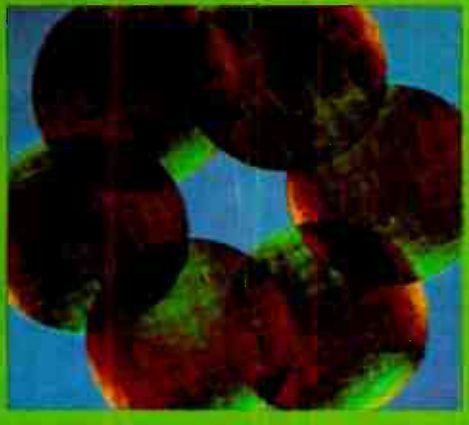
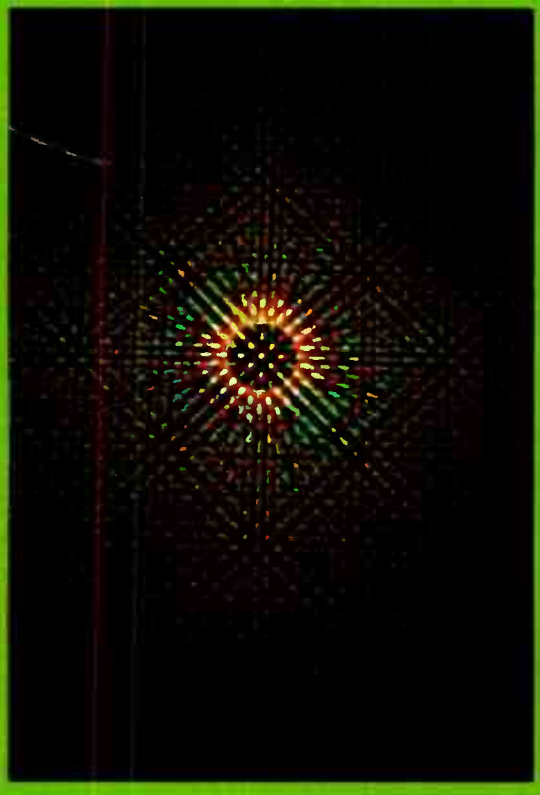
November 8, 1971 $1.00 A McGraw-Hill Publication

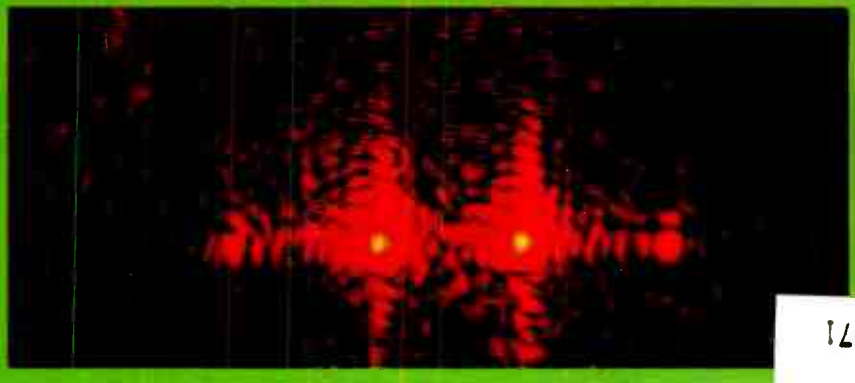
Electronics

SPECIAL REPORT

Broad job spectrum opens up for optoelectronics







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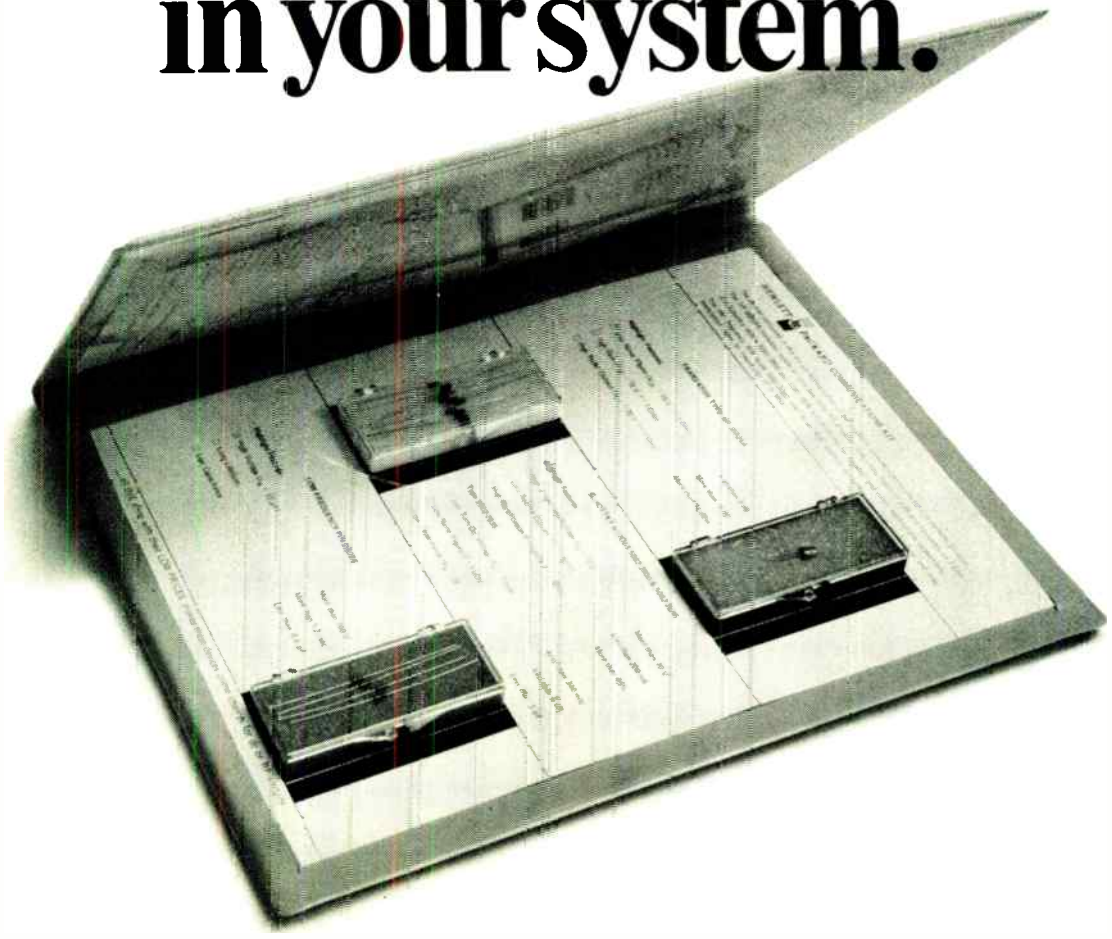
Circle 900 on reader service card

Save $15 on our new communications kit and get something special in your system.



The kit contains 12 Schottky diodes, 4 pin diodes, and one low-noise, high-gain transistor. As well as application notes and data sheets.

If you bought these components separately, it would cost you more than $34. But right now you can buy the whole kit and kaboodle for $19.40. We're sure that once you've tried them, you'll come back for more.

Performance like this will bring you back. The HP 2800 Schottky diode is ideally suited for high level detector applications with a breakdown voltage of 70 volts. The HP 2835 Schottky diode, with a breakdown voltage of 5 volts and a forward voltage drop of .33 volts at one mA makes an ideal VHF/UHF mixer.

The HP 3080 pin diode as an AGC element guarantees low cross-modulation and intermodulation down to frequencies of 5 MHz. The HP 35824A transistor makes an ideal low-noise, high-gain RF amplifier with a noise figure of 3 dB and a 12 dB gain at 1 GHz.

So if you're looking for ways to improve the performance of your RF amplifiers, mixers, detectors or AGC's, tear out the coupon and a check and send them both in.

You may also want one of our very popular Schottky diode kits. For $8.40, you get eight each of three different Schottky barrier diodes. Try them and see what a difference they make in your circuits.

Clip this coupon and mail with check, money order or P.O. to: Hewlett-Packard Associates, 620 Page Mill Road, Palo Alto, California 94304. Your local HP sales office can also handle the order.

$34.00 value for $19.40!

(offer expires on January 31, 1972)

☐ Send me one of your communications kits. (HP 5082-0051)

☐ Here's $8.40 for a diode kit. (HP 5082-0050)

(California residents add 5% sales tax)

Name_____

Company_____

City/State/Zip_____

Frequencies ☐ less than 10 MHz
☐ 10 to 250 MHz ☐ 250 to 500 MHz
☐ 500 to 1000 MHz ☐ greater than 1000 MHz

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Our IMPATT diodes will uncomplicate your circuits.

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Our IMPATT diodes are available in a price range that others can hardly match: 100 mw family, less than $15; ½ watt family, less than $50; 1½ watt family, $75. (100 quantity prices). Start uncomplicating your circuits today and write for our IMPATT application brochure and other information: Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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Circle 2 on reader service card

Electronics
The International Magazine of Electronics Technology
November 8, 1971

Volume No. 44, Number 23

Electronics

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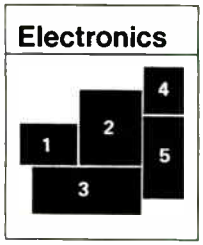
Publisher's letter

Optoelectronics is changing almost as fast as the speed of light, on which it is based. When our solid state editor, Larry Altman, started out on his reporting, which included a three-week swing to all the major optoelectronic capitals in the nation, we thought we had a nice comfortable 16-page special report to present to you. When he came back, with far more valuable information than could fit in that space, we shifted gears. Now the 16-pager (see page 61) is the first in a series of optoelectronic specials we will publish in upcoming issues.



Our optoelectronics cover is certainly colorful enough to stand on its own, but we thought you might be interested in what the photos really are. The shot in the No. 1 position, from Sandia Corp., shows the color variations obtainable in PLZT crystals. No. 2 and No. 4 from Ampex Corp., are a diffraction pattern from a halftone screen and circular inspection pattern used with holographic filters, both generated by an argon-krypton laser, a source of optical energy for failure-prediction equipment. No. 3, also from Ampex, is a CRT readout of two frequencies separated by 0.5 hertz, a resolution of better than 0.03%. No. 5, from Sandia, demonstrates how colors can be filtered in strips of PLZT crystals by changing the electrical field and allowing the material to relax to saturation remanence.

Picturephones are the subject of the first byline in *Electronics* for Lyman Hardeman, our new communications and microwave editor. Hardeman, an EE from Texas A&M, comes to us after six years at Texas Instruments, where he worked on the Mera solid state, phased-array radar, and two years as an electronics trade magazine editor.

While his background is heavy in the microwave end of communications, he is fascinated with what communications terminals can do. For the Picturephone story (see page 97), Hardeman made the required pilgrimage to Bell Labs in Holmdel, N.J., where he was given a glimpse of the future uses of the devices. "One of the Picturephones was tied to a computer, and by pressing two buttons, the screen showed how many employees were at work that day and the price of AT&T stock at the moment. Another pair of buttons commanded the computer to display the classic sliding number game, with 15 numbers in a four-by-four grid. You just keyed in the number you wanted to slide to the blank."

Those were just demonstrations, of course, but Hardeman says he can hardly wait until he can have one of his own, tied to a computer's memory, on his desk. Then he can not only use the units' long-distance sketching possibilities to clear up technical points for his *Electronics* articles, but also to get fast access to dictionaries and other reference works.

November 8, 1971 Volume 44 Number 23
89,985 copies of this issue printed

Published every other Monday by McGraw-Hill, Inc. Founder James H. McGraw 1860-1948. Publication office 330 West 42nd Street, N.Y. N.Y. 10036. second class postage paid at New York, N.Y. and additional mailing offices.

Executive, editorial, circulation and advertising addresses: Electronics, McGraw-Hill Building, 330 West 42nd Street, New York, N.Y. 10036. Telephone (212) 971-3333. Teletype TWX N.Y. 710-581-4235. Cable address: MCGRAWHILL N.Y.

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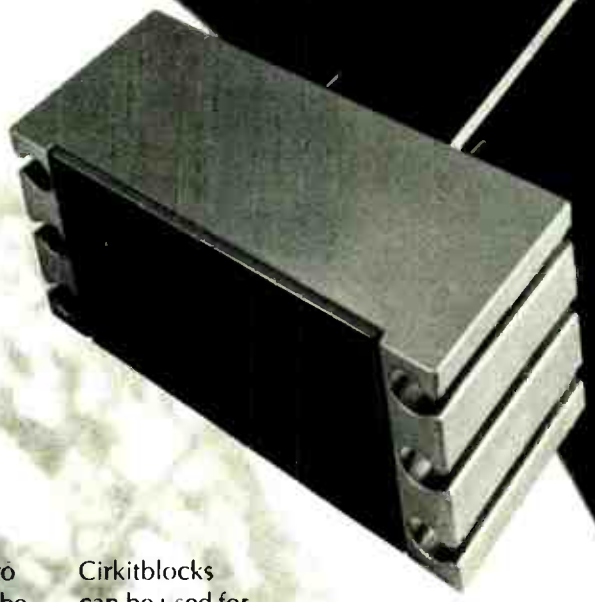
from space-age technology

Cirkitblock™ modules for industrial power supplies



Now space-age technology has fallen out to the industrial area. Similar to the Powercube modules used aboard NASA satellites and probes, new Cirkitblock modules let you build instrumentation power supplies at a substantial reduction in size and weight – with industrial-priced, off-the-shelf blocks!

Cirkitblock modules offer high efficiency conversion and low thermal rise. They are ruggedly constructed, completely self-contained, easy to install. Three basic types – pre-regulators, power generators, and output modules – are available, (provides outputs from 4vdc – 4000vdc in power range of up to 100w.)

Cirkitblocks can be used for breadboarding as well as final systems. Even system changes can be accommodated simply by changing an output module instead of redesigning the system.

If you are involved in the design or manufacture of small, portable instrumentation, you will be interested in Cirkitblock power modules. Send for your Cirkitblock power supply design chart today. It can help you make the right module selection, to get a power supply that's out of this world.

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SUBSIDIARY OF UNITRODE CORPORATION

Readers comment

Spectran replies

To the Editor: In his letter concerning our microwave measuring system for carpet backing [Oct. 25, p. 6], Mr. Childress of Uster Corp. refers to a dominant cutoff mode of 1.2 gigahertz. In so doing, he is assuming that the frequency propagated is related to spacing between bars. This is not true, because in the Spectran system this is a straight transmission line, and the space between bars changes only their impedance, not the upper cutoff. We are simply radiating many frequencies and picking up the return. As for his assertion that the Uster system plots continuously while the Spectran recorder plots an average, he overlooks the fact that a sampling oscilloscope provides an instantaneous picture for making adjustments. And the continuous plotting in the Uster system is done by a moving microwave head, much slower than our system, which monitors all points at once.

Jerry Aukland
Spectran Inc.
Hollywood, Calif.

Sorry

To the Editor: In the story on "Consumer renaissance flowers in Europe" [Aug. 30, p. 71], the passage referring to Mullard activity says, "Like the Motorola chip it needs peak-to-peak output." This is meaningless. You go on to state that "Like the Plessey chip there are age generators for tuner and an afc buffer." Later the chip is referred to as being complete with its own afc generation. The latter statement is correct and the reference to the buffer is misleading.

B.M. Whale
Mullard Ltd.
London, England

■ *The first sentence should have read, "Like the Motorola chip it needs preamplification—70 millivolts input is needed for a 3-v peak-to-peak output." Our computer dropped a line.*

Plated wire in the '70s

To the Editor: I must rebut the comments of James. J. Orris of Varian Data Machines that appeared in the firmware section of the special report on computers in the '70s [Sept. 13, p. 61]. There are two basic architectures for minicomputers—the less-flexible "hard wired" and the newer, highly flexible microprogramable. The Varian 620 family is basically a "hard-wired" design; thus a read-only memory or an electrically alterable read-only memory are of limited or specialized use. However, microprogramed machines can offer enormous benefits if fitted with a writable control store. IBM uses a "floppy disk" as the reloadable control store backup in case of power failure, or for startup. A minicomputer user can't justify the cost, and our position is that he doesn't have to—we'll sell him a truly idiot-proof, nonvolatile, plated wire Earom that doesn't "need loading every morning." Several of our customers are using Earoms in systems that are dynamically reloadable (from disk or tape). In fact, we profitably sell complete plated wire Earom systems at costs similar to those of programable ROM chips of similar speed.

The preoccupation with IC memory devices is understandable. But the solution to volatility requires a new device; nothing on the market except plated wire does the job cost-effectively.

Bruce Kaufman
Memory Systems Inc.
Hawthorne, Calif.

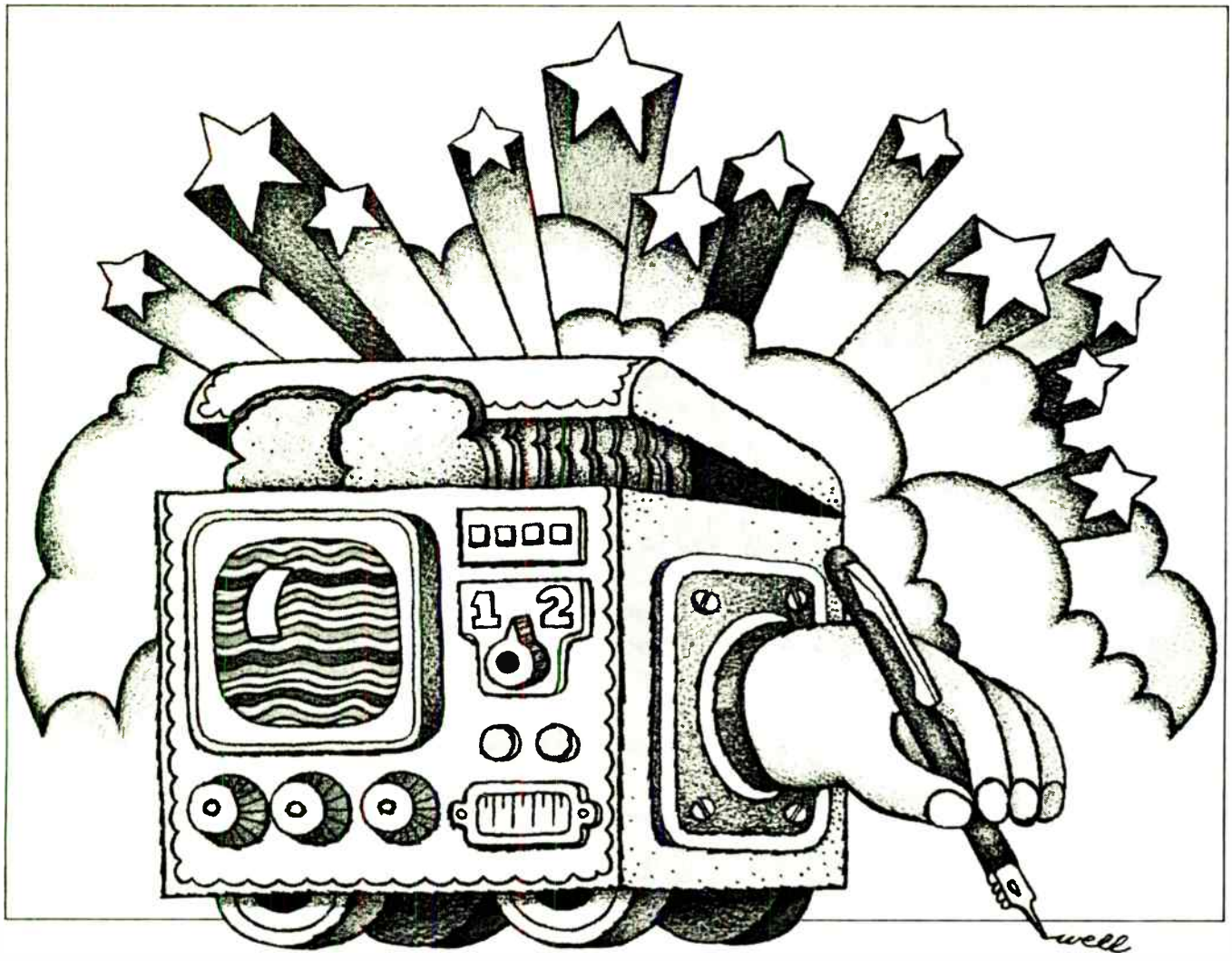
Know your mnemonics

To the Editor: I was appalled by the letter complaining about the use of mnemonics such as DIP, MOS, BCD, etc. [Aug.30,p.6]. *Electronics* is an industry trade journal. It would be a grave disservice to the majority of your readers if you were to make compromises for those who should be reading Electronics Illustrated.

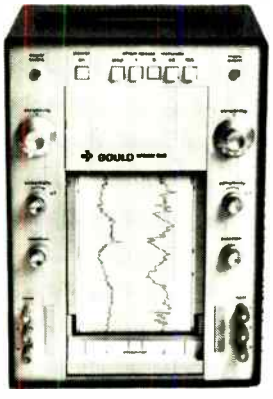
E. Douglas Jensen
Logic Associates
Dallas, Texas

Scanner resolution

To the Editor: The Electronics Newsletter of Sept. 13 says of the 256-element self-scanning array that "resolution of an image produced by the chip is equal to or better than that of a standard television set."



What's smaller than a breadbox, has two channels and built-in preamps, and writes well under pressure? Answer: the Brush 220.



The Brush 220. A rugged, two-channel recorder that's little to the tune of 25 pounds, accurate to 99½% linearity.

Just plug it in. And then let Brush performance take over.

It starts with our pressurized ink system. A system that forces ink into the paper, instead of just laying it on. So you get traces that are clear, clean, and crisp. And a disposable ink cartridge holds a year's supply of ink.

Built-in preamps give you a measurement range of 1 millivolt per chart division to 500 volts full scale. And a choice of 20 signal conditioners give you an even wider range. Four chart speeds are push-button controlled. And two event markers are standard.

The Brush 220. It just may solve your recording riddles. To see the Brush 220 in action, call your Brush Sales Engineer. Or write for more information to Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114 or Rue Van Boeckel 38 Brussels 1140, Belgium.

BRUSH INSTRUMENTS

GOULD

Readers comment

This is wrong: 256 elements, no matter if they are used along the horizontal or vertical axis, produce only about half that resolution.

In the vertical axis of a standard TV screen, about 490 lines are visible. If replaced by 256 lines, vertical resolution would drop to 52% of normal. As for the horizontal, allowing for retrace blanking and overscan, 50 microseconds of scan time is available. The 256 discrete elements can reproduce up to 128 cycles, but this must be multiplied by the Keil factor of 0.7 to allow for the fact that discrete elements can be reproduced as a step function only at fixed locations. Thus, equivalent horizontal resolution is 90 cycles which, transmitted in 50 microseconds, corresponds to a video cutoff at 1.8 megahertz. Commercial monochrome sets are at least twice as good; thus, horizontal resolution is at best 50% of normal.

Robert Adler
Zenith Radio Corp.
Chicago

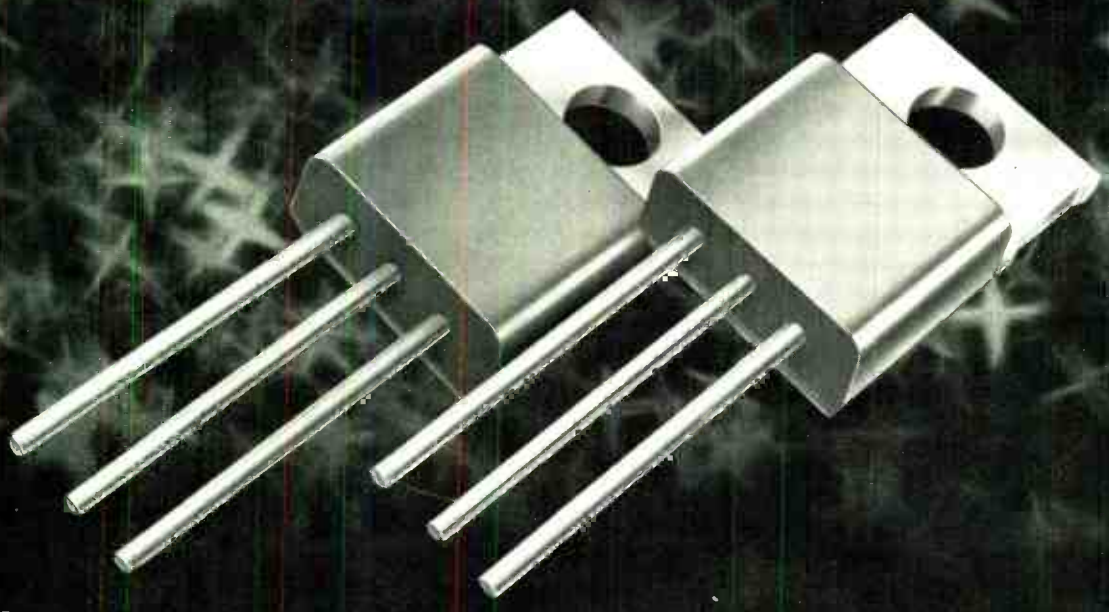
▪ *Mr. Adler's analysis is correct, says John J. Rado, president of Reticon Corp. The company was scanning an 8-millimeter film with a standard RL-256 array and imaging it on a Tektronix 602 display unit. The resulting picture, he notes, presented the same "quality" to the eye a viewer is accustomed to in ordinary TV sets. Mr. Rado also notes that since the display was not on an actual TV screen, some of the limitations presented by established standards in the TV industry do not necessarily limit scan rates here.*

Pioneers

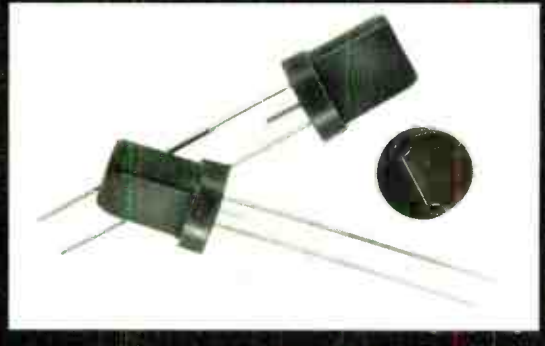
To the Editor: The Electronics Newsletter of Oct. 11, in announcing TI's plans to enter the tuning diode market, names Motorola as the only domestic manufacturer of these devices. In fact, the US division of ITT Semiconductors for four years has pioneered the development and application of tuning diodes. Since June 1970, our facility has made and sold them for a variety of frequencies; they're in radio, TV, and avionics receivers.

Thomas R. Mills
ITT Semiconductors
Lawrence, Mass.

GE DESIGNED THESE TRIACS FOR YOU



GE originated the triac in 1963 and now offers new standards of performance and reliability. Silicone encapsulated SC141 and SC146 triacs, up to 500 volts, and 6 and 10 amps respectively, feature the new proprietary ***POWER-GLAS***™ passivation process which creates a void free bond between the silicon chip and the matched glass. This results in low "off-state" currents of typically 10 μA. The SC141 and SC146, like all GE triacs, have inherent immunity from transient voltage damage and improved commutating dv/dt. Additionally these rugged packages incorporate a stress-free assembly system, which offers you torque limit-free tab mounting and easily formed round leads. For your convenience, GE offers 6 standard lead configurations. These features make the SC141 and SC146 your best value in 6 and 10 amp triacs.



Another GE creative design, the ST4 asymmetrical trigger, is an ideal trigger for light dimmer applications. It features performance comparable to triggering circuits using at least 3 additional passive components and greatly reduces hysteresis effects by means of a single RC time constant. At 46¢ each in 1,000 unit level, it is truly an economical companion to GE ***POWER-GLAS***™ passivated triacs.

GENERAL ELECTRIC

Interested in seeing how GE triacs and triggers can help you design? For free SC141B and ST4 samples write on company letterhead to GE Semiconductor Products Department, Electronics Park, Bldg. #7, Mail Drop 49, Syracuse, New York 13201.

40 years ago

From the pages of Electronics, November 1931

A radio set can be no better than its weakest part. The last year or two have seen too much yielding in the direction of cheapening and weakening. Against reduction in quality, the great influence of the Institute of Radio Engineer's gatherings must now be organized and thrown determinedly in the direction of building quality upwards, insisting that every part be adequate.

Meanwhile the pressure of every sales department continues inexorable, to hold down the overall price at which the radio set must be sold. From this dilemma in which the set designer thus finds himself, he has one escape. He can turn for help to the makers of quality components and parts. Their experience can be used by the set-maker—with marked saving of plant investment and increase of manufacturing flexibility. There is no warrant for repeating, in radio, the classical incident of the Rolls-Royce engineers who designed and built their own special horn push-button, at a cost for tools and dies of $12 per car,—and later found that a better button could be bought on the open market at 10 cents!

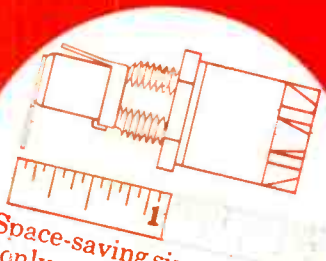
A principle of motion picture projection without a shutter and with the film moving continuously through the projector was described by H.E. Edgerton of MIT.

The adaptation of intermittent light using mercury-arc lamps for taking motion pictures was illustrated by examples. There are in general two methods of using the intermittent light. One method is used to take moving pictures where the light is caused to flash for each frame and the film runs at a continuous speed. The second is used to take stroboscopic moving pictures of rapidly moving objects by causing the light frequency to approach the frequency of the motion of the object. Examples of the latter method were demonstrated, these being stroboscopic movies of a crude motion picture claw mechanism operating at 30 f.p.s. and of the surges in the valve springs of a gasoline engine running at 1930 r.p.m.

only a BUSS fuseholder could have so many quality features squeezed into such a small package

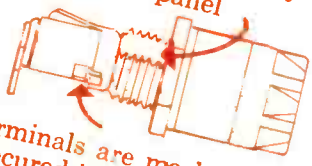
Space Saver!

Space Saver!



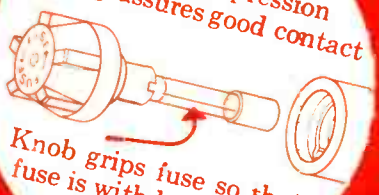
Space-saving size: projects only one inch behind panel, only 1-25/32 inches overall length

Made for installation in D-hole to prevent turning in panel



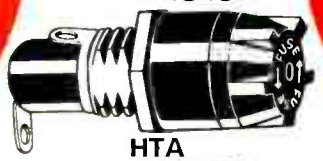
Terminals are mechanically secured in holder as well as soldered

Easy-grip bayonet-type knob —sturdy compression spring assures good contact

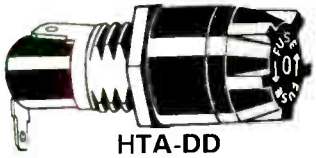


Knob grips fuse so that fuse is withdrawn when knob is removed

BUSS



HTA



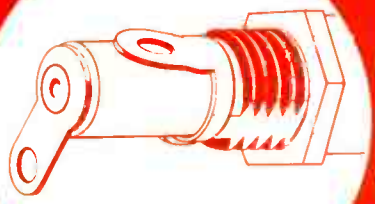
HTA-DD

HTA-HH

FUSEHOLDERS

FOR ¼ x 1¼ INCH FUSES

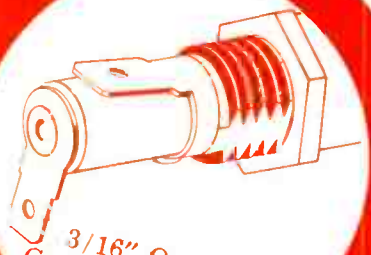
Knob has break-out hole to allow use of test probe



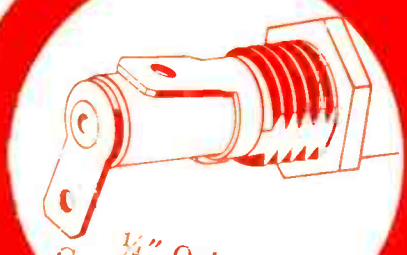
Solder Terminals (HTA)

Rated for 15 amps at any voltage up to 250

Dielectrically capable of withstanding 1500 volts A.C. between terminals and between terminals and panel



3/16" Quick-Connect Terminals (HTA-DD)



¼" Quick-Connect Terminals (HTA-HH)

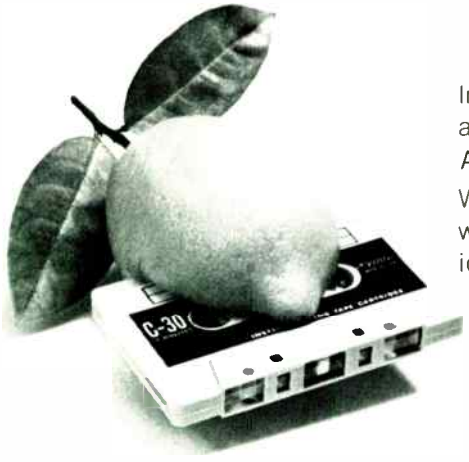
For more information on the HTA Fuseholder and the complete BUSS QUALITY line of small dimension fuses, fuseholders, and fuseblocks, write for BUSS Bulletin SFB.

BUSSMANN MFG. DIVISION,
McGraw-Edison Co., St. Louis, Mo. 63107

SUPPLIED THE ECONOMICAL WAY . . . THRU DISTRIBUTORS

BUSS QUALITY FUSES

Two Years Ago, Almost

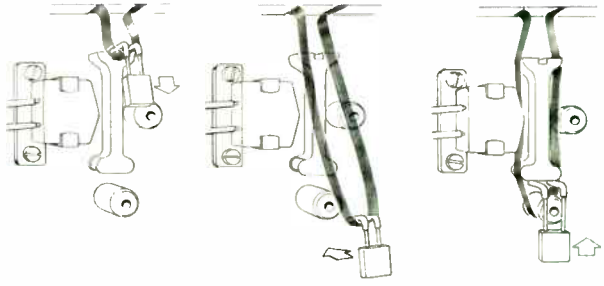


Including us. A digital cassette recorder. Seemed like a great idea at the time. But there was too much garbled info. And lousy reliability. A bumper crop of real lemons.

Well, we licked our wounds along with everyone else. But we also went back to the drawing board because we still thought the basic idea was sound. And we came up with a unit that really works.

A Whole New Concept

To get super reliability, we reasoned, you have to control that tape. So, we started from scratch. Got rid of the traditional pinch rollers, belts, solenoids, levers and mechanical linkages from the transport. Took out the head guide forks.

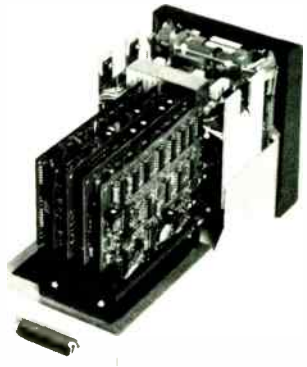


Eliminated the need for pressure pads. Those were the main cause of head and tape wear, oxide shed and dropout.

Then, instead of just pushing the head up to the tape as it rolls by, we decided to get the tape out of the cassette. (That way the cassette is just a tape holder.)

So we designed two little fingers that pull the tape down past the head, over a precision guide and around a capstan. That maintains optimum head wrap angle—critical for read-after-write operation. And it's all done automatically as you load. (We've got a patent pending, in case you're interested.)

The Insides



Next, we put in three DC motors. One for the capstan and one for each reel. Servos positively control tape tension on both sides of the capstan. And tension sensors confirm proper loading to BOT—no writing on tape leader. There's no drag on the tape. Ever.

So now we have high bi-directional tape speed, fast start/stop times, precise start/stop distances.

Reel motor torque is automatically reduced when EOT or BOT is sensed to prevent pulling tape from cassette reel hubs or other possible tape damage.

All modular electronics. Plug in PC boards. Logic and interface that're TTL compatible.

Everybody Brought One Out

The Outsides

All these components are mounted in a cast aluminum frame. Very, very rugged. So it works for any number of EDP OEM applications. And we supply it for users in a handsome case with straightforward, push-button controls.

Real Reel to Reel Performance

Our basic Model 240 has 2 tracks, selectable data rates from 2 to 20 ips, with start/stop times of 15-30 msec. Same start/stop times for 50 ips search or fast forward/reverse. It operates in incremental and/or continuous modes, and in several combinations of recording codes/data channel selections. Test data indicates: calculated MTBF in excess of 2,000 hours. Thousands of passes without tape damage.

Options

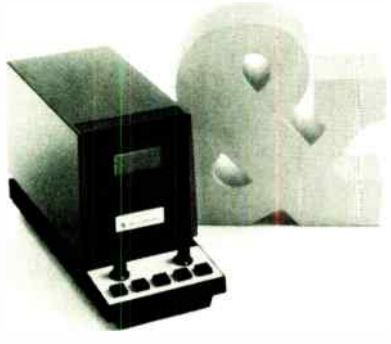
All sorts of options. Like two selectable read/write speeds. Dual gap read-after-write head. Separate read-after-write heads. Power supply. Rack mount kit. Automatic tape cleaner. Etcetera.

Don't Wait. Order Now

Now that we've really licked performance and reliability problems, we figure our recorder's a natural for business machine manufacturers, terminal makers, mini computer builders.

And users. A great replacement for punched paper tape. Even some reel to reel mag tape applications. Especially at the price. About $500 to $600 in bunches.

Bell & Howell & a Digital Cassette Recorder That Works



☐ Send me all the specs.
☐ Send a guy around for a demo.
☐ Here's my P.O. You fill in the blanks.

Name _____

Title _____

Company _____

Address _____

City _____ State _____ Zip _____

Bell & Howell—Electronics & Instruments Group,
360 Sierra Madre Villa, Pasadena, California 91109

See us at FJCC this year. Booths 1651-1653.

ELECTRONICS & INSTRUMENTS GROUP

BELL & HOWELL

People

The new buzz words in the military marketplace are high-power lasers. As competition builds to sell a set of specifications for these new rangefinders and target designators, the man behind the technology at IBM's Federal Systems division is James T. Vanderslice, a 31-year-old physicist at the division's Gaithersburg, Md., headquarters.

Armed with a nondegradable dye Q-switch—for which IBM has filed patents and which Vanderslice calls a "breakthrough"—plus a high-power Raman laser emitting in the 1.54-micron "eye-safe" region, the young, Boston-bred manager of electro-optical systems development is moving in on a major market. Current military forecasts put the potential for ground and airborne systems in existing aircraft, missiles, and other ordnance as high as 4,200 over the next two to five years [*Electronics*, Oct. 25, p. 36]. IBM is pitted against other competing specialists like Hughes, Martin Marietta, Sperry Rand, and RCA.

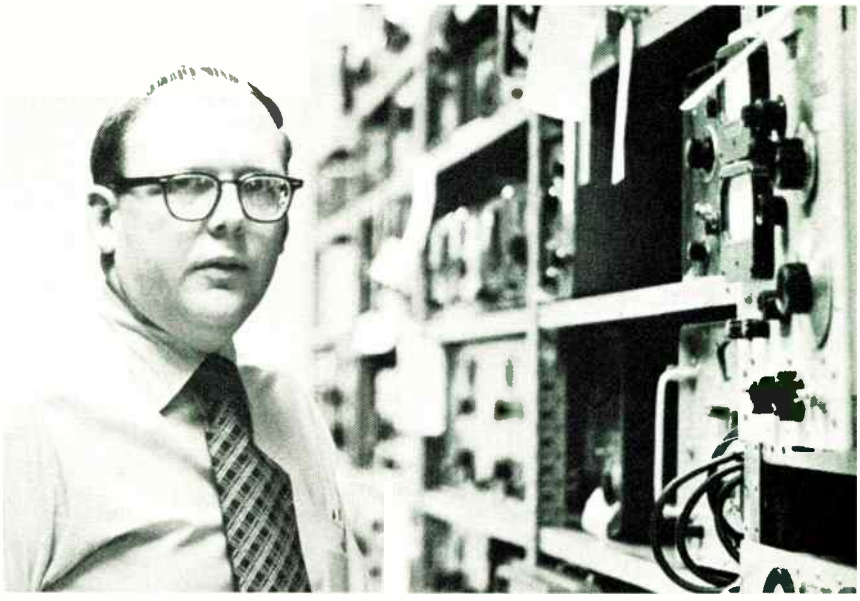
Competition is nothing new to Vanderslice, who grew up in a family environment as the youngest of four sons, three of whom acquired doctorates. Of the family's two physical chemists, brother Joe is chairman of the University of Maryland's chemistry department while Tom is a vice president of General Electric. Jim, the physicist, took his baccalaureate at Boston College in his hometown of Newton, Mass., and then moved south to take his Ph.D. at Washington's Catholic University, where he continued research before joining IBM's quantum electronics department in June 1966.

Vanderslice numbers among his honors fellowships from NASA and the National Academy of Sciences, his wife Louise and four children ranging in age from five years to one month.

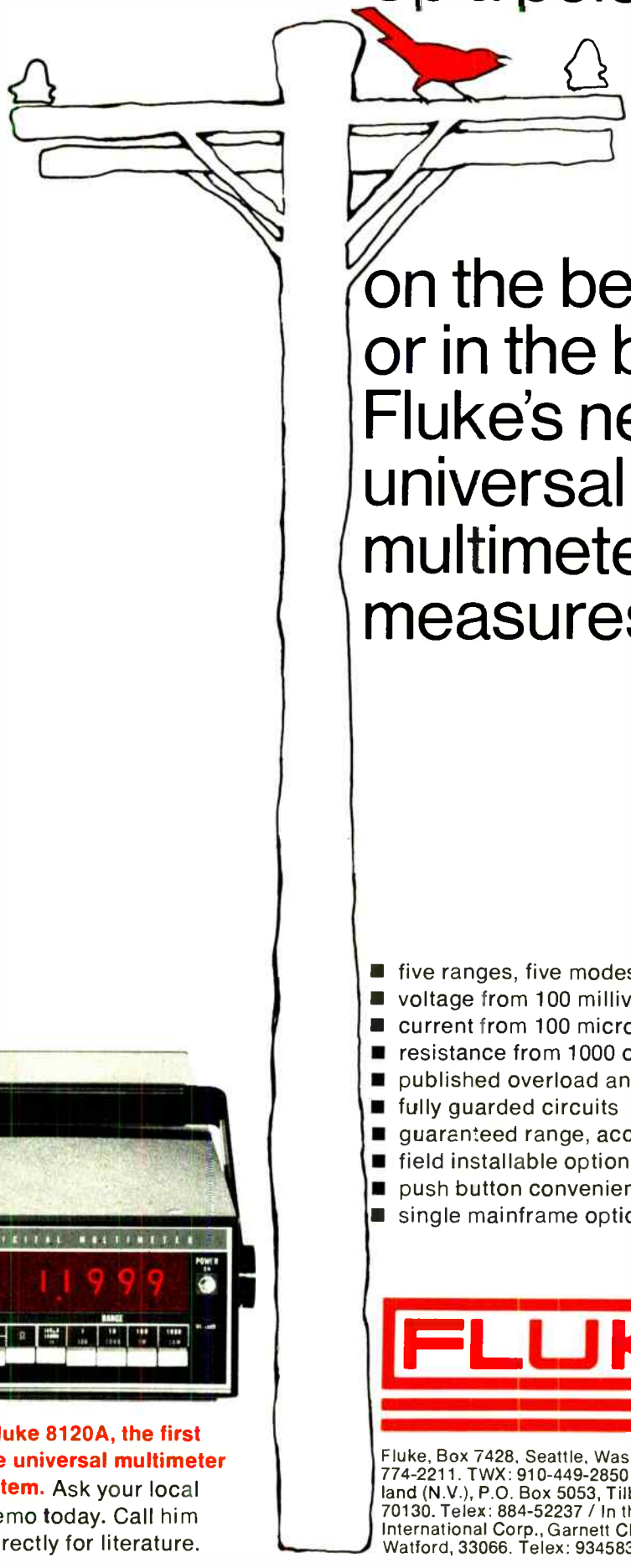
"We want to be the Sears Roebuck of test equipment," says James R. Tucker, president of Tucker Electronics in Garland, Texas. But not being content with that goal, Tucker hopes to do more. He wants to offer a complete test equipment service, selling not only many brands of equipment—including popular types of new equipment under a private label—but also offering reconditioned used equipment, service and calibration for all brands, and leases and rentals.

His plans sound ambitious, but Tucker has made a good start. His four-year-old company now has a volume of about $1.5 million—recently he opened a sales office in Orlando, Fla., and is presently expanding his sales office in Edison,

Tucker: Becoming the Sears Roebuck of test equipment though sales, service, and rentals.



Up a pole,



on the bench, or in the boonies, Fluke's new universal multimeter measures more.

- five ranges, five modes, 4½ digits, $795
- voltage from 100 millivolts to 1000 volts
- current from 100 microamps to 1 amp
- resistance from 1000 ohms to 10 megohms
- published overload and environmental specs
- fully guarded circuits
- guaranteed range, accuracy and resolution specs
- field installable options
- push button convenience
- single mainframe option structure

Introducing the Fluke 8120A, the first low cost complete universal multimeter measurement system. Ask your local Flukeman for a demo today. Call him now or write us directly for literature.

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People

N.J., to include service and calibration. His acquisitions include about a third of a million dollars in additional capital to aid expansion as well as a former vice president from Collins Radio to help with the financial end of things.

Tucker himself is a soft-spoken Texan from McKinney, about 25 miles north of Dallas. He got his EE from Stanford and subsequently spent three years with LTV as an antenna engineer.

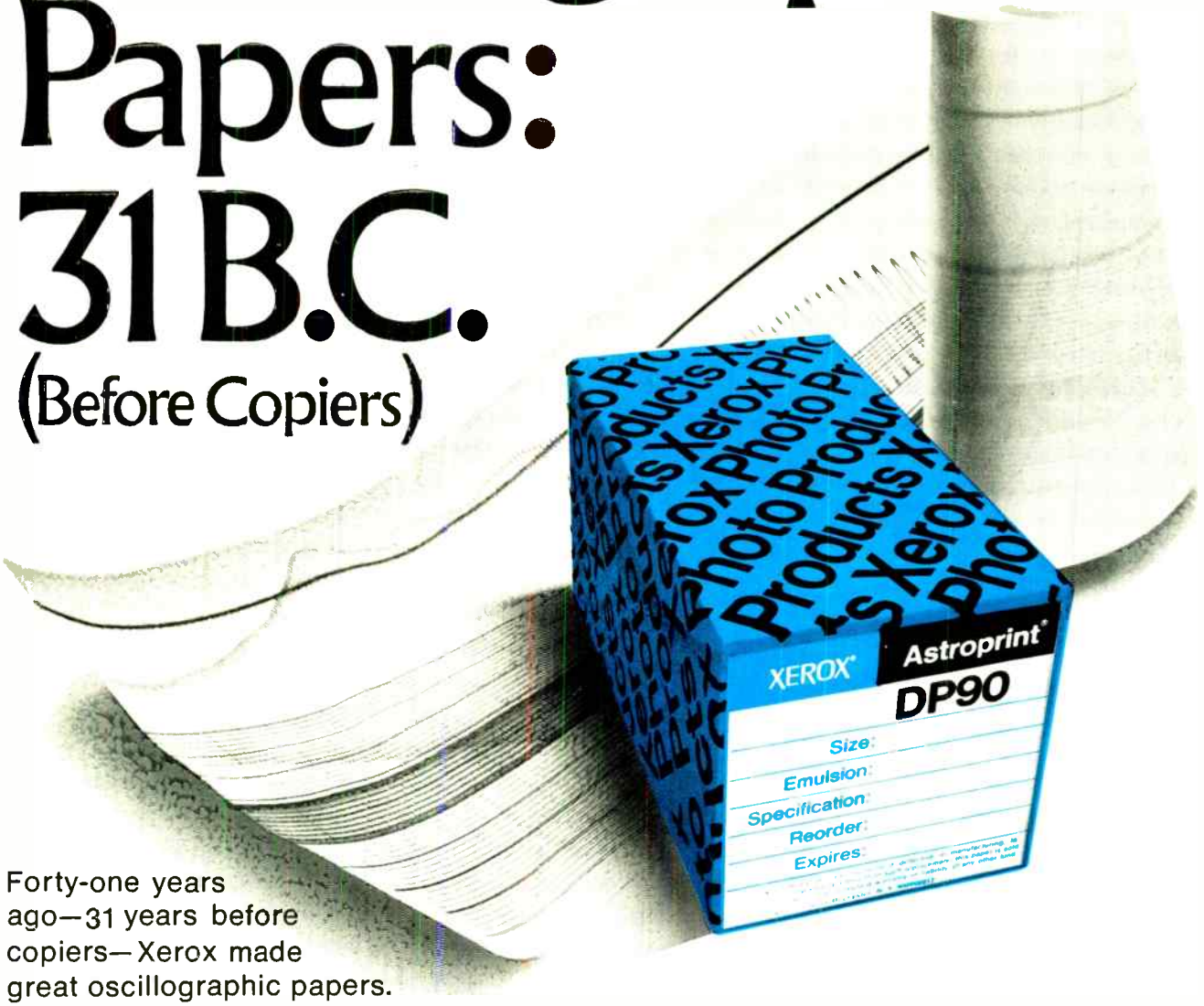
He claims that Tucker Electronics probably already has the largest volume in reconditioned equipment, "but we don't find quantities of late model equipment that people want to buy." So he is looking closely at expanding his sales of new equipment. The firm, still primarily in the reconditioned equipment market, also sells three lines of new equipment, including the Triplett and Simpson meters. "In other businesses, such as car sales or machinery, you can get all your needs taken care of at one place. But not in the test equipment business."

The two giants of the industry, H-P and Tektronix, offer sales plus service of new equipment, but not of reconditioned devices. Tucker points out that "It makes more sense for the smaller companies to sell and service through someone with a good organization such as the one we're establishing, than to try to do it on their own."

Tucker believes that it will be necessary to go to private labels for at least part of the new equipment sales. "The present pricing structure is set up for reps, and makes it hard to stock equipment as a distributor. But if we can develop a strong enough marketing and service organization, we should be able to sell private labels." He is already negotiating with a number of American firms.

"There are so many $399 DVMs on the market, for example, that we have to evaluate the equipment and the company carefully," he explains. And Tucker realizes the problem ahead of him. "We've been selling H-P and Tektronix on their names. Now we'll have to see how it works when we're selling under ours."

Xerox Oscillographic Papers: 31 B.C. (Before Copiers)



Forty-one years ago—31 years before copiers—Xerox made great oscillographic papers.

And we've been improving them ever since. You can order them direct from your local Xerox Product Specialist listed in your telephone directory for fast shipment from our Regional Supply Centers—our way of helping you save time and money, while solving storage and delivery problems. Check performance, price and service benefit that's yours with Xerox Astroprint DP90. Xerox Corporation, Business Products Group, Department HL, Rochester, New York 14603.

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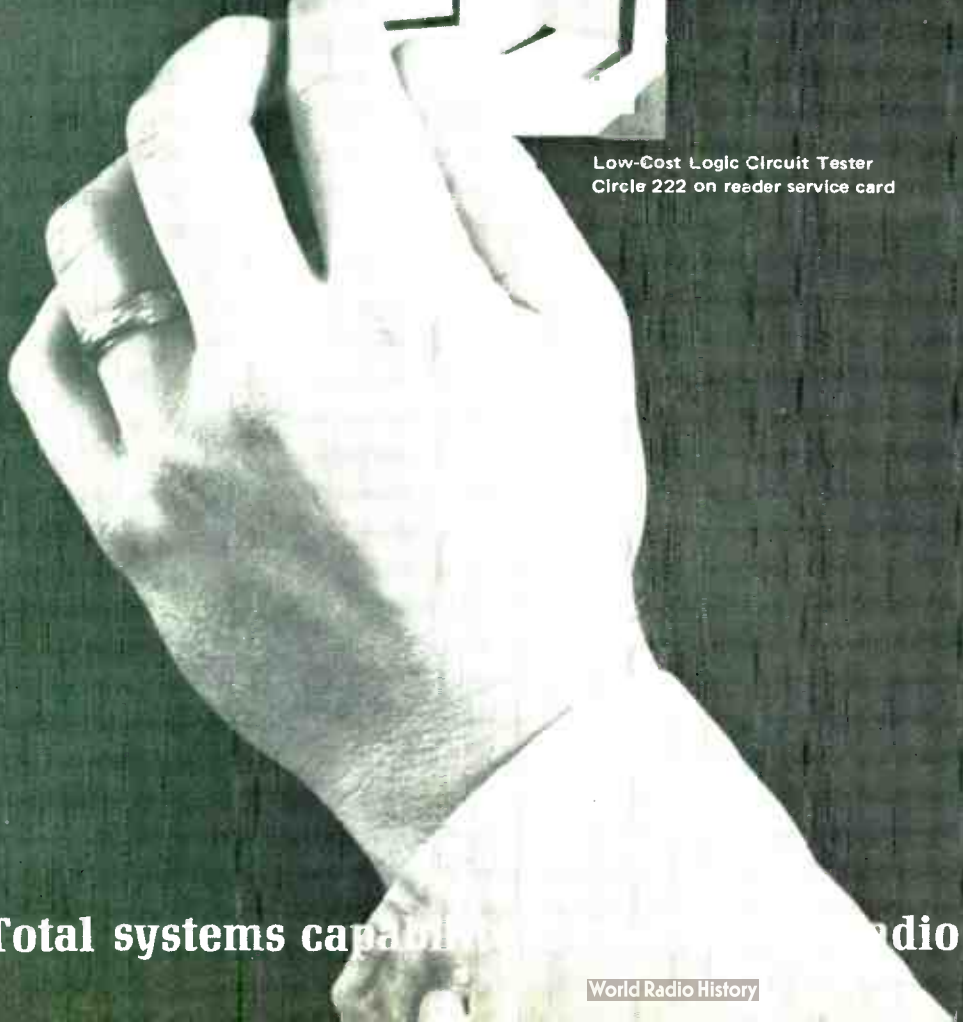
The GR Systems Family

GR Resistance Anodize Trim System
Circle 221 on reader service card

Micronetic s Laser Trimming System
Circle 220 on reader service card

Low-Cost Logic Circuit Tester
Circle 222 on reader service card



Total systems capa dio

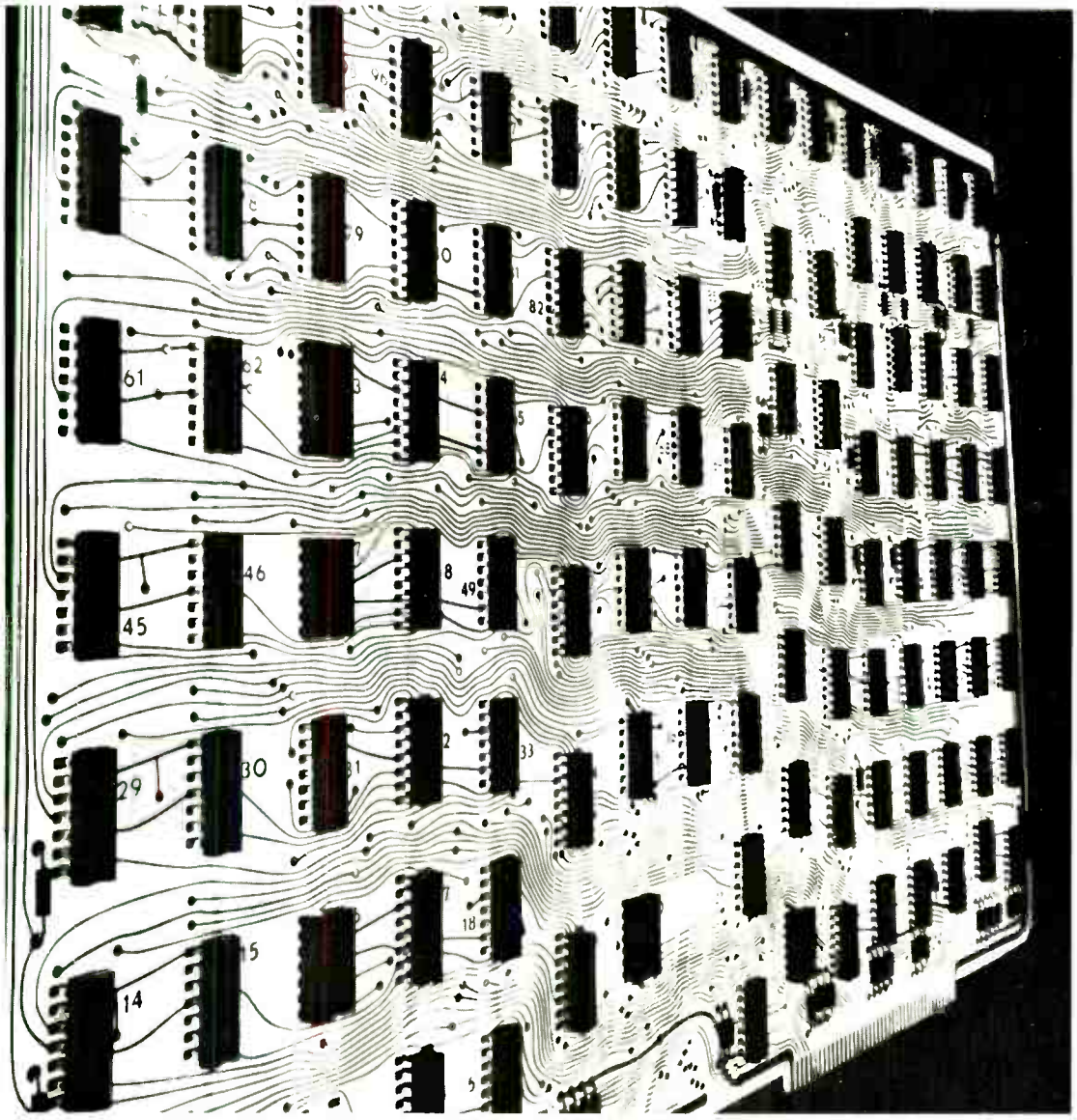


Photo Courtesy of Incoterm Corporation.

