

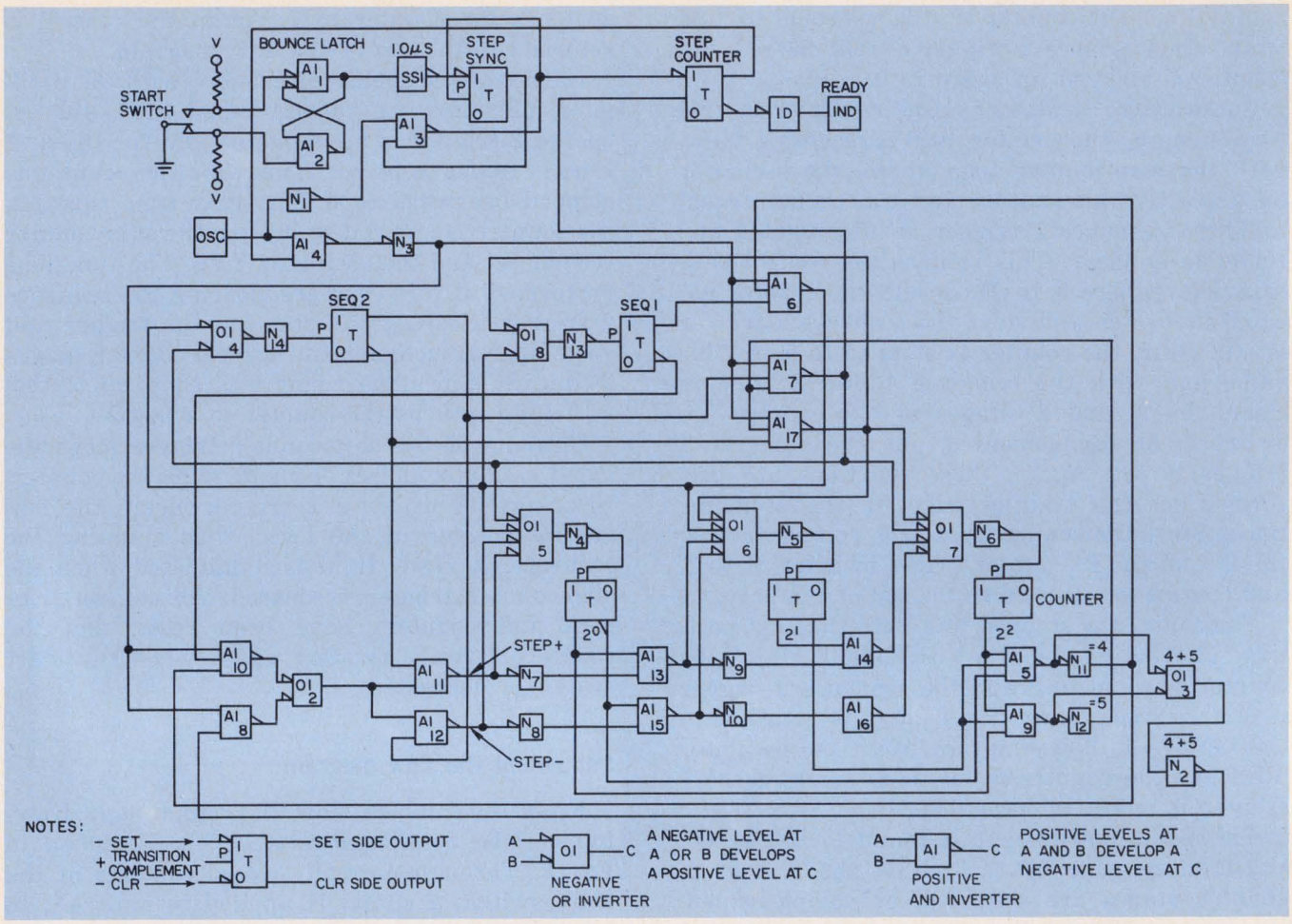
The transition from a clear to a set state fires single-shot 1, a 1-μs negative pulse. This pulse, in turn, sets the step-sync trigger. Gate $A1_3$ is conditioned by the step-sync trigger being set and by negative alternations from the oscillator through inverter 1. Thus $A1_3$ generates a negative-going pulse to set the step-counter trigger on the leading edge of the pulse.

The purpose of the step-sync trigger is to set the step-counter trigger on a negative alternation of the counter. In this way the step-counter trigger is set in a synchronized fashion.

The logic drawing corresponding to the step-sequence control (Fig. 2) begins with $A1_4$ and N_3, for the step-counter trigger set and the oscillator YES decision, respectively.

Follow a control path

Let's follow one of the control paths in Fig. 2 and show the logic implementation in Fig. 3. The first path activated is as follows: step-counter trigger set, oscillator YES, counter not equal to 4 or 5, and sequence 2 trigger clear. The execu-



3. **The implementation of the logic flow diagram** can be simplified even further by taking into account such factors as the logic family selected and the packaging of the logic. Binary triggers with a ground level dc set and clear are used. The complementing input switches the trigger from the set to the clear, or vice versa.

tion for this path is to step the counter up by one count on the trailing edge of the pulse.

Gate $A1_8$ is conditioned from the output of N_2, which indicates when the counter is not 4 or 5. The other input to $A1_8$ comes from the output of N_3. The output here consists of gated positive alternations of the oscillator. The output of $A1_8$ drives 01_2, which in turn drives $A1_{11}$ and $A1_{12}$. Since the sequence 2 trigger is clear, $A1_{11}$ is conditioned, thus driving N_7 and the step-plus line.

New path for counter equals 4

Once the counter equals 4, the following path in Fig. 2 is activated: step-counter trigger set, oscillator YES, counter equal to 4, sequence 1 trigger clear and sequence 2 trigger clear. The final block steps the counter +1 on the trailing edge.

Gate $A1_{10}$ is the AND circuit for this leg. Its inputs are as follows: output N_{11}, which indicates the counter is equal to 4; the output of inverter 3, the output consisting of gated positive alternations of the oscillator; and the clear side of the sequence 1 trigger. The output $A1_{10}$ drives 01_2, which drives $A1_{11}$ and $A1_{12}$. As before, the sequence 2 trigger is still cleared, so it's $A1_{11}$ that generates an output to N_7, stepping the counter from 4 to 5.

Now that the counter is equal to 5, another control path is activated. As shown in Fig. 2, it is as follows: step-counter trigger set, oscillator YES, counter equal to 5 and the sequence 2 trigger clear, leading to the execution block, which switches the 2^1 and 2^2 counter stages and sets the sequence 1 trigger. The implementation of this path starts off with N_{12}, which indicates the counter is equal to 5. This output conditions $A1_{17}$. The other inputs to $A1_{17}$ are the clear side of the sequence 2 trigger and the output of N_3, the output consisting of gated positive alternations of the oscillator.

The output of $A1_{17}$ drives 01_7 and 01_6. The output of 01_7 through inverter 6 switches counter stage 2^2 and the output of 01_6 through N_5 switches counter stage 2^1. $A1_{17}$ also drives 01_8, which drives N_{13} and switches the sequence 1 trigger to the set state. The complementing, or switching, of counter stages 2^1 and 2^2 switches the counter

from 5 to 3. At this point the control path is active for oscillator YES and the counter not equal to 4 or 5.

When the counter reaches 4, the operational control path is: step counter trigger set, oscillator YES, counter equal to 4 and sequence trigger 1 set.

This path is shown in logic in Fig. 3, as follows: The output from N_{11}, indicating counter equal to 4, conditions $A1_6$. The output of N_3 also conditions $A1_6$. The third input to $A1_6$ is the set side of the sequence 1 trigger. The output of $A1_6$ drives 01_6, 01_5, 01_8 and 01_4. 01_6 through N_5 switches counter stage 2. And 01_5 through N_4 switches counter stage 2^0. Gate 01_8 through N_{13} switches sequence 1 trigger to the clear state, and 01_4 through N_{14} switches the sequence 2 trigger to the set state. The switching of counter stages 2^0 or 2^1, with the counter stepped to 4, sets the counter to 7.

Counter stepped backward

Now that the counter has been stepped to 7, the active control path in Fig. 2 is as follows: step-counter trigger set, oscillator YES, counter not equal to 4 or 5 and sequence 2 trigger set. This path steps the counter back one on the trailing edge of the pulse.

The implementation of this control path (Fig. 2) is as follows: The output of N_2, indicating counter not equal to 4 or 5, conditions $A1_8$. Gate $A1_8$, also driven by inverter 3 or the positive alternations of the oscillator, drives 01_2, and 01_2 drives $A1_{11}$ and $A1_{12}$. This time, however, instead of $A1_{11}$ being conditioned by the clear side of the sequence 2 trigger, $A1_{12}$ is conditioned by the setting of the sequence 2 trigger.

With A_{12} fully conditioned, N_8 and the step line of the counter are driven. Ensuing oscillator pulses step the counter from 7 to 6, and then to 5, at which time a new control path takes over. This path is: step counter trigger set, oscillator YES, counter equal to 5 and sequence 2 trigger set. The execution for this path is to clear the sequence 2 trigger, clear the step counter trigger and switch stages 2^0 and 2^2, thereby setting the counter to 0.

The implementation is as follows: N_{12} drives $A1_7$. The output of N_{12} indicates the counter is equal to 5. Gate $A1_7$ is also driven by N_3 or the positive alternations of the oscillator, and by the setting of the sequence 2 trigger. The output of $A1_7$ drives 01_7, 01_5 and 01_4. Gate 01_7 switches the 2^2 stage of the counter. Gate 01_5 switches the 2^0 stage of the counter, and 01_4 clears the sequence 2 trigger. $A1_7$ also clears the step-counter trigger.

The sequence is complete. The counter is reset, and all control triggers are clear. Since the step-counter is clear, the ready indicator lights. ■■

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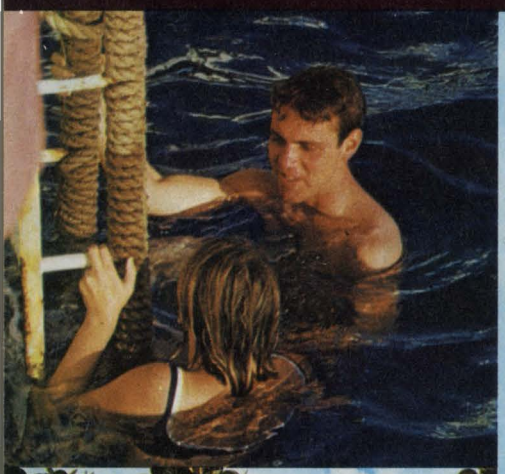

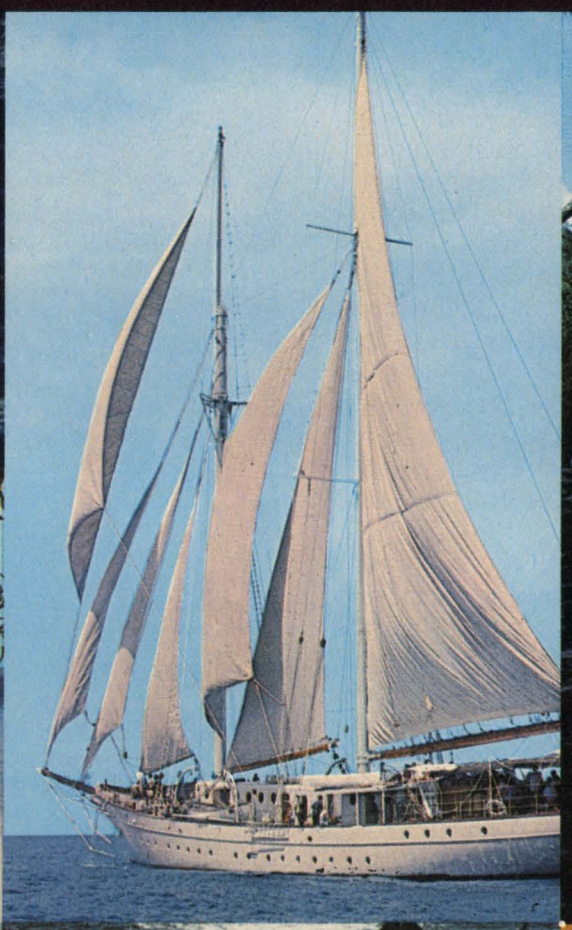

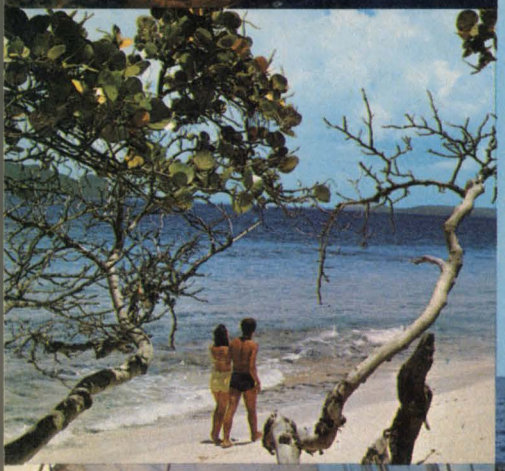

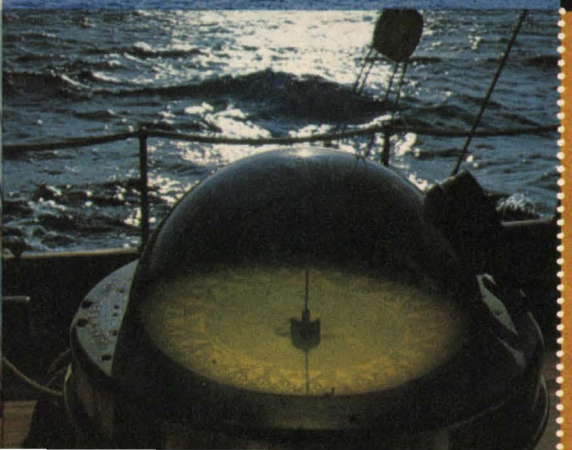

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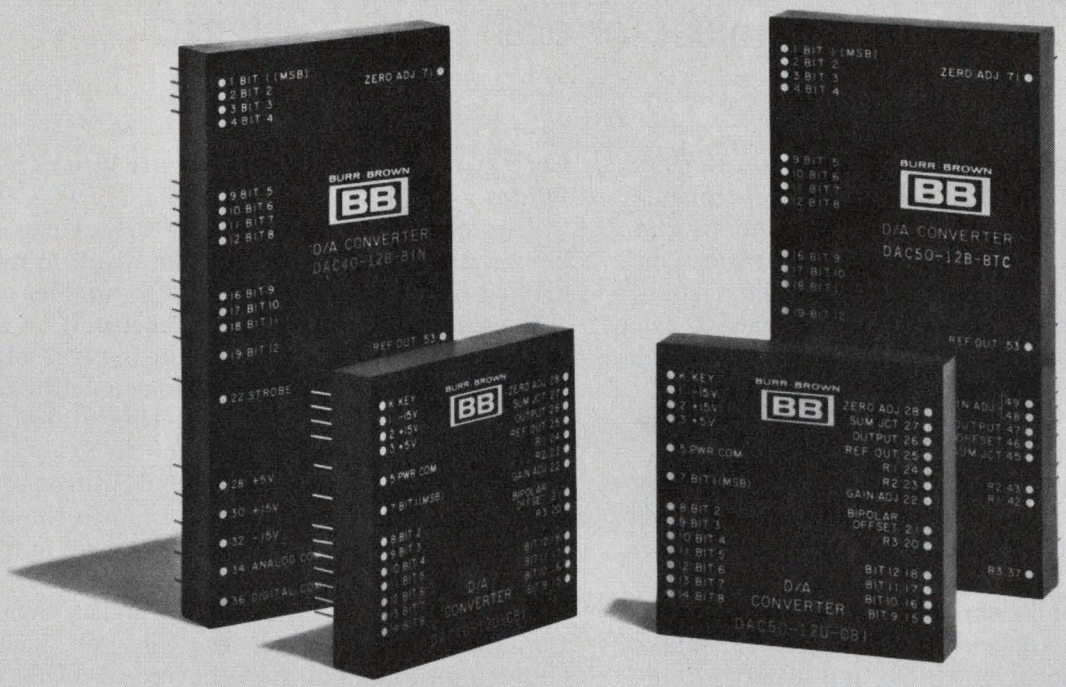

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INFORMATION RETRIEVAL NUMBER 29

Constructing the primitive flow table,

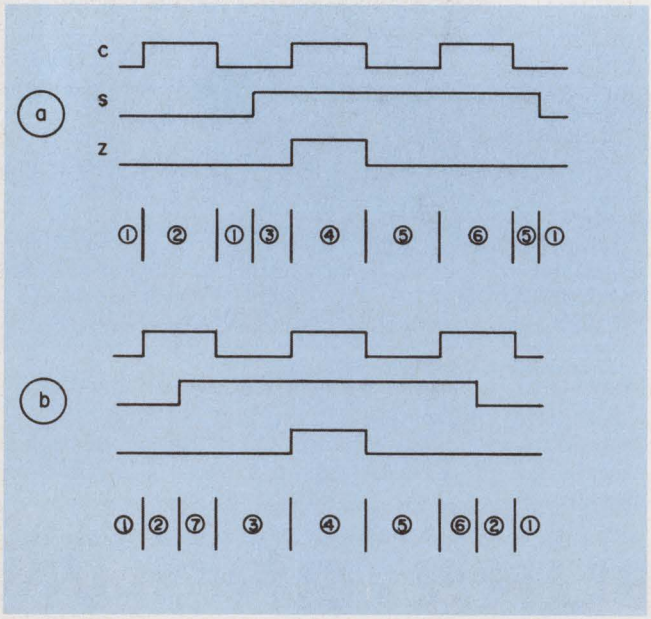
the initial step in any sequential circuit synthesis, helps you avoid uneconomical, or even faulty, designs.

In the synthesis of sequential circuits, the first step in the design is the construction of a primitive flow table from the word statement of the problem.[1] Knowledge of which circuit actions can occur and which cannot can be very important to the minimization of the circuit or even to the circuit's performance. Negligence in this regard can lead to an uneconomical or faulty design.

So let's study in detail the construction of the primitive flow table.

For our example, we'll design a sequential circuit with two inputs, C and S, and one output, Z. The C input is a periodic clock signal, and the S input is a switch. Each time S is closed, the circuit is to transmit the next complete positive clock pulse as the output, Z. Two possible timing sequences are shown in Fig. 1, and a partly completed primitive flow table is shown in Fig. 2.

Mitchell P. Marcus, Senior Engineer, Systems Development Div., IBM Corp., P.O. Box 6, Dept E52, Endicott, N. Y. 13760.



1. **Timing sequences fall into two categories:** those in which the switch closes while the clock is OFF (a) and those in which it closes while the clock is on (b).

Corresponding state numbers are used in these figures.

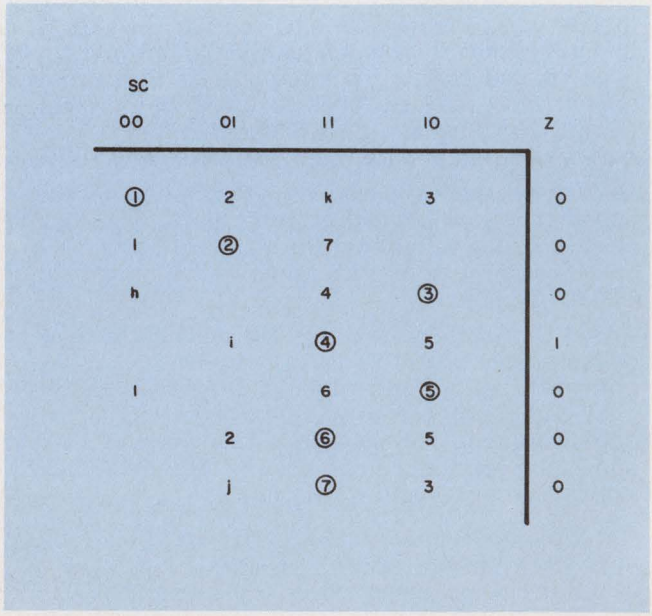
The table contains those states that can easily be written down by inspection. But states indicated by letters are not quite so simple.

Consider first the entries labeled h, i and j. If the circuit is in state (3) and S turns off, the circuit cannot return to state (1); since the output pulse has not yet occurred; another state, (8), is needed, and the h entry must be an 8 .

If the circuit is in state (4) and S turns off, the circuit cannot return to state (2), since the output pulse has not been completed; another state, (9), is required, and the i entry must be a 9 .

If the circuit is in state (7) and S turns off, the circuit cannot return to state (2), since the output pulse has not yet occurred; another state, (10), is needed, and the j entry must be a 10 .

Blindly adding these three states would be unfortunate if they proved to be unnecessary. If the closure of the switch, S, is known to be of long duration relative to the clock signal, C—which, in fact, is very likely from a practical standpoint



2. **To properly complete this primitive flow table,** we must ask whether or not the switch closure is known to be of long duration relative to the clock signal, C.

—none of the preceding transitions would ever occur, and the three additional states would add nothing but cost to the circuit. Thus knowledge of the circuit action can result in optional entries in the flow table, rather than additional unnecessary states.

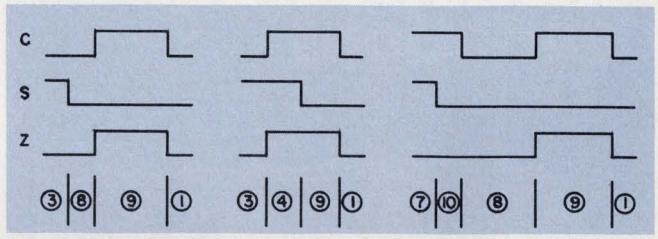
Simultaneous changes must be considered

The remaining entries all relate to both inputs changing state simultaneously. We cannot assume that simultaneous input changes are impossible; in fact, in this example such transitions are entirely possible, since the switch closure is random.

Blindly assuming that certain transitions are optional when, in fact, they may actually occur can lead to false circuit action. The most interesting case in this example relates to the entry labeled k. If the switch is turned ON simultaneously with the start of a clock pulse, the choice exists for making that clock pulse the output pulse, by a transition to state (4), or for making the following clock pulse the output pulse, by a

SC 00	01	11	10	Z
①	2	4 OR 7	3	0
1	②	7	3	0
–	–	4	③	0
–	–	④	5	1
1	2	6	⑤	0
1	2	⑥	5	0
–	–	⑦	3	0

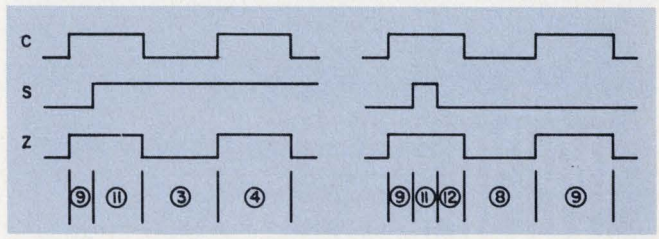
3. **If the switch closure is of long duration** compared with the clock signal, and if simultaneous changes in S and C are possible, this completed table results.



4. **When the switch closure can be of short duration** relative to the clock signal, these additional sequences become possible.

SC 00	01	11	10	Z
①	2	4 OR 7	3	0
1	②	7	3	0
8	9	4	③	0
1	9	④	5	1
1	2	6	⑤	0
1	2	⑥	5	0
8	10	⑦	3	0
⑧	9			0
1	⑨			1
8	⑩			0

5. **Things get more complicated** when we consider the possibility of a short-duration switch closure. This is the partly completed primitive flow table resulting from the additional sequences in Fig. 4.



6. **Things can get even more complicated,** as shown by these additional sequences that arise when the time between closures is small relative to the clock period.

SC 00	01	11	10	Z
①	2	4 OR 7	3	0
1	②	7	3	0
8	9	4	③	0
1	9	④	5	1
1	2	6	⑤	0
1	2	⑥	5	0
8	10	⑦	3	0
⑧	9	4 OR 11	3	0
1	⑨	11	3	1
8	⑩	7	3	0
8	12	⑪	3	1
8	⑫	11	3	1

7. **Here's the primitive flow table** that results when the sequences shown in Fig. 6 can occur.

transition to state (7). If the k entry were made an optional entry, the danger could exist of the transition terminating in state (6), in which case the circuit design would be faulty, since no output pulse would then occur.

