$1.00 A McGraw-Hill Publication
August 4, 1969

Electronics®

It's a GRrrrand Counter

Aye, that's what you'll think of our new counter. From its wee size to its big performance, the 1192 is new in every respect.

- It's only 8½ inches wide by 3½ inches high.
- It measures frequency (from dc to 32 MHz), period (single and multiple), time interval, frequency ratio, and, of course, it counts.
- Units of measurement and decimal point are automatically displayed.
- Input sensitivity is another surprise, a wee 10 mV is all you need (up to 25 MHz); and you can control trigger threshold and attenuation.
- An internal crystal oscillator gives more than enough stability for most work.

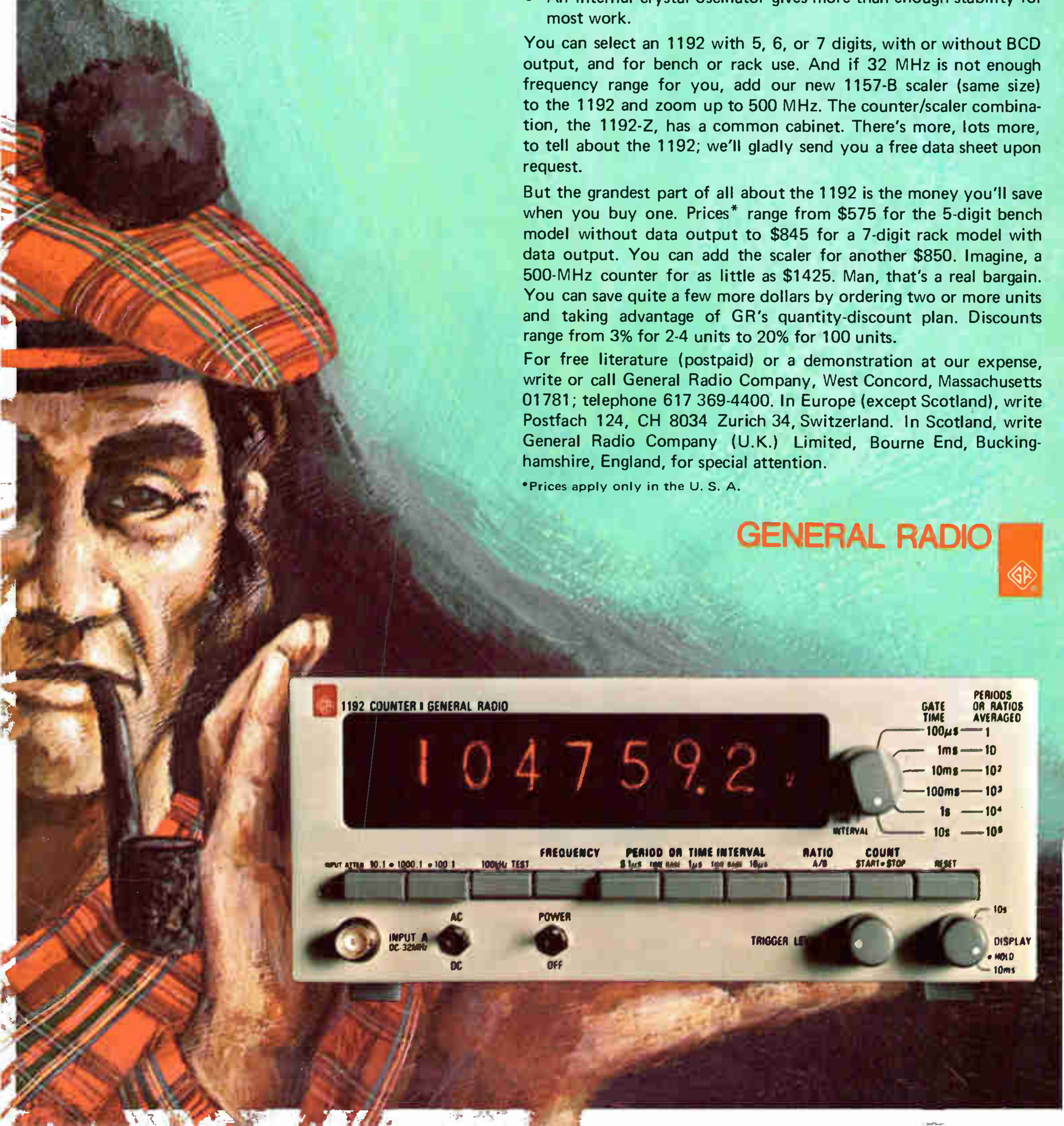
You can select an 1192 with 5, 6, or 7 digits, with or without BCD output, and for bench or rack use. And if 32 MHz is not enough frequency range for you, add our new 1157-B scaler (same size) to the 1192 and zoom up to 500 MHz. The counter/scaler combination, the 1192-Z, has a common cabinet. There's more, lots more, to tell about the 1192; we'll gladly send you a free data sheet upon request.

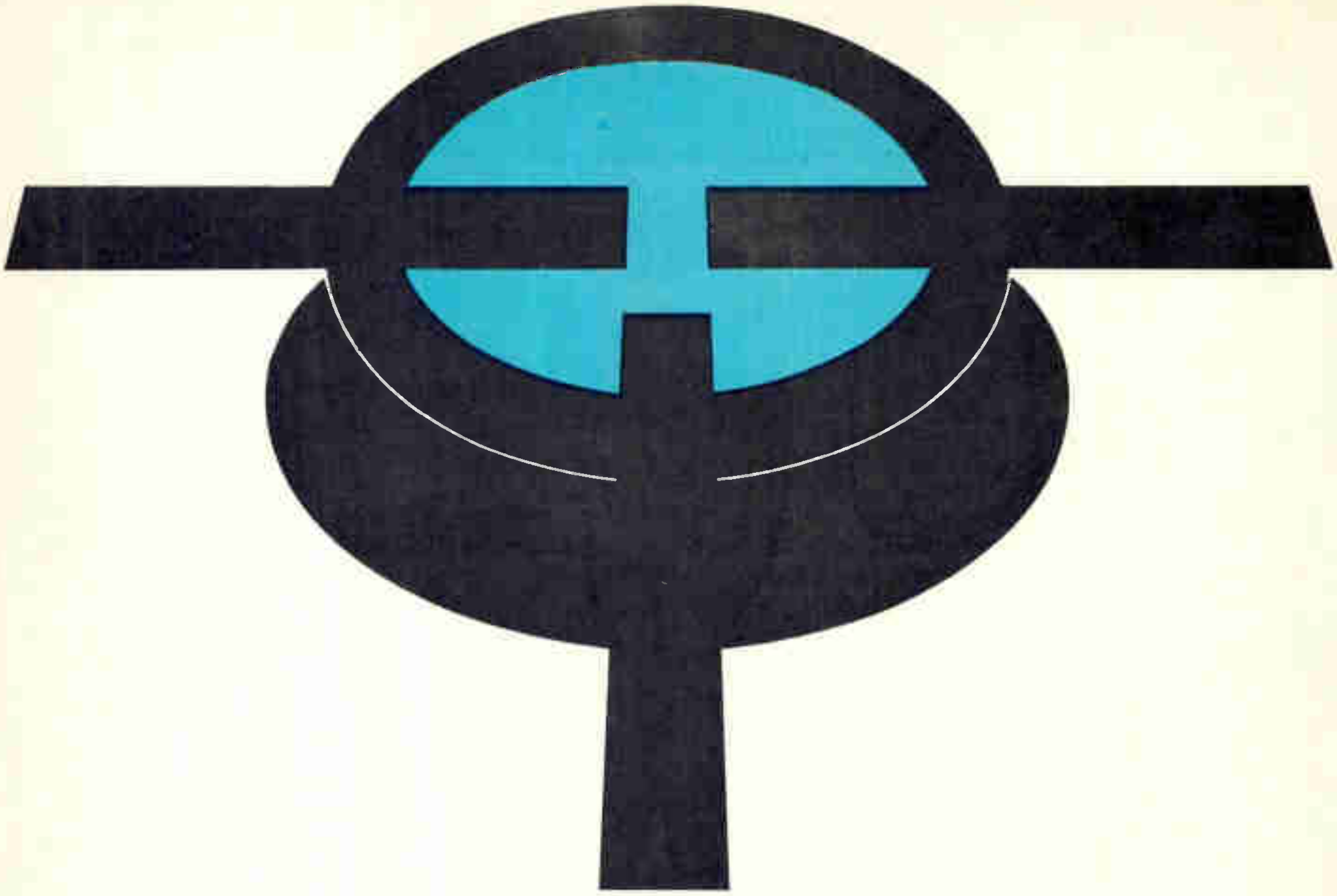
But the grandest part of all about the 1192 is the money you'll save when you buy one. Prices* range from $575 for the 5-digit bench model without data output to $845 for a 7-digit rack model with data output. You can add the scaler for another $850. Imagine, a 500-MHz counter for as little as $1425. Man, that's a real bargain. You can save quite a few more dollars by ordering two or more units and taking advantage of GR's quantity-discount plan. Discounts range from 3% for 2-4 units to 20% for 100 units.

For free literature (postpaid) or a demonstration at our expense, write or call General Radio Company, West Concord, Massachusetts 01781; telephone 617 369-4400. In Europe (except Scotland), write Postfach 124, CH 8034 Zurich 34, Switzerland. In Scotland, write General Radio Company (U.K.) Limited, Bourne End, Buckinghamshire, England, for special attention.

*Prices apply only in the U. S. A.

GENERAL RADIO





Stripline Star

With our new stripline microwave transistors in your microwave circuits, you can be sure the show will go on. And on.

Each transistor's superior performance is uniformly predictable. Because each transistor is S-parameter characterized and guaranteed at microwave frequencies.

And there are several star performers to make life easier for you. Such as the HP 35803B, common base configuration, with 40 mW output as a 4 GHz oscillator (typical f_{max}=6 GHz). Or the HP 35806E, common emitter configuration, with 20 mW output and 10 dB gain as a 2 GHz linear amplifier (typical f_{max} =7 GHz). The HP 35805B can deliver 200 mW output as a 2 GHz oscillator. And the HP 35805E has 175 mW output and 7 dB gain as a 1 GHz linear amplifier.

There are more hermetically-sealed stripline stars in our line-up too. All are ideally suited for your most stringent oscillator and amplifier requirements. All of them turn in great performances.