The under $20,000 Computer-Controlled Logic-Circuit Tester is here

You can't buy one for less. You can't build one for less. And General Radio hasn't compromised capability for the sake of a low price tag. With this new system you can perform high-speed functional GO/NO-GO and diagnostic tests even on big boards with more than 100 IC's.

GR's new 1793 Logic-Circuit Tester is a full-blown computer-controlled system with a 4k memory minicomputer, paper-tape input, and teleprinter output. Test programming is done in a simplified high-level language. Personnel with little or no previous programming experience can write test programs after only a few hours training. What's more, the system design, hardware, and software have been field-proven over the past two years in GR's highly successful 1790 system.

The basic 1793 gives you 96-pin capability. We can furnish more if you need it.

This new system from GR brings high-speed logic-circuit testing into the price range of almost every company. We'd like to tell you the full story on the 1793. Write or call the GR office nearest you or GR in Concord, Mass., (617) 369-4400, for complete information on the low-cost 1793. In Europe write Postfach 124, CH 8034, Zurich, Switzerland.

General Radio

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SELECTED SPECIFICATIONS

TOLERANCES	Absolute to ± 5%
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Investigate the advantages of Allen-Bradley cermet R/C networks. For information write: Marketing Department, Electronics Division, Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wisconsin 53204. Export office: 1293 Broad St., Bloomfield, N. J. 07003 U.S.A. In Canada: Allen-Bradley Canada Ltd., 135 Dundas Street, Galt, Ontario.

NEW DIMENSION ELECTRONICS

ALLEN-BRADLEY

A-B QUALITY

Circle 20 on reader service card

Meetings

Fall Joint Computer Conference: IEEE, Convention Center, Las Vegas, Nov. 15-18.

Ultrasonics Symposium: IEEE, Carillon Hotel, Miami Beach, Dec. 6-9.

Vehicular Technology Conference: IEEE, Sheraton-Cadillac Hotel, Detroit, Dec. 7-9.

Reliability Symposium: IEEE, El Cortez, San Diego, Jan. 25-27.

Power Engineering Society Winter Meeting: IEEE, Statler Hilton Hotel, New York, Jan. 30-Feb. 4.

Aerospace & Electronics Systems Winter Convention (WINCON): IEEE, Biltmore, Los Angeles, Feb. 8-10.

International Solid State Circuits Conference: IEEE, Sheraton Hotel, University of Pennsylvania, Philadelphia, Feb. 16-18.

International Convention & Exhibition: IEEE, Coliseum and N.Y. Hilton Hotel, New York, March 20-23.

International Geoscience Electronics Symposium: IEEE, Marriott Twin Bridges Motor Hotel, Washington, D.C., April 9-14.

International Conference on Magnetics (INTERMAG): IEE, Kyoto International Conference Hall, Kyoto, Japan, April 10-13.

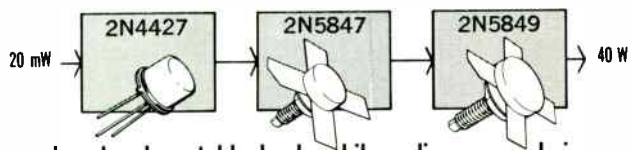
CALL FOR PAPERS

International Conference on Magnetics (INTERMAG): IEE, Kyoto International Conference Hall, Kyoto, Japan, April 10-13, 1972. All digests must be submitted no later than Nov. 20 to Eiichi Goto, c/o INTERMAG 72 Secretariat, KDD research & Development Laboratory, 1-23 Nakameguro 2-chome, Meguro-ku, Tokyo, Japan.

Ninth Annual Design Automation Workshop: IEEE, Statler Hilton Hotel, Dallas, Texas, June 19-21, 1972. Deadline for submission of abstracts is Jan. 3, 1972, to R.B. Hitchcock, Watson Research Center, Box 218, Yorktown Heights, N.Y.

We Must Communicate

. . . on land!

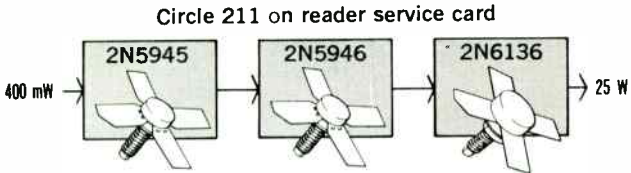


Low-band, portable land-mobile radio power chain.

25 to 50 MHz, 12.5 V.

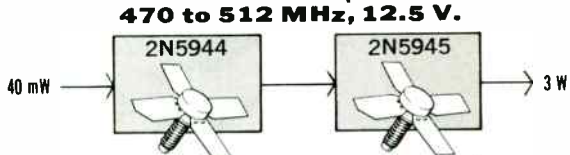
Send for data sheets and AN282: "Systemizing RF Power Amplifier Design" and AN502: "A 40 W, 50 MHz Transmitter for 12.5 V Operation."

Circle 211 on reader service card



UHF land-mobile radio power chain.

470 to 512 MHz, 12.5 V.

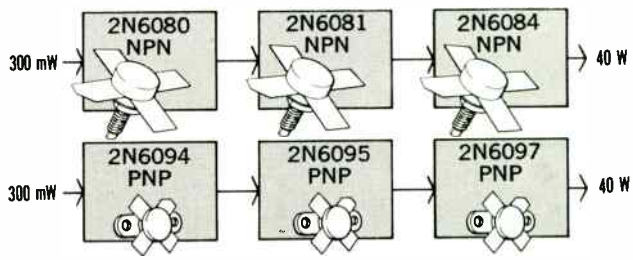


UHF portable land-mobile power chain.

470 to 512 MHz, 7.5 V.

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

Circle 212 on reader service card



High-band, portable land-mobile radio power chain.

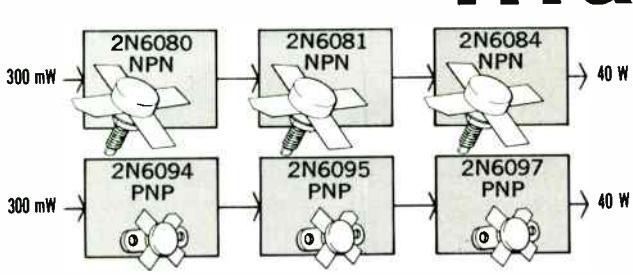
150 to 175 MHz, 12.5 V.

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

Circle 214 on reader service card

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.

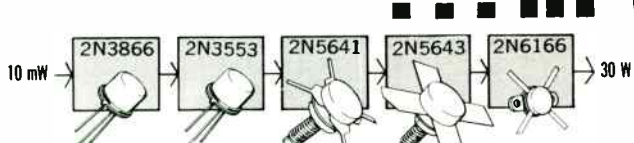
152 to 162 MHz, 12.5 V.

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

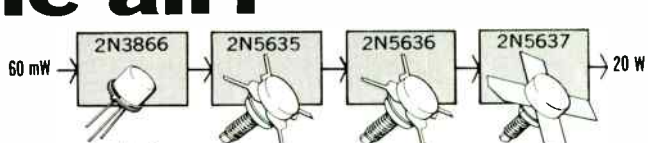
Circle 215 on reader service card

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."

Circle 213 on reader service card

Circle 216 on reader service card

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

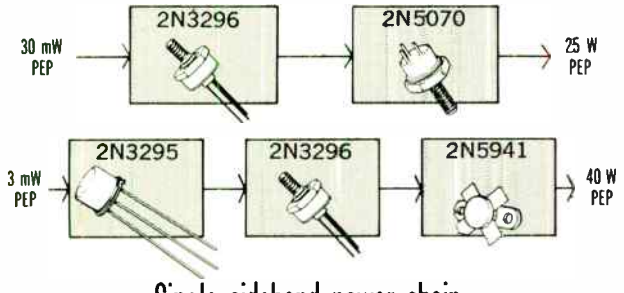
CATV. **5 to 300 MHz**

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!

Circle 217 on reader service card

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."

Circle 218 on reader service card

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."

Circle 219 on reader service card

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.

MOTOROLA RF
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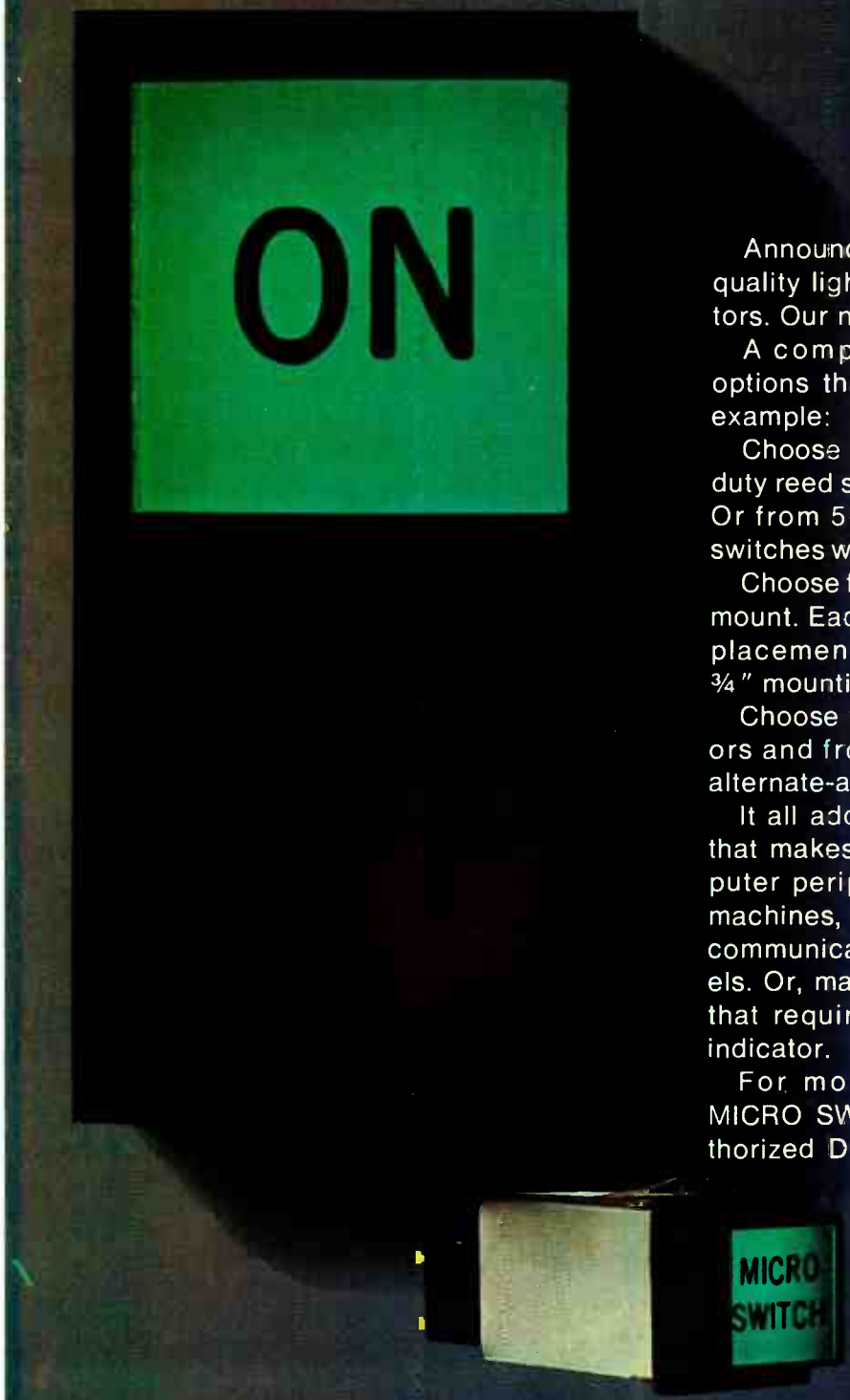
A new pushbutton line has come to light.



Announcing a medium-priced line of quality lighted pushbuttons and indicators. Our new Series 3.

A complete line with a choice of options that never seems to stop. For example:

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Electronics Newsletter

November 8, 1971

MOS RAM boasts under-100-nsec speed

MOS memory makers, stung earlier this year when bipolar makers announced new high-density processes, are beginning to counter with memories that offer bipolar speed.

The latest such device is an n-channel silicon gate 1,024-bit random access memory from Electronic Arrays, Mountain View, Calif., the first n-channel device on the market. The new memory has an access time that is "well under 100 nanoseconds, and we are seeing power dissipation in a system of 10 milliwatts per package," according to a company spokesman. This is an order of magnitude improvement in power dissipation over p-channel silicon gate parts.

Probably even more important, the new memory does not have to be cycled through the addresses to be refreshed as do other MOS memories—the refresh is accomplished by a write cycle. Parts will be available next month.

Solid state sensors for air pollution rely on ion exchange . . .

Experimental all solid state sensors are showing "remarkable responses" in detecting many common air pollutants at Environmental Metrology Corp., Ann Arbor, Mich. The end product, says Verne R. Brown, president, might be an atmospheric pollutant-measuring device far simpler and more rugged than present devices that rely on ultraviolet, infrared, photometric, and wet-chemical principles.

Sensors consist of thin-film electrodes made of catalytic metals such as palladium, nickel, platinum, and gold, deposited on a solid dielectric—a developmental sulfonated Teflon-like sheet material from DuPont. A gas flowing over the sensor triggers an ion exchange in the electrolyte and generates microampere-sized currents. Current varies with the gas and its concentration, with the electrode materials, and with magnitude and the polarity of the bias that's applied to the electrodes.

. . . as developer seeks electronics partner

The next step for Environmental Metrology is to get together with an electronics company to develop a scanner, memory, and display for identifying gases automatically. The scanner would, for example, sample an array of sensors whose outputs would be compared with values stored in memory. Identification and concentrations could then be displaced.

Enmet has constructed individual sensors, but the most ambitious thus far is one with six different electrode materials deposited on a 1-inch-square electrolyte. Based on the differing responses from these electrodes, it's possible to develop a characteristic signature for each gas and its concentration, the company says. Gases and vapors tested by Enmet using room-temperature nitrogen as a carrier include sulfur dioxide, nitrogen dioxide, hydrogen sulfide, ammonia, gasoline, benzene and alcohol.

Monsanto making green MAN-1 LED

Monsanto's MAN-1, seven-segment, light-emitting-diode numeric display soon will be available in green as well as red. The company has perfected a gallium phosphide process that will enable it to manufacture displays that emit green light at 5,600 angstroms.

Efficiency of the material is about the same as the MAN-1A high-brightness red unit, and current requirements are also the same—20 milli-

amps per segment. Initial cost is expected to be $9.50 each in quantities of 1,000.

H-P to introduce medium-sized computer

At the Fall Joint Computer Conference in Las Vegas next week, Hewlett-Packard will unveil its entry into the medium-sized computer field. Called the System/3000, the new hardware-software package is said to be the first computer system designed from the ground up specifically with multiprograming and multilingual capabilities. Price tag is expected to be $100,000 to $300,000.

Mini calculator competition heats up

Hard on the heels of the announcement that Ragen Precision Industries will build a mini calculator with liquid crystal display [*Electronics*, Oct. 25, p. 32], Busicom Corp. of Tokyo has finally put out a data sheet on another promised version [*Electronics*, Feb. 1, p. 19].

The Japanese firm is currently selling a light-emitting diode mini in this country for $395, less battery charger. But it is also promoting a single C/MOS-chip unit with liquid crystal display planned for U.S. entry if and when the consumer market takes shape. Busicom's proposed model is larger than the one planned by Ragen, measuring 5.6 by 0.78 inches. The company refuses to disclose price, but says that it should be less than half that of the LED unit.

At the same time, Garrett Micro-Circuits of Rancho Bernardo, Calif., has built a prototype calculator, using a proprietary MOS chip, that it expects would eventually sell for under $100. The firm, which sold its assets to Burroughs in August but retained the corporate name and a team working on proprietary developments, will not make the chip or calculator itself. Rather, it plans to provide masks and engineering help to semiconductor firms that will make the chips on a custom basis.

"Within the next month we expect to have a manufacturer for the calculator, and production should start in January," says George Cone, director of operations.

Now it's the personal programed calculator

Look for the almost-minicomputers—programable calculators—to invade more and more commercial applications in brokerage houses, banks, and medical laboratories. Insiders are already talking about "personal programables" to replace, or substitute for, computer terminals as the nonengineering uses are fast catching up to traditional markets at Wang, Hewlett-Packard, and Compucorp. Japanese makers are in an all-out drive to make programables next year's commercial market bonanza as hand-held minicalculators move into the consumer market.

Addenda

Mostek will soon begin second sourcing National's 4,096-bit ROM. At the same time, separate development is continuing at Mostek on an 8,192-bit ROM that also will be ready shortly. . . . Texas Instruments' Equipment group is apparently buying 100,000 1103 RAMs from Intel Corp. for its new 960A minicomputer [see p. 111]; the order may be one of Intel's largest single deals for the 1,096-bit 1103. Also, the 960A comes with 4,096 bits of 16-bit memory, or a minimum of 64 1103s. TI also has plans to build its own versions of 1103 part. . . . The Instrument Systems Corp. system for electronically changing door locks from a remote console [*Electronics*, May 24, p. 17] is being demonstrated this week.

NEW! "THE SWITCH."

A unique high-performance C/MOS analog switch offering multiple configurations on one chip.

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Features:

Monolithic C/MOS
Low leakage <50nA. @ +125°C
High speed 250 ns.
Low power dissipation 5 mW.

Type	R_{ON}
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Single DPDT	125Ω
Single SPDT	60Ω
Dual SPST	60Ω
Single SPST	30Ω

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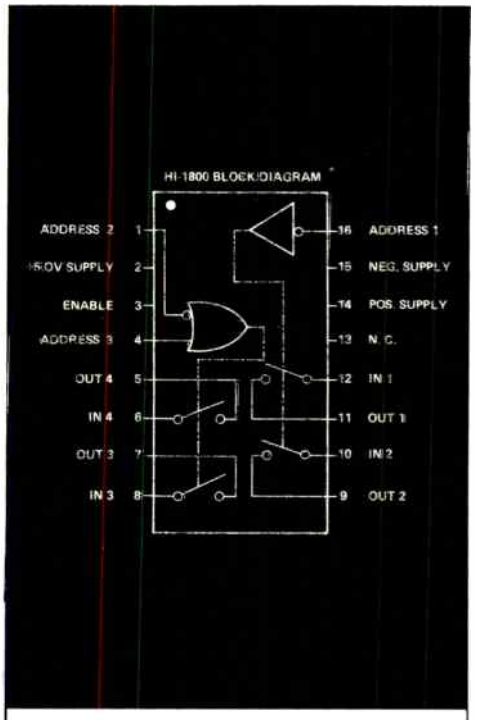
−55°C to +125°C	**$ 13.75**
HI-1800A	
0°C to +75°C	**$11.55**
−55°C to +125°C	**$17.05**



TRUTH TABLE

INPUT ADDRESS				SWITCH CHANNELS			
1	2	3	$\overline{EN}$	1	2	3	
L	X	X	L	ON	ON		
H	X	X	L	OFF	OFF		
X	L	X	L			ON	ON
X	X	H	L			ON	ON
X	H	L	L			OFF	OFF
X	X	X	H	OFF	OFF	OFF	OFF

H ≥ +4.0V L ≤ +0.4V

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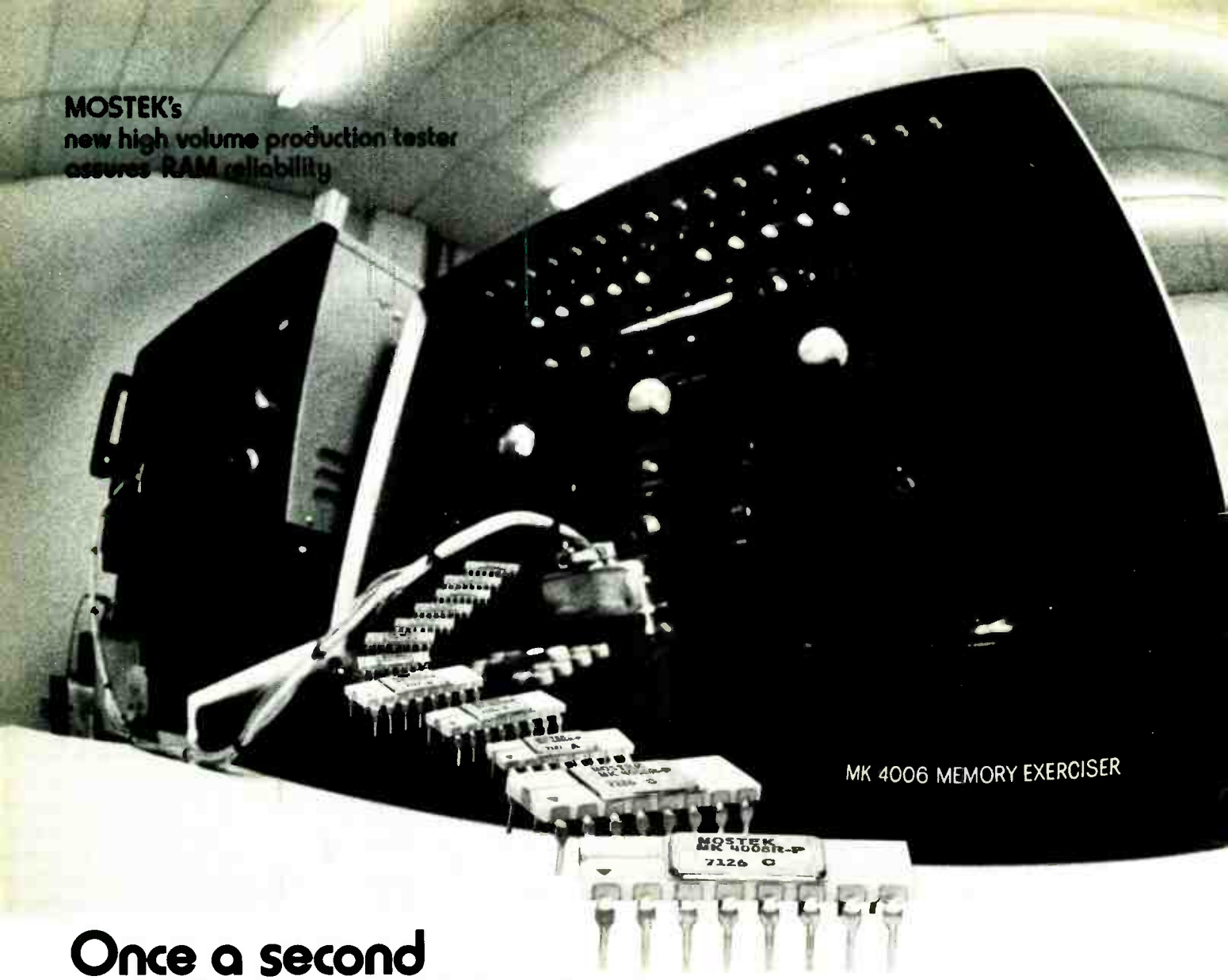

Once a second our 1024-bit RAM risks its reputation to help preserve yours!

Since we introduced it just a few months ago, our ion implanted 1024-bit RAM, the MK 4006 P, has set a new standard for superior performance without speed or cost penalties. Now there's another reason for buying your next RAM from us.

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Circle 28 on reader service card

Processing advance brings solid state tube another step closer

Ability to apply low-work-function layer to cold cathode improves current density

A whole new field of electronics based on semiconductor tubes may be in the offing. Helping it along is a solid state p-n junction cold-cathode vacuum tube being developed jointly by two Texas firms—Spectronics Inc. in Richardson and General Electrodynamics Corp. in Garland—that uses gallium phosphide for its cathode material. The tube is coated with a low-work-function material, such as cesium or cesium oxide, to let the electrons escape into the vacuum.

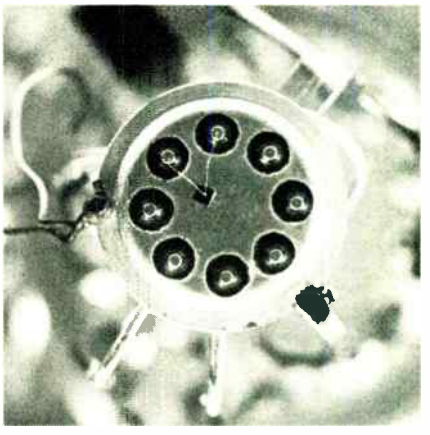
Robert Beard, Spectronics' vice president for R&D, points out that vidicon camera tubes could be built with an array of solid state cathodes each of which would address a section of the target. This would mean less energy spread on the electron gun, and reduced lag. The concept could lead to the development of flat video tubes.

Search. Researchers have been excited for some time about the possibilities of solid state tubes. For example, RCA, long active in cold-cathode work [*Electronics*, Oct. 12, 1970, p. 45] has recently operated a silicon version successfully. In that device, essentially a forward-biased silicon p-n junction, the p surface is activated into a state of negative affinity to allow electrons to escape into the vacuum.

The p-n junction cold cathode is a device that emits electrons directly into vacuum when the diode is forward biased. In the Spectronics device, operation is made possible by the low work function that can be achieved when a clean GaP surface is treated with cesium or cesium oxide. Here, ohmic contacts and mounting techniques allow the device surface to be cleaned at 500 C before the low-work-function layer is applied.

To come. When the surface work function is less than the band gap of the semiconductor, minority carrier electrons injected at the junction diffuse to the surface and are emitted into the vacuum. Current density is presently small and must be increased to approach commercial significance.

Spectronics selected GaP because of its wide band gap and poor light-emitting properties—photons would represent lost electrons.



Texas tube. Gallium phosphide cold cathode may find its way into vacuum tube. GaP is coated with low-work-function material to ease electron escape into vacuum.

Military electronics

Four-man council set to run telecommunications

A new top-echelon council has been formed to run the World Wide Military Command and Control System. The four-man council, which is taking over responsibility for the system from the Defense Communications Agency, also will have the final word on planning, coordination, and new procurement. Goal of the council will be to spur military commanders and electronics contractors to come up with systems whose performance matches their promises.

This is evident in Deputy Defense Secretary David Packard's saying that he wants to unsnarl the WWMCCS network—particularly the National Military Command System segment at the Pentagon—to avoid any repetition of foulups like the Mediterranean incident a few years ago, the Pueblo incident, and the EC-121 incident, all of them embarassing to the U.S.

Unhappy. Though Packard didn't spell it out, the council's formation makes it clear to government and industry telecommunications specialists that the Pentagon has been less than pleased with the performance of the Defense Communications Agency as manager of the WWMCCS net. At the same time, formation of the WWMCCS council—comprising Packard, the Chairman of the Joint Chiefs of Staff (who will have responsibility for operations), and the Assistant Secretaries of Defense for telecommunications and for intelligence (with responsibility for technical aspects of the system)—downgrades the role of individual

military commands and, presumably, their potential as electronic customers.

Boss. "I lean very strongly in the direction that you've got to have one guy in charge," says Packard explaining his appointment of the chairman of the Joint Chiefs to run the NMCS operations. In effect, Packard is recentralizing authority that former DOD Secretary Robert McNamara decentralized when he created the unified and specified commands in the mid '60s. "Local commanders now have as their first priority to design their command system to meet the requirements of the national command system and only second, to meet the requirements of their mission."

Job open. To Defense officials, Packard's personal participation in the new council indicates his concern with the vacuum created in the Pentagon's telecommunications hierarchy by the death of the first assistant to the secretary.

So long as his position remains unfilled, the plan to integrate military communications systems among the three services is in abeyance. Several leading lights in U.S. communications are known to have turned down the post because of its politically sensitive nature, including the possibility that they could be out of work after the next Presidential election. A top priority job will be doubling the size of the national Military command Center headquarters in the Pentagon basement.

Communications

Signal processor speeds code changes

A signal processor marrying two emerging technologies—surface acoustic-wave-delay lines and silicon-on-sapphire control circuits—promises to permit hundreds of code changes per second when required by a program.

Two of the units, built by the research and technology facility of the Autonetics division of the North American Rockwell Corp., have been delivered to the Air Force's Wright Patterson Avionics Laboratory in Dayton, Ohio.

The encoding and decoding portion of the processor is a 16-tap programable surface acoustic-wave delay line in which the taps are controlled by the SOS circuit. Because switching speed in SOS circuits is high—several hundred nanoseconds—input data can be fed into the delay line encoder at data clock rates of 10 to 20 megahertz and transferred to hold circuits controlling the output of each line tap.

Every 5 μsec. Once held, other codes can be fed in as required, then transmitted, received, and processed, at which time the held code could be activated again. In this manner code changes could be made in intervals as small as 5 microseconds.

Peter Hagon, director of the project, points out that communication systems are not equipped to utilize fully the entire capability of these new processors. "But," he says "when system analysts realize the extent of its flexibility they may design new systems around it."

Common carrier. Carrier frequencies as high as several megahertz can be accommodated, making the processor useful in the most common transmitting bands.

The delay line is made on lithium niobate, with the acoustic taps bonded to pads on the SOS substrate. The SOS circuit is a standard two-phase dynamic shift register, but it has resistive loads instead of the conventional transistor loads because in SOS configurations these are faster. This arrangement gives the circuit its fast code change ability.

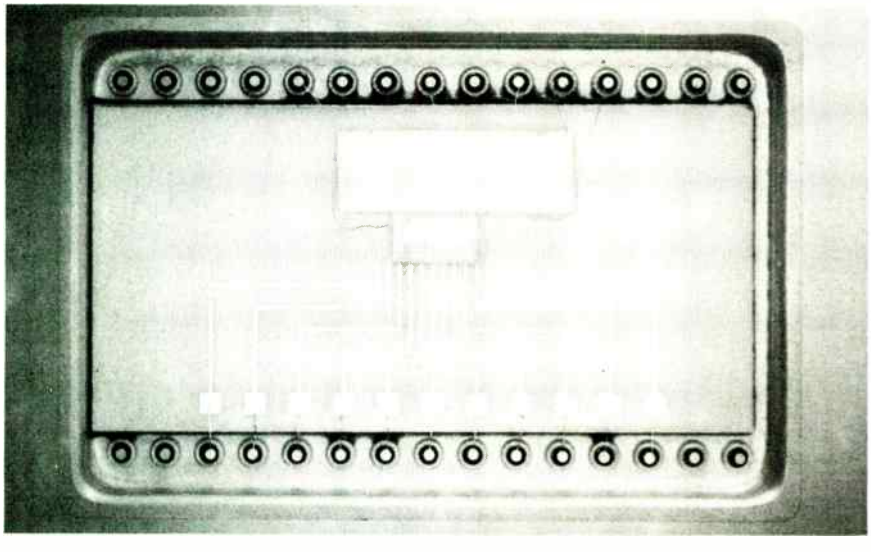
Coming. Hagon indicates that his group is now working on a fully monolithic version of the device. This one, a 32-tap processor with a 20-MHz data rate, will have a single-crystal aluminum nitride acoustic line fabricated on the same substrate as the SOS control registers. This represents the most advanced signal processing technology to date. "Look for it in six months," says Hagon.

Medical electronics

NAE urges biomedical evaluation board

A study by the National Academy of Engineering recommends creation of a national body of industrial, medical, engineering, and social experts to clarify Government's role in biomedical engineering. The body also would stimulate industry participation and understanding of the biomedical electronics marketplace.

To be dubbed the National Biomedical Engineering Evaluation Board, the group also would pro-



SOS to rescue. By joining surface-acoustic-wave delay line with silicon-on-sapphire control circuitry, Autonetics can change codes at extremely high speeds.

Electronics Index of Activity

Nov. 8, 1971

Though September's total production index climbed 1.2% from the revised August level of 113.0, it was still 2% lower than the year-ago figure.

All areas of the index contributed to September's increase. Consumer, the biggest gainer, was up almost 8% from August's sharply revised 89.3, leaving it 14% above the September 1970 result. Defense showed a 1.5% increase from the previous month's 115.9, leaving it down 4.1% from its year-ago total. Industrial-commercial was up 0.7%, which is 5.7% below September 1970.

Segment of Industry	Sept. '71	Aug. '71*	Sept. '70
Consumer electronics	96.4	89.3	84.7
Defense electronics	117.6	115.9	122.6
Industrial-commercial electronics	118.3	117.5	125.5
Total industry	114.4	113.0	116.7

Indexes chart pace of production volume for total industry and each segment. The base period, equal to 100, is the average of 1965 monthly output for each of the three parts of the industry. Index numbers are expressed as a percentage of the base period. Data is seasonally adjusted.
*Revised

vide communications between medical and technical personnel, collect technical and market information, and encourage alterations in the educational process.

Surgery. The report, to be published by the NAE's committee on the interplay of engineering with biology and medicine, reflects a survey of 50 biomedical engineering firms by Arthur D. Little Inc. In addition to the board, the report calls for a government organization similar to the Food and Drug Administration to regulate biomedical products. It also urges the National Institutes of Health to expand their role in biomedical engineering by endorsing the overview board, supporting goal-oriented research, expanding its in-house engineering competence, supporting engineering internships at NIH, and establishing university programs for design- and product-oriented biomedical engineers.

Industry says the major problem is slow market acceptance. The reason is lengthy and unstandardized clinical evaluation procedures—it often takes five years or more to get a product from idea to market acceptance. And doctors are conservative about new techniques that may involve a certain amount of risk.

Related problems include estimating the market size for specific products, finding capable salesmen, providing sufficient instructions for use and maintenance, and providing service facilities. The maintenance function, the study concludes, is a loss, or, at best, a break-even proposition. For example, electronics companies say that doctors call in service personnel before seeing that equipment is being operated properly.

Costly. Industry also cites high product development expense as constraining. The most often-quoted figure was 8% to 10% of sales for development, although the study concludes that the biomedical electronics industry does not undertake or support basic research to a significant degree. Also, the custom nature of small quantities of products, which generally cannot be marketed through dealers' or manufacturers' representatives, adds to high product costs.

Industry also reported that variations in product specifications—including performance standards, product features, and safety standards—can be attributed to uncertainties in the market place. Most companies indicate that they would be happy to see standardized clinical evaluation procedures, and that they favor laws setting device standards. However, only half the companies surveyed say they comply with voluntary safety and performance standards issued by outside organizations—a lack of faith that industry associations will be able to

agree on voluntary standards, NAE concludes.

Unseen. In addition, NAE reports that industry does not recognize many of the problems plaguing biomedical markets, such as the need to develop management and technical personnel. There was a surprising resistance to formally trained, research-oriented biomedical engineers—most companies prefer using a combination of specialists. The NAE recommends that industry increase its involvement in academic biomedical internships in industry.

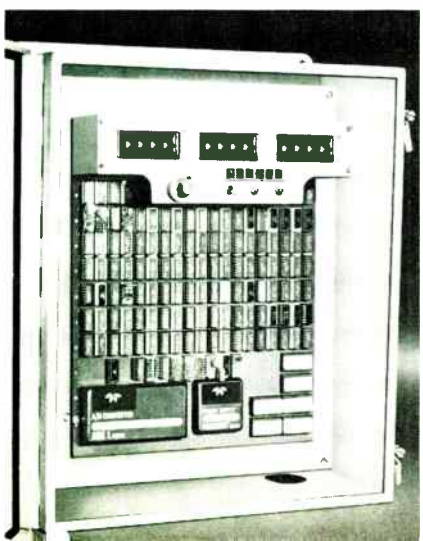
The biomedical electronics industry does not realize that its relationship with medicine is "inadequate," the committee decided. "The major sources of product ideas are conventions, public resource papers, and the advice of one or, at most, a few medical consultants."

Companies reported that foreign competition is not a major threat at this time. But the NAE warns that foreign government subsidies, such as the underwriting of the nuclear industry in France and England, greatly enhance those countries' capabilities. And an NIH source reports that Japan and Germany are preparing a strong push into the U.S. medical electronics market.

Instrumentation

Gas chromatograph tailored for drug test

The development of a gas chromatograph for hospital drug tests of comatose patients is helping to change the image of the instrument from a complex research tool to a simple, useful clinical device that can be operated by technicians. The result may be a line of "less-knobs" gas chromatographs for specific industrial applications.



Match. "We're matching the chemistry to the electronics instead of vice versa," says Joe W. Lee, senior sales engineer at the Bendix division. "All the gas chromatograph's controls have been incorporated into a logic circuit to minimize the instrument's external knobs."

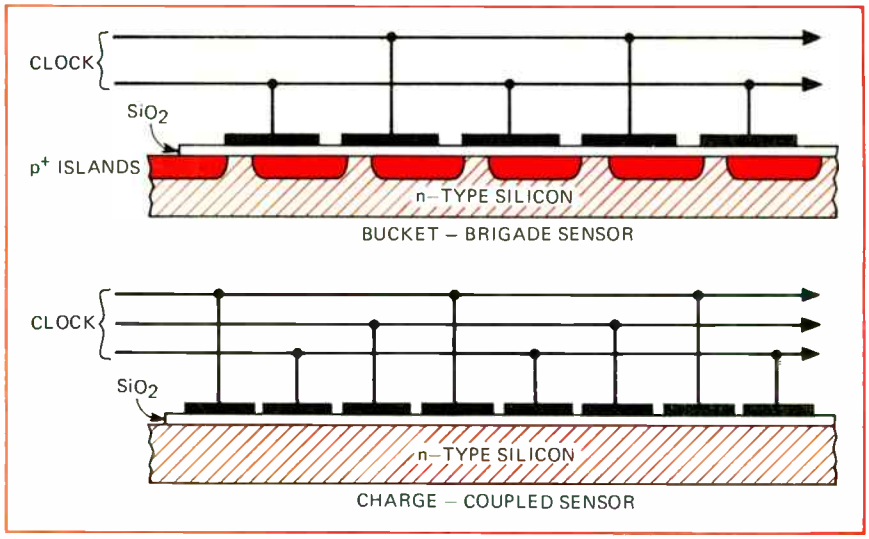
Bendix calls its hospital machine the Toxichron drug analyzer system, and it's scheduled for introduction in January by American Hospital Supply Corp.'s Scientific Products Division. A potential market of 7,000 hospitals has been pinpointed, especially those of over 100 beds in rural areas, for the $7,000 Toxichron system.

"The payoff is in lives," says Lee. The Bendix pilot installation saves a life a month at a poison center in Charleston, W. Va., a clinical lab serving 1,000 hospital beds. A similar setup in Philadelphia averages 10 lives a month saved from potentially fatal drug overdoses.

By injecting a sample of the patient's blood or urine parallel with a company-supplied drug standard, technicians can perform in minutes qualitative and quantitative analyses for drug abuse, as against hours for thin-layer chromatographic techniques that are merely qualitative.

The Toxichron is now programed to clinically determine heroin use by sensing morphine and quinine in serum and urine; and methadone, codeine, alcohol, and barbiturates to 2% accuracy. Under development are standards for other drugs.

All the analyzer's electronics are in one module consisting of nine snap-in circuit boards—each off the shelf. Output is normally displayed on a strip-chart recorder, but Toxichron can be tied to an electronic digital integrator or through Teletype to the hospital's own data processing system.



Call the bucket brigade. Salient difference between bucket-brigade and charge-coupled devices: bucket brigade requires two diffusions per bit processed; CCD requires none.

Displays

RCA bucket brigade in new camera tube

No sooner did vidicons with solid state targets appear on the market than researchers started casting about for techniques to make them without having to pack 750,000 diodes on a single silicon slice. Among the ways to go: charge-coupled and bucket brigade devices. Though the bucket brigade technique has been around longer, most corridor talk at recent technical meetings has been of CCD.

However, it appears that bucket

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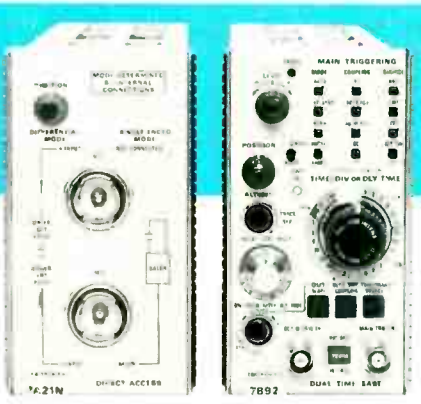

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500 MHz @ 10 mV/cm

7D14 Digital Counter
525 MHz direct counting

7B92 Dual Time Base
500 ps delayed sweep

OR . . .

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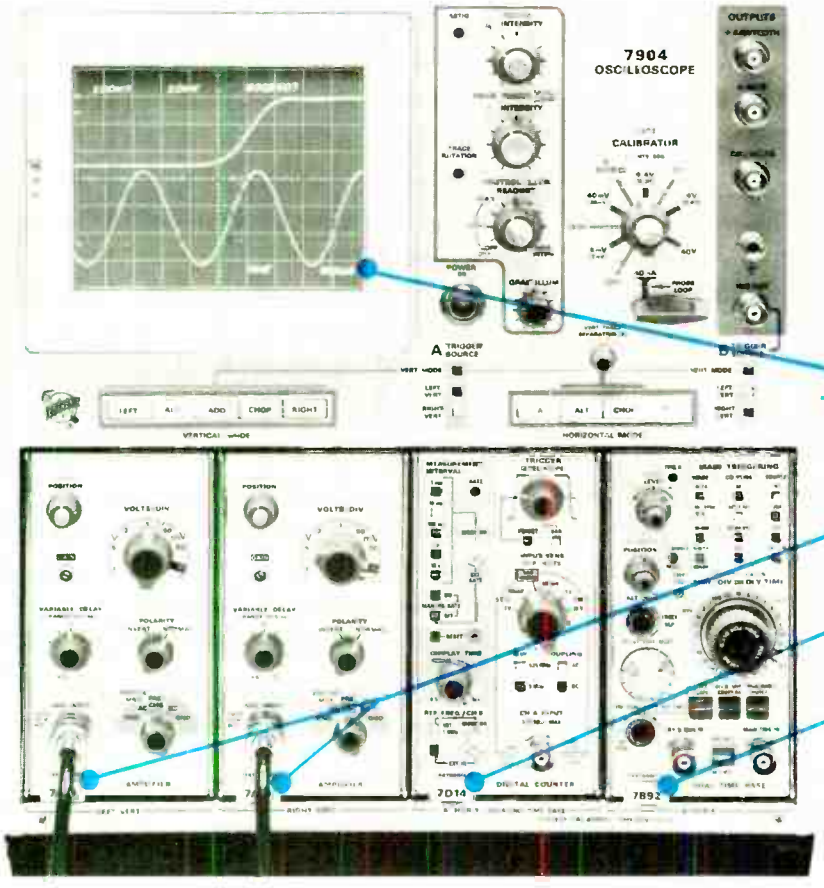

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brigades will find their way into camera tubes before their CCD cousins. In fact, one of the research groups that was into the bucket brigade approach early, RCA's Sarnoff Research Laboratories in Princeton, N.J., feels it has refined the technology to the point where imagers are not far off. Researchers have built a completely integrated self-scanned sensor with 32 by 44 elements spaced on 3-mil sensors; as an area imager it's more advanced than any using CCD

No loss. Bucket brigade IC techniques offer practically all the fabricating simplicity inherent in CCDs (they're a little more complex, needing a few diffusions per storage element, whereas CCD needs practically none) but they have the salient advantage of not experiencing the charge transfer loss at high scanning rates that's one problem with CCDs. Also, they're closer to standard MOS structures.

Both types offer the advantage of scanning the image by transferring charge, as opposed to the more conventional X-Y addressing of diode-target imagers. This translates into improvements in sensitivity, uniformity of output, and ease of fabrication. Both sensitivity and uniformity improvement will follow from a reduction of the switching transients over that obtained with X-Y addressing.

Nonuniform. Since the transients in X-Y addressing depend on critical phase differences between successive pulses, they vary somewhat randomly in time, and hence contribute to a nonuniform background level. On the other hand, a charge-transfer sensor that collects its output signals on a common electrode would be expected to provide a more uniform background.

Paul K. Weimer, leader of the research team responsible for RCA's bucket brigade development, points out that the RCA approach is to build the arrays "in a ladder-like pattern that could be used to take TV pictures. To form the overall TV pictures," Weimer says, "the charge storage pattern is read out a line at a time. In this way only nine external leads to the device are needed for both passing control signals in the sensor and for receiving the picture output."

Lasers

Bell's laser writer may be CCTV alternative

Piping lectures and hand-drawn materials into classrooms over the wideband lines of closed-circuit television can be an expensive proposition. Bell Laboratories feels it may have found a more economical way with its experimental system for transmitting handwritten information over phone lines [*Electronics*, Oct. 25, p. 25]. The result could be an elegant new piece of equipment—a laser writing and image projector about the size of a 16-mm movie projector, says F. E. Froehlich, head of the Telephone Technology department at Holmdel, N.J.

Bell is developing its system on the assumption that the visual aids required in many subjects often are only the equations and schematics drawn by the lecturer while he speaks. Full TV images of the instructor himself are unnecessary.

The position of a writing implement such as a piece of chalk, pen, or stylus is sensed acoustically, converted to digital data for transmission over phone lines, and reconverted at the receiving end in real-time.

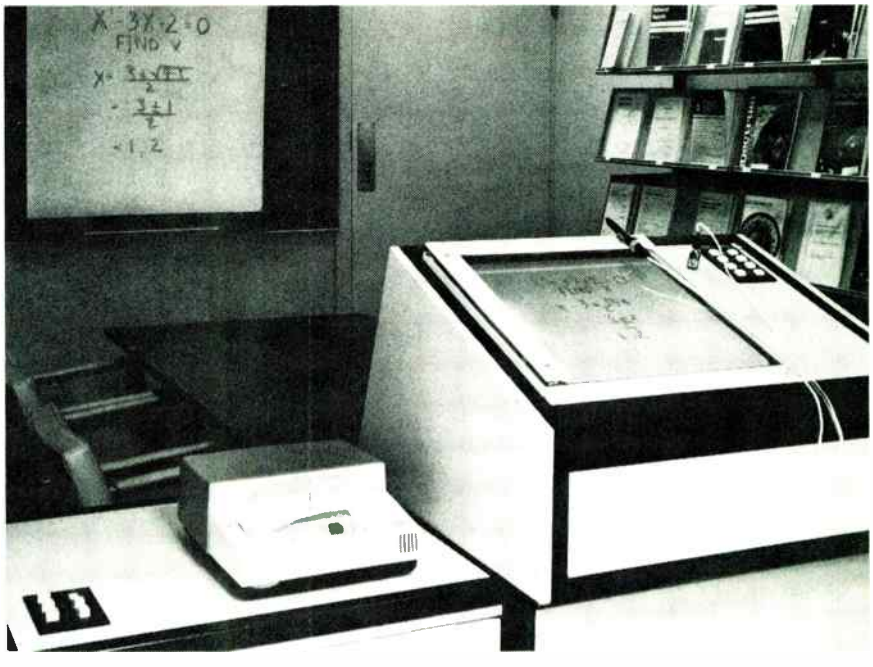
Initially, Bell is using a modified, commercially available, computer graphics terminal, a Science Accessories Corp. GP-1 Graf/Pen.

Mikes. This device comprises two electret strip microphones, placed at right angles to each other at the edges of the writing surface. They receive acoustic pulses from an ultrasonic emitter fastened to the writing implement. No special writing surface is needed with the pickup, point out engineers C. Blake McDowell III and L. E. O'Boyle; it can use a full-size blackboard or a small writing pad.

Time. Position is fixed by measuring the time it takes for a sound pulse to travel from the stylus to each microphone. These times are expressed in 10-bit output pulses, which are transmitted over phone lines using Bell Model 102 Dataset.

At the receiver, Bell uses a non-scanning technique for recreating the handwriting. This consists of a modified slide projector containing

Schematics by phone. Bell labs experimental "remote blackboard" transmits information written on 14 X 14 in. surface. Desk-size cabinet houses laser, projector, optics, circuitry.



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Type	Peak Power Output, kW	Pulse Width, Max.	Duty Factor, Max.	Plate Voltage	Frequency MHz, Max.
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TH 296	150	400	.050	15 kV	500

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standard size, 2-by-2-inch slides coated with an ultra-violet-sensitive Dylux writing material. Information is written on the slides with a beam from an ultraviolet helium-cadmium laser—RCA Model 2119 with about 6-milliwatt output. This beam reproduces the writing by being deflected by an X-axis and a Y-axis galvanometer mirror, which are controlled by the digital data sent over the phone lines. Focused on a coated slide, the laser beam forms a dark dye almost instantaneously; this is then projected immediately onto a viewing screen.

Use. Bell plans to use the system in connection with one of its employee education courses next spring. Two-way audio will be transmitted via the Bell system's Model 50A portable conference system. Right now, the receiving and projection unit is about the size of a desk, and researchers are working to bring the size down.

One possible way is to replace the RCA laser, which is about a yard long, with a new type of helium-cadmium laser still under development. This new device will use metallic cadmium, rather than an isotope as required in commercially available units, and could be as short as 15 inches.

In particular, Bell wants to learn more about the human factors associated with the system, points out Froehlich, as well as insuring itself of commercial feasibility. The type of writing implement that will prove most comfortable is one question to be answered, he says. Another question is whether viewers will accept the color scheme that the Dylux material requires—black-appearing writing on an orange background.

Consumer electronics

TV pictures ride fm bands in slow-scan trials

A scheme to transmit narrowband video over fm radio subcarriers is to undergo tests early next year in Flint, Mich., and South Bend., Ind. Designed for educational use, the system transforms standard 525-line television frames into slow-scan signals of 8 kilohertz.

The picture, reduced to 120 lines, then can be broadcast to an fm receiver connected to a decoder, which converts the signal into a still photograph on a standard TV tube. Audio is transmitted on another subcarrier. A sliding pulse generator continuously delays the horizontal lines 10 to 60 microseconds. Then each line is sampled and held on a magnetic storage disk until the completed picture is ready to be sent.

Costs less. According to developer Glen Southworth, president of Colorado Video in Boulder, Col., this transmission provides a usable picture suitable for illustrating lectures at less cost than home video cassettes or relatively untried frame grabbers. Transmission time, he adds, is 2 to 30 seconds, depending on the complexity of the picture. Preliminary tests produced a 30-decibel signal-to-noise ratio with no crosstalk between channels.

The converter, connected to a standard closed-circuit TV camera, would cost about $2,000 in quantity. Ultimately, Southworth predicts, this compressed video approach will be the least expensive method for transmitting medium-resolution displays because the frequency-divided system can use economical narrowband services. And because the images can be stored on computer disk memory, time-sharing information retrieval will be possible for the home screen, he points out.

Commercial electronics

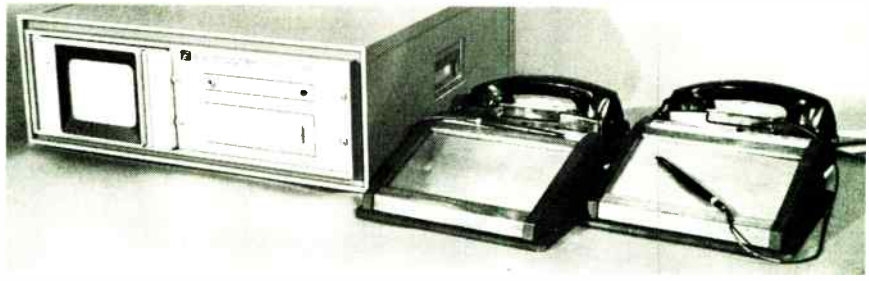
Signature check by phone designed to stymie forgers

A system for verifying signatures remotely via intercom or telephone lines has been developed for banks and security control points. Manufactured by Interand Corp., Chicago, the system, called Electrochek, has a plain stainless steel "pad" on which the user writes his name, either with a pencil or stylus.

30-minute hold. Special analog circuits, under wraps until patents are issued, pick up the writing for transmission to a central handwriting-verification center. A standard electrostatic storage tube captures the signature and can hold it for at least 30 minutes while a clerk checks it against a sample filed at the center.

Two models, one for hard-wired intercom and another with coupler for telephone links, are available. A five-station, hard-wired system costs $2,600 plus $1,650 for the display. The same five-station setup with telephone coupling costs $5,495 plus $200 for each additional signature plate.

Since it's virtually impossible to forge a signature without seeing the writing, banks will probably favor a pen-sized stylus for the writing instrument, says Electrochek developer Leonard Reiffel. And it's also possible to transmit other graphic data on the 4.5-in.-by-6-in. plate and capture the input on the CRT. A scan converter can replace the storage tube for display on a television monitor, if necessary. According to Reiffel, the phone coupler model of Electrochek is noise immune, making transmission as reliable as a



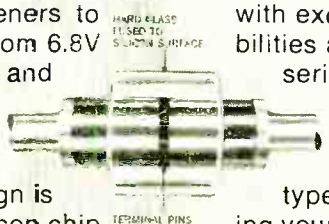
Genuine. Signature verification gear has stainless steel pad, stylus. Analog circuits pick up signature, transmit it to verification center's display tube. There, it is held for 30 minutes while a clerk checks it for accuracy. System comes in two configurations: one for hard-wired intercom, the other for phone link.

Whiskers are out.

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

The 1N4461-89 series from Unitrode is available off-the-shelf as JAN and JANTX zeners to MIL-S-19500/406 in most voltages from 6.8V to 100V. They offer greater reliability and improved electrical characteristics at no more cost than conventional 1watt whisker-type metal can zeners.

The reliability of the double pin design is further increased by bonding the silicon chip directly between terminal pins and then fusing a hard glass sleeve to the exposed silicon surface and pins.



This results in a voidless, monolithic structure with exceptional zener stability. Surge capabilities are 5 times greater than the 1N3016B series. Zener impedances are improved and reverse currents are two orders of magnitude lower. The point is, now you can switch from whisker-type to double slug design without shaving your standards. For fast action, call Sales Engineering collect at (617) 926-0404, Unitrode Corporation, Dept.12C, 580 Pleasant Street, Watertown, Mass. 02172.

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standard closed circuit hook up, but much easier to install than the cumbersome CCTV cables.

Industrial electronics

Calculator chips help measure gas

Standard MOS calculator chips are finding wide application outside desk and pocket machines, but one of the more unusual users may be in a gas flow calculator developed by Teledyne Geotech in Garland, Texas. According to R.R. Ryder, manager of the Products division, the new unit provides 0.1% measurement accuracy over a 100°F range on gases flowing through large transcontinental pipelines. It replaces older techniques that were often 10% off.