If it is known that the closure of the switch is of long duration relative to the clock signal, and if we assume that simultaneous input changes are possible, the completed primitive flow table shown in Fig. 3 results.

If the switch closure can be of short duration relative to the clock signal, some additional sequences are possible (Fig. 4), and the partly completed primitive flow table in Fig. 5 results.

A new parameter must now be considered: the repetition rate of switch closure. If the duration between successive closures is known to be long relative to the clock, none of the remaining transitions can ever occur, and the six remaining entries in the flow table in Fig. 5 can be optional.

If the duration between successive switch closures can be short relative to the clock, we have a condition in which the switch can close during a clock pulse that is being transmitted as an output pulse, which will, according to the specifications, call for the next clock pulse to generate an output pulse also. This leads to some additional possible sequences (Fig. 6) and to the completed primitive flow table in Fig. 7.

To summarize, full knowledge of possible circuit action should be utilized in constructing the primitive flow table. Failure to take advantage of possible optional transitions can lead to redundancy in the circuit and a more costly design. Capricious assumption of optional transitions when, in fact, they are not optional can lead to a faulty circuit design. ■■

Reference

1. Marcus, M.P., *Switching Circuits for Engineers*, Prentice-Hall, Inc., Englewood Cliffs. N.J., second edition, 1967.

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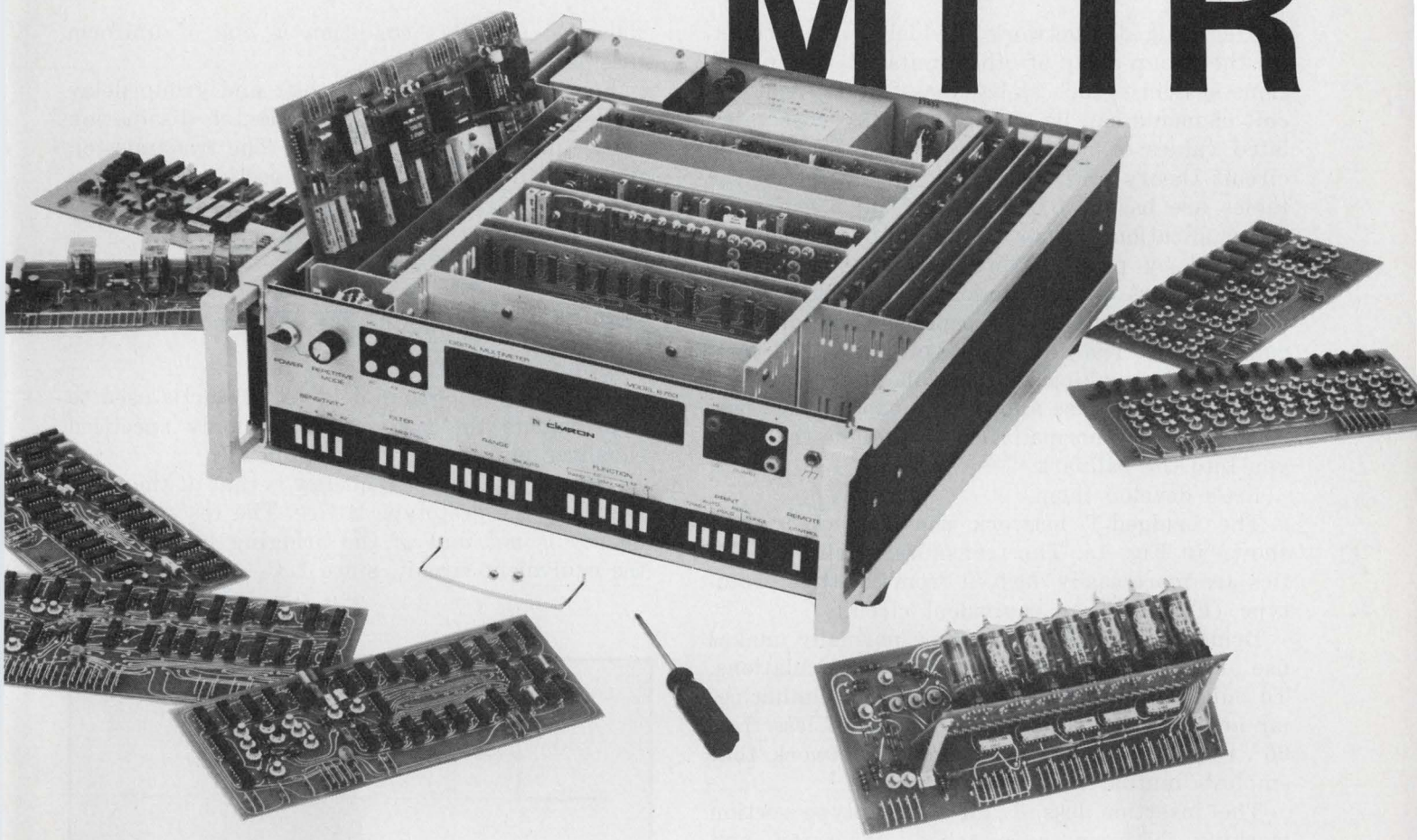

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Start bridged-T equalizer designs easily

with approximate formulas that avoid trial and error. You can estimate equalization fits and finite-Q effects.

The bridged-T network is widely used to equalize the group delay of other units in communications systems—such as bandpass filters. And circuit elements can be obtained readily with tabulated values of normalized components. But the circuit theory and design criteria on which the tables are based do not include quick estimates of equalization fit, nor the amplitude variations incurred by practical bridged-T networks that use inductors with finite-loaded Qs. This leaves the designer with the prospect of building an equalizer by trial and error—either with a computer or by making tedious lab tests. A better alternative is to use approximate formulas based on a frequency normalization technique that gets you into the ballpark.

Let's develop them.

The bridged-T network usually employed is shown in Fig. 1a. The transmission characteristics are more easily derived from a lattice prototype (Fig. 1b)—an equivalent circuit.

Bridged-T network analysis normally makes use of polar coordinates to simplify calculations. To build this bridged-T network, a minimum polar angle of 60° is required. Angles of less than 60° require a different bridged-T network that employs mutual inductance.

The insertion loss, L, of a prototype section working between a matched generator and matched load is given as

$$L = 10 \log \left[\frac{(1 + d_o)^2 + x^2}{(1 - d_o)^2 + x^2} \right] dB, \qquad (1)$$

where $x \cong 2(f - f_o)/\Delta f$ is the normalized frequency variable, f is the frequency, f_o is the center frequency, Δf is the normalizing bandwidth, $d_o = Q_u/Q_{ul}$ is the normalized dissipation factor, $Q = f_o/\Delta f$ is the network Q and Q_{ul} is the unloaded Q of the lattice resonators. When $x = 0$, then $f = f_o$, and the bandwidth for $x = \pm 1.0$ is Δf.

It is assumed that both the series and shunt resonators of the equivalent lattice have the same unloaded Qs. This condition is one of uniform dissipation.

For transmission phase shift and group delay responses, the effects of incidental dissipation can be neglected. Thus, $d_o = 0$. The transmission phase shift, θ, of an equalizer section is then

$$\theta = 2 \tan^{-1} x \text{ rad}, \qquad (2)$$

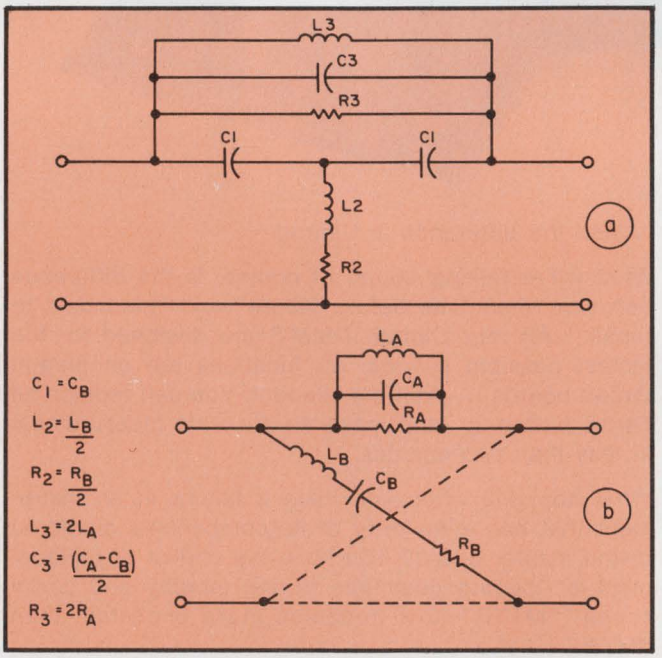
and the group delay response is

$$\tau = \frac{2}{\pi \Delta f} \left[\frac{1}{1 + x^2} \right] \mu s, \qquad (3)$$

where Δf is in MHz.

The bridged-T group delay equalizer is used to approximate the two most commonly specified equalizer fits—parabolic and linear.

The design center frequency is that of the resonators of the prototype lattice. The resonant frequency is not that of the bridging resonator in the equivalent circuit, since L_3C_3 is not equal to



1. **A popular network for the equalization of group delays** of other networks, the bridged-T equalizer (a) is an all-pass network when pure reactive elements are used. For transmission analysis, it's more convenient to treat the equivalent circuit—a lattice prototype (b).

Richard M. Kurzrok, Consultant Engineer, 545 West End Ave., New York, N.Y. 10024

$L_A C_A$. Actually, $L_3 C_3 = L_A (C_A - C_B)$.

The equalizer, frequency-centered at x = 0, operates out to some limiting values, plus and minus of the normalized frequency.

Rewriting the group delay response from Eq. 3 as a relative response gives:

$$y = \frac{1}{1 + x^2} = \tau/\tau_o, \qquad (4)$$

where y is the relative group delay and $\tau_o = 2/\pi\Delta f$ is the group delay at x = 0. Equation 4 is plotted in Fig. 2.

If we now restrict the usable equalizer frequency range to $0<|x|<|1.1|$, then the equalizer fit is approximated by the following parabola:

$$y = 1 - (1/2)\, x^2. \qquad (5)$$

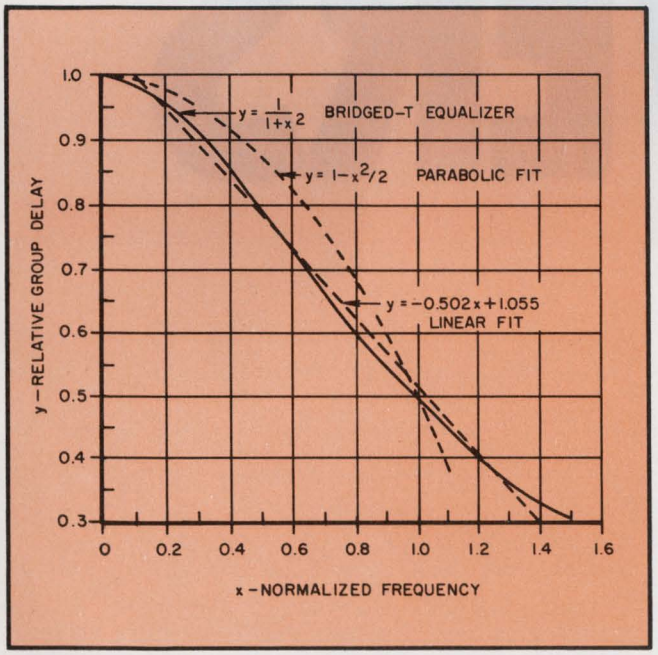
Equation 5 is also plotted in Fig. 2. The error in the parabolic fit is limited to 9.7%, which is adequate for many applications.

For linear group-delay fits, the closest approximation is found this way: The center frequency of the linear fit is offset, above or below lattice resonances, to normalized frequencies near the points of inflection of the bridged-T group delay response curve. By successively differentiating Eq. 4 and equating to zero, the points of inflection are found to be x = ±0.577. For practical linear group delay equalizers, the design center frequencies are offset to x = ±0.6.

By restriction of the usable equalizer frequency range to $-1.3<x<-0.1$ (for positive linear slopes) or $+0.1<x<+1.3$ (for negative slopes), a good linear fit is achieved. The negative linear slope is approximated by the following straight line:

$$y = -0.502\, x + 1.055. \qquad (6)$$

Equation 6, also plotted in Fig. 2, gives a difference error limited to 3.2%. The bridged-T equalizer inherently provides a better linear fit than parabolic fit.



2. **The bridged-T is used to approximate parabolic and linear** equalization fits. As a parabolic approximation, the best fit occurs when both center frequencies are at x = 0. But for a linear fit, the straight line intersects the bridged-T curve at its inflection point.

Practical equalizers, of course, do not realize idealized all-pass behavior. Because of finite Qs, some dissipation exists and amplitude variations result. To estimate the amount of the variation, let's take a closer look at Eq. 1.

For small values of the normalized dissipation factor d_o, the equation simplifies to

$$L \cong 10 \log \left[\frac{(1 + 2\, d_o + x^2)}{(1 - 2\, d_o + x^2)} \right] \text{dB}. \qquad (7)$$

At x = 0,

$$L_o \cong 10 \log \left[\frac{1 + 2\, d_o}{1 - 2\, d_o} \right] \cong 17.36\ d_o\ \text{dB}. \qquad (8)$$

Equation 8 provides the magnitude of the amplitude notch that occurs at x = 0 for an imperfect dissipative equalizer section. When x = 1.0, Eq. 7 reduces to:

$$L \cong 10 \log \left[\frac{2 + 2\, d_o}{2 - 2\, d_o} \right] \cong 8.68\ d_o\ \text{dB}. \qquad (9)$$

If the range of usable normalized frequency is restricted to $0<|x|<|1.0|$, the amplitude variation, ΔL, due to incidental dissipation is

$$\Delta L = L_o - L = 8.68\ d_o\ \text{dB}. \qquad (10)$$

Equation 10 can now be used to provide quick estimates of the amplitude variation in most bridged-T equalizers.

The discussion so far has been based on the assumption that equalizer bandwidths are narrow. When this is the case, arithmetic symmetry can be used for small percentage bandwidths—those of less than 10%. Of course, this normalization becomes invalid when larger percentage bandwidths are encountered; they require a normalization that produces geometric symmetry.

If geometric symmetry is assumed, Eqs. 1-6 can be used with certain modifications. These include a new normalized frequency variable,

$$x = Q\, (f/f_o - f_o/f). \qquad (11)$$

The Q is unchanged from the form given under Eq. 1.

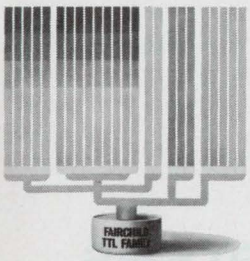
The center frequency group delay now becomes

$$\tau_o = \frac{1}{\pi\, \Delta\, f} \left[1 + (f_o/f^2)\right] \qquad (12)$$

Eq. 12 introduces a skewing that superimposes a linear component on the bridged-T quasi-parabolic response shape. ■■

NEW TTL/MSI PROBLEM SOLVERS

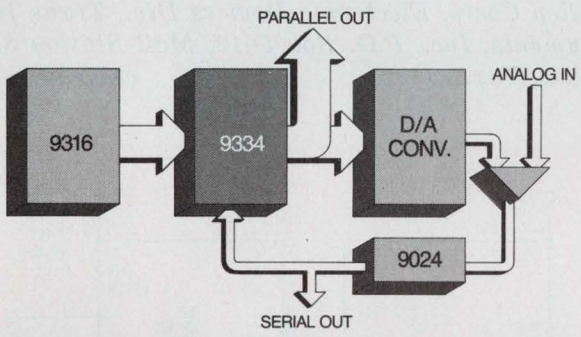
From our TTL Family Tree, simple new solutions for A/D converters, minicomputers, high speed systems.



Four new high quality members have been added to the Fairchild family of 96 TTL/MSI circuits. Each can be used in a variety of designs—alone, or combined with other members of our TTL and/or MOS families—for simple solutions to complex systems problems: For example:

9334 8-Bit Addressable Latch for general purpose storage in high speed digital systems. Combined with other MSI devices, it can be easily expanded to form large storage arrays. By itself, the 9334 can serve as an 8-bit addressable latch memory, one-of-eight decoder or one-of-eight demultiplexer.

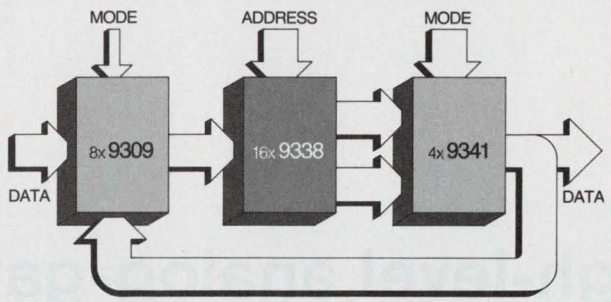
SUCCESSIVE APPROXIMATION A/D CONVERTER



In an A/D Converter, the 9334, combined with a 9316 Binary Counter and standard linear devices, provides a successive approximation analog-to-digital conversion. Send for our Appl. Note 294.

9338 8-Bit Multiple Port Register for high speed storage in an arithmetic logic unit is probably the most significant new function yet designed for minicomputer memories. Uniquely, it eliminates any addressing restrictions by permitting simultaneous read/write without race problems and by allowing data to be written into any one of the 8 storage locations and read out of any two of the locations *simultaneously*.

16-BIT ALU WITH 8 ACCUMULATORS



Used as a one-bit slice of eight registers/accumulators, it combines with either the 9340 or 9341/74181 ALU device to become the powerful heart of a minicomputer central processing unit. It's equivalent to a 9301 decoder, a 9308 latch, two 9312 multiplexers and a dual flip-flop. Send for our Appl. Note 220.

93H00 and 93H72 High Speed 4-Bit Shift Registers improve system performance up to 300% over a wide range of design applications that are based on the 9300 industry standard shift register.

The 93H00 has the same pin configuration as 9300 but has improved minimum shift rate by a factor of 3 (to 45MHz). This high-speed 4-bit shift register is a multi-functional sequential logic block, useful in a wide variety of register and counter applications.

The 93H72 has a minimum shift frequency of 45MHz and typical 58MHz. It uses the same basic 4-bit shift register configuration as the 9300 but with additional logic flexibility. 9300 J and K inputs are replaced by single D type input and a clock enable input E, providing a HOLD ("do-nothing") state. This eliminates the need for external clock gating.

These MSI devices are indicative of the problem-solving power of the Fairchild TTL Family Tree, most comprehensive TTL line in the industry. They are available, along with product and application information, from your friendly Fairchild Distributor.

MADE IN FAIRCHILD

FAIRCHILD SEMICONDUCTOR, A Division of Fairchild Camera and Instrument Corporation, Mountain View, California 94040. (415) 962-5011. TWX: 910-379-6435

INFORMATION RETRIEVAL NUMBER 32

ideas for design

High-level analog-gate circuit reverses polarity without operational headaches

Controlling ac signals isn't easy; most devices are not bilateral, and they don't function properly when the polarity is reversed. The polarity problem can be overcome by using a relay, of course, but if no contact bounce and small current are required, a better solution is to use a 3N160 P-channel enhancement mode FET.

In the diagram the source is connected to the 5-V supply because the gate must be negative with respect to the source to turn the device ON. The substrate is connected through a 47-kΩ resistor to the gate. This keeps the substrate reversed biased when the device is OFF and allows the device to operate bilaterally—the key to the operation of the circuit.

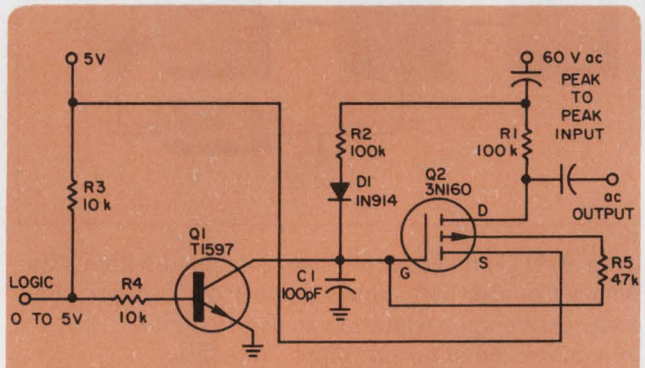
When logic ZERO exists at the base of Q_1, the device turns OFF, allowing the gate of Q_2 to rise to the peak value of the ac signal. This is accomplished by charging C_1 through R_2 and D_1. For Q_2 to turn OFF, the gate must be ZERO, or positive with respect to the source and drain.

By holding the gate at the peak positive value of the ac signal, we turn the device OFF, and the signal passes through R_1 to the output.

When there is a logic ONE at the base of Q_1, the device turns ON, and the collector goes to ground, discharging C_1 and placing the gate at −5 V with respect to the source. Thus Q_2 is turned ON, and the signal is shunted to ground.

Glen Coers, Electronic Devices Div., Texas Instruments, Inc., P.O. Box 5012, Mail Station 84, Dallas, Tex. 75222

CIRCLE NO. 310

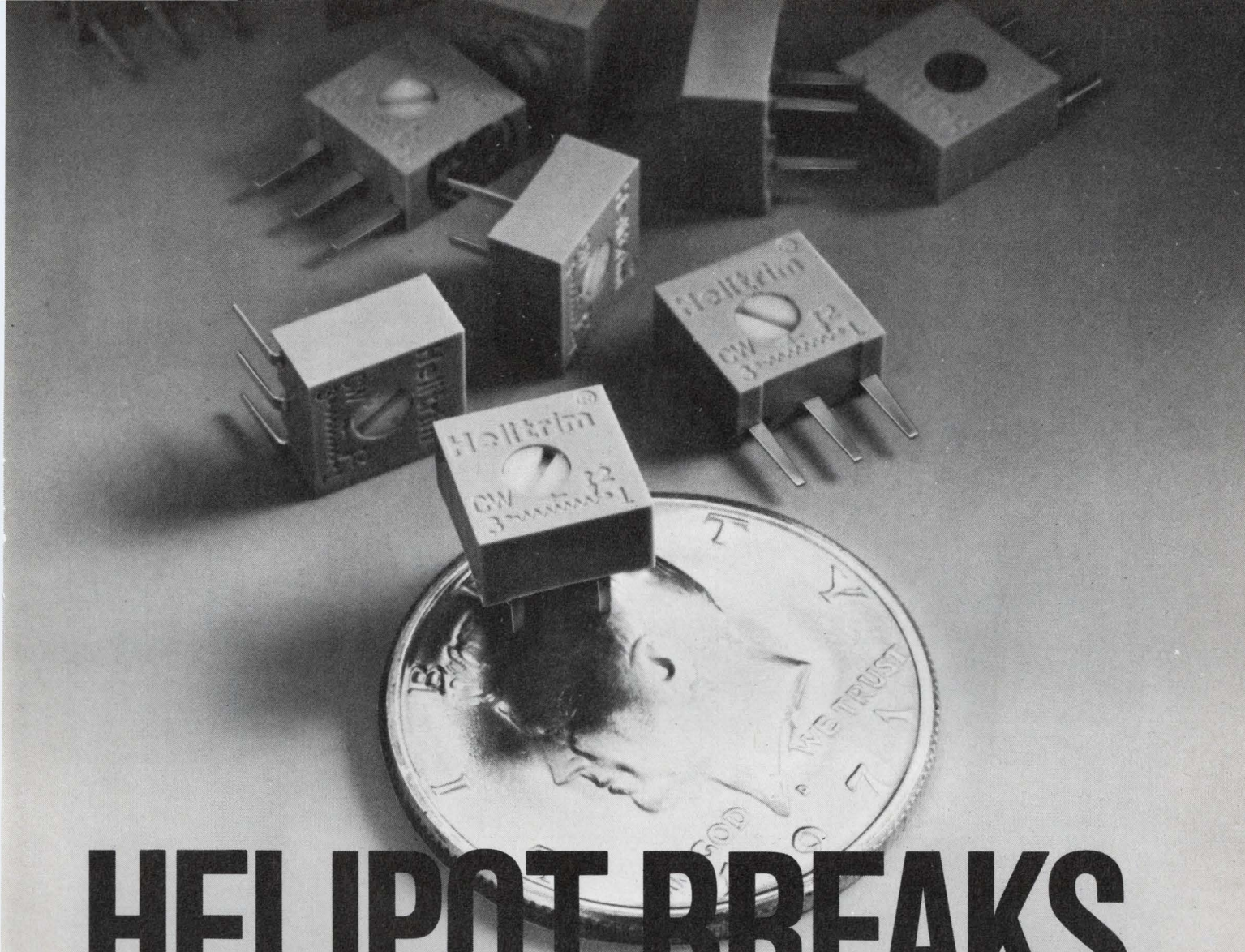


No contact bounce, low switching current and small size are the advantages of this high-level shunt, analog-gate circuit over a relay. The circuit can be used wherever ac signals need to be controlled.