To get this all-star cast for your high-frequency circuits, call your HP field engineer. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

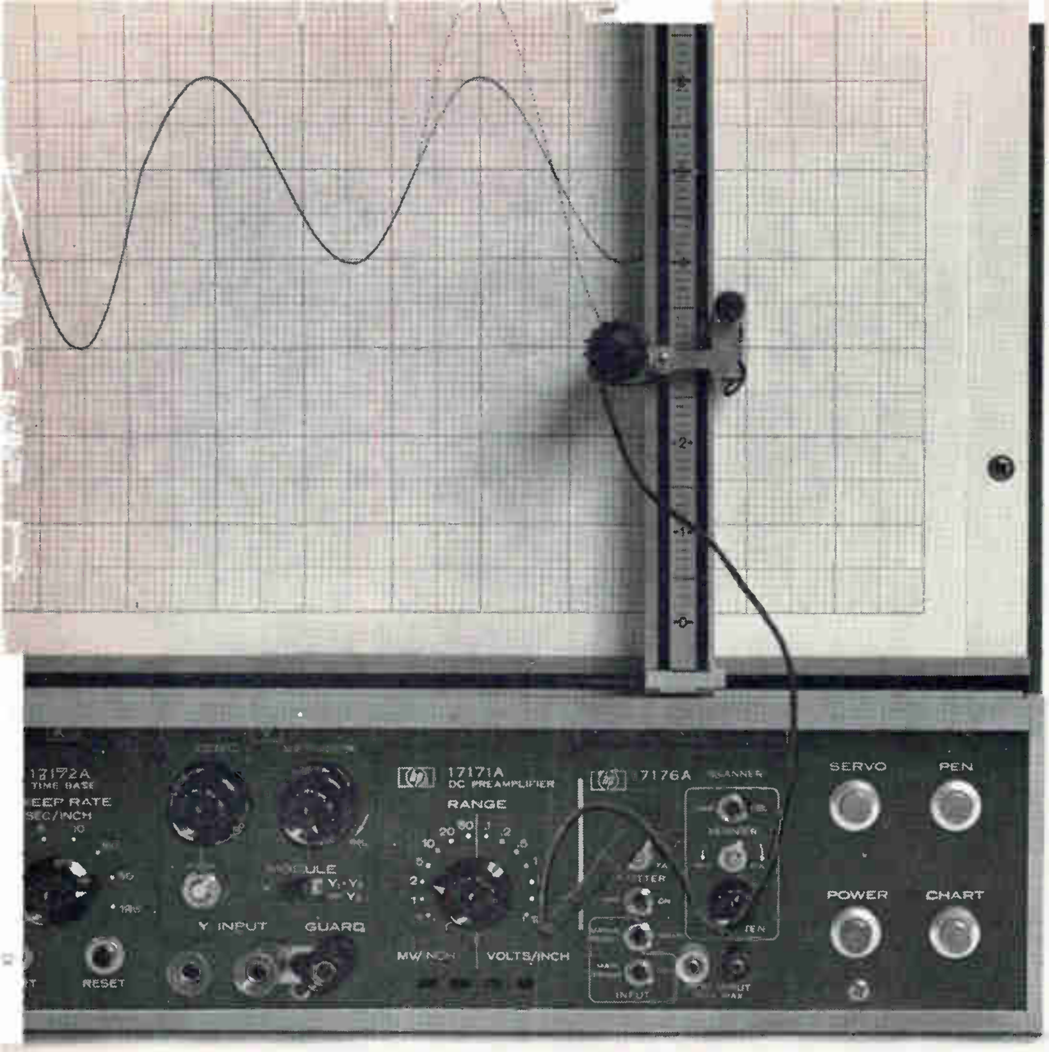
04905

HEWLETT hp PACKARD

SOLID STATE DEVICES

← Circle 900 on reader service card

Circle 1 on reader service card



Two in one

Hewlett-Packard now offers you a new extra advantage in X-Y recording – the 17176A Dual-Trace unit – a new accessory for the world's first truly "plug-in" recorder, the 7004A. It lets you plot, with a standard recorder, two variables against a third – without the expense of a two-pen system.

Teamed up with the 7004A and the 17012B Point Plotter, the new 17176A gives you two y-traces by alternately scanning between two y-input channels. Plotting rate is continuously variable between 10 points per second and 6 points per minute, depending on the resolution you need. Points are divided equally between the two traces. A built-in attenuator modifies the additional channel.

Price, too, is part of the new plug-in's uniqueness: $300. The 7004 X-Y Recorder costs $1395. The 17012B Point Plotter, $95. Additional plug-ins for either x or y channels start at $25.

To find out how you can get double your money's worth in an X-Y recorder, call your local HP field engineer. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

GRAPHIC RECORDERS

Circle 2 on reader service card

11810

Electronics

Volume No. 42 Number 16 August 4, 1969

News Features

Probing the News

U.S. Reports

Electronics International

New Products

Technical Articles

Departments

Electronics

Editor-in-Chief: Donald Christiansen

Senior staff editors
Technical: Stephen E. Scrupski
News: Robert Henkel
International: Arthur Erikson

Managing editor: Harry R. Karp
Art director: Gerald Ferguson

Senior associate editor: Joseph Mittleman
Assistant managing editors: Eric Aiken, H. Thomas Maguire, Howard Wolff
Senior copy editor: Frederick Corey **Senior staff writer:** John Johnsrud
Special projects editor: Roger Kenneth Field

Department editors
Advanced technology: William Bucci, Richard Gundlach
Communications: John Drummond, Raphael Kestenbaum
Computers: Wallace B. Riley, George Weiss
Design theory: Joseph Mittleman
Instrumentation: Owen Doyle
Military/Aerospace: Alfred Rosenblatt; Paul Dickson (Aerospace)
New products: William P. O'Brien
Solid state: George Watson, Stephen Wm. Fields

Field bureaus
Boston: James Brinton, manager; Gail Farrell
Los Angeles: Lawrence Curran, manager; Ralph Selph
New York: Peter Schuyten
Washington: Ray Connolly, manager; Paul Dickson, Lois Vermillion
Bonn: John Gosch
London: Michael Payne
Paris: Arthur Erikson
Tokyo: Charles Cohen

Copy editor: Edward Flinn

Assistant art director: Charles Ciatto
Production editors: Susan Hurlburt, Arthur C. Miller

Editorial research: Virginia Mundt

Editorial secretaries: Lorraine Longo, Claire Goodlin, Barbara Razulis, Vickie Green, Bernice Pawlak, Patricia Bispham

McGraw-Hill News Service

Director: Arthur L. Moore; **Atlanta:** Fran Ridgway; **Chicago:** Robert E. Lee
Cleveland: Arthur Zimmerman; **Dallas:** Marvin Reid
Detroit: James Wargo; **Houston:** Barbara LaRouax
Los Angeles: Michael Murphy; **Pittsburgh:** Louis Gomolak
San Francisco: Margaret Drossel
Seattle: Ray Bloomberg; **Washington:** Charles Gardner, Daniel B. Moskowitz, Herbert W. Cheshire, Seth Payne, Warren Burkett, William Small, William D. Hickman

McGraw-Hill World News Service

Bonn: Robert Dorang; **Brussels:** James Smith; **Hong Kong:** Kate Mattock
London: John Shinn; **Mexico City:** Gerald Parkinson; **Milan:** Ronald Taggiasco, Jack Star
Moscow: Jack Winkler; **Paris:** Robert E. Farrell, Stewart Toy
Rio de Janeiro: Leslie Warren; **Tokyo:** Marvin Petal

Reprints: Gail Niles
Circulation: Isaaca Siegel

Publisher: Gordon Jones

Assistant to the publisher: Wallace C. Carmichael

Electronics: August 4, 1969, Vol. 42, No. 16

Published every other Monday by McGraw-Hill, Inc. Founder: James H. McGraw 1860-1948. Publication office 99 North Broadway, Albany, N. Y. 12202; second class postage paid at Albany, N. Y. and additional mailing offices.

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

Subscriptions solicited only from those professionally engaged in electronics technology. Subscription rates: qualified subscribers in the United States and possessions and Canada, $8.00 one year, $12.00 two years, $16.00 three years; all other countries $25.00 one year. Non-qualified subscribers in the U.S. and possessions and Canada, $25.00 one year; all other countries $50.00. Air freight service to Japan $50.00 one year. Single copies: United States and possessions and Canada, $1.00; all other countries, $1.75.

Officers of McGraw-Hill Publications Company: Joseph Allen, President; John R. Emery, J. Elton Tuohig, Senior Vice Presidents; Gordon L. Jones, Jr., Group Vice President; Vice Presidents: John R. Callaham, Editorial; Paul F. Cowie, Circulation; John M. Holden, Marketing; David G. Jensen, Manufacturing; Jerome D. Luntz, Planning & Development; Robert F. Marshall, Administration; Robert M. Wilhelmy, Finance.

Officers of the Corporation: Shelton Fisher, President and Chief Executive Officer; John L. McGraw, Chairman; Robert E. Slaughter, Executive Vice President; Daniel F. Crowley, Donald C. McGraw, Jr., Bayard E. Sawyer, Senior Vice Presidents; John J. Cooke, Vice President & Secretary; Gordon W. McKinley, Vice President & Treasurer.

Subscribers: The publisher, upon written request to our New York office from any subscriber, agrees to refund that part of the subscription price applying to copies not yet mailed. Please send change of address notices or complaints to Fulfillment Manager; subscription orders to Circulation Manager, Electronics at address below. Change of address notices should provide old as well as new address, including postal zip code number. If possible, attach address label from recent issue. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Fulfillment Manager, Electronics,
P.O. Box 430, Hightstown, New Jersey 08520

Readers Comment

Clouding the picture

To the Editor:

Your newsletter concerning the performance of the Dants night-vision system [May 12, p. 75] is badly misleading. Unfortunately, it has stimulated a fairly large amount of work at considerable cost by systems manufacturers interested in the military market. Various companies have requested their technical staffs to reopen their thinking to confirm or deny the inference of your newsletter.

In general, one would never expect a tube with the characteristics of a lead-oxide vidicon or Oxicon to be compatible with high-quality, low-light-level performance because of the high target capacitance.

Lucien M. Biberman
Institute for Defense Analysis
Arlington, Va.

▪ In a forthcoming issue of *Electronics*, Mr. Biberman will expand on some of the arguments concerning the application of various tv tubes in a signed article.

Credit where it's due

To the Editor:

You did a "spin-out" when it came to crediting the manufacturer of the multihead disk recorder used to read out the color signals in parallel format for the Apollo 10 mission [July 7, p. 114]. It was a standard recorder made by Data Disc Inc. that was used at NASA's Manned Spacecraft Center at Houston.