Other companies have recently introduced analog gas flow calculators using servos, pots, and the like, but Ryder says that the Geotech unit, which uses the Electronic Arrays set of calculator chips plus considerable additional electronics and logic, is the first digital version.

Gas flow has traditionally been measured with an orifice meter driving a chart recorder; most operations mail the charts in daily to a central office for integration by mechanical instruments. However, resulting inaccuracy causes a problem—the distributors who tap onto the pipelines pay severe penalties for excess delivery. They have to adjust their orders by a few percent to avoid the charges. Thus, Ryder says, his unit, which costs under $1,800, can pay for itself in a few months.

Harvest. Geotech's new calculator accepts inputs from a number of sensors—flowing temperature, flowing pressure, specific gravity, and differential. After appropriate signal conditioning and analog-to-digital conversion, the calculator chips determine the gas flow by following instructions programed in an MOS read-only memory. The formula for the calculation also involves a supercompressibility factor, which also is figured automatically.

The unit can accept inputs from a number of parallel pipes, a common arrangement. It can be incorporated in various systems for local or remote monitoring or control; Geotech recently received a major contract to automate one of the major pipelines, Tenneco's Tennessee Gas Pipeline and some of the units will be installed there. As for possible markets, Ryder notes that Tenneco alone has 300 metering points and Transcontinental Pipeline includes somewhere around 550 metering locations on its maps.

Integrated electronics

Raytheon steps into 'power module' market

Finding new growth areas within the framework of a semiconductor company is getting harder and harder. Part of the problem is that extending semiconductor technology into the subsystems area has the effect of creating enemies—the semiconductor manufacturers wind up competing with their customers.

Raytheon Semiconductor, however, has entered a new market area where this subsystem capability is welcomed. Raytheon's Mountain View, Calif., facility manufactures both discrete transistors and diodes and linear and digital ICs, and last year started to produce a thin film hybrid packaged so that it can handle up to 25 watts. Says Robert T. Borawski, operations manager for the hybrid and discrete facilities, "We wanted to move into new market areas characterized by high technology, medium volume requirements, an expanding market, and need for a high engineering content where we could make a definite contribution."

The answer is what Borawski calls the "power module" area. In the communications field, for example, Borawski says that the makers of land mobile equipment are changing over from tube designs to solid state units, and are very happy to buy a complete amplifier instead of designing the amplifier.

Look deep into my circuit.

You see an operational amplifier, very operational. You see a minimum gain of 10^6. You see an offset voltage drift of less than 1μV/°C. You see CMRR and PSRR errors of less than one part in a million. You are not sleepy.

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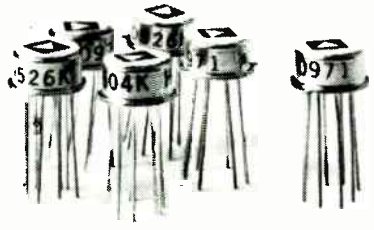


Circle 40 on reader service card

Electronics review

Another market area for power modules is cable television. Borawski says that CATV equipment manufacturers need integrated functions. But because of frequency and power requirements, they can't turn to monolithic circuits. "And because of stability requirements, they can't turn to thick film hybrids either," he adds. His facility is presently gearing up for production of proprietary cable television amplifiers.

"The problem here," he explains, "is that a flat amplifier that has very low cross modulation and low intermodulation distortion and that can also put out 10 milliwatts or 30 decibels of gain from 30 to 300 megahertz requires about 7.5 watts." This is a lot of power to handle in a cubic inch of space (the size of a power module), but it can be done if the hybrid is mounted on a block of aluminum or copper.

For the record

Tape system. A magnetic tape system, called Masstape, has been introduced to help operators of large computer installations cut tape-handling time. While it still relies on magnetic tape as the basic storage medium, hardly anything else about the system resembles conventional ones.

The half-inch-wide instrumentation tape records binary data in a modified phase-encoded form, in serial format, at 8,000 bits per inch on each of 16 tracks. It comes in 260-foot lengths in cartridges; one cartridge stores a maximum of 44.5 million bytes, the equivalent of 1½ conventional reels. The basic storage unit holds 352 cartridges, and thus stores nearly 16 billion bytes on line; a single system can employ as many as eight storage units, storing 127 bytes or just over a trillion bits.

Masstape's control unit is plug-to-plug compatible with IBM's System 360 and 370, and with the operating system software that supervises the large computers.

The system's manufacturer, Grumman Data Systems Corp., a subsidiary of Grumman Corp., says deliveries are expected to begin in the second quarter of next year.

Wang's new direction. Seeking new markets in office equipment, Wang Laboratories of Tewksbury, Mass., has added a computerized typewriter to its line of programable calculators. IBM now dominates the market. Wang's System 1200 Cassette Typewriter automatically justifies typed lines, centers headlines, sets tabs, and establishes margins. A one-tape system and a two-tape system sell for $7,000 and $7,400, respectively.

Invasion. Construction by Japanese television makers of assembly plants in the U.S. because of the Nixon economic game plan is beginning to look like a trend. First there was the Matsushita move into Puerto Rico; now the Sony Corp. plans to build a 140,000-square-foot plant near San Diego, Calif.

Sony says that it will be putting together 5,000 Trinitron one-gun TV receivers monthly by 1972.

And counter invasion. In the short time it has taken for the Japanese electronic calculator makers to capture 70% of the U.S. market—90% counting private-label deals—the traffic in desktop and handheld machines has been or way. Now a U.S. company, armed with a new $179 mini unit, has announced plans to reverse the flow.

Commodore, Santa Clara, Calif., which has been importing Japanese-assembled calculators, last month revealed that not only will all its future machines be all-American, but it will attempt to compete in Japan for the mini-machine market. The opening gun of this reverse invasion is the Minuteman I, a four-function rechargeable battery unity designed around a single Texas Instruments MOS/LSI chip. It has a light-emitting diode display with a constant memory plus floating and fixed decimal. First deliveries are planned for January 1972.

Panasonic entries. More confusion over which type of home video cassette player will dominate the industrial and consumer field developed

late last month when Panasonic (Matsushita), threw its considerable weight behind both the ½-inch and the ¾-in. formats.

The ¾-in. model is compatible, feature for feature, with the Sony player and recorder-player announced earlier.

Rival. Varian Data Machines of Irvine, Calif., claims to be the first minicomputer manufacturer to reach the market with an on-line, real-time operating system that will make a minicomputer rival much larger machines in capability. The system is called Vortex, for Varian Omnitask Real-time Executive, and uses a Varian 620/f.

Vortex will be available in January, and offers users automatic batch processing in a background mode while providing on-line, real-time foreground operations in the same system. A minimal Vortex system, including the 620/f, will cost approximately $48,000; a more versatile package will sell for $55,000.

Spending less. Plant and equipment spending in the electronics industries during 1972 is expected to decline 9% compared to 1971, according to the latest McGraw-Hill capital spending survey. This can be ascribed partly to the continuing massive cutbacks in defense spending and to the fact that facilities probably will be utilized well below their capacity. By contrast, most other industries covered in the survey expect plant and equipment outlays to increase next year by a total of 7% to $87 billion.

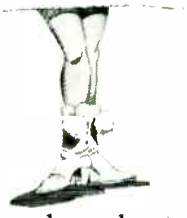
Gloom. Third quarter losses of $3,057,000 on sales of $46.3 million, or $0.70 per common share, by Fairchild Camera & Instrument prompted C. Lester Hogan, president and chief executive officer, to say: "Return to profitability in 1971 must be considered unlikely." This was in marked contrast to Hogan's predictions after second quarter results when he said, "Current booking trends in the semiconductor industry appear encouraging. . . . We expect the industry's recovery from the sales downturn of last year."

You're invited to a private screening

of the National Semiconductor Memory Seminar Film.

In your office.

A Film Is Born



Recently, we captured our best memory spokesmen on film as they discussed the National Semiconductor memory design philosophy, our current broad-based product line, and upcoming new designs, as well as a number of memory *system* applications.

The result is *The National Semiconductor Memory Seminar Film:* an informative, no-holds-barred, no b.s. look at the past, present and future of semiconductor memories.

A 30-minute filmic experience we'd like to share with you in the privacy of your own office.

With up to 25 of your friends and co-workers.

Free crackerjacks.

And one of our best applications engineers as projectionist/answer man.

Five-Part Flick

Before asking you to sign up for a free private screening of The National Semiconductor Memory Seminar Film, we'd like to offer a brief summary (realizing of course that mere words can never fully describe the exact nature of this unique, five-part cinemagraphic work):

Part One: Mainframe Memories

A quick-paced, yet highly significant review of National's mainframe memory capability in which the MM1103 and a couple of dynamic MOS RAM superstars are put into proper focus. Namely, the Tri-State* 1024-bit MM5260 and the 2048-bit MM5262.

Part Two: Scratchpad/Cache Memories

A thought-provoking presentation of scratchpad and cache memory applications featuring the breathtaking (Tri-State, 256 x 1) DM74200 and a bevy of other highly talented National bipolar RAMs.

Part Three: Silicon Store Memories

This highly-informative, slickly-produced portion of the film is devoted to the introduction of the revolutionary new "silicon store" memory; an inertia-less electrically rotating data string ideally suited to the dual 256-bit MM5012 and 1024-bit MM5013, National's up-and-coming pair of new longer length dynamic accumulators with Tri-State logic.

Part Four: Buffer Memories

A hard-hitting, two-fisted recap of commonly known buffer memory applications, liberally sprinkled with appropriate devices from National's arsenal of static MOS RAMs, shift registers and bipolar RAMs.

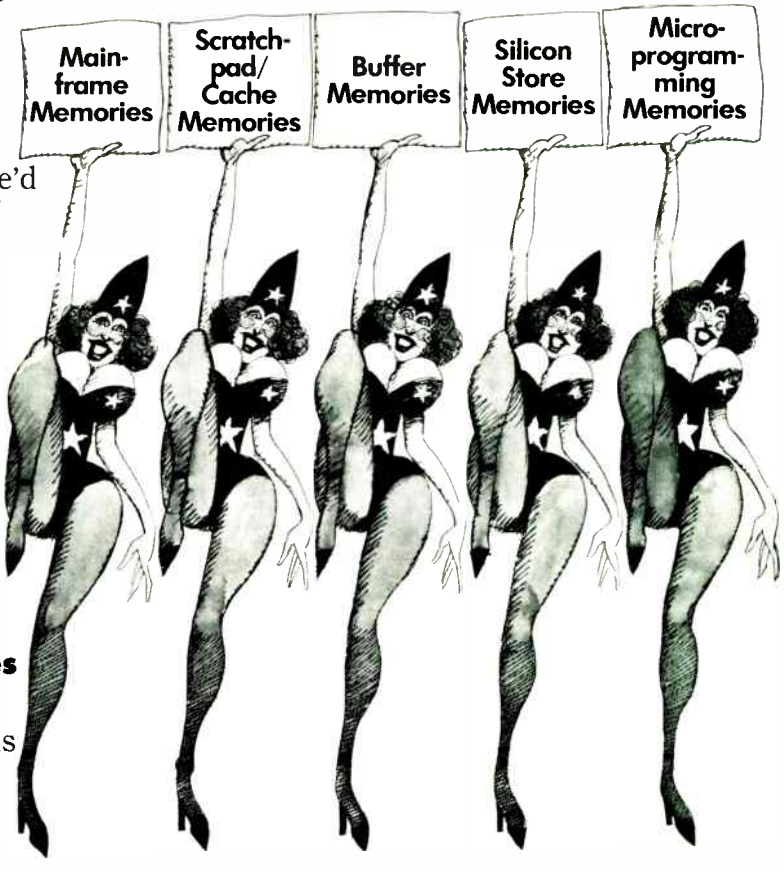
Part Five: Microprogramming Memories

As the proverbial "light at the end of the tunnel" appears, a number of devices are quickly exposed; including the DM8597 (1024-bit bipolar ROM), MM5203 (2048-bit MOS pROM) and the MM5232 (Tri-State 4096-bit static MOS ROM).

(For your convenience, we've taken the liberty of listing our complete line of semiconductor memory devices. Look them over carefully. We'll be glad to send complete specs on any category you wish.)

All you have to do now is fill out and mail us the handy free film coupon.

*Tri-State is a trademark of National Semiconductor Corporation.



Mainframe Memories

MM5260	1024-bit Tri-State MOS RAM
MM1103	1024-bit MOS RAM
MM5262	2048-bit MOS RAM

Scratchpad/Cache Memories

DM7489	16 x 4 bipolar RAM
DM8599	16 x 4 Tri-State bipolar RAM
DM74200	256 x 1 Tri-State bipolar RAM (read-write)
DM86L99	16 x 4 low power bipolar RAM
DM8594	64 x 4 Tri-State bipolar RAM

Buffer Memories

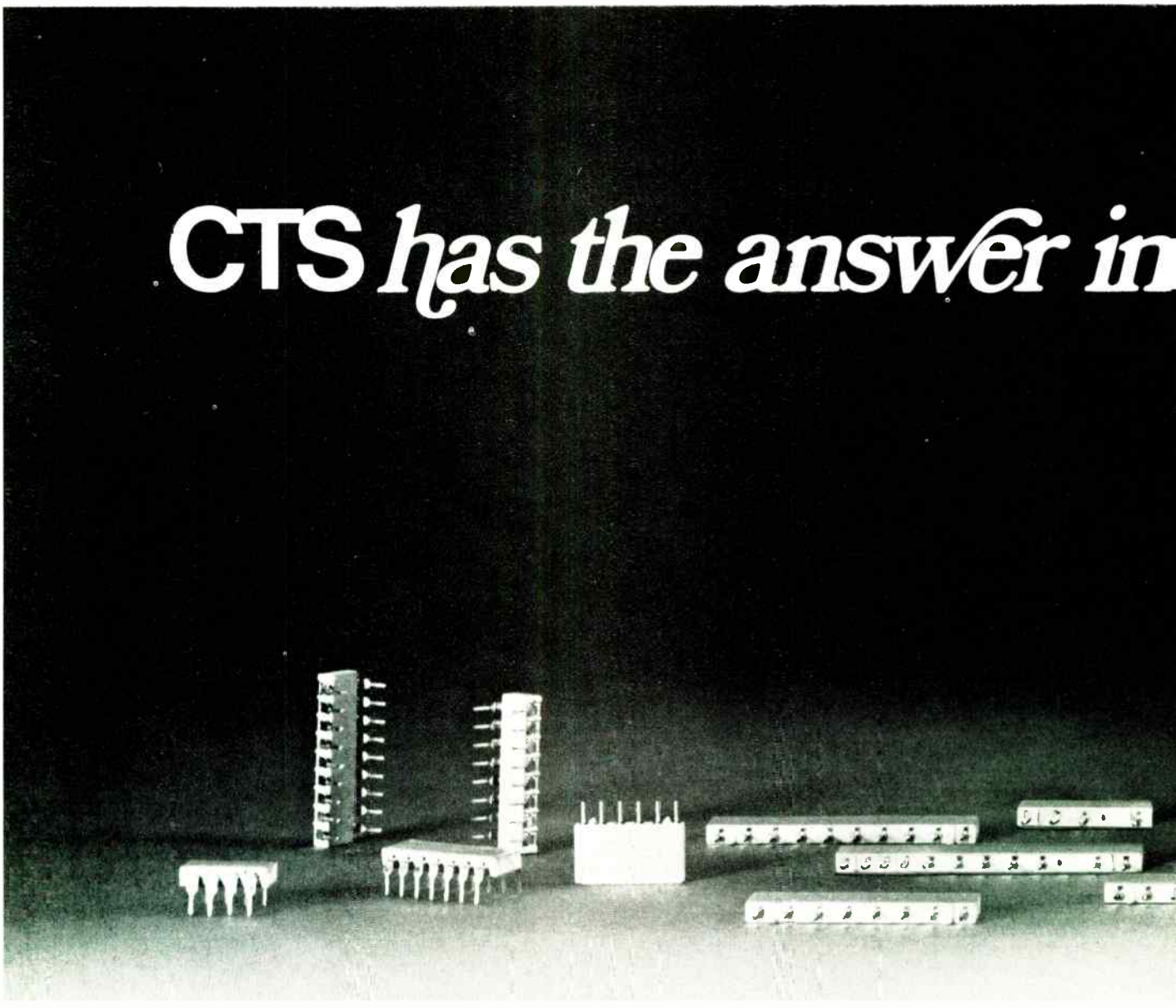
DM7489	16 x 4 bipolar RAM
DM8599	16 x 4 Tri-State bipolar RAM
DM86L99	16 x 4 low power bipolar RAM
MM1101A2	256 x 1 MOS RAM
MM1101	256 x 1 MOS RAM
MM11011	256 x 1 MOS RAM
MM1101A	256 x 1 MOS RAM
MM1101A1	256 x 1 MOS RAM
MM5054	dual 80-bit tapped-static shift register
MM5052	dual 80-bit MOS shift register
MM5053	dual 100-bit MOS shift register

Silicon Store Memories

MM5012	dual 256-bit Tri-State dynamic shift register/accumulator
MM5013	1024-bit Tri-State dynamic shift register/accumulator
MM5016	500/512-bit dynamic shift register
MM5017	Dual 500/512-bit dynamic shift register
MM5019	Dual 256-bit mask programmable dynamic shift register

Microprogramming Memories

DM8598	256-bit Tri-State bipolar ROM
DM7488	256-bit bipolar ROM
DM8597	1024-bit Tri-State bipolar ROM (256 x 4)
DM74187	1024-bit bipolar ROM (256 x 4)
MM5203	2048-bit MOS PROM (256 x 8 or 512 x 4)
MM5231	2048-bit MOS (factory programmable) ROM
MM5241	3072-bit Tri-State static MOS ROM (64 x 6 x 8)
MM5232	4096-bit Tri-State static MOS ROM (512 x 8 or 1024 x 4)



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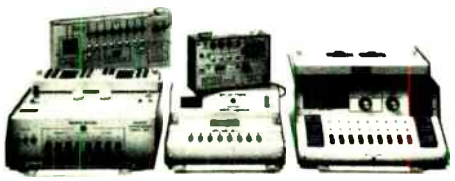

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Washington Newsletter

November 8, 1971

U. S. exports of "know-how" threaten jobs, trade . . .

Government administrators, along with aerospace and electronics executives, are becoming increasingly alarmed at what is beginning to look like European and Japanese raids on U.S. aerospace technology. Latest example is General Electric and Pratt & Whitney proposals to SNECMA, whereby the French company will produce an advanced jet engine of American design. At the same time, the Japanese are considering proposals from Boeing, Lockheed and McDonnell Douglas to design a 250-passenger jetliner to be built in Japan.

U.S. fears that the next generation of American technology will appear first in foreign-made products are intensified both by the knowledge that many U.S. consumer electronic products are already produced offshore, and by increasing Pentagon interest in European missiles and radars [*Electronics*, March 29, p. 31, and Dec. 21, 1970, p. 39]. Should Japan and Europe, particularly France, further improve their aerospace capabilities with U.S. technological knowhow, their competition in U.S. world markets could seriously threaten U.S. aircraft sales overseas—a contributor to the U.S. balance of trade.

. . . yet DDR&E pursues European technology

The Directorate of Defense Research and Engineering is pushing ahead with its program to take a close look at European technology for incorporation in future systems, despite the concern in the defense electronics and aerospace industries with a tight procurement budget, and the resultant decline in contract opportunities and jobs. Dr. John S. Foster, Jr., DDR&E chief, is "very much interested in finding things that can be used," says his boss, Deputy Secretary David Packard, "particularly European developments, that would avoid our having to do the job" of development at higher U.S. costs. Ongoing changes in the international monetary structure, adds Packard, "will help make foreign buys more attractive to us."

Law enforcement hardware standards to be set . . .

To assist law enforcement groups in buying and using specialized equipment, a National Bureau of Standards laboratory is compiling a list of potential contractors who may be asked to develop sets of performance standards, says an official of the NBS Law Enforcement Standards Laboratory. The year-old group had planned to contract out only weapons and vehicles testing, but now, apparently stymied by President Nixon's freeze on Federal hiring, will have to rely on companies for standards-setting work in other areas, such as fixed-wing, VTOL, and STOL aircraft, alcohol breath testers, narcotics test kits, mobile vehicle communications systems, and voice scrambler devices. While priorities have not yet been established by the Law Enforcement Assistance Administration, laboratory officials say they expect that equipment with a large electronics content will be high on the list.

. . . as LEAA prints new handbook on telecommunications

Electronics companies anxious to tap the police telecommunications market should study the Law Enforcement Assistance Administration's recently published inch-thick telecommunications guidebook, say agency officials. "Technically competent companies have a great interest in being responsive to this market," comments an LEAA source, "but we've found

that many are completely unversed in the peculiarities of police and urban telecommunications."

"Police telecommunication systems," written for the LEAA by the Associated Public-Safety Communications Officers and the ITT Research Institute, is primarily aimed at planners and officials responsible for evaluating police telecommunication system modification and design projects.

Federal R&D trust fund unlikely to appeal to Congress

A new national trust fund—rather than a more liberal tax structure of credits and rapid depreciation of new research and development investments—may be recommended by Presidential assistant William A. Magruder as a means of encouraging increased application of electronics, aerospace and other technologies to U.S. industries [*Electronics*, Oct. 11, p. 25, and Sept. 27, p. 33]. Such a trust fund would back industry R&D projects and require repayment out of profits, but the concept is likely to be strongly opposed by Congressional leaders, who construe such appropriations as blank checks for the Executive branch. Proposal of a similar fund for the defunct supersonic transport program—which Magruder headed—proved one of its principal political defects.

Nixon could boost the whole technology transfer project by declaring the program a "national goal" similar to John Kennedy's 1961 declaration of plans for a manned lunar landing. Important objectives of the Nixon program, of course, are to make U.S. industries more competitive in world markets and to increase U.S. engineering job opportunities while making them less dependent upon aerospace and defense.

Air Force sees 1973 approval of command post . . .

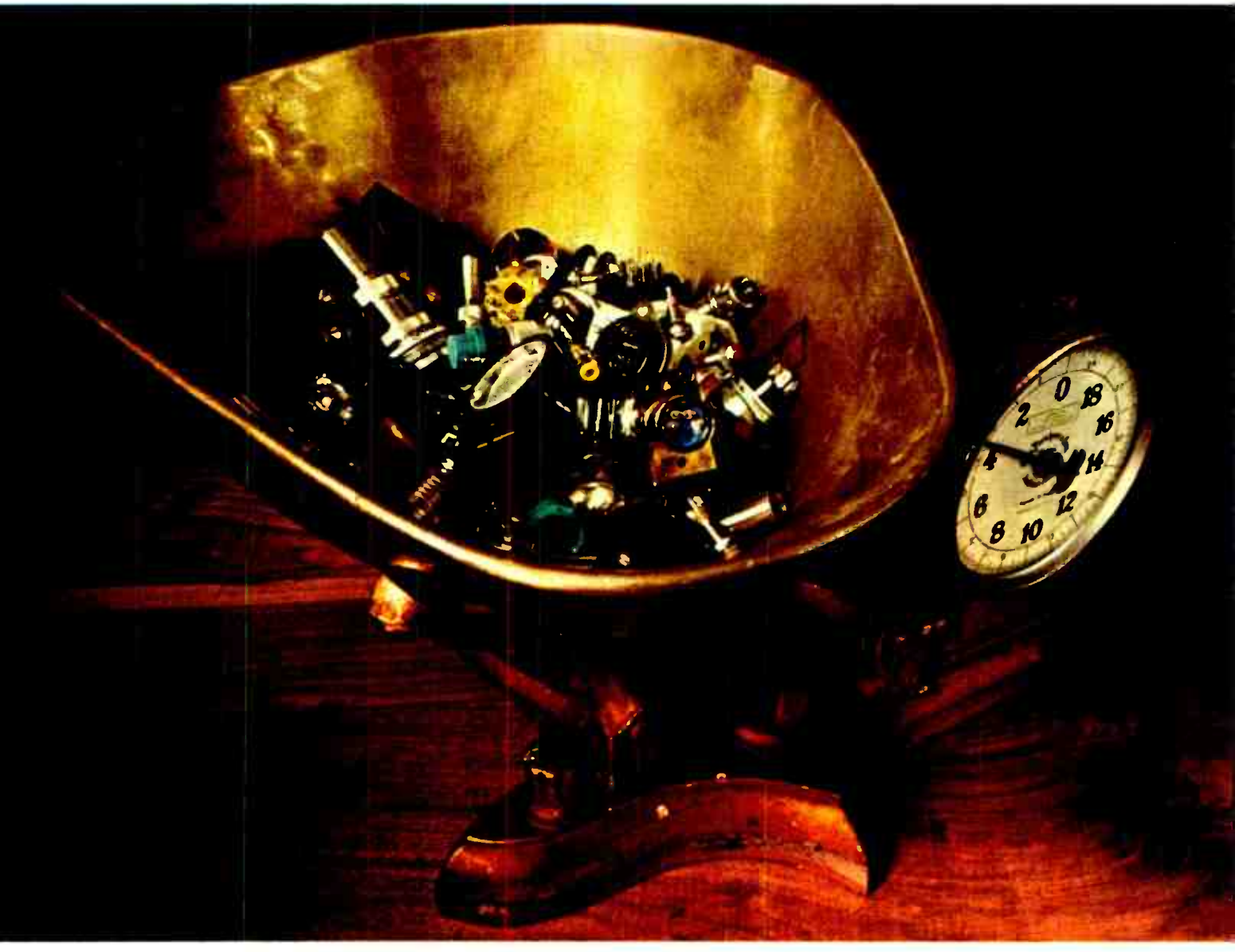
After several years of delay, the Air Force expects to get fiscal 1973 budgetary blessing for its Advanced Airborne Command Post, now that Deputy Defense Secretary David Packard has created his four-man World Wide Military Command and Control System council (see p. 29) to upgrade command and control performance. Packard says the WWMCCS council "will enable us to move ahead with some of the programs which are on the books, for example, this airborne command post."

The Air Force has been anxious to proceed with the AACP as the successor to the Strategic Air Command's "looking glass" aircraft with its largely manual command and control system. First moves are already in progress to pull together AACP electronics requirements—notably possible combinations of onboard computers and integrated radar and ground forces communications capabilities—for future development. The service's funding goal for next year is $10 million, though DOD sources call this figure "optimistic" and say it is more likely to run to half that level.

. . . but choice of aircraft could be controversial

Speculation in some quarters of the aerospace industry is that political considerations could require the Advanced Airborne Command Post to use the controversial Lockheed C-5 jumbo jet or the L-1011 wide-bodied jet, even though the Air Force leans to the longer-range and proven Boeing 747. Most recent public word on the subject came from the Air Force assistant secretary for R&D, Grant L. Hansen, when he told Congress earlier this year that "the most likely airframe candidate would be the 747, although we certainly have to consider the other large air frames, the C-5, the [McDonnell Douglas] DC-10, and the L-1011."

For basic industrial connectors



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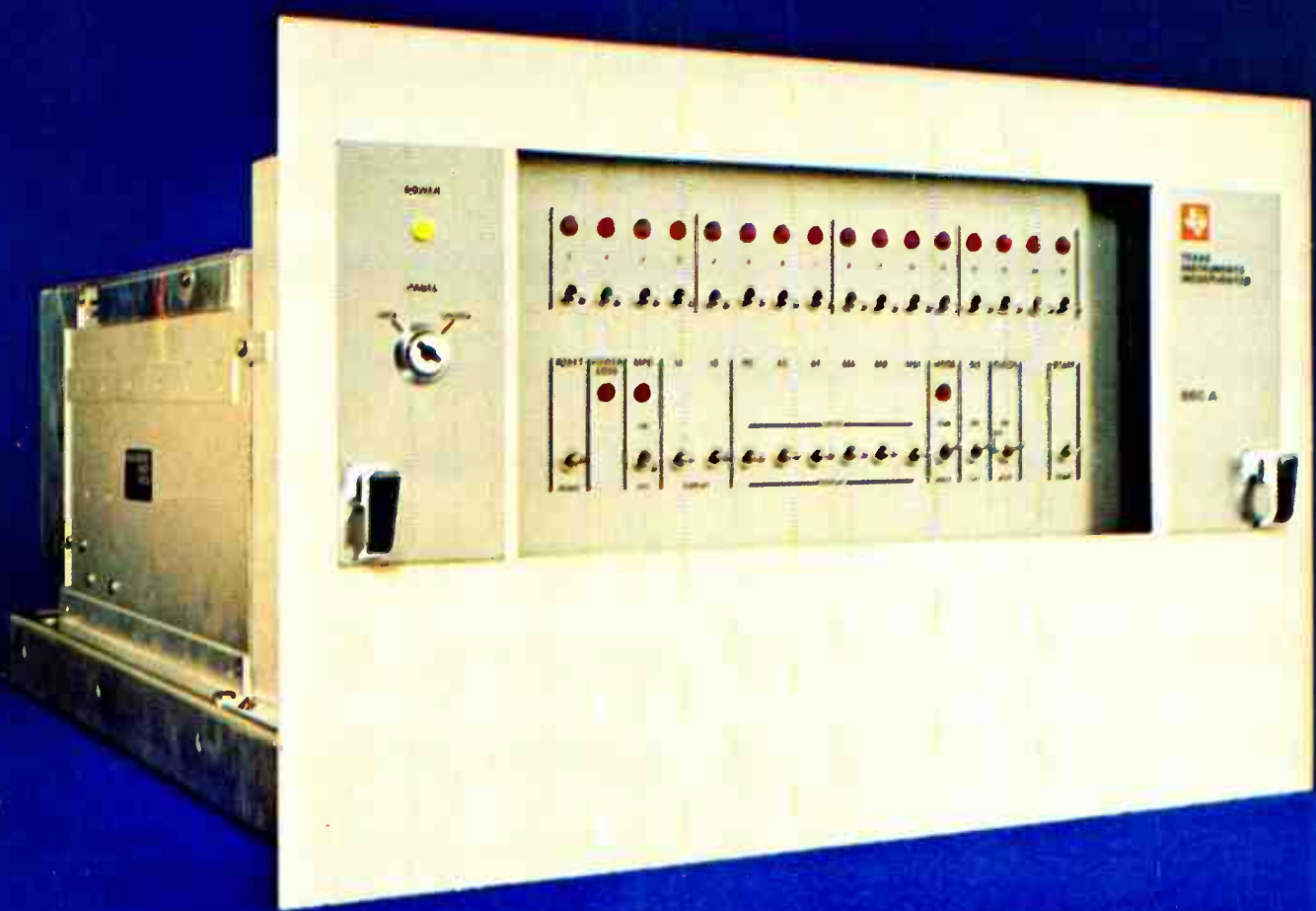

in minicomputer price/performance

Model 960A
$2,850

Quantities 1 to 100
CPU with 4K memory $2,850
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The 960A is the newest addition to the proven family of TI computers used to solve the problems of industrial automation.

With the capability of using single bits of standard 16-bit words to perform sensing and control functions directly, and the easy-to-use "shop language" software, the 960A is especially cost effective in manufacturing automation, process control and data collection systems applications.

The basic price of the 960A includes the power supply, a Direct Memory Access (DMA) channel, automatic parity checking, and a full, lockable front panel. The new 750-nanosecond semiconductor memory is expandable to 32K in the basic chassis at $1500 for each 4K increment. Also provided in the basic chassis is space for 512 input/output lines that are expandable to 8,192 I/O lines.

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- ☐ Assemblers and Linking Relocating Loaders.
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For applications support TI offers the resources of its experienced Applications Engineering group. Also, training courses on 960A software and hardware are scheduled regularly, and TI service facilities are located throughout the United States and abroad.

Would you like to know more about the new 960A price/performance leader? Write to Computer Products Marketing Manager, Texas Instruments Incorporated, P.O. Box 1444, Houston, Texas 77001. Or call (713) 494-5115, extension 2745.

See the 960A at FJCC Booth 1312

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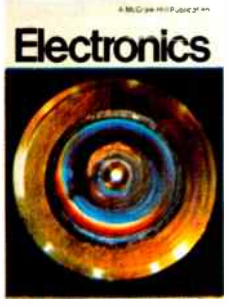

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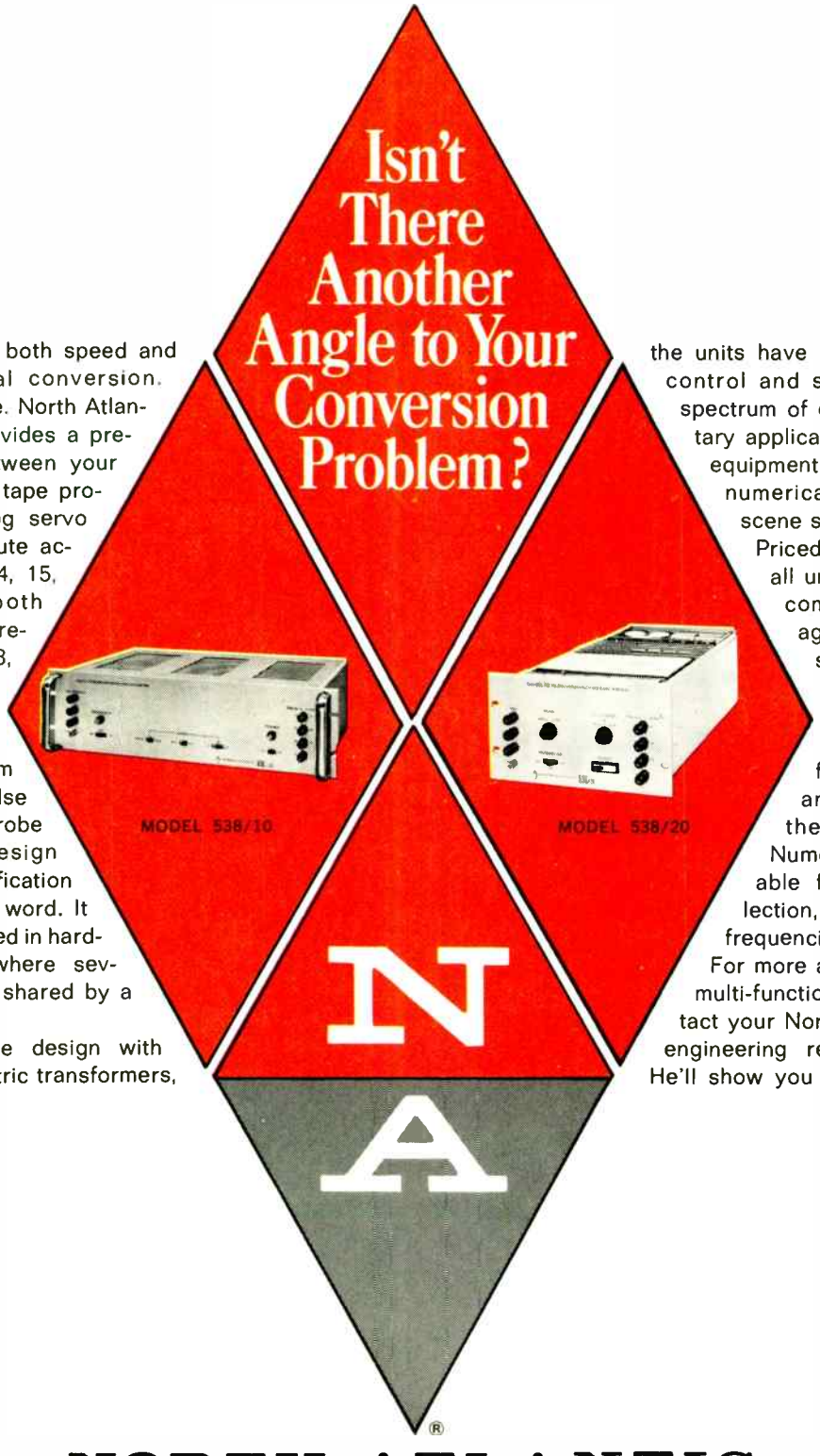

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Featuring solid-state design with precision trigonometric transformers, the units have introduced improved control and speed to the entire spectrum of commercial and military applications: automatic test equipment, production testing, numerical control, celestial scene simulation, etc.

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SPECIAL REPORT: Optoelectronics makes it at last. . .

. . . in computers, optical character recognition equipment, and industrial controls. Part I of this three-part report links the popu ation explosion in photodevices to still newer applications

by Laurence Altman, *Solid State Editor*

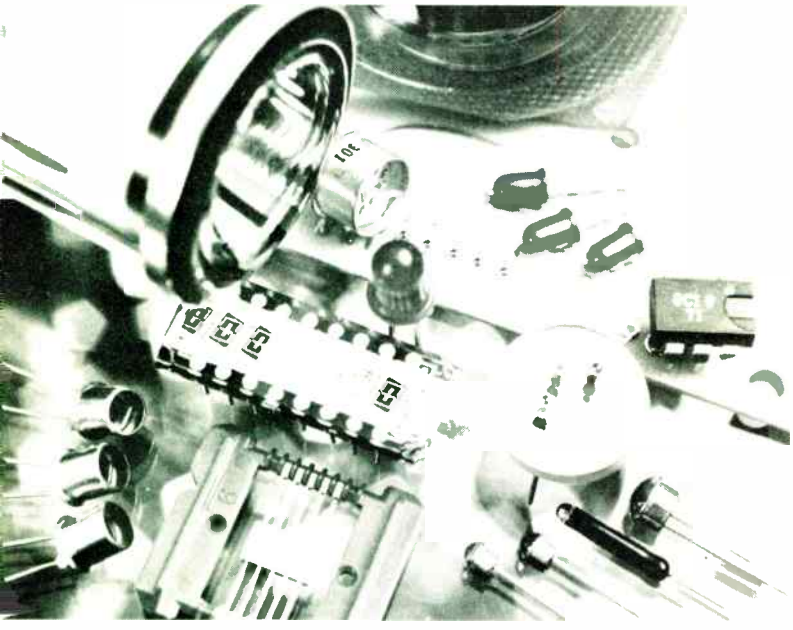
Between the maturation of a new technology and its widespread use there often is a temporary lag. Equipment designers simply aren't aware of what's available. Optoelectronics has reached this stage of development: its technology is ripe, and its markets are green. But the next few years will see a vastly increased demand for optical techniques in all segments of the electronics industries, and this could spell millions of dollars in new sales for the manufacturers of optoelectronic components and equipment.

The number and variety of such components is growing rapidly. In addition to the familiar phototransistor and photodiode there are:

- The photosensitive field effect transistors built by techniques born in integrated circuit technology.
- Beam lead emitter and detector arrays that now have 200 to 300 or more elements on a single chip and could be used for sophisticated optical character recognition.
- Photodiodes, either the standard diffused type or the new Schottky barrier type, but both capable of speeds compatible with those of computer peripherals.
- Optically-coupled isolators in standard dual-in-line packages that can switch small signals in microseconds or handle hundreds of volts and tens of amps.
- Self-scanning photodiode arrays, containing silicon-gate MOS shift-registers fabricated directly on the array chip for use in complex reading and facsimile equipment.
- Optically pumped amplifiers and silicon avalanche photodetectors that could find a variety of uses in communication systems.

Paralleling this surge in optoelectronic components is the growth and maturity of the laser, vital to many industrial optoelectronic applications. Off-the-shelf helium-neon and argon laser sources form the basis of interferometric, geodolite, and laser ranging and recording equipment. Optical communications systems have at their heart either the new neodymium-doped YAG lasers that are optically pumped with linear LED arrays placed along the cavity or the new, more efficient miniature diode lasers that can operate at room temperature. Industrial process control equipment is also going to laser beams and photodetectors.

The older markets are growing, too. Advanced optical character recognition equipment requires diode arrays and optical scanners. The computer industry relies more heavily on end-of-tape optical sensors, and punched-card and -tape readers. Optical isolators are replacing twisted pairs and coaxial cables in industrial equipment. Point-of sales terminals, credit card readers and mail sorters will use optoelectronic components.



Versatility. Boom in components is illustrated by this TI assortment, ranging from isolators to multi-element card readers.

Zigzag path to power. New types of laser are being built for an ever increasing number of optoelectronic jobs. This recently developed glass laser from GE will be capable of 140 watts average power. Zigzag construction makes heat removal efficient and power high.

Detectors and isolators are moving up

Two of the fastest moving component areas, in terms both of developing technology and of expanding markets, are detectors and coupled-pair isolators. Of the many types of detector available today—phototransistors, Darlingtons, photodiodes, Schottky photodiodes, silicon controlled rectifiers and field effect transistors—the phototransistor makes up the bulk of market activity. According to Ian McCrae, marketing manager for Texas Instruments' large Optoelectronic division, it alone accounts for 80% of today's detector sales, mostly in simple card or tape readers. Indeed, both TI and Motorola feel it will continue to dominate the detector market in the next five years, as computers continue to take over the inventory control jobs that use tape and card readers.

But the more sophisticated reading functions performed by point-of-sales and credit card verification equipment, for instance, may need faster and more sensitive detectors or ones that can handle large currents. To meet this need, the major optoelectronic component manufacturers are concentrating their efforts on developing fast photodiodes, Schottky diodes, and silicon controlled rectifiers.

Each new type offers the user its own set of design tradeoffs. A conventional diffused diode is faster than a transistor, but has a very small current output. A Schottky barrier device, having no diffusions, may be easier to fabricate, is also faster and more sensitive, but has a smaller (microampere) output than diffused diodes. PhotoFETs offer high gain and wider ranges of sensitivity, made possible by control of the transistor's beta, while the SCR could handle larger current loads but, on the other hand, is rather slow and could be expensive to fabricate.

Parallel evolution

As the detector technology evolves, so too will that of the optical isolator: a detector forms half the coupled pair, and an infrared light-emitter forms the other half. In general, an optical isolator is inserted between two components or between two systems to provide near-infinite electrical isolation. As many types exist as there are photodetectors. There are isolators with phototransistors, Darlingtons, photoFETs, diffused diodes,

Schottky diodes, and SCRs as their output component.

Monsanto is an active manufacturer of isolators. According to Mike Bottini, manager of isolator development, the optically coupled pair became practical with the development of low-cost ir light-emitting diodes—but what put the device on the map was Monsanto's development of the dual in-line package for isolators. Bottini states that "this was not as easy as it seems since previously the standard DIPs dealt with components that were all in the same plane, whereas isolators are two-plane devices—the ir LED in one plane, the photosensor in another. Producing the package required retooling to accommodate two-plane devices," he adds, "and this gives equipment designers the DIP's convenience and familiarity."

As with couplers, the gain and speed of an isolator must be considered in relation to a particular function, and these parameters are determined by the kind of detector used. For example, a typical phototransistor has a gain of 0.5 and a bandwidth of about 150 kilohertz, yielding a gain bandwidth product of about 75 kHz. On the other hand, a diode with the same gain bandwidth product, operates at very high speed (5 to 10 megahertz), but with very low gain (no greater than 0.0015). With it, typical 50-milliampere inputs result in only 75-microampere output signals, which are too small for many requirements. Moreover, if a standard amplifier follows the diode, it increases the load impedance and slows down the diode drastically.

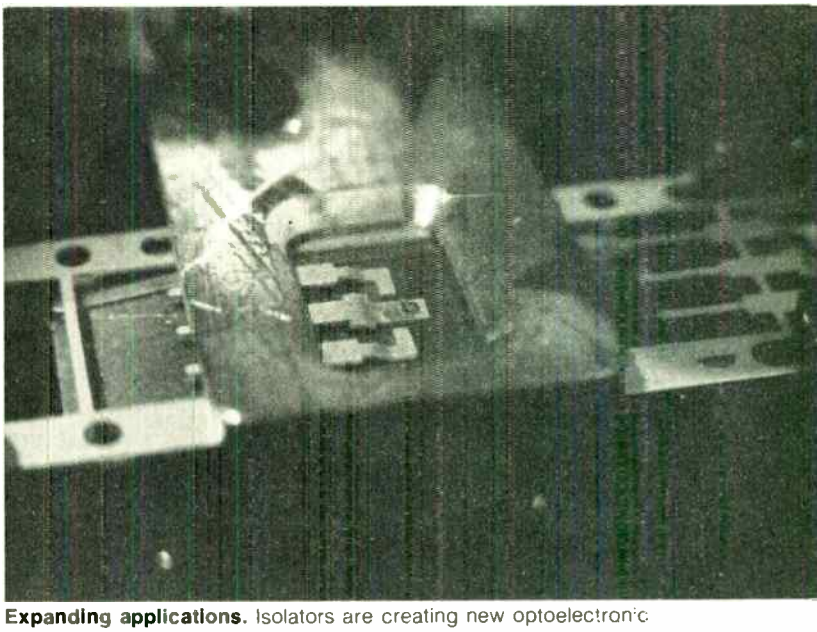
A best buy

Perhaps a good compromise is the Darlington photo coupled pair with its gain of 10 and speed of 5 to 10 kHz, both adequate for many applications. Pete Polgar, manager of Motorola's Optoelectronics division, points out that Darlington isolators, along with the standard phototransistor isolator, could satisfy almost all coupler applications, with the exception of a few high-speed computer applications that may require p-i-n diodes.

In fact, the speeds, gains and current-handling capacity Darlington devices make them suitable for many industrial tasks now performed by electromechanical relays—as Texas Instruments in Dallas was quick to realize. A new TI isolator features a Darlington-connected output stage with an input-to-output current transfer ratio as high as 15,000. According to Lin C. Wettereau, Jr., TI's manager for standard sensors, emitters and photocouplers, the device could find application in telephone circuit and remote terminal isolation, also as an SCR and triac trigger, and as a replacement for mechanical relays and pulse transformers.

Polgar sees a bright future for the SCR coupler, too, which has the highest current capability of any optocoupler device and can provide up to 200 volts of blocking voltage. He says, "The SCR can impact the relay business right now. For example, some people are introducing solid-state control relays with diode-output optical couplers. But these are low-output devices that need additional active elements, whereas high-gain SCR couplers could do the job without these."

The one design problem with SCR isolators is their inability to turn off when the light source is removed.



Expanding applications. Isolators are creating new optoelectronic markets. Detector in Monsanto device is seen at bonding station.

Typically, SCRs must be cycled through a zero voltage point before they can be turned off.

In general, SCR isolators, with their high blocking voltages and 200-ampere current capacity, are the ideal component to trigger another control SCR or, with rectification, to trigger a control triac. These features could be useful, too, in isolating sensitive digital MOS logic from the damaging high voltage spikes of an ac line, which are transmitted through the base of the control SCR. The MOS logic in washing machine control, for example, could well use SCR optical isolators.

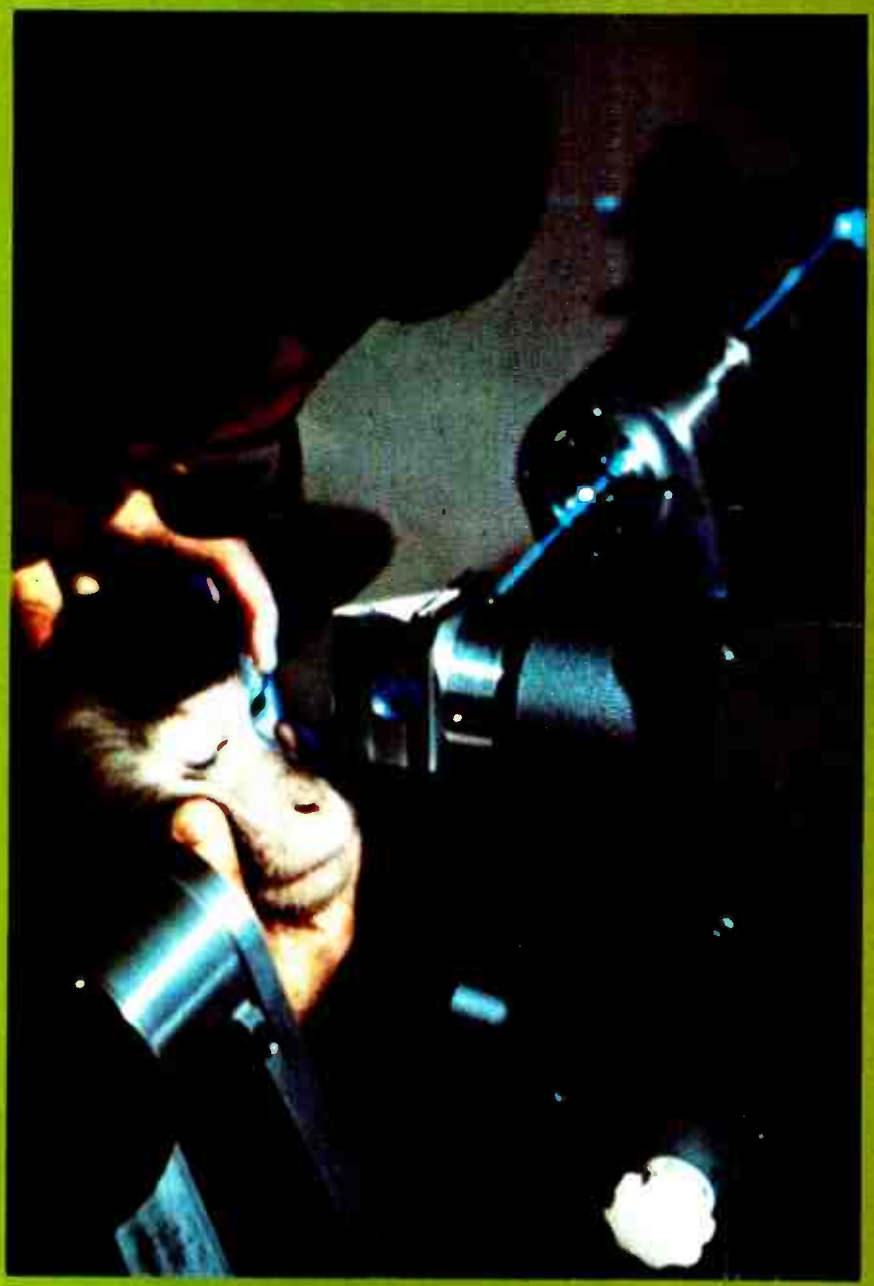
Where the isolator will impinge

Motorola's Polgar is very optimistic about optical coupled pairs for the industrial market in general. He sees the "range of applications as being vast, with new sockets almost limitless." "If the cost can be kept down," he adds, "we can even impact the reed relay people. But certainly optical isolators would be ideal in industrial markets, where noisy environments are often too much for sensitive equipment that now relies on twisted pairs or shielded cable for isolation. This is especially true where heavy-duty equipment operates near control equipment using sensitive ICs," he points out.

Computers are often cited as a likely target for optical isolators. These can act as buffers between mainframes, or between mainframe and peripherals, for instance. But Polgar points out that the devices will have to be speeded up and outputs boosted substantially before many computer people get interested in this application. Also, multichannel devices must be developed.

Monsanto, however, regards the computer industry as an immediate market for isolators, particularly because of their ability to eliminate ground loops between computer and peripherals.

Isolators can also be used with a computer that controls mechanical equipment like motors, where high-gain Darlington or SCR devices would yield the higher power required. Again, a Darlington type would be appropriate for a computer system working in conjunction



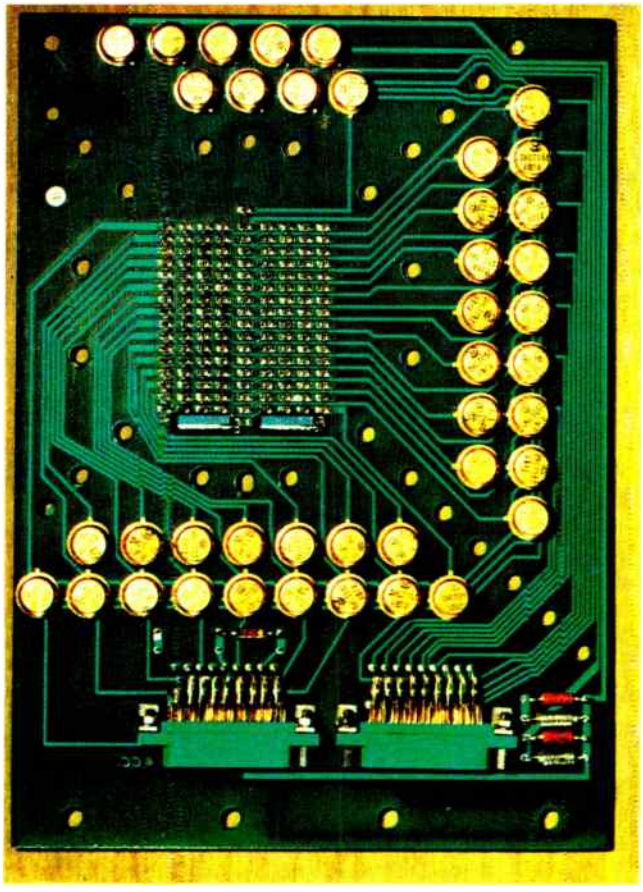
Eye beam. Monkey's cornea is operated on with a Spectra-physics argon laser. Counting blood cells, mending brain tissue, are among the many other medical uses of lasers.

Light industry. This Bendix tag reader and box sorter is typical of industrial machines that depend on the availability of efficient, reliable, and not too expensive lasers.

Making light work. The laser is probably the single most important opto-electronic device: it is central to almost every industrial, communication, and scientific system application that relies on optical techniques. The popularity of these systems is a recent growth, however, and dates from the availability of production lasers reliable enough to be designed into systems by equipment manufacturers. Today, helium-neon and argon gas lasers, gallium-arsenide diode lasers, and an assortment of solid state models such as the ruby and YAG lasers are obtainable from several suppliers, all as off-the-shelf items.

Diode lasers are being used in ranging systems, as illuminating sources for active surveillance systems, and in closed-circuit TV systems. Recent improvements in their structure nave enabled these semiconductor devices to operate efficiently at room temperatures. YAG lasers are being designed into longer-range communication networks, and are also being thought of as possible local oscillators in future data communications systems. Shown here too are some He-Ne and argon laser applications.

Worth waiting for. Measuring lengths to optical accuracies dates back to last century, when Michelson invented the interferometer. Elegant as the device is, it has come into general use only fairly recently: no reliable source of coherent light was available before the development of the He-Ne laser. A Hewlett-Packard interferometer (left) records vibrations at San Francisco's Embarcadero.



Growing up. Discrete detector arrays are becoming more complex. Motorola unit has hermetic photodetectors, decoding hybrids.

with banks of relays, where high sensitivity is required without high speed.

Monsanto is also looking at the reed relay market, but sees this one as a "tough one to crack," says Stu Harris, its isolator applications engineer. "That's because reed relay applications require a device with a low, constant 'on' resistance," he explains, "and virtually all isolators have an offset voltage and high impedance when 'on'." Reed relays are heavily used in telephone crosspoint switching, and Harris points out that no optical isolator now available can do that job.

In general, impact on the relay market will only come, in Harris' opinion, with the development of both normally open and normally closed devices (today's isolators are all normally closed). Coupled with a low "on" impedance, this would allow isolators "to crack the communications market," he says. For this, photodiode devices seem the best bet because they are fast and capable of handling megabits of data per second. "However, gain here must be increased," he asserts.

Monsanto is actively developing multichannel devices for the computer market, and is expected to announce a dual-channel isolator shortly. Since the device requires four chips instead of two, as well as two outputs that must be matched, the problem is to achieve high enough yields to make the price attractive.

Reduction of offset voltage and "on" resistance represents another hurdle for isolator manufacturers. Ideally what's needed here are devices with zero offset and resistances of below 1 ohm. Offset of today's devices ranges from 0.2 volt for phototransistors to 1 V for Darlingtons. Resistances range from 1 to 2 ohms for high-current Darlingtons to 1,000 ohms for low-current types.

For these reasons, although Monsanto sees the computer market as maturing rapidly, they predict high-volume business will await isolators that can operate at 10mW and at TTL-compatible logic levels, generally 5 V. This means a gain bandwidth product of greater than 10 MHz, compared with the 75 kHz of the best available diode.

As for the future, Monsanto predicts isolators with triacs in the same package, couplers with 10-MHz bandwidths, normally open and normally closed devices, and devices with optical fibers linking a laser source and a fast diode combination and capable of transferring signals at gigahertz rates and high output levels.