Build a digital clock without BCD conversion in the design

Digital clocks—driven from a 60-pulse-per-second source—usually also require either one programmable ROM or a number of standard ICs to get the proper BCD coding for the hour count. But by manipulation of only a few standard counter sections and the addition of one quad NOR gate, a digital clock can be built with the required BCD coding built in (see diagram).

The input of 60 pulses per second is divided by 3600 with three μL9305 variable modulo counters (U, V and W) and a quad NAND gate (S) that provide ÷16, ÷ 15 and ÷ 15, respectively. The divide by 15 is accomplished by controlling the modulus of the three digit (D, C, B)



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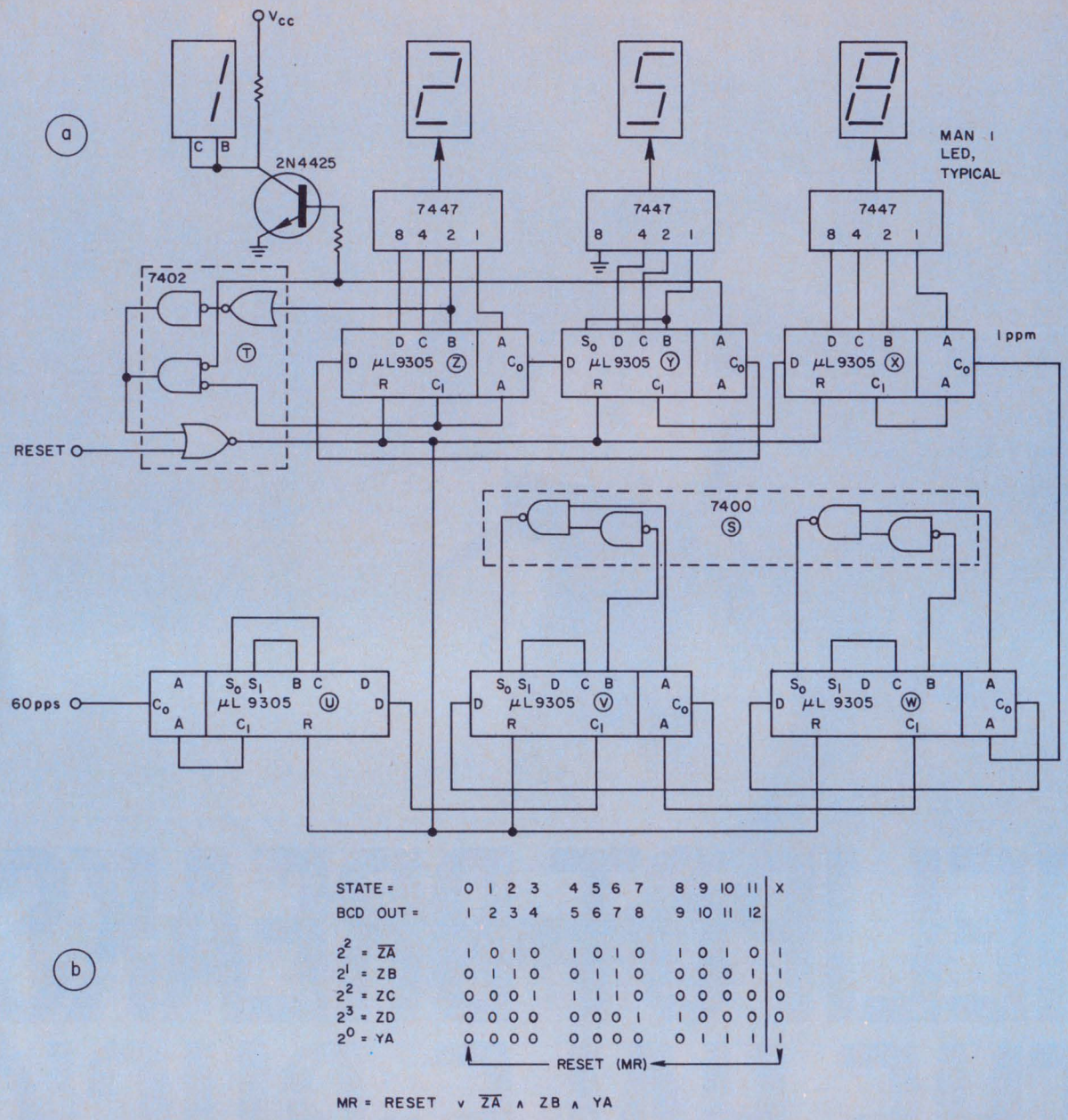
INFORMATION RETRIEVAL NUMBER 33



The digital clock circuit is simplified with a rearrangement of standard modulus counters to give directly the necessary BCD coding (a). An hour sequence table and the reset equation are given (b).

counter section, with the output of the succeeding digit (A).

With A = 0, the modulus is 8. On count 8, A is toggled, and the modulus is changed to 7. The μL9305 counters toggle on the positive edge. Therefore succeeding stages are driven by the inverted outputs, which assure integrity of count after the reset is released.

The minutes and hours are counted and BCD is encoded by three additional μL9305 counters (X, Y, Z). The minute LSD is a straight decade count. The minute MSD is a modulo 6 connection of the three-digit section of Y.

The hour LSD is a decade connection, except that the first-stage (A) outputs are reversed. This provides the proper 1 thru 12 (zero skipped) code sequence, and a 1:00 code when reset. The hour MSD is obtained with the extra digit section of Y. The required modulo 12 count is attained by deriving a master reset pulse from the 13-code output that instantly resets the counters to 1:00.000.

Walter L. Rutchik, Associate Research Engineer, Corporate Development Dept., Cutler-Hammer, Inc., 4201 N. 27 St., Milwaukee, Wis.

CIRCLE NO. 311

Heath/Schlumberger?

That's right . . . Heath/Schlumberger. A new name in design-quality, factory assembled and calibrated instruments.

The "Heath" part of our name comes from being a division of that well known manufacturer of kits. But we don't make kits. In fact, Heath/Schlumberger is an entirely separate operation.

The "Schlumberger" (pronounced Shlum-bear-zhay) part of our name comes from being a member of that world-wide corporation devoted to measurements of many kinds. Schlumberger is one of the leading European manufacturers of electronic instrumentation.

With that background, you can see why we are producing state-of-the-art, ready-to-use, instrumentation . . . comparable to some of the best in performance . . . but with better performance/price ratios.

So when you are ready to buy electronic instruments, check the growing Heath/Schlumberger line.

We're the group to watch.

To order or receive additional information, write Dept. 520-26.

HEATH
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Heath/Schlumberger
Scientific Instruments
Benton Harbor,
Michigan 49022

A. SM-104A 80 MHz counter. BCD output. 1 MHz TCXO with 1 ppm/yr. stability. $500.

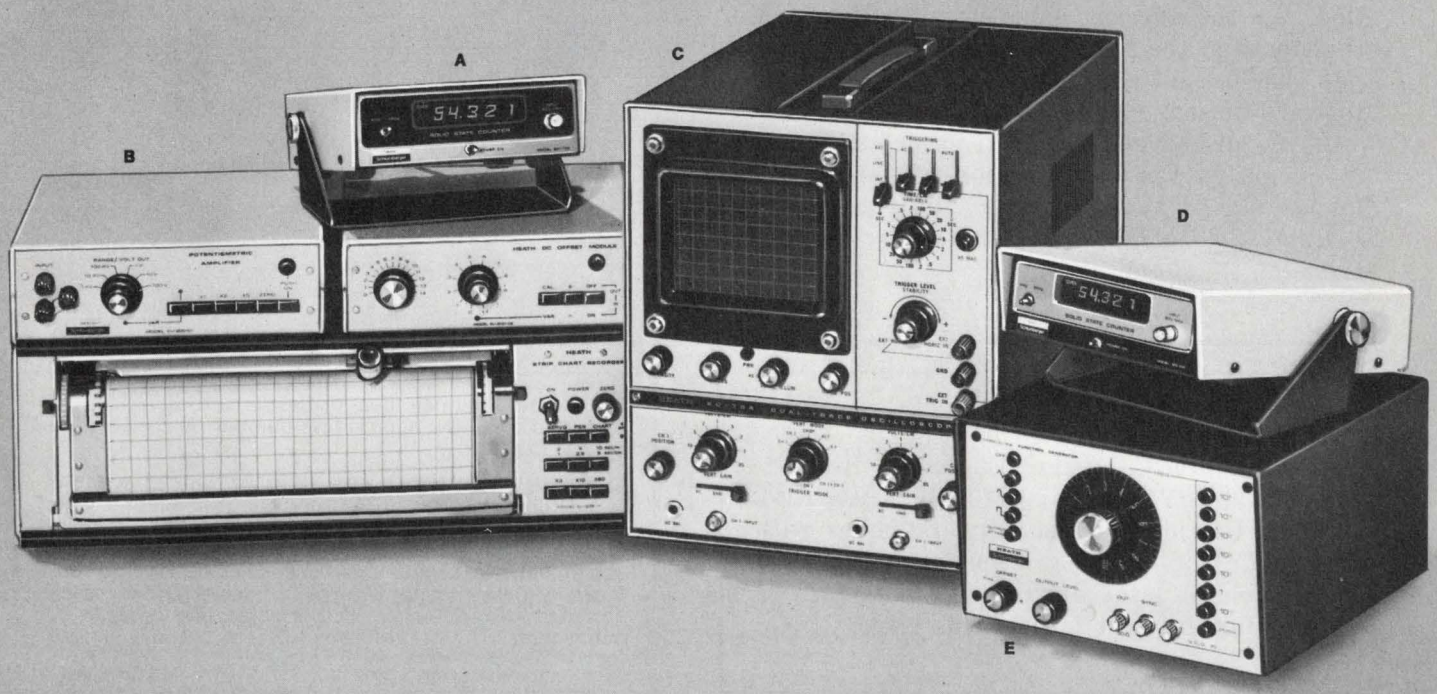
B. EU-205B solid-state strip chart recorder. 23 speeds, 30 in/min. to 0.2 in/hr.; 18 calibrated ranges, 1 mV to 500 V full scale. 0.5 sec. pen response. 0.1% tracking accuracy and linearity. Completely programmable. $675.

C. EU-70A solid-state dual trace scope. DC-15 MHz. Complete dual trace capability. Triggered sweep. 18 calibrated time bases. X-Y capability. $595.

D. SM-105A 80 MHz counter. Same as SM-104A above but without BCD output and uses a 1 MHz crystal with ±10 ppm/yr. stability. $350.

E. EU-81A function generator. Sine, square and triangle wave output. 0.1 Hz to 1 MHz. Linear dial. External voltage control. $245.

EK-308



INFORMATION RETRIEVAL NUMBER 34

Replace UJT and SCR in a timing circuit with a programmable unijunction transistor

The timing and switching functions in a timing circuit are usually obtained with a UJT and SCR. But a simpler and less-expensive circuit with increased reliability results when the UJT and SCR are replaced by a programmable unijunction transistor (PUT).

With a PUT in the circuit, the timing and latching functions are independent, because the R_TC_T timing network is connected to the gate and the V_S reference is applied to the anode (see diagram). The valley current, I_v, can be programmed between 25 μA and 150 mA without affecting the timing.

Delays from 0.05 to 60 seconds or longer are provided, and the reset time is less than 5 ms. While most UJT-SCR timing circuits are limited to not less than 5 to 10 mA load currents by the maximum holding current requirement I_H, the PUT-designed system will handle load currents from 25 μA to 150 mA.

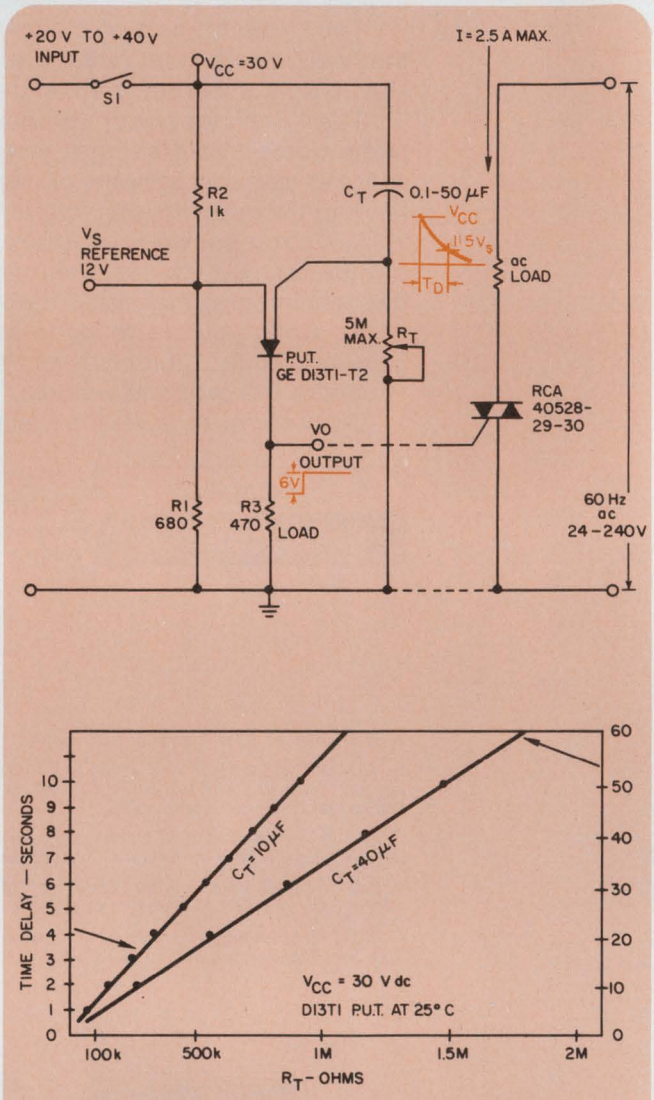
It can operate from 20 to 40 V, with ±2% or better repeat accuracy, and it will operate between −30 to 170 F with less than ±10% change in timing and without compensation. Changing the ratio of R_1 to R_2 by a small amount provides a calibration of the timer.

When R_3 is replaced by a triac, the circuit operates as follows: Capacitor C_T charges to V_{CC} with the closing of the switch. The instantaneous charging current of C_T develops a voltage drop across R_T, reverse-biasing the gate to anode junction. As the current exponentially decays, V_{RT} is reduced at the same rate and at $(V_S - V_{AG})$ the pnp base-to-emitter junction of the PUT becomes forward-biased.

As C_T discharges, the PUT is driven through the negative resistance region, and the circuit latches on.

Ernie Foldzari, 1520 Plymouth Circle, Carpentersville, Ill. 60110

CIRCLE NO. 312



Cost savings and increased reliability are obtained with a programmable unijunction transistor in this timing circuit (a). The PUT replaces a UJT and SCR. Measured time delays are given as a function of timing resistance for two capacitance values (b).

IFD Winner for August 5, 1971

Doug Clifford, Design Engineer, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. His idea "Reset dividers faster with a single flip-flop" has been voted the Most Valuable of Issue award.

Vote for the Best Idea in this issue.

VOTE! Go through all Idea-for-Design entries, select the best, and circle the appropriate number on the Reader-Service-Card.

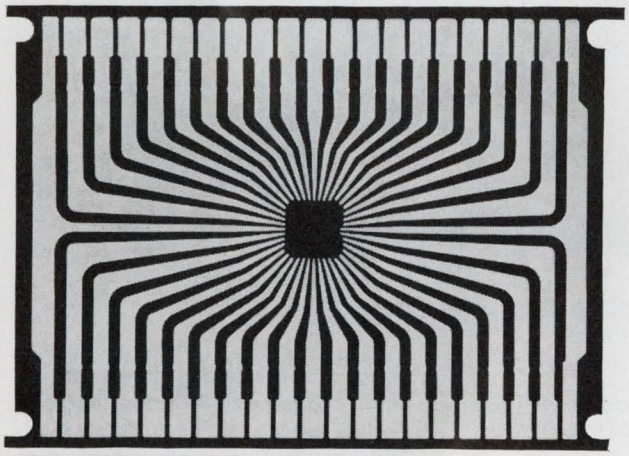
SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas-for-Design editor. You will receive $20 for each accepted idea, $30 more if it is voted best-of-issue by our readers. The best-of-issue winners become eligible for the Idea Of the Year award of $1000.

Let us mill.

Not all sheet-metal parts should be manufactured by force and violence. It's much more humane to dissolve away the unwanted metal. This process, called photo chemical machining, leaves the parts unstressed, unbent, unbroken, unbeaten. It's extremely accurate. And it may cost less than militant methods such as stamping and machining.

We became expert in photo chemical machining by running one of the largest chemical milling operations ever set up. It's a continuous process that turns out a couple of million color TV aperture masks per year. (Each mask is pierced by half-a-million tiny, round holes.)

If we can make masks, we can make almost anything by photo chemical machining: parts such as IC lead frames, display-tube numbers, grids, heaters, computer-card guides, electric-razor cutter heads. We do everything: artwork, milling, finish plating.



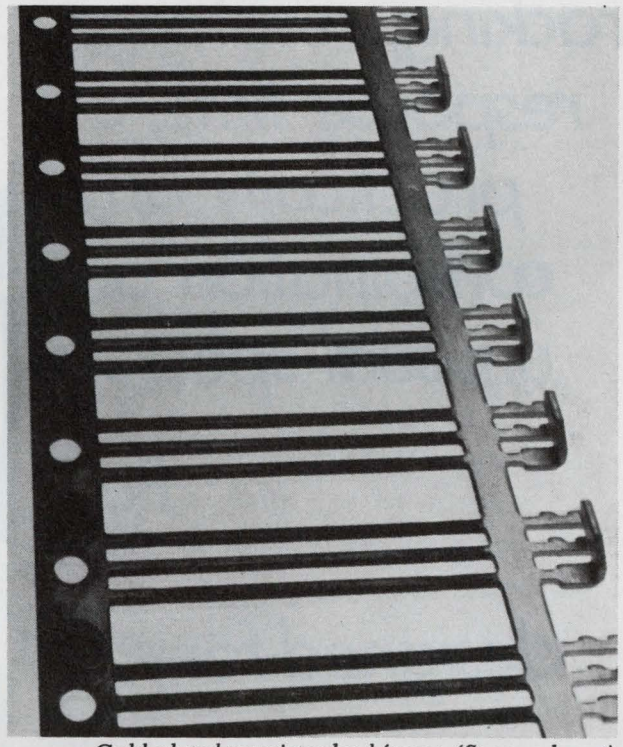
40-lead IC frame. (PCM part)

Naturally, we welcome run-of-the-mill chemical milling work. (It's our bread and butter.) But we're overjoyed when people give us a really tough PCM job. We have a whole crew of metallurgists, chemists and designers, and they can come up with sweet answers where others produced sour notes.

So if you're having any problem with PCM parts, come to us.

Instead of just milling around.

For more about PCM, call Bill Johnson at 717-265-2121. Or write him at GTE Sylvania, Chemical & Metallurgical Division, Towanda, Pa. 18848.



Gold-plated transistor lead frame. (Stamped part)

Stamp out everything.

One of our most creative areas is the stamping of electronic parts.

We can bang them out like a machine gun—about 10 million parts per day. From a wide range of materials. In all sorts of finishes and tempers. To extremely close tolerances.

We've got presses that will blank, cup, draw, pierce, bead, knurl and trim—all in one pass.

We'll take on the most intricate shapes you have, make our own dies for them and knock out beautiful parts by the barrelful.

And we'll do it at a reasonable cost. (After all, stamping is the most economical way to mass-produce metal parts.)

So give us your huddled contacts. Your teeming lamp bases. Your integrated circuit parts. Your cans and headers. Your anything and everything.

And we'll stamp 'em out for you.

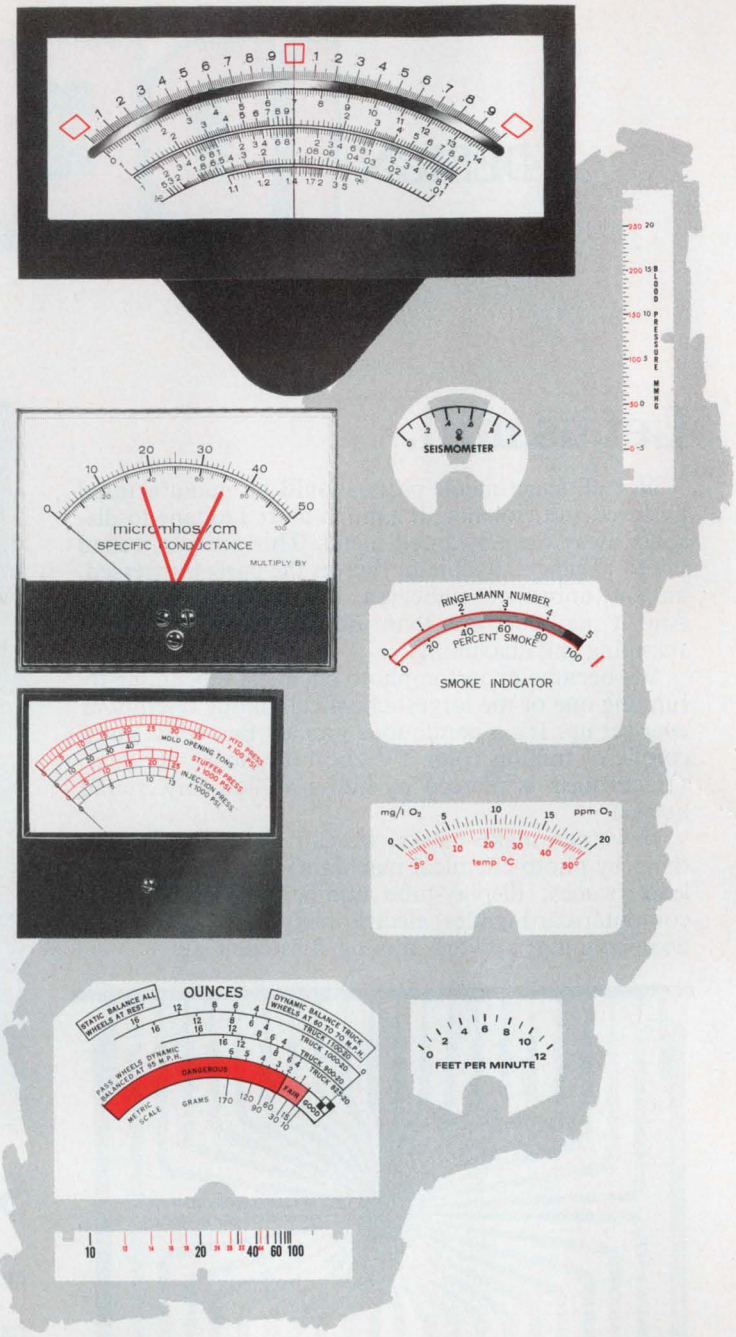
Call our stamping people at 717-764-9853. Ask for Hal Martin. Or write to him at: GTE Sylvania, Parts Division, 1128 Roosevelt Ave., York, Pa. 17404.

GTE SYLVANIA

INFORMATION RETRIEVAL NUMBER 35

If you need panel instruments with custom dials, cases, accuracy, tracking, resistance, response time, or practically any combination of unusual specs...

Buy Triplett's designed-for-you Panel Instruments



Although we stock some 1369 different styles, sizes and types of standard panel instruments, a very large proportion of our customers buy custom instruments.

Because they need:

custom dials
reading in such units as pH, roentgens, mm Hg, rpm, %, inches.

custom cases
square, round, rectangular, edgewise (horizontal and vertical), wide, narrow, shallow.

custom accuracy
to within ½% with mirror scales and knife-edge pointers.

custom tracking
to match the specific needs of existing or new instrument designs.

custom resistance
for low circuit loading with tolerances as low as ±1%.

custom damping
to meet stringent electrical and vibration requirements.

For instance, one of our customers had us design and manufacture a custom instrument to replace — in every detail of physical and electrical specifications — one which he was using on a delicate piece of medical instrumentation. Rejects from his previous source had risen to over 20%. He rejected only 3 of the first hundred we shipped—with almost negligible rejections from the many hundreds we've shipped since.