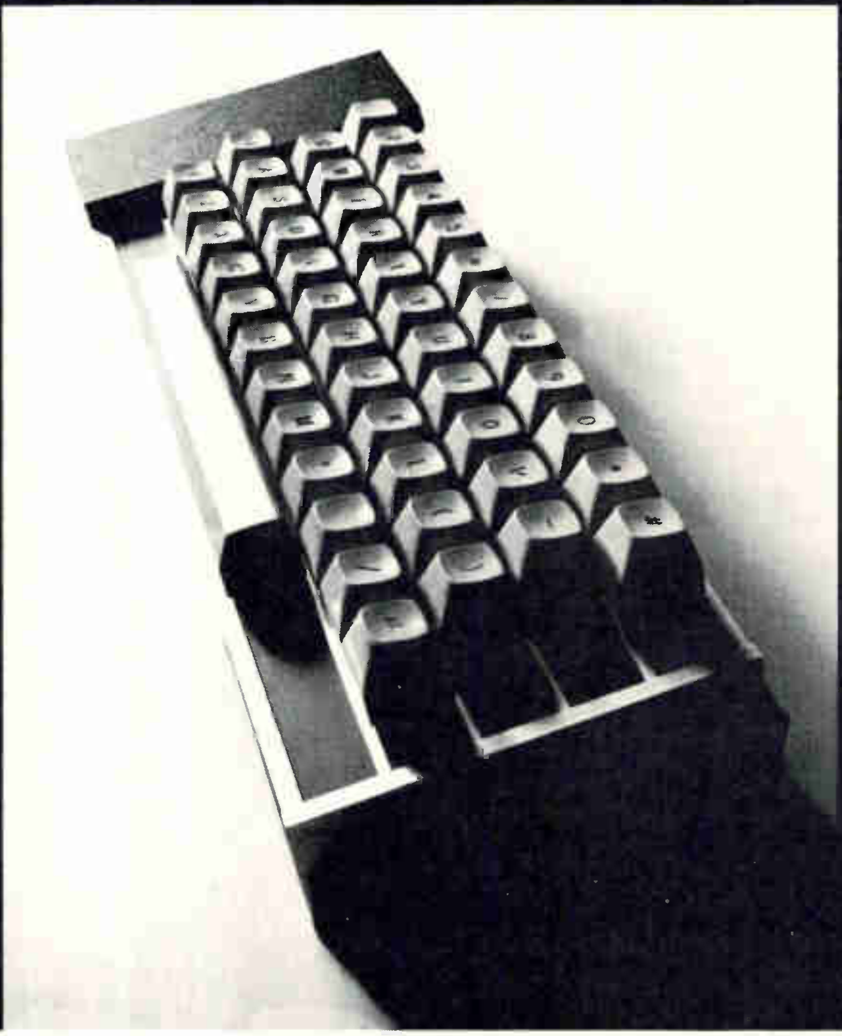
R.R. Troxell
Data Disc Inc.
Palo Alto, Calif.

'Black-box' tariff

To the Editor:

Regarding the "black-box" tariff [April 14, p. 69], perhaps your readers aren't aware that Magnavox, too, is involved in this market. Magnavox developed such a device in 1965 and licensed Xerox to

If you have more brains than money...



If you could eliminate the semiconductors from a computer, and still get the same performance, could you see some dollars saved? Could you see higher reliability?

That's the approach we have taken with our input keyboard. We made it self encoding without electronics. We eliminated built-in solid-state circuits. We kept it simple.

And we saved you money. The Synergistics Self Encoding Keyboard is only $68 in quantity orders. That's with a 65-key layout. With fewer keys it's less, with more it's more. But the point is you can specify your own layout, from 12-key Touch Tone to over 100 keys – even mix keyboard sizes and shapes – without extra charge. Change keys yourself, too.

Most important, the Synergistics keyboard is here now, manufactured in quantity. Or, if you would like to check out everything we claim, order one for evaluation. And if you want to call us, ask for George Rice.

Synergistics, Inc.
10 Tech Circle, E. Natick, Mass. 01760 (617) 655-1340

Yes, I am interested in the Synergistics Self Encoding keyboard. Please send me:

- ☐ Additional technical information.
- ☐ Instructions for ordering one keyboard for evaluation, made to my layout specifications. Prices to be included.

Name____________________
Title____________________
Company____________________
Address____________________
____________________Zip________

Circle 5 on reader service card

When You Choose An AC Meter Best Isn't Always Most Expensive

So you're going to buy an AC meter. You want the best meter for your job—at the best price. Right? You have a problem! Let's talk about it.

We have AC meters, lots of AC meters. We have AC meters that sell for more than $4500—and for their job, they can't be beat.

But how about the engineer who doesn't have a big production problem or need 5-digit resolution? How about the engineer who is making only two or three measurements a day... or week? We have a series of meters for him, too.

A series that has built a solid reputation for accurate performance and reliability—most of you have used them in the past. About three years ago, Hewlett-Packard updated with three redesigned, solid-state instruments—the 400 E/EL for broad frequency, 10 Hz and 10 MHz; the 400 F/FL for high sensitivity, 100 μV to 1000 V; and the 400 GL for broad dB range, −100 to +60 dB, 100 μV to 1000 V sensitivity.

These instruments are packed with convenience features. Two of these meters have a built-in 100 kHz low-pass filter to take out unwanted high frequencies for low-level audio measurements. You get fast response—a reading in less than 2 seconds after turn-on, and <2 seconds overload recovery. These instruments have an internal wideband ac amplifier, with an 80 dB gain—so we put an output on the back. With all these you can have the log scale uppermost for greater resolution in dB measurements.

Each HP-made taut-band suspension friction-free meter movement is individually calibrated to its scale for accurate readings over the entire range. Elimination of friction gives these meters excellent repeatability.

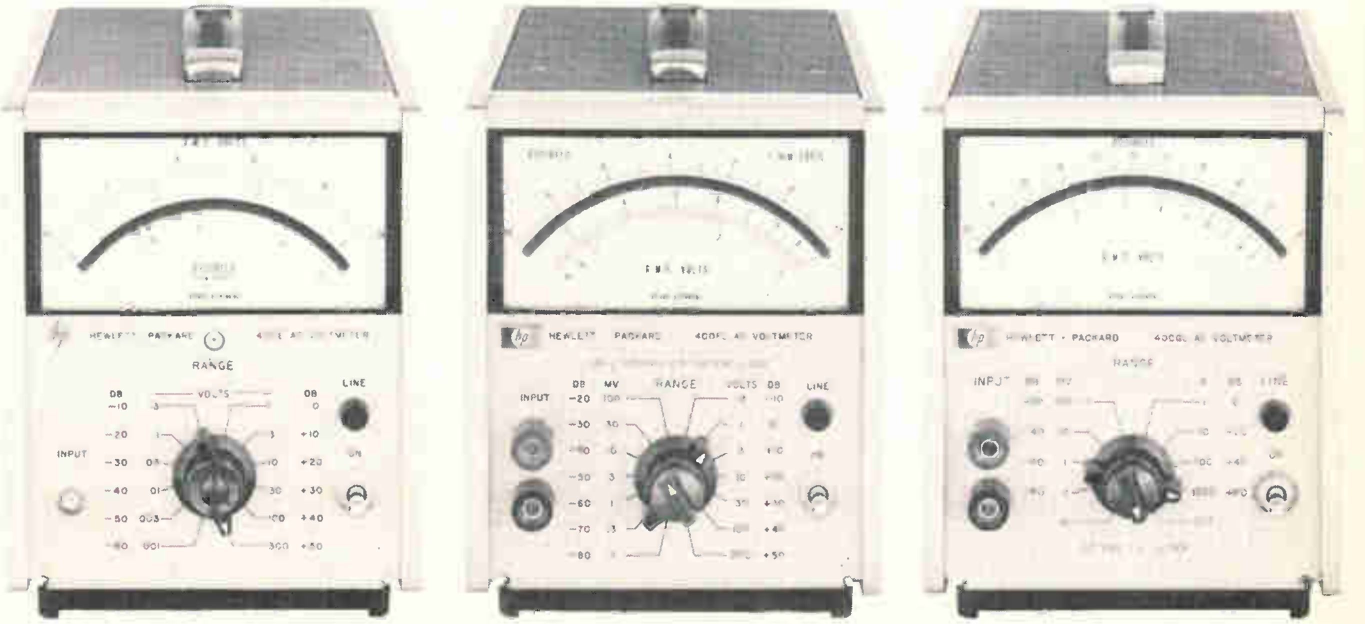
These, and more, are the features that assure reliable, day-in, day-out performance that gets the job done on time. If your problem is in sonar, acoustics, audio response, communications, calibration, ac to dc conversion and amplification—or any other application where precision ac voltage measurements are a must—then consider the HP 400 series carefully. They will fit your measurement requirements, leave your wallet fatter, and make your job easier and faster.

Check your HP catalog, starting on page 201, and choose the meter that best meets your measurement needs. Order today by calling the nearest HP order desk. For data sheets, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland. Price: $275 to $390.

099/18

HEWLETT hp PACKARD

ANALOG VOLTMETERS



market the unit. Xerox is now marketing its own unit and paying royalties to Magnavox.

Both companies are competing directly, but with compatible equipment—an influencing factor on the future facsimile market.

James R. O'Malley
Magnavox Systems Inc.
New York

Aeronautical, not aviation

To the Editor:

In mentioning the Ryan Aeronautical Co.'s landing radar on the Apollo 11 lunar module [July 7, p. 62], you inadvertently called the company Ryan Aviation. Moreover, the system isn't new. It was first tested in space on Apollo 9 and was used on Apollo 10 to measure the low point of the pass over the moon and to test lunar radar reflectivity.

Robert P. Battenfield
Ryan Aeronautical Co.
San Diego, Calif.

Out of the picture

To the Editor:

While it is true that the TelePrompTer Corp. was engaged in developing a subscription-tv system a number of years ago, the company no longer is actively engaged in this project and no longer can be counted among the would-be pay-tv entrepreneurs you cited in your article [May 26, p. 123].

TelePrompTer presently is concentrating on cable-tv systems.

John R. Barrington
TelePrompTer Corp.
New York

Aesthetics, continued

To the Editor:

Regarding the use of standards, your reply to Mr. Soanes letter [July 7, p. 7] rather amazed me. While the use of standards is not mandatory, except in military documents, it is difficult to follow your reasoning as to "communicating better without them." Surely the IEEE and the EIA have the same problems of aesthetics and communication, yet they follow the standards in all their documents.

The important thing to remember is that the electrical and electronics industries spend large sums and many man hours to establish national and international standards. It is therefore discouraging to find a leading magazine unwilling to cooperate in promoting the standards.

Julian Loebenstein
General Instrument Corp.
Newark, N.J.

▪ Mr. Loebenstein, like Mr. Soanes, is a member of the IEEE standards coordinating committee for letter and graphic symbols (SCC11), and is chairman of the committee for definitions and type designations (JS-7).

SUBSCRIPTION SERVICE

Please include an Electronics Magazine address label to insure prompt service whenever you write us about your subscription.

Mail to: Fulfillment Manager
Electronics
P.O. Box 430
Hightstown, N.J. 08520

To subscribe mail this form with your payment and check ☐ new subscription ☐ renew my present subscription

Subscription rates: qualified subscribers in the U.S.: 1 year $8; two years, $12; three years, $16. Non-qualified: 1 year $25. Subscription rates for foreign countries available on request.

CHANGE OF ADDRESS

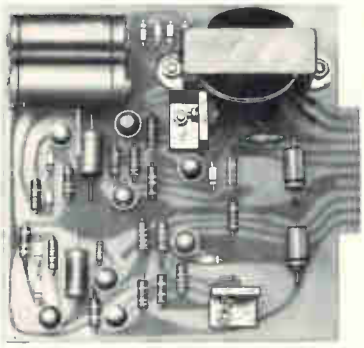
ATTACH LABEL HERE

If you are moving, please let us know five weeks before changing your address. Place magazine address label here, print your new address below.

name

address

city state zip code



Who's Who in this issue

McCormick

A change of scene from the Hoosier State to California appears to have agreed with Richard McCormick, whose article on Telonic's three-color scope appears on page 84. Holder of a master's degree from Purdue, McCormick joined the firm's Indianapolis labs in 1965, later transferring to the Laguna Beach facility.