Rows and columns

Keeping pace with the development of discrete optical components are recent advances in electro-optical arrays. Texas Instruments, a pioneer in this type of device, has built a wide assortment of emitter and detector arrays, both as separate components and in pairs (as emitter detectors) in the same package with beam leads or conventional wire.

McCrae states that the big market for arrays today is in punched-card and -tape readers, where they replace hot and troublesome filament lamps and bulky photodetectors. To enable more complex cards to be read, increasingly larger emitter arrays are being developed—for example, TI's new series of tape and card reader arrays of nine or 12 LED emitters and a corresponding number of phototransistors. (Emitter and detector arrays can be supplied in pairs or individually.) The emitter arrays have a minimum radiant power output of 0.4 milliwatts and a peak emission wavelength of 0.93 microns, a good spectral match with the sensitive range of the phototransistor detector array. Continuous power dissipation for the entire array is only 50 mW.

Texas Instruments is also developing still larger arrays for more complex reading applications, and has built custom units with hundreds of elements on a single chip. A standard TI product is a new 120-element phototransistor array designed for reading garment tags. It measures only 1.3 by 0.9 inch, and the transistors are beam-lead-bonded to reduce the number of external wire-bonds.

Fairchild's Microwave and Optoelectronic division in Mountain View, Calif., another major factor in the tag and card reader business, also plans to introduce a 10-by-12 transistor array for standard merchandise tags (for example, Kimball's). For an array that size, it will have the smallest package so far—one that's only 50 mils wide, 100 mils long and 80 mils high. Up to now, because no suitably compact array has been available with enough elements, cards could be read only by highly complex and bulky assemblies of standard phototransistors and fiberoptic bundles.

Spectronics Inc. in Richardson, Texas, specializes in building large custom arrays for card and tag readers in special applications. For instance, the company's latest product was designed for an optical read-only memory.

and contains 1,024 LEDs and photodiode combinations mounted on an etched circuit board and electrically wired in a 32-by-32 matrix.

The LED anode frames are connected together to form a third level of interconnect above the surface of the etched circuit board, leaving the back of the board free for any rerouting necessary to achieve the circular layout. Even more important, the design yields an array with random access to any element in it. Pulse rates of 10-megabits are possible with the device.

Self-scanning for OCR

Though the developing boom in standard diode and phototransistor arrays is significant, something of a genuine breakthrough has occurred in integrated diode arrays with self-scanning schemes built onto the chips. Optical component manufacturers are learning how to integrate MOS devices on the same chip with the light-sensing array. This results in a self-scanning sensing array having few lead bonds and operating at scanning rates of more than 5 MHz. Manufacturers of optical character recognition equipment, like Recognition Equipment Inc. of Dallas, Texas, say this is the development they've been waiting for: it has the speed, resolution, and simple optics they need to greatly improve their equipment.

To date, three companies have announced self-scanning arrays: Reticon of Mountain View, Calif., with a 64- and 256-element array in a DIP; Fairchild, also of Mountain View, with a 96-, 128- and recently a 256-element array; and Integrated Photomatrix Ltd. of Britain, weighing in with 64-, 100-, 128-, 200- and 256-element devices.

Reticon's most recent development, the 256-element linear array in a 16-lead DIP, integrates a scan generator (to address the diodes) with a preamplifier (to boost the video output), and includes a TTL-compatible driver circuit all the same chip.

Silicon gate MOS was chosen for the process because metal gates are limited in density and scanning speed. With silicon gates it's possible to place diodes 2 or even 1 mil apart, a separation that allows scanning to be done at a 10-MHz rate. To produce the chips, John J. Rado, Reticon's president, turned to Intel Corp., Santa Clara, Calif., for what he terms "the industry's most advanced silicon gate MOS technology."

As with most self-scanning arrays, its diodes operate in the charge storage mode—they stay on until all the incident light is integrated. Thus, they can operate with low light levels, down to a few milliradiums.

One of the first to announce a self-scanned linear diode array was Integrated Photomatrix Ltd. Its most advanced 256-element device has impressive specifications: scanning rates up to 5 MHz, 10-volt video signals obtainable with a fixed-pattern dark noise of 0.5 V or less, and the sensitivity of each diode in the array matched to within ±0.75% typically. The device is encapsulated in packages that are compatible with standard sockets.

Fairchild's latest diode linear array is also a 256-element device composed of a matrix of MOS shift register counter stages—a four-tier circuit arrangement that yields the maximum number of shift register elements per linear direction of array. The photodiode sensors are on 1-mil centers, making the total length of the array only about 0.25 inch. Though its scan rate is only 1 MHz, experiments indicate that 5 MHz or more is possible.

In addition, Rudy Dyke, manager of Fairchild's Optoelectronic R&D effort explains that the sensor was designed for minimum noise, a major OCR requirement: the device presently has a 35:1 signal-to-noise ratio.

Integrated arrays are being considered for OCR, pattern reading, facsimile, edge sensing, width monitoring, and a number of other less obvious applications, such as measuring wire diameters in manufacturing processes. Says G.R. Parsons, marketing manager for Integrated

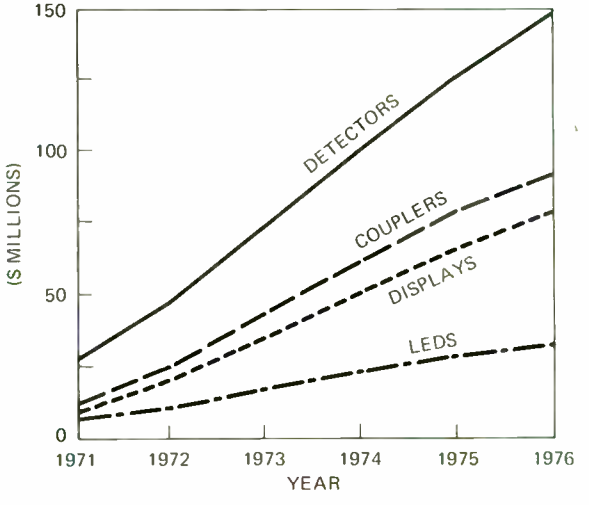
The bright market prospect

Optoelectronics could mean millions of dollars of new sales in the next few years. Defined in its broadest sense, as that branch of electronics incorporating optical technology in all kinds of equipment—from video players and pre-recorded cassettes, to laser ranging and industrial processing control equipment—then Arthur D. Little consultants estimate that 1970 optoelectronic sales in the free world exceeded $10 billion, or half as much again as computer industry sales.

Even when optoelectronics is limited to its traditional, narrower meaning—the implementing of electronic functions by optical means—the market is rich and the potential vast. According to the *Electronics* 1971 annual market survey, U.S. sales of optoelectronic components alone will total almost $36 million, with sales expected to exceed $80 million by 1975.

Worldwide, the numbers are still more impressive. A recent Motorola market analysis anticipates that 1971 sales of all optoelectronic devices will run as high as a $65 million, and will have jumped to an astonishing $225 million by 1976.

The question is, where will the action be? Contrary to common belief, the greatest boom will not be light-emitting diodes and LED displays, which these days are receiving the most publicity. Rather, photo-detectors and couplers, about which comparatively little is heard, are expected to take the lead. According to the figure, supplied by Motorola, the detector market will grow from its present $15 million to at least $75 million, and couplers from $1.5 million to almost $15 million by 1976.



And what of the tube?

By no means all the new technical activity is taking place in solid-state photodevices. In several laboratories various combinations of the III–V materials, such as gallium phosphide, gallium arsenide and gallium indium arsenide, are being used as cathode surfaces in highly sensitive photomultiplier tubes. These are increasingly popular in areas where very low light levels must be detected, as in astronomy and medicine, or where near infrared signals cannot be detected by the standard S-1 surface.

The III–V cathode phototubes offer better efficiency in detecting light than the old photoconductive surface—two to 50 times that of the conventional S-1 and S-20 surfaces over most of the optical spectrum. Since the III–V compounds can be made extremely sensitive to a wide spectral range with the addition of other elements, a single cathode tube of the new kind can efficiently span a greater portion of the optical spectrum than any one old tube—from uv to the ir wavelengths.

RCA at its Lancaster Tube division has extended the range of III–V tubes into the infrared, to wavelengths beyond 1.06 microns. By using various percentages of indium, RCA engineers have developed GaInAs photomultipliers with quantum efficiencies better than four times that of the S-1 photocathode, which is the only conventional surface with any useful response at the 1.06-micron wavelength.

Already RCA has operated GaInAs photomultipliers in the laboratory at 2.5% quantum efficiency, compared to 0.5% for the S-1s. Packaged tubes evaluated by the U.S. Army Electronics Command in Fort Monmouth, N.J., operated typically at better than 0.1% efficiency, double that of the S-1. RCA engineers expect soon to be building photomultipliers with efficiencies in the 10% to 20% range and perhaps as high as 40%.

Significantly, dark current with the GaInAs cathodes is one thousandth of the noise of the S-1 surface tubes. Because of this, sensitivity is greatly expanded: at 1.06 microns, a typical GaInAs photomultiplier has a sensitivity of 10,000 amperes per watt of light input and a bandwidth of 100 megahertz. This means that 1 nanowatt of light incident on a typical five-stage GaInAs tube yields an easily detectable 10-microamp signal. The detection limit appears to be about 10^{-13} W, and this together with an extremely fast rise time—better than 600 picoseconds—makes these tubes ideally suited to high-speed, low-level infrared applications.

Already these tubes are being evaluated for optical communication systems and laser ranges running at the 1.06-micron wavelength. In these applications, photocathodes with lower indium content are ideal for use with GaAs lasers, while the higher indium content photocathodes are ideal with YAG lasers. Astronomers are also using these tubes, primarily to look at red stars with weak emission spectra.

In a related effort, RCA Lancaster engineers are integrating the power supply into the tube package, a development that rids the photomultiplier tube of its last vestige of the old vacuum tube technology—the oversized, bulky external power supply that's required to operate it. Because 100 to 5,000 volts are typically needed, the power supply requirement limits these tubes to systems that can tolerate bulk. Designers often must turn to photodiodes, although they can't offer the sensitivity and noise performance of the phototubes.

Photomatrix, "Our chip size for the larger array is over 1 inch by 60 mils, and we feel this is not the end of the line. The yields we are obtaining indicate that 1,000-by-1 arrays are more than gleams in the eye." The company also envisions two-dimensional imaging compatible with, say, video phones. "It's a matter of simply building a two-dimensional array with a modest amount of signal processing to give acceptable picture quality," says Parsons, and adds, "The only hold-up here at present is development costs."

Where the components go

Optical character recognition equipment is a highly lucrative outlet for optoelectronic component makers. It makes use of discrete phototransistors and diode sensors, discrete and monolithic detector arrays, self-scanning arrays, LED indicator lights, numeric readouts, and CRT displays, as well as a large assortment of optical parts. Clearly, as such equipment proliferates—in customer credit billing, stock inventory, packaging routing, business and banking transactions, point-of-sale terminals, and post office address reading—so too will the demand for optoelectronic devices.

Essentially, an OCR system has three parts: a retina or scanner that detects the characters to be recognized, a recognition unit that compares the detected input with the machine vocabulary, and a vocabulary computer that contains the basic set of character masks—as many as 360 in advanced machines.

The biggest opportunity for manufacturer lies in the retina, the eye of an OCR system. It converts the optical image into an electronic one for comparison with the machine store, and consists of either a fixed single detector with a multiple or moving light source or an array of detectors with a single light source.

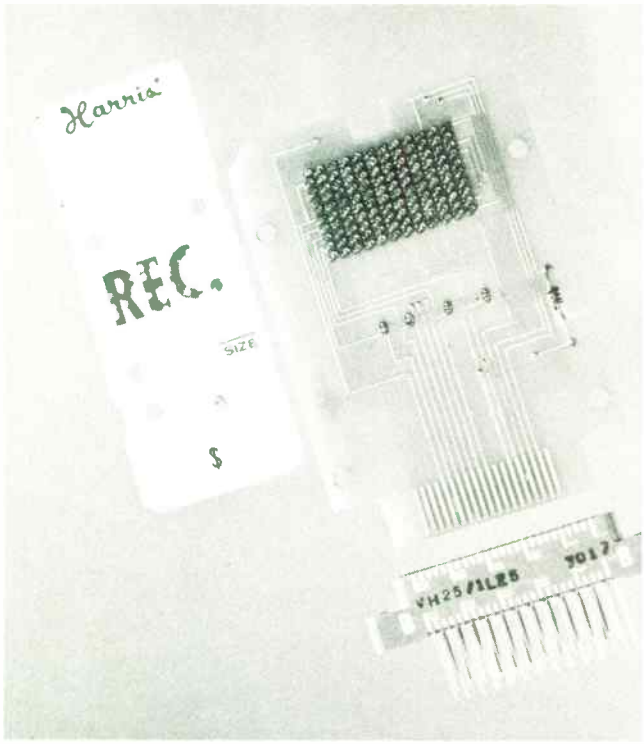
Resolution, which limits the complexity of document that can be recognized, depends on the type of detector used in the retina and its method of scanning. Since the recognized character is converted into a number of bits, the larger this number is, the better the recognition rate and the more complex the retina's detector must be.

Recognition Equipment Inc., one of the major suppliers of OCR equipment, will soon make machines that will contain a wide assortment of scanning mechanisms. They range from single-diode or -phototransistor types to complex integrated sensor arrays. The simplest readers, designed for credit card or invoice numbers, are used by the major oil and credit card companies to sort incoming invoices. Since only a short line of alphanumerics must be read, usually a single photosensor or simple linear array can do the job.

For more complex jobs, such as reading 8½-by-11-in. pages, single sensors are not adequate. Instead, Recognition Equipment is turning to monolithic arrays—for example, Fairchild's 96-element diode array, or Motorola's line arrays, or those of various complexity supplied by Integrated Photomatrix. Since these units don't have a shift register scanning mechanism on the same chip, scanning still requires standard optics.

Multiple-element sensors, as Stan Requa, research engineer for Recognition Equipment, points out, add considerable complexity to the retina. Each photodiode,

Light shows all. Two applications of light at work—one an RCA laboratory experiment, the other a record of the atmosphere over the Detroit river—illustrate the many uses to which the new optical techniques can be put. In the photograph on the right, a polarized light pattern, diffracted through an m-nitroanile crystal, is indicative of the high nonlinear coupling coefficient of this compound, and suggests searching for other material with a similar structure and could serve as tunable parametric oscillators. The two ir thermal maps shown below were photographed with a Bendix multichannel spectrum analyzer. The picture on the right, made with a single ultraviolet channel, shows the Detroit river near Fighting Island. The blue is smoke, the violet patches dense puffs of smoke. The same scene, recorded simultaneously over three other channels that allow the analyzer to penetrate below the smoke, shows refuse (white and red areas) dumped on the island.

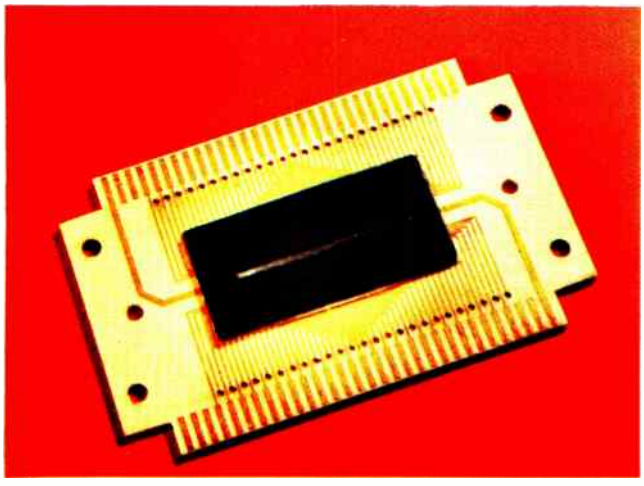


In small packages. Fairchild's circuit squeezes 120 transistors into a 50-by-100-by-80-mil package for reading of tags shown at left.

because of its low output, has to be followed by a preamplifier and amplifier—96 of each for a 96-element array. In addition, the system needs a multi-plex circuit for the scanning function, and an analog-to-digital converter to accommodate the recognition unit.

Equipment of this complexity is expensive to manufacture and difficult to maintain. And Requa indicates it may still not measure up to many OCR jobs. One problem is with low-quality inputs, between which the detector often cannot distinguish—it may mistake a D for an O, or completely fail to recognize a really bad input.

The answer, says Gordon Cooper, Recognition Equipment's director of research, is higher-order, self-scanning, integrated arrays, such as the 256-element units currently being developed. Since an MOS scanning circuit (shift register) is incorporated in the sensing chip



Crowded picture. Monolithic arrays are in demand for OCR: 100 phototransistors fit on Motorola chip bonded to a ceramic substrate.

to do the multiplexing chores, all but one preamp and amplifier can be eliminated. The result is high resolution, fast MOS scanning rates (up to 5 to 10 MHz), fewer and more reliable parts, and lower manufacturing and assembly costs. These features might be important in OCR systems designed for the post office, where millions of letters must be read and sorted each day.

In fact, Recognition Equipment will be supplying machines along with IBM for evaluation for the address and zip code reading of business mail in New York's central post office. But these will not have self-scanning detector arrays.

Outside OCR, development of most other optoelectronic system equipment was stalled till reliable, powerful and inexpensive lasers became available a few years ago. Today, the helium-neon and now the argon laser are standard, off-the-shelf items that can be acquired in a range of sizes, with a variety of outputs and characteristics. They yield continuous output powers of from 1 milliwatt up to tens of watts, and have a wide range of spectral responses. Pulsed devices generating hundreds of watts are also available.

One result of the helium-neon laser's new ubiquity is the development of interferometric equipment that can measure dimensional change to within a fraction of an inch. All such systems need coherent light sources.

The optical system of most interferometers is practically the same as the one Michelson used in 1892. Essentially, an interferometer consists of a source of light, a beam splitter and two mirrors. The incoming beam is divided by the beam splitter. One beam travels a reference path, the other the path to be measured. A mirror at the end of the path to be measured reflects this beam back to the interferometer, where it recombines with the other beam and reveals an interference pattern that varies with the degree to which the two paths have differed.

If the path difference is an integral number of wavelengths, constructive interference takes place. If it is an odd integral number of half-wavelengths, destructive interference occurs. If one of the paths is variable, the observer will see a complete interference fringe cycle for every full-wavelength change in the length of this path.

Delicate business

Because of its delicacy, interferometric equipment has always been difficult to use in the industrial environment. The intensity of the laser beam may be seriously affected by impurities in the air, or when turbulence deflects the beam slightly or warps the wavefronts. These intensity changes may be large enough to trigger the detection system, yet trigger levels can be adjusted only for long-term changes.

To get around this problem, Hewlett-Packard—one of the first companies to develop the laser interferometer—designed an instrument that operates on a heterodyne principle. While conventional interferometers mix two light beams of the same frequency, the HP interferometer uses a two-frequency laser and mixes light beams of two different frequencies.

The virtue of the two-frequency system is that the dimensional information is carried on ac carriers rather

than in dc signals, and unlike dc amplifiers, ac amplifiers are not sensitive to changes in the dc levels of their inputs.

The ac signals representing dimensional change are produced by mixing two slightly different optical frequencies, near 5×10^{14} Hz, differing by a few parts in 10^9. The frequencies are generated by applying an axial magnetic field to the laser and forcing it to oscillate on two frequencies simultaneously.

One of the two frequency components is used as the measuring beam and reflected from the cube corner. On return it is mixed with the second frequency, or local oscillator, and produces fringe patterns of light and dark bands. These are monitored by a photodetector and converted to an electrical signal. A second photo-detector monitors fringe frequency before the paths are separated, as a reference for the fringe rate corresponding to zero motion.

The two frequencies from the photodetectors are next counted in a form of reversible counter. One frequency produces up-counts, the other down. If there is no motion, the frequencies are equal, and no net count is accumulated. Motion, on the other hand, raises or lowers the Doppler frequency, producing net positive or negative counts.

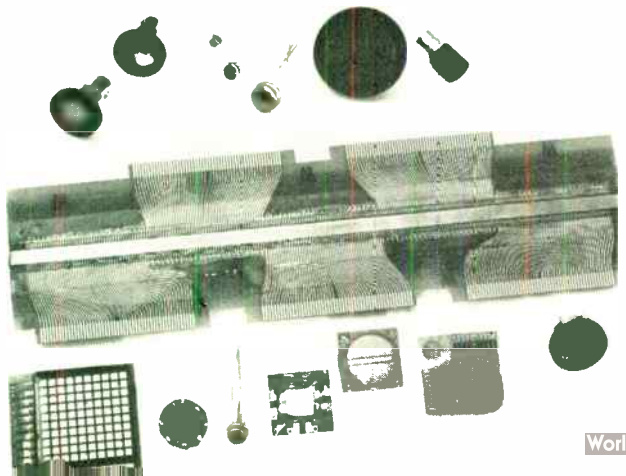
A remote interferometer technique, also a recent HP development, eliminates another problem, the error caused by slight movement of the laser head relative to the reflector. A remote section is made to serve as the retroreflector and in this capacity contains all the reflecting optics.

Its principle of operation is simple. After a small portion of the beam has been reflected for a reference signal, f_1 and f_2 are transmitted to the remote interferometer. They are separated by a polarizing beam splitter such that one is reflected, the other transmitted. In the distance measuring mode, f_2 is reflected by a fixed cube corner, f_1 transmitted to the movable cube corner. For differential and angular measurements, f_2 can be turned through 90° to be parallel to f_1. The reflected beams then recombine at the polarizing beam-splitter surface, and finally return to an optical element in the laser head where fringes become visible to the photodetector.

Bendix, another supplier of interferometric equipment, has detailed the many applications opening up for these instruments. For example, laser interferometers have found ever-increasing application in industrial machine shops. Also, they are found in the feedback loops of numerically controlled, high-precision measuring machines and machine tools. Portable systems can be used to check the slide motions of machines and the tolerances produced by precision machine tools, where they eliminate the need for gage blocks. Because they have essentially infinite resolution, laser interferometers also make machine checkout possible for extremely tiny dimensions and increments of length, for which no tangible physical standards exist.

Null tracing in coordinate measuring is yet another job that a laser interferometer can do. The system projects a small spot of light from the laser onto the part surface and senses the movement of this spot over the surface. The magnitude and phase of the output signal produced by the probe indicate respectively how far the distance between part and probe deviates from some preset null position, and what the direction of that deviation is. This output can be used to drive a servo system that moves the probe so as to keep it a constant distance from the part surface. The laser source is remote from the probe, the light being brought to the probe through a fiber-optic bundle. Overall system resolution is better than 0.0005 in.

Detectors galore. United Detector Technology products include large arrays for OCR, tiny discretes for sensitive light measurement.



Future interferometry: the hologram

To increase the resolution of the standard interferometer even further, Bendix is developing an interferometer in which a holographic image takes the place of the test and reference object. This experimental system improves resolution by a factor of 2 over previous configurations, and appears to be superior to any other "single-beam" device known.

The laser beam is divided by a beam-splitter. One portion is directed to the left, is eventually diverged, and provides the reference beam for the hologram. The other is collimated and directed by a large beam-splitter onto the test object. Part of the energy scattered and reflected from the object passes in the opposite direction through the splitter and continues to the hologram plate.

Although the optical elements of the interferometer should be of good quality, extremely accurate surface finishes required by conventional interferometers are not necessary. Reasonable levels of imperfection cancel optically because the paths for the reference and the test beams are almost identical.

Another instrument using a laser source is the geodolite, which is particularly useful for precise measurements of distances of less than two kilometers. Much like the interferometer, it projects the beam from a collimated He-Ne laser to a corner cube retroreflector target, and measures the distance to the target by comparing the phase of the modulated outgoing beam with that of the returning beam. The output of the instrument is a voltage proportional to the distance measured, 1 v/0.30480061 meter (1 ft) over the modulation wavelength.

Spectra-physics Inc. in Mountain View, Calif., is one of the major suppliers of geodolites. In their systems, the transmitter is a 1-in. telescope mounted coaxially to the 8-in. diameter receiving telescope. The light re-

Tuning in. Texas Instrument researcher adjusts lead tin telluride diode laser for detecting pollutants. The PbSnTe laser represents new class of tunable devices. Pattern below is from flashlamp-pumped dye laser, another tunable type.

Two applications. The National Bureau of Standards, Colo., now uses lasers to make measurements. At left, old mine shaft is scene where an interferometer records strain in granite caused by seismic disturbances or tides. Glowing cylinder is He-Ne laser whose beam is directed to an interferometer which can be seen through tunnel door. The laser beam excites the interferometer's fringes and gives the earth strain information. Below, a recently developed T laser from Bendix may be powerful enough to be used for such industrial applications as stripping wire.

flected from the target retroreflector passes through a 0.5-nanometer bandpass filter and a variable iris diaphragm, and hits a photomultiplier. Controls are provided to adjust the angular alignment of the outgoing beam, the size of an iris diaphragm to reduce background light, attenuation of the received light to a level compatible with photomultiplier, and photomultiplier gain.

The geodolite laser altimeter is another application finding its way into industry. Operated from an airplane, it could give complete terrain profile data. A system built by Spectra-physics employs a continuous wave modulated laser to obtain continuous measurement of the height of the instrument above the ground. A helium-neon laser producing 25 mw of red light at 6,328 angstroms provides the transmitted signal. A Kerr cell modulator in the optical path acts as a high-speed shutter to modulate the amplitude of the transmitted light at selected precision frequencies.

Lasers are at the heart of newly developed automated

systems for inspecting machined surfaces for defects such as cracks, pits, or roughness. Typically, human inspectors do this, and their accuracy and level of performance vary widely, both among inspectors and for a given inspector over a long period of time. Moreover, if minute defects have to be detected, inspection takes a relatively long time. These problems are compounded when the surfaces are difficult to view—for instance, it is very hard to look closely at inside diameters or gear-teeth surfaces.

Bendix has developed an optoelectronics approach to this type of surface inspection, based on the principle that a laser beam reflected from a machined surface contains information that defines the smoothness or roughness of the surface. This information is conveyed both by the intensity of the reflected light and by its shape or pattern.

The approach also has the advantage that both the illuminating beam and the reflected beam can be optically manipulated to permit the inspection of limited-access areas. Numerical-control techniques are used to position the optics and/or the part under inspection over a predetermined path that will allow the required surface to be scanned. The reflected optical pattern is converted into a set of electrical signals that can be processed by means of pattern-recognition techniques to extract the required information.

Boring work

An automated system of this nature is currently being used on a production basis to inspect the inner bores of automotive master-brake-cylinder bodies at the Hydraulics division of the Bendix Corp., St. Joseph, Mich. The condition of the surface can be related to the bright elliptical pattern reflected from a smooth (15- to 20-microinch) surface. The pattern reflected from a rough (30-to 35 in.) surface is less predominantly elliptical in shape and has a more scattered appearance. A surface with a crack (approximately 0.020 in. wide) yields a pattern with a definite void—a nonreflecting area caused by the crack. Thus, both the shape and the intensity of the reflected pattern are needed to detect both surface roughness and flaws.

In operation, the part to be inspected is clamped in the inspection position, the system scans the bore of the part, the results are displayed on the display panel, and the part is returned to its initial position, where it is unloaded by the operator.

The pattern-recognition portion of the system, which consists of a phototransistor sensing array and both analog and digital electronics, has three functions: flaw detection, roughness detection, and hole detection. The presence of a flaw decreases the intensity of the reflected light pattern. Roughness increases scattering in the reflected light pattern. A hole is indicated by laser light striking an external sensor.

Cylinder-bore surface scanning is the easiest to accomplish with optical systems because the surface to be inspected is usually a simple surface of revolution. The technique is applicable not only to master brake cylinders but also to wheel cylinders, engine cylinders, valve bodies, and bearing sleeves and races.

Outside surfaces can also be scanned automatically in this way. Although their optical geometry may be somewhat more involved than that of the insides of cylinders, some of the problems are manageable. Currently studies are under way of the applicability of the technique to crankshaft bearings, tapered and cylindrical roller bearings, rolls of flat strip steel, and flat part surfaces following grinding operations.

Inspection of parts that can be defined in terms of a profile or a specific two-dimensional shape is also amenable to an optoelectronic approach. Instead of reflected light being converted into electronic representation, as in the case of surface inspection, the profile coordinates of a part are represented electronically, and the results compared with stored data on the desired profile coordinates.

For instance, one machine that's available uses this technique to inspect the alignment of a rubber diaphragm on the plastic body of a power-brake vacuum-assist unit. Gear teeth, gear assemblies, fillets, and stampings can also be similarly checked.

Tracking and ranging

Optical tracking and ranging systems have become a practicability with the availability of reliable lasers. Sylvania Systems division in Mountain View, Calif., using its expertise in laser development and optical processing, has developed one of the most advanced of these. Called the precision aircraft tracking system (PATS), the device is an automatic laser radar system designed to

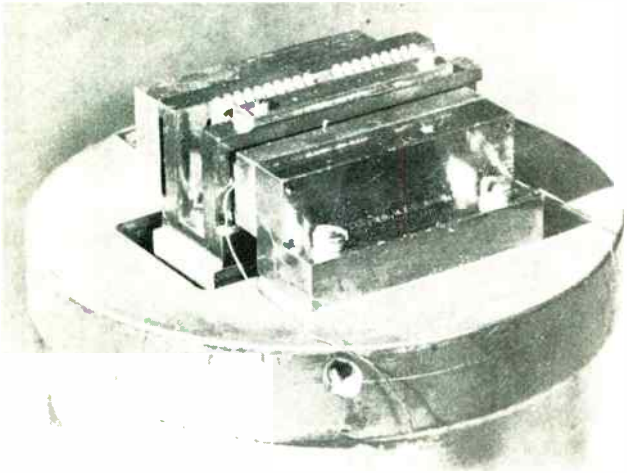
Diode lasers range far and wide

Last year saw the GaAs injection laser become the most efficient source of coherent light, largely due to the development of a new double heterojunction structure. Now operating at higher power and room temperature, this small, compact device is finding its way into an ever widening assortment of ranging and communication systems: closed-circuit TV, data links, line-of-sight multi-channel voice communicators, and ir surveillance systems.

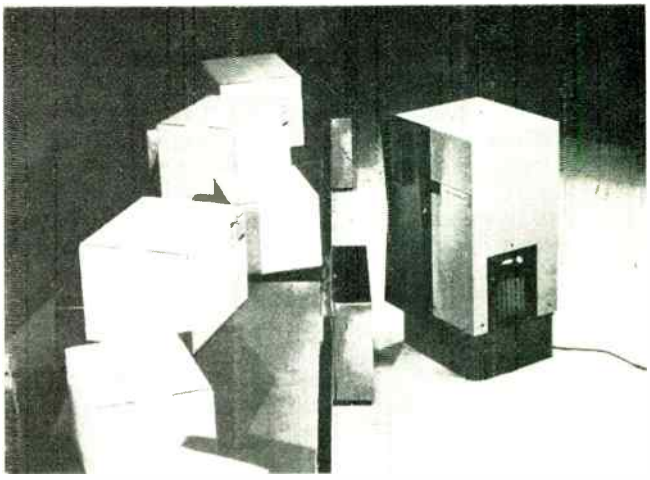
RCA, a leader in the development of the GaAs laser, was instrumental along with Bell Labs in evolving the room temperature diode laser. More recently still, a team headed by Henry Kressel of RCA's Princeton Laboratory developed a new laser structure that doubles the output efficiency of previous semiconductor lasers at high powers. Quantum efficiencies as high as 40% to 50% and overall efficiencies up to 20% are typically possible with 20-watt peak power output at 3% duty cycle, compared to the 1-w levels of the old devices.

Kressel points out that unlike previous semiconductor lasers, which required special cooling at high powers and high duty cycles, the new laser will function at room temperature. Moreover, it can also operate reliably at extremely high temperatures—even above the boiling point of water.

The improved performance is due to a "large optical cavity (LOC) design which is located directly next to the p-n junction," says one of the developers, Harry Lockwood. This means that the light propagation region is separated from the generation region, and the light-absorption loss is reduced.



News flash. Ytterbium- and neodymium-doped YAG lasers have communications potential. TI's Yb-YAG laser is in cooling tank.



Fast reader. Bendix pattern recognition equipment could help automate warehouses; laser reader could control sorting mechanism

loss into the resonator that would not be reflected into output.

Now the scattering efficiency of an acousto-optic deflector is a monotonically increasing function of its acoustic power. Consequently, the fraction of the circulating laser beam fed back to the lasing medium can be precisely controlled by controlling the power applied to the deflector. This in turn permits the laser threshold to be lowered to any arbitrary value at any time during the pumping cycle simply by controlling the timing and amplitudes of the rf pulses applied to the acousto-optic device. This allows the laser intensity to be regulated by the cavity switched.

The laser head consists of a 2 × 0.25-in. Nd-YAG laser rod and a single krypton flash lamp in an elliptical pumping cavity. The acousto-optic deflector consists of a fused silica prism bonded to a crystal quartz transducer tuned to 100 MHz.

Bell Laboratories' high-pulse acousto-optic Q-switching has been directed toward micromachining images on suitable materials and thus to the achievement of the long-sought image recording by laser beams. Here images are recorded on a 600-angstrom-thick, ½-in.-wide bismuth film on a nylon substrate by acousto-optically modulating a cw 20-mW argon laser.

The recorded image size is 10 × 11 mm, and the writing speed is 10^6 spots per second. Images of documents which were originally 8.5 × 11 in. have a resolution of over 175 lines. When magnified to the original size, the picture obtained is comparable with a good black and white photograph with nine to ten shades of gray. The required energy density (given by the pulse peak energy divided by the spot area) has a maximum value of about 0.060 joule/cm^2.

An acousto-optical intracavity modulation system produces 25-ns light pulses of 20mW average power. The video information is acquired by a He-Ne laser scanner. A balanced mixer amplitude-modulates a 5-mW 450-MHz rf signal with the video signal. If a dc bias were supplied in addition, the modulation depth could be adjusted to obtain the proper gray scale.

A second balanced mixer, triggered with 30-ns-duration base band pulses at a 1-MHz repetition rate, produces the rf pulses required to switch the cavity. The video-modulated 30-ns rf pulses, after being amplified by a 20-w linear amplifier, are fed directly into a zinc oxide transducer sputtered on a fused silica modulator.

As the result of Bragg interaction between the acoustic pulses and the light beam, 25- to 30-ns light pulses are dumped out of the cavity at a 1-MHz repetition rate. They are intensity-modulated at the video frequency, and then collimated and focused with an f/5.6 lens onto the bismuth film, out of which they machine spots 6μm in diameter. □

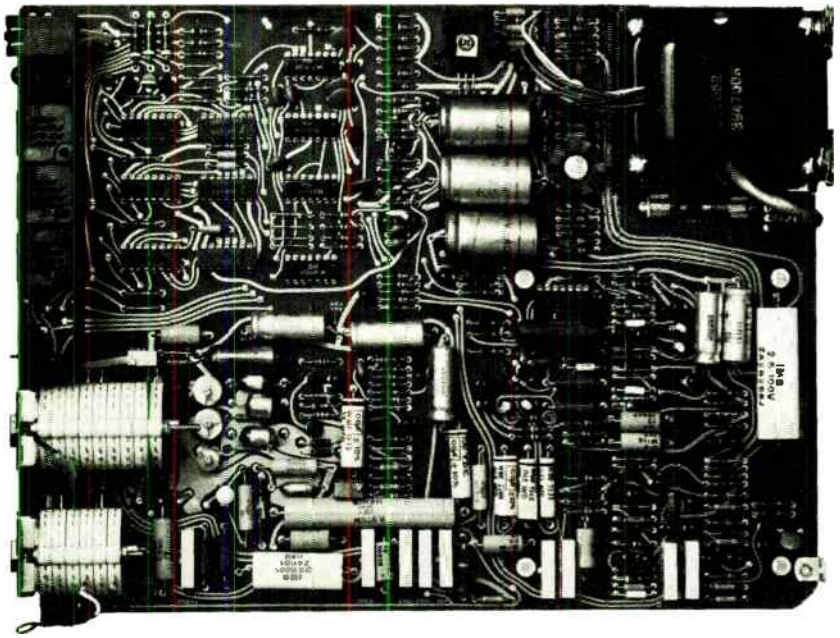
A Dutch treat

An advanced optical system being developed in Holland is the only known one of its kind. Built by Philips Laboratory in Eindhoven, it's a grating-type interferometric measurement system with a difference—it is designed around the polarization of light instead of around its intensity. The equipment has already enabled Philips researchers to achieve resolutions of less than a hundredth of a micron, and they expect to attain a thousandth of a micron within two years.

As in a conventional grating interferometer, the system produces a reflective phase grating pattern that is imaged onto itself by a concave mirror system. But by depending on phase variations in the polarization of the two beams, it escapes errors caused by variable intensity of the light source, differences in grating reflectance, etc.

The measuring system has been used by Philips in a pattern generator and, together with high-precision bearings, has been incorporated into a numerically controlled lathe. The pattern generator's specifications are impressive: writing area is 200-by-200 square millimeters, with an absolute accuracy of ±1 micron; maximum writing speed is 10 mm per second; maximum acceleration is 0.5 mm/s^2; line widths range from 2 to 1,900 microns in 200 steps. The system draws any pattern with straight or curved elements.

This is the first of a three-part series on optoelectronics. Part II will deal with tunable lasers and their role in pollution measurements, and Part III with optical approaches to information storage, retrieval, and display. Reprints of Part I are available at $2.00 each. Write to Electronics Reprint Department, P.O. Box 606, Hightstown, N.J. 08520.



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MOTOROLA

Designer's casebook

Comparator logic limits switching regulator current

by Robert S. Olla
National Semiconductor Corp., Sunnyvale, Calif.

A switching regulator that uses digital current limiting provides a current regulation of better than 1%, while offering good frequency stability and fast response to transients. Essentially, the regulator uses two NAND gates as a pulse-width modulator to keep current from exceeding the present limit.

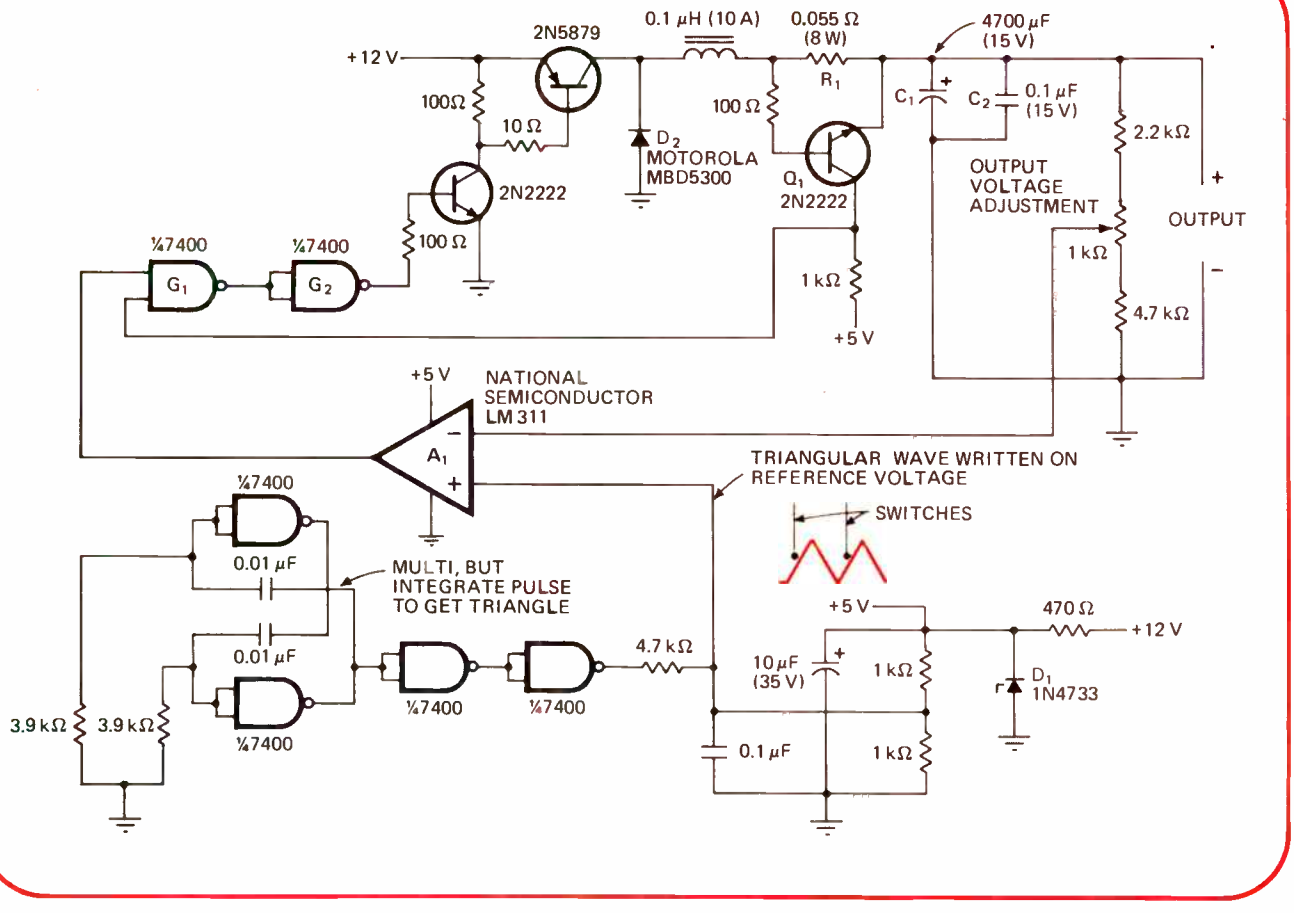
The circuit employs a zener diode, D_1, to provide both the circuit reference voltage and supply power for the logic. A hot-carrier diode, D_2, is used for efficient elimination of spikes in the output.

As long as the current limit, I_L, is not exceeded, transistor Q_1 remains off; I_L is determined by the value of resistor R_1. For the resistor shown, I_L approximately equals 10 amperes.

The signal at Q_1's collector is used to inhibit the output pulses from comparator A_1. When Q_1 is off, all pulses pass through NAND gates G_1 and G_2. However, if I_L exceeds the preset 10 A, Q_1 conducts, and its collector voltage goes low. This inhibits the comparator pulses until the current falls below I_L.

A triangular wave is applied to the noninverting comparator input. It is obtained from a multivibrator whose pulse output is integrated and written on the zener reference voltage. The comparator switches one time during each triangle cycle, when the wave's slope is positive; the switching point is determined by setting the 1-kilohm potentiometer. Operating frequency of the switching regulator is the frequency of the triangular wave.

Digital current limiting. Output current of switching regulator is held to desired limit by digital comparator. Transistor Q_1 remains off as long as current limit is not exceeded. If current goes beyond limit, Q_1 turns on, inhibiting A_1's output pulses. NAND gates G_1 and G_2 form pulse-width modulator; zener diode D_1 supplies regulator's reference voltage. Current limit for circuit shown is 10 amperes.



Transistor matrix driver supplies varying loads

by S.S. Durvasula
Honeywell Information Systems, Framingham, Mass.

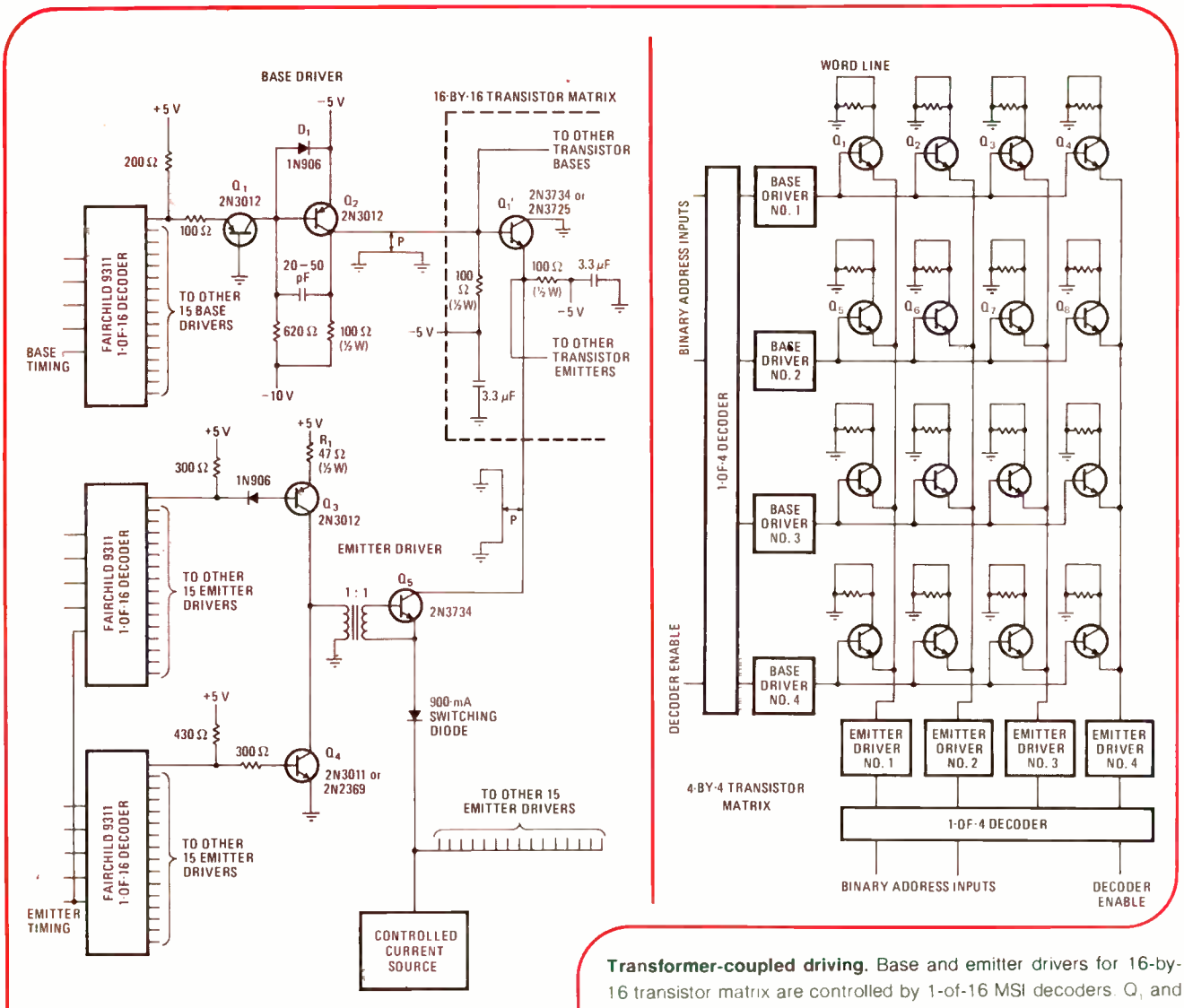
Testing magnetic memory planes containing transistor matrices often requires special drive circuitry between the decoding logic and matrix because of varying signal conditions. The matrix drive circuitry illustrated compensates for these changing signal and load variations, and yet maintains power dissipation at a minimum. The decoding logic used in the matrix driver circuitry is greatly simplified by the use of medium-scale integrated circuits, like three 1-of-16 decoders.

There are 16 base and 16 emitter circuits to drive the 16-by-16 transistor matrix. Operating the matrix may require switching pulses of up to 900 milliamperes with 40-nanosecond rise and fall times. This should be provided by a current source that controls pulse amplitude and width, and maintains specific pulse rise and fall times.

Operation of the matrix base drive is straightforward. When the top decoder's output is high, Q_1 is on, and Q_2 is off since D_1 clamps the base of Q_2 at a diode drop above −5 volts. Once the decoder goes low, Q_1 turns off and Q_2 saturates, driving the base bus of Q_1 through a twisted pair.

Emitter drive operation is slightly more complex. Normally, the decoder outputs that feed Q_3 and Q_4 are high, keeping Q_4 on, and Q_3 and Q_5 off. When the decoder outputs go low, Q_3 turns on, Q_4 turns off, allowing Q_5, which is a current-driven switch whose base drive is fixed by R_1, to conduct. Current flows through Q_5's collector-emitter junction only when the decoder control voltage is changing.

The load requirements of Q_5 are for controlled cur-



Transformer-coupled driving. Base and emitter drivers for 16-by-16 transistor matrix are controlled by 1-of-16 MSI decoders. Q_1 and Q_2 form base driver; Q_3, Q_4, and Q_5 constitute emitter driver. Q_5 is a current-driven switch whose turn-on and turn-off times are enhanced by the overdrive action of Q_3 and the transformer. Q_4 keeps Q_5's switching times constant even though load conditions change.

rent and pulse conditions. But since the voltage excursions of Q_5's collector and emitter could vary over a wide range, a transformer-coupled drive is used to correct for changing load conditions.

Transistor Q_3 and the transformer provide overdrive for a pulse leading edge so that Q_5 turns on quickly. When current flows in the opposite direction during a pulse trailing edge, transformer droop removes any stored charge from the base of Q_5, forcing it to turn off quickly.

Since the circuit must accommodate varying pulse widths, Q_4 is used to make Q_5's turn-on and turn-off times always as fast as possible. Although the leading-edge overdrive, which is fixed by R_1, is not affected by narrow pulse widths, transformer droop is no longer available to enhance turn-off time. However, during the trailing edge of a narrow pulse, Q_4 turns on and provides a reverse current through the transformer droop and decreasing Q_5's turn-off time.

Matrix bases and emitters not selected look like capacitances distributed along the bus lines. The capacitance per transistor depends on the back-bias voltage at the base-emitter junction of the unselected device; it can be determined from manufacturer's specifications.

FET current source gives stable, precise ramp

by Thomas D. Price
Saunderstown, R.I.

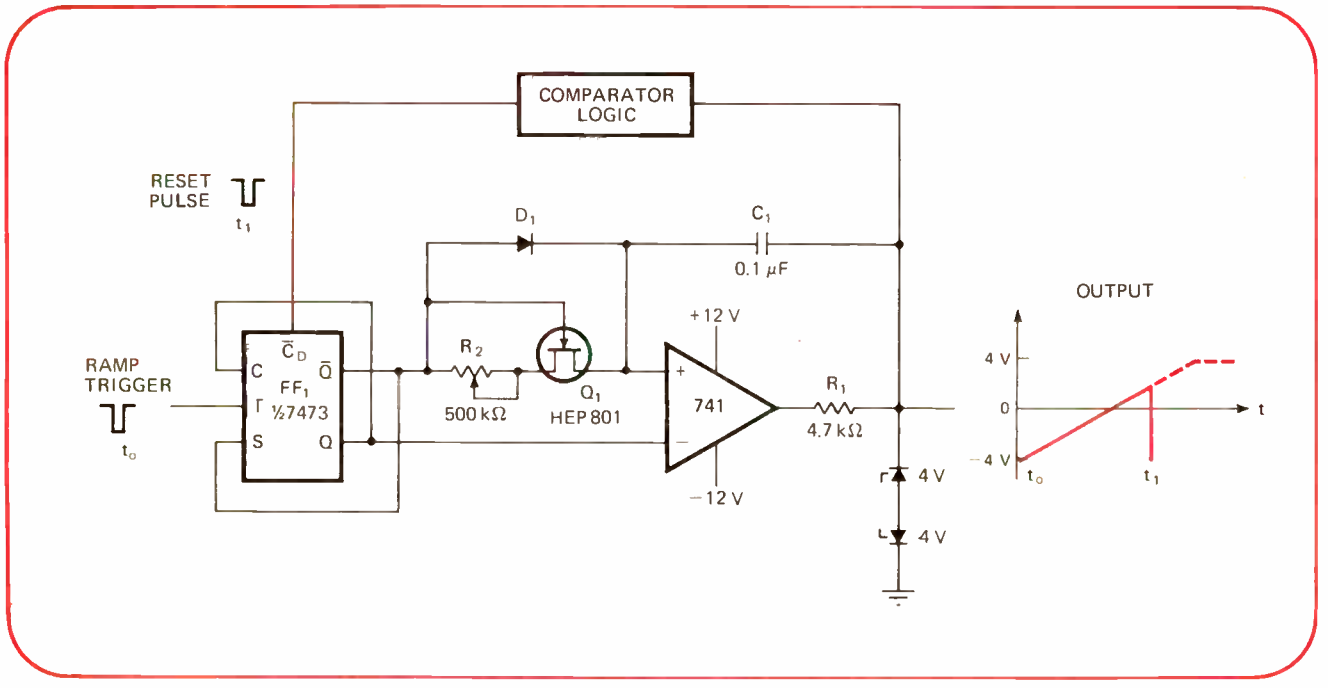
Employing a field effect transistor as a constant-current source in a ramp generator can produce an output with a linearity and slope that is virtually independent of unwanted variations in control voltages. The resulting circuit is a stable, highly linear ramp generator that is both simple and inexpensive to build.

Before the ramp trigger is applied, the Q output of flip-flop FF_1 is low and the amplifier output is clamped low by back-to-back zener diodes. Resistor R_1 limits amplifier short-circuit current. At time t_0, the ramp trigger causes the Q output of FF_1 to go high, producing an output ramp whose rate is determined by the value of capacitor C_1, and a constant current from FET Q_1, which is set by resistor R_2. (For this circuit, ramp slope is 100 volts per second.)

The output ramp, in turn, drives external comparator logic, which produces a reset pulse for FF_1 at time t_1. The pulse input at t_1 is preset at some desired voltage level: for instance, an unknown voltage that is being measured. Once FF_1 is reset, its Q output goes high, C_1 discharges fast through D_1, terminating the ramp.

Without Q_1, ramp slope is determined only by C_1, R_2 and the voltage level of FF_1's Q output. Any change in this voltage, caused by power supply variations and/or transients, will produce ramp inaccuracies. Using Q_1 and R_2 as a constant-current source isolates the output ramp voltage from supply irregularities.

Linear ramp generator. Constant-current source, formed by FET Q_1 and resistor R_2, enables precision ramp generator to supply very linear output. Input trigger sets FF_1, whose output is integrated by amplifier Q_1, C_1, and R_2 to produce a ramp. Constant current makes ramp insensitive to supply variations. Comparator logic, external to generator, terminates ramp with pulse that resets flip-flop FF_1.



Logic signals pulse heaters for multiplexed display

by Eric Breeze
Fairchild Semiconductor, Mountain View, Calif.

Seven-segment fluorescent readout tubes can be multiplexed with a heater supply that operates from 5-volt logic levels. Because of thermal inertia, pulsed power keeps the filament hot during the pulse off-period.

Basically, the readout is a vacuum tube diode with seven phosphor-coated anodes. When a positive potential is applied between the cathode and an anode, electrons strike that anode, activating the phosphor. To use the readout in a multiplexing mode, both its anodes and cathode must be addressed.

Since the tube's heater acts as the cathode, it is difficult to supply power to one heater and isolate it from the others. The solution is to use logic signals with a one-eighth duty cycle (for an eight-digit display).

The circuit shown is for eight multiplexed digits, but it can easily be changed to six digits by modifying the scan counter. Each of the heaters has a transistor, a diode, and a resistor associated with its supply. When the transistor conducts, the readout is active. When the transistor is off, the resistor pulls the cathodes up to the positive supply potential, reverse-biasing the diode and leaving no potential across the tube.