What custom panel instrument specifications do you need to make your product more reliable, more accurate, more rugged and — in the long run — less expensive? For quick, dependable delivery of small quantities of Triplett's "designed-for-you" panel instruments, contact your Triplett Sales/Service/Modification Center. For prototypes or production quantities, contact your Triplett representative. He'll put you in touch with our Instrument Designers/Engineers who'll help you analyze the problem and suggest the optimum cost/result solution.

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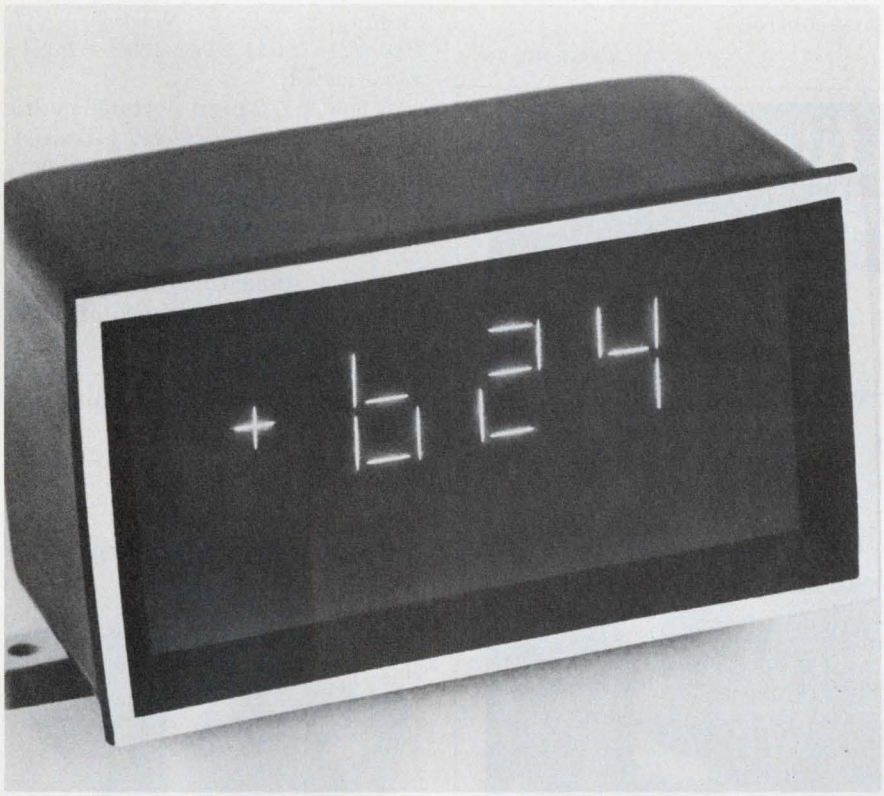
INFORMATION RETRIEVAL NUMBER 36

new products

Smallest-volume 3-1/2-digit DPM features the lowest price of $89



Just under 8 cubic in. in volume, this smallest 3-1/2-digit DPM is also the lowest priced—$89 in quantities of 100.

Analog Devices, Inc., Norwood, Mass. Phone: (617) 329-4700. P&A: $89 (100-up); stock.

The latest victory in the size and price battles in digital panel meters comes—not from one of the old-line DPM vendors—but from Analog Devices, a large manufacturer of analog and conversion modules, a small manufacturer of monolithic ICs and a brand new manufacturer of panel meters.

In quantities of 100, the company's bipolar 3-1/2-digit AD2001 costs $89—just $6 less than Analogic's AN2532, the lowest-cost bipolar, cased DPM. Weston's unipolar 1291 costs $99.75. Datascan's unipolar 610 costs $95 and its bipolar 620 costs $101, but case and bezel for either cost an extra $5.

The AD2001's price advantage is small. Its size advantage is large. The aluminum case has dimensions of 3-in.-wide by 1-3/4-in.-high by 1-1/2-in.-deep for an over-all volume just under 8 cubic in. That's less than half the 18 cubic in. of Digilin's LED-readout 3330—the smallest DPM till now.

While most DPMs use gas-discharge readouts and a few use LEDs, the AD2001 uses RCA's Numitrons. The DR2110 for full digits and the DR2120 for the ±1 have 0.4-in. characters.

Unlike most DPMs, the AD2001 does not operate from the ac line, so it saves the price, size and weight of a line transformer, rectifier and filter. Further, thanks to new, "Analok" circuitry, which the company won't describe till its patent application has been acted on, the meter doesn't need the inverter required by other DPMs that operate from 5 V to allow bipolar operation or readings near 0 V. There are two 5-V terminals (which can be commoned). An unregulated source of 5 Vdc at 800 mA (or 5 Vac) can power the display while +5 V dc at 200 mA, with a modest regulation of 5%, can drive the rest of the circuitry.

Accuracy is 0.05% of reading ±1 digit and tempco is 0.005% of reading per degree C. Noise rejection is 40 dB at 60 Hz, which is good, but hardly sensational. Full scale is 199.9 mV and the unit can take a 20-V input without damage. The meter can operate from 0 to +60°C.

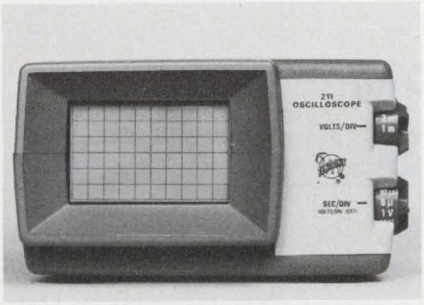
The meter includes automatic zero correction; in effect, it shorts the input once every reading. Conversion rate is five per second with the internal trigger, up to 20 per second with an external trigger.

The unit has BCD output for the three full digits and outputs for the most-significant 1, polarity, the conversion gate and readings beyond 200 mV (which make the "1" flash). The meter can accept print commands and commands to hold a reading.

All the circuitry is contained on two small (about 1-1/2 by 2-7/8 inch) PC boards. They are held together, at right angles, by three DIP IC's along the corner—with half their leads in one board, half in the other.

For Analog Devices: **CIRCLE NO. 250**
For Analogic: **CIRCLE NO. 251**
For Datascan: **CIRCLE NO. 252**
For Digilin: **CIRCLE NO. 253**
For Weston: **CIRCLE NO. 254**

Palm-size 3-lb scope works to 0.5 MHz

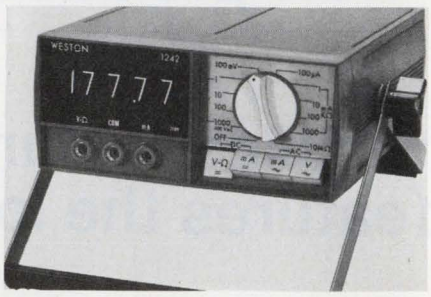


Tektronix, Inc., Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $545 (includes batteries); stock.

The tiny 211 solid-state miniscope is a 0.5-MHz lab scope weighing just 3 lbs and measuring only 3 by 5-1/4 by 9 in. It has an integral 1-MΩ probe and operates from the ac line or up to 5 hours on internal batteries. Deflection factors are 1 mV/div. to 50 V/div. and sweep rates extend to 1 μs/div. Triggering is simplified to one rotary control.

CIRCLE NO. 255

$595 4-1/2-digit DMM features 25 ranges



Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, N.J. Phone: (201) 243-4700. P&A: $595; stock.

A new 4-1/2-digit portable multimeter includes 25 ranges for measuring ac and dc voltage and current and resistance. The new model 1242 has a maximum ±19999 reading and is small enough to be carried in a standard attache case. It can be bench or rack mounted and weighs only 4.5 lb. Dc accuracy is 0.05% of reading ±1 digit and ac accuracy is ±0.2% of reading ±1 digit.

CIRCLE NO. 256

Frequency counters mount in panels

Anadex Instruments, Inc., 7833 Haskell Ave., Van Nuys, Calif. Phone: (213) 782-9527. P&A: see text; 4 wks.

The CPM-600 series of digital panel meter counters feature 10-mV sensitivity, 5-digit displays, BCD output, remote programming, integral power supplies and small size. Four models are presently available: the CPM-600 counter-timer ($425), the CPM-601 variable-time-base counter ($595), the CPM-603 frequency counter ($295) and the TPM-600 totalizer ($250).

CIRCLE NO. 257

REQUESTED DATA DELIVERY SERVICE is here—see card inside front cover.

85-mil Centers

If you need a bright spot of light but don't want to give up much real estate on your PC board, note our new MV5080-series. They're T-1 bulb size, and have straight-down leads that let you array them on 85-mil centers. They give you all the good things you expect from GaAsLITEs — long life, reliability, low power (1.6 V @ I_F=20mA). Let your mind wander over applications for our clear or red-lens versions for on-board diagnostics, film annotation arrays, or . . . **59¢***

*All prices quoted are unit price in 1000 lot quantities.

Panel Light Package

If you're looking for a panel indicator lamp that's as easy to mount as it is to see, gaze on our new MV5025, the T-1¾ bulb size. It's fully-flooded for maximum visibility from any angle and comes with its own snap-in bezel mount. Fits standard panels ranging in thickness from .062 to .125". It's quick, neat, and sexy as heck for dressing up your product. Also: when it comes time to cost out the panel light (a modest cost in your over-all part count anyhow) think what it costs to change a burned-out light bulb. Ours don't burn out. That's one reason so many smart engineers are doing the GaAsLITE thing in their new gear . . . **71¢** including mounting clip.

Axial leads, anyone?

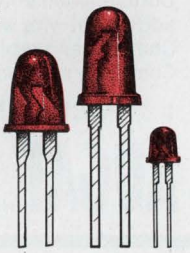
Our MV50 GaAsLITEs feature axial leads that can mount on 100-mil centers. More MV50's are in use today than any other light-emitting diode in the world. And the new red-lens version looks like a winner, too. The MV50 has documented reliability: over 400,000 hours of testing at maximum current. Oh, yes: it's bright, long-lived, and (yawn! you know this already) very low cost: **49¢**

GaAsLITE Update

In September we shipped more than a quarter million discrete GaAsLITEs. The reason? Availability on our distributors' shelves, proven reliability, low prices that even include extensive testing and applications help, and products like these:

More Panel Lights

Everything we've said already about the MV5025 goes for the other panel light varieties we offer under the secret code names of MV5010, 5020, and 5030. They have leads and lenses of varying lengths and sizes, and come in clear, clear red, diffused, red diffused, and . . . Hell, why don't you get our data sheet and figure out which one is right for your application. We know that one is bound to be. And they're beautiful . . . As low as **69¢**



Distributors at your service

All the GaAsLITEs we've mentioned here — and a whole lot more — are in stock, in quantity, at our fine distributors. Call your P.O. numbers to them.

Elmar Electronics
Kierulff Electronics
K-T/Wesco
Liberty Electronics
Schweber Electronics
Semiconductor Specialists
Western Radio

ENGLAND
Semicomps Ltd.
Semiconductor Specialists
FRANCE
Radio Television Francais
GERMANY
Alfred Neye-Enatechnik
ITALY
Silverstar Ltd.
JAPAN
New Metals & Chemicals Ltd.
SWEDEN
Ingenjoersfirman
Gunnar Petterson
SWITZERLAND
Omni Ray A/G

Monsanto

For additional technical information write
Monsanto Electronic Special Products
10131 Bubb Road, Cupertino, California 95014
(408) 257-2140

INFORMATION RETRIEVAL NUMBER 38

INSTRUMENTATION

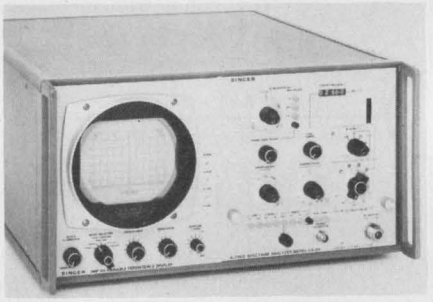
4-1/2-digit DMM houses 25 ranges

John Fluke Mfg. Co., Inc., Box 7428, Seattle, Wash. Phone: (206) 774-2211. P&A: $795; stock to 30 days.

A new 4-1/2-digit multimeter, the model 8120A, features 25 measurement ranges and modes. The instrument has ac and dc ranges from 100 mV to 1000 V, current ranges from 100 μA to 1 A and resistance ranges from 1000 Ω to 10 MΩ. Overranging on all ranges is 20%. Other features are fully guarded circuits and field-installable options.

CIRCLE NO. 258

Spectrum analyzer spans 0.5 to 1300 MHz



Singer Co., Instrumentation Div., 3176 Porter Dr., Palo Alto, Calif. Phone: (415) 493-3231. P&A: $5995 to $6995; 30 to 60 days.

A general-purpose spectrum analyzer with normal and variable-persistence storage displays operates from 500 kHz to 1300 MHz. The Alfred model SA-70 has a dynamic range of 141 dB—from −121 to +20 dBm—and can resolve equal-amplitude signals as close as 300 Hz. It also features a crystal-controlled marker generator, with markers at every 100 MHz across the band.

CIRCLE NO. 259

These amplifiers make your test equipment– and your budget–look good.

Hewlett-Packard's new wideband RF amplifiers improve the sensitivity of your scopes, spectrum analyzers, counters, network analyzers – anywhere you need low-noise, high-gain amplification.

As a result of HP's hybrid thin-film microcircuit technology, these amplifiers bring you superior performance and high reliability at low cost.

The table below gives frequency ranges, prices and performance of the six basic configurations. Dual channel versions of the preamps can also be supplied to improve the performance of 2-channel instrumentation.

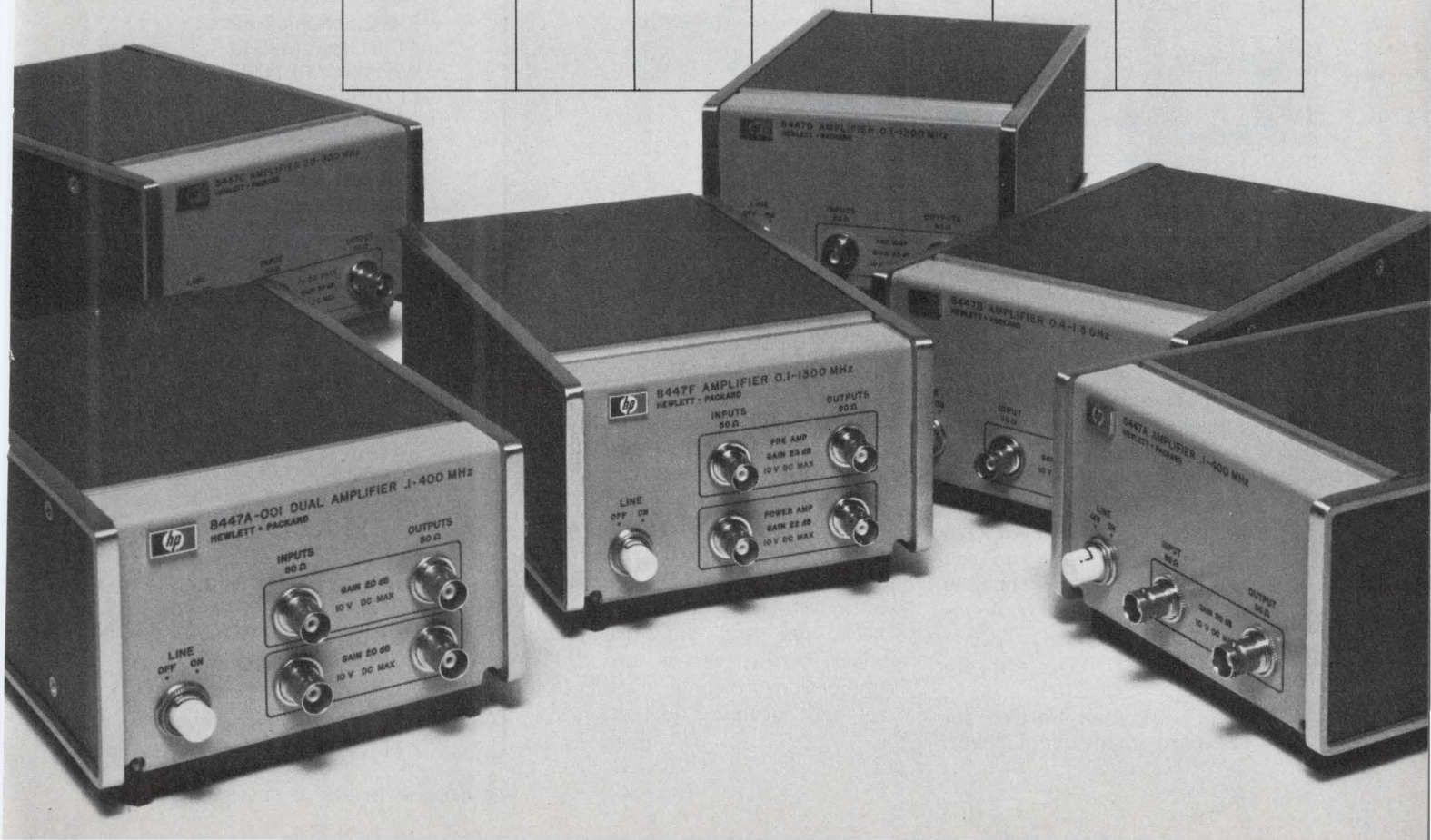
They're ready for delivery now. A call to your HP field engineer will bring you the details of how these amplifiers can help enhance the test equipment you're using now. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

04021A

HEWLETT-PACKARD 8447 SERIES LAB AMPLIFIERS

	HP 8447A Preamp	HP 8447B Preamp	HP 8447C Pwr. Amp.	HP 8447D Preamp	HP 8447E Pwr. Amp.	HP 8447F Preamp/Pwr. Amp.
Frequency Range	0.1-400 MHz	0.4-1.3 GHz	30-300 MHz	0.1-1300 MHz	0.1-1300 MHz	0.1-1300 MHz
Nominal Gain	20 dB	22 dB	30 dB	26 dB	22 dB	48 dB
Gain Flatness	±0.5 dB	±1 dB	±1 dB	±1.5 dB	±1.5 dB	±3 dB
Noise Figure	<5 dB	<5 dB to 1.0 GHz <6 dB, 1.0-1.3 GHz	<11 dB	<8 dB	<11 dB	<8 dB
Output Power @ 1 dB Gain Compression	>+7 dBm	>−3 dBm	>+17 dBm	>+7 dBm	>+14 dBm	>+14 dBm
Price	$550	$600	$450	$650	$700	$1175



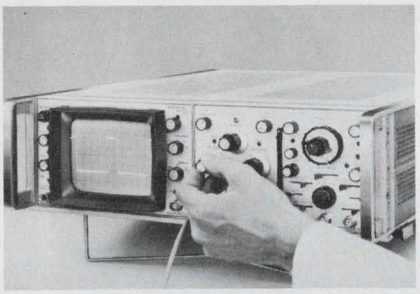
75-MHz counter/timer handles many functions

Monsanto Electronic Instruments, 620 Passaic Ave., W. Caldwell, N.J. Phone: (201) 228-3800. P&A: $895; stock.

The new half-rack counter/timer model 113A is a 75-MHz universal dual-input counter that can count or measure the frequency of electrical events, can measure the period, the average period, the ratio of two events, elapsed time, the time between events and the time between the leading and trailing edges of a pulse.

CIRCLE NO. 260

High-speed scope writes 1500 cm/μs



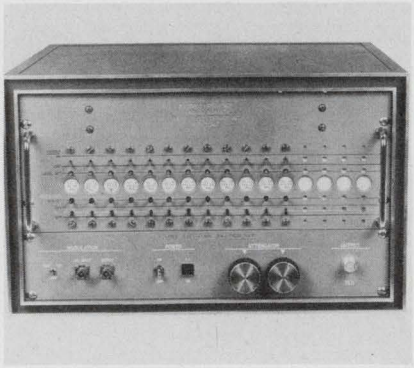
Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 493-1501. P&A: $950 (180C cabinet version), $1050 (180D rack version); 6 wks.

In the new model 180C/D version of its 180 series oscilloscopes, Hewlett-Packard has increased trace brightness by a factor of about 5 to give a writing speed of 1500 cm/μs (with P31 phosphor and 10,000 ASA film without film fogging). The new scope can use all existing plug-ins for the 180 series that give real-time frequency response to 100 MHz.

CIRCLE NO. 261

A FREE new Hayden Service for you—see card inside front cover.

Multi-channel source spans 50 to 300 MHz



Dix Hills Electronics, Inc., 163 Dix Hills Rd., Huntington Station, N.Y. Phone: (516) 271-9800. P&A: $6100; 6 wks.

A new multiple-frequency signal generator for CATV and broadband systems is useful in making cross-modulation, intermodulation and gain-flatness measurements. The SX-16 offers high-level, multiple-signal outputs over 50 to 300 MHz. Its front panel can accommodate up to 16 channels with +57 dBm V of output per channel (after combining).

CIRCLE NO. 262

Transistor tester provides fast checks

J & J Electronic Laboratories, Box 247, New City, N.Y. Phone: (914) 638-0776. P&A: $169.50; stock.

A new instrument uses a visual display on the face of a small CRT to ascertain the type of and the quality of the transistor under test. Named the Q Check model 100A, it can be operated by unskilled personnel and will provide an instant result by displaying characteristic patterns. It can check npn and pnp transistors, diodes, SCRs, zeners and UJTs. Applications include quality control and incoming inspection.

CIRCLE NO. 263

Why buy the Star of India? When you really need a little gem.

Overbuying can be princely fun. If you're the Aga Kahn.

But now, with the current budget squeeze, common sense has entered the picture. So has Raytheon's CDU-150 scope.

A top quality, general-purpose oscilloscope with price/performance second to none. DC to 35MHz at 5 mV/cm. Dual channel. Big, bright 8x10 cm display. Stable triggering over the full bandwidth. Time-base delay.

Plus light weight for honest portability. Ruggedness that can easily take hundreds of miles in the trunk of your car without a flutter. At a price of only $1495.

Think about it. The uncompromising quality of the CDU-150. And the money you save by not buying more than you need. Send us the coupon. Or contact the nearest sales reps on the opposite page.

Raytheon Company
Instruments Operation
175 Middlesex Turnpike
Bedford, Mass. 01730

Gentlemen: Send information on the CDU-150.

Name_____

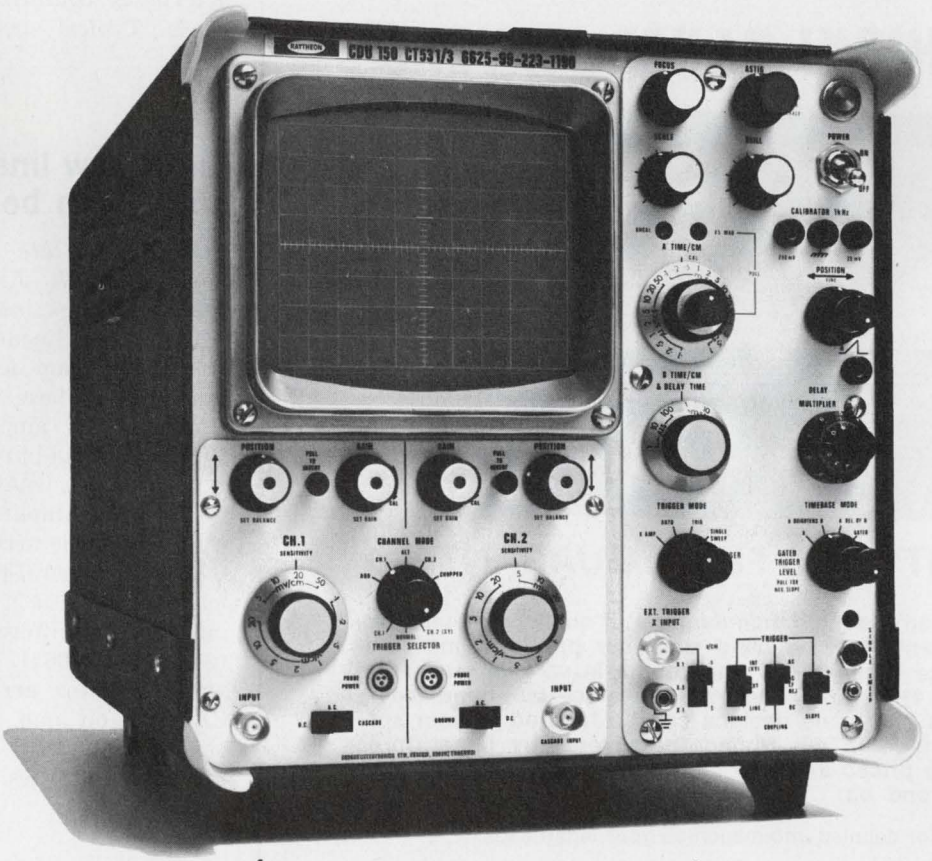
Company_____

Address_____

City_____

State_____ Zip_____

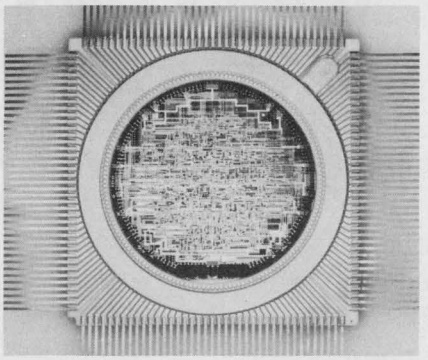
RAYTHEON



(Our little jewel.)