Aiken Strassler

Joining forces on short notice, Eric Aiken, assistant managing editor, and David Strassler, market research manager, put together the report on the midyear state of the mart that begins on page 118. Strassler, who assembled the vital statistical data, has been with McGraw-Hill four years; he holds an M.A. from Brooklyn College. Aiken wrote the piece on the basis of detailed memos from department editors and field correspondents. A 10-year veteran of the business journalism field, he's worked at Douglas on the Thor, Nike Hercules, and Sparrow missile programs. Aiken also served as a radio/radar operator on DC-7 test flights. Inside cover photo was done by Bill Farrell.

McLin Knauer

The two-man team of Paul Knauer and Gene McLin produced the article on Magnavox's automatic-tint control circuit for color television sets that starts on page 102. Knauer, chief engineer for color tv at the company, is a Purdue graduate and a Navy veteran. McLin training development manager for the service training department at Magnavox, is a graduate of the University of Evansville (Indiana) and has a varied background as a broadcast engineer.

Segarra Perkins

Another twosome, Edwin Segarra and John F. Perkins, did the honors on the story about Raytheon's new analog control computer (page 96). Currently manager of the radar systems department at the company's Missile Systems division, Segarra is a CCNY graduate. Perkins heads the systems electronics group in Segarra's department.

EAGLE

...where the state of the art is the standard of the industry

Versatile Delay Timers with Solid-State Reliability

CG 10 Series ON-DELAY Timer

These time-delay modules are fully transistorized for maximum reliability. Available in four dial ranges to provide delays of 2, 10, 30, and 60 seconds for controlling such equipment as motors, machine tools, elevators, X-ray machines, packaging equipment and molding presses. Circuitry incorporates such state-of-the-art components, in its class, as tantalum timing capacitor, unijunction transistor, SCR and 10-amp output relay. Built-in transient suppression for protection against premature load contact actuation and in the event line voltage is removed before time out. Remote setting available as a kit.

Send for Bulletin 158

CG 300 OFF-DELAY Timer

A sustained contact, solid-state timer designed to replace many electromechanical and pneumatic units. Timing is accomplished by an RC circuit in conjunction with a 4-layer diode actuating a transistor. Design and all components are state-of-the-art for its class. Power application closes two sets of contacts. Removal of power initiates the timing cycle. If power is re-applied during the preset delay, contacts remain energized until delay cycle is completed. Time ranges are available in 1-10, 3-30, and 6-60 seconds. The unit provides a choice of both integral and remote time adjustments.

Send for Bulletin 159

NEW CE 400 PRECISION Delay Timer

Provides a highly precise and adjustable time delay between actuation of a control circuit and operation of a load circuit. Special mirror dial minimizes parallax errors in setting. Slide-rule graduations enhance readability. Famous Cycl-Flex® plug-in case allows five-second replacement with the same or different time range from 1.5 to 600 seconds.

Send for Bulletin 126

GET THE SPECS and full details... more than $1 million in Eagle time/count controls, control relays, precision potentiometers... waiting to serve you in 35 major areas throughout the world... including U.S.A., S.A., Europe, U.K., Canada and Australia.

**"See Our New State of the Art Products—
Booth 5207-5208, WESCON SHOW"**

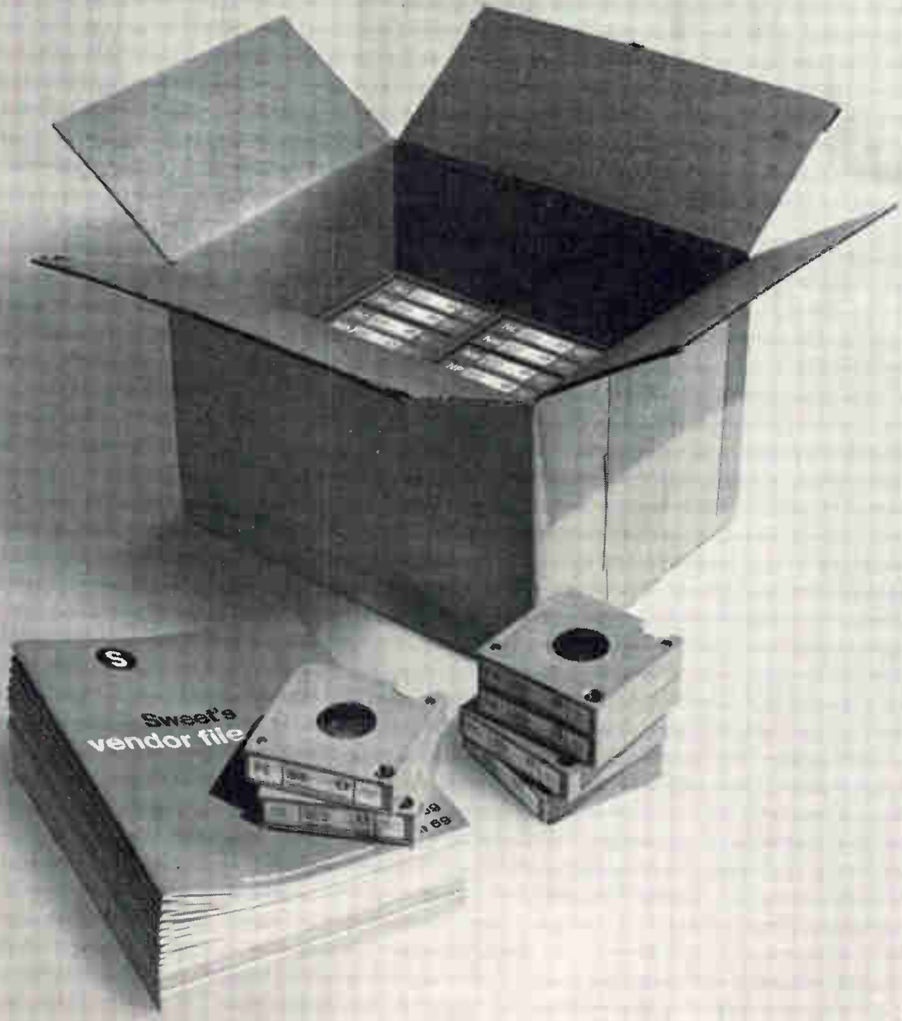
G+W **Eagle Signal Division**
A GULF + WESTERN COMPANY

Davenport, Iowa 52803

The February update: 82,400 pages of product data

The April update: 95,100 pages of product data

The June update: 90,400 pages of product data



Every other month, Sweet's Microfilm System packages the data explosion

In 5 minutes, you can collect, index and file the data explosion. That's the amount of time you'll spend every other month putting the latest Sweet's Microfilm System update into the cartridge carousel. Essentially zero-maintenance; Sweet's has done all the work.

We mail about 30 cartridges in each bimonthly update of our product/vendor file. The *total* of current information is already more than three-quarters of a million pages. *More current information than contained in any other system . . . updated more often, more thoroughly, than any other system.*

A typical update will contain new and revised data from about 800 important industrial suppliers . . . 75% of them new to the file. For example we've recently added a 3500-page apparatus handbook . . . and lots of smaller but equally important firms too. And we keep them all up to date.

How could you possibly keep up with all this new data? Obviously, you can't. Sweet's can, with a simple plan and a computer. The plan is simply that we don't charge anyone to get their data into our File. *So we get all their data, and new information as soon as it issues.*

Then a computer takes over, after we've thoroughly indexed the new data. A complete new index is printed out by computer for every update. Over 6,000 product entries, plus vendor index, speed you to the right information in minutes. (You'd have a terrible time finding data if we just issued supplemental indexes with the updates.) If you want a copy of the data you've found, our reader/printer delivers one in 6 seconds . . . *and the File remains wholly intact.* No data gets borrowed, and the cartridges easily go back into the carousel without filing confusion.

Sweet's Microfilm also has several other important data packages. Our MIL Specs file has all of them, complete, updated with a new index every month. Another package contains five important sets of MIL Standards. And, we've just added the ASTM Standards to the system, *exclusively*. These standards are conveniently offered in four sections, with automatic updating every two months.

Now, Sweet's introduces a new data system: Characteristic Search. The capability is fast survey and comparison of product areas. The first segment, the six-volume Electronic Instruments Edition, will issue shortly. More than 35,000 electronic instruments have been described with up to 15 important parameters; manufacturer's data is in the Microfilm System for final reference if needed. Use the coupon to get information on this new system.

You may already be sold on microfilm for data storage and retrieval . . . because of the amount of data there is now . . . and the amount that's coming next month. Sweet's is not the only system available. But Sweet's Microfilm System has more data than anyone. And we update more often, to make sure things stay that way . . . and to make sure your engineers find what they want, fast.

We make engineers out of engineers.

SWEET'S INDUSTRIAL DIVISION
McGraw-Hill Information Systems Company

See us at booth 5210 and 5211

Please send a complete information package on:

☐ Sweet's Microfilm System.
☐ Sweet's Characteristic Search: Electronic Instruments
☐ ASTM