To find the total filament voltage (V_H) required for pulse-mode operation, use:

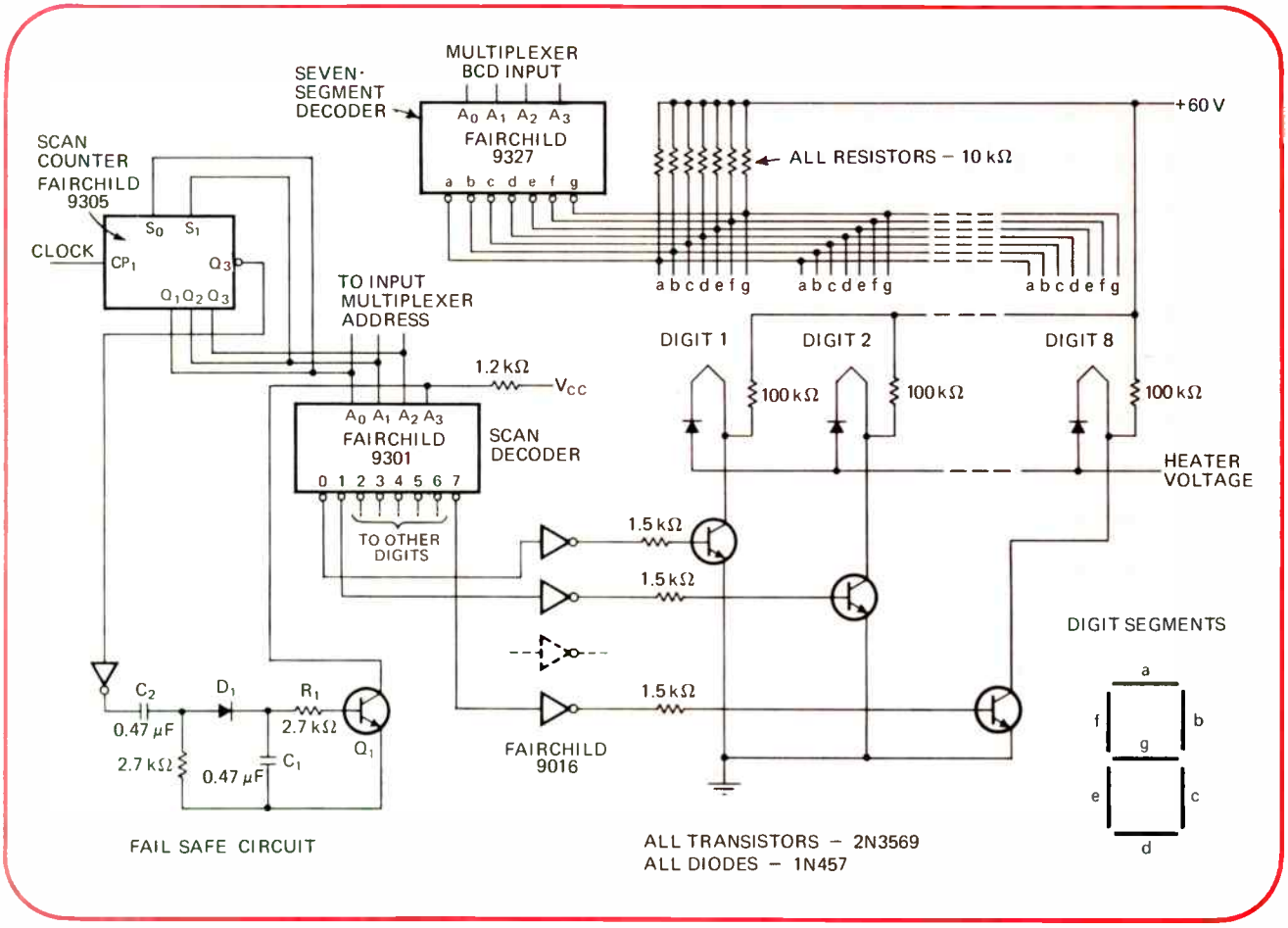
$V_P = N_s V_F$ + diode and switching losses, where N is the number of parts in the scan cycle, and V_F the tube filament voltage. If Sylvania, Tung-Sol, or General Electric readouts are used, $V_F = 1.4$ v. For the eight-digit ($N = 8$) display shown:

$V_P = 8(1.4) + 0.9 = 4.9$ V

In the event of clock failure, a fail-safe circuit on the most-significant bit of the scan decoder prevents the full filament supply voltage from being applied to any one heater. As long as the counter is operating, pulses to diode D_1, resistor R_1, and capacitor C_1 bias transistor Q_1 on. Clock failure removes the bias from Q_1, changing the input code to the scan decoder so that the decoder's unused outputs are addressed. Ac coupling through capacitor C_2 is necessary in case the counter output should stop in the high condition.

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $50 for each item published.

Eight-digit display. Filament supply for multiplexed seven-segment readout tubes is controlled by logic signals. Pulses of heater power keep tubes operating even during pulse off-period, and the filaments remain isolated from each other. Fail-safe circuit prevents individual filaments from receiving full heater supply voltage if the clock fails. Clock frequency can be as high as 20 kilohertz.



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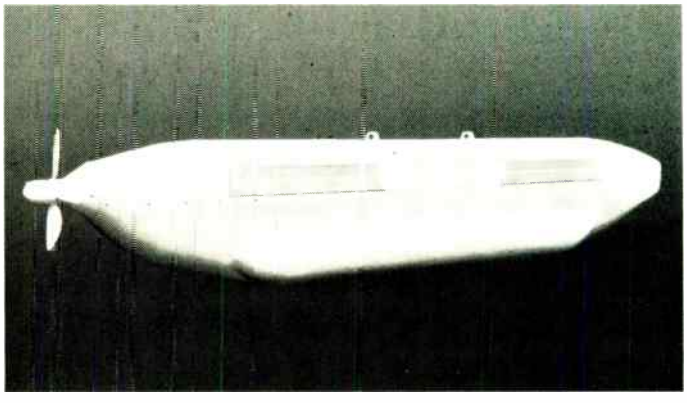

Garrett AiResearch enclosures are also cooling the pod mounted ALQ-76 and ALQ-99 electronic countermeasures systems. The enclosure in the ALQ-99 pod (shown above) for the EA-6B utilizes surface heat exchangers as the ultimate heat sink.

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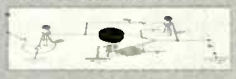

These Detector/ Amplifier's combine a PIN silicon photodiode and a matched low noise op amp in a single package. Unique characteristics include: DC & AC detection, dynamic range of 10^8, response to 10 megahertz, sensitivity to 10^{-12} watts.

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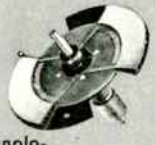

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Dynamic MOS shift registers can also simulate stack and silo memories

Two useful functions for digital systems, often implemented with complex software routines, can instead be built from circulating shift registers; they're economical, and open up many new applications in small systems

by Richard Percival, *National Semiconductor Corp., Santa Clara, Calif.*

☐ Small digital systems often require certain specialized internal functions that are complex to execute in software, yet difficult and expensive to design onto large-scale integrated circuits. For example, push-down stack and silo memories should make excellent parallel-character buffers in such equipment as point-of-sale terminals, printers, data-transmission units, and keyboard-to-tape machines. But addressing and control problems, and high cost, have limited their usefulness in this equipment.

These problems are circumvented by a new method of simulating stack and silo operations with metal oxide semiconductor dynamic shift registers, which normally operate like delay lines or rotating magnetic drums. The difference in this application is an additional shift register that contains marker bits to identify data locations.

A stack memory reads out stored data in a last-in, first-out mode. This mode is often used in computers for compiling programs written in a high-level language into machine language, but also has many other uses. In point-of-sale terminals or printing equipment, for example, a stack memory can tabulate data, align margins, and speed the transmission of records of variable length.

Conversely, a silo memory reads out stored data in a first-in, first-out mode. It is ideal for interfacing a slow data-transmission unit with a fast telephone line, or a keyboard operating at human speeds with a magnetic tape or other medium operating at electronic speeds.

By contrast, a conventional shift-register memory can read out data more or less in any order—but at the expense of a counter and comparator which the system uses to track the location of circulating data. This addressing method is like those used with acoustic delay lines or with electromechanical disks and drums.

A new independence

By eliminating the need to locate data in a specific time frame, the new technique makes the memory virtually independent of system control except for read-write requests: all that's needed is a demand/response schedule. A request to store information, accompanied by the word, is honored by the memory at the right time. Data is continuously available at the memory's output, enabling the system to pick it up at leisure.

The word on the output lines at any moment is the most recently stored word when the memory is operating in stack mode; in the silo mode it's the word that has been stored the longest time. The memory can operate in either mode, and the system can switch from one to the other without disturbing stored data. Immediately after changing mode, the new current word may not become available for up to a few hundred microseconds as it circulates into position through the shift registers.

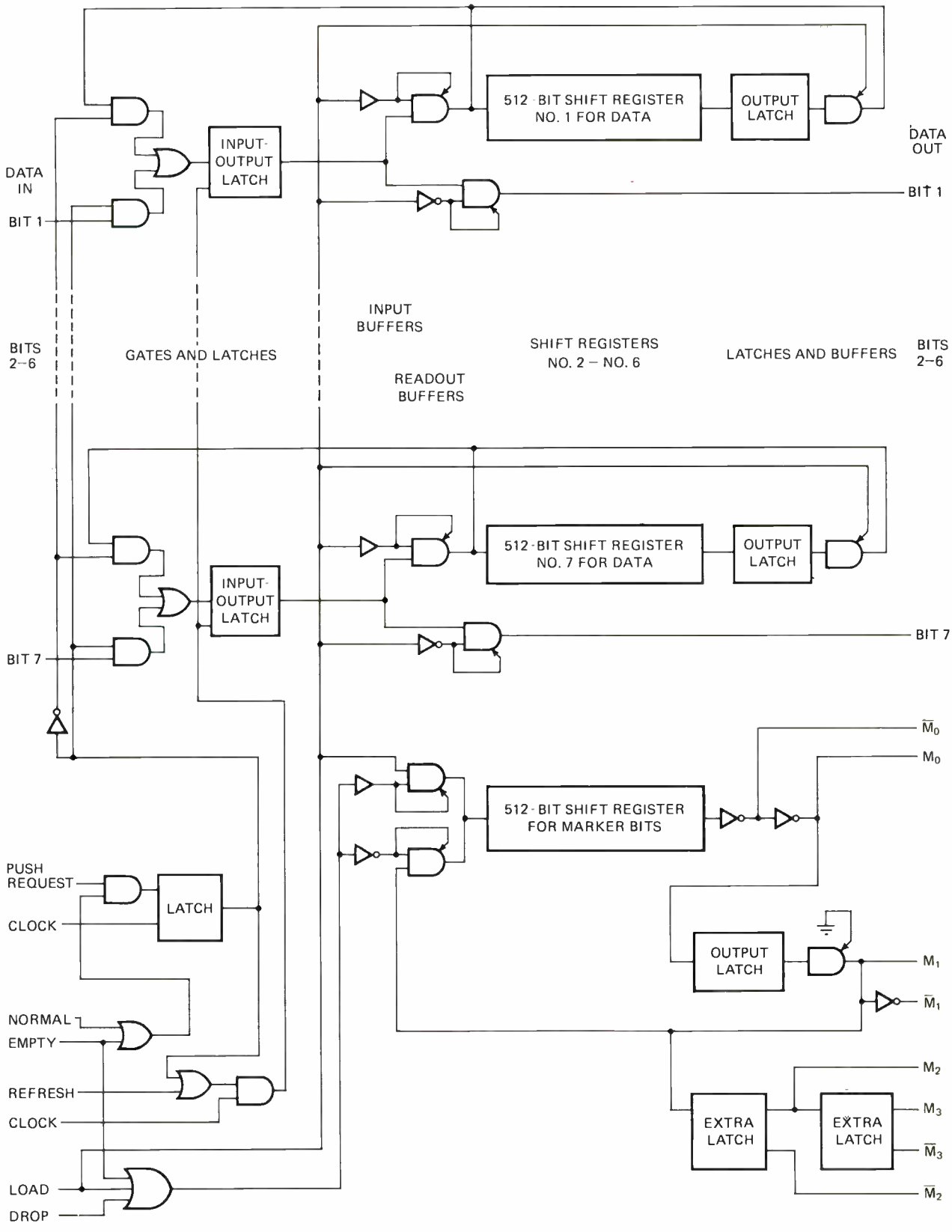
Marker register needed

Like conventional MOS dynamic memories, the stack and silo memories consist of shift registers operating synchronously. Each register corresponds to a single bit position in a word; reading or writing a word consists of simultaneously removing from or adding to one bit in each of the memories. But unlike conventional memories, the new control technique marks the location of stored data with 1 bits, called marker bits, circulating in an additional dynamic shift register. This one extra register (also synchronized with the data) and a small amount of associated logic replace large quantities of software, address decoding, and other complications of conventional memory controls.

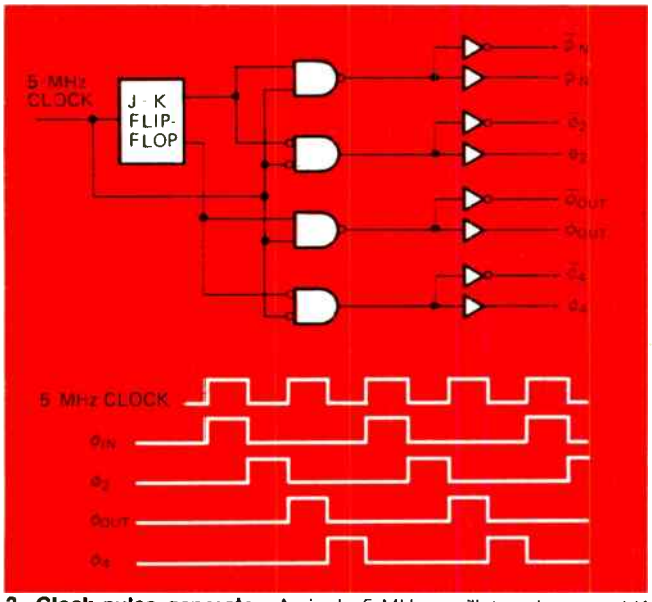
The control technique is exemplified in Fig. 1. This is a 512-word, seven-bit dynamic memory that always loads the same way, but unloads like either a stack or silo memory, as determined by the associated system. It contains seven 512-bit shift registers for the data, and an additional register in which the marker bits circulate. These registers operate with a maximum clock rate of 2.5 megahertz, corresponding to a minimum bit period of 400 nanoseconds. Necessary clock pulses at the proper frequency, together with syncopated pulses for the control logic, can be generated from a single 5-MHz clock and a few logic blocks, as shown in Fig. 2.

Any actual application would require some control logic, with signals passing between it and the shift registers, as shown in Fig. 3. Also shown are the signal lines along which the registers and the control logic communicate with an associated digital system.

Feeding each shift register is a Tri-state buffer switch. (Tri-state is the trademark for three-state transistor-transistor logic. It is a bus-connectable variety of TTL that offers high-speed active-pullup outputs [*Electronics*, Sept. 14, 1970, p. 78].) The buffer has a normal TTL output when enabled, but may be disabled into a high-impedance third state. There, no data is transferred and



1. Stack or silo. This collection of dynamics MOS shift registers can operate as either a push-down stack (first-in, first-out) memory or a silo (first-in, last-out) memory. The key to operation in either mode, in contrast to conventional operation of dynamic shift registers, is the marker register. This extra register contains a 1 bit for each word stored in the data registers. The marker register plus a small array of logic blocks replaces the complex software and decoding that conventional stack/silo implementations require. The clock rate is 2.5 megahertz.



2. Clock pulse generator. A single 5-MHz oscillator plus one J-K flip-flop and four gates can generate all the timing pulses needed by the stack-silo memory of Fig. 1 and its associated control logic. Amplifiers are necessary to provide sufficient power.

only a very small leakage current can exist. Through its input latch, the buffer controls entry into the shift register of new data being loaded from the system.

At the register's output is another latch and a Tri-state output buffer switch. The latch serves as one more stage in the shift register, and lengthens the circulation time by 400 ns. During this interval, the control logic can examine the contents of the marker register, and establish proper timing for load and unload operations. The latch is needed so that the control logic can look at the first two marker bits emerging from the shift register, and so that the data registers and marker register are the same length.

In parallel with the input buffer switch is another switch through which data is unloaded. These two switches are basically identical, but in the present design they have different National Semiconductor part numbers—DM8094 for the input switch and DM8093 for the readout. Both have one data input direct to the switch, and one control input; and in both switches, the control input drives the Tri-state enable/disable circuit. But the control in the DM8094 is noninverting, and that in the DM8093 is inverting, so that a binary signal connected to the two control inputs opens one switch and closes the other as it changes state.

Two switches, single load

Because the input transistor in both switches is the conventional TTL multiple-emitter transistor, it can be fully switched by the control input. Thus, when the control input disables the switch, the latter presents no further load to the data input. When the control input enables the switch, the data input presents a single load to its driver. As a result, the data input can be driven by a low-power source that couldn't otherwise be connected to two gates at once. In this design the source is an AND-OR-INVERT gate and an input-output latch, four of which are available in one package as the DM74L98.

These three sets of buffers—input, output, and readout—define three operating functions: normal recirculation, data unloading, and data loading.

During either normal recirculation or data unloading, both the output buffer and the readout buffer are enabled (the output is disabled). Data circulates from the output latch through the output buffer, directly to the register input. Meanwhile, data also is routed to the input-output latch, from which it is available to the system through the readout buffer.

While loading new data, both the output buffer and the readout buffer are disabled, and the input buffer is enabled. New data enters through the AND-OR-INVERT gate and the input latch, and goes to the shift register at the proper time. This "pushes" previously loaded data further "down" into the register, in either stack or silo mode, old data being unloaded from the "top" in stack mode or from the "bottom" in silo mode (Fig. 4).

The connection from the output buffer to the register input is possible only with the Tri-state circuit—the register is common to both the output and the input buffer, so that one or the other is always disabled. Without this capability, another set of AND-OR-INVERT gates would be necessary.

Continuous circulation

The system can retrieve from the readout buffer either the newest or the oldest word from the circulating data at any time. But having retrieved it, the system cannot take another until it appears in the input-output latch—a wait of a few hundred nanoseconds in stack or a few hundred microseconds in silo. And when the system retrieves a word in this fashion, that word is logically removed from the file, but continues to circulate in the memory until a new word is loaded in its place or unit power is turned off.

The input-output latch's contents change only when a word is loaded into or taken out of memory. In stack, a newly loaded word becomes the output word: when the system takes it, the next previously loaded word replaces it in the input-output register. In silo, the newly loaded word occupies the input-output register only until the oldest word again circulates through the shift register and replaces it. When the system takes that oldest word, the next-oldest replaces it after another round trip through the register.

The key to automatic operation is the marker register, the eighth shift register in Fig. 1. It assures that data input and output are always correctly timed, regardless of the number of words stored. It contains a sequence of adjacent 1 bits preceded or followed by a sequence of adjacent 0 bits; otherwise there are no 1s or 0s in the register. The sequence of 1s in the marker register identifies the location and length of a string of words in the data registers.

When a new word is to be loaded into memory, it must wait until the beginning of the string of 1s starts to emerge from the marker register. Just as the first 1 in the string reaches the end of the marker register, the new word is loaded into the registers, and a new 1 bit is inserted into the marker, ahead of the approaching 1 bit. That way, new data always is in front of old data progressing through the synchronized memories (Fig.

5)—only one new word can be loaded on each round trip of data through the shift registers.

The practical capacity of the stack-silo memory is one less than the number of bit positions in the shift register (511 words in the present design). This can be extended or reduced by using a shift register of a different length. At least two empty spaces must appear following the last word of data, to separate it from the oncoming leading word following it through the register. These two spaces correspond to the remaining position in the register and to the output latch. One round trip through 513 bit positions takes about 205 μs at a 2.5-MHz bit rate. To load up the memory completely from an empty state would take just over 100 milliseconds.

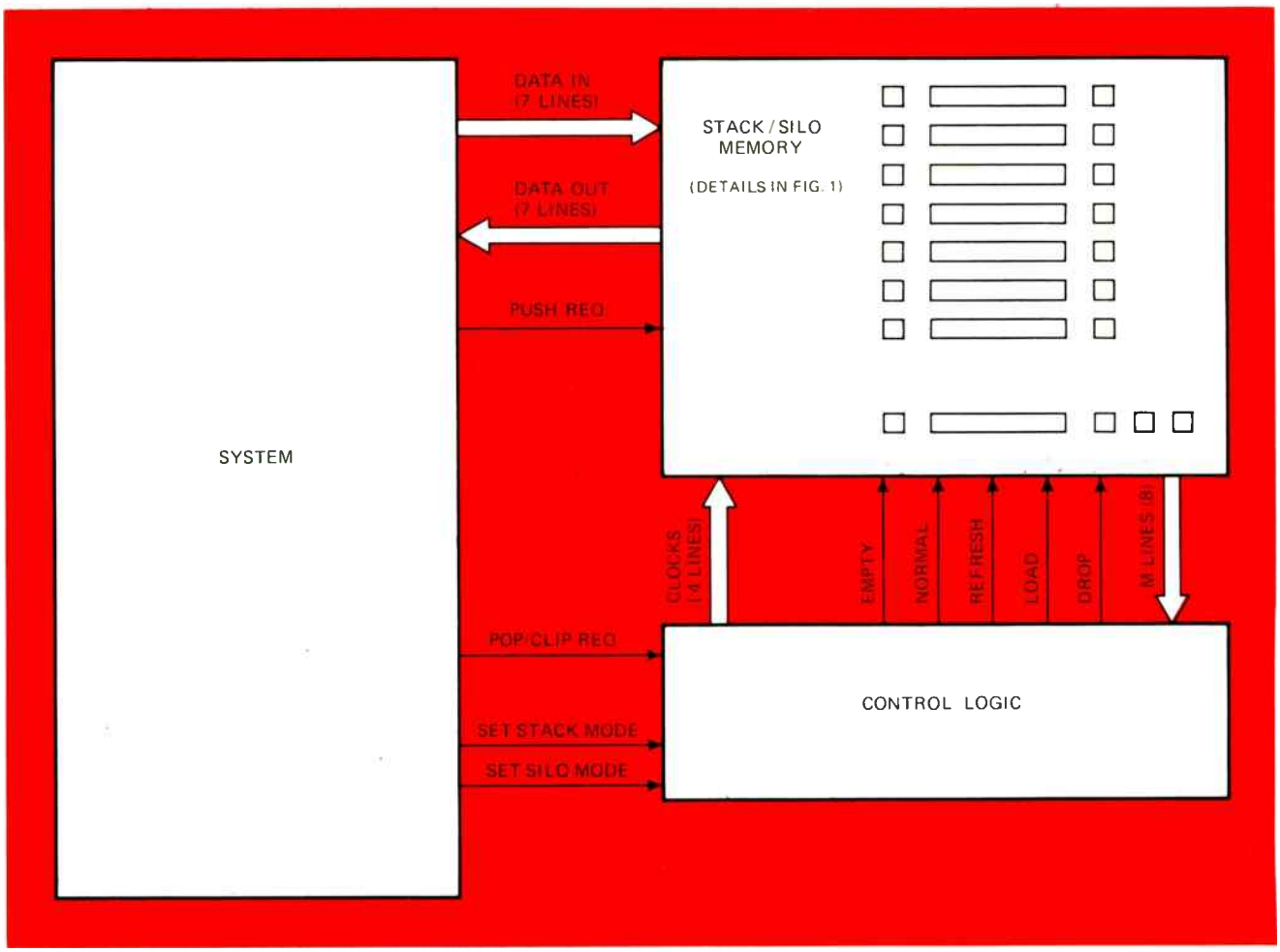
Doling out data

Unloading data depends on the operation mode. In stack, the most recently loaded data is taken out first (a "pop"), so that the approach of the string of 1s signifies that unloading may take place; the loading 1 bit in the marker register is replaced by a 0. Data can be removed at the clock rate in stack mode—therefore a single data burst can empty the memory completely in one round trip. In silo the oldest data is taken out (a "clip"), and is timed by the approach of the string of 0s; the trailing 1 bit is replaced by another 0. Only one word can be unloaded per round trip of data in silo mode.

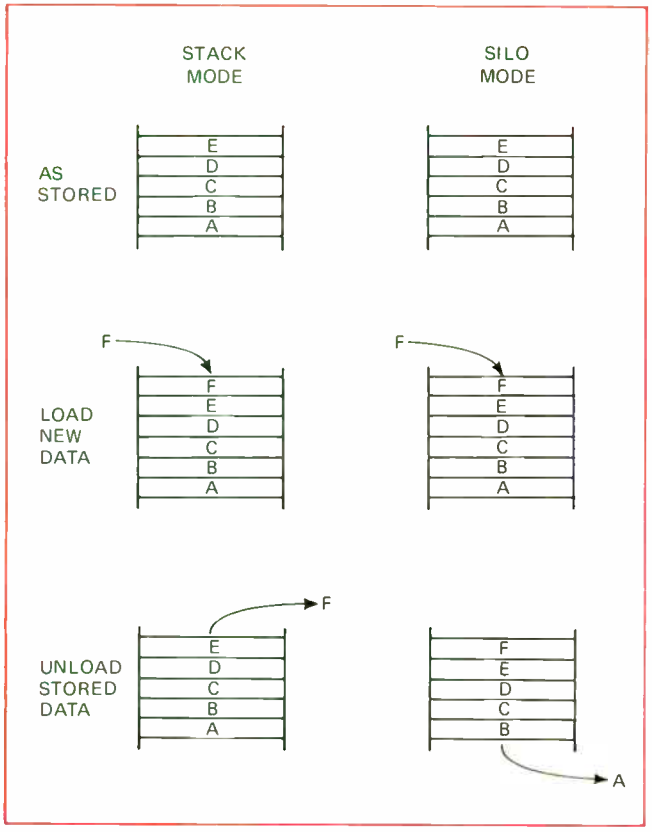
The marker register also has a latch at its output, but between the register and the latch are two inverters which make available both the bit M_0 emerging from the register and its complement, $\bar{M}_0$, and which provide enough drive to set the output latch and also to drive external logic in the controller. These inverters add a slight delay to total marker circulation time, but it is negligible relative to the spacing of clock pulses that controls circulation.

The output of the latch, M_1, recirculates the marker bits to the input of the register, just as with the data registers, except that the latch output is always enabled and the recirculating bits always pass through a DM8093 gate at the register input. The latch output also drives two cascaded "extra latches" that store the value of the two preceding marker bits, M_2 and M_3, and their complements. From this, external control logic can locate the first-in and last-in words.

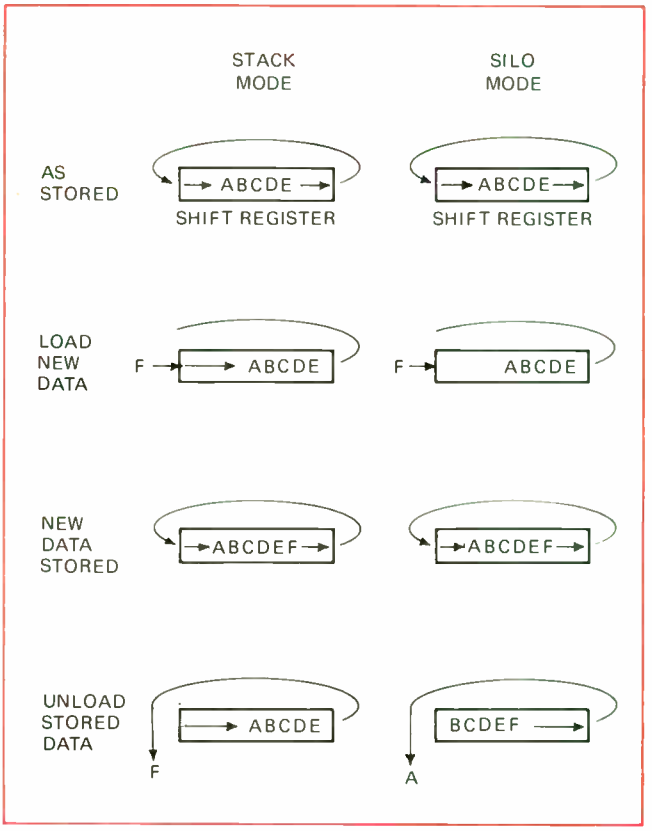
Details of the external control logic depend somewhat on the system in which this stack/silo memory is used. But its basic function is to provide signals that load and unload the memory. The control would require, at most, three flip-flops, logic to control them and to decode their outputs, and a memory clock. The three flip-flops would encode the eight stable states of the



3. Relation to system. The stack/silo memory of Fig. 1 can be used in any small or large digital system. It is almost completely independent of the system, because it requires only data lines in both directions, a "push request" signal to initiate loading a new word, and a few signals to the control logic. The memory runs with its own clock, and therefore is asynchronous to the system in which it is installed.



4. Functional appearance. To the system, the stack and silo versions look like these representations. New data always goes in at the top. Old data is unloaded from top in stack mode (first-in, last-out) and from bottom in silo mode (first-in, last-out).



5. Actual operation. When dynamic shift registers are organized as stack or silo memories, new data always goes in front of old data circulating through the registers. Old data is "clipped" off the rear of the data in silo mooe, "popped" off the front in stack mode.

control logic. These are one each for EMPTY, NORMAL, and FULL, one each in response to a PUSH REQUEST, a POP REQUEST, and a CLIP REQUEST, as well as one each for the short intervals following a pop or a clip, during which the next current word for readout is awaited. Less complex control logic would be necessary, for example, in applications where only the stack mode is needed.

But both stack and silo modes can be useful in a single application. For example, in a keyboard-to-tape machine, the memory is loaded from the keyboard and unloaded in silo mode when the data is transferred to the tape. But if the operator makes a mistake and presses the backspace key, the last character entered must be unloaded in stack mode.

Loading data

In the empty state, with all data purged from the system, marker recirculation is disabled and the memory can receive a word of data at any time. The system signals its intention to store a word with the line PUSH REQUEST, which is asynchronous relative to the memory's clock, independent of the system clock. The memory synchronizes this request with its own clock and immediately loads the word—the registers are empty. As it does so, it inserts a 1 into the marker register via the load line in Fig. 1.

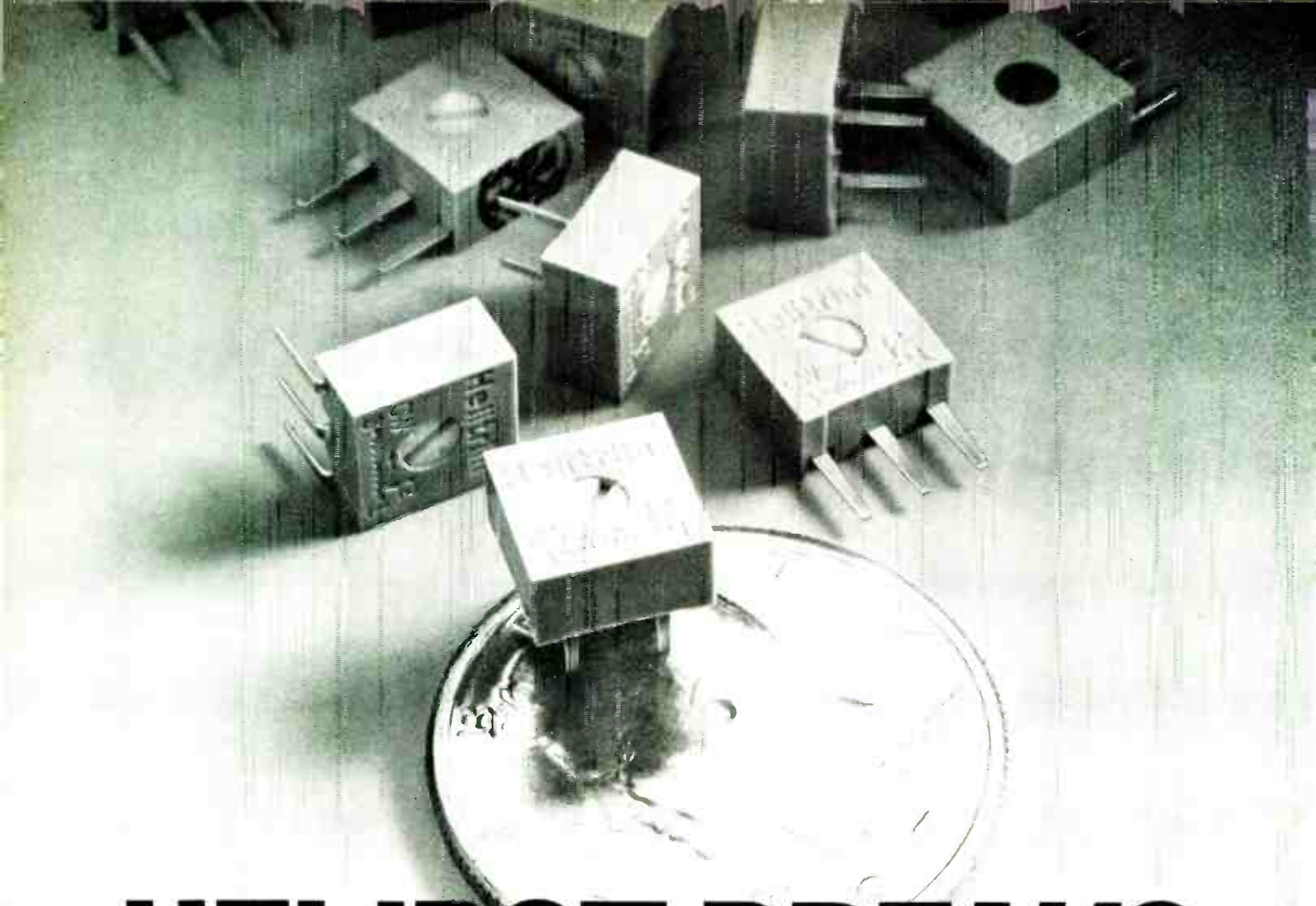
When the first word has been loaded, the memory transfers into the normal state, where it stays until either the registers are full or are again empty. In the normal state the memory can still receive words for storage, but it must synchronize them with previously stored words already circulating in the registers. As each new word arrives, the normal state goes down, to block further push requests until the word actually goes into the data register. When it does so, another 1 goes into the marker register.

Refreshing interval

While in the normal state, the controller periodically generates a refresh signal, which sets the word currently available to the system into the input-output latch. Timing of refresh depends on memory mode. In either case, if the system accepts the output data, it responds to the memory with a signal indicating its acceptance, which the memory uses to insert a 0 in the marker register. (The signal is shown in the diagram as "drop.")

As for specific circuits, in most cases polarities of signals would have to be altered, and additional logic stages inserted, to utilize the levels that particular circuits would provide. For example, the eight shift registers could be implemented with four National MM5017 packages; the output buffers with two DM8551s; the input gates and latches with two DM74L98s; and the two extra latches at the output of the marker register with one DM7474.

The memory design would be much more complicated if Tri-state logic were not employed. The preceding discussion has pointed out some elegant shortcuts made possible by Tri-state circuits, which are available from several manufacturers as second sources. □



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Today's dynamic IC tests won't work without meaningful specs

To obtain accurate and reliable testing of devices at production rates, both manufacturer and end user must correlate their test specifications to simulate realistic operating conditions

by Jack Salvador, *Teradyne Dynamic Systems Inc., Chatsworth, Calif.*

☐ Since very fast digital integrated circuits are chosen primarily for their dynamic characteristics, it's important that they be subjected to accurate dynamic tests. Though this seems obvious, the testing situation is far from cut and dried. In fact, even the best dynamic testers can give meaningless test results. For instance, an IC may pass a propagation delay test even though its actual delay is long or short enough to cause a logic-race condition in the system. The fault lies not in the tester but in the way the tester is used—or misused.

It all points to the fact that test results can be meaningless if the test specifications inadequately define the test conditions, fail to simulate the real applications environment, or ignore the test system characteristics. On top of that, the demands on dynamic testing keep escalating. Today, logic circuits with speeds close to 1 nanosecond are being tested. They are very difficult to check out accurately at production rates unless the capabilities and limitations of advanced dynamic testers, such as those in the system in Fig. 1, are appreciated.

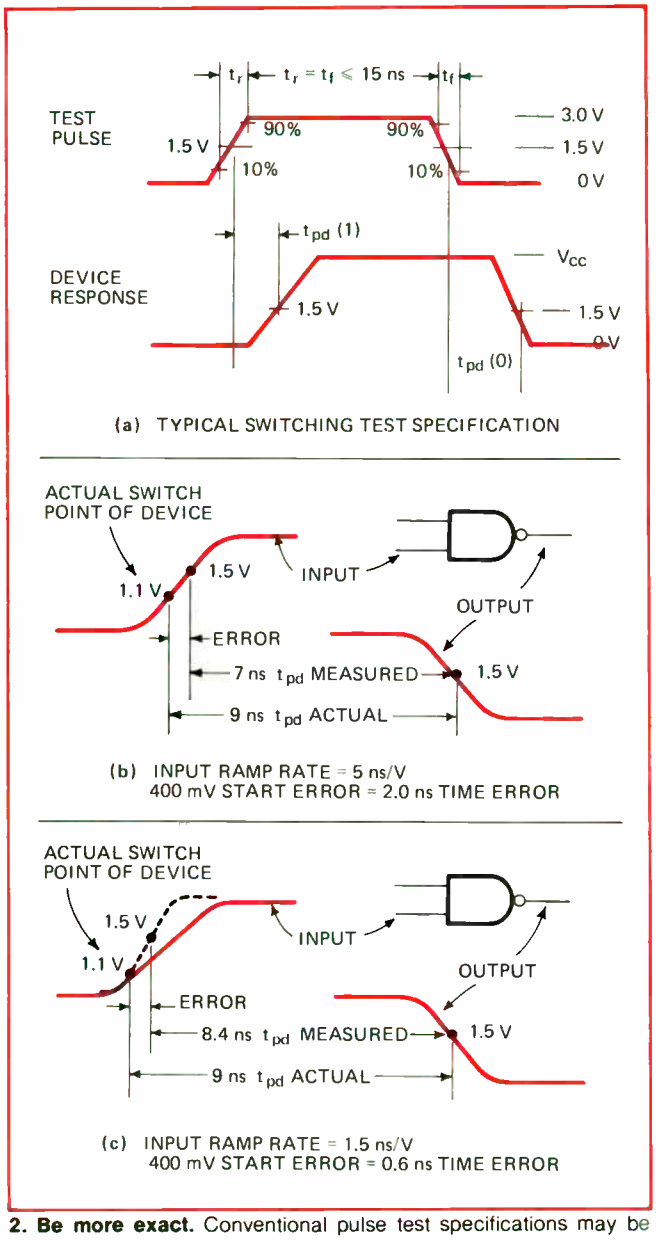
Device test specifications often are written as though the device were to be evaluated under laboratory conditions instead of being tested prior to system assembly. Emitter-coupled logic test specs, for example, sometimes call for an output load of 5 picofarads when the equivalent input capacitance of devices in that IC family is 8 pF. In other words, the test could not show whether a "good" IC would even drive a similar circuit in the intended application. And one device spec even called for "zero shunt capacitance"—no allowance was made for test fixture capacitance.

Ambiguities

Why do test specs sometimes ignore the realities? In laboratory evaluations, it is often desirable to set up special bench tests to determine how a circuit will perform under flat-out conditions. Developers of high-speed transistor-transistor logic seem to prefer 5-to-10-pF loading for evaluation, while the least that can be expected in a practical application or test system is 15 pF. Negligible loads and other specialized lab conditions must be weeded out of device data sheets and production test specifications.

A more prevalent problem is specs that, while reflecting realistic conditions, are so loosely written that a test can be set up to provide a desired result rather than the

1. Real-time tester. Digital integrated circuits with nanosecond switching times are checked at Honeywell Information Systems with this real-time test system. ICs from gates to memories are 100% tested for dynamic as well as functional and dc characteristics in a single pass through the automatic tester at left. The test station at center is a multiplexed unit for dc and functional checkouts.



2. Be more exact. Conventional pulse test specifications may be ambiguous about pulse timing (a). Two pulses, each with a rise time of less than 15 nanoseconds, can result in a 1.4-ns variation in errors in propagation-delay tests (b and c). A specific, fast ramp rate reduces error and makes the test reproducible.

actual circuit performance. Since one tester can make a circuit look fast and another can make the same circuit look slow, the sellers and buyers will wonder where the correlation went. Worse, the user won't really know the dynamic characteristics of his ICs.

Therefore, an essential requirement for accurate dynamic IC testing is correlation between test results obtained by device manufacturers and device users with different test equipment. This cannot be achieved without realistic test specifications. Another requirement is automated equipment with high throughput. To eliminate extra handling and test equipment, both the dynamic or high-frequency tests, and the static or low-frequency and dc tests, should be made with a single insertion of the device in a general-purpose test fixture.

Propagation delay is perhaps the most useful measurement to make on a digital integrated circuit—and, if approached in the right manner, is the simplest dynamic measurement to make. It gives a direct indication of the maximum frequency at which a circuit will operate; it provides the information needed to eliminate race conditions in the logic design.

The delay test should reject circuits that are too slow or that might cause logic-race conditions—the designer has used the delay spec to establish data rates and design against race problems.

Suppose a TTL logic gate with a real propagation delay of 9 ns is to be tested. The IC manufacturer generally specifies the test timing pulse as in Fig. 2(a). Propagation delay is defined as the time between 1.5-volt points on the input and output transitions.

He may say the input pulse rise time shall be "less than 15 ns." If this is taken literally and a test pulse rising to 3 volts at a ramp rate slightly under 5 ns/V is applied, the measured delay will be about 7 ns, as in Fig. 2(b). The gate appears to be 2 ns faster than it actually is because TTL typically switches at 1.1 V, not at 1.5 V.

On the other hand, if the input pulse ramp is 1.5 ns/V, as in Fig. 2(c), the measured delay will be 8.4 ns—1.4 ns nearer the real condition. The manufacturer and user should agree, for good correlation, on a specific ramp rate to make the tests reproducible. With good IC process controls, there should be little variation in the device switch point and thus in the measuring error. Any error that results can be added to the time measurement to obtain a test result close to the actual device delay.

Choosing levels

Another source of ambiguity is shown in Fig. 2(a). Pulse rise and fall times generally are specified as the times between 10% and 90% pulse amplitudes, yet the 0 and 100% levels are not absolute references. In many actual applications and in dynamic test systems, ringing, overshoot, and other distortions will be found at the beginning and end of a high-frequency pulse.

The example in Fig. 3 is the output pulse shapes of an ECL synchronous decade counter. Where are the 10% and 90% levels? Variations of at least 50 to 75 millivolts can be seen where the 0 and 100% levels are supposedly located. A good dynamic test system will detect 10-mV noise signals at very high frequencies, so variations in the references will show up in the test results if the conventional pulse spec is used.

However, note how clean the transitions are through most of their rise and fall times. The correct procedure is to set up the test system to detect specific levels in the transitions, measure the time between levels, and agree to specific test conditions. Then, both IC manufacturer and user will have a correlatable performance measure.

The moral to be followed in dynamic tests is: bipolar switching devices are sensitive to absolute voltage levels, not percentages. A well-designed test system detects levels to test, not measure, device characteristics.

Many dynamic testing problems stem from the basic design and specifications of subsystems in the test system. These must also be understood to make meaningful tests.

The greatest single source of error in most pulse-test

systems usually is the digitally programed pulse generator. For example, pulse delay is traditionally specified from an arbitrary starting time (t_0 in Fig. 4) to the midpoint of the first transition at minimum rise time. But the minimum time may not be used, making the real delay parameter unknown. Good pulse generators are capable of 1-ns rise time, while many device tests require 3 ns.

The ambiguity is illustrated in Fig. 4—the desired delay, and therefore the midpoints of the pulse leading and trailing edges, are not defined. This would prove troublesome when a characteristic such as skew is to be measured accurately, since that measurement depends on the delay between voltage points on two pulses.

In a device such as a large-scale memory IC with several inputs, if the skew tolerance is, say, 5 ns, the input pulses should be timed within 0.5 ns lest cumulative test-pulse errors be larger than the skew tolerance. Further, if times between input and output transitions of the IC are to be measured, the combined uncertainties can leave the IC user completely in the dark as to actual device performance.

The pulse generator spec follows classic practice, going back to the days when engineers put together instrument collections for bench tests. Not knowing the setup, the device, or the fixturing involved in the end use, instrument manufacturers gave the performance limit.

Shaping up

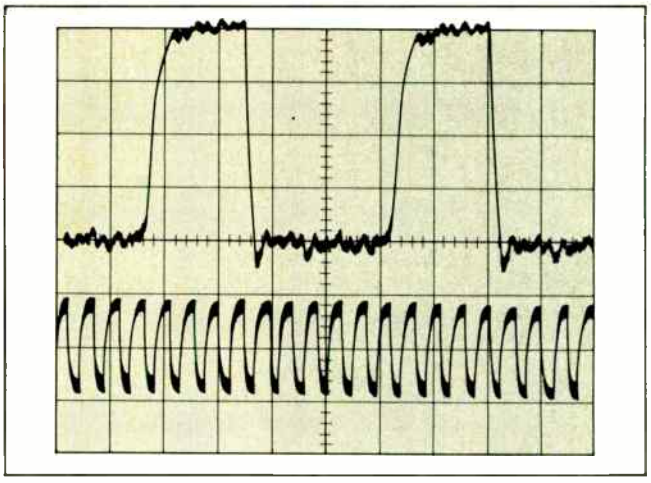
A bench setup can be tuned by adjusting the instruments and watching a scope until the test stimulus applied to the device has the desired shape. This is the procedure followed in many dynamic test systems. The pulse-shape-and-timing spec is written by the device designer. When this spec is used to program the pulse generator, the actual pulse arriving at the device pin is entirely different—it is changed by line delays, line distortions, fixture bandwidth, high-impedance test probes, and other total-system factors. By trial and error, the test programer and the technicians rewrite the program until the right pulse comes out of the test connector or probe. Meanwhile, the test system is down.

The tester manufacturer cannot adjust the pulse generator in advance—he cannot foresee all the changes the user may make in test specs, fixturing, and load boards. The latter are needed to make ac and dc tests. The classic, universal fixture will not take all types of ICs.

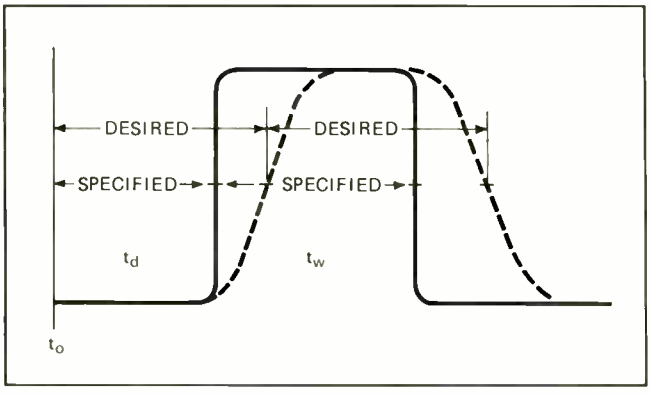
Typically, this fixture has a device socket as its hub, with signal lines radiating out like the spokes of a wheel. The fixture is a compromise, which allows ac and dc testing to a point. That point is reached when the leads become too long. Some devices cannot be tested in the nanosecond region unless leads are shorter than 2.5 inches and unshielded. Try to put together a radial fixture for 40-pin packages and not exceed a diameter of 5 inches—it can't be done.

Nor can longer, smaller coaxial cables be used in many cases—DTL and several TTL families cannot be tested accurately in such a low-impedance environment. And though ECL can drive 50-ohm lines, the pulse degradation problem remains.

What's the solution? In addition to advanced fixture design, the important factor is to use the system's test



3. How high the pulse? Pulse rise and fall times are conventionally defined as the time taken to go between the 10% and 90% amplitudes. But the references at the zero and 100% levels are lost in noise. Times should be measured between voltage levels in the clean regions of the pulse transitions. The upper waveform is the fours ouput of an ECL decade counter at a scale of 200 mV per vertical division, the lower trace is the clock at 500 mV per division; the horizontal scale is 20 nanoseconds per division.



4. Pulse-generator errors. Specifications of pulse generators typically give the delay t_d at minimum rise time, which may be 1 ns. When a longer rise time is desired, the delay is unknown. Error can be avoided by having the test system calibrate the pulse.

capabilities to adjust the signal source programing.

Instead of rewriting test specifications each time system operating conditions are changed, provision should be made for system self-test. A computer in the system makes this fast and practical. The program is written so that the computer analyzes the pulse or other stimulus right at the test socket. Then the computer automatically changes pulse generator settings until the desired pulse is obtained. Like the engineer using a benchtest setup, the computer makes a calibration run before the test run.

Since the stimuli are virtually identical to the test specs, test results obtained by different test systems are reproducible without much program debugging. The results are correlatable even if the specs are improperly written.

The choice between real-time or sampling tests depends on the tests to be made. Experience indicates that real-time testing is more generally applicable. Figure 1 shows a real-time test system. Such a setup makes dis-

crete, digital tests. A gate is triggered by a single pulse, for example, to test propagation delay.

A sampling system basically is an analog tester. It may pulse the gate 500 or 1,000 times so the waveforms can be inspected and measured with a sampling scope or other detector. This type sometimes is preferred because smoothing or averaging techniques can be used to make accurate measurements in a high-noise environment. In principle, the concept resembles the classic integrating techniques for averaging out broadband noise riding on a dc or low-frequency signal.

To make nanosecond pulse tests, the real-time system must have a bandwidth from dc to at least 350 megahertz. For economy, the same system is used to make low-frequency and dc tests. Consequently, it may pick up broadband noise from the low-frequency test responses.

On the other hand, the sampling test may not be able to simulate IC applications. And another major objection is that some types of sampling tests take a relatively long time, slowing throughput. Furthermore, sampling is really a measurement technique rather than a digital test method.

Consider the actual operation of an output buffer in a core memory. Each memory output pulse should put the buffer output in a known state. The buffer gets one, and only one, pulse to make this decision. It does not integrate and sample the pulses.

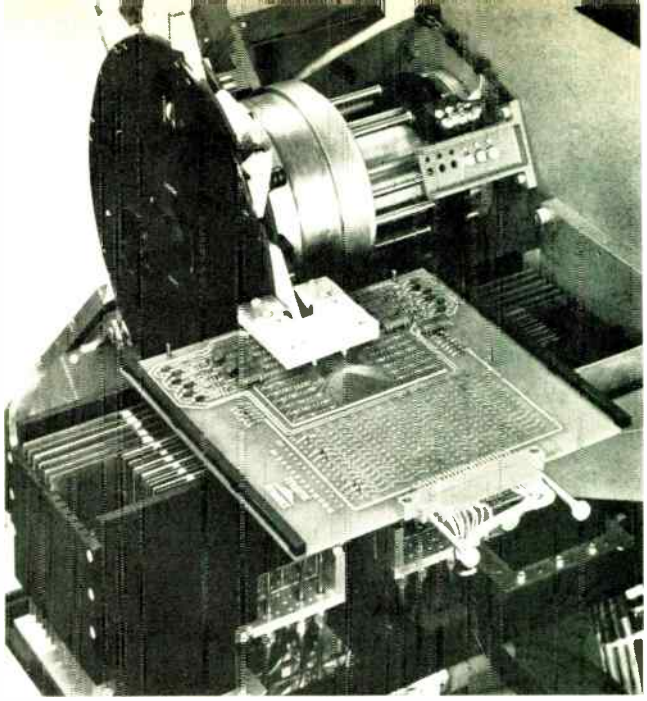
It's true that within a millisecond the buffer may be switched by 1,000 pulses. Repetitive pulsing of a sampling system simulates this and is therefore useful in measuring temperature-dependent characteristics. But the real-time system gives the option of cold or warm tests, or both, in a short time. A device can be tested cold with a single pulse (to represent performance during intermittent operation, for example). Then a train of clock pulses can be applied for as long as desired to reach operating temperature. Finally, the clock can be removed and a single test pulse applied immediately. Note that the rate and duration of the clock pulse may be independent of the test pulse, making test conditions still more variable.

The real-time system also can perform averaging functions. In this configuration, the device is pulsed repetitively and the results of each test statistically averaged by the computer (the digital tests can simulate the analog sampling measurements).

Testing time

Another point to be considered is the time needed to check out an IC that requires a large number of conditioning pulses so that internal states can be set up for a test. Such tests are common in LSI testing. One of the simplest LSI devices is an MOS shift register that has serial entry and serial output. A length of 1,024 sequential stages is typical. To test such a device completely, the register requires 1,024 pulses at a single input before a known state is detectable at the single output. If the register must be recycled many times, the test time becomes long indeed.

A simple binary circuit such as an R-S flip-flop must be toggled repetitively for a propagation delay test in sampling system. Pulses must be applied in rapid alternation to the reset and set inputs. Although toggling has nothing to do with the delay time, two pulse generators must be provided, programed, set up, and debugged.



5. Sorting it out. A tough problem in production-line IC testing is to interface an automatic handler with a nanosecond system while preserving signal integrity. One solution was to use a carefully designed interface to the Daymarc 852 "stick-to-stick" sorter.

The real-time tester applies one pulse to the set input, measures the on propagation delay, pulses the next input, makes another measurement, and continues until the test conditions are exhausted. Since pulses are applied serially, only one pulse generator is needed.

Finally, the test-system user also must recognize the limitations of resolution. The system must look at a noise bandwidth extending to beyond 350 MHz when testing a device such as an ECL circuit, with switching transients on the order of 1 ns. Further, a well-designed system that is flat beyond 350 MHz will also see frequency components in the gigahertz region. These will be attenuated, but they will still affect the ability of the system to reproduce precise measurements. For example, a voltage swing of 1 volt that takes place in 1 ns corresponds to 1 mV/picosecond.

Suppose that a typical real-time test system is expected to have 10 picoseconds as the least-significant digit since 10 ps can be equated to 10 mV in a 1-ns measurement. This means that the entire system is being limited by 10 mV of noise throughout a noise bandwidth greater than 350 MHz. Also, note that 10 ps relates to 100-GHz frequency components.

A fast IC's parasitic oscillations do go to frequencies above 1 GHz. Any oscillation with more than a few millivolts of amplitude will significantly affect the reproducibility of time measurements—they figure in the measurement circuits, the pulse sources, and the IC itself. There is no sure way of precisely measuring and rejecting noise levels of less than 10 mV in the gigahertz region while detecting a very fast digital transition.

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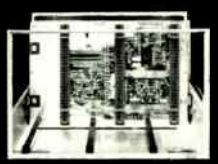

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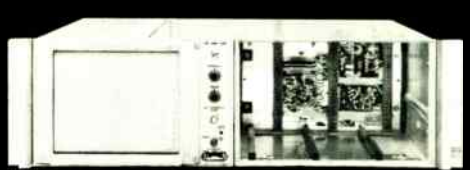

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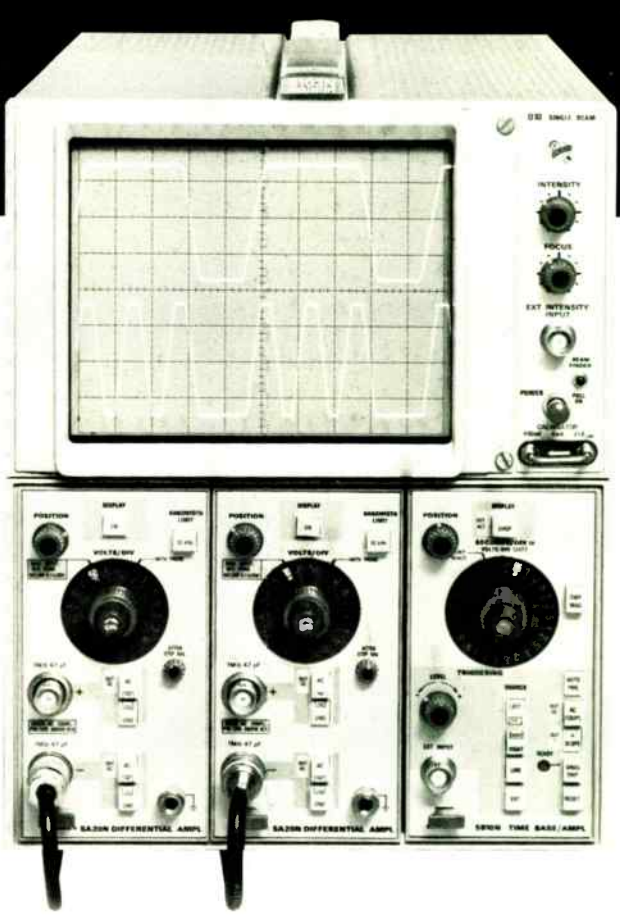

When your applications change, just buy components instead of a complete oscilloscope. Interchangeable display units let you update to dual beam, or storage, or dual-beam storage by simply buying a module—not a new scope. Here's another way to save. When your applications call for a new configuration, you can change these oscilloscopes from cabinet to 5-1/4 inch rackmount and back. It takes only a few minutes and a low-cost kit. And with plug-in flexibility you solve many measurement problems in one mainframe.