INFORMATION RETRIEVAL NUMBER 43

8-bit LSI multiplier comes on a single wafer



Hughes Aircraft Co., Microelectronics Div., 500 Superior Ave., Newport Beach, Calif. Phone: (714) 548-0671.

A new 8-bit full-wafer bipolar LSI multiplier is designed for high-speed signal processing and digital filtering applications. The new 8-bit plus-sign multiplier designated H1002MC is comprised of 52 full adders and 96 gates for an equivalent 616 gates integrated on a single 1-1/2-in. silicon wafer. It will operate at a rate of 8 million multiplications of two 8-bit words plus sign per second. Its electrical characteristics conform to TTL logic levels. Typical speeds are 10 ns/gate.

CIRCLE NO. 264

Eight new linear ICs come with beam leads

RCA Solid State Div., Rte. 202, Somerville, N. J. Phone: (201) 722-3200. Price: see text.

Eight new linear ICs are available with beam leads and sealed junctions. These include Type CA3015L op amp ($2.03), CA-3018L general-purpose transistor array ($1.53), CA3028AL differential/cascode amplifier ($1.39) and CA3039L diode array ($1.53). Also CA3045L general-purpose transistor array ($1.53), CA3054L dual independent differential amplifiers ($1.96), CA3084L general-purpose pnp transistor array ($2.80) and CA3741L op amp (internally compensated) ($2.70). All prices are for 100 quantities.

CIRCLE NO. 265

Announcing REQUESTED DATA DELIVERY, it's free—see card inside front cover.

NEW! THE PRAM.™

The first 4-channel programmable op amp. With more application possibilities than we could possibly list on this page.

HA-2400/2404/2405
Take a good look at this new linear building block. It's unique and so versatile we keep discovering more and more applications for it.

Each PRAM contains four preamplifier sections, one of which is selected through the DTL/TTL compatible inputs and connected to the output amplifier. The selected analog input terminals and the output terminal form a high performance operational amplifier for just about any use you can dream up. And we hope you'll dream up some. If you do, send them along to us and we'll see what we can dream up by way of a reward.

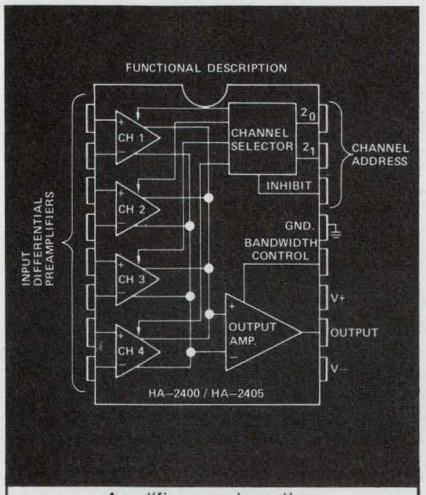
Features:

Offset current	5nA
Voltage gain	150K
Slew rate	
Av = +1	±15V/μs
Av = +10	±50V/μs
Gain Bandwidth Product	
Av = +1	8MHz
Av = +10	40MHz

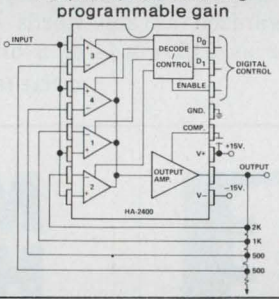
DTL/TTL compatible

	100-999 units
0° to +75°C	**$10.45**
−25°C to +85°C	**$15.95**
−55°C to +125°C	**$23.65**

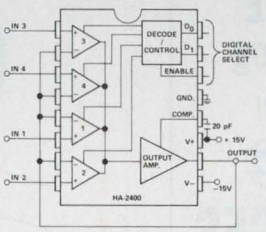
For more details on the PRAM contact your Harris representative or distributor.



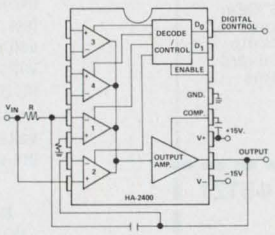
Amplifier, non-inverting programmable gain



Analog multiplexer with buffered input and output



Integrator/ramp generator with initial condition reset



More challenges:
The foregoing diagrams show just three of many applications we've designed using the PRAM. The following lists other possibilities we haven't had time yet to prove out. Why don't you try your hand at designing them or any other ideas you come up with, and send them to:
E. Fernandez
P.O. Box 883
Melbourne, Florida 32901.

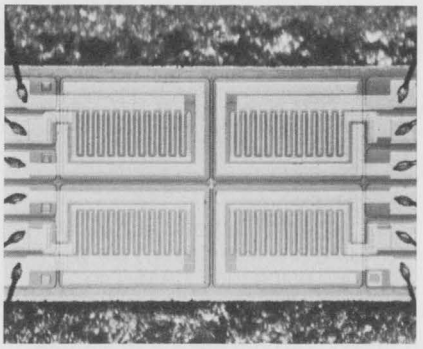
- A to D converter, Dual Slope Integrating
- Active Filter, State Variable Type with Programmable Frequency and/or Programmable "Q"
- Amplifier with Programmable D.C. Level Shift
- Chopper Amplifiers
- Crossbar Switches
- Current Source, Programmable
- F.M. Stereo Modulator
- F.S.K. Modem
- Function Generators, Programmable
- Gyrator, Programmable
- Monostable Multivibrator, Programmable
- Multiplier, Pulse Averaging
- Peak Detector with Reset
- Resistance Bridge Amplifier/ Comparator with Programmable Range
- Sense Amp/Line Receiver with Programmable Threshold
- Spectrum Analyzer, Scanning Type

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS-INTERTYPE CORPORATION
P.O. Box 883, Melbourne, Florida 32901
(305) 727-5430

DISTRIBUTORS: Schweber Electronics: Westbury, New York (516) 334-7474; Rockville, Maryland (301) 881-2970; Hollywood, Florida (305) 927-0511 **Harvey/R & D Electronics:** Lexington, Massachusetts (617) 861-9200/**Semiconductor Specialists, Inc.:** Chicago (312) 279-1000; Detroit (313) 255-0300; Minneapolis (612) 884-8132; Kansas City (816) 452-3900; St. Louis (314) 428-6100; Dallas (214) 358-5211; Indianapolis (317) 243-8271; Pittsburgh (412) 781-8120; Dayton (513) 278-9455/ **R.V. Weatherford Co.:** Albuquerque (505) 265-5671; Anaheim (714) 547-0891; Austin (512) Enterprise 1443; Dallas (214) 231-6051; Denver (303) 427-3736; Glendale (213) 849-3451; Houston (713) Enterprise 1443; Palo Alto (415) 321-5373; Phoenix (602) 272-7144; Pomona (714) 623-1261; San Diego (714) 278-7400; Seattle (206) 762-4200.

INFORMATION RETRIEVAL NUMBER 46

Quad transistor array delivers 1-A pulses

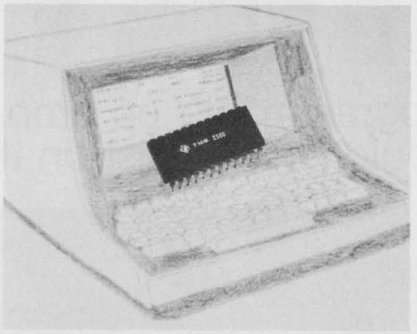


Harris Semiconductor, Melbourne, Fla. Phone: (305) 727-5412. P&A: $5.85 (100 quantities); stock.

A new quad npn transistor array consists of four transistors on a common chip and delivers up to 1 A of pulsed current. The HT-6500 array is intended primarily for use as a memory core and relay driver, or in similar applications requiring pulsed currents of up to 1 A at up to 50 V. In operation, one of the four transistors on the chip functions at any one time.

CIRCLE NO. 266

2560-bit ROM family accesses in 400 ns

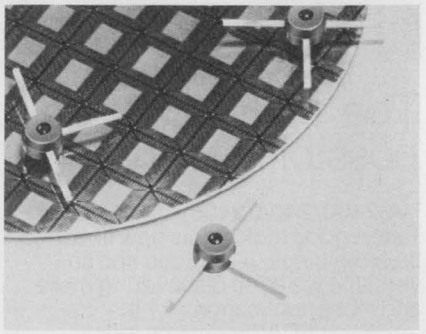


Texas Instruments, Inc., 13500 N. Central Expwy., Dallas, Tex. Phone: (214) 238-2011. P&A: from $11.25 (100 quantities); stock.

A new family of static 2560-bit MOS/LSI ROMs features access times of 400 ns. Designated the TMS2500 series, the circuits in this family are architectured for fast character generator and ROM applications in a variety of displays and peripherals. They may be organized as 256 words of 10 bits or as 512 words of 5 bits.

CIRCLE NO. 267

Miniature SCRs have 0.1-in. diameters

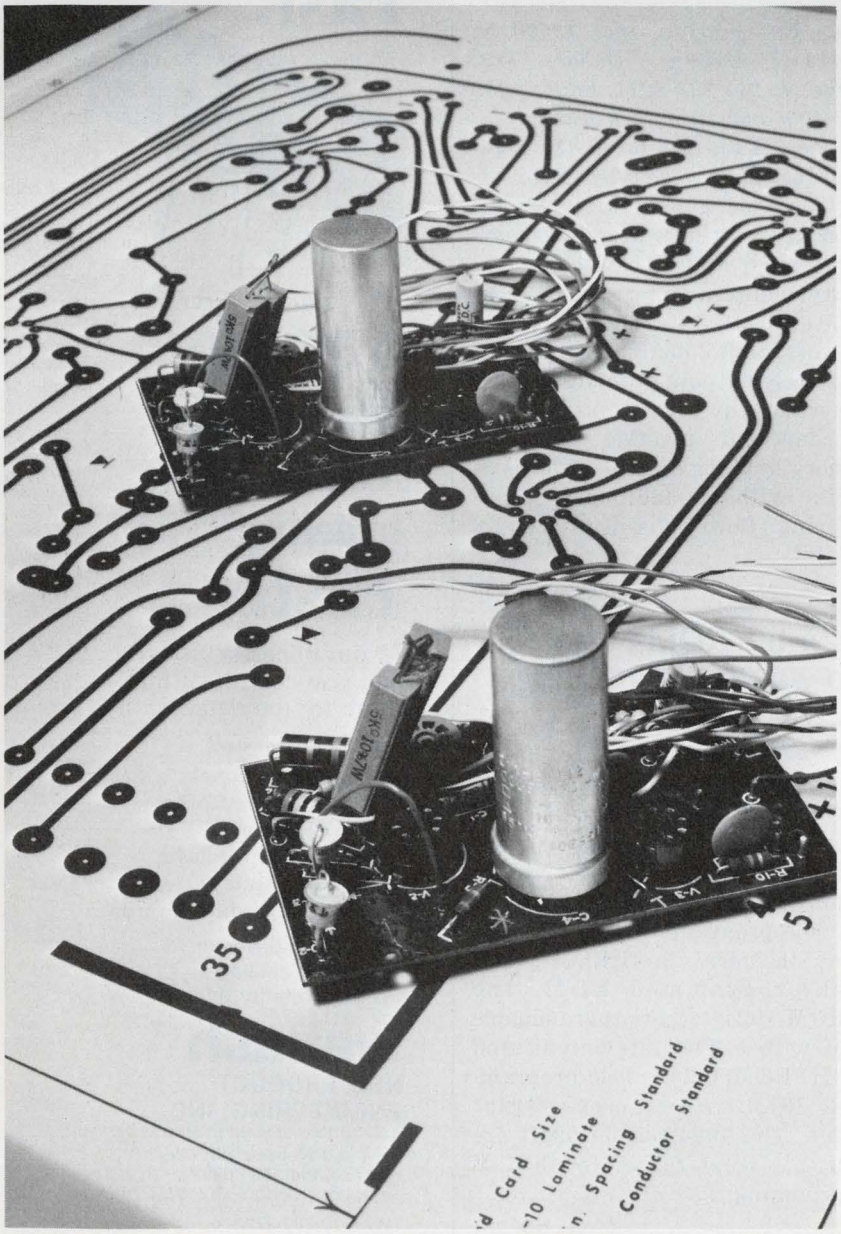


Motorola Semiconductor Products, Inc., Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: from $3.40 to $4.95; stock.

Control in miniature-space applications can be maintained by using the new Micro-T MCR051 through MCR054 plastic SCRs. The miniature-package SCRs are less than 1/10th of an inch in body diameter. Their gate trigger currents of 200 μA maximum provide triggering from low-level sources. Peak forward surge-current rating is 6 A.

CIRCLE NO. 268

Don't repeat yourself.



Use KODAGRAPH Films for repetitive design elements.

It's easy to bypass tedious retracing when the same design must be repeated in a drawing. Or when you want to transfer a design from one drawing to another. Let photography and Kodagraph films do the work for you.

We'd like to show your drafting/design department our new slide presentation, "Focus on Drafting." It will clue them in on the many shortcuts possible with Kodagraph films and papers. Whenever you're ready, just call your Kodak Technical Sales Representative.

Or write for literature to Eastman Kodak Company, Business Systems Markets Division, Dept. DP837, Rochester, N.Y. 14650.

DRAWING REPRODUCTION SYSTEMS BY KODAK

Kodak

INFORMATION RETRIEVAL NUMBER 49

ICs & SEMICONDUCTORS

Bi-directional one-shot IC has ±4-mV threshold

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. Phone:(408) 739-7700. P&A: $5 (100 quantities); stock.

A new bi-directional one-shot digital IC is available for use in disc file controllers and in applications that require high-speed low-level-signal processing. Designated as the N8T20B, the IC functions as a zero-crossing detector with thresholds of ±4 mV over its dynamic range of −3.2 to +4.2 V. Typical propagation delay time is 30 ns.

CIRCLE NO. 269

256-bit TTL RAM accesses in 45 ns

Texas Instruments, Inc., 13500 N. Central Expwy., Dallas, Tex. Phone: (214) 238-2011. P&A: 10¢/bit (100 quantities); 8 wks.

A new TTL 256-bit RAM organized as 256 words by 1 bit is fully decoded and features typical 15-ns access times from memory-enable input and 45-ns access from binary address inputs. The SN-74200's triple-state outputs retain the desirable characteristics of totem-pole outputs yet may be bus-connected. Up to 256 outputs can be connected together to form memory systems up to 65k words of n bits without additional output buffering. Power dissipation is 1.8 mW/bit.

CIRCLE NO. 270

1024-bit ROMs offer two-way programming

Harris Semiconductor, Melbourne, Fla. Phone: (305) 727-5412. Price: $55 for programmable devices and $33 for custom-programmed devices (100 quantities).

A new series of 1024-bit ROMs includes both mask-programmed and field-programmed devices. The series includes the HROM-1024B mask-programmed ROM, the HPROM-1024 field-programmable ROM with a Tri-state output, and the HPROM-1024A field-programmable ROM with an open-collector output. The 1024A and 1024B are identical except for the method of programming.

CIRCLE NO. 271

Agc IC amplifier works up to 2 MHz

Lithic Systems, Inc., Box 869, Cupertino, Calif. Phone: (408) 257-2004. P&A: $11.70 (100 quantities); stock.

The LS170 agc IC is a dc-to-2-MHz monolithic amplifier whose gain may be continuously varied by an external dc voltage. It also has an independent input level detector which provides the high current, fast attack and slow release needed for squelch and VOX switching. The LS170 has input characteristics similar to those of an op amp. Operating voltage range is from 4.5 to 24 V. At 4.5 V, power dissipation is 18 mW.

CIRCLE NO. 272

MOS calculator sets provide low-cost logic

Electronic Arrays, Inc., 501 Ellis St., Mountain View, Calif. Phone: (415) 964-4321. P&A: $40/set (100 quantities); stock.

Two new MOS calculator circuit sets are designed to provide low-cost logic with standard or custom programming. The S-101 and S-114 are 4-chip versions of the standard S-100 6-chip MOS calculator set. The S-101 handles 8-digit entries and the S-114 16-digit entries. Both provide keyboard input processing, add, subtract, multiply, divide, stored-constant operation, keyboard setting of decimal-point location and BCD outputs.

CIRCLE NO. 273

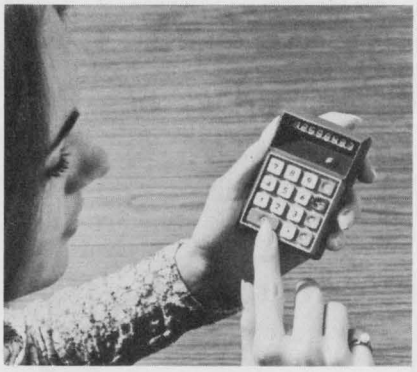
Linear IC trio form color TV chroma system

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. Phone: (408) 739-7700.

Three monolithic ICs constitute a complete chroma system for color TV receivers. The system consists of the N5070B chroma signal processor, the N5071A chroma amplifier and the N5072A chroma demodulator. The N5071A features automatic color control, dc chroma gain control, a color killer and short-circuit protection. The N5070B features dc hue control and a shunt regulator. The N5072A achieves the R-Y, G-Y and B-Y color difference outputs.

CIRCLE NO. 274

Shirt-pocket calculator retails under $100



Ragen Precision Industries, Inc., 9 Porete Ave., N. Arlington, N.J. Phone: (201) 997-1000. Price: see text.

A new shirt-pocket-sized electronic calculator features a tiny 2-3/8 by 7/8 by 3-1/2-in. size and retails under $100. The new eight-digit (16-digit capacity) "micro" calculator can add, subtract, multiply and divide and uses a floating decimal point. It operates for more than a year on throw-away batteries that need no recharging.

CIRCLE NO. 275

Thermal printer-key unit has expandable memory

Electronic Communications, Inc., 1501 72 St., St. Petersburg, Fla. Phone: (813) 347-1121. Price: under $8000.

A new thermal printer-keyboard with an expandable message memory is the ANGGC-46 Mini Comm-Terminal with an MTBF of 2000 h and a small size of 5 by 13 by 17 in. It can receive hard copy at 300 words/minute (30 characters/s) and transmit at unlimited speed. It has an optional incoming storage memory and 94 alphanumeric characters designed from a 35-element matrix font of 7 horizontal lines and 5 dots.

CIRCLE NO. 276

Selectric KSR terminal leases at $52/month

Terminal Equipment Corp., 750 Hamburg Tpke., Pompton Lakes, N.J. Phone: (201) 839-3000. P&A: see text; 60 days.

The new Holmes Tycom model 38 KSR terminal can be leased at only $52/month with the customer furnishing the Selectric typewriter. Maintenance service will be provided by Terminal Equipment or by the Raytheon Service Co. through its network of service centers across the country. The Tycom 38 replaces Teletype Corp. models 33, 35 and 38 terminals.

CIRCLE NO. 277

DATA PROCESSING

Real-time software for 620 computers

Varian Data Machines, 2722 Michelson Dr., Irvine, Calif. Phone: (714) 833-2400. P&A: $48,000 for a complete package which includes installation, training and documentation.

Vortex (Varian Omnitask Real-Time EXecutive) operating system is a new software package that significantly increases the capability of a Varian 620 computer installation. It custom tailors computer hardware, rotating memories, and peripheral devices into a true real-time system.

With Vortex software controlling the system, the user is freed from such chores as I/O handling, interrupt servicing, and resource allocation. These operations are handled instead by a real-time executive task stored in the computer's main memory, which enables the user to assign priorities to real-time foreground duties, that may be loaded and run either immediately or in the future.

This can be in response to a real-time clock, an external interrupt, the operator or an inter-task command.

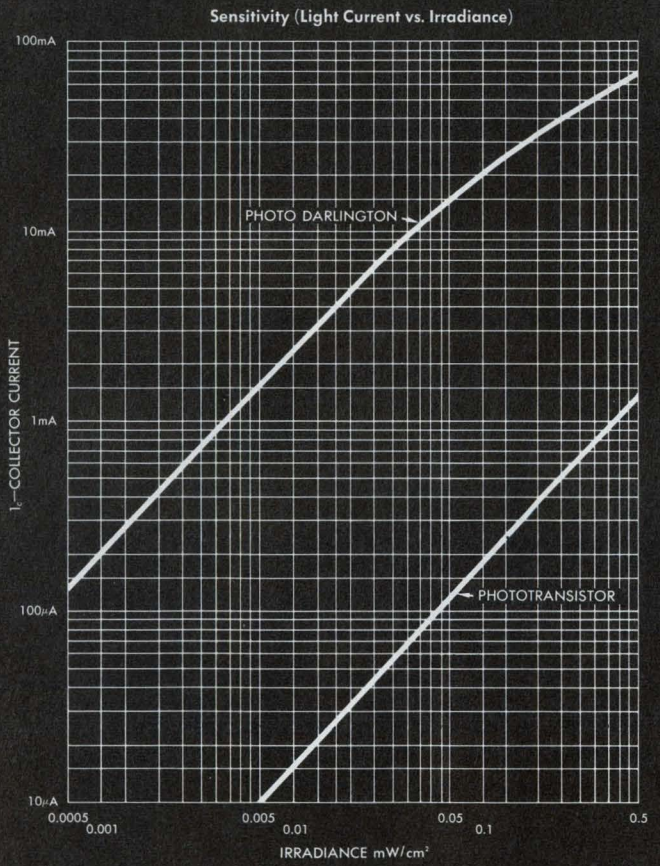
The real-time program performs the housekeeping functions that permit general-purpose background tasks to be run concurrently with the real-time foreground operations in multi-programming.

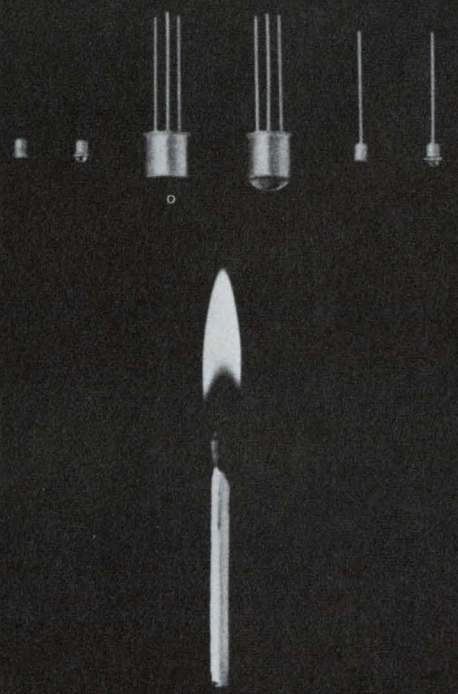
This multi-programming capability of the Vortex system takes advantage of normally wasted periods of idle time which are embedded in most programs. Since such periods often constitute a large percentage of the run time of a program, Vortex may actually double system hardware utilization by using these periods to run lower priority tasks.

The fact that all foreground tasks and the Vortex nucleus run in protected memory insures system integrity for the real-time application. At the same time, the background user has such advantages as easier software debugging (e.g. his program may blowup in the background without disturbing system operation or necessitating lengthy coldstarts and reload operations).

CIRCLE NO. 278

Clairex phototransistors give you higher sensitivity at extremely low illumination levels.... and they cost no more.





One of our customers is using our phototransistors to detect signals from an LED at distances up to 60 feet.