Name____________________________

Title____________________________

Company____________________________

Address____________________________

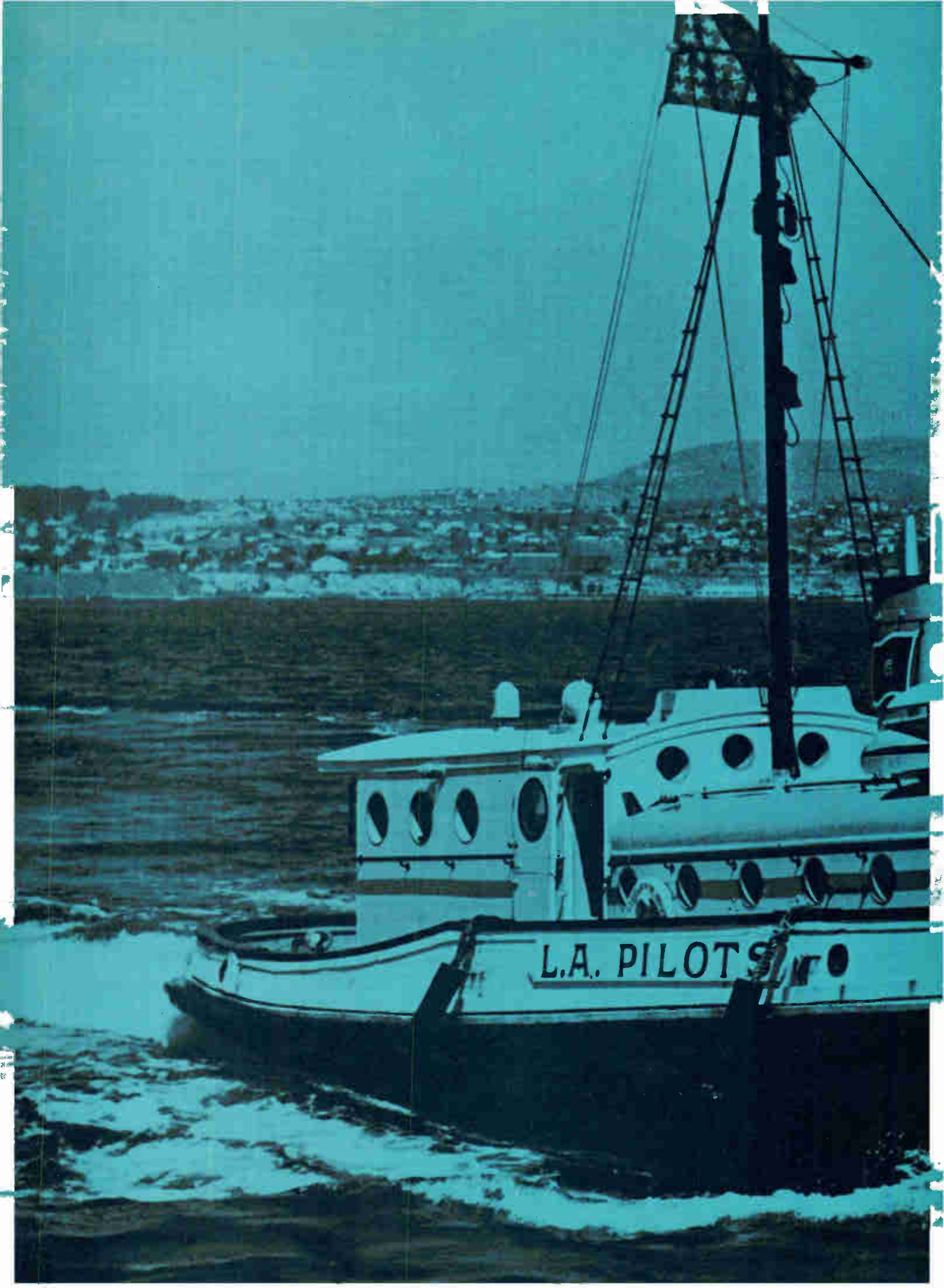
City____________________________

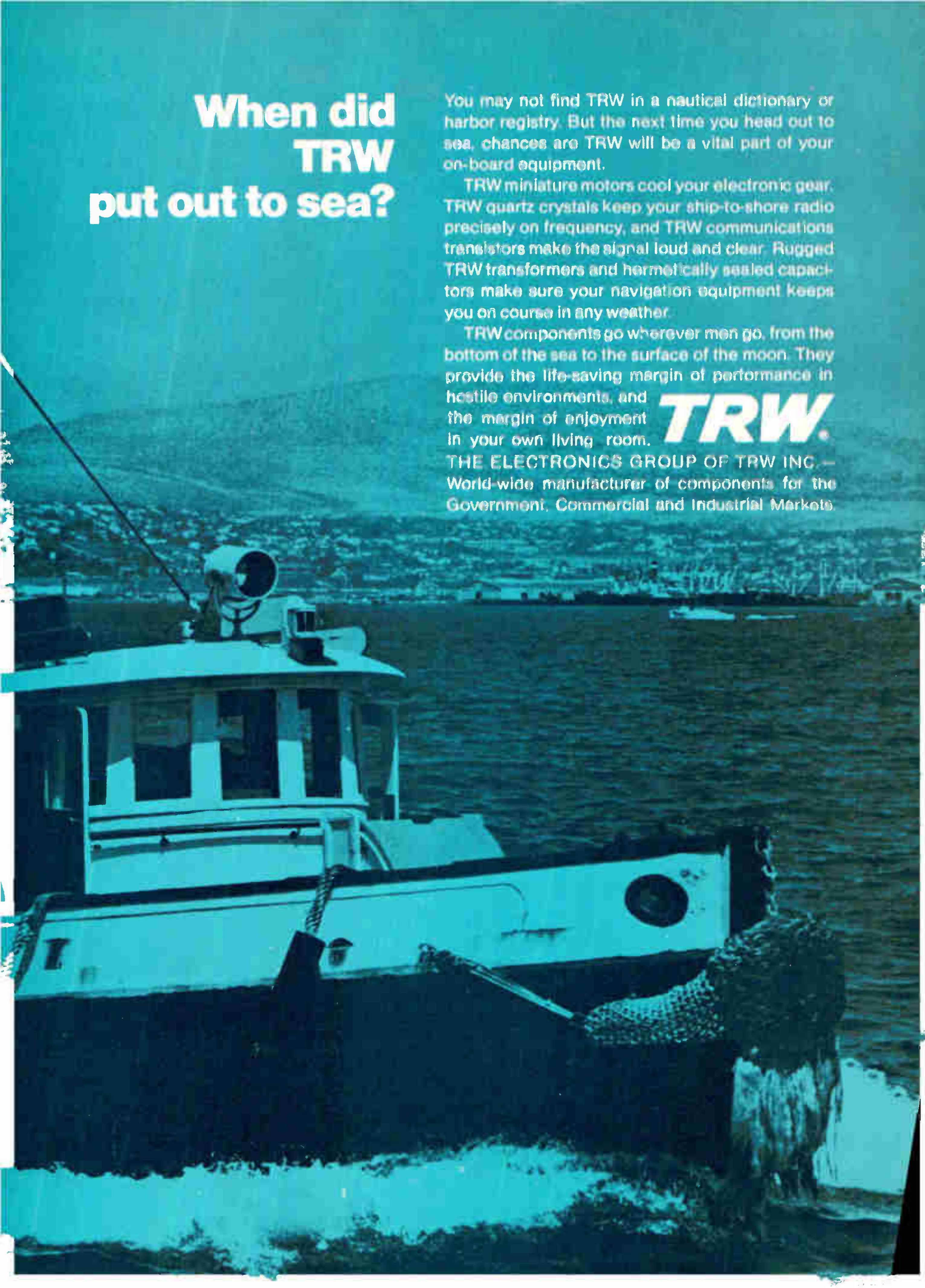
State________________Zip__________

Send to Sweet's Microfilm System, Dept. EL57, 330 West 42nd Street, New York, N.Y. 10036 or call G. O. Stevens collect at (212) 971-3586.

Circle 11 on reader service card

Circle 13 on reader service card →


L.A. PILOTS



When did TRW put out to sea?

You may not find TRW in a nautical dictionary or harbor registry. But the next time you head out to sea, chances are TRW will be a vital part of your on-board equipment.

TRW miniature motors cool your electronic gear. TRW quartz crystals keep your ship-to-shore radio precisely on frequency, and TRW communications transistors make the signal loud and clear. Rugged TRW transformers and hermetically sealed capacitors make sure your navigation equipment keeps you on course in any weather.

TRW components go wherever men go, from the bottom of the sea to the surface of the moon. They provide the life-saving margin of performance in hostile environments, and the margin of enjoyment in your own living room.

TRW.

THE ELECTRONICS GROUP OF TRW INC.—
World-wide manufacturer of components for the Government, Commercial and Industrial Markets.

Who's Who in electronics

RCA's Rajchman

The grand old man of memories, as Jan Rajchman is sometimes called, may not be so old after all. For one thing, on his birthday next week he'll be only 58. And for another, Rajchman, who has just been appointed staff vice president in charge of the Information Sciences group at RCA Laboratories, is still very much in the thick of new memory development.

Officially, Rajchman, in his new job, is responsible for directing "a number of exploratory ventures in the information sciences." But according to Rajchman, this can be interpreted specifically as developing an optical computer memory.

Optics ahead. It's no secret to Rajchman, or anyone else in the computer industry, that optics offer far denser information-packing capacity than present-day memory systems, including those of the semiconductor variety. The question is, however, what form such a memory would take and when it would be available.

Rajchman believes the industry will see its first optical memory in product form in the mid-1970's. "In the last two years we've made great progress. Now we believe that we've taken most of our concepts off paper and turned them into laboratory developments. The next stage is improving and refining what we've already done, and then we'll have to build our developments into a system. That's the really monumental job," he says.

The latest development to come from Rajchman's group is a read/write, or erasable, hologram which has a potential density of 10^8 bits per square centimeter. Basically, Rajchman explains, it's a manganese bismuth-coated magnetic substrate, which when struck by laser light, changes magnetic direction at 1.5 light-wavelength intervals.

In its final form, according to Rajchman, the optical memory may well be used as a very large mass, or archival, memory in conjunction with the fast transistor memories.

Rajchman looks upon his new position (previously he was staff vice president for data processing research at the labs) as a combination of line and staff work. "In one sense, I'm sort of a salesman to upper management, but I'm also very closely tied to research."

Almost two years had passed more or less quietly at Litton Industries' Litcom division after it rose from the ashes of what was called the Westrex communications division. But four months ago, Herbert L. Robinson—Litcom president for only seven months—left suddenly. And for more than three months, while Litton searched for a successor to Robinson, an air of uncertainty settled over Litcom's Mel-

These are specialized TRACOR instruments designed for your specific needs.

FREQUENCY STANDARDS

RUBIDIUM FREQUENCY STANDARD
Long Term Stability 5x10^{-11} (Std. Dev./Yr.)
Drift Rate <1x10^{-11}/month
use Reader Service #500.

CRYSTAL STANDARDS

Long Term Stability<5x10^{-10}/24 hours
5, 1, 0.1 MHz
use Reader Service #501.

Long Term Stability <5x10^{-11}/24 hours
5, 1, 0.1 MHz
use Reader Service #502.

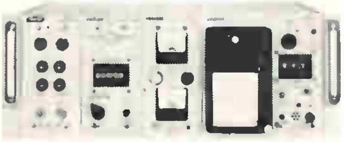
CLOCKS

PORTABLE
RUBIDIUM
ATOMIC
CLOCKS
6x10^{-12}/100
Sec. Avg
38 Pounds
14 Hrs.
Self-contained
Batteries
use Reader Service #503.

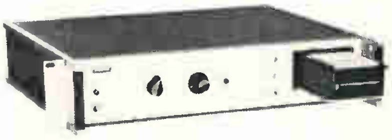
CRYSTAL
CLOCKS
2x10^{-6} Secs/Day
38 Pounds
15 Hrs.
Self-contained
Batteries
use Reader Service #504.

PORTABLE
CHRONOMETERS
1x10^{-3} Sec/Day
8 Pounds
80 Hrs.
Self- contained
Batteries
use Reader Service #505.

VLF RECEIVERS

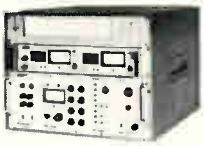


VLF TRACKING
RECEIVER/COMPARATORS
5.0 - 99.95 kHz continuous tuning
use Reader Service #506.



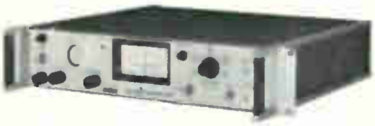
TWO FREQUENCY VLF RECEIVER
20 & 60 kHz for rating house standard
use Reader Service #507.

NAVIGATION SYSTEMS

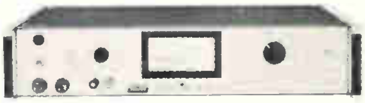


VLF/OMEGA NAVIGATIONAL SYSTEMS
4 Channel
Receives all Omega Frequencies
Digital Lane Counter
use Reader Service #508.

TIME AND FREQUENCY INSTRUMENTS



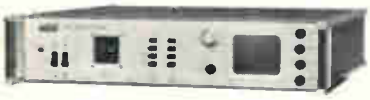
FREQUENCY DIFFERENCE METER
Instantaneous Determination of
Fractional Freq. Diff. to 1x10^{-11}
use Reader Service #509.