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Circle 96 on reader service card

When will Picturephone break out?

Not before switched intercity service is available, say trial users; transmission—link problems must be worked out before costs fall

by Lyman J. Hardeman, Communications & Microwave Editor

With less than 100 Picturephones in actual commercial service, the Bell System's bright star seems to be fading far behind the goal set three years ago by AT&T Chairman H. I. Romnes of 1 million subscribers by 1980. In fact, some sources predict that it will take over 20 years to get Picturephone into homes. The chief reason offered so far for Picturephone's lagging progress is "a depressed economy," but looking ahead, the biggest question seems to be whether the service will catch on when the economy improves.

The answer to that question depends on when intercity switched service will be available and how it will be achieved; whether technological problems in making the equipment and in reducing bandwidth requirements can be overcome and whether Picturephone service charges can be justified.

Field trials for intercity links have been technically successful, but user demand was so light that the maintenance costs did not warrant commercial service. And AT&T has retracted its application with the FCC for intercity service.

Another reason for AT&T not going intercity with Picturephone is that New York State's Public Service Commission has rejected the telephone company's bid to initiate the service in New York City. Without being able to connect to the city—headquarters of many giant national corporations—Picturephone may remain more of a novelty than a practical communications tool.

The 100 Picturephones in commercial switched service are in Chicago and Pittsburgh. In an attempt to get subscribers, Illinois Bell cut tariff rates by 50 percent. Intracity switched service was set at $75 per month ($50 for line service and $25 for the set rental). There is no installation charge, and additional sets can be connected for conference or intercom use at $25 per unit; this

The station set. The Picturephone set consists of four units, including the standard pushbutton telephone, display unit, and control unit shown. A fourth service unit (not shown) contains the low-voltage power supplies, control circuitry, and the station set equalizer.

monthly charge includes 30 minutes of free use. Additional use costs 15 cents a minute.

Though Bell refuses to estimate what charges will amount to in widespread use, one guess from industry sources is $30 a month.

But despite this active marketing effort, Illinois Bell claims only 37 working stations representing 16 customers. The company does have orders for 113 more units, most of which are planned for installation by year-end.

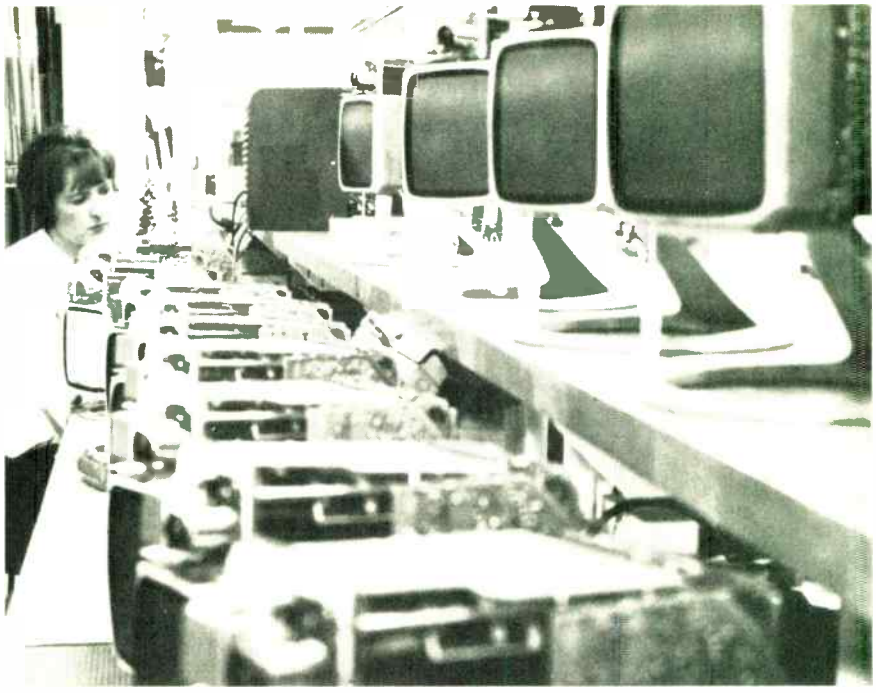
Go intercity, young service. The first users represent a cross-section of businesses. The list includes law and real-estate firms, hospitals, television stations, publishing and printing companies, and industrial corporate headquarters. The users in Chicago and Pittsburgh have been creative in uncovering new applications for video telephones.

But they still believe Picturephone will have to go intercity before it really takes off. Officers at Hartnutt-Show and Associates, a national real-estate company with headquarters in Chicago, use Picturephone six to eight times a day, averaging over five minutes per call, according to Stephen Sanders, a spokesman for the firm. Most calls are between the president or the chairman and the firm's law offices located in another part of the city.

"We would love to be able to talk to our branch offices in La Jolla, Calif., via Picturephone," says Sanders, "A live on-site view of our condominium project there would eliminate a number of trips to the site by our board chairman."

WLS-TV in Chicago has also found interesting applications for Picturephone. "We were the first to use Picturephone on television," claims Squire Rushnell, the station's programs manager. "We have a morning talk show where viewers can call in and participate," he says. "Previously this show was done by voice only. Now, with several Picturephone terminals installed in public places, viewers can call in and their expressions, as well as their voices, can be captured."

While this may be a novel role, another use of Picturephone in the television industry may be more important. With intercity service, a local TV station could call a Congressman, for example, for a live interview on the evening news.



Assembly line. Over 1,000 Picturephone sets (very low volume by AT&T standards) have been assembled and tested at Western Electric's Indianapolis plant.

Technology. Picturephone is one of the most complicated instruments ever aimed at widespread use. It must not only transmit and receive good-quality TV images, but it must operate as reliably as the telephone under varying temperatures and be able to withstand the hazards of subscriber abuse.

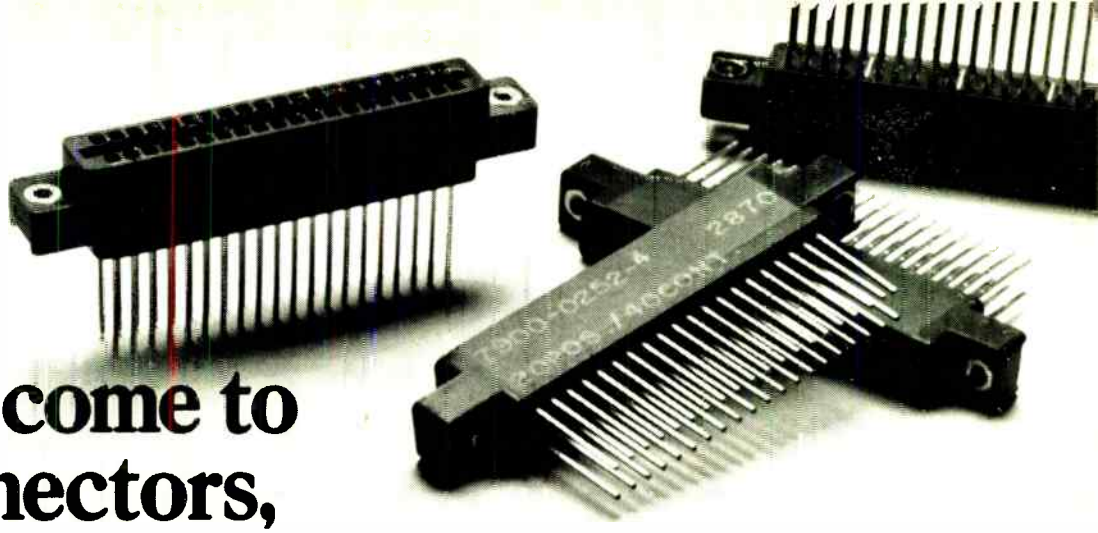
Even though the system has been in development since 1964, there are still difficulties with transmission and terminal requirements. According to William Cagle, who heads Picturephone development at Bell Labs, Holmdel, N.J., the stickiest technical problems do not concern the station sets, but the switched transmission links that connect these sets. While the intercity links are technically feasible, they may be prohibitively costly for many users.

The transmission plan considered most feasible by Bell uses digital links for the long-haul portion of the network and analog links for the short-haul sections connecting the customer to the local exchange office. Analog transmission for these short lengths uses 2 sets of wire pairs for video (one video signal in each direction). Voice is transmitted via conventional means. Pulse code modulation must be used, says Cagle, to maintain the required picture quality over long distance. Since the transmission lines are costly, sophisticated and expensive terminal equipment can be justified to reduce the signal bandwidth.

An analog Picturephone signal uses 1 megahertz of bandwidth, about 250 times the 4-kilohertz channel used for voice circuits. After PCM coding for long-distance transmission, the video signals require about 100 times the bandwidth of the coded voice signal. Techniques are being studied to reduce this factor even further so that the PCM signals may be carried at a 15-megabit-per-second data rate.

Spokesmen at Bell believe that with volume Picturephone use, its long-distance rates can be reduced to about 10 times that of the telephone.

One problem in manufacturing Picturephone has been magnetic deflection camera tube using an array of silicon diodes as the sensing elements. [*Electronics*, Jan 19, 1970, p. 131]. "Reproducibility problems in manufacturing a silicon target camera tube haven't been easy to overcome," says Cagle. "But the serious problems are solved." □



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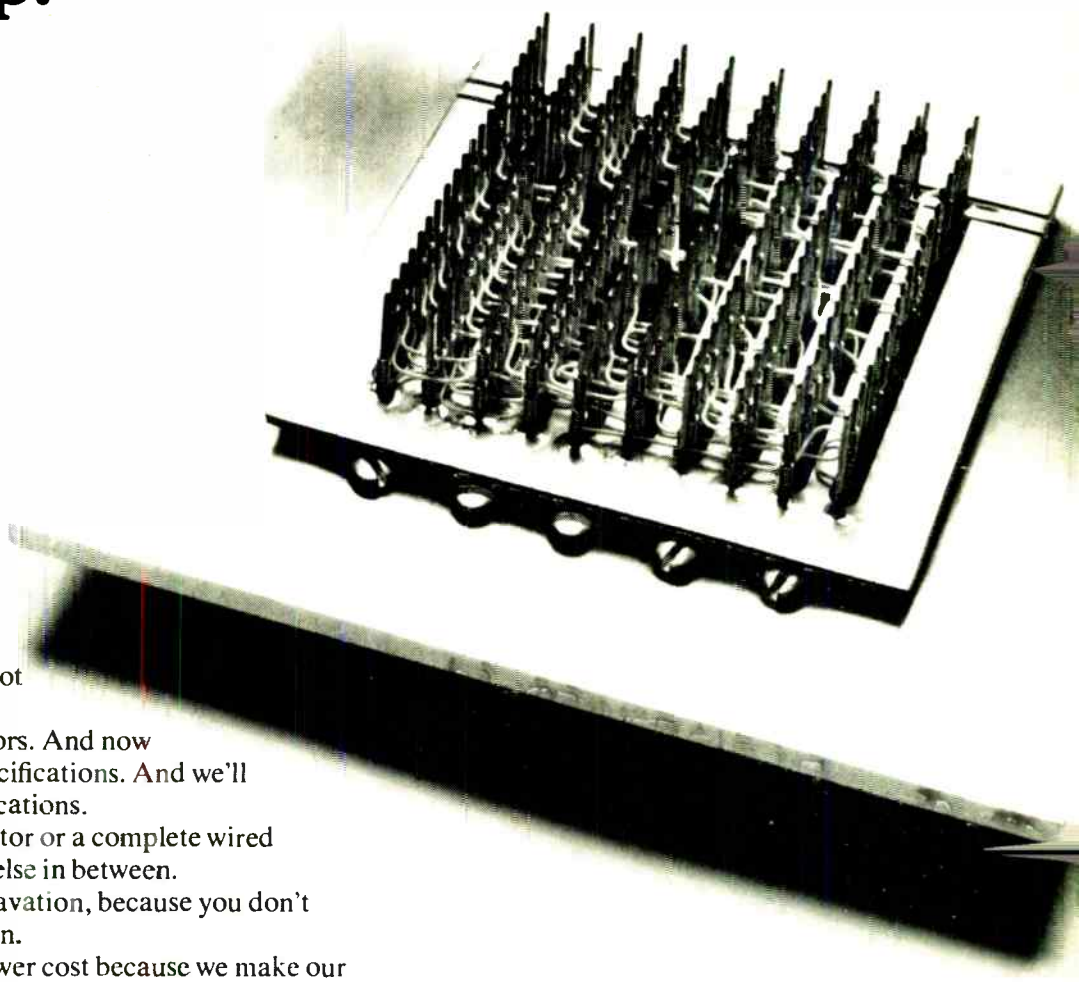

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Circle 99 on reader service card

Commercial electronics

'And leave the designing to us'

Lambda Electronics provides free custom power-supply designs if customer buys the parts from the firm and does his own assembly

by Alfred Rosenblatt, New York bureau manager

Custom design is a get-what-you-pay-for proposition at most electronics companies: to obtain special features they have to incur special design costs. Dissenting, however, is Lambda Electronics Corp., Melville, N.Y. That long-time manufacturer of off-the-shelf power supplies will throw in custom design and engineering free, provided the customers buy Lambda-furnished parts and assemble them themselves.

This new approach is geared toward capturing the custom power-supply business Lambda has long ignored. With sales of about $15 million, it figures it is the largest maker of off-the-shelf supplies.

And the custom business it's now after, says Merrill Simon, Lambda's marketing vice president, is "very, very big," bigger than the test equipment, laboratory and breadboard markets combined. He estimates that altogether, power supplies built in-house and by custom suppliers for makers of all types of electronic original equipment are worth anywhere from $300 to $500 million yearly. This size is the reason why Lambda is expanding its assemble-it-yourself standard supply kit program introduced about a year ago to include custom units.

Requirements. The parts charge alone, says Lambda, will cover such special design requirements as multiple output voltages and currents, regulation, ripple, and form factor. The firm will design circuits, make thermal design calculations, and develop a components layout to assure operation at a safe temperature.

Lambda is betting that it can handle its custom orders routinely and swiftly, relying on its 23 years experience in designing its own standard units. Simon notes that power supply design requires the cooperation among circuit, mechanical, and thermal engineers.

"Many companies can't afford to keep one full-time supply designer on staff, let alone three," he says. "That's why they turn to outside help." Lambda didn't want to sell custom supplies in the usual way. "We'd just have to be cheaper and it would be hard to beat the guys already in the business."

You do it. Merrill Simon has Lambda tackling do-it-yourself custom power supplies.

At present, output limits in Lambda's kits are set at about 150 volts dc and currents of 25 amperes dc for regulated lines, and 50 A for coarsely regulated lines. Input may be any of the 50- and 400-hertz and 110 and 220-V power systems usually available.

The upper limits on the outputs coincide with the operating ceilings of the components Lambda has been using in its standard supplies, particularly of the integrated circuit hybrid regulators Lambda has been offering since spring [*Electronics*, March 15, p. 123]. "Without the hybrid regulator, you might as well forget about the whole thing," Simon says. This single device replaces as many as 60 discrete components, he points out; without it, it would be impossible to custom-design a system with so many parts at no charge.

Savings. As for his customers' advantages, Simon notes that equipment manufacturers will save money because they won't have to pay for the value added plus profit to an outside supplier. What's more, the manufacturer will have better control over his production—he won't have to worry about a supplier meeting delivery dates. And with a short lead time, the customer will be able to respond quickly to fluctuations in sales volume, so that he won't be stuck with a shipment of assembled supplies arriving after a decision to curtail production.

Simon also points out that Lambda will be providing parts it orders "in tremendously large quantities" for its standard line of supplies. Consequently, it will be possible to pass on to custom-parts customers the cost savings incurred

by ordering parts in large volume.

Lambda's competitors have other views. At Kepco Inc., Flushing, N.Y., a spokesman says that firms specializing in building power supplies can do the job for considerably less than companies whose forte is assembling other systems.

James R. Bright, director of sales at the Electronetics division, North Electric Co., Galion, Ohio, another Lambda competitor, agrees, especially for production runs in the thousands of units which could be where outside suppliers will continue to have the advantage. He says his custom supply customers would generally realize a greater return on their labor dollars if they devoted them to manufacturing their particular line of equipment, rather than power supplies.

But Lambda counters that cost savings may still be great enough to warrant in-house assembly. Another factor to be considered, according to Bright, is that the OEM's dollars may be unnecessarily tied up in parts during the time it takes to receive them, put them into stock, and move them out to the assembly floor. Ordering completed supplies, delivered when needed, could prevent this, he feels.

Quotes. Yet, Lambda has been quietly pushing its idea since June, and the company has quoted on at least a hundred different systems, says Simon. Customers include manufacturers of communications, medical electronics, peripherals, and cable television gear.

One buyer is Intercontinental Services Inc., Sparks, Nev. Edward J. Trent, assistant general manager, claims he will save more than $400 on each supply his company assembles. Intercontinental, a 23-man operation with a five-man assembly shop, manufactures keno ticket-issuing machines for casinos. The company ordered 100 custom kits and expects a production run of 400 to 500 machines.

Cost of parts for each supply, which includes two transformers providing five regulated and three unregulated outputs, is $280; projected assembly cost is $50. An additional $12 per supply is for power transistors Trent is buying himself. Separate off-the-shelf units supplying the outputs would have cost close to $1,100, Trent says. And the quotes received from custom houses "invariably" were in the $700 to $800 range, he adds.

Work-maker. Trent says assembly of the power supplies is an "ideal time filler for slack periods." Alan Selin, a test supervisor at the Instrument division, Perkin-Elmer Corp., Norwalk, Conn., also cites this as a reason for building his own power supplies. Selin says his company is considering putting Lambda custom do-it-yourself kits in some of its atomic absorption gear.

Still another reason is cited by an engineer at Hughes Aircraft Co., El Segundo, Calif. He needed about two dozen power supplies for prototype ground receivers and went to Lambda because he wanted to "use their expertise in picking components. We're in the microwave business, not in the power supply business," he points out, adding that his requirements were very similar to what Lambda was already offering in a kit form.

A similar sentiment is held by T.J. Meloro, a supervisory engineer at Bendix Corp.'s Navigation and Control division, Teterboro, N.J. He's "considering" purchasing Lambda-supplied parts to fit a custom design for his company's BDX-9000-series of commercial ground-based digital computers. Like the Hughes man, Meloro says he's in the computer design business and would rather not devote manpower to designing supplies, or even to selecting the proper components.

Confidence. He trusts Lambda's experience in handling these chores and describes its approach as offering him something halfway between an off-the-shelf supply and a fully customized design. And he adds: "We'll get a custom design without having to pay for the design labor and the extra cost of designing something from scratch." When it comes to building the power supplies, Meloro will schedule the work in with the assembly of the rest of the computer.

Lambda's Simon calculates that production runs as low as 25 pieces could justify the engineering his company is ready to provide with the power supply kits. Just where the economical upper limit lies, though, varies from case to case. □

Commercial electronics

Point-of-sale gear set for takeoff

Makers of retail store electronic terminals, cash registers, and coding schemes are ginning up for push that could bring $650 million market by '75

by Paul Franson, Dallas bureau manager

Electronic point-of-sale equipment is moving at last. Already, 7,000 terminals are operating and makers now expect to convert a goodly number of cash register rings into steady electronic hums by 1975. Despite the cautious trial-and-error approach taken by retailers and the lack of standards (see "Standards: Point of Contention," p.105), some 170,000 units worth $650 million are expected to be humming away by 1975, according to research by Dean Witter & Co., New York City.

Right now, five major companies dominate the point-of-sale market—Unitote, Singer-Friden, NCR, Pitney Bowes Alplex, and Litton Industries' Sweda division. Singer-Friden, New York City, scored a major coup with an order for 19,000 terminals from the Sears, Roebuck organization, and the success is not lost on other electronic companies, including IBM, which are carefully eyeing the point-of-sale equipment market.

Retail stores are now looking closely at what point-of-sale equipment can do and what it costs. Conventional cash registers cost $2,200 to $4,600, but prices of electronic units are more difficult to determine: A terminal that lists for $1,900 may end up costing $9,000 installed with all the required telephone lines, back-room computers, and other equipment. The registers alone are generally in the $3,000 to $4,000 range, with some of the equipment costing $5,000.

There seems to be general agreement on what the retailer wants: "We'd like complete merchandise tracking, on-line credit checking, full management information, and reliability—at the same price as a conventional register," says Irving I. Solomon, vice president and manager of the Information Systems division of the National Retail Merchants Association. And he adds, "nothing is available that does that." Roy Burns of the Dayton Co., Minneapolis, operator of the Target Discount Stores, agrees. "The real incentive is increased information."

Where it's at. The terminal itself is only the beginning, the "tip of the iceberg," says C.S. Adams, vice president of Litton Industries, and head of the group that includes Sweda, of Orange, N.J., and Stockholm. Litton is working on other aspects of information for retailers: point-of-receipt terminals for merchandise and management systems.

The company's complex terminals are virtual minicomputers with two-way telecommunications capability for credit verification, management reports, and maintenance of customer accounts. Electronic cash registers, too, are expected to take off, but this market is hard to pinpoint because significant sales and installations have been made only in this year.

Point-of-sale terminals have been in use since at least 1962, when Unitote started installing its models. These registers used electromechanical relay logic, and resembled conventional cash registers.

The next step up is typified by the Singer-Friden store-and-forward system, which stores data on a tape that is polled automatically by a

More than a cash register. The Olivetti AR 600 point-of-sale terminal reads customers tickets, records sale, and checks credit instantly.

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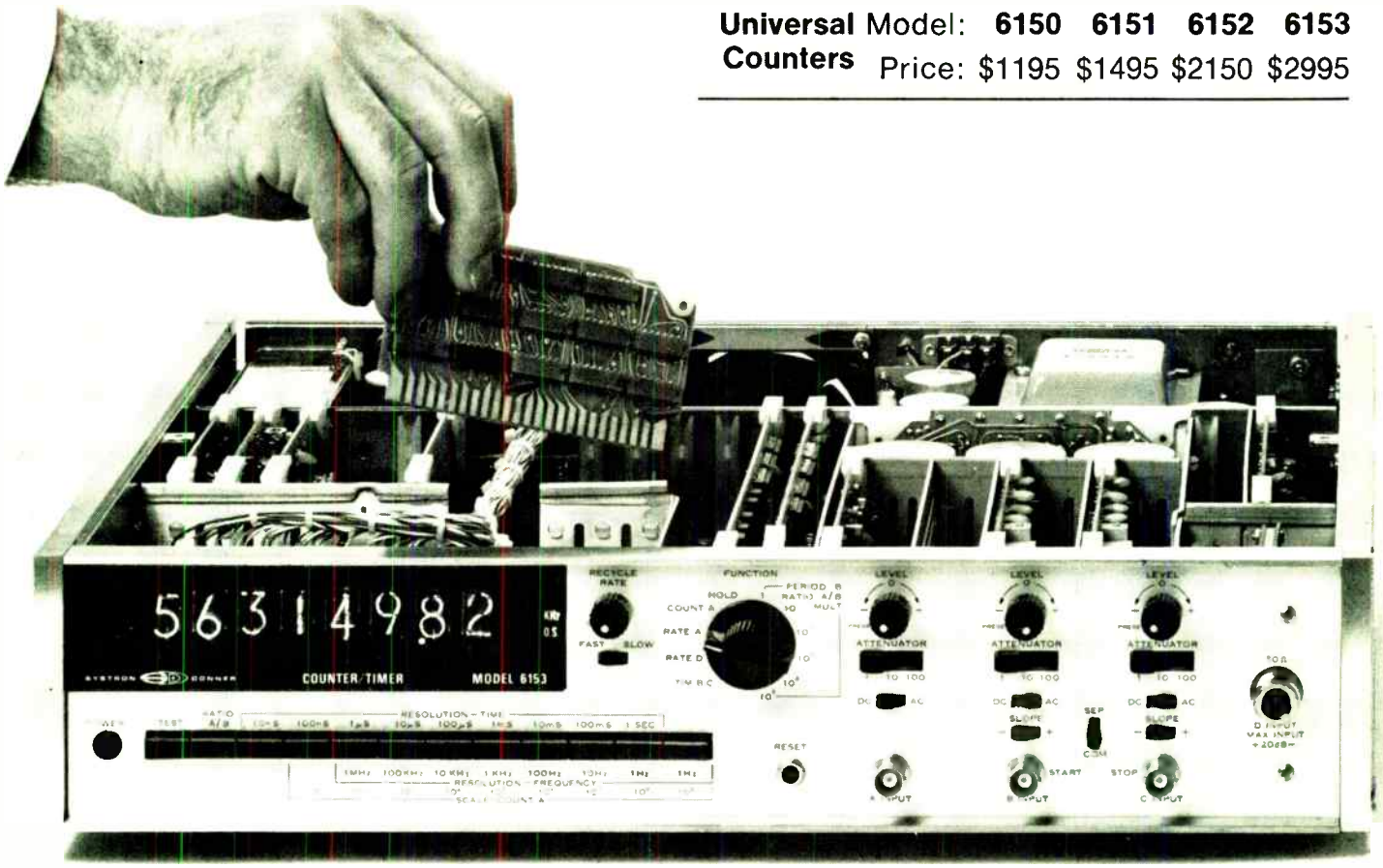

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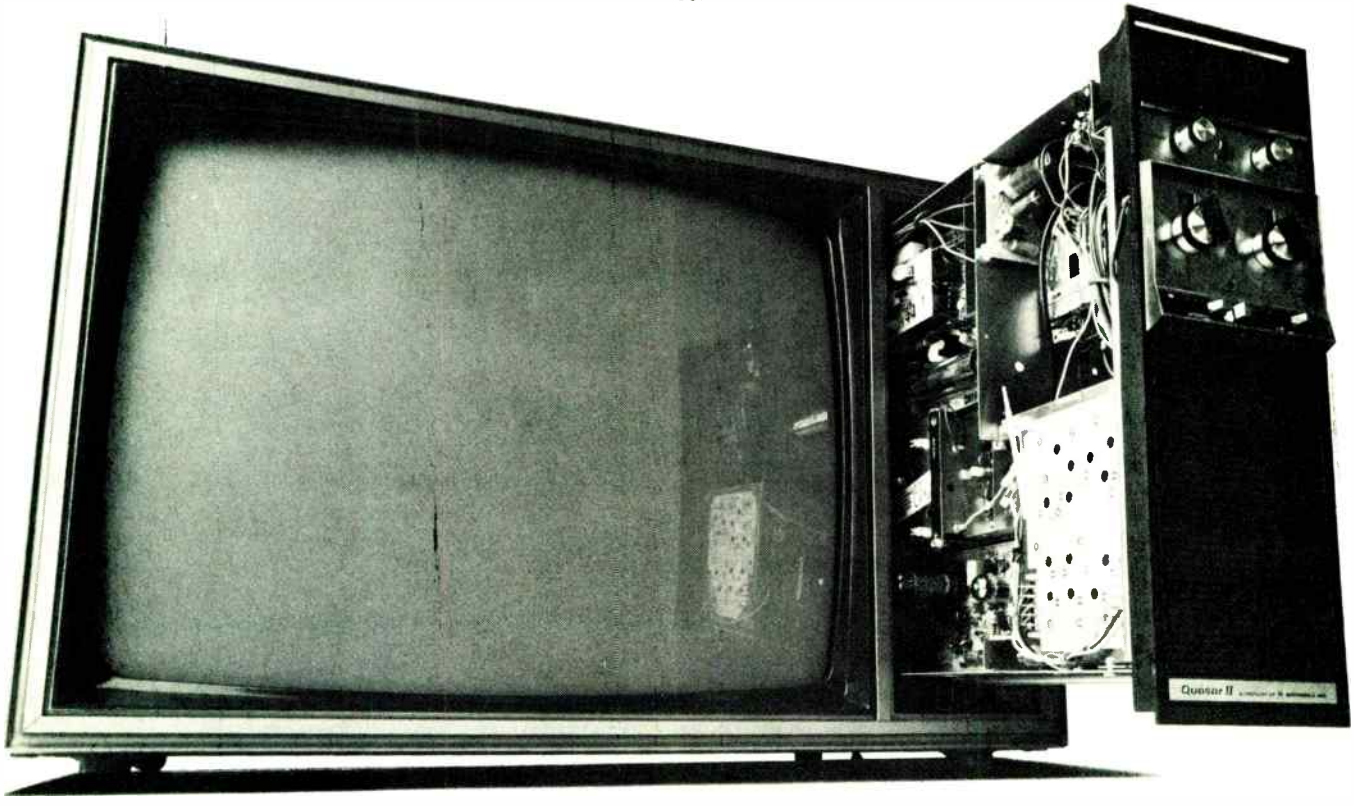


central computer after business hours. These registers can provide vital management information, and if desired, data for billing customers with credit at the store. But they cannot give on-line credit checks.

A variation of the stand-alone register with the individual recorder permits a number of independent registers to share a single recorder that can be polled or operated off-line. NCR, Dayton, Ohio, is a proponent of this approach, but the company has also introduced a cassette recorder usable with a single machine. Singer-Friden and Sweda have similar systems. All can be adapted for credit checking.

For stores with many cash registers, a minicomputer with memory and central credit files can provide considerable information to the local manager, and greatly reduce the number of communications to the central installation as well as the amount of mainframe time. All of these registers stand alone. Completely computer-controlled registers, however, cannot operate alone—or at least they have very limited capability without their controller to tell them what to do.

A must: Reliability. The major questions about computer-controlled registers concern reliability: a merchant cannot afford to have his cash register quit, even for an hour, if that hour is on a Saturday just before Christmas. Here, minicomputers look best: They are readily adapted to simple changes in operating procedures and are relatively inexpensive since the logic and operating memory of the minicomputer are shared among many terminals, while the stand alone-terminal must contain its own. However, recent developments in inexpensive computers, calculators on a few MOS chips, and inexpensive MOS memory may reduce very rapidly the advantage of minis. For example, North American Rockwell Microelectronics Corp., Anaheim, Calif. recently announced a set of MOS chips designed for cash register use; other MOS firms are known to be quite interested in the business [*Electronics*, Oct. 25, p. 26].

These new cash registers hold a lot of electonics: MOS and TTL, plus older DTL and discrete parts. Singer-Friden's machines, which have wide acceptance, make extensive use of MOS RAMs and ROMs, plus TTL. Singer-Friden depends on standard parts rather than custom, and apparently National Semiconductor Corp., Santa Clara, Calif., has the lion's share of the business. NCR uses many custom parts—about 150—in four-phase MOS logic using older processes. General Instrument Corp., Hicksville, N.Y., supplies most of the MOS, with NCR's in-house facilities providing second-sourcing as well as the design.

The Sweda terminals now use TTL, but are in the process of converting to MOS, including some large ROMs. Advanced Retail Systems, the engineering development and manufacturing group of Litton that makes the terminals, is considering a number of sources, but American Micro-systems Inc., Santa Clara, Calif., and Mostek, Dallas, Texas, seem likely to share the work.

Coding. To take full advantage of the capabilities of electronic cash registers, manufacturers must use machine-readable price and stock tags, credit cards, and employee numbers. Small punched tags (Kimball tags) have been in use for many years and are the standard in about 80% of all major department stores, but other schemes seem destined to replace them. Kimball itself, a division of Litton, has developed magnetically coded tags that can be read with a hand-held wand.

Other major companies have decided on optical coding of tags and credit cards: NCR is "strongly committed" according to a spokesman, to its three-color (black, white and green) coding. But one problem has been that this tag requires an expensive encoder, but NCR has just announced some less-expensive units suitable for store use.

Pitney Bowes Alpex has its tag, too: it has black-and-white bars that can be prepared inexpensively, and can also be easily preprinted on merchandise packaging. And just to round things out, IBM, Armonk, N.Y. recently showed a black-and-white scheme it calls Delta Distance Coding. And though it's a little difficult to believe that IBM developed it just to be nice to the industry, IBM still will not comment on whether it will jump into the retail point-of-sale marketplace. □

Standards: point of contention

While business has perked up for retail point-of-sale systems, there still remains a nagging problem of standardization in this neo-industry. Five committees are working for over two years under National Retail Merchants Association sponsorship to hammer out specifications for exactly what store owners need.

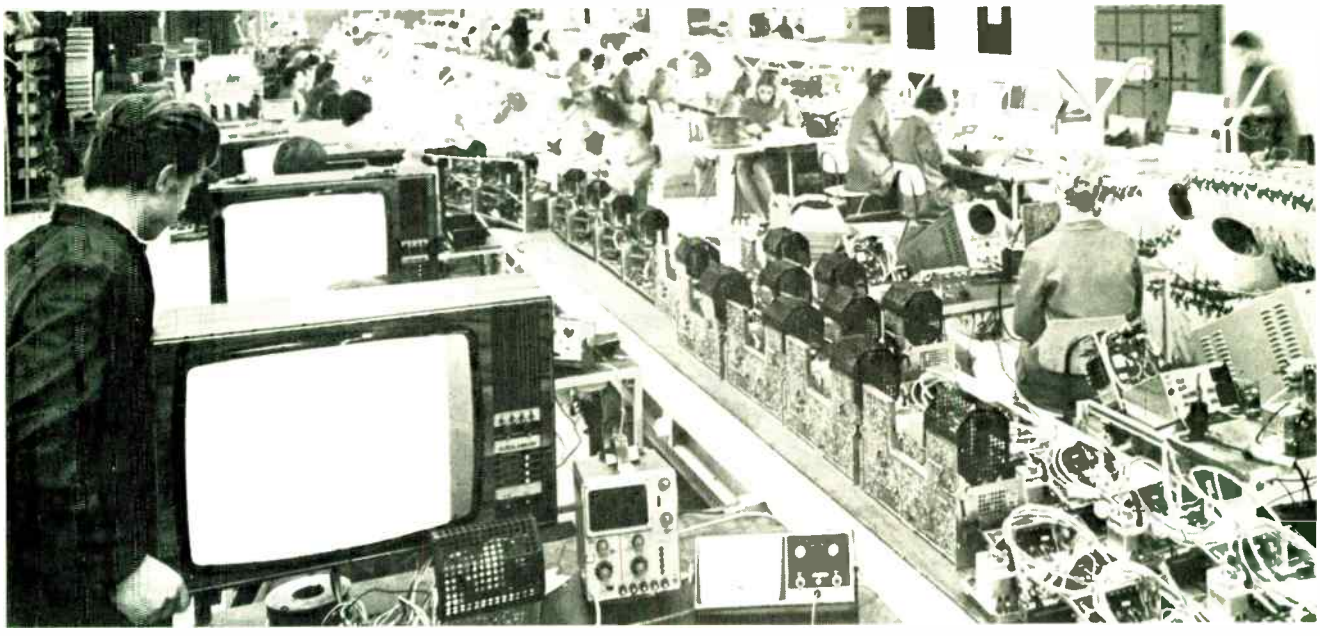
So far, the many divergent approaches vying for leadership have prevented NRMA from coming up with the answers. One rub is in coding—NCR has a three-color optical bar tag with complete equipment to run a dedicated system, Pitney-Bowes Alpex has a two-color optical bar system, and other manufacturers are spread out between punched or magnetic tags. Retailers, caught in a storm of sales rhetoric, are playing it cool. Just about every major chain is evaluating more than one possibility.

And the result has been a cautious trial-and-error period. Irving Solomon of NRMA says the systems specifications are coming to a head so that in approximately two months, requirements for point-of-sale equipment should be in their final stages. How these specs will accommodate the varied—and incompatible— systems remains to be seen.

Echoing the manufacturing view, Owen B. Garner, vice president, Market Development division of NCR, advises, "Total systems must be planned, not individual pieces of equipment. Only then will new technologies be compatible with present equipment."

However, Robert Shinberg, director of research systems for Bloomingdale's New York, counters, "Do you have to marry one bride? The questions of free-standing vs dedicated terminals, number of digits per tag, how much information to collect, and how much to leave still have to be researched."

Once this logjam is cleared, however, Garner predicts, "there won't be a retail store that will buy an electromechanical cash register instead of an electronic terminal."



International

Finnish electronics rides sales wave

Native companies enjoy soaring sales of goods ranging from color TVs to process control gear, with high percentage exported

by Robert Skole, McGraw-Hill World News, Stockholm

While the electronics industries in the U.S. and parts of Europe are in the doldrums, brisk trade winds are keeping electronics in Finland on a steady course, with some companies reporting gains in sales volume of 65% a year or better. Finland is exporting TV sets to Britain, process control equipment to the U.S., and telecommunications and factory automation electronics to both Eastern Europe and the West.

With highly developed mining, metalworking, shipbuilding, pulp, and paper-making industries, and with a we-can-do-it-better national attitude, it has not been difficult for the Finns to zero in on special areas and come up with some highly competitive products. And with a limited domestic market (Finland's population is only 4.7 million), the Finns have concentrated on products with export potential.

Moreover, because wages in Finland are relatively low—an assembly line worker earns about a dollar an hour—companies can keep competitive in the European market. (In Sweden, the highest-wage nation in Europe, an assembly line worker earns about $2.50 an hour.)

At Salora Oy in Salo, central Finland, sales growth has nearly doubled in recent years. This year, sales are up "only" about 65%. Salora Oy is the nation's leading entertainment electronics firm and the second-largest TV maker in Scandinavia. The company's sales last year were about $15 million, compared with $9.5 million in 1969.

Color TV moves. Salora Oy is very strong in TV receivers. It has about half of the black-and-white and color TV market in Finland, and exports about 60% of its total production. This year the company will make about 110,000 TV receivers, 50,000 radios, and 1,000 radiotelephones. About half of Salora's 35,000 color TVs will go to Tele-Rent of Great Britain, a TV renting firm owned by Granda TV System. "We have no marketing problems on the color side," says Pentti Immonen, Salora's information director. "Our entire capacity for next year is sold out. Granda will get about 20,000 color sets— they'd like even more, but so would our other customers."

At the American Mining Congress meeting in Las Vegas last month, one of the exhibits drawing considerable attention was a Finnish on-line X-ray analyzer for use in ore-processing plants. The maker, Outokumpu Oy, is confident the system can pay for itself within a matter of months in some big mines, even by scoring an improvement in ore recovery of as little as 0.5%. The machine automatically analyzes six elements in 14 continuously flowing slurries, and it can be tied in to a computer-controlled system for complete closed-loop operation. It sells for $250,000.

Outokumpu Oy is Finland's huge state-owned mining company,

From RCA... RF Tube/Cavity Combination for 1 kW VHF-TV Translator Service

The RCA-8792 Cermolox® Tube/Y1167 Cavity combination, now available, is recommended for 1kW VHF-TV translator service.

8792/Y1167 provides 12 dB of gain with a third order intermodulation distortion product of greater than −50 dB at 1000 watts in VHF-TV translator service. Designed especially for such service, this compact combination can introduce as much as a 4-to-1 savings in plate dissipation alone. Think of the lowered operating costs per hour!

RCA-8792 is a tetrode that has surpassed the stringent linearity requirements while operating with less than the rated 1500 watts of plate dissipation—desirable performance for translator service. The tube is equipped with an efficient, forced-air-cooled radiator which reduces blower noise problems and increases system efficiency. Its sturdy matrix cathode increases system reliability, too—a feature that is ideal for unattended locations.

Y1167 is a cathode-driven, double-tuned, coaxial cavity designed especially for use with the 8792. In translator service, the module amplifies both visual and aural signals.

For more information on RCA tube/cavity combinations, see your local RCA Representative or your RCA Industrial Tube Distributor. For technical data, write: RCA, Commercial Engineering, Section 70K-8/ZR6, Harrison, N. J. 07029. International: RCA, Sunbury-on-Thames, U. K., or 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P. O. Box 112, Hong Kong.

RCA

Probing the news

which has its electronics research laboratories outside of Helsinki. The company got into electronics when it needed instruments for its own ore-processing plants in the mid 1960's. An early product, a metal detector, designed to locate stray metal pieces in ore, has been redesigned and is now used at airports as a weapons detector.

At Helsinki's Nokia Oy, a conglomerate that is Finland's second-largest company, outstanding orders in the electronics division at the end of last year amounted to about $9 million, more than total net invoicing for the entire year. Nokia also makes control systems—for paper and pulp, power plants, oil reserves, and shipboard automation—and remote control systems for power networks. It also produces data logging equipment and industrial measuring instruments.

Wanted: U.S. engineers. Nokia is planning to build a large factory outside Helsinki for its electronics division and officials are looking for topnotch American electronics engineers with broad research, development, marketing, and management background. "We want to get fairly big quickly, so we can have more funding for development work," says a company spokesman. "Right now we are looking for some top U.S. electrical engineers, preferably some who have had line experience and responsibility."

Many electronic firms tend to specialize. Elektronikikkayhtymae Oy, for example, specializes in weighing and batching control. Oy Labko AB makes measuring control and alarm systems, while Wallac Oy is in nuclear electronics, producing liquid scintillation counters, radiation monitors, and isotope measuring instruments. Philips Gloeilampenfabrieken of the Netherlands has a plant in Finland making hi-fi equipment, primarily stereo amplifiers and fm receivers.

Nokia Oy got into the electronics business, as its marketing man puts it, "because we wanted to have something to connect our cables to." Nokia was organized in 1967 by the merger of a paper and pulp firm, a rubber company, and a cable works (the cable unit had formed an electronics division in 1967). This division will have sales of about $15 million this year, compared with $9 million last year. Some 30% of sales are on export markets, with the major single customer the Soviet Union.

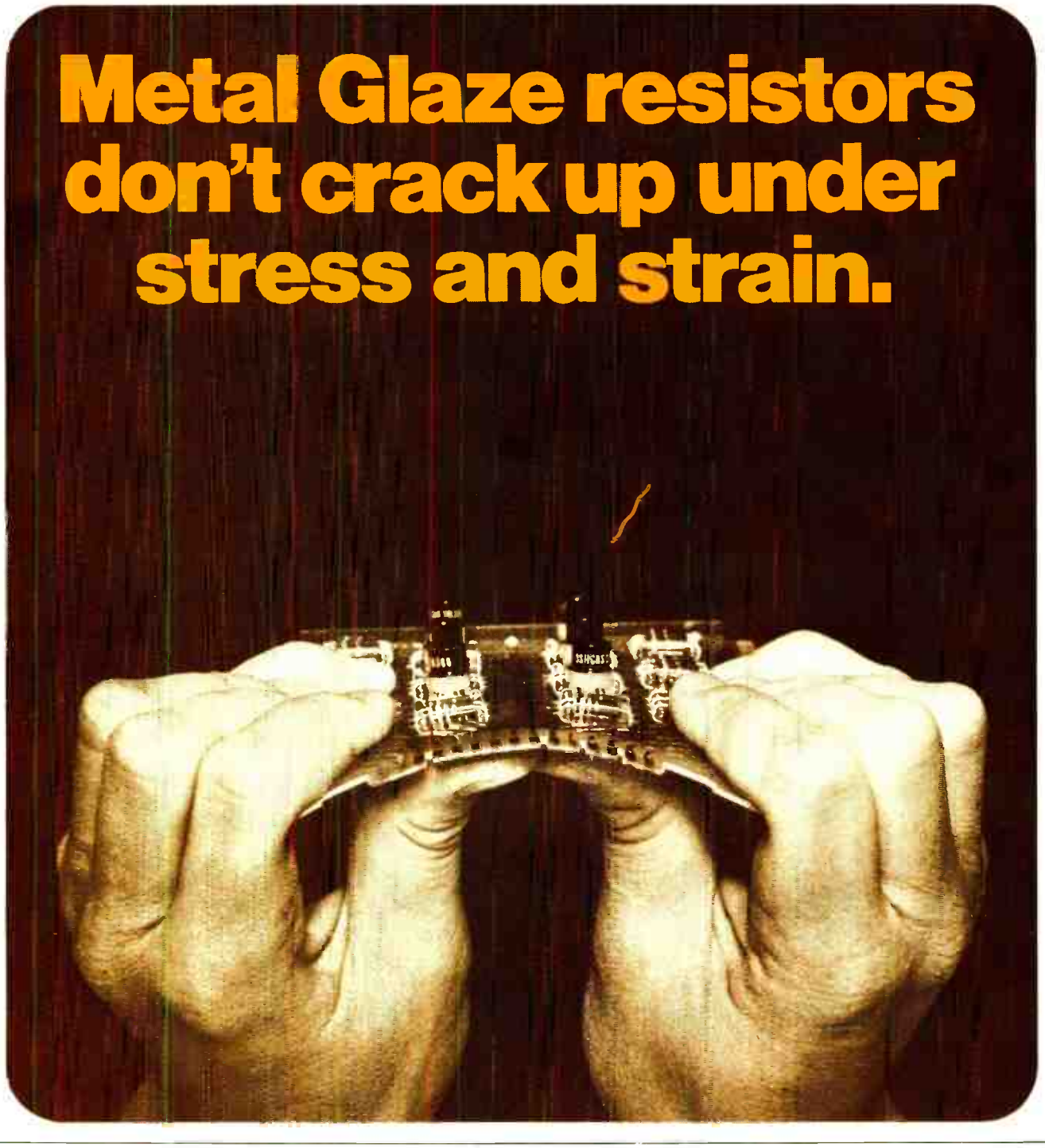
East side, West side. Nokia's long-range marketing plans call for its sales to break down at 50% domestically, 30% in the East, and 20% in the West by 1975. About half its sales are in process control equipment and industrial electronics, and in telecommunications. A large portion are in data processing: it represents Honeywell Information Systems in Finland and also manufactures modems, data transmission equipment, and paper tape readers. In telecommunications, Nokia was one of the first companies to produce a 30-channel pulse code modulation system. Its first unit was operating in Finland in 1967.

Nokia also makes multiplexing equipment, line gear, and vhf, uhf, and microwave radio links. One of Nokia's best-selling single items is a multichannel pulse analyzer, whose modular design enables expansion from 100 to 200, 400, or 800 channels. About 90% of logic is made up of IC's, thus allowing small size and weight of only 50 pounds. Nokia says price, starting at $5,000, is highly competitive.

Another diversified company that has gone into electronics is Oy Fiskars AB, which started as an ironworks in 1649. Fiskars' move into electronics came in 1964, with a study of the feasibility of establishing a Finnish semiconductor industry, especially for thyristors and power transistors.

Product search. Though the semiconductor outlook was poor—the domestic market was too small and international competition was too tough—Fiskars continued to search for product lines it could get into. The first electronic unit was a dc power supply, constant voltage rectifier for telephone exchanges. Next was microwave ovens, and the newest models feature electronic stepless timers. Ovens make up half of Fiskars' total electronic sales of $2.5 million this year, compared with $1.75 million last year. □

Metal Glaze resistors don't crack up under stress and strain.



Metal Glaze™ resistors are made to take stresses and strains that crack up so many other types. Physically and electr cally, they're tough customers.

Metal Glaze resistors can take PC card flexing, exposure to solvents, automatic machine insertion, potting—and general knocking around. The glass-hard Metal Glaze film is permanently fused to a solid ceramic core. Lead wires are soldered to the core in a patented process. This makes the resistive element and the terminations one continuous component which, even in its sub-assembly form, is mechanically stronger than many finished resistors. Molded in a tough, environmentally protective envelope, Metal Glaze resistors are practically indestructible.

Metal Glaze resistors can take their share of electrical jolts, too. For power handling they're conservatively rated, and often can be operated at twice rated power without degradation. Short-time overload and high temperature characteristics are excellent.

Competitively-priced Metal Glaze resistors are available in power ratings from 1/8 watt to 2 watts, in ± 1% to ± 5% tolerances.

TRW Metal Glaze resistors are available in quantity from your local TRW industrial distributor. Or contact TRW Electronic Components, IRC Boone Division, Boone, North Carolina 28607. Phone (704) 264-8861.

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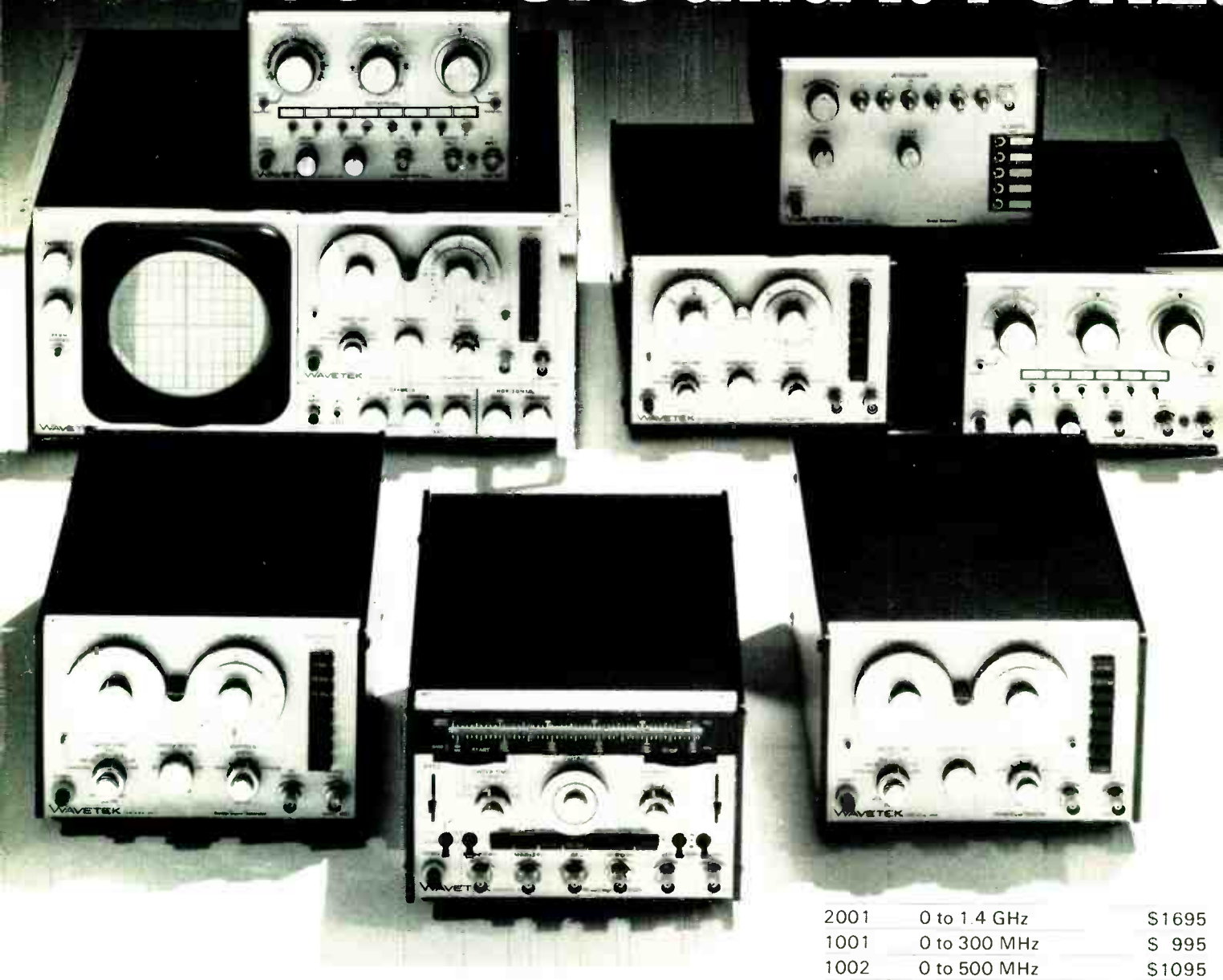

2001	0 to 1.4 GHz	$1695
1001	0 to 300 MHz	$ 995
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1004	500 MHz to 1 GHz	$ 995
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No matter what your frequency range or your price range, there's a Wavetek Sweep/Signal Generator to fit it. All have laboratory and production capabilities in a rugged solid-state design. They include such features as pin diode internal or external leveling, front panel crystal-controlled markers with amplitude, width and tilt controls, and up to 90db attenuation. And the frequency, amplitude and sweep width may be remotely programmed. So take your pick.

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TI elbows way into low-price minicomputer race

by Paul Franson, Dallas bureau manager

Single-quantity tag of $2,850 tailored to small user for control, automation jobs; machine to bow at FJCC

A giant step toward staking its claim in the computer business will be taken by Texas Instruments this month at the Fall Joint Computer Conference when the company's Houston Equipment Group introduces a new 16-bit minicomputer [*Electronics*, Oct. 11, p. 93].

In a market already rife with severe price cutting, TI will sell the 960A—which has a 750-nanosecond cycle time and 4,000 words of semiconductor memory—for $2,850 in quantities of one to 100. The lowest price previously announced in the field was $3,000 for Digital Equipment Corp's PDP 11/05—but the $3,000 tag was for quantities of 100.

Richard Jennings, manager of computer marketing for the TI group, expects the new computer to be attractive for process control and factory automation applications: not only does it offer the small user what is virtually an OEM price, but the computer was designed specifically for use in TI's own extensively automated factories. The new 960A uses the small dual-mode architecture that TI developed in the earlier 960 [*Electronics*, May 25, 1970, p. 159], but the 960A is a completely new machine. Jennings says that TI engineered it for economical mass production, using new components and techniques. The latest published price of the 960 is $8,450.

Among cost-saving steps in the 960A is widespread application of standard 7400 TTL MSI. The central processing unit is on one 10-layer board, and the front panel is also formed from a circuit board. Except for a few wires in the power supply, all internal cabling has been eliminated and the back panel is wire-wrapped on a numerically controlled machine.

Cost-saving is also evident in the memory. The standard 4,096-word memory is composed of 1103-type MOS chips, the price of which is rapidly dropping. It is expandable internally to 32,768 words of MOS memory at $1,500 per 4,096 words, and up to 32,768 words of external core memory can also be added. Another economy became possible in the recent reductions in the price of LEDs used for panel display.

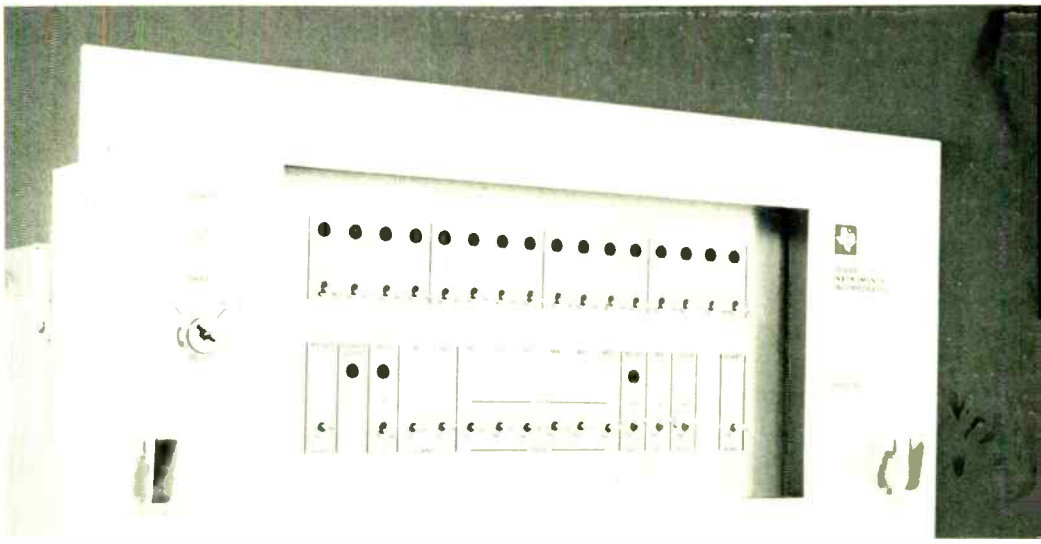
Simple command. Jennings says that significant features for users are the ease of input/output interconnections, and the manufacturing-oriented programing of the computer. A single-bit word can be used for controlling "peripherals" such as motors or valves, and the user can energize a motor simply by commanding "Turn motor 1 on."