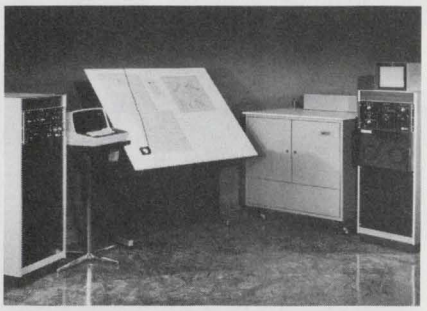
If you need phototransistors to give you more current at lower light levels, call (914) 664-6602, or write Clairex®, 560 South Third Avenue, Mount Vernon, New York 10550.

CLAIREX ELECTRONICS

A DIVISION OF CLAIREX CORPORATION

INFORMATION RETRIEVAL NUMBER 58

Graphics digitizer simplifies CAD

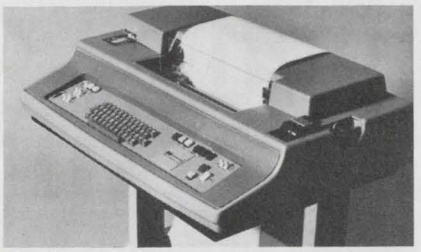


Bendix Computer Graphics, 23850 Freeway Park Dr., Farmington, Mich. Phone: (313) 477-3700. Price: approx. $100,000.

A new computerized system can be used by unskilled personnel to generate precise engineering drawings from rough sketches in a fraction of the time required by trained designers using conventional methods. Called the Interactive Graphic System 100, it allows the operator to communicate with the computer without knowing programming or data processing techniques.

CIRCLE NO. 279

Asynchronous terminal prints 30 characters/s

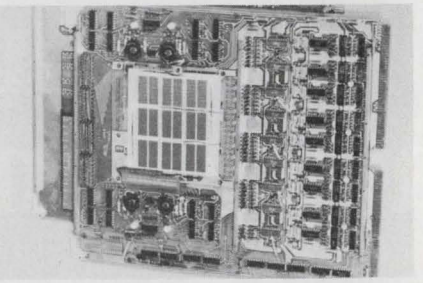


Synerdata, 133 Brimbal Ave., Beverly, Mass. Phone: (617) 927-3222. P&A: see text; 30 days.

TotalTerm, a new high-speed 30-character/s communications teleprinter, is an asynchronous system which prints on edge-sprocketed multi-part forms and is fully adjustable to 132 columns. It incorporates a proprietary incremental printing mechanism, solid-state circuitry and controls and a power source with a one-year warranty on all parts. Purchase prices are: $4200 for RO models, $4760 for KSR models and $6490 for ASR models. Lease and maintenance terms are also available.

CIRCLE NO. 280

Space-saving core memory cycles in 650 ns



Lockheed Electronics Co., Inc., 6201 E. Randolph St., Los Angeles, Calif. Phone: (213) 722-6810.

A new core memory system offers users high-speed operation (650-ns cycle time) at space savings of 25 to 30% over conventional systems of equal performance and capacity. The CB-65 memory system uses 18-mil cores in 3-wire 3D arrays. A single logic board carries 4096 18-bit words of memory, the entire bit structure of the words and all the sensing electronics. A second timing and interface logic board completes the entire system.

CIRCLE NO. 281

AIRPAX™ Type 203 Electromagnetic Circuit Protector

Now with Illuminated Rocker Arm

This exclusive combination of ON-OFF switch function, snap-in front panel mounting, and illuminated single-rocker actuator has made the Airpax Type 203 Circuit Protector ideal for use in computers, computer peripherals, copying machines, air conditioners, marine controls, and other high-quality industrial and military equipment where accurate, reliable protection is demanded.

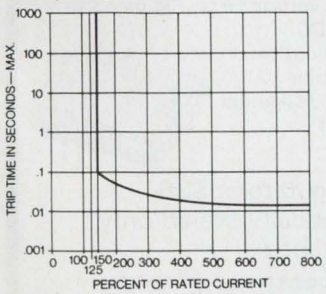
ACTUAL SIZE

FEATURES

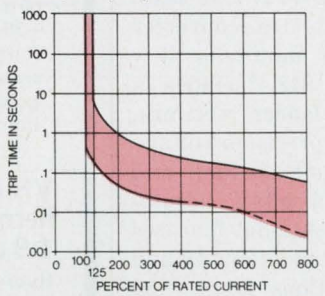
- Illuminated single rocker actuator for 1, 2, or 3-pole assemblies
- Choice of illumination voltages
- Snap-in front panel mounting for fast, economical installation
- Optional flush rear mounting available
- 32V DC and 250V AC (50/60 or 400 Hz)
- Current ratings from 0.020 to 20 amperes
- Choice of inverse time delay or instant trip

Trip Time vs Percent Rated Current @ 25°C

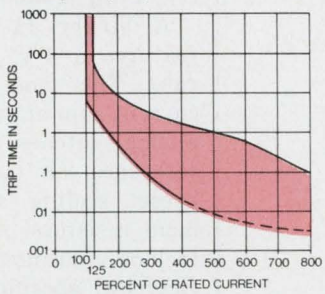
Delays 40, 50, 60



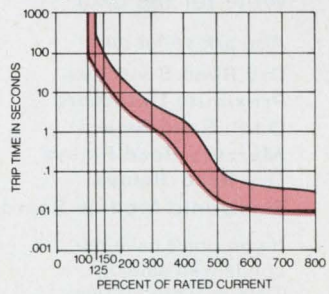
Delays 41, 51, 61



Delays 42, 52, 62



Delays 43, 53, 63



Delays 40, 41, 42 and 43 are for use in 400 Hz systems; delays 50, 51, 52 and 53 are for use in DC systems; and delays 60, 61, 62 and 63 are for use in 60 Hz systems.

For complete details, specifications and application examples, call or write:

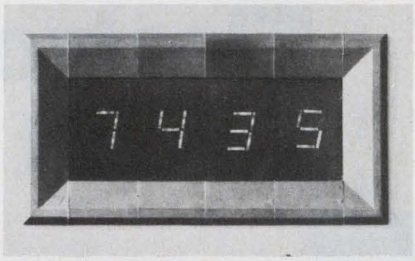
AIRPAX™

AIRPAX ELECTRONICS / CAMBRIDGE DIVISION / Cambridge, Maryland 21613 / Phone (301) 228-4600 / TELEX 8-7715 / TWX 710 865-9655

INFORMATION RETRIEVAL NUMBER 61

MODULES & SUBASSEMBLIES

Green LED display is available commercially

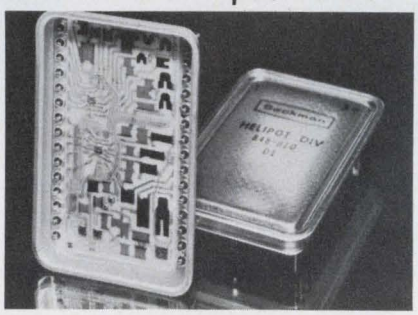


Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. Phone: (408) 257-2140. P&A: under $10/digit (1000 quantities); stock.

Monsanto has introduced the first commercially available green GaP LED display. The device peaks at 5600Å, very close to the average human eye's response which peaks from 5500 to 5600Å. Except for its thickness of 0.18 in. and 0.125-in. lead length, it has the same physical characteristics as those of the MAN-1A.

CIRCLE NO. 282

11-bit d/a converter slews at 4 V/μs



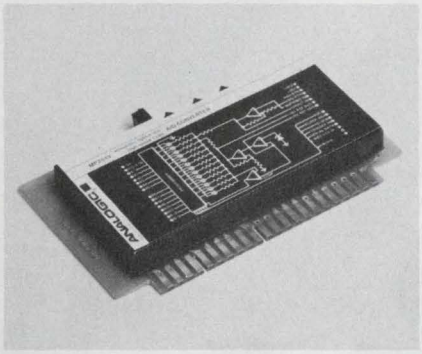
Beckman Instruments, Inc., Helipot Div., 2500 Harbor Blvd., Fullerton, Calif. Phone: (714) 871-4848.

A binary 11-bit d/a converter features a 4-V/μs minimum slew rate. The model 848 includes a current-summing ladder network, analog switches, a precision voltage reference, an output op amp and preset scaling and offset adjustment resistors. Additional features include guaranteed montonicity and electrical specifications from −55 to +125°C. It meets MIL-STD-883 environmental specifications.

CIRCLE NO. 283

Have you filled out your free REQUESTED DATA DELIVERY enrollment form? See card inside front cover.

13 and 14-bit a/ds convert to 6 μs/bit

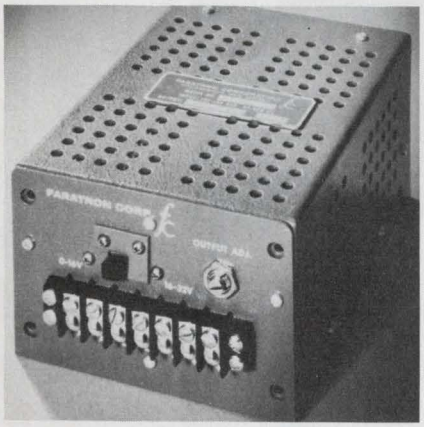


Analogic, Audubon Rd., Wakefield, Mass. Phone: (617) 246-0300. P&A: $345, $395; stock to 3 wks.

New series 2813 and 2814 13 and 14-bit monolithic hybrid a/d converter modules feature accuracy to ±0.01% of full scale, stability to 6 ppm and an adjustable clock of 2 to 6 μs/bit. Their precision voltage switches track over the range of 0 to +70°C. Input options of +5 V, +10 V, ±5 V, ±10 V and ±10.24 V full scale may be specified. An optional input amplifier can be supplied in several gain ranges.

CIRCLE NO. 284

Tiny 0-to-32-V supply delivers up to 1.75 A



Faratron Corp., 290 Lodi St., Hackensack, N.J. Phone: (201) 488-1440. P&A: $95; 3 days.

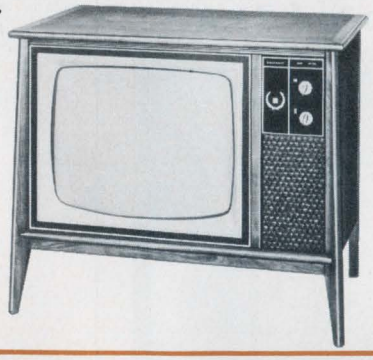
The model MR-95 is a 0-to-32-V dc supply with a 175 A output capability. A front-panel slide switch enables the user to select either 0-to-16 or 16-to-32-V dc ranges. The supply has a constant-current limiting feature and line and load regulation of ±0.005% for rated input changes and no load to full load respectively. Ripple is under 0.5 mV rms.

CIRCLE NO. 285

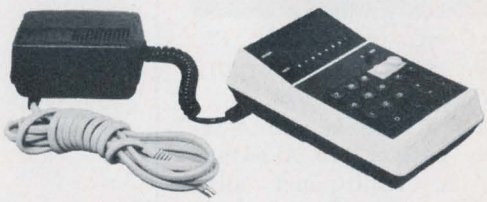
We'll send you on the vacation cruise of a lifetime if you can choose the ten ads appearing in the January 6th, 1972 issue that get highest reader recall "seen" scores in the same ranking as selected by readers. It only takes a little time and some marketing smarts to enter. And it's fun to see if you can outsmart the experts! It may be your ticket to winning these nifty prizes:

1st PRIZE—10 unforgettable days for 2, cruising the storied Caribbean aboard the coveted Windjammer schooners. Sunshine and blue water unlimited... enough out-of-the-way beaches and tropical lagoons to last a lifetime of memories. AND round-trip luxury flights for 2.

2nd PRIZE—Heathkit 25-inch Solid State Color TV. World's most unique color TV, ultra rectangular, largest picture in the industry.



3rd PRIZE—Brother miniaturized Desk-Top Digital Calculator—and 100 other prizes.



Nothing to write, no gimmicks—all you need do is check the ads carefully and pick those you think have the most memorable information and data and will be best read by your colleagues in engineering and management. It's the one contest that tests your marketing sense. It proves, once more, that computers can't do everything.

Electronic Design

1972 TOP TEN CONTEST

More Prizes, More Excitement, More Fun Than Ever Before! It's All In The January 6th Issue.

FOLLOW THESE EASY STEPS...IT COULD BE YOUR FIRST STEP TOWARD A CARIBBEAN CRUISE!

1. Look over the January 6, 1972 issue with extra care.
2. Pick the 10 ads that you think will be the best read in the Jan. 6 issue.
3. List your selections on the specially provided Top Ten entry blank available in the January 6, 1972 contest issue.
4. Mail to Electronic Design before midnight, March 15, 1972.

This year the Top Ten ads will again be selected on the basis of "Recall Seen" scores. This means that attractive, well-designed ads in smart form will be *on a par* with strong marketing ads... messages that offer dramatic news, give complete product data and features in compelling copy terms...ads that produce purchasing action for advertisers.

The judges will select winning entries based on the "seen" category of Reader Recall—Electronic Design's method of measuring readership in the contest issue. Remember, in selecting your Top Ten list of ads, be sure to watch for both the graphic form and appealing words that you think would stimulate a strong sales reaction from our 74,000 engineer subscribers.

READ THE RULES CAREFULLY, EXAMINE THE ADS, MAIL IN YOUR ENTRY BEFORE MARCH 15, 1972, AND THIS YEAR YOU MAY BE THE WINNER OF THE WINDJAMMER CRUISE OF A LIFETIME!
ENTRY FORMS IN THE JANUARY 6TH ISSUE

1972 TOP TEN READER CONTEST RULES

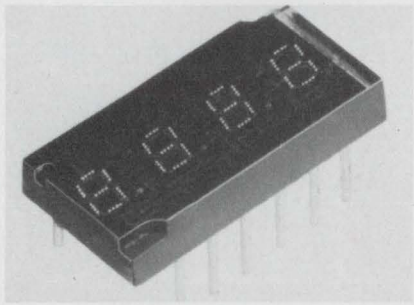
1. Enter your Top Ten selections on the entry blank provided, or on any reasonable facsimile. Be sure to indicate the names of the advertiser and page number for each of your choices. These choices should be placed in the order you think readers will rank them. (Ads placed by Hayden Publishing Company in Electronic Design should not be considered in this contest.)
2. No more than one entry may be submitted by any one individual. Entry blank must be filled in completely, or it will not be considered. The box on the entry blank marked "Reader Contest" must be checked. Electronic Design will pay postage for official entry blanks only.
3. To enter, readers must be engaged in electronic design engineering work, either by carrying out or supervising design engineering or by setting standards for design components and materials.
4. No cash payments, or other substitutes, will be made in lieu of any prize.
5. Contest void where prohibited or taxed by law. Liability for any taxes on prizes is the sole responsibility of the winners.
6. Entries will be compared with the "Recall Seen Most" category of Reader Recall (Electronic Design's method of measuring readership). That entry which in the opinion of the judges most closely matches the "Recall Seen Most" rank will be declared the winner.
7. In case of a tie, the earliest postmark will determine the winner. Decisions of Top Ten contest judges will be final.

THERE IS A SEPARATE CONTEST— SEPARATE PRIZES FOR ADVERTISERS

Each advertisement ranking in the Top Ten will receive a free rerun. In addition there is a separate contest, separate prizes for advertisers. The 3 winners can also receive free ad reruns. SEE THE LAST PAGE OF THE JAN. 6, 1972 ISSUE FOR RULES AND PRIZE INFORMATION.

MODULES & SUBASSEMBLIES

7-segment LED displays come in 4-digit arrays

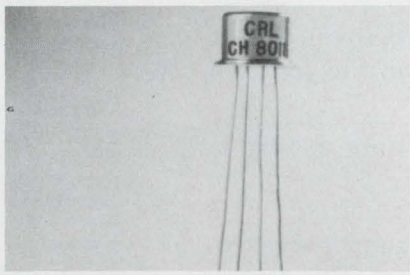


Litronix, 19000 Homestead Rd., Cupertino, Calif. Phone: (408)257-7910. P&A: $3.80/digit (1000 quantites); stock.

A new four-digit array of seven-segment LED displays is the Data-Lit 34 which has 0.125-in.-high characters and exhibits four times the light-emitting area as the MAN-3A, its nearest competitive device. It has brightness of 200 foot-lamberts at 5 mA. In pulsed operation, with average current as low as 2 mA, the device has a typical brightness of 100 foot-lamberts. The four digits are mounted in a standard 14-pin DIP on 0.187-in. centers and can be stacked end-to-end.

CIRCLE NO. 286

Reference amplifiers start from 10-ppm TC



Centralab Semiconductor, 4501 N. Arden Dr., El Monte, Calif. Phone: (213) 686-0567. P&A: from $4.25 (1000 quantities); 4 to 6 wks.

A new family of stable reference amplifiers for use in precision measuring applications includes the CH2001 through CH2004 which exhibit reference-voltage temperature coefficients of ±10, ±25, ±50 and ±100 ppm/°C, respectively. The new amplifiers consist of matched npn transistor and reference-diode chip combinations in TO-12 packages (4-pin TO-5s). Operating temperature range is from 0 to +75°C.

CIRCLE NO. 287

Limiter/dead-band units enhance analog designs

Optical Electronics, Inc., Box 11140 Tucson, Ariz. Phone: (602) 624-8358. P&A: $65, $32; stock.

Two new analog function modules are available. The model 9005 features independent negative and positive limiting levels and has 0.1% accuracy of input signal and limiting levels. Its gain changes from unity below limiting to less than 0.001 above limiting. Model 9006 is a precision analog dead-band unit. Its output is at zero until the input is above a given positive and negative threshold level. Gain below the threshold is less than 0.01 and unity above the threshold.

CIRCLE NO. 288

D/a converters settle in 20 μs

Zeltex, 1000 Chalomar Rd., Concord, Calif. Phone: (415) 686-6660. P&A: $19, $39; stock.

New ZD429 and ZD433 d/a converters accept 2 and 3-digit BCD inputs and provide corresponding outputs of 0 to +9 V and 0 to +9.99 V. These completely self-contained units have a settling time of 20 μs and ±1/2-LSB linearity. Their temperature coefficient is ±20 ppm/°C. Additional features include pin-for-pin compatibility between models, adjustable full scale and zero offset, DIP socket compatibility and a 16-h burn-in at 85°C to ferret out infant mortality.

CIRCLE NO. 289

Digital-to-sine/cosine converter uses 1.2 W

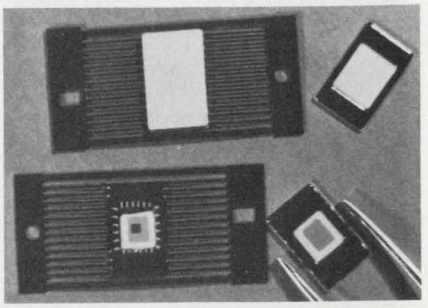
Progressive Technology, Inc., 1019 Westminster Ave., Dix Hills, N.Y. Phone: (516) 586-6382. P&A: $385; stock.

A new low power digital-to-sine/cosine dc converter is the model DSC-1212 which features a total power consumption of only 1.2 W. Its accuracy is a full 12 bits ±1/2 LSB. The analog outputs are 10-sine θ and 10 cosine θ with a temperature dependence of 10 ppm/C maximum. The converter is a module 3.5-in. long by 2.5-in. wide by 1.25-in. in diameter.

CIRCLE NO. 290

PACKAGING & MATERIALS

Beryllia ceramic cases enhance IC packaging

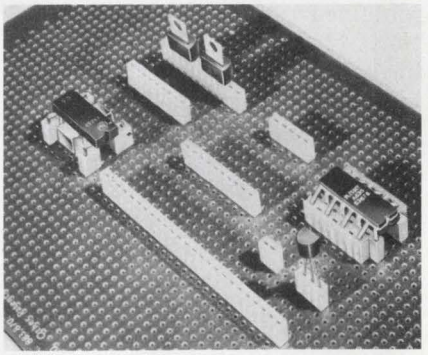


Brush Beryllium Co., Metal and Oxide Div., Elmore, Ohio. Phone: (419) 862-2715.

A full line of new beryllia ceramic flatpack and dual-in-line packages are available for integrated circuit designers. The packages offer substantially lower thermal resistance and superior heat dissipation than either alumina or plastic packages. They are designed for applications in packaging high-speed TTL and ECL integrated circuits.

CIRCLE NO. 291

Single-strip socket holds 25 contacts

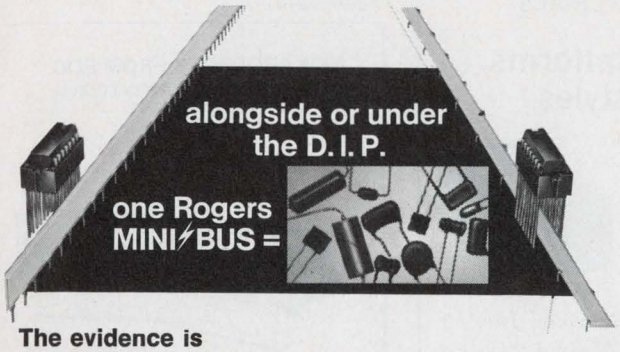


Jermyn, 712 Montgomery St., San Francisco, Calif. Phone: (415) 362-7431. Price: $1.25.

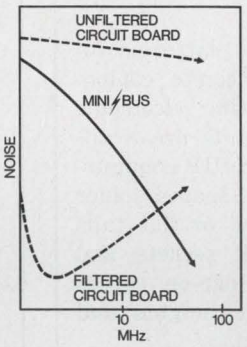
The A23-2033TR 25-contact single-strip socket provides the ideal answer to most non-standard requirements. This new concept in socket design for IC and semiconductor devices is molded in transparent glass-filled nylon and can accept flat or round leads. It can be cut into any number of contacts and mounted in any configuration on a 0.1-in. matrix.

CIRCLE NO. 292

REQUESTED DATA DELIVERY SERVICE is here—see card inside front cover.



The evidence is accumulating. You may eliminate *all* discrete by-pass capacitors — and get a lower-noise printed circuit board at frequencies where it counts — with a single Rogers Mini/Bus.



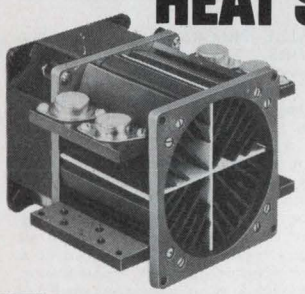
DELIVERY: Standard configurations are available on short notice. **Telephone EAST: (203) 774-9605; WEST: (602) 963-4584** to know where we stand today on your requirements. Ask for our Mini/Bus brochure, showing standard parts.

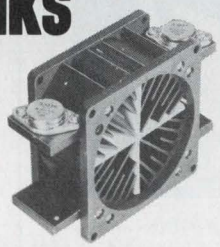
Rogers Corporation Rogers, Conn. 06263 (203) 774-9605

INFORMATION RETRIEVAL NUMBER 70

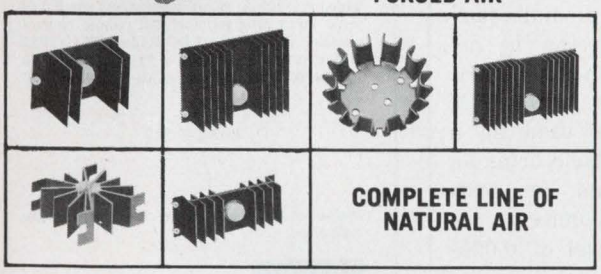
tran-tec

IMPROVED-DESIGN HEAT SINKS





COMPLETE LINE OF FORCED AIR



COMPLETE LINE OF NATURAL AIR

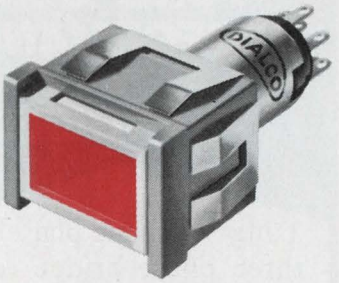
We fabricate heat sinks to your specifications. Write for NEW CATALOG.

tran-tec
CORPORATION
P.O. Box 1022 — Columbus, Nebr. 68601

INFORMATION RETRIEVAL NUMBER 71

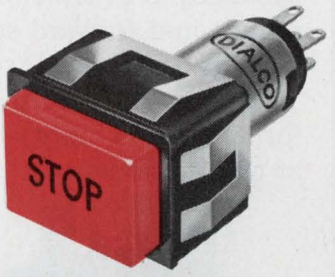
You say you want a

low-profile snap-in-mounting push button switch or matching indicator that is interchangeable with most 4-lamp displays... available in a full range of cap colors ...with a choice of bezels with or without barriers in black, gray, dark gray or white.