LINEAR PHASE/TIME COMPARATOR
1 nanosecond time resolution
0.01 cycle phase resolution
use Reader Service #510.

FREQUENCY DISTRIBUTION SYSTEM
Provides up to 16 outputs
Front panel adjustment
use Reader Service #511.

SPECTRAL SYSTEMS AND INSTRUMENTS



DATA SCANNER
Scans and serial outputs
up to 80 data channels
use Reader Service #512.

SPECTRUM ANALYZER
Real Time PSD Analysis
From 0.1 Hz to 100 kHz
1-, 1/2-, 1/3-, 1/6- octave bandwidths
use Reader Service #513.

SPECTRUM GENERATOR/SHAPER
Programmable random noise from 0.1Hz to 100kHz
1-, 1/2-, 1/3-, 1/6- octave bandwidths
use Reader Service #514.

WESCON/69
Eight great shows in one!

Booth Nos. 1701, 1702 & 1703

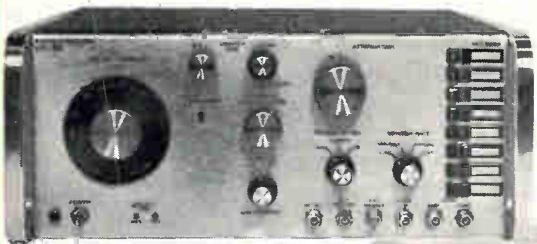
Industrial Instruments
TRACOR®

6500 TRACOR LANE, AUSTIN, TEXAS 78721 (512) 926-2800

THE
VS-80
sweep
generator
ALL SOLID-STATE

TECHNICAL LEADERSHIP IS STATE-OF-THE-ART SOPHISTICATION & PERFORMANCE

Test capabilities usually available only through the use of two or more instruments are yours in the Texscan VS-80. It covers all normal IF bands, and FM, VHF TV, UHF TV, and most communication bands . . . can be used for radar and communications RF, IF, and video testing, also as a chirp radar simulator and for wide band amplifier testing. VS-80 is available in a ruggedized model that meets MIL-T-21200F, as well as in the popular laboratory/field model. Write for free descriptive literature with complete technical details.



RUGGEDIZED UNIT

key specifications

LABORATORY UNIT

Frequency Range: 1 MHz to 1200 MHz in two overlapping, switchable bands, 1—300 and 290-1200. Can be centered on any frequency between 1 MHz and 1000 MHz and sweep up to 1200 MHz at maximum sweep.

Sweep Width: On the low band, continuously variable from 50 kHz to 300 MHz; on the high band, can be varied to 40% at 1000 MHz. Unit also has CW output mode for signal generator applications.

RF Output: Rated at least 0.5 vrms into a 50-ohm load.

Operating Temperature: Continuous —20 +55°C; intermittent to +71°C.

Shock: 20 G's, 3 shocks along each of 3 mutually perpendicular axes.

EMI: IAW Mil-Std-826A, notice 1, class Gp.

Reliability: 500 hours MTBF IAW Mil-Std-781A, Test level E except lower temperature —20°C.

Maintainability: IAW Mil-Std-470 & 471.

PRICE AND DELIVERY

Model VS-80 $1550.00 Model VS-80 DH $3050.00 (Combination Case)

Delivery is within four weeks maximum; in some cases models and accessories are available from stock.

Texscan CORPORATION
2446 NORTH SHADELAND AVENUE
INDIANAPOLIS, INDIANA 46219
Phone 317-357-8781—TWX: 810-341-3184

Circle 16 on reader service card

Who's Who in electronics

Litcom's Norsell

ville, Long Island, plant.

With the appointment of Paul E. Norsell, 36, as president, optimism has returned.

Norsell who, unlike Robinson, comes to Litcom from another Litton division (he was vice president for engineering at the Data Systems division in Van Nuys, Calif.) feels confident that he can chart a steadier course than Robinson did. He knows what's expected of him because he's been with Litton for almost six years.

Systems. As explained by Norsell, Litcom is fast assuming the posture of a communications systems house selling such items as radios, high-powered r-f, loran and Omega equipment, as well as such interior communications gear as multiplexing systems. Neither the size nor the reputation of competitive firms—among them, RCA, Collins Radio, and Bendix—awes him.

Even the fact that most of Litcom's work is aimed at military markets at a time when many firms are trying to reduce the percentage of their military work does not worry Norsell. "We'll stick with military work," Norsell says confidently. He anticipates Litcom's making proposals for a number of long-term military programs including the on-again, off-again Awacs program.

What to do about the headache of small "problem" parts? Make them yourself? That means a major investment in special machinery and skilled labor. If you already make them, how do you know somebody else can't make them for you more economically?

Like Anaconda, for instance. They have Anacondability—all the facilities and capabilities to produce a large variety of parts that can be stamped or drawn—in any metal (copper, brass, bronze, nickel silver, iron, steel, stainless or aluminum)—and with any finish.

Most importantly, FMG engineers have often been able to redesign a part so that it can be made more economically (as much as 50% less!) *with no sacrifice in quality!*

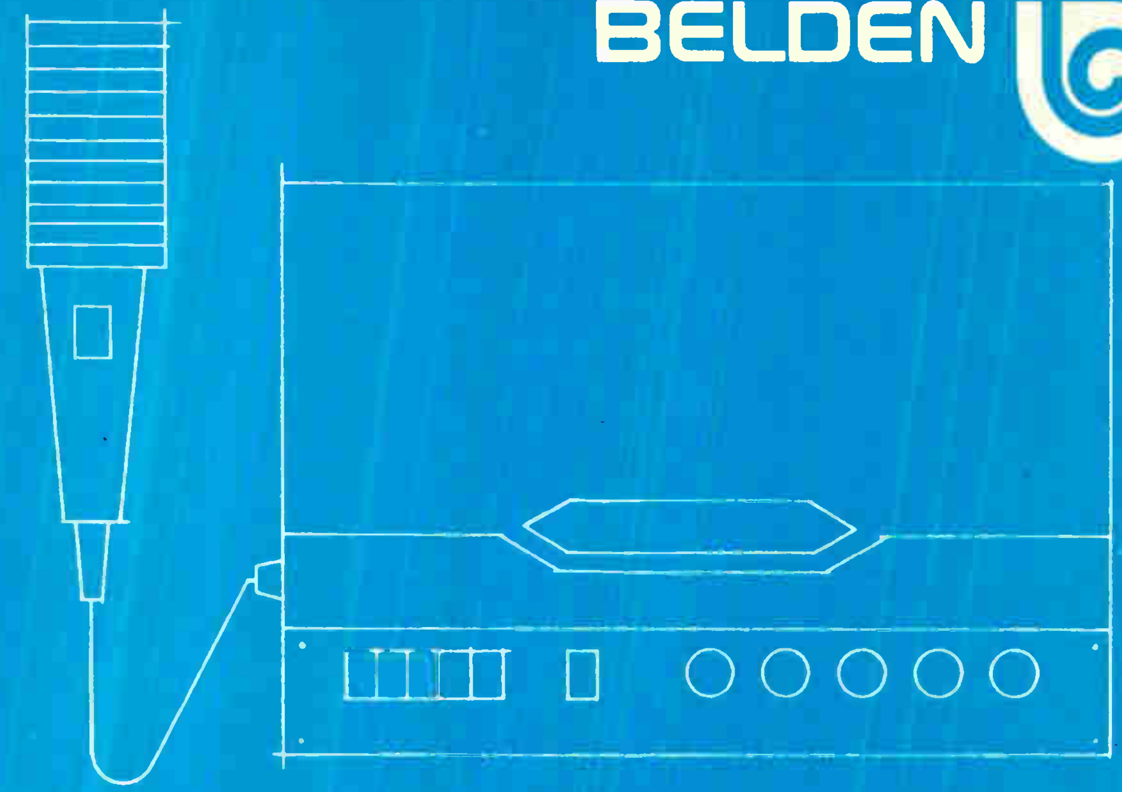
It won't cost you a cent to find out what FMG can do for you. Send a blueprint; they'll do the rest.

Get rid of that headache faster than you can say, "Anacondability"! Please write Anaconda American Brass Company, 414 Meadow St., Waterbury, Conn. 06720

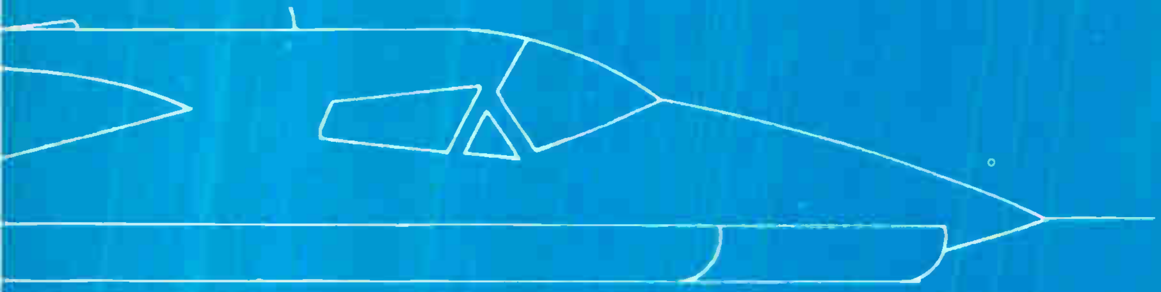
Fabricated Metal Goods Division
ANACONDA®
AMERICAN BRASS COMPANY