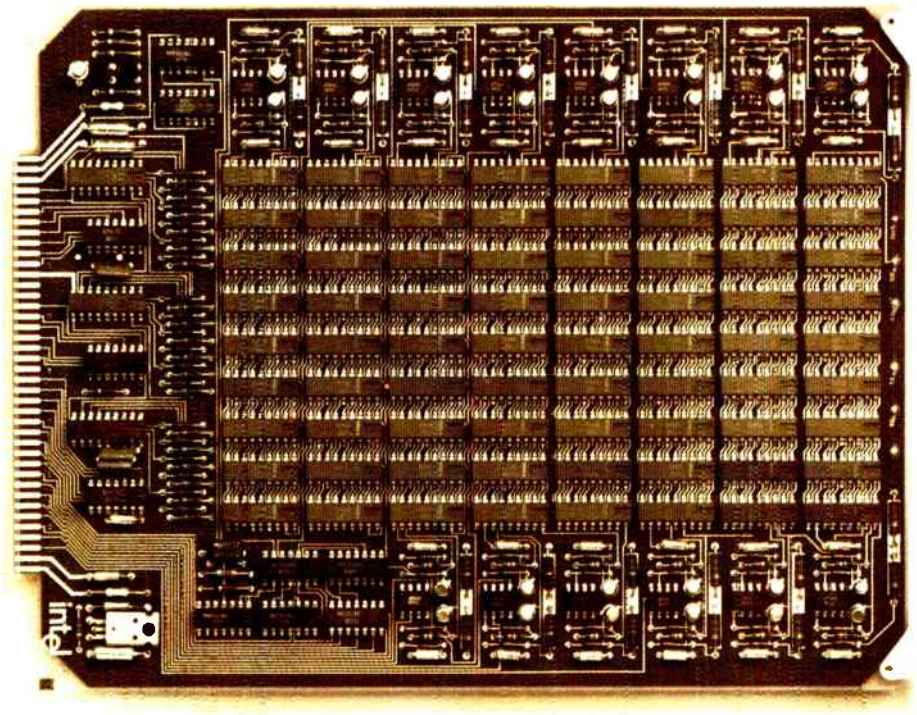
Included in the price of the 960A is the power supply, a direct-memory-access channel, automatic parity checking, memory write protect, and a lockable front panel. Optional features include a combination of up to 512 I/O lines (expandable to 8,192), hardware multiply and divide, and a memory refresh battery pack good for two weeks without external power.

Numerous software options are available, including Fortran, monitors, loaders, microprocessors, and an overlay link editor.

Deliveries of the TI 960A will begin in late 1971. Texas Instruments Digital Systems Division, P. O. Box 1444, Houston, Texas 77001 [338]

Shop tool. Hardware and software design of the 960A minicomputer make it suitable for automated manufacturing applications, process control, and data collection systems.





RAM systems to beat the system

Intel has beat system application problems for you — with plug-in semiconductor memory systems built with Intel RAMs. They give you all the advantage of Intel's expertise, incorporated in systems designed to meet most people's requirements for speed, reliability, size and cost.

Two TTL-compatible MOS systems are now in stock. Bipolar systems are so close that now's the time to talk to us. (When you have quantity requirements, we're ready to customize.)

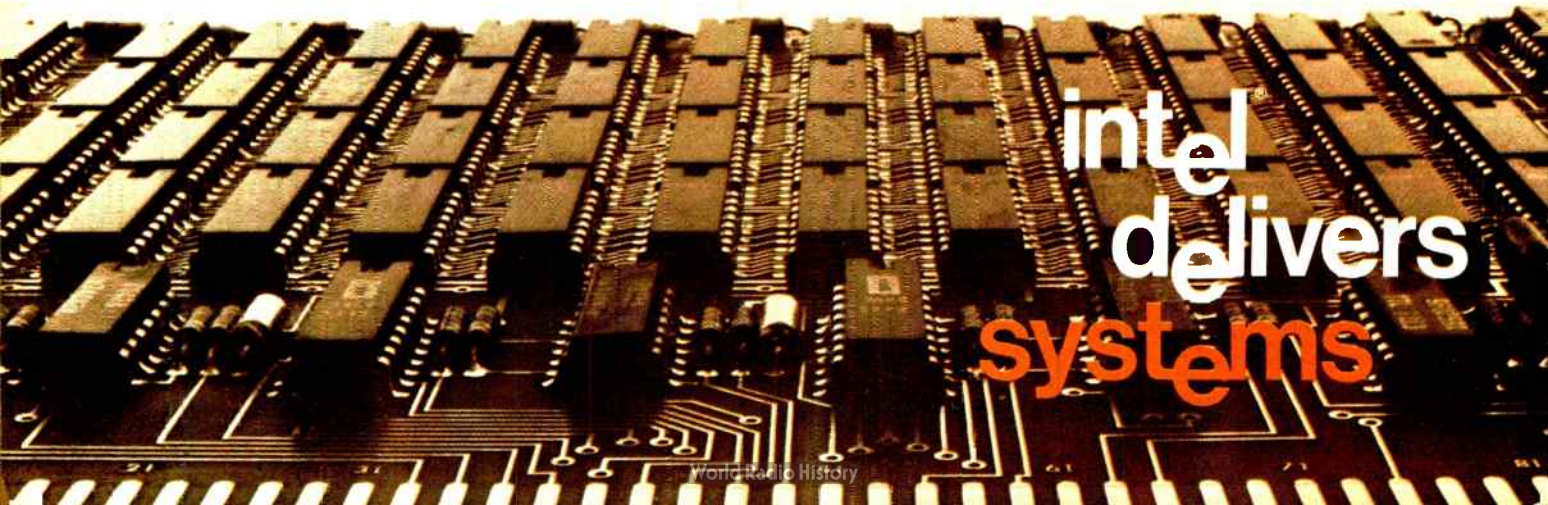
First in stock is System in-10, a dynamic MOS memory assembled modularly from 8" x 10" cards. Each memory card (top photo) stores 4K 18-bit words or 8K 9-bit words. A complete, self-contained system requires only one off-the-shelf control card for every eight memory cards. Maximum system cycle time is a fast 450 ns. Price is 1¢ to 1½¢ per bit in quantity.

Also in stock is System in-20, a static MOS memory built modularly with 6" x 8" cards. Each memory card (bottom photo) stores 1K 12-bit words and forms a complete system. Maximum system cycle time is 900 ns. Price is 2¢ to 4¢ per bit in quantity.

Both MOS systems operate from 0° to 50° C ambient. Byte control, card selection and address register are standard features. Power supply and card chassis for mounting in a 19-inch rack are optional.

For more information on MOS or bipolar systems phone your local Intel salesman or contact Intel Corporation at 3065 Bowers Ave., Santa Clara, Calif. 95051. Phone (408) 246-7501. In Europe contact Intel at Avenue Louise 215, B 1050 Bruxelles, Belgium. Phone 492003. In Japan contact Nippon IC, Inc., Parkside Flat Bldg. No. 4-2-2, Sendagaya, Shibuya-Ku, Tokyo 151. Phone 03-403-4747.

Circle 112 on reader service card

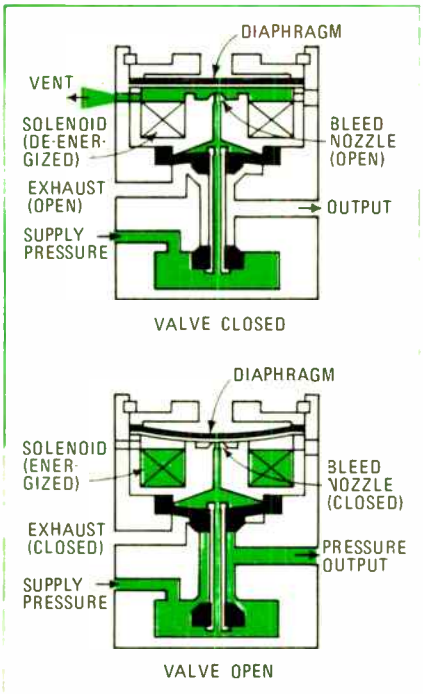


Industrial

Half-watt runs pneumatic lines

Electronically actuated fluid amplifier directly controls high-pressure air flow

High-pressure pneumatic power lines in machine tools, packaging machinery, computer hardware, and electronic test equipment are often controlled by electronic logic circuits operating at relatively low power levels. One problem is that the low-level logic cannot drive the pneumatics directly. An interface is



needed between the two that might consist, for example, of an amplifying circuit driving a solenoid powerful enough to activate the valves in the pneumatic lines.

Northeast Fluidics Inc. thinks it has gotten around this requirement with a new type of solenoid that can control high-pressure (20-to-100-pounds-per-square-inch-gage) pneumatic lines while driven by signals from a low-powered transistor. Northeast's model 2013 Electronic Fluidamp draws less than a half-watt at rated voltages of either 6 or 24 volts dc, depending on solenoid coil design, says Melvyn M. Brown, vice president and sales manager. This power is impressively low, asserts Brown, when compared with the requirements of the usual ac- or dc-powered solenoids: roughly 7 watts of holding power and 12 W of in-rush, or turn-on, power.

Power is low because the new unit does not have to move the heavy plunger of a conventional solenoid. Instead, it moves a lightweight metal diaphragm. The latter acts within a three-way air valve identical to one in an earlier Northeast product—the Fluidamp 2010 fluidic interface valve which amplifies low-pressure air-jet signals to working power levels. The company has taken this original valve and added an electronically actuated solenoid for moving the diaphragm.

In its normally closed state, line pressure at the supply port pushes up against and closes off the lower portion of the poppet, or lift, valve. During this state, a small amount of air passes through an orifice in the center of the valve up through a bleed nozzle, and out to the atmosphere.

When the solenoid coil is energized, the diaphragm, made of a springy magnetic material, is pulled down magnetically against the nozzle, closing it off. With air now no longer able to escape, there's a rapid pressure buildup below the diaphragm which pops the valve into a new position. The exhaust port closes, the lower valve opens, and line pressure appears at the output port.

When the solenoid is de-energized, the valve returns to its original position, load pressure vents through the exhaust port, and output pressure drops to zero.

Brown claims the Electronic Fluidamp will, with its simple, lightweight structure, operate for 100 million cycles, at least an order of magnitude longer than conventional units. Switching speed is 10 milliseconds. Units measure 1.36 inches in diameter and 1.64 inches long, and come in oil-tight cases.

Price is $29, with discounts for large orders. Northeast Fluidics Inc., Amity Road, Bethany, Conn. [370]

Training system teaches digital circuitry

A general purpose digital training system has been developed to ease the job of teaching students the fundamentals of digital circuitry. Aimed at universities and military and other training schools, the BES-18 enables the student to assemble modules into a simulated system and to develop the capability to wire circuits and check their validity against set specifications.

Built by Beta Engineering & Development, the training system has specific integrated circuits in each of the modules, which may be interconnected by the student through the use of patch cords. This allows for a variety of basic digital circuits to be demonstrated. An instructor, using any test circuit, can demonstrate logic circuitry, current consumption and short-circuit and malfunction protection. Beta Engineering & Development, a subsidiary of Gerber Scientific Instrument Co., P.O. Box 2004, Hartford, Conn. 06101 [371]

Tunable CO_2 laser puts out 5 watts at 10 wavelengths

A tunable CO_2 laser provides calibrated selection in either of the two high-gain CO_2 bands. From 14 to 18 transitions are available in the 10.17–10.81 or 9.22–9.66 micro-

meter ranges, specified at the time of purchase. A minimum of 5 watts output power is provided at more

New products

than 10 wavelengths. The laser, model 950, is suited for infrared spectroscopy, atmospheric propagation experiments, signature studies for element identification, scattering effects, and Doppler measurements. Price is $12,635. Electro-Optics Organization, GTE Sylvania, P.O. Box 188, Mountain View, Calif. 94040 [373]

Preselector-protection unit prevents front-end burnout

Receiver operation in installations requiring co-location of transmitting and receiving antennas is made possible by the model RF-507 preselector and protection unit. It has full duplex operation from 1.5 to 30 MHz in seven tunable bands, and the self-contained system includes a 115/230-V, 50/60-Hz power supply. The unit can be used with any receiver antenna system with a nominal 50-ohm impedance. RF Communications Inc., 1680 University Ave., Rochester, N.Y. 14610 [375]

Heat-cool controller has automatic reset and rate

A problem with heat/cool controllers has been the abrupt change in controlled temperature when the instrument moves from the heat to cool region. This is eliminated on the model 96 series units by automatic reset and rate on both the heat and cool channels. Output is generated on a plug-in board that is interchangeable with other series 96 outputs such as the time proportional relay and the SCR drive. A 9-in. calibrated analog scale or digit

switch setpoint is also included. Eurotherm Corp., The Isaac Newton Center, Reston, Va. 22070 [374]

Fast-response IR analyzer monitors air pollution

A computer-compatible, nondispersive infrared analyzer for monitoring air pollution, stack gases and auto emissions gives a response that is 90% of the final reading in five seconds. The model M-S-A LIRA 202, with a specially designed, air bath, proportional temperature controller, assures operation in ambient temperatures from 40 to 120 F. Zero drift is less than 1% of full scale in less than 24 hours, and repeatability-accuracy is ±1% of full scale. Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh, Pa. 15208 [377]

Temperature controllers have rated accuracy of 0.5%

Indicating potentiometric temperature controllers using integrated circuit design have a rated control accuracy of ±0.5%. The model 49 series includes proportioning, limit, and heat control models, all offering thermocouple input, full scale indication, plug-in construction, and heating and cooling lights. The units occupy a 4- by 4 ¼-in. panel space.

Price of the proportioning and limit units is $110. Love Controls Corp., 1714 S. Wolf Rd., Wheeling, Ill. 60090 [376]

Buy the performance you need at the right price.

Sorensen DCR's.

Today every budget dollar has to go as far as possible for both new and replacement equipment. And Sorensen's DCR line saves you money because it offers you regulated dc power at the lowest cost per watt in the industry. Not only that, you select from the broadest line available anywhere. Pick the exact unit you need from 37 models covering power levels from 400 W to 20 KW . . . voltage ranges from 20 V to 30 KV. Remote programming and sensing, too. The cost? Consider the typical comparisons below.*

Output	Power Supply	Cost/Watt
400 Watts	DCR 40-10A	$0.78
	Mfr A	1.02
	Mfr B	1.18
2400 Watts	DCR 300-8A	0.36
	Mfr C	0.47
5000 Watts	DCR 20-250A	0.31
	Mfr C	0.60

*Specific competitive model numbers available on request.

For complete information on our DCR's, contact Raytheon Company, Sorensen Power Supplies, 676 Island Pond Road, Manchester, N.H. 03103. Telephone 603-668-1600.

Sorensen POWER SUPPLIES

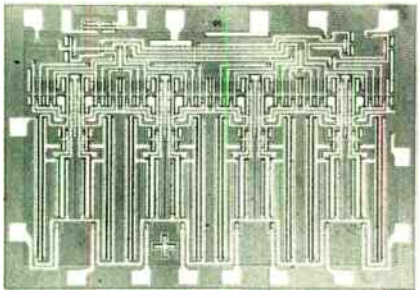
Circle 116 on reader service card

Data handling

Multiplexer has low distortion

C/MOS device for analog, digital switching also offers low 'on' impedance

In multiplexing equipment for analog and digital signals, one of the most important design considerations is the level of distortion introduced by the multiplexer itself. An eight-channel C/MOS unit developed



by Ragen Semiconductor contributes what the company calls "extremely low distortion" over a full 8-volt signal range. Distortion into a 10,000-ohm load (at 4 v rms and 1 kilohertz) is less than 0.05%—"So low we had difficulty measuring it," says Albert Medwin, Ragen Semiconductor president.

When operating with a 15-v supply, the "on" impedance of the monolithic device is nominally 100 ohms, probably the lowest among similar units on the market, says Medwin. "Off" impedance is 10^{10} ohms.

Static power dissipation of the multiplexer, called the MS-504, is a low 50 nanoamperes at 15 v. Crosstalk also is minimal—less than 0.5 picofarad of coupling between any two pins.

The MS-504 is on a single chip, measuring 91 by 64 mils, that also contains the circuitry for full three-bit decoding and chip selection.

Switching or access time of the multiplexer is less than 50 nanoseconds, fast enough for digital as well as analog applications, Medwin points out. Applications include telephone switching, audio and digital switching, and multiplexing for low-level ac and dc measurements. Operating temperature range is −55 C to +125 C.

The multiplexer is available from stock in 16-lead flat packs or dual in-line ceramic packages. On special order, it can be supplied with two chips in the same package.

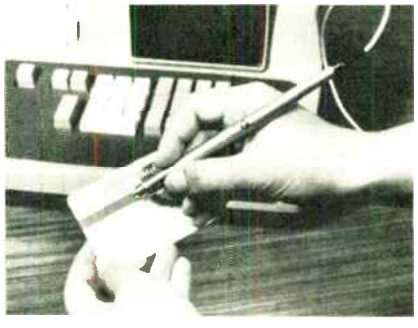
Prices for the MS-504 are: 1-24, $38.50; 25-99, $23.60; 100-999, $14.40. Ragen Semiconductor, a subsidiary of Ragen Precision Industries, Inc., 53 S. Jefferson Rd., Whippany, N.J. 07981 [361]

Nonimpact line printer runs at 1,200 lines/min

A line printer called the X/3 employs a nonimpact technique that produces computer printout on ordinary fanfold paper at speeds of 1,200 or more lines per minute with a 96-character set. Quality of characters permits forms to be processed by optical character reader. Fonts or character styles can be easily changed and the printer can directly generate an unlimited number of types of business forms. Price starts at $20,000 and leasing per month is $600 including maintenance, Scan-Optics Inc., 22 Prestige Park Rd., East Hartford, Conn. 06108 [368]

Magnetic pen's circular gap reduces digital error rate

The DigiWand, a pencil-sized, azimuth-independent magnetic reader, is fabricated with a circular gap configuration that reduces digital error



rate. The DigiWand permits the operator to tilt the pen approximately 20 in any direction, and the read bandwidth is 10 kHz. Other specifications include a recording density of 250 bits per inch, wiping speed of 15 in./s, and inductance of 100 mH. The unit is for use with point-of-sale digital systems. Nortronics Co. Inc., 8101 Tenth Ave. North, Minneapolis, Minn. 55427 [364]

Communications capability added to input stations

A communications system links the company's 220 Typescribe, 510 Pooler, and 1500 Data Editor in a network called Sycom. It allows the user to record source data in a remote location, and then transmit it to a central site for input to the computer. Source data may also be sent from the 1500 Data Editor, which

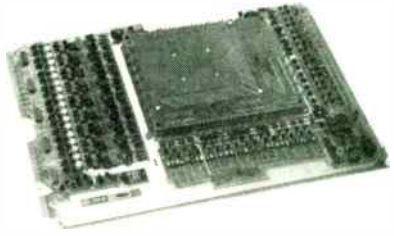
performs comprehensive editing and validation of data to make it ready for processing. The Typescribe with communications leases for $125 a month, the Pooler with communications for $350, and the Editor with communications for $1,455. Data Action Corp., 4445 W 77th St., Minneapolis, Minn. 55435 [366]

New configuration doubles capacity of memory card

The capacity of the ECOM series of core memories has been doubled by the addition of an 8,000-word con-

New products

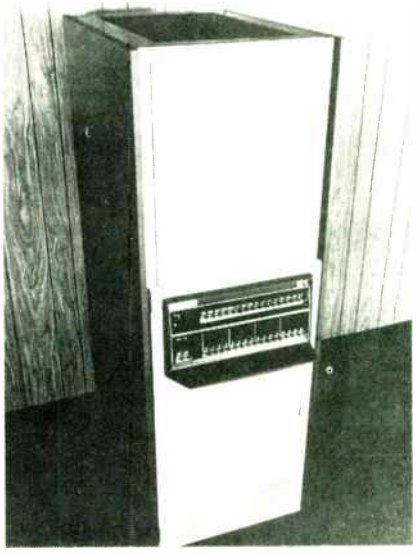
figuration of the digital stack card. Bit length remains at from nine to 18 bits. Full cycle time is 750 nanoseconds, and the same size card is



used as in the older version. Standard Memories Inc., 15130 Ventura Blvd., Sherman Oaks, Calif. 91403 [363]

Communications processor aimed at heavy data traffic

Programable data communications processor model 16 consists of a model 5 minicomputer with a model 16 ROM, which contains an expanded I/O instruction set for data communications requirements. The



model 16 has a comprehensive set of 114 instructions, and the core memory is directly addressable and alterable to the eight-bit level. The instruction set includes fixed-point arithmetic, logical, byte handling, status control. Single unit price of the 16 is $14,700. Interdata Inc., 2 Crescent Pl., Oceanport, N.J. 07757 [365]

Minicomputer has large repertoire of instructions

Microprogramable general-purpose minicomputer model Micro 1600/21 permits more efficient use of core memory in most applications because of an instruction set with 107 different operations. Modular design allows system expansion within a single basic enclosure, and the control memory, processor options, input/output elements, and

magnetic core main memory are all expandable. The main memory is organized into pluggable modules of 4,096 and 8,192 bytes each, and it is byte-addressable. Price is $6,995 for a unit with 8 kilobytes of main memory, and under $5,000 in OEM quantities. Microdata Corp., 644 E. Young St., Santa Ana, Calif. 92705 [367]

Writable control stores can be modified on site

A series of writable control stores are plug-compatible with most minicomputer systems, and can be modified on site, in real time, under keyboard, console or software control. After the new contents are in place, the device operates as a true read-only memory. Called the OmniROM, the nonvolatile plated-wire memory retains data indefinitely, even through power shutdown. Price, in OEM quantities, ranges from 5 to 10 cents per bit, depending on size and configuration. Memory Systems Inc., 3341 W. El Segundo Blvd., Hawthorne, Calif. [369]

THE CROWD DISAPPEARS AT 20MHz

Now we're alone with the world's first 20 megahertz function generator, which starting at 0.0001 Hz, makes it twice the frequency range of other wide-range function generators. The model 7230 thus opens up new signal generator applications in the testing of MOS devices and IC's where frequencies are well over 10 MHz and will be going higher. It also will find application in pulse generation with its 30V P-P outputs and 10 nanosecond rise/fall times (equivalent slew rate of 2400 V/microsecond). Another new field for the 7230 will be intermediate frequency applications in FM receivers and telemetry. For only $795 you get a precision source of sine, square, triangle, ramp, pulse and sync waveforms, plus these other features: VCF input control; several choices of DC offset; sync input for locking the generator to an external clock, and 80 db of step attenuation. And if 11 MHz is still all you need, you should check out EXACT's other three fine instruments in this series: the Model 7030, which has the same operating features of the 7230 above but saves you $200; the Model 7050, same as the 7030 but with the additional capability to trigger and gate (with variable start/stop levels on the triggered and gated waveforms) for $745; and the Model 7060, which at $845 adds a second generator (again at 11 MHz) for ramp, pulse and sweep, 1000 seconds to 100 nanoseconds. Call on us to rise above the crowd with your next function generator.

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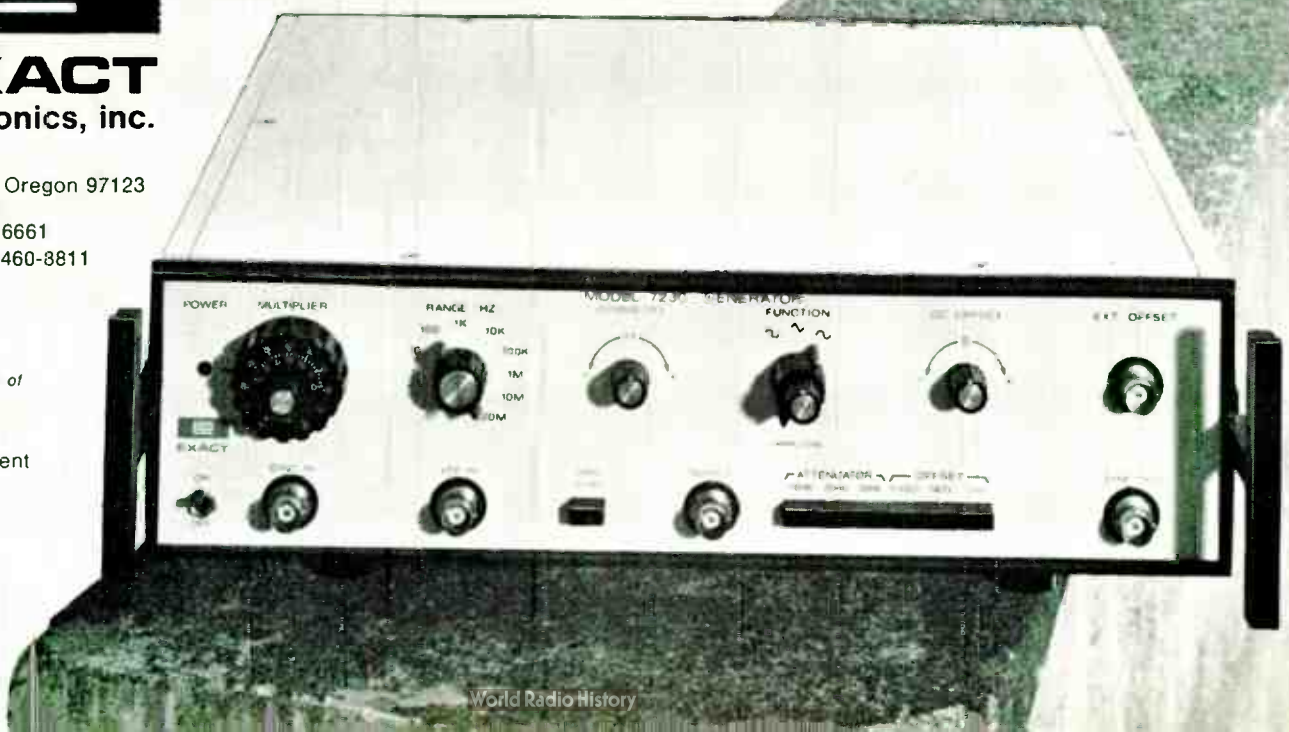


Semiconductors

Building blocks are on one chip

IC for communications breadboard has gain block, multiplier, and oscillator

Three main types account for a large number of the circuits employed in communications systems. These are multipliers, which are used in modulators, phase comparators, and synchronous detectors; gain blocks, which appear as operational amplifiers, sense amplifiers, and comparators; and oscillators, which are either fixed- or variable-frequency types and are either voltage- or crystal-controlled. And while any one of these three types is readily available as a monolithic integrated circuit, systems made with combinations of them still require a number of monolithic circuits. By combining all of these basic building blocks on one chip, Exar Integrated Systems Inc. hopes to provide the communications engineer with a tool for developing completely monolithic systems.

Called the XR-S200, the IC contains a multiplier with two inputs, two outputs and two gain control lines; a gain block that has both inverting and noninverting inputs, a comparator input, and both an analog and a digital TTL level output for threshold detection; and an oscillator with both digital and analog inputs and outputs, and gain, and sweep control lines, as well as a crystal input. All are contained in a 24-pin package and, as a system, can operate over the frequency range of from 0.1 hertz to 40 megahertz with supply voltage ranging from ±2.5 volts to ±25V.

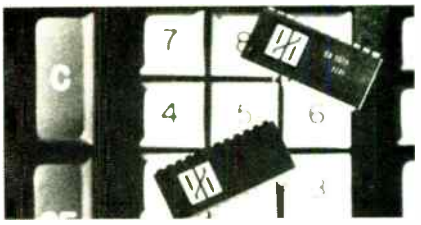
According to Alan B. Grebene, vice president and director of engineering at Exar, "Each of the three circuits on the monolithic chip is designed for maximum flexibility of its performance characteristics and with a large number of design options." Grebene points out that previously, even if the three basic functions could be obtained in three packages, "usually they wouldn't be compatible with each other and would require level shifting or biasing networks. But the components on our chip are all compatible with each other." Two of the design options include ECL compatibility, and an 80 MHz oscillator.

The circuit, while it can be used in a system directly, is intended as a design breadboard. The systems designer receives a pc card and an instruction book along with the XR-S200. He then can proceed to design a circuit for his specific application and, after wiring up the pc card, try it out. After it is proved, he sends the design back to Exar where it's turned into a metal mask pattern. Grebene explains that most designs won't require 24 external connections; the internal connections can be made on the final metal mask. Thus a smaller cheaper package can be used. Exar can stock "blank circuits" and, as custom designs come in, they will complete the circuits. The basic kit, which Exar has in stock, sells for $40.

Grebene feels that this approach to "custom communications circuits" will save the customer considerable time and money since he himself is designing the circuit and the IC company is making a "standard part." A few examples of what can be built include fm demodulators for commercial broadcast equipment, military communications systems or subcarrier music detection; frequency synthesizers; a-m demodulators; tone decoders; and waveform generators. Exar Integrated Systems Inc., 733 North Pastoria Ave, Sunnyvale, Calif. 94086 [411]

MOS circuit sets provide low-cost calculator logic

Two MOS calculator circuit sets, the S-101 and the S-114, handle eight-digit and 16-digit entries respectively, both providing keyboard input processing, add, subtract, multiply, divide, and stored constant operation; keyboard setting of decimal point location, and BCD outputs for display control. The four chips are: input subsystem, control and memory subsystem, arithmetic and register section, and output subsystem. Program changes can be made on custom orders. Price is $40 per set in quantities of 100 to 249. Electronic Arrays Inc., 501 Ellis St., Mountain View, Calif. 94040 [413]

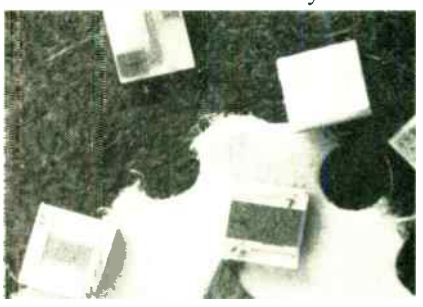


C-band Impatt diodes deliver up to 1 watt

Designed for use in local oscillators and rf power sources, the VAO-30 series of 10 Impatt diodes operates in C band, between 6.0 and 8.0 GHz. The low-noise, avalanche silicon devices range in continuous rf power output from 10 mW to 1 W. Typical efficiency ranges from 0.8% for the 10-mW unit to 7.0% for the 1-W device. Operating voltages are from 100 to 125 V. Varian, Solid State Div., Salem Rd., Beverly, Mass. 09195 [414]

Chip-resistor values range from 0.5 to 10 ohms

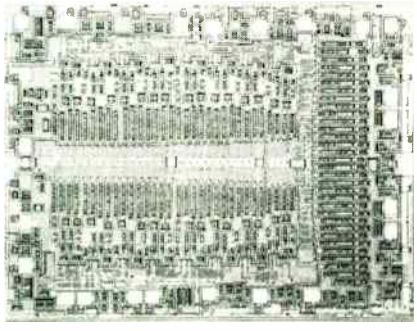
Thin film chip resistors, which are composed of a 96% alumina substrate, chromium resistor element, and either gold or solder terminations, are for use in hybrid cir-



cuitry and low VSWR microwave terminations. Resistance values range from 0.5 ohm to 10 ohms. Three sizes are available, with power dissipation from 50 to 100 mW. Price ranges from 37 cents to $1.45 per chip depending on quantity and tolerance levels. Film Microelectronics Inc., 17 A St., Burlington, Mass. 01803 [415]

Simultaneous read-write built into TTL memory

A TTL memory, a 16-bit quadriport register file called the model SN74172, is suitable for use in high-speed buffer and cache memories. Its simultaneous read-write capability is equivalent to 196 gates. Available in a 24-pin package, the memory is organized as eight words



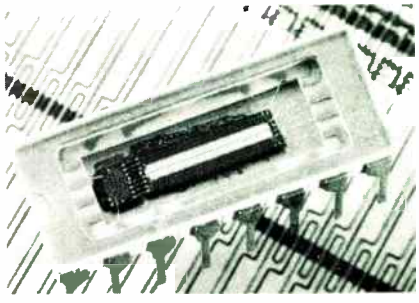
by two bits, and has the ability to access any two-bit words for read or write operations while accessing a third word for the opposite function. Price is $9.80 to $14.70 in lots of 100 to 999, depending on package. Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas, Tex. 75222 [416]

MOS memories challenge System/360 core storage

Built for IBM System/360 model computers, n-channel MOS memories are capable of 200-nanosecond operation. They also provide the user with up to double the storage capacity of regularly available IBM core storage units. The plug-to-plug memory units are available in four models: the SSM7330 with a storage capacity of up to 128k bytes; SSM7340, 512k bytes; SSM350, 1024k bytes; and SSM7365, 2048k bytes. Potter Instrument Co., Melville, N.Y [418]

Self-scanning optical array built for OCR, facsimile

Designed for OCR, facsimile, TV camera, and industrial control applications demanding high resolution, the RL256 self-scanning optical array has 256 elements. The photo-



diodes of the monolithic image-sensing device are spaced on 1-mil centers, with on-chip scanning circuitry for serial output on a single video line. TTL compatibility is achieved through drive circuitry provided in the same 16-lead DIP. The silicon gate sensors are operated in the charge storage mode providing high sensitivity at up to 10-MHz scan rates. Price is $250 in OEM quantities. Reticon Corp., 365 Middlefield Rd., Mountain View, Calif. 94040 [417]

High-gain phototransistors directly switch TTL, DTL

At very low light levels, high-gain phototransistors called the STPT-260 Quantistors deliver sufficient output to directly switch TTL, DTL, or RTL. And at typical light levels, they are said to provide seven times greater output than conventional units. They offer 70 mA typical output at 5 mW/cm^2, 11 mA at 1 mW/cm^2, and a switching speed of 6 μs. Peak spectral response is 800 nm. Sensor Technology Inc., 7118 Gerald Ave., Van Nuys, Calf. [419]

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The Heavy-Duty DMM

This versatility is standard; you get it all in the $435 price. If you add options and accessories, then the 3300A goes to 30 kilovolts AC/DC. It has a clamp-on current probe good to 100 amperes, DC as well as AC. With an Adapter, the Multimeter becomes a counter up to 20 MHz.

If you want a sweet multimeter, take a look at the Hickok 3301. It has the same measurement capabilities as the portable 3300A in a line-operated bench-top configuration. And it has a sweet price—$385. Options for the 3301 include a BCD output or an internal rechargeable battery.

You'll like the other features standard with both Hickok models: automatic polarity and decimal point position, out-of-range indication, 1500 volts off ground operation, outstanding overload protection, easy operation with color-coded front panels, and continuous automatic zeroing.

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Take a look at the digital multimeter you can really knock around—and still get 0.1% accuracy for a year. The Hickok 3300A in its tough Cycalac case and with its shock-mounted circuits has enough built-in versatility to take the place of a stack of instruments.

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Subassemblies

Supplies are programable

Power sources keep voltage, current levels constant for up to 10,000 tests a second

In testing advanced semiconductors and in exercising computers, the power delivered to the system is a critical factor. To meet the needs of checkout operations like these, the SRC division of Moxon Inc. has developed two supplies that deliver constant voltage and current and are programable by a computer or a data generator.

The model 3532 offers ±1-, 10-, and 100-volt outputs; the 3533 offers only the lower two. In output current, model 3532 provides 0 to 0.01, 0 to 0.1 and 0 to 1 ampere; the 3533 provides those three plus a 0-to 10-ampere capability. Both sell for $2,540 and are available for immediate delivery.

Dale Romrell, applications engineer, stresses that the principal advantage of the two power supplies is that they can be programed for constant-voltage, constant-current operation while testing digital or analog circuits at rates of up to 10,000 tests a second. A digital computer or data generator can set the dc voltage output to within 0.01%: a digital word from the computer is converted into either a precise voltage with a current limit or a precise current with a voltage limit.

In addition, says Edgar Romo, SRC/Moxon's chief engineer for instruments, the power supply meets the needs of advanced semiconductor testing in that it can program both the positive and negative input and the output voltage and current specifications. He says that about a third of the market for the two units will be made up either of semiconductor manufacturers who build their own test equipment, or semiconductor users who build such equipment for incoming inspection.

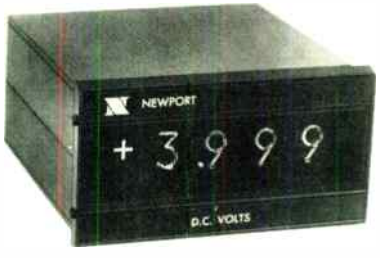
Another third of the market, Romo believes, will consist of users of large, complex systems who have to check the continuity and impedance of thousands of wires connecting one system to another, while the remainder of users will want to exercise digital or analog computers—signals can be generated that simulate how the computer will accept phone line data, for example.

There are 31 input lines from the power supply to the computer that controls it, each with a memory. The digital word representing a voltage or current is applied to the input memory, where it is stored on command from the strobe lines. Once that data is in memory, the input lines are free to accept new data to exercise some other peripheral device, say, in a computer system.

One of the digital lines is used to turn the units' output on and off, preventing the wrong voltage or current level from being applied to external equipment while the current is being switched from one level to another. SRC Division, Moxon Inc., 2222 Michelson Dr., Newport Beach, Calif. 92664 [381]

Digital panel meter offers multiplexed BCD outputs

A ±3999-count digital panel meter designated the series 400A has multiplexed BCD outputs for time-share recording. Other standard features



are display blanking, autopolarity, remote hold command, read rate control, overload and plus-minus indicators, and true differential inputs. Accuracy of 0.05% is maintained with digitizing rates of 0 to 60 readings per second. Price is $189. Newport Laboratories Inc., East Young St., Santa Ana, Calif. [383]

Dc power supplies rated at 0 to 100 volts

Two general-purpose laboratory dc power supplies, designated models 6211A and 6212A, are both rated at

0 to 100 volts, 0 to 100 milliamperes. The 6211A is constant voltage/current-limited and the model 6212A is constant voltage/constant current. Applications include circuit design, testing, student experiments, laboratory use, or wherever a low-cost dc source is needed. Load and line regulation is 0.01%, and output is isolated so that the supplies can float at up to 300 v above ground. Price of the 6211A is $105; the 6212A, $130. Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304 [387]

Display module includes memory, anti-blur circuits

Variable-intensity, seven-segment display modules, called the TR-510 series, allow data to be stored on

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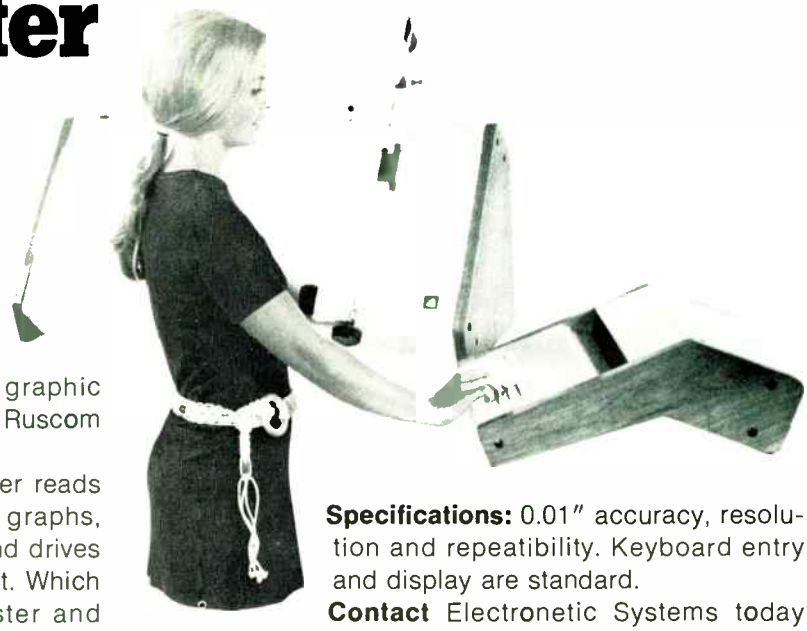

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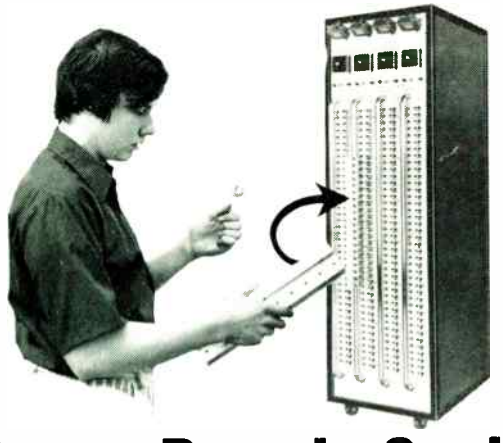

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command, and also permit visual monitoring of all significant digits even at a 20-MHz data input rate. Using an automatic internal latch clock, the TR-510 samples incoming data within the normal human visual response frequency, so that dis-

plays do not appear blurred. The modules operate from a single 5-V source, are available with three to six digits complete with TTL-compatible latches, driver-decoders, and decimal point at each position. Price is $20 per digit. Tronix Inc., Box 349, Phillipsburg, N.J. [384]

FET-input amplifiers have programable gain to 2,000

A family of four instrumentation amplifiers with field effect transistors for front ends have an externally programable gain of from unity to 2,000—set by a single resistor. The encapsulated modules exhibit up to 100 dB of common mode rejection ratio at a gain of 1,000 with common mode voltages to ±10 V. Maximum unity-gain frequency response is 1 MHz. Four models are offered, with stabilities from 50 μV/°C through 3 μV/°C. Prices range from $35 to $59 in 1-9 quantities. Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890 [386]

Hybrid voltage regulators cover range of 5 to 24 V

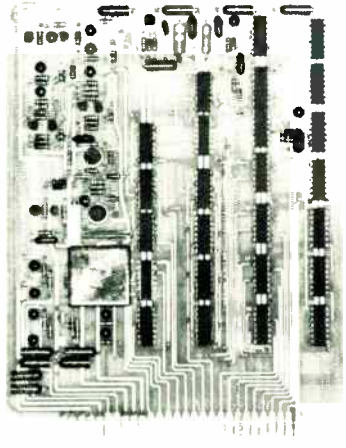
Fixed-voltage hybrid integrated circuit regulators, series 102, are for dc voltages in the range of 5 to 24 V and will handle a continuous load current of 2 A. Studs for mounting permit power dissipation of up to 20

New products

W. Specifications include regulation of 20 mV for load current of 0 to 1.5 A; 10 mV per volt input change, and temperature coefficient of 0.01%/ C. Epitek Electronics Ltd., 19 Grenfell Cres., Ottawa 12. Ontario, Canada [385]

A-d converter gives 0.015% accuracy at 40-ms speed

Bipolar 4½-digit analog-to-digital converter model 1010 is built on a plug-in circuit card, and includes dual input amplifiers, a two-channel multiplexer, internal clock, output register, dual-polarity reference supply, and encode clock. When operating with a single input, the 1010 achieves 0.015% accuracy with a conversion speed of 40 ms. Users



may choose from four input voltage ranges and four output code formats. Price is $255. Libra Systems, P.O. Box 161, Collegeville, Pa. 19426 [388]

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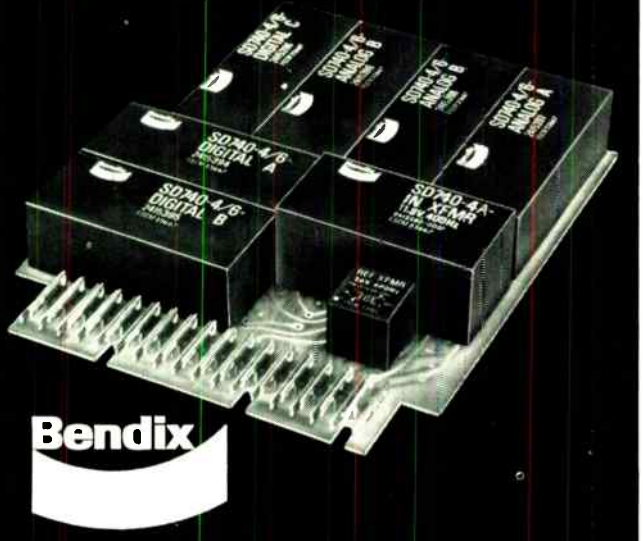
More information? Quotations on quantity sales? Contact: The Bendix Corporation, Environmental Science Division, Dept. 81, 1400 Taylor Ave., Baltimore, Maryland 21204.



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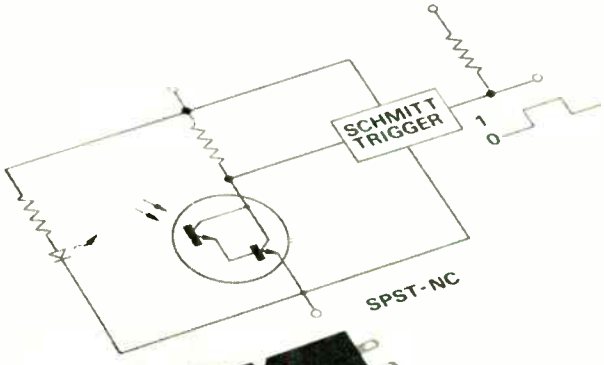

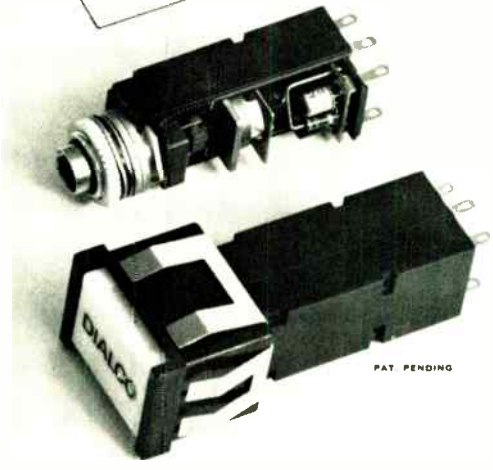

Dialight's new contactless solid state switch

This new illuminated pushbutton switch eliminates contact bounce, contamination, intermittent switching at low levels . . . *all* the problems associated with mechanical switches. Because it switches *electronically*. Pressing the button interposes a shutter between an LED light source and a photo-Darlington amplifier. This actuates a built-in Schmitt trigger to provide clean switching with rise and fall times of less than 100 nsec—many times faster than any mechanical or Hall Effect switch. It has many times their life too—10^7 operations at rated load.

The Dialight Contactless Switch interfaces directly with ICs or discrete circuitry. It's available for panel and snap-in mounting (interchangeable with existing Dialight switch caps and bezel assemblies), and in SPST-NO, SPST-NC and SPDT types. Write for technical and applications bulletin SW6110.

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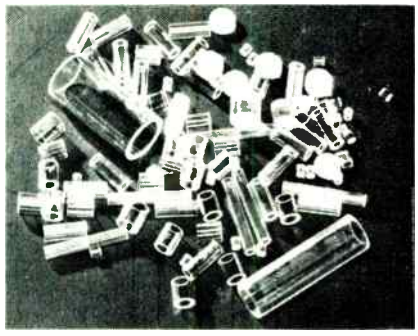

Clear cut-glass tubing and rods are for hermetic sealing for relay actuator arms, diode enclosures, and lamp seals. In addition, they can be used in optoelectronics applications as hermetic window seals for photocells and light-emitting diodes. Mansol Ceramics Co., 141 Little Street, Belleville, N.J. [481]

Flexible polyimide film laminate called Poly-Clad is copper clad on both sides with an epoxy adhesive that withstands solder-pot temperatures of 500 F without blistering or delaminating. It is stress-free, dimensionally stable from pre-etch to etch condition, and compatible with through-hole plating and rigid-flex combination circuitry when used with coverlay adhesives. Fortin Laminating Corp., 1323 Truman St., San Fernando, Calif. 91340 [483]

Etchant type C-35 one-part material is for gold conductive layers in hybrid and integrated circuits. It etches films up to 1,000 microinches, and can etch a 100-microinch thickness in less than 15 seconds at 90°C. Price for one quart is $14.40; quantity discounts are available. Film Microelectronics Inc., 17 A St., Highland Industrial Park, Burlington, Mass. 01803 [484]

Phosphate-free liquid detergent, called Liqui-Nox, and low phosphate powder detergent, Alconox, are for manual and ultrasonic machine cleaning of electronic parts. They are soluble at any temperature, remove grease, oil grime, dust and common soilants from almost any surface, and are suitable for clean-room maintenance. Alconox Inc., 215 Park Ave. So., New York, N.Y. 10003 [485]

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NOVEMBER 1971

That market letter may be injurious to your wealth

Not so long ago, a market advisory letter published in Canada started appearing in the mailboxes of U. S. investors. Its advice seemed so consistently sound that many investors began to swear by it. Soon, however, they were swearing *at* it. When their confidence was at a peak, the advisory service shot out a telegram telling them to grab immediately all they could of an obscure mining issue. Too late, the investors discovered that their prized market letter had merely been used to set them up for a swindle. The stock proved worthless, and the market letter was heard from no more.

Fortunately, the flim-flam market letter is rarely that successful. But the truth about market letters in general is that, while few aim to defraud, none is "right" about the market all the time. Their advice can range from excellent to abominable. It can be so couched in "gobbledygook" and "bafflegab" as to be incomprehensible or, worse, misleading. Yet they are essential tools for any investor. Professional money managers spend fortunes on market information. So do bankers, investment counselors and brokers. The problem for the individual is to separate the good from the bad.

One basic rule wise investors follow: Beware "free", unsolicited advice. There are "services" for which selling otherwise unsaleable securities is part of their stock in trade. Generally these advisories can be recognized by the promises they make. "The more they promise," says one market veteran, "the more careful you must be."

Brokers, of course, supply market letters to their clients and prospective clients. These, it should be remembered, are primarily prepared as a means of producing commission business. That is not necessarily a black mark against them, since the well-established firms realize that the more useful their information, the more successful they will be in holding onto the business they seek. A problem with even the best, however, is that in recommending a broad spectrum of stocks as most of them do, they leave the individual investor pretty much on his own in building his portfolio.

Further, market letters are not always as helpful on specific stocks as an investor might like them to be. Some merely state their opinion on an issue, without backing it up with reasons. Others merely state the case statistically, and let the investor make up his own mind. The moral: No investor can expect any single market letter or advisory service to solve all his problems; he needs a selection.

Some of the better brokers' market letters can be obtained from New York Stock Exchange firms such as Harris-Upham, E. F. Hutton, Reynolds, Paine Webber, Dean Witter and Spencer Trask. Merrill Lynch's *Investor Reader* with the largest circulation of all goes bi-monthly to over 300,000 readers.

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large number of market letters. The difficulty is that most investors have only a limited amount of time to give to such reading. Another source of a prodigious amount of information is a new daily publication, *The Media General Financial Daily,* which has just been started in Richmond, Va. It combines in one place an amazing amount of material on almost 4,000 stocks.

A major question is the relationship between what an individual investor can logically spend for services in relation to the size of his capital. The burden is somewhat eased because money paid for market letters is tax-deductible.

One way to decide is to examine the popular services at most brokers' offices. It can also be done by mail at home. The Select Information Exchange, Box 770, Wall Street Station, New York 10005, sends on request a 45-page pamphlet listing 615 investment and business services. These are analyzed, priced and categorized. The SIE acts as selling agents for these services and does not give out addresses. But it does provide an economical means of sampling. Provision is also made for sampling up to 30 varying services and letters at relatively nominal cost.

Among the oldest and best-known publishers are Moody's and Standard and Poor's. S&P, the largest investment advisory and statistical organization, provides a wide choice of services available. One of the best all-around services is *The Value Line Investment Survey*. It gives tabulated and charted information weekly on 1,400 individual stocks. Unlike many letters, the advices are specific. The Mansfield Stock Chart Service provides charts and dozens of points of tabulated information weekly on over 3,000 stocks.

There is such a large variety of mutual funds today that they need to be selected in much the same manner as stocks in general. The best source of information is the Weisenberger Manual available in brokers' offices. Arthur Lipper & Co. provides current and complete fund statistics too costly for the average investor. This service is taken in the main office of the large brokerage firms. Stock Market Trendex and Related Services, published in San Antonio by E. C. Coppock, combines relative strength figures with perceptive comment.

In the final analysis, one must educate oneself, and take the time to make the most use of the market letters one receives. The greatest danger is to place too much confidence in a single source.

The time of year when stock losses can spell profits

It happens every fall, seemingly just in time to catch the World Series and the football season as it roars its way into action. An investor will examine his portfolio, survey his purchases and sales for the year to date, and decide, then and there, that something must be done to reduce the pain of the tax bite come the following April. And every year, that distinct minority of savvy traders knows precisely how to tackle the problem: Sell chunks of the portfolio and take tax losses to compensate for those taxable capital gains that seemed so burdensome earlier.

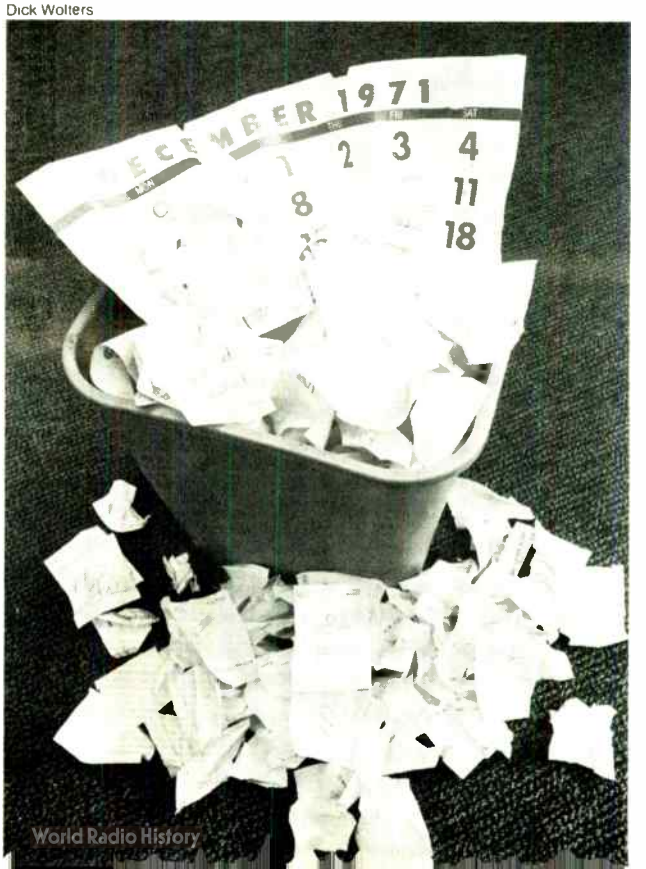
Late this year—in fact, right about now—perhaps a record number of American investors will join the pros in the yearend sell-off for tax purposes. The reasons for the crush this year are varied, but with the Dow-Jones industrial average meandering up and down through a 200-point range all year, chances are that more investors than ever before need the kind of tax write-offs end-of-the-year selling can provide. Whatever the reasons, however, one thing is certain: Any investor must carefully appraise his or her portfolio and—in concert with broker, investment adviser, or accountant—plan a rational strategy.

The reason for yearend tax selling, of course, is simply to balance gains or losses taken earlier. But as one Wall Street tax-sale expert cautions, "It's absurd to let the prospects of a few saved dollars in taxes govern portfolio strategy completely." Some investors, for instance, find liberal carry-over rules just too attractive to pass up. This lure is simply that a tax loss of any size can now be carried over indefinitely—until it's used up in its entirety. One can count himself lucky if he is not among these "I *must* sell it now" thinkers, but instead, uses tax sales for their intended purpose.

Once an investor has decided what he wants to sell for his tax loss and then has that strategy executed by his broker, he has taken the first step, but only the first. For example, if Harry Brown realizes $35,000 from a tax-loss sale in mid-November, he's still faced with a big decision: what to do with the money. One option is to wait out the market, and in doing so, plunk the money into some short-term markets—U. S. Treasury bills or commercial paper issued by corporations. But here one must tread cautiously; ever since the Penn Central bankruptcy, many brokers have assiduously avoided the commercial paper market like the plague. If Brown is not a veteran in that game, he should probably steer clear.