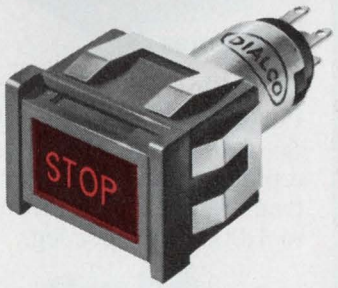
and a

legend presentation that's positive (like this one) or negative (like the one below) or just plain (like the one above)... one that's white when "off" and red, green, yellow (amber), blue or light yellow when "on"... or colored both "on" and "off."



and a

highly reliable switch proven in thousands of installations ... available in momentary or alternate action... N.O., N.C. or two circuit (one N.O., one N.C.)... that accommodates a T-1¾ bulb with midget flanged base, incandescent, in a range of voltages from 6-28V.



etc.
etc.
etc.

Now, for the first time Dialight gives you custom panel designing with a standard line of push-button switches and matching indicators

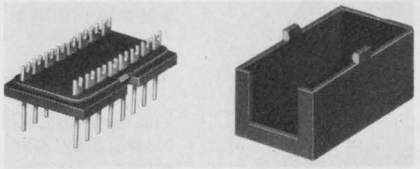
Dialight offers a broader range of switch and indicator possibilities than you'll find anywhere in a standard single-lamp line. Sizes: ¾″ x 1″, ⅝″ and ¾″ square and round. Send today for our new catalog.

DIALIGHT

Dialight Corporation, 60 Stewart Ave., Brooklyn, N.Y. 11237 DT-125

INFORMATION RETRIEVAL NUMBER 72

Component platforms come in DIP styles

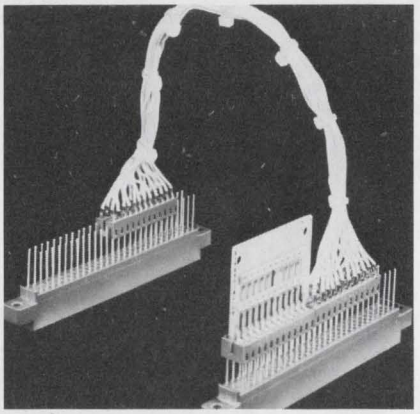


Component Mfg. Service, Inc., 1 Component Park, W. Bridgewater, Mass. Phone: (617) 588-0163. P&A: 62¢ for 14-pin platform with cover (500 quantities); stock to 4 wks.

Versatile low-cost platforms allow mounting of discrete components and constructing electronic circuits. The new units are available in 14 and 16-pin DIP configurations and feature U-shaped solder terminals with round or flat tails that plug into DIP sockets and packaging panels. Snap-on covers are available in five heights and permit encapsulation.

CIRCLE NO. 293

Transition connector interfaces backplanes



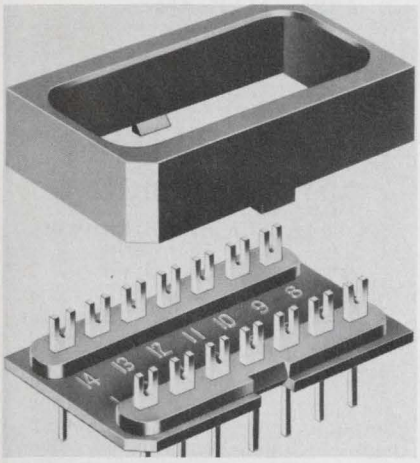
SAE Advanced Packaging, Inc., 2165 S. Grand Ave., Santa Ana, Calif. Phone: (714) 540-9256.

The 2501-24 series multi-purpose transition connector is designed to interface with backplanes. Pin-to-pin compatible with IBM equipment, it can be used as a board-mounting receptacle or as an input-output, cable-end or test-point connector. The connector engages on the third level of 0.025-in. Wire-Wrap pins with conventional 0.125 by 0.25-in. spacing.

CIRCLE NO. 294

A FREE new Hayden Service for you—see card inside front cover.

Adapter plug assemblies use snap-open covers

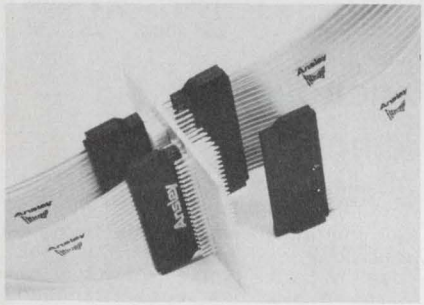


Augat, Inc., 33 Perry Ave., Attleboro, Mass. Phone: (617) 222-2202. P&A: 10¢ to 50¢; stock to 2 wks.

New inexpensive plugs may be used as module bases with open-top snap covers for potting. They are available in 14 and 16-contact configurations with polarization notch and numbers for identification and plug into standard 8136 series IC packaging panels. Plugs and covers are available separately in glass-filled nylon material and gold-over-nickel-plated slotted brass contacts.

CIRCLE NO. 295

Connector-cables stack on 0.1-in. centers



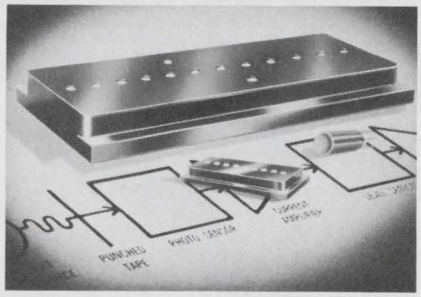
Ansley Electronics Corp., 4100 N. Figueroa St., Los Angeles, Calif. Phone: (213) 223-2333. Price: $7.50 (100 quantities of 12-in. cable).

New flat Flex-Strip connector-cable assemblies can be stacked row-to-row on 0.1-in. centers. They can easily be plugged into either side of back-panel wiring systems, to pins mounted on circuit boards, to NAFI type hardware and to ends of other cables. Three types of contacts are available.

CIRCLE NO. 296

MICROWAVES & LASERS

Opto-hybrid devices contain sensors/amps

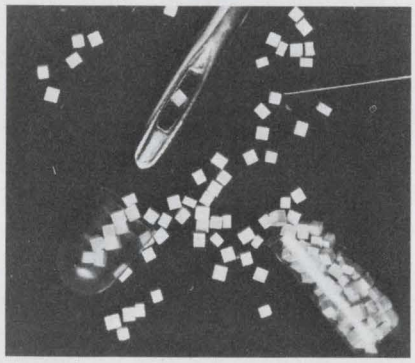


Centralab Semiconductor, 4501 N. Arden Dr., El Monte, Calif. Phone: (213) 686-0567. Availability: 4 to 6 wks.

A new series of standard 1, 9 and 12-position IC chip opto-hybrid devices utilize monolithic IC chip amplifier/digitizers with DTL/TTL-compatible outputs. With built-in light sensors, they provide a complete sub-system with plug-in-and-use convenience for applications of light sensing at precise levels.

CIRCLE NO. 297

Porcelain capacitors work up to 12 GHz



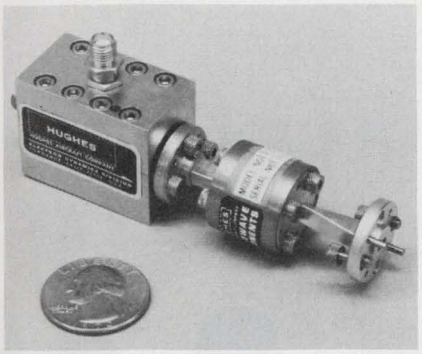
American Technical Ceramics, 1 Norden Lane, Huntington Station, N.Y. Phone: (516) 271-9600. P&A: from 46¢ (1000 quantities); 2 wks.

The ATC150 series of porcelain microwave chip capacitors has low insertion loss to 12 GHz in capacitance values from 0.1 to 100 pF. The capacitors come in case sizes only 50 mils cube. Their termination material is palladium-silver. Features include power handling of 15 W, 50 WV dc, a TC of +90 ±20 ppm and operating temperature of −55 to +125°C.

CIRCLE NO. 298

Announcing REQUESTED DATA DELIVERY, it's free—see card inside front cover.

V-band power sources deliver up to 75 mW

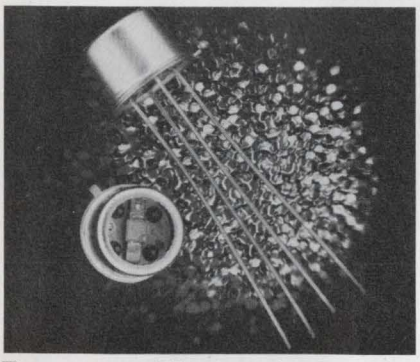


Hughes Aircraft Co., Electron Dynamics Div., 3100 W. Lomita Blvd., Torrance, Calif. Phone: (213) 534-2121. P&A: $4750, $4000, $3000, $2500; 60 days.

A series of V-band 50-to-75-GHz power sources feature up to 75-mW output power and both mechanical and electrical tuning capabilities. Model numbers 44050H, 44051H, 44052H, and 44053H have 75, 50, 25 and 10-mW outputs at 3%, 2%, 1% and 0.5% efficiencies, respectively. All models have 0.5-GHz minimum mechanical tuning, except for the model 44050H which has a fixed frequency.

CIRCLE NO. 299

Fast photo control unit has 3.5-μs rise time



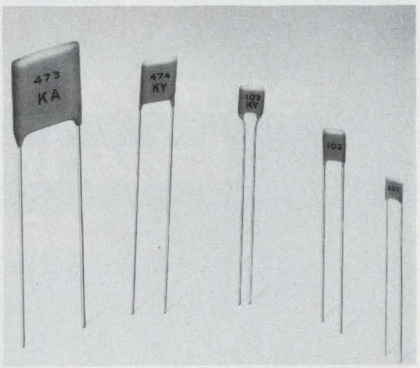
European Electronic Products Corp., 10150 W. Jefferson Blvd., Culver City, Calif. Phone: (213) 838-1912. Price: $5.77 (100 quantities).

High sensitivity and large angle of opening are featured in a new silicon photo-electronic control unit which contains a silicon photo element, a silicon npn transistor and two silicon diodes. Suitable for direct relay driving, the EPX28 is fast—it has a rise time of 3.5 μs. It operates from a collector-emitter voltage of 45 V.

CIRCLE NO. 300

COMPONENTS

Ceramic capacitors come with radial leads

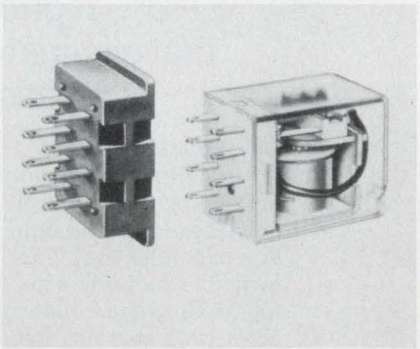


Vitramon, Inc., Box 544, Bridgeport, Conn. Phone: (203) 268-6261.

Two new series of low-cost VK dipped-ceramic capacitors feature radial-lead configurations and 0.1-in. lead spacing. The NPO type BA series is offered in five body sizes and capacitance values ranging from 1 pF to 0.047 μF at TCs of 0 to ±30 ppm/°C. Designers seeking higher volumetric efficiency can obtain the general-purpose type BY series which is offered in four body sizes and capacitance values ranging from 10 pF to 0.47 μF at TCs of 15%.

CIRCLE NO. 301

Compact plug-in relays feature 5-A capacity



Guardian Electric Mfg. Co., 1550 W. Carroll Ave., Chicago, Ill. Phone: (312) 243-1100.

A space-saving new dpdt series of enclosed plug-in miniature relays feature 5-A control capacity. Series 1330 relays measure 1.1 by 0.744 by 0.894 in. and feature rugged construction with mechanical life of 100 million operations dc and 50 million ac. They are available with a choice of plug-in and printed-circuit terminations.

CIRCLE NO. 302

Thermal ribbon sensors sense −328 to +500°F

MINCO Products, Inc., 7300 Commerce Lane, Minneapolis, Minn. Phone: (612) 786-3121. Availability: stock.

Thermal-ribbon temperature sensors are available to provide fast and accurate sensing of air, gas, liquid or solid surface temperatures from −328 to +500°F. Two basic sensor types are available to match either new or existing instrumentation: Platinum or nickel-iron element resistance thermometers and thermocouples. Thermal-ribbon temperature sensors can be used in various industrial, commercial and aerospace applications.

CIRCLE NO. 303

High-speed TV camera tubes widen video band

ITT Electron Tube Div. of ITT Corp., 3700 E. Pontiac St., Fort Wayne, Ind. Phone: (219) 743-7571.

Two high-speed Vidissector TV camera tubes, the F4077 and F4087, are available for modulated-carrier laser tracking and high-information-rate scanning systems where wide video bandwidths (745 MHz) are required. Both have focused, high-speed electron multipliers. In addition, the F4087 has an evaporated image-section wall electrode that reduces high-scan-speed eddy current losses. Various input windows and photocathode spectral sensitivities can be provided to cover the UV, visible, and near-IR spectral regions.

CIRCLE NO. 304

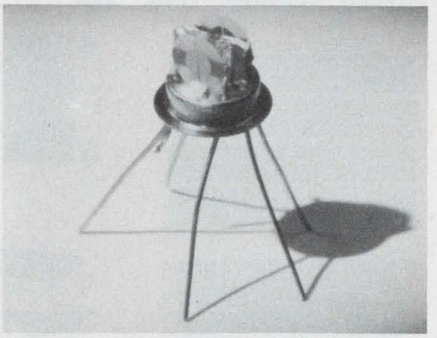
Time-delay relay includes bezel mount

Potter & Brumfield, 1200 E. Broadway, Princeton, Ind. Phone: (812) 385-5251. Price: $36 to $50.

A new bezel-mount solid-state time-delay relay designated the PT series is available. The PT relay is an improved design over the usual motor-driven timers that require mechanical speed reduction. It is engineered for easy front-panel mounting and time-adjustment accessability. A large knurled knob and an easy-to-read time selector dial allows convenient time-setting changes.

CIRCLE NO. 305

4-pole monolithic filter fits on a TO-5 holder

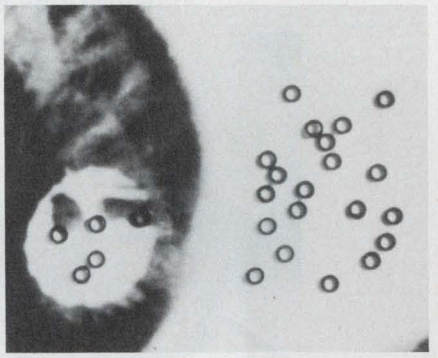


McCoy Electronics Co., Mount Holly Springs, Pa. Phone: (717) 486-3411.

Ideal for miniature receivers and paging systems, two two-pole monolithic units are contained within one TO-5 holder to yield a four-pole design. The resultant four-pole filter has a center frequency of 20 MHz, minimum 3-dB bandwidth of 16 kHz and insertion loss of 3-1/2 dB maximum. Its ripple is 0.5 dB.

CIRCLE NO. 306

14-mil lithium cores increase memory speeds



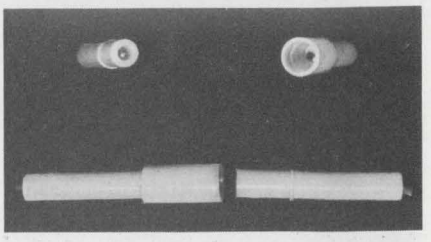
Data Products Corp., 6219 Desoto Ave., Woodland Hills, Calif. Phone: (213) 887-8246.

New 14-mil lithium memory cores are available to offer memory peaking speeds of 50 ns and switching times of 100 ns. The fast-switching cores, designated MT-1401, can make possible a 4K-word by 18-bit memory system with an access time under 235 ns and a cycle time of less than 500 ns. Such a system is also very compact—it can be readily fabricated on a 4-in.^{2} circuit board.

CIRCLE NO. 307

Have you filled out your free REQUESTED DATA DELIVERY enrollment form? See card inside front cover.

evaluation samples



High-voltage connector

A new high-voltage single-circuit connector with 0.093 in.-dia. terminals is designed for 5000-V use. Plug and receptacle model 1951 in the 03-09 connector series was designed as a focus connector for solid-state color TV sets. It is also adaptable for any single-circuit high-voltage use within specifications. Standard 0.093-in. crimp-type terminals are housed in the connector. The female plug is designed with a 7/16-in.-dia collar that is 7/8-in. long over the terminal connecting length. Plug diameter is 15/16 in. for the balance of the connector's length of 2-1/4-in. The mating receptacle has a 5/16-in. outside dia and is 1-55/64-in. long. Detailed engineering specifications and a free sample are available. Molex Inc., Downers Grove, Ill.

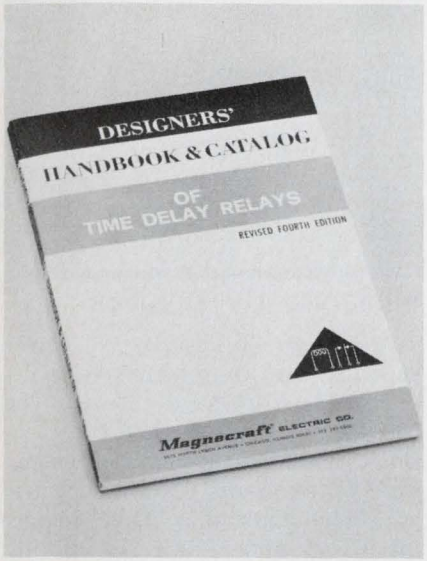
CIRCLE NO. 340

Aluminum-foil nameplates

A new aluminum foil mylar-laminated nameplate is designed to substantially reduce the overall cost of making and attaching serial nameplates. The nameplate with Pres-a-ply self-adhesive backing offers several unique advantages over rigid stamped metal types. It eliminates die-setting and can be embossed on a standard Dennison dial-set printer—in-plant and on-line—at the rate of 165 plates/minute. The new nameplate adheres easily and permanently and eliminates the need for screws and rivets. This reduces the cost of preparation and the time-consuming labor involved in attaching metal nameplates. Free samples are available. Dennison Mfg. Co., Marking & Attaching Systems Div., Framingham, Mass.

CIRCLE NO. 341

application notes



The time-delay handbook

Magnecraft Electric has just come out with its revised fourth-edition of the "Designers' Handbook & Catalog of Time-Delay Relays." This handy 92-page reference is divided into two main sections—a handbook section and a catalog section. The handbook section offers a glossary on time-delay terms, discusses their styles, characteristics, principles of operation and application and design considerations. A comparison is made between electromechanical and solid-state time-delay relays. The booklet also shows designers how to specify time-delay relays and details various testing procedures. Magnecraft Electric Co., Chicago, Ill.

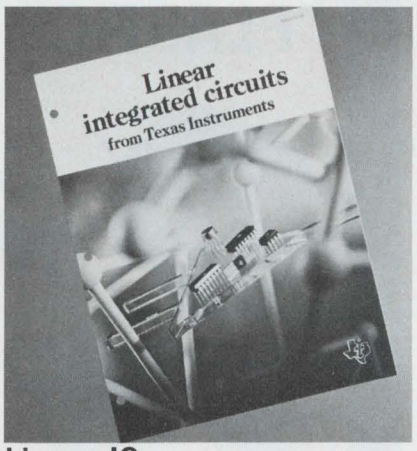
CIRCLE NO. 342

Logic design

An application note shows how the circuit designer, faced with solving logic noise problems, can quickly overcome these problems with a few simple design techniques. The note discusses industrial applications of high-noise-immunity logic to replace switches, latching and stepping relays and mechanical counters. Teledyne Semiconductor, Mountain View, Calif.

CIRCLE NO. 343

new literature



Linear ICs

A new linear IC brochure describes Texas Instruments' complete line of linear ICs. The six-page bulletin covers differential video amplifiers, op amps, communications circuits, voltage comparators, line drivers and receivers, peripheral drivers, sense amplifiers and memory drivers. A full page is devoted to 16 recently announced computer systems interface circuits. Texas Instruments Inc., Dallas, Tex.

CIRCLE NO. 344

Transistor sockets

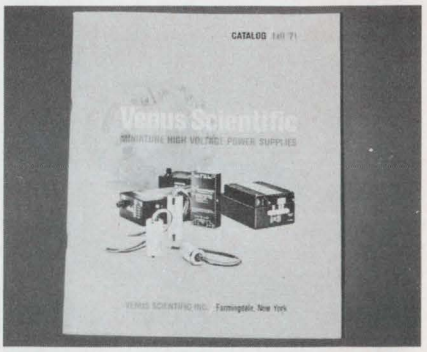
A new eight-page catalog supplement introduces a broad line of standardized transistor sockets and allied mica insulators and mounting hardware for use with TO-3, TO-66, npn/pnp plastic silicon and hybrid power transistors. Keystone Electronics Corp., New York, N.Y.

CIRCLE NO. 345

NBS time standard

A brochure is available explaining the NBS's current experiment which utilizes a geostationary satellite to broadcast standard time and frequency information and encourages interested parties to participate in the experiment. Included in the brochure is a block diagram and explanation of a typical receiver system and its requirements. Previous experiments with other satellites are also described. U.S. Dept. of Commerce, National Bureau of Standards, Boulder, Colo.

CIRCLE NO. 346



Miniature HV supplies

Miniature high-voltage power supplies are comprehensively described in a 30-page catalog. The booklet contains complete specifications and descriptions of many high-voltage units designed for use with photomultiplier, CRT image-intensifier and night-vision gating systems. Background data and a capabilities index are included for ready reference. Venus Scientific Inc., Farmingdale, N. Y.

CIRCLE NO. 347

Stepper motors

A four-page bulletin describes a series of high-energy permanent-magnet stepper motors. A. W. Haydon Co., Waterbury, Conn.

CIRCLE NO. 348

Terminal boards

A booklet provides technical data on a wide variety of insulated feed-through terminal boards. Kulka Electric Corp., Mount Vernon, N.Y.

CIRCLE NO. 349

Motor starters

A handy guide simplifies selection of three-phase solid-state motor starters. Fractional 2, 5 and 10-hp motor ratings are included. Hamlin Electronics, Inc., Lake Mills, Wis.

CIRCLE NO. 350

Chip capacitors

A new four-page brochure describes and illustrates a series of monolithic ceramic chip capacitors. Gulton Industries, Inc., Metuchen, N.J.

CIRCLE NO. 351

Radio Shack catalog

Radio Shack's new 1972 electronic equipment catalog features four-channel quadraphonic stereo equipment as well as a complete line of conventional audio components. The 92-page full-color catalog includes Radio Shack's Allied and Realistic brand radios, phonos, shortwave receivers, police band monitors, home and auto tape players and intercoms. Radio Shack, a Tandy Corp., Fort Worth, Tex.

CIRCLE NO. 352

Adhesives selector

To make a designer's job a little easier, Emerson & Cuming, Inc., offers a newly revised Eccobond adhesive selector chart in the form of a folder suitable for notebook or wall mounting. The folder describes 17 non-conducting and 9 electrically conductive adhesives. Emerson & Cuming, Inc., Canton, Mass.

CIRCLE NO. 353

Power supplies

A 27-page catalog lists over 1000 models of dc-to-dc power supplies with single, dual, triple and quadruple outputs up to 20 W. Mil Electronics, Inc., Lowell, Mass.

CIRCLE NO. 354

Thick-film pastes

A four-page brochure contains information on thick-film pastes for hybrid ICs, ceramic packaging, digital displays and microcircuit applications. Electro-Science Laboratories, Inc., Philadelphia, Pa.

CIRCLE NO. 355

GaAs lasers/IR diodes

A cotalog describes GaAs injection lasers and IR-emitting diodes. RCA Solid State Div., Somerville, N.J.

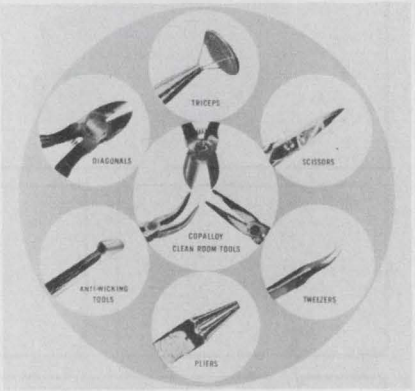
CIRCLE NO. 356

Potentiometers/trimmers

An easy-to-use short-form reference catalog features quick access to a diverse line of trimmers, potentiometers, pressure transducers and switches and turns-counting dials. Amphenol Controls Div. of Bunker Ramo Corp., Janesville, Wis.