Circle 17 on reader service card

BELDEN



systems turn us on

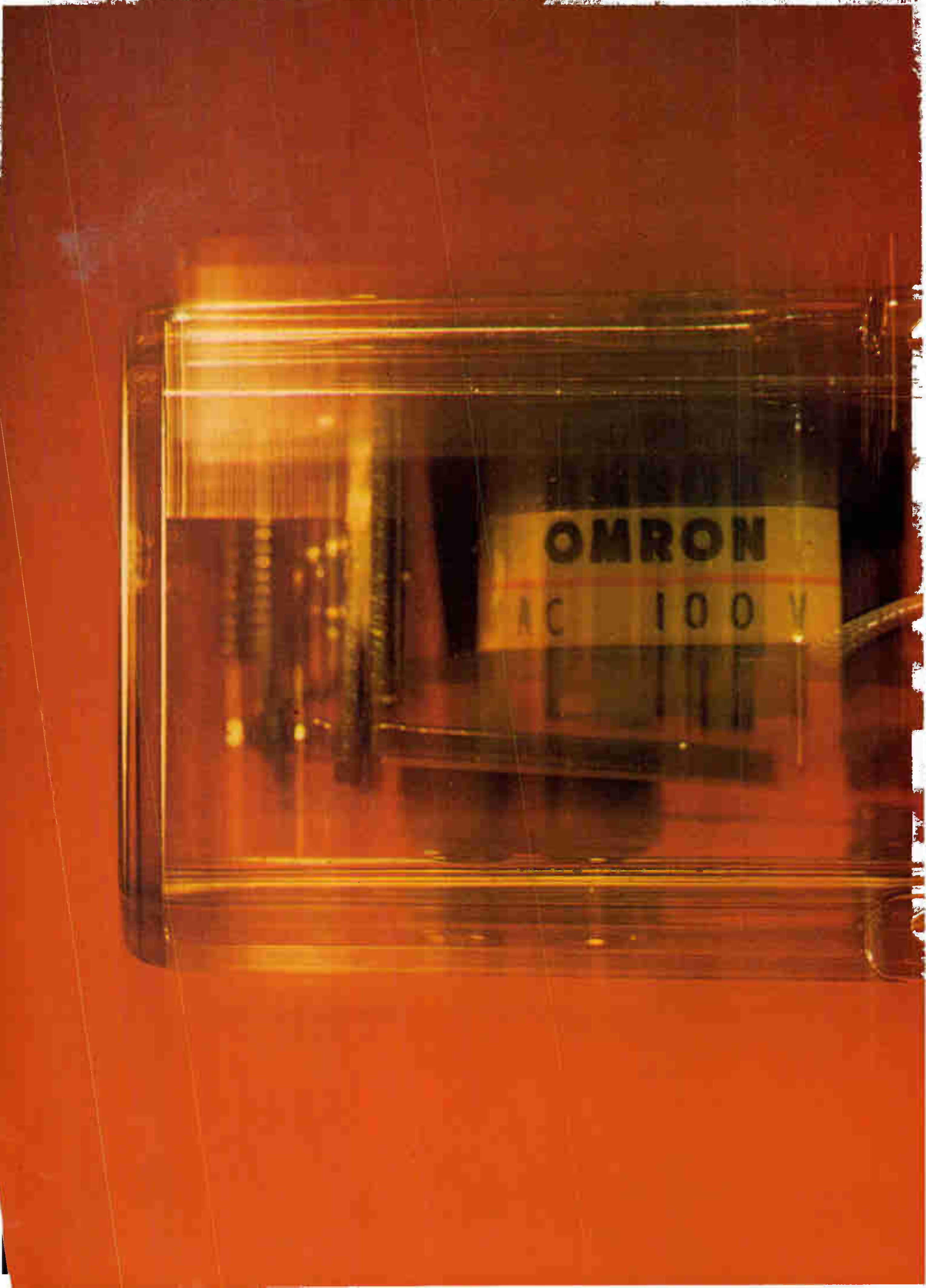


We have an active imagination when it comes to wiring. Because it's sparked by a lot of savvy about wire and cable and its capabilities. With applied imagination we can create fresh ideas that help a customer get a better value for his dollar. Our Wire Systems Specialists are trained to explore every wire-related aspect of a product—compatibility, production, packaging, operating environment . . . the entire system. And then put their imaginations to work. To eliminate a shielding or stripping problem*. Or save money. Or enhance the product's reliability. And whatever type of wire or cable it takes to turn an idea into reality . . . well, we make all kinds of wire for all kinds of systems. Why not see what we can imagine for your product? Call or write: Belden Corporation, P.O. Box 5070-A, Chicago, Illinois 60680. And ask for our catalog, and the reprint article, "Key Questions and Answers on Specifying Electronic Cable."

*For example. We've insulated some of our lead wire with silicone. So no glass braid protection is needed. This means that stripper blades will last much, much longer. And a potential health hazard to stripper operators is eliminated.

Circle 19 on reader service card

Circle 21 on reader service card →

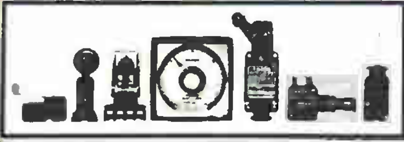

OMRON
AC 100 V

How does uncompromising OMRON beat shock challenge?

A relay must be ready to face unforeseen challenge. OMRON's own uncompromising standard requires that it is Once installed it's got to perform perfectly—not only und ideal conditions, but hostile conditions as well.

OMRON's tough, critical quality control, based on MIL-Q-5923C, begins at the very first stages of research and development.
Materials, processing, measuring instruments—even personnel fitness—are tested to ensure that subsequent quality control testing and inspecting are faultless.
And then to determine that our products are worthy to carry the name OMRON, victims are selected for grueling endurance tests.

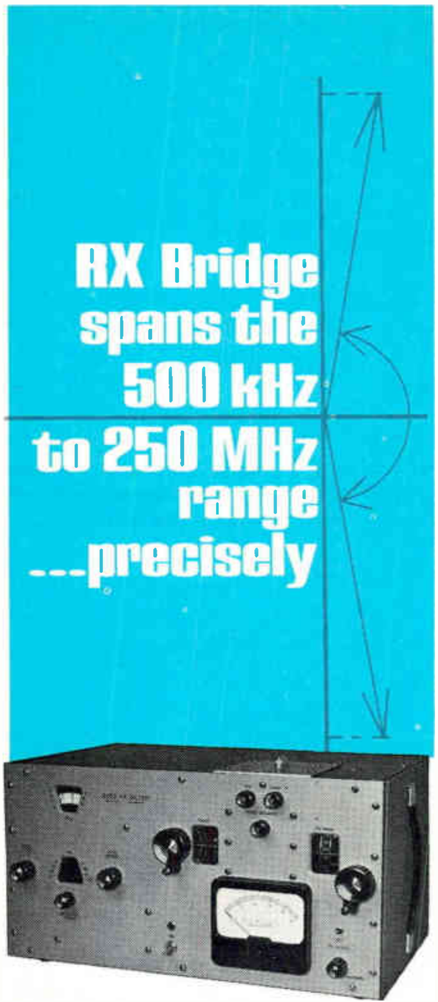
OMRON. Think of us before you decide. If a product doesn't measure up, it doesn't go in. That's one reason wh we became Japan's largest producer of electric and electronic components, carrying of course UL, CSA, SEC and SECV international authorization.



OMRON

OMRON TATEISI ELECTRONICS CO.

SALES OFFICE/Toa Bldg., 5, Yonban-cho, Chiyoda-ku, Tokyo, Japan
Phone (265) 4611 Telex 232-2179 Cable Address OMRONELCO TOKYO
OVERSEAS DISTRIBUTORS:
● AUSTRALIA/H.Rowe & Co., Pty., Ltd. ● AUSTRIA/Carlo Gavazzi-Billman G.m.b
● ITALY/Carlo Gavazzi S.p.A. ● BELGIUM/Carlo Gavazzi Belgium s.a.
● ENGLAND/Keyswitch Relays Ltd.
● FORMOSA/Hai Nan Trading Co., Ltd./Sheng Ching Trading Co., Ltd.
● FRANCE/Billman-Carlo Gavazzi S.A.R.L.
● HOLLAND/Carlo Gavazzi-Billman Nederland N.V.
● SPAIN/Carlo Gavazzi-Reguladores Billman s.a. ● MEXICO/Schultz Y Cia., S.A.
● SWEDEN/Billman Regulator ab. ● SWITZERLAND/Carlo Gavazzi-Billman AG.
● U.S.A./Sigma Instruments Inc. ● SOUTH AFRICA/P.J.Yelland & Co. (Pty) Ltd.
● WEST GERMANY/Carlo Gavazzi-Billman Industriezulieferung G.m.b.H.



Meetings

Showing the way to strapdown guidance

While hardware for strapdown guidance will be evaluated in several papers at this month's Guidance, Control, and Flight Mechanics Conference, most of the papers will deal with flight mechanics and control concepts. The conference, sponsored by the American Institute of Astronautics and Aeronautics, will be held at Princeton University in Princeton, N.J., Aug. 18-20.

Three researchers from MIT's Instrumentation Laboratory will present results of an evaluation made on a strapdown package containing single-degree-of-freedom gyros in a digital torque-to-balance control loop. The three are J.P. Gilmore, R.A. McKern, and D.W. Swanson.

Real time. Two Raytheon engineers, J.B. Matthews and G.R. Taylor, will discuss the feasibility of a strapdown system that uses a general-purpose computer. And in another paper, F.A. Evans and J.C. Wilcox of TRW Systems will describe a strapdown redundant-sensor package containing six gyros and six accelerometers. Sensor signals are processed in real time by a digital computer.

Another strapdown system will be described by P.G. Savage of Honeywell in a session on optical- and radar-guidance techniques. His system uses a laser phased-array seeker system for a homing missile. Also in this session will be a paper, by C.L. Wyman of NASA's Marshall Space Flight Center, describing a scanned-laser system with a random-access capability that can be applied to spaceborne radar and communications.

For information, contact Meetings Department, AIAA, 1290 Ave. of the Americas, New York, N.Y. 10019

Calendar

International Photoconductivity Conference; Stanford University, Palo Alto, Calif.; **Aug. 12-15.**

Western Electronic Show & Convention (Wescon), IEEE; Cow Palace & San Francisco Hilton Hotel, San Francisco; **Aug. 19-22.**

Symposium on Programing Languages Definition, Association for Computing Machinery; San Francisco; **Aug. 24-25.**

Defects in Electronic Materials for Devices, Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers; Statler-Hilton Hotel, Boston; **Aug. 24-27.**

ACM National Conference and Exposition, Association for Computing Machinery; San Francisco Civic Center; **Aug. 26-28.**

Cornell Biennial Conference on Engineering Applications of Electronic Phenomena, IEEE; Cornell University, Ithaca, N. Y.; **Aug. 26-28.**

Education and Training Technology International Convention, IEE; London, England; **Sept. 2-6.**

Electrical Insulation Conference, IEEE; Sheraton-Boston Hotel & War Memorial Auditorium, Boston; **Sept. 7-11.**

European Microwave Conference, International Symposium on Man-Machine Systems, IEE; St. John's College, Cambridge, England; **Sept. 8-12.**

Convention of the Society of Logistics Engineers; Cape Kennedy Hilton Hotel, Cape Kennedy, Fla.; **Sept. 9-10.**

Petroleum & Chemical Industry Tech. Conference, IEEE; Statler Hilton Hotel, Los Angeles; **Sept. 14-17.**