Even if he knows what to do with the money, he may forget to plan adequately for short-term cash needs—for such

Dick Wolters



things as, say, taxes. It sounds silly, of course, but some investors get caught with not enough money in their wallets on April 15. What can make matters worse is the very fact that the novice, if he finds himself in this bind, may also have sold the weaker stocks in his portfolio for losses. Thus, to pay the Internal Revenue Service, he must dip into the quality goods.

Such caution aside, there are some handsome benefits in tax-loss selling. For instance, once Brown balances capital losses against capital gains, he can offset up to $1,000 of highly-taxed ordinary income with any excess carried over to future years. With a little astute juggling, Mr. Brown might even be able to maintain his original position in a stock when making a loss sale. One way is to "double up" in November. In other words, Brown could buy a like number of shares of the same stock, then wait 31 days to clear the "wash sale" rule, which cuts off at 30 days—and sell to take the loss before yearend. (A note of caution on the "wash sale" rule: A recent IRS ruling states that stock bought on margin is now subject to the same criterion as stock bought for cash. Thus, Brown would lose the deduction if he sold margined stock at a loss within 30 days of buying other shares for cash.)

There are other forms of juggling. Harry could take the loss by Dec. 31, then wait the required 31 days to buy back; but this also is a bit chancy. Few investors have the patience to wait it out. Instead, they get anxious and purchase something else—often not as good as their original stock. A third form of maneuvering is the "switch". Promoted by some aggressive brokers, this method simply switches Brown into a similar stock in the same industry, using a list of "paired" issues supplied, of course, by the broker himself. But this may be dangerous, too, for obvious reasons.

If he plays his cards right, the investor might even be able to freeze a profit—or loss—and postpone the tax bite until 1972. For example, if he wanted to establish his paper profit, but avoid paying the capital gains tax next April, he could sell short (borrowing shares he doesn't really own, usually from his broker), then deliver in January or February his original shares in payment. By this method, the gain on the late-year short sale becomes 1972 income.

There are some drawbacks to this type of wizardry. If the stock nose-dives, the investor is safely ahead of the game. But, if it skyrockets, he misses the chance to ride up on the crest of the market.

Top analysts note that stocks that have been in a decline for most of the year tend to dive even deeper in December. Their advice to the tax-loss-sale investor with such goods in his portfolio: Sell now and avoid the Christmas rush.

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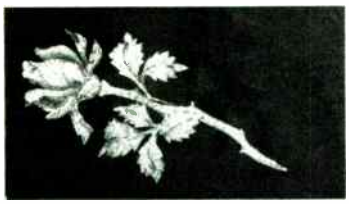


Jewelry is always an appreciated gift to give at Christmas—but also one of the most difficult to shop for. After settling the confusion over styles, quality and price, a man then usually is faced with the problem of coming up with something that is uniquely "personal". And if a special design is required—even a simple one—orders should be placed four or five weeks in advance.

Some comfort comes in knowing that not all purchases need be "big ticket items". The top shops, from New York's Tiffany to Shreve & Co. in San Francisco, all are showing popular and fashionable pieces in the $50 to $1,500 price range.

This season the trend is to polished yellow gold jewelry in classically simple patterns. The "in" items, such as heavy link bracelets, large clip earrings, and wide gold rings are all chunky-looking and geometrically designed. Styles and prices show up this way:

Bracelets of gold links are very popular gifts for wives. They sell for $250 to $450, depending on the bulkiness of the links. Or, in silver, shops such as Georg Jensen in New York are showing similar designs in sterling at $75 to $200. Bangle bracelets (solid circle) are popular, too, and if the woman in mind happens to favor delicate designs, Cartier's stock is quite good ($250). Wide, modern-looking puzzle bracelets, in 18-karat gold, run $800 and up at Tiffany's.

Hoop earrings are always in style. Plain gold rope designs—large and heavy—are available at Everts in Dallas ($200), and braided gold hoops run close to $300. Large geometric-shaped gold earrings are this season's choice in a number of leading stores around the country ($400 and up).

The simple chain necklace is another favorite; one particularly attractive pattern is of gold beads and twisted links ($280). One set with lapis lazuli, a strong blue stone, is $875. Shreve's big item this year is gold coin pendants which can be dangled from the chains. The pendants, mostly U.S. coins set in grooved rims, cost $110 to $175. Jeweled pins, too, are in vogue. A textured gold leaf with a single ruby or sapphire is $50 at Georg Jensen. And Shreve sells lots of braided bow pins ($100). A popular item at Chicago's Costigane & Geiger is an 18-karat yellow gold humming bird brooch set in diamonds and one emerald-$500. Tiffany's "Love" pin, set in diamonds and platinum, charms some buyers out of $975.

If the lady likes rings best, and most do these days, the style is most important. Something simple and classic is always a safe bet: a flexible gold link ring with four small diamonds ($425), a platinum band, set part way with small diamonds ($300), or with a full circle of sapphires ($430), or rubies ($450). Tiffany's "criss-cross" setting is in quiet, good taste. In gold, the ring costs $250, in coral or lapis lazuli, it's $975.

For the cocktail party circuit, Lambert Bros., New York, among others, is showing a striking solitaire ring of tanzanite, an intriguing blue-purple stone. It resembles a sapphire but costs only ¼ the price. Another eye-catcher is Tiffany's wide, square-shaped gold ring with letters on four sides spelling "love" in diamonds—$1575.

Diamonds are still "a girl's best friend" and a good investment, too. A one-karat diamond that sold for $1500 in 1965, this year is easily worth $3000.

Gold pill boxes pretty up a woman's purse and Tiffany has designed one studded on top with garnets and one diamond—$650. Watches are also welcome gifts. One with jade or lapis lazuli dials costs $750 and up.

Jewelry for a daughter or young bride may call for some ideas in a more modest price range. Solid gold chokers are still popular on the West Coast—$35. In the East, Georg Jensen has 14-karat gold pierced earrings with tiny cultured pearls attached—$20.

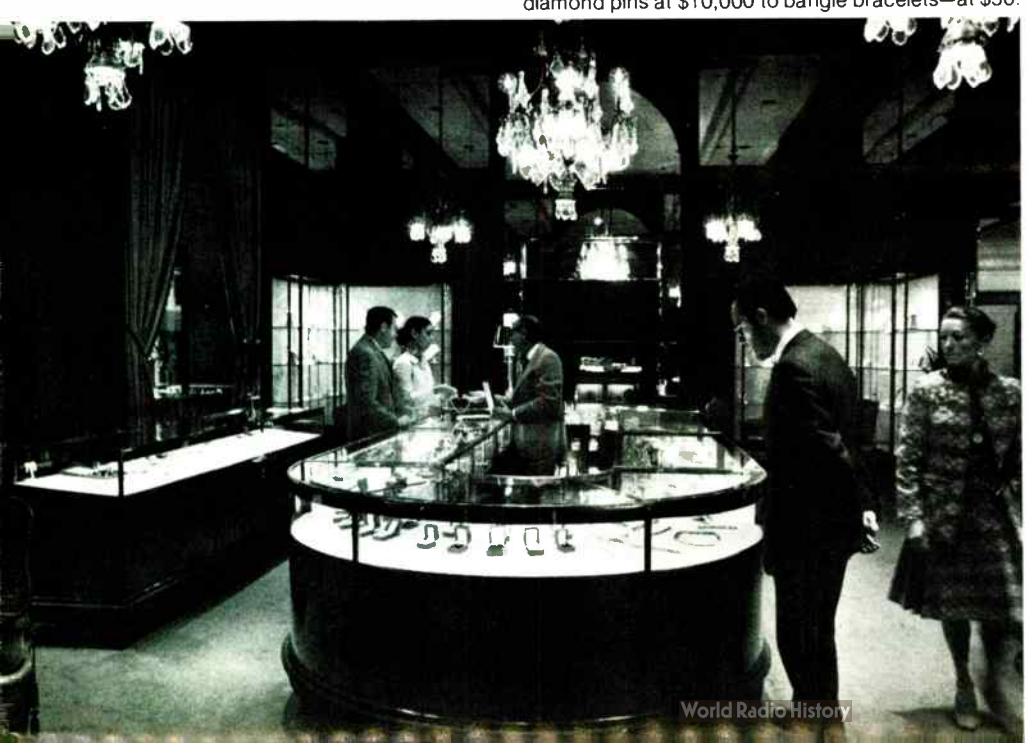
Successful gifts also include slim gold "pierced-look" hoop earrings ($55 and up) and thin gold bangle bracelets (up in price—$150).

Another fashionable idea for a young gal is a good-looking gold watch with a black leather strap ($75 to $100). A gold band can be added for another festive occasion ($150). Shreve's watch pendants are very reasonable at $25 to $50.

A gift for the secretary is next on the Christmas list. If she's under 35, jewelers suggest a pair of simple gold hoop earrings or a plain gold bangle bracelet ($20 to $50). If she's gadget-minded, a gold typewriter or phone, or such, shrunk down to charm size is well-liked ($30 and up). Or maybe better yet, a money-order for $30.

Some people are buying imitation jewels because of the increased danger of theft and the trouble and expense insurance involves. Top-rate department stores often carry a selection. For instance, Lord & Taylor's and Saks Fifth Avenue's Triamond and Diamonair are simulated—good foolers to wear to the fund-raising balls that get crashed by all sorts of people ($50 a karat).

Cartier's lovely shop in New York has everything from diamond pins at $10,000 to bangle bracelets—at $50.



Dick Wolters

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Big Island offers everything Hawaii has—and more

Each of Hawaii's seven volcanic isles has something different to offer, but the Big Island—the island of Hawaii which gives the 50th state its name—wraps up all their tropical treats in one neat package. Well, almost all. For some reason, it has no pineapples. So far it also lacks the traffic jams of Honolulu and the high-rise hotels of Waikiki.

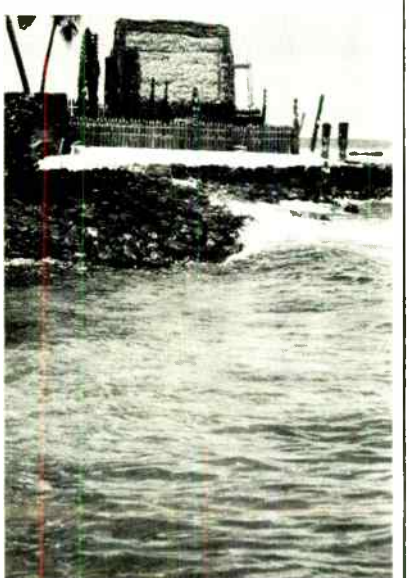
It *does* have golden sands and surfer's waves, swaying palms, bikinied girls, waterfalls tumbling into lush tropical valleys, wild orchids and live volcanoes—all standard equipment on Hawaiian isles. Then, exclusively its own, the Big Island boasts two of the world's loftiest mountains, exotic black-sand beaches, the second-biggest U.S. cattle ranch, and a melange of sports ranging from snorkeling to snow skiing, to sailing, sailplaning and sailfishing, plus big game hunting and upland bird shooting.

Real mountains are a rarity on so small a Pacific island—Big Island is big (80 X 100 mi.) only in comparison to the others—yet Mauna Kea soars 30,000 feet from the ocean floor to 13,730 above its surface, and its sister peak, Mauna Loa, is only 50 feet shorter. Even at this latitude (20 deg. N), both are crowned in winter with skiable snow. The scarred slopes of Mauna Loa, world's largest active volcano (its latest, leisurely eruption occurred in 1950), so resemble the moon's surface that U.S. astronauts trained there for their lunar landings. Snug against Mauna Loa's side lies Kilauea Crater, part of Volcanoes National Park, which has managed to generate a mild but spectacular eruption nearly every year for the past decade.

Centuries ago, violent eruptions spewed lava all the way to the sea, where it quickly cooled into crude obsidian glass. Time has slowly turned it into fine, black sand, creating the rare black beaches of Kalapana and Panaluu, along the Big Island's southern shore.

The Big Island's cattle tradition goes back to 1815, when seaman John Palmer Parker left his ship to help round up wild cattle for King Kamehameha I. The ex-sailor married a Hawaiian princess and set up a ranch of his own. Today the Parker Ranch runs 45,000 head of Herefords and 1,200 horses, tended by *paniolos*, tough Hawaiian cowboys who wear flowered *leis* for hatbands.

Adjoining the ranch is the Mauna Kea Beach Hotel. Travel writers grope for words to describe it, but usually settle for *spectacular*. Its championship golf course, designed by Robert Trent Jones, was carved out of an ancient lava flow,



The City of Refuge was an inviolate sanctuary for those fleeing tribal wars; its temple and great wall were built before 1550.

Red-hot lava bubbles in the weird lunar landscape of Hawaii's Kilaeua Crater.

Robert Emmett Smallman

and nearly every tee has a view of the sea; a Pacific cove, in fact, serves as the water hazard for the short third hole. The hotel's open-air corridors feature museum-quality art objects from throughout the Pacific and the Orient. At night, there are torchlit luaus at the water's edge, and underwater floodlights attract giant manta rays to play in the surf.

Mauna Kea Beach is not the Big Island's only fine hotel by any means. Others include Kona Village, luxuriously simple thatched cottages surrounding a lagoon, and the Kona Hilton, whose stepped-back terraces echo the shape of the volcanic mountains. Resort day rates (double) range from $22 to $65 at the Hilton, $55 to $85 at Kona Village, and $65 to $85 at Mauna Kea.

Few places on earth provide such a variety of action sports in so compact an area. The world record Pacific blue marlin (1,100 pounds) was caught just off the Kona coast, where charter boats can always be hired. There is superb snorkeling off Mauna Kea's own beach or state park beaches to the north, and fine scuba diving in deep waters off the lower Kona coast. Wilderness trips can be arranged to the summits of Mauna Kea or Mauna Loa, or into the mile-deep, tropical forests of Waipo Valley. Hawaii Island Safaris, Hilo, or Hawaii Trails, on the Kona Coast, can also arrange winter ski trips to the volcanic slopes, where the runs are five miles long, or sailplane flights over the Kohala peaks.

On the Parker Ranch and adjoining high country, the bird season runs from November through January. Besides in-season shooting for quail, pheasant, partridge and dove, there is bow hunting year-round for wild boar and the longhorn Mouflon sheep.

Both Pan American and United airlines provide daily jet service direct to Hilo, on the Big Island. Round-trip rates from the West Coast range from $387 for first-class on weekends to $222 for weekday coach. For the same price, visitors can arrive at Honolulu and leave from Hilo, or work out any combination within the Los Angeles-Hilo-Honolulu-San Francisco loop. And neighboring islands can be visited at the bargain rate of $5 apiece. There is scheduled shuttle service, too, between Hilo and the Kona resort coast, and one of the best ways to orient oneself to the wonders of the Big Island is a charter ride with Royal Hawaiian Airlines.

Mauna Kea Beach hotel is strikingly furnished inside (below), and smartly equipped for golfers (left), swimmers, sun lovers.

Robert Emmett Smalliman

It's a slim year, but Broadway still has much to offer

"I went to Philadelphia once," said the late Joe E. Lewis, "but it was closed." Lately other comics have been tempted to apply the old joke to Broadway. Year after year, the number of new plays and musicals that draw visitors to New York has shrunk. This year, with recession clipping the wings of potential backers, scarcely a dozen new shows are opening. But among them are hits that visitors will not only want to see but almost *have* to see before they go home, and the Philadelphia jokes about Broadway are—for another year—premature.

This season's big sure-fire smash is *Jesus Christ, Superstar*, the rock-opera retelling of the Passion that sold $1-million in advance tickets before opening. Performed at the Mark Hellinger Theater, with a gigantic cast and orchestra on a massive stage that rivals Radio City Music Hall's for trick effects, it is stunning audiences without regard to race, creed, color, age or national origin.

Neil Simon is back, too. The prolific author who brought Broadway *Plaza Suite*, *The Odd Couple*, and nearly a hit-a-year for the past decade, has done it again with *The Prisoner of Second Avenue*, pure Simon comedy augmented by the direction of Mike Nichols. With Peter Falk and Lee Grant in starring roles, *Prisoner* is at the O'Neill Theater, probably for a long run.

What *No, No Nanette* did for nostalgia last year, the 1940-ish splashy musical, *On the Town*, is doing this season, at the Imperial Theater. This is the one about the three sailors who spend their 24-hour liberty in New York in quest of the girl whose face smiled at them from a subway poster. Dancing and singing to the unforgettable Leonard Bernstein score, they are directed this time around by Ron Field of *Applause* fame of two

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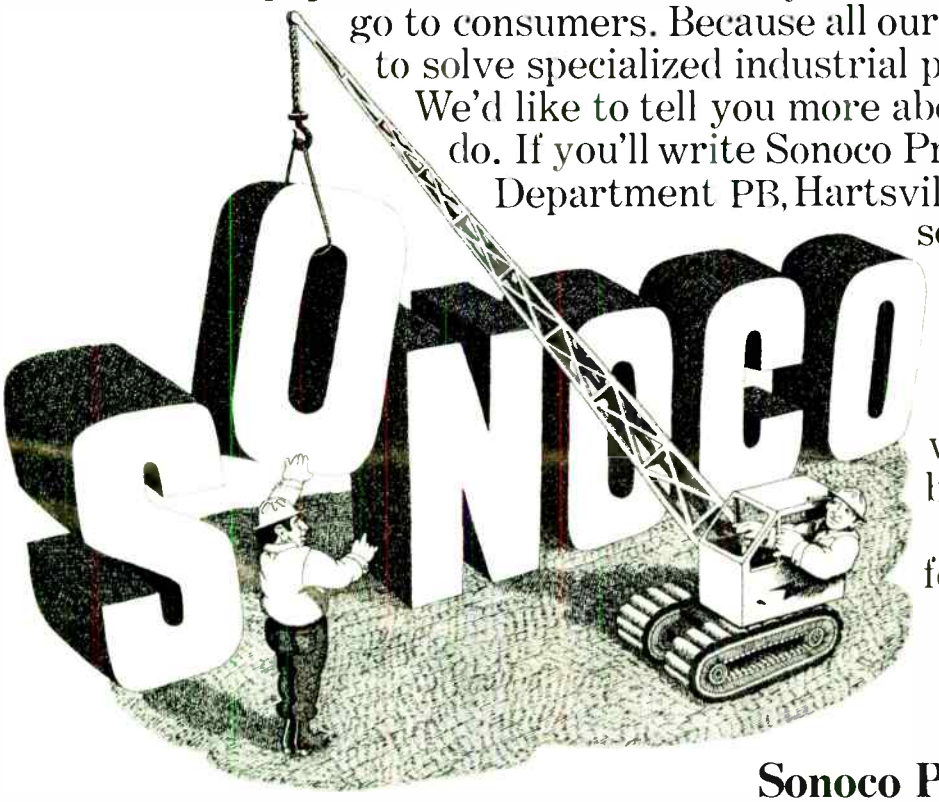

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seasons ago. With a big advance sale, *On the Town* seems sure to last.

For drama lovers, a handful of new plays are set, but the current tendency of Broadway audiences to foresake all but one or two each season makes it questionable which will be running during a visitor's stay. Last year's successful *Sleuth* and *Lenny* are both still running, of course. Among the new plays:

- *Old Times*, by Harold Pinter, at the Billy Rose. It has a top cast: Robert Shaw, Mary Ure, Rosemary Harris.
- *Twigs*, by George Furth (who wrote the book for the hit musical, *Company*), at the Broadhurst Theater.
- *Solitaire, Double Solitaire*, two one-act plays by Robert (*Tea and Sympathy*), Anderson, at the Golden Theater. The show was the first this season produced under a plan to cut ticket prices.
- *Ain't Supposed to Die a Natural Death*, by up-and-coming black playwright Melvin Van Peebles, at the Barrymore Theater.
- *Three by Roth*, three one-actors by Philip (*Portnoy's Complaint*) Roth, produced in the off-beat *Story Theater* "narration" style, at the Plymouth Theater.

Theater-goers also will want to keep an eye out for at least three other shows slated for Broadway runs. These include a revival of Leonard Bernstein's *Candide*; a play by Connor Cruise O'Brien, called *Murderous Angels*, and a dramatization of the life of writer-critic Max Beerbohm, *The Incomparable Max*, by Jerome Lawrence and Robert E. Lee, noted for *Auntie Mame*.

Last fall, a dozen new shows blos-

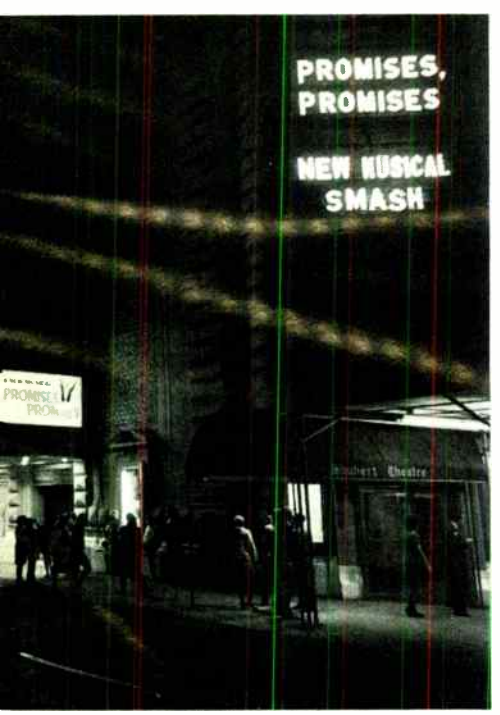
Broadway scene: With far fewer shows in town, the big hits are like pure gold.

somed off-Broadway. This year only two had been definitely set to open as the season began. Both are musicals—*Leaves of Grass*, based on the Walt Whitman work, and something called *Drat*. The famed Circle in the Square Theater also tentatively plans a musical version of *Member of the Wedding*, and Joseph Papp's New York Shakespeare Festival operation can usually be counted on for exciting and off-beat productions at its downtown Public Theater, where *Hair* and the Pulitzer Prize-winning *No Place to Be Somebody* were born, and ticket prices are reasonable.

Uptown, the Repertory Theater of Lincoln Center is playing a new translation and adaptation of Friedrich Schiller's *Mary Stuart*. It will be followed in January by *Narrow Road to the Deep North*, by the young Englishman, Edward Bond.

One happy result of the economic recession has been the blanket it has thrown over spiraling ticket prices, a Broadway plague in recent years. Slumping attendance, too, has prompted producers to offer "twofers"—discount tickets with which patrons can buy two seats for the price of one. The discount tickets can often be found in quantity at hotels and Broadway restaurants.

Some solace to the late-comer who can't get into *Superstar* or the new Neil Simon comedy is the availability of seats to some outstanding survivals from previous seasons. These include *Applause* (with Anne Baxter in the original Lauren Bacall role), *Follies*, *Company*, *Fiddler on the Roof*, *Hair*, *House of Blue Leaves*, and the youth-oriented musical, *The Me Nobody Knows*. Any one of them offers a memorable evening of theater.



Dick Wolters

Cash flow: The tax scene, and the SBICs

A tight squeeze in some businesses has junior, middle, and top-rank executives on the look-out for new jobs. Internal Revenue has at last cleared some air and given the man who is "relocating" a cash dividend. You can now tax-deduct the cost of employment agency fees, counseling fees, and even psychological testing fees—assuming you can show that by paying such charges, you were, in fact, installed in a new job. In a word: What you pay to *get* relocated is deductible; but what you pay for a fruitless search, is not. . . . Meantime, anybody who takes work home from the office may now deduct office-at-home expenses with less fear of being hauled on the carpet. Says the Tax Court: It's enough now to show that the homework is job-related—that it helps get the workload done. It is no longer necessary to prove that it is "essential," or required by the company. . . . Club note: A taxpayer tried to deduct his 19th-hole bar bill—and even his country club dues—because he played golf with clients. But the Tax Court turned him down flat: He failed to show that the costs were business-related. He was merely a gregarious golfer.

Small business investment company (SBIC) common stock is getting a bit of play. These firms, licensed by the Small Business Administration (SBA), put cash into new ventures, hope for profits and capital gains—and offer their own investors a unique tax break. An example from First Connecticut SBIC which is listed on the American Stock Exchange: Jones buys 1,000 shares of an SBIC common at $15 a share; a year later he sells at $20, and pays capital gains tax on his $5,000 profit, as usual. However, say that the market crumbles and in a year's time the SBIC drops to $10. Jones can take his loss by selling—and write off his *entire* $5,000 loss.

Hunting season is rated "good"

Things look interesting for hunters in most sections of the U.S., according to a detailed check of conditions by the Winchester people as reported in their updated *Hunter's Handbook, 1971-72.* Among big game, antelope will prove to be the highlight of the season, while white-tailed deer rate from "excellent" in New York state to "spotty" in parts of the upper Midwest (check on local conditions). You can look for mule deer to be in heavy supply in Montana and western South Dakota, and good to fair in most other areas. Ruffed grouse are rated high on the small game roster in most sections, with bumper crops, says Winchester, in the Midwest. As for ring-necked pheasant and bob-white quail, the situation is generally quite good. But if you go out for cottontail rabbit, pick your spot: the rating is good or better in 33 states, but spotty in 17 states. Full flights of ducks and geese across the U.S. mean local seasons and bag limits at about the same levels as last year.

Xmas planning: high-powered ideas—for Dad

You might start to do a bit of early Christmas-gift hinting, and line up an item that someone in the family may decide is just what *you* really need. Here are a few choice high-ticket ideas that may take some advance planning: Eastman Kodak has two new super-8 movie cameras that make it possible to do indoor scenes in color without using movie lights. With a new type film, you can even bring off candlelight shots (XL33 and XL55 cameras, $120 to $200). . . . Smith-Corona's entry for the man who types in duck blinds or on Caribbean beaches is the Electra SS which has a nickel-cadmium rechargeable battery, with no plug-in needed for efficient electric typewriting ($190). . . . Hand-size electronic calculators that can save hours of pencil work, no matter where you are, are gaining favor; Monroe's new Shrimp model does a print-out on tape ($379), and Sharp has over 15 models that come with and without the printing feature (tax-deductible, $190 up). . . . Omega's new Speedmaster chronograph watch is well designed, has a heavy-duty stainless steel case; worn by Apollo astronauts ($195). . . . Cheers: The Wine Vault is a completely self-contained "cellar" made of redwood; stays at 53-57 deg. Smallest size racks 256 bottles, is 4 x 3 x 6, costs $995 (Box 6298, 909 Park Ave., San Jose, Calif. 95150).

International Newsletter

November 8, 1971

TI wins contract for MRCA nose radar . . .

The award for the mapping and terrain-following radars on the British-German-Italian Multi-Role Combat Aircraft finally has been made, and the winner is Texas Instruments Inc., Dallas. TI took the contract, worth an initial $1.3 million, from high-powered competition including the Autonetics division of North American Rockwell, and Britain's Elliott Automation Radar Systems Ltd. and Ferranti Ltd. [*Electronics*, International Newsletter, Aug. 16].

The award, granted by Panavia Aircraft GmbH, the German firm that has overall responsibility for the plane, covers development and testing of the radar, but has options that permit production of the unit by TI, by selected European companies, or both. As for other MRCA hardware, German sources say Litton Technische Werke, a Litton Industries subsidiary, is the front-runner for the weapons computer.

. . . and designs two ICs for TV sets

Texas Instruments Ltd. of Bedford, England, is readying two TV receiver integrated circuits that promise substantial manufacturing savings. One will give line and frame oscillator outputs; the line unit contains a phase comparator, voltage-controlled oscillator, and flyback pulse shaper, and the frame section a frame integrator, oscillator, and two optional outputs. Both sections are fed from an integrated sync-pulse separator and noise gate in parallel. TI engineers say minimal external components will be required without sacrificing performance, so that set-making costs can be cut. The second item is a four-pin, 2.5-watt rms, Class A-B audio amplifier specifically for TV and intended to be cheaper than the discrete components it replaces. Both should be available early next year.

Fujitsu boosts capabilities of newest computer

Lower prices of integrated circuits, particularly TTL/MSI, have enabled Fujitsu Ltd. to greatly expand the capacity of its latest computer model, the Facom 230-55, without significantly raising prices. The new unit had been slated to go on the market as the Facom 230-45D [*Electronics*, Electronics International, March 1], but was renamed to reflect the increased capacity—three times that of the Facom 45S and about five times as much when used as a multiprocessor. Capabilities added by the greater use of ICs include pipeline processing and expansion of the data bus; the unit has 32 data channels. Memory configurations are a wire unit with a cycle time of 0.6 microsecond or a core version with a 1.2-microsecond cycle time. Maximum storage size is 2,040 kilobytes.

British wind down Black Arrow program

The success of the second all-British attempt to put a spacecraft into orbit may also be the last all-British launch. The $5 million, 145-lb. X-3 technology-proving satellite, built by British Aircraft went into polar orbit from a Black Arrow launcher late last month from Woomera, Australia (the first attempt failed 14 months ago). But because the Black Arrow program is being run down to save money, the only definite successor is X-4, another small technology prover, which will go up in an American Scout Rocket early in 1974; Hawker Siddeley Dynamics Ltd. is prime contractor. The government won't decide what's to follow X-4 till next year; best bet is a larger, geostationary technology prover. It's not likely that the government will kill the satellite programs.

International Newsletter

Yet another new low for Japanese calculator prices . . .

The latest company to drag down the steeply declining price curve of Japanese electronic calculators is Eiko Business Machine Co. Ltd. The firm will be selling by the end of the month a 12-digit, line-operated unit in Japan for about $90. **An important reason for the calculator's low price, says Eiko, is the inexpensive cost of the unit's single LSI chip imported from Caltex Corp. of Saratoga, Calif.** Eiko plans to export the calculator to the U.S. next year as a semifinished product, with the LSI chip to be installed by Caltex.

. . . as Germans fret over domination of their market

West Germany's calculator manufacturers are angry over unabated imports of low-priced Japanese models, which have now captured roughly 80% of the German market. Although Japan officials recently declared they will not step up their sales activities in Europe to offset losses on U.S. markets, **the West German industry remains highly skeptical.** Prices for Japanese calculators sold in West Germany have dropped very significantly in the past five years, during which time their share of the market has risen from less than 10% to the present 80%. Calculator producers in West Germany and elsewhere in Europe are now considering an appeal to Common Market commissioners.

French move to curb imports from Asia

France and Japan are optimistic that they can get together on terms for a new bilateral agreement limiting importation of Japanese consumer electronics into France. The current four-year agreement expires in 1973, and French and Japanese officials recently decided to open talks next April for a new accord.

Meanwhile, French customs officials are cracking down on importation of Asian components, apparently on instruction from the highest government levels. Quotas on components shipments from Asian countries previously had not been rigorously enforced, **but now "they're interpreting the law to the letter,"** complains an executive of a company that has spent several weeks trying to get clearance for a $30,000 semiconductor shipment from its Formosa plant.

ITT subsidiary takes contract for British telephone exchanges

The British Post Office has awarded contracts for that nation's first large electronic telephone exchanges to Standard Telephone and Cables Ltd., an ITT subsidiary. Worth $36 million, the award covers final development, production, and installation **of initial systems that will use electrically held reed relay switches controlled by solid state logic.** Call instructions are in plug-in, threaded-core storage modules. The system, known as TXE-4, is a joint development of the Post Office and industry for local exchanges of up to 40,000 lines. It complements TXE-2, which is similar in principle and handles up to 2,000 lines. London will get the first exchange, probably in early 1975.

East, West Germans set up TV link

Although politically still far apart, the two Germanys are getting a bit closer together in communications. In addition to establishing considerably more direct telephone, teletype, and automated telegram connections, **negotiators have agreed to set up an across-the-border microwave link for television transmissions.** The link, to be built by West Germany's Siemens AG and scheduled for operation in mid-1972, will be the first to be established since the Berlin Wall went up in 1961.

Japanese computer leaders team up

Hitachi and Fujitsu, two of leading computer makers, surprise industry by plans to jointly build new line

Japanese computer companies, with government-approved liberalization of foreign investment only a couple of years away, are beginning to join forces in what will be a major industry realignment.

But far faster than anyone expected, two of the three top computer makers, Hitachi and Fujitsu, have revealed they will jointly develop their next generation of computers.

Significantly, the new computer line will be compatible with the requirements of the Nippon Telegraph and Telephone Corp.'s ambitious time-sharing system and the policies of the powerful Ministry of International Trade and Industry.

It will be at least three years before the first computers developed under this agreement are ready for the market. The complete series of 3.75- or 3.8-generation computers will probably cost between $150 million and $300 million to develop. The fourth generation will be the pattern-oriented computers to be developed in MITI's eight-year large-scale project [*Electronics*, Sept. 13, Electronics International].

Compatible. Both companies want the new line of computers to become the main series in Japan. That is why they want to build computers that meet NTT and MITI standards. A commercial line of computers that meets NTT's DIPS time-sharing system's specifications will make life easier for manufacturers by eliminating the need to build two series of computers, and it will make costs much lower for NTT because of higher production.

The agreement was initially worked out by vice presidents of the companies, Toshihiko Kubo of Hitachi and Hiroshi Seimiya of Fujitsu. They were classmates in high school and because they are working in the same industry have kept in touch with each other through the years.

They say that there is no definite date when they first agreed to agree, but the impetus came toward the end of this spring as MITI firmed up its decision to liberalize foreign investment for production of computers in three years.

Kubo says that talks had started before RCA announced that it was withdrawing from computer production, and that the move did not have much effect. Starting last year RCA slacked off on development as its computer income fell off, and Hitachi was not receiving much of value from RCA recently, according to Kubo.

MITI. An important factor in inducing the two companies to agree to cooperate is the policy of the Ministry of International Trade and Industry. It is now negotiating with the Finance Ministry for a special appropriation to promote the electronic computer industry that will total (at the deflated rate of 330 yen equal $1) $421.2 million during fiscal years 1972-1976.

Funds from this appropriation would not be available to individual companies but only to groups of companies for joint development—this is a sweetener to promote realignment of the industry. The source of these funds would be increased tariffs from imports of data processing equipment in excess of $70.9 million expected to be collected during the current fiscal year.

Most important categories within this appropriation include a subsidy for the promotion of the development of new models of computers. This means computers competitive

Joint venture. Laying the foundation for what could become Japan's leading computer producer are Yoshimitsu Kora, president of Fujitsu, Kenichiro Komai, president of Hitachi, and Kakuei Tanaka, head of the Ministry of International Trade and Industry.

with IBM's series 370. Total for this category would be $300 million, of which MITI will request $15.2 million for 1972.

The others. Meanwhile, there is the question of how the four remaining major computer companies in the industry will realign. Most observers feel that Nippon Electric Co., will form one group, and Oki Electric Manufacturing Co., Oki Univac Kaisha Ltd., and Mitsubishi Electric Corp. will form a third.

Toshiba has expressed an interest in cooperating with Nippon Electric. But NEC is not as eager, because it holds the best cards. NEC sales of computers run between two and three times those of Toshiba. Also, NEC is a supplier of both DIPS computers and electronic telephone exchanges to NTT, while Toshiba is in neither of these two markets.

Both companies have ties with Honeywell Information Systems: Nippon Electric on the strength of an overall agreement with Honeywell, Toshiba on the strength of a model-by-model agreement with General Electric.

Mitsubishi Electric and Oki Electric say they are seriously considering buying equal size blocks of each others stock, probably 1 million shares each.

France

High-speed camera dissects explosions

Necessity, that well-known mother of invention, has pushed French military researchers into development of an electronic camera that can stop action at any given nanosecond. Ballistics experts have kept the device busy eight hours a day for several months snapping somewhat foggy but quite revealing pictures of explosives in the act of exploding.

Without revealing any military secrets, Jacques Marilleau, project manager of the team that perfected the instrument, first spoke publicly about his research a year ago at an international congress on high-speed photography in Denver. Since then he and about a dozen aides have put their camera into full operation. They believe they have the fastest shutter in the world, using a Hyperelec image converter tube instead of the conventional mechanical open-shut device to capture a glimpse of movement as brief as one nanosecond.

Marilleau still declines to talk much about what's happening on the firing range, but he says his camera is taking it all down with precision. One example he cites is a test of a detonator, which should cause an explosive device to explode uniformly.

But by photographing the bottom of the device, the experts found that the explosive material under test was being ignited unevenly because the detonator was slightly cockeyed. Calculations from the photograph showed that a minute adjustment of some 0.3 millimeter was needed in the device to attain uniform detonation.

Three shots. Marilleau's lab, which is in the military applications section of France's Atomic Energy Commission, worked on the camera for more than two years, striving to better the maximum speed that a mechanical camera can achieve—about 100 nanoseconds.

It seems 100 nanoseconds was just too slow for checking out the behavior of the latest explosives. Electronics provided the answer—the key component being the electron image tube that receives the visual image via a zoom lens. The image tube contains a photoemitting cathode plane separated by a few millimeters from a photoluminescent anode. The exposure time, or shutter speed, is regulated by controlling the duration of a 10-kilovolt pulse applied between cathode and anode. The beam of light to be photographed is split in three parts and fed into three tubes so that the camera can take up to three pictures in sequence with variable intervals between exposures.

Instead of using emulsion-coated paper to capture the image, the team channels the image-tube emissions through a conveying lens, then into a storage tube. The picture can be recorded on magnetic tape, visualized on a cathode ray tube, or digitalized computer analysis.

Marilleau and his crew say they don't expect to sweep the consumer market with their $100,000 instrument, but they say three have been built for use in France.

Austria

Paralyzed patients get an electronic hand

For people whose limbs are paralyzed as a result of certain spinal cord injuries, help is coming in the form of an electronically controlled device that lets them move at least their fingers again. Developed by a small Austrian firm, the apparatus enables patients to do on their own such basic life functions as eating, and it allows the use of their hands even for more complicated jobs like writing and dialing a telephone.

The device was developed at Viennatone Hörgeräte GmbH, a Vienna-based company known in Europe primarily for its expertise in hearing aid design. Lately, though the company has been getting involved in building electronically controlled artificial hands and limbs [*Electronics*, May 15, 1967, p. 233]. Called Orthomot, Viennatone's new apparatus has already proved itself at Austria's Tobelbad Rehabilitation Center and is now being used at various medical institutions throughout the country.

Control problem. As in artificial limb control units, tiny myoelectric signals generated by muscle contractions are used to initiate motion of the patient's fingers. However, limb control in a paralyzed person is a much more difficult task because only one muscle may be still active enough to generate usable signals. In that case the same signal must be used to control gripping an object, releasing it, or holding it tighter. Thus, Viennatone came up with a different approach to electronic control circuit design.

In the Orthomot system, the

Gripping. Unit uses impulses from single muscle for holding, tightening, or releasing.

muscle-generated signal—usually in the order of microvolts—is picked up by a gold-plated electrode on the skin near the active muscle. A small integrated circuit preamplifier incorporated in the electrode housing boosts that signal by about 20 decibels and passes it through an impedance converter to the control unit. Here, in a three-stage, low-frequency amplifier, the signal is again boosted, this time by approximately 60 dB, and applied to a small motor, which controls a flexible cable attached to the patients fore and middle fingers.

The control unit, about the size of a cigar box, is usually fastened to the patient's wheel chair but can also be attached to his belt for easier switch manipulation. In addition to the amplifier and the motor, the 3-pound unit houses a reduction gear for the motor as well as the power supply.

When the one active muscle is contracted the fingers begin to close, and when the muscle is relaxed the finger motion stops. At the same time, a sequencing circuit is "preprogramed" for the subsequent finger opening so that the next muscle contraction results in releasing motion.

However, if the patient wants to tighten his grip around an object, he momentarily contracts the muscle, producing a short pulse-shaped signal. This intermediate pulse bypasses the control circuit's's direction-reversing portion and causes the already closed hand to exert more pressure around the object.

Threshold. The sequence circuit employs digital techniques in which a Schmitt trigger, a bistable multivibrator, and several gate circuits handle the signal processing jobs and provide the proper 1 and 0 inputs to a bridge circuit preceding the motor. When the amplified and rectified myoelectric signal at the input of the Schmitt trigger reaches a certain threshold, the digital outputs of that trigger and of the multivibrator work to open the hand. When the signal remains below the threshold, the outputs cause the motor to close the hand.

Once an object is grasped, an automatic locking mechanism keeps the fingers around the object after the muscle is relaxed. This feature enables the patient to hold objects easily for longer periods of time.

So far, Viennatone has built around 40 prototype Orthomots. Once volume production gets underway, it will sell for around $420.

Japan

3-d radars take shape

Three-dimensional radar is one area of defense electronics where the Japanese have advanced a long way by themselves. Unlike much other defense electronics, where the U.S. shared its technology with Japan, 3d radar was withheld from the Japanese, who were thus compelled to develop their own. They now have two advanced types of S-band systems, one for permanent installations and one that is transportable.

Until now Japanese radar sites have used two-dimensional radar for distance and direction information, and separate nodding-type height-finding radar to obtain all third-dimension coordinates. But in the early 1960s, as plans were made for upgrading sites to include automatic tracking, simultaneous digital processing of several targets, and rapid digital transmission of data, the nodding-type radars became a bottleneck.

Progress. In 1964, a 3-d radar prototype development contract was awarded to Mitsubishi Electric Corp., which began its work with development of the antenna system. Overall cost of developing the prototype and testing was more than $3 million. The first operational 3-d system will be completed and installed before the end of next March, and one system will be installed each year for the next few years.

This radar is similar to Mitsubishi's air traffic control radar [*Electronics*, June 21, p. 68], but uses multiple mirror and horn antennas rather than a single mirror and horn antenna and multiple stick antennas. The transmission of a fan beam from a single mirror and horn antenna enables it to maintain all of the desirable aspects of previous two-dimensional systems while adding a third dimension.

The prototype system used vacuum tube circuits and has a total of four mirror and horn antennas to form the phased array needed for height information. The operational radars use solid state circuits except for high-power transmitter stages and have a total of three mirror and horn antennas.

They will be installed in place of radars now used at sites of Japan's Base Air Defense Ground Environment system. In addition to its excellent characteristics, this radar also includes moving target indication (MTI) capabilities and sophisticated capabilities against electronic countermeasures (ECM) including jamming and chaff.

Portable. In 1969 a contract was awarded to Nippon Electric Co., for a transportable 3-d radar system for use as a backup to the fixed site radar. In this program, the prototype phase was skipped and the first sys-

tem built was an operational unit, which was delivered last March.

The principle of operation is completely different from that of the Mitsubishi equipment. NEC uses a single planar phased-array antenna with phase-frequency scan. Combined phase-frequency scan is used for elevation scan while the azimuth scan is performed by mechanical rotation of the antenna. This radar has many of the same features as the fixed radar, including digital processing of data from many targets, MTI processing, track while scan, and ECM capabilities.

Feeding. The aperture of the antenna for this radar consists of 64 identical waveguide linear arrays, each of which contains 76 inclined radiating slots. In series with the feed of each linear array is a four-bit digital nonreciprocal ferrite phase shifter, which can be set for one of 16 different phase shifts.

Since each one of the linear arrays is fed from a different point along a common feed line, the phase with which each linear array is excited varies with frequency. In this antenna, the effect is enhanced by having the feedline meander rather than going straight between arrays to achieve additional delay.

The antenna is designed so that succeeding steps of the digital phase shifters cause a radar beam scan of 3°. In practice, scan in increments of 1° is achieved by using three separate frequencies for transmission—the phase shift in the meandering line then gives a 1° difference in scan angle between frequencies.

In operation each pulse from the radar consists of three subpulses of different frequency. These pulses leave the antenna with directions differing by 1° increments.

Balance. The combined use of frequency and phase scan is very advantageous. Use of frequency scan alone would require a very wide bandwidth. The band allocated for radar in Japan is not too wide, and use of the necessary large frequency sweep would cause interference to other radars and other services. The use of phase scan alone would require an excessively long time for each scan.

The antenna is about 20 feet wide and can be transported in a truck. Altogether the radar system with an air-inflated command center can be transported in six trucks.

Great Britain

For phased-array radar, a new steering technique

To simplify some of the problems of driving phased-array radars, researchers at University College, London, have developed an harmonic oscillator locking technique as a means of accurately shifting the phase of a fundamental frequency.

A free-running oscillator is quite often controlled by feeding into the circuit a small-signal oscillation that locks the oscillators phase or frequency. Though the frequency ratio of the oscillations is generally 1 to 1, the technique will work equally well if the locking frequency is at some harmonic of the locked frequency, say 3 or 4 to 1.

Jump. The principle of the UCL group's work is that with a locking frequency of four times the fundamental frequency the phase can be shifted through 90° if the fundamental oscillator can be made to jump out of lock and resettle one cycle of the locking signal earlier or later. A double jump would give 180°. Other angular shifts can be obtained by changing the harmonic.

Using 100-milliwatt, 1 gigahertz transistor oscillators, the UCL researchers have found that a short pulse of around 50 millivolts applied to the transistors base will change its frequency by about 1 megahertz, which is sufficient to make it jump out of lock and resettle 90° away. Whether it is earlier or later depends on the polarity of the pulse.

The greater the pulse voltage, the faster is the rate of change of frequency, and hence the quicker the phase change can be made. John Forrest, one of the development team, says they have not tried to optimize pulse voltage and duration yet, but with the 1-gigahertz setup they have achieved 90° switching times of 40 nanoseconds. In any case, voltage and duration do not seem to be critical within 20% or 25% of the probable optimum. Transistor oscillators require less power than Impatt oscillators for locking and shifting between second and fourth harmonics, but Impatts are better between third and fifth. Forrest says this is because the two types of device have different nonlinear characteristics.

Test. The group has expanded the experiment into a five-element, inline phased-array antenna, using a 4-GHz locking signal. With the five transistors locked in phase, the antenna is looking at right angles to the array. A probe test after moving the first transistor 180° forward, the second 90° forward, the fourth 90° backward, the fifth 180° backward, and leaving the middle alone, showed that the beam had steered.

Forrest says a practical cw surveillance radar would probably use some dozens of transistor oscillators or Impatt oscillators controlled from a single locking oscillator. Beam steering flexibility would depend primarily on the transmission wavelength and the distance between the elements, and it is unlikely that a harmonic higher than the fourth would be necessary for the locking oscillator. It should be possible to phase shift all the outputs more or less simultaneously.

Compared with conventional cw phased-array systems, the UCL system has the advantage that it could be made entirely from low-power solid state devices, and it would need no power dividers or ferrite phase shifters. It could also be very easily controlled from a computer.

Limits. Forrest doubts it would work in the fm mode. That's because fm radars use a bandwidth greater than the frequency range through which any likely output oscillator would stay in lock, so that the system would be unstable. He thinks that even in the cw mode there might be a problem from interference pulses producing spurious jumps, but this could be countered by returning to the in-phase condition on all elements between steer points instead of moving progressively.

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Brussels 1040, Belgium
Tel. 13-65-03

Stockholm: Brian Bowes
Office 17, Kontor-Center AB, Hagagarten 29,
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European Special Project Manager: Oliver Ball
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Tokyo: Masaru Wakeshima, McGraw-Hill Publications Overseas Corporation, Kasumigaseki Building 2-5, 3-chome, Kasumigaseki, Chiyoda-Ku, Tokyo, Japan
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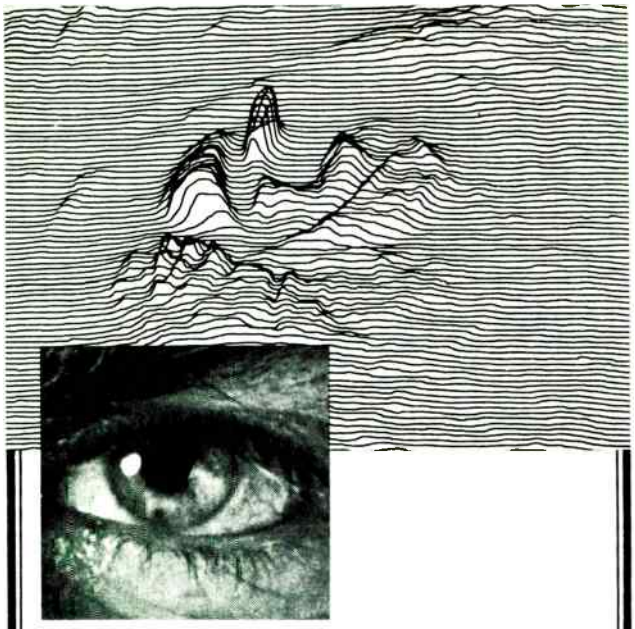

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6	27	48	69	90	111	132	153	174	195	216	237	258	279	300	321	342	363	384	405	426	447	468	489	965
7	28	49	70	91	112	133	154	175	196	217	238	259	280	301	322	343	364	385	406	427	448	469	490	966
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20	41	62	83	104	125	146	167	188	209	230	251	272	293	314	335	356	377	398	419	440	461	482	958	979
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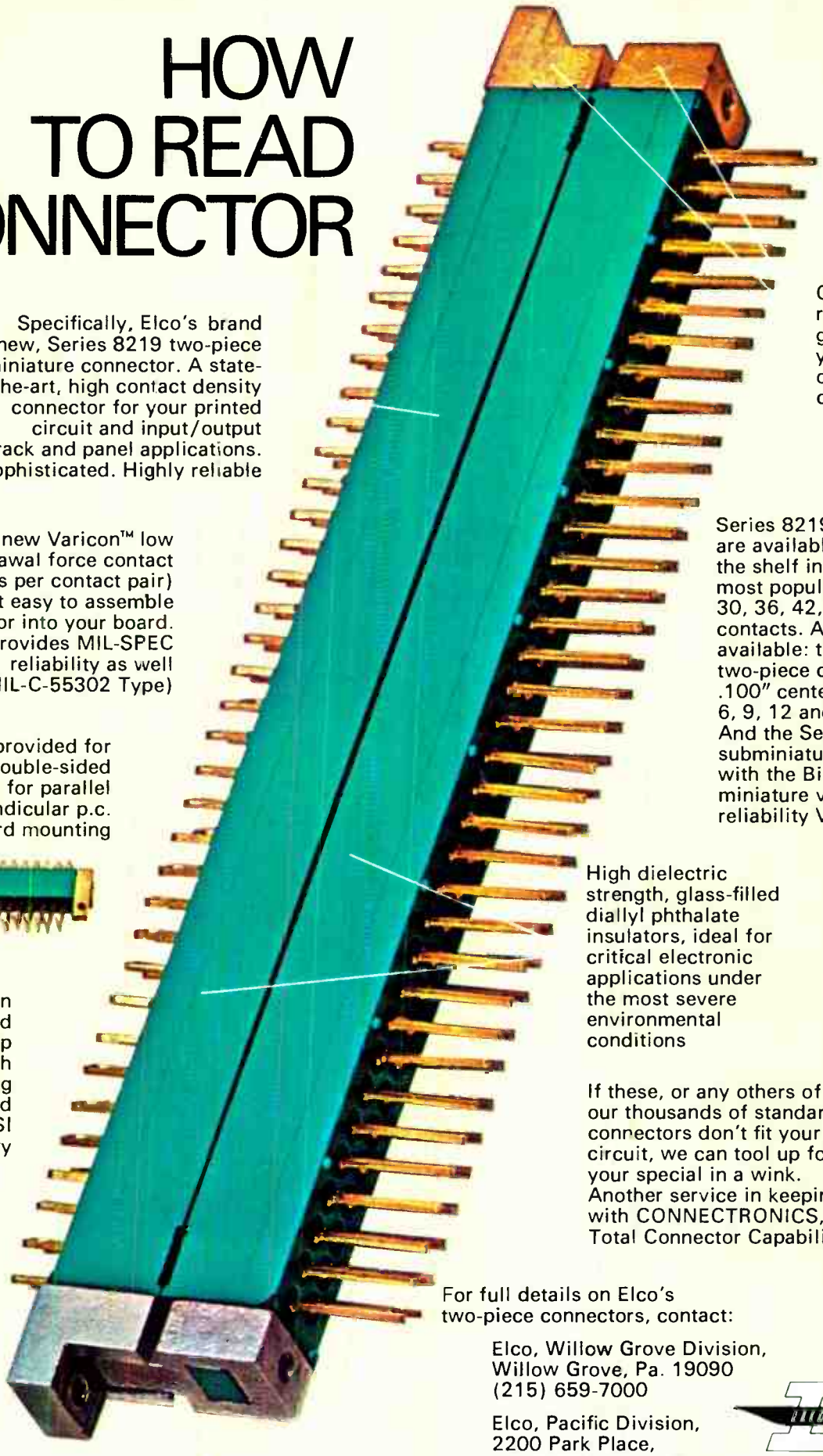

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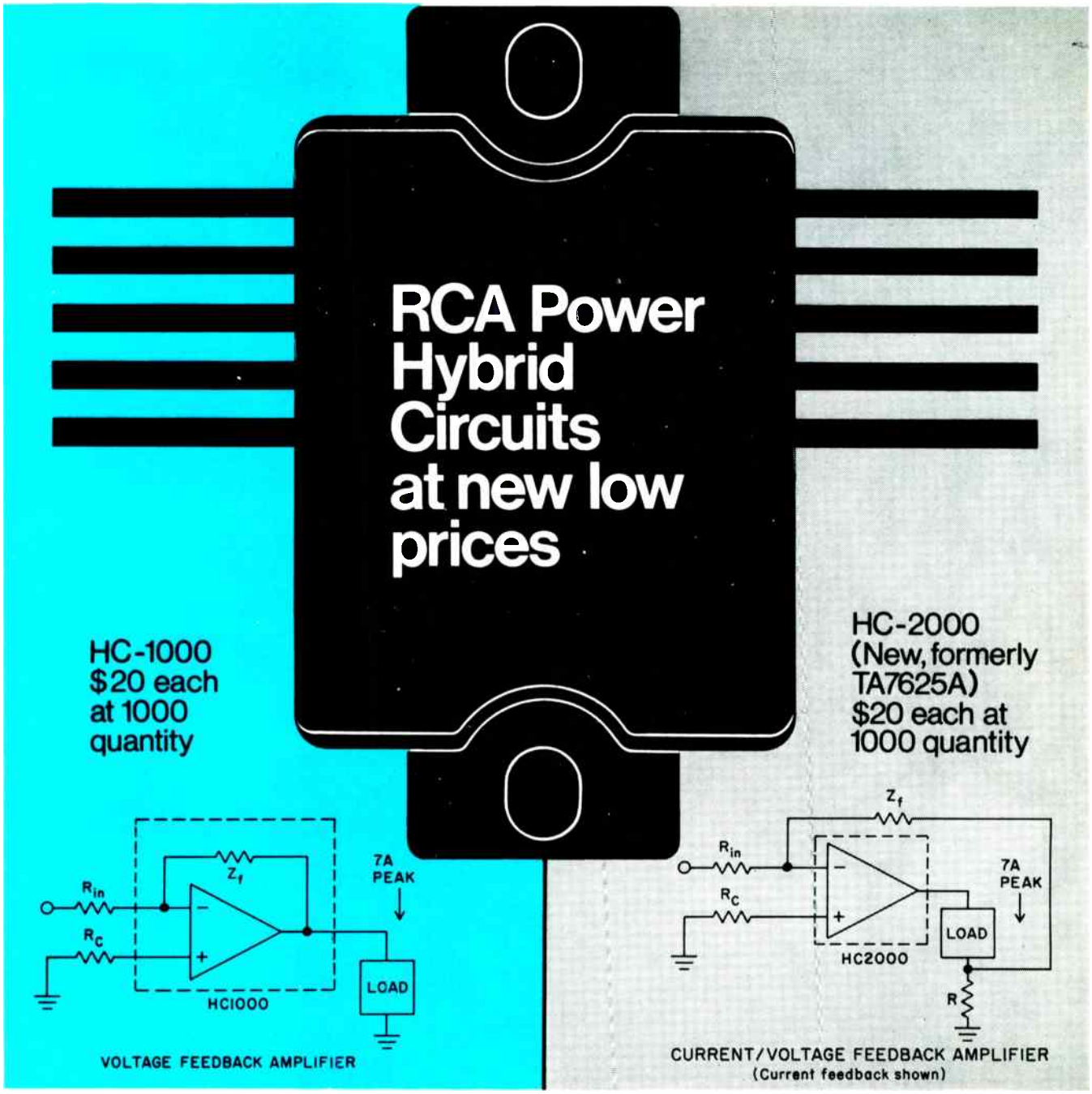

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