CIRCLE NO. 357

NEW LITERATURE



Clean-room tools

A 20-page catalog of hand tools for production and laboratory activities features ultra-clean-room tools which can be used with minimum contribution to over-all contamination levels. The stock tools are nickel-chromium plated and can be completely degreased prior to use. Atsing Assembly Materials, Inc., Big Flats, N.Y.

CIRCLE NO. 358

Buss interconnections

A 32-page catalog covers a complete product line of laminated buss bars, solderless clip-on busses for various types of terminals, circuit-board busses and special buss-interconnect devices. Bussco Engineering, Inc., El Segundo, Calif.

CIRCLE NO. 359

Portable digital VOM

A two-page data sheet describes a small new portable 2-3/4-digit VOM. Triplett Corp., Bluffton, Ohio.

CIRCLE NO. 360

Ac dielectric testers

A 16-page brochure is available on a line of ac dielectric/insulation test equipment. Hipotronics, Inc., Brewster, N.Y.

CIRCLE NO. 361

Hardware

Three new catalogs list complete lines of security hardware for industrial, institutional, transportation and marine fields. The hardware includes a wide range of cam and pawl locks and latches, padlocks, hasps, seal-type door latches, lock handles, truck safes, trailer king pin locks and many other items. AIMSCO Inc., Seattle, Wash.

CIRCLE NO. 362

bulletin board

Westinghouse Electric Corp. has announced **a major advance in TV CRTs that increases both the brightness and contrast of the pictures displayed on home TV receivers.** Westinghouse says that the improvement results from a new method of color tube manufacture developed at the company's Electronic Tube Div., in Pittsburgh, Pa.

CIRCLE NO. 363

General Computer Systems, Inc., Dallas, Tex., has announced **several additional standard software features now available at no extra cost on its System 2100 key-disc-tape data entry systems.** A new re-entry capability allows an operator to interrupt the entry of a data batch for any reason and continue that same batch from the point of interruption.

CIRCLE NO. 364

Prices of Hewlett-Packard's series 5082-7100 of alphanumeric GaAsP LED displays have been cut for the second time since they were introduced early in 1970. This latest price reduction cuts nearly 50% off recent prices. For example, in quantities of 1000, prices per character have been reduced from $20 to $11. Comparable price cuts were also announced for lesser quantities.

CIRCLE NO. 365

The Cyphernetics Corp. of Ann Arbor, Mich., has announced **operational software support for the recently announced Textronix 4010 graphic terminal.**

CIRCLE NO. 366

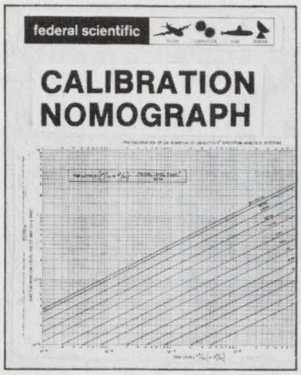
Fairchild Semiconductor has expanded its line of 9500 series temperature-compensated ECL ICs with the addition of 15 new devices. Four of the new circuits are MSI devices. Fairchild's latest additions include the 95L series of low-power and high-speed gates (2 ns at 20 mW).

CIRCLE NO. 367

Design Data from Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-Service Card.
(Advertisement)

Free Nomograph Simplifies PSD Calibration

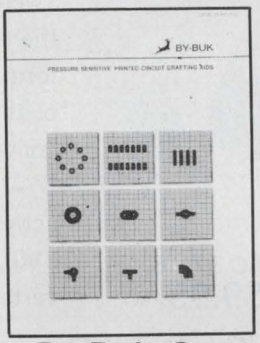


A new unique tool, Federal Scientific's Nomograph provides a fast means of calibrating a real-time power spectral density system in terms of PSD level using a sine wave calibration signal. It makes it possible for the user of a Ubiquitous® Spectrum Analysis System to easily scale the output data in terms of g^2/Hz and V^2/Hz. Printed on 8½ x 11 heavy glossy stock for durability, it is useful for all those who analyze random data such as noise, vibration, or underwater acoustic signals. It applies expressly to Federal's Ubiquitous series of Real-Time Spectrum Analyzers with 200, 400, 500, 1000, or 2000-line resolution. It allows a non-technical operator to take into account the bandwidth of analyzers and gain settings of the system when performing calibration. Write to Federal for your copy.

CIRCLE NO. 171

Federal Scientific Corporation
a subsidiary of Elgin National Industries, Inc.
615 West 131st Street, New York, N. Y. 10027

PC Drafting Aids Catalog

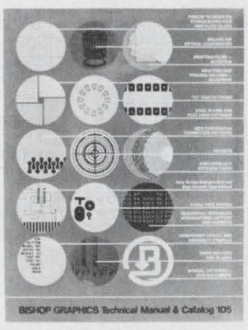


Thousands of time saving, cost saving artwork ideas are found in the By-Buk P-50 catalog of pressure sensitive printed circuit drafting aids. With the most practical artwork patterns for: TO cans, multi-pads, dual-inlines and flat packs featured. Donuts, connector strips, teardrops, ovals, tapes, tees, 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.

CIRCLE NO. 172

By-Buk Company
Subsidiary of Webtek Corp.
4326 W. Pico Blvd.
Los Angeles, California 90019
(213) 937-3511

1972 Electronic Components Drafting Aids Catalog



Free Catalog! Free Samples! Exciting innovations in pressure-sensitive electronic component drafting aids and methods are detailed in the new 1972 edition of the combined Bishop Technical Manual and Catalog 105.

84 illustrated pages of over 15,000 multi-pad configurations, symbols, tapes, sequential reference designations plus hundreds of time-and-money saving hints in making artwork for PC boards. Includes instructions for using the industry's only red and blue tape system for making two-sided boards in perfect registration.

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CIRCLE NO. 173

Bishop Graphics, Inc.
7300 Radford Avenue
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(213) 982-2000 Telex: 674672

Electronic Design

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- 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 encourage our readers as responsible members of our business community to report to us misleading or fraudulent advertising.
- To refuse any advertisement deemed to be misleading or fraudulent.

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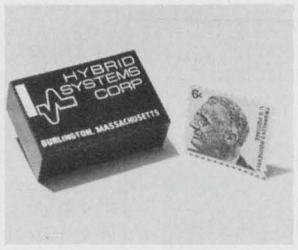
Nylomatic
11 Nolan Ave., Morrisville, Pa. 19067
A DIVISION OF WEHCO PLASTICS INC.

D/A Converters – 25 New Models



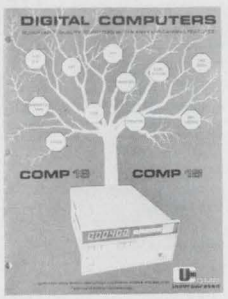
DAC 371-8
$9.95

Twenty-five new D/A converters are described in the file folder brochure. All specifications, performance data, and applications are listed. Some of the new units are: DAC 371 low cost miniature converters; DAC 372 series, a family of low cost D/A converters featuring hermetically sealed active components, thin film resistors; and DAC 390-10, ultra-fast settling multiplying D/A converter.

CIRCLE NO. 175

Hybrid Systems Corporation
87 Second Ave., Northwest Industrial Park
Burlington, Massachusetts 01803
Tel: 617-272-1522

Revised Digital Computer Brochure



UniComp's 16-page fully illustrated brochure has been completely revised to describe UniComp's FAST FOURIER TRANSFORM PROCESSOR that reduces FFT Computation Time by more than 100 times over software, as well as the increased power of their COMP-16 and COMP-18 Minicomputers, and the expanded Command list.
The revised brochure contains a general description of UniComp's ruggedized Digital Minicomputers, as well as photographs, illustrations, specifications and engineering drawings. A full page is devoted to the COMP-18 and its interface modules available to augment the CPU for specific applications.

CIRCLE NO. 176

UniComp, Incorporated
subsidiary of Hoffman Electronics Corporation
18219 Parthenia Street, Northridge, California 91324
(213) 886-7722

Manufacturers

lvertisements of booklets, brochures, catalogs and data sheets. To order use Reader-ServiceCard
(Advertisement)

Minimizing Capacitance Changes

Causes of capacitance value changes in wound dielectric capacitors are treated in an Electrocube technical bulletin to aid designers in selecting and using capacitors. Graphs and formulas are used to illustrate the straight-forward discussion and to compare performance of various dielectrics with changes in operating and environmental conditions. Also available are bulletins treating the sometimes confusing considerations of capacitor dissipation factor and insulation resistance, as part of a continuing series of two and four page technical discussions by Fred L. Johnson.

CIRCLE NO. 177

Electrocube, Inc.
1710 South Del Mar Avenue
San Gabriel, California 91776

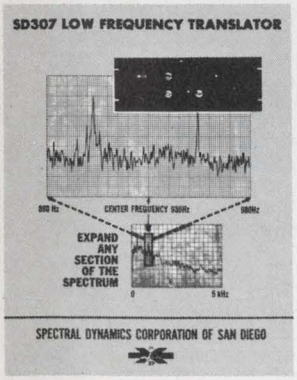
Economical High Performance Electrometers

New P.A.R. electrometers offer superior performance at low cost. Model 134, with wide range and high stability, is priced at $615; Model 135, with self-contained battery power supply, $675; and Model 136 with digital display and BCD output, $1125. Drift, offset and noise figures are lowest available in this price range. Other features include guarded input circuits and fast recovery from large overloads. Full line of accessories available. Request new brochure, demonstration or applications assistance.

CIRCLE NO. 178

Princeton Applied Research Corporation
Box 565, Princeton, New Jersey 08540 — (609) 452-2111

"Zoom In" on Any Portion of the Spectrum During Real-Time Analysis



Closely spaced harmonics in a frequency spectrum can be clearly separated, analyzed and displayed in real time by combining the **SD307 Low Frequency Translator** with any SD301-series Real Time Analyzer. In effect, it expands a given spectrum band like a zoom lens, to enable detailed examination. Resolution can be increased by as much as 1000 to 1. The combination is especially valuable for detecting very low level periodic signals normally buried in noise. The SD307 selects any one of four "windows": 50 Hz, 100 Hz, 500 Hz and 1 kHz, providing detailed narrowband analysis of 0.15 Hz, 0.3 Hz, 1.5 Hz and 3 Hz, respectively. Send for data.

CIRCLE NO. 179

Spectral Dynamics Corporation
P.O. Box 671, San Diego CA 92112

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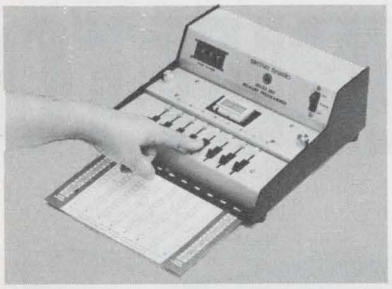
BPEA BPA

AMERICAN BUSINESS PRESS, INC.

advertiser's index

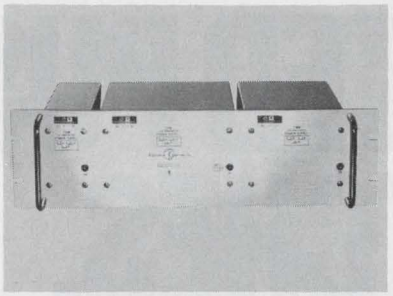
quick ads

New and current products
for the electronic designer
presented by their manufacturers.



Program all fusible-link programmable ROMs manually with the Model 300. Designed with a 4096 bit (512 words x 8 bits) capacity. Both 115 VAC and 220 VAC versions available. Spectrum Dynamics, Inc., 2300 East Oakland Park Boulevard, Ft. Lauderdale, Florida. Phone (305) 566-4467 or 566-2547.

INFORMATION RETRIEVAL NUMBER 181

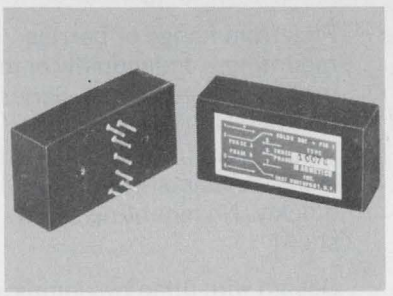


Create your own special power supplies with TDM & TDMD modules bolted to a single 5¼" panel. No costly cabling, racks or accessories. Outputs 0-305VDC, .06-60A. Modules feature front panel voltage & current limit adj., test points, ind. lamps. OV crowbar protection. Transistor Devices, Inc., Cedar Knolls, N. J. 07927.

INFORMATION RETRIEVAL NUMBER 182

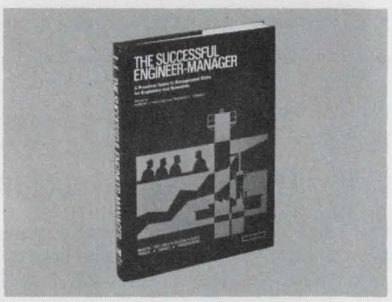
Treating materials according to their function, these design aids combine essential background with immediately workable data and techniques. Series in Materials for Electrical and Electronics Design, Edited by Alex. E. Javitz. Hayden Book Co., Inc., New York, N. Y. 10011.

INFORMATION RETRIEVAL NUMBER 183



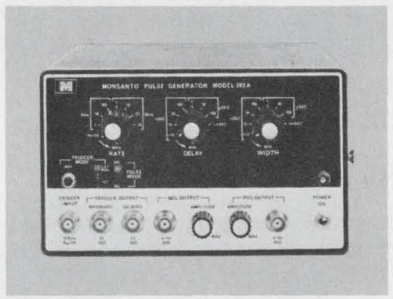
Scott-T-Transformers — 30 arc seconds accuracy, 90 volts or 11.8 line to line synchro inputs at 60 or 400 Hz sine & cosine outputs. Standard units resolver to synchro available. In quantity $19.00 each. Magnetico Inc., East Northport, N. Y. (516) 261-4502.

INFORMATION RETRIEVAL NUMBER 184



The Successful Engineer-Manager, Edited By R. C. Haavind and R. L. Turmail. Depth discussion and insights of the experts isolate the fine points of management: career, decisions, people, projects, finances, communications. Hayden Book Co., Inc., New York, N. Y. 10011.

INFORMATION RETRIEVAL NUMBER 185



High performance pulse generator provides simultaneous positive and negative pulses with < 5 ns rise — fall times at rates from 10 Hz to 50 MHz. Front panel switches select external or manual trigger and double pulse operation. 2 outputs (50-ohm source impedance) are short-circuit protected. $425. Monsanto Instruments, West Caldwell, N. J. 07006.

INFORMATION RETRIEVAL NUMBER 186

Advertisers wishing to reserve Quick Ad units should note the following mechanical requirements: Specs—Supply glossy photo of product and approximately 40 words which will set no more than 10 lines of 34 characters each. AFTER SUBMISSION NO COPY CHANGES CAN BE ACCEPTED. Quick Ads cost only $300 per insertion, less for frequency advertisers.

RATES:

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52x
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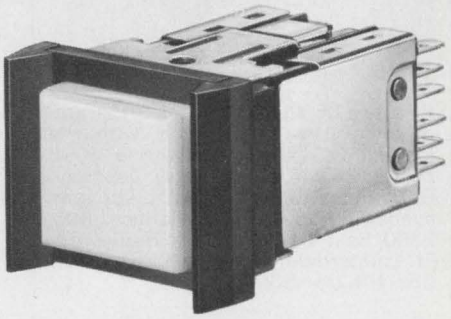
$230

A NEW FIELD-OF-ONE IN LIGHTED PUSHBUTTON SWITCHES.



ACTUAL SIZE

Switchcraft's "PUSH-LITE" switch offers reliable leafspring switching in a neat little package.

This whole new field of compact (1″ x 1 1/16″ x 1 3/4″) pushbutton switches reduces the size of your control panels, consoles—and cost, too! Our new field-of-one consists of 6 series—including non-illuminated and illuminated single and twin-lamp units in two housing colors (black or grey). Up to 4PDT switching in momentary and push-lock/push-release functions. Ratings range from dry circuit switching, up to 3 amps., A.C., non-inductive load.

A rugged molded housing encloses the highly reliable leafspring switching and protects against dust, dirt and mishandling.

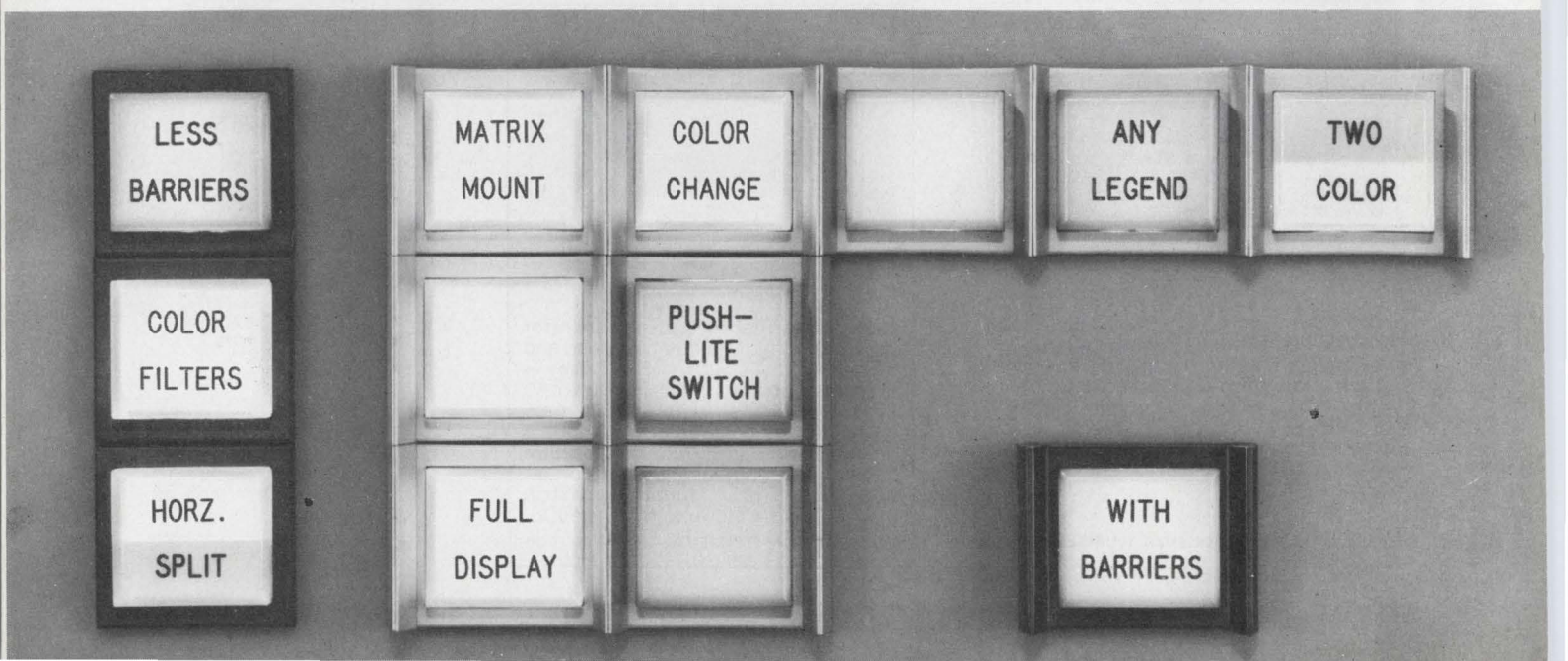
Pick from flange or barrier mounting—individually or in matrix configurations. Series PL "PUSH-LITE" switches mount from front of panel with clamp brackets, simply and quickly. No mounting screws show!

Design with up to two lamps and either full or split display screens—vertically or horizontally. Full display provides up to 3 lines of 6 characters each. Virtually unlimited lighting versatility provided by 7 different colors of pushbuttons, insert filters and silicone boots.

For additional information, contact a Switchcraft Representative or write for Catalog S-345. SWITCHCRAFT, INC.
5529 N. Elston Avenue
Chicago, Illinois 60630

SWITCHCRAFT® INC.

INFORMATION RETRIEVAL NUMBER 89



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>50% efficient, 20 KHz switching, 50mV P-P ripple, 0.1% line or load regulation

SINGLE OUTPUT

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5 VOLTS 30 AMPS
WITH OVERVOLTAGE
PROTECTION BUILT-IN

DUAL OUTPUT

$380

±15 TO ±12 VOLTS
8.5 AMPS EACH OUTPUT

TRIPLE OUTPUT

$395

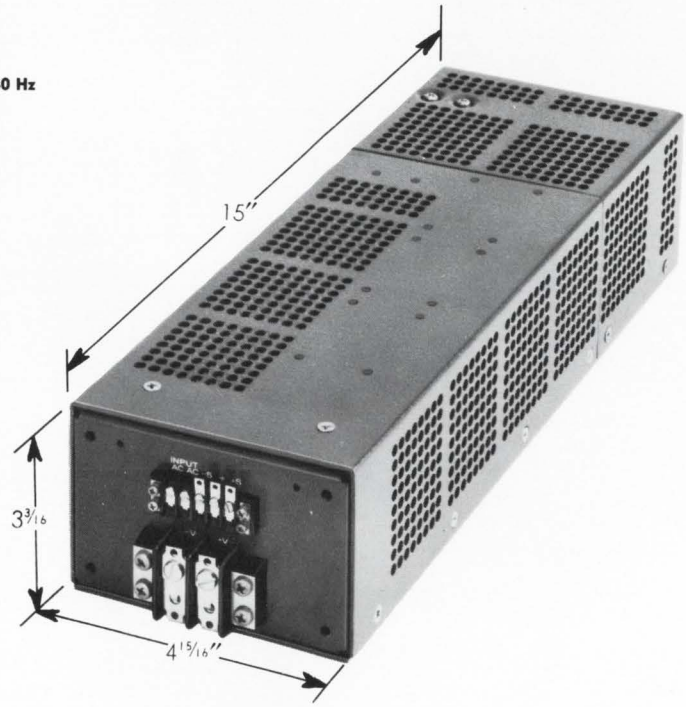
5 VOLTS 18 AMPS
DUAL ±15 TO ±12 VOLTS
2 AMPS EACH OUTPUT

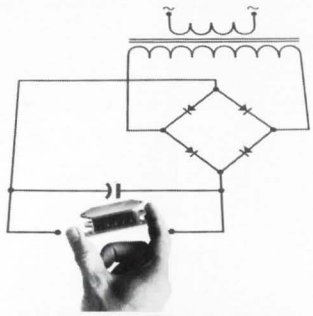
QUADRUPLE OUTPUT

$450

5 VOLTS 16 AMPS
DUAL ±15 TO ±12 VOLTS
1.5 AMPS EACH OUTPUT
24 TO 28 VOLTS 1.0 AMPS

AC input: 105-132 VAC, 47-440 Hz
DC input: 145 VDC ±10%





11 standard models in single, dual, triple or quadruple outputs in new "5" package. Triple and quadruple output models incorporate Lambda Power Hybrid Voltage Regulator.

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INFORMATION RETRIEVAL NUMBER 242

RCA extends triac capabilities again with this exclusive new 80-amp series.

You can hold down design costs for high power lighting and heating controls, welders, induction motors and other applications, because these new triacs simplify circuitry and heat sinking.

And you save on device costs because the triacs utilize the RCA low cost package with compression seal. Available in press-fit and stud packages. Four modes of gate control add design flexibility. All this means more amps per dollar.

That's why the new 80-amp triac is another example of cost effective simplification from RCA.

Unit prices are $25 to $45 in small quantities. Call your RCA Representative or RCA Distributor. For new RCA catalog write RCA Commercial Engineering, Section 57L9/UR12, Harrison, N.J. 07029. International: RCA, Sunbury-on-Thames, U.K., or P.O. Box 112,Hong Kong. RCA Limited, St. Anne deBellevue, 810 Quebec, Canada.

Repetitive Peak Off-State Voltage V_{DROM}			
PACKAGE	200 V	400 V	600 V
Press Fit	TA7752	TA7753	TA7754
Stud	TA7755	TA7756	TA7757
Isolated Stud	TA7937	TA7938	TA7939

All types are available with flexible lead attachments.