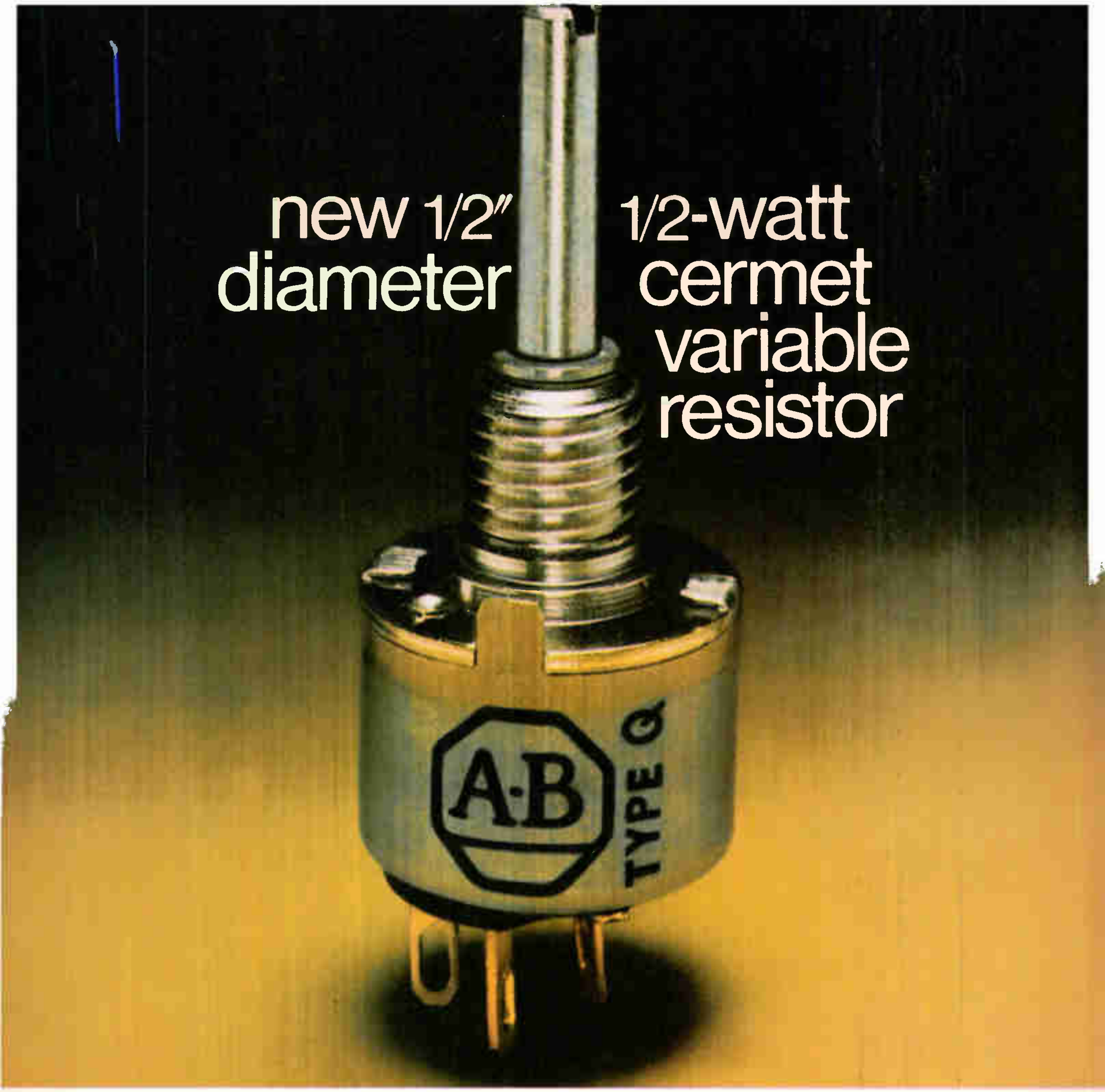
International Telemetry Conference, International Foundation for Telemetering, Sheraton Park Hotel, Washington, D.C.; **Sept. 15-17.**

Conference on Trunk Telecommunications by Guided Waves, IEE; London, England; **Sept. 15-17.**

Solid State Devices Conference, IEE; University of Exeter, Exeter, Devon, England; **Sept. 16-19.**

Symposium on the Biological Effects

(Continued on p. 24)



Type Q Meets Requirements of MIL-R-23285 Style RVC6

A-B Type Q Shown actual size

Rating: ½ watt @ 125°C.

Temperature Range: −65°C to +175°C.

Resistance: 100 ohms through 2.5 megohms

Temp. Coef.: Less than ±250 PPM/°C for *all* resistance values and over *complete* temperature range.

Load Life: Less than 3% total resistance change after 1000 hours, ½ watt at 125°C.

Sealed Unit: Enclosure is immersion-proof.

Tolerances: ±10% and ±20% standard.

If you're looking for a better source...write:

ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS
1201 S. Second St. Milwaukee, Wis. 53204

EC69-14

Circle 23 on reader service card

Meetings

(Continued from p. 22)

and Health Implications of Microwave Radiation, Biophysics Department of the Virginia Commonwealth University, Bureau of Radiological Health, Environmental Control Administration, and U.S. Public Health Service; Richmond, Va.; **Sept. 17-19.**

Annual Broadcasting Symposium, IEEE; Mayflower Hotel, Washington, D.C.; **Sept. 18-20.**

Joint Power Generation Conference, IEEE, American Society for Mechanical Engineers; Charlotte, N.C.; **Sept. 21-25.**

Annual Intersociety Energy Conversion Engineering Conference, IEEE, American Society for Mechanical Engineers; Statler Hilton Hotel, Washington, D.C.; **Sept. 21-26.**

Ultrasonics Symposium, IEEE; Chase Park Plaza Hotel, St. Louis, Mo.; **Sept. 24-26.**

International Electronics Conference, IEEE; Automotive Building, Exhibition Park, Toronto, **Oct. 6-8.**

Annual Conference of the American Institute of Ultrasound in Medicine; Winnipeg, Manitoba, Canada, **Oct. 6-10.**

IGA Group Annual Meeting, IEEE; Statler Hilton Hotel, Detroit, **Oct. 12-16.**

Annual Symposium on Switching and Automata Theory, IEEE; Waterloo, Ontario, Canada, **Oct. 15-17.**

International Symposium on Remote Sensing of Environment, The Center for Remote Sensing Information and Analysis; University of Michigan, Ann Arbor, **Oct. 14-16.**

Engineering Management Conference, IEEE; Montreal, Quebec, Canada; **Oct. 9-10.**

Joint Materials Handling Engineering Conference, IEEE, American Society of Mechanical Engineers; Sheraton Motor Inn, Portland, Ore.; **Oct. 27-29.**

Nuclear Science Symposium, IEEE; Sheraton Palace Hotel, San Francisco; **Oct. 29-31.**

International Electron Devices Meeting, IEEE; Sheraton Park Hotel, Washington; **Oct. 29-31.**

Northeast Electronics Research & Engineering Meeting (NEREM), IEEE; Sheraton Boston Hotel, War Memorial Auditorium, Boston; **Nov. 5-7.**

University Conference on Ceramic

(Continued on p. 26)

Ball .002″ dia., Iteration ±5%

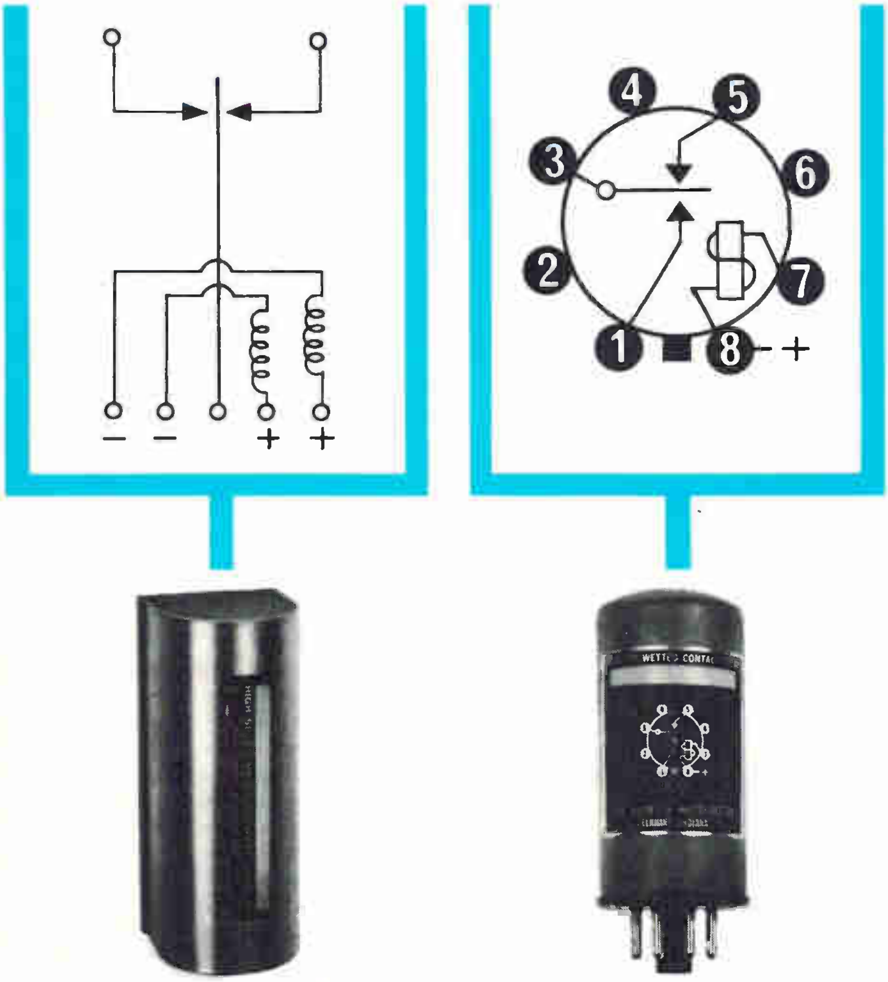
TEMPRESS HYDROGEN FLAME-OFF TORCHES FOR LEAD-BONDING MACHINES ARE STAINLESS STEEL, WITH SAPPHIRE ORIFICE INSERTS that maintain size and shape accuracy of the 2166°C hydrogen flame. The highly polished inner surface of the sapphire insert assures this by eliminating gas turbulence and a resultant distortion of the flame. The end result is essentially identical gold balls on every lead, from start to finish of a production run. 14X magnification of operation shows flame-off torch at left, with orifice partially visible. Gold wire, with perfectly formed ball, protrudes from Tempress tungsten carbide capillary tube, ready for next bonding cycle. This extreme precision symbolizes the Tempress approach to every project . . . explains why it requires 11 months to train an operator for many Tempress production operations. Other Tempress products include automatic scribing machines, diamond scribers, diamond lapping points, and tungsten carbide probe contact needles.

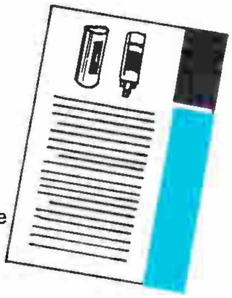
Lead-bonding, Model DTN-1, at Union Carbide Electronics.

TEMPRESS

Tempress Industries, Inc., 980 University Ave., Los Gatos, Calif. 95030

Circle 25 on reader service card





Meetings

(Continued from p. 24)

Science, Dept. of Metallurgical and Materials Engineering, University of Florida; **Nov. 10-14.**

Symposium on Adaptive Processes, IEEE; Pennsylvania State University, State College; **Nov. 17-19.**

Fall Joint Computer Conference, IEEE; Convention Hall, Las Vegas; **Nov. 18-20.**

Commerce Laser Colloquium, Electronic Industries Association and the U.S. Commerce Department; Paris, France; **Nov. 18-20.**

Conference on Magnetism and Magnetic Materials, IEEE, American Institute of Physics; Benjamin Franklin Hotel, Philadelphia; **Nov. 18-21.**

Short courses

Automation in Electronic Test Equipment, New York University; **Aug. 18-22.** $265 fee.

Science and Technology of Information Display, Polytechnic Institute of Brooklyn Graduate Center, Farmingdale, L.I., N.Y.; **Aug. 19.29.** $375 fee for both parts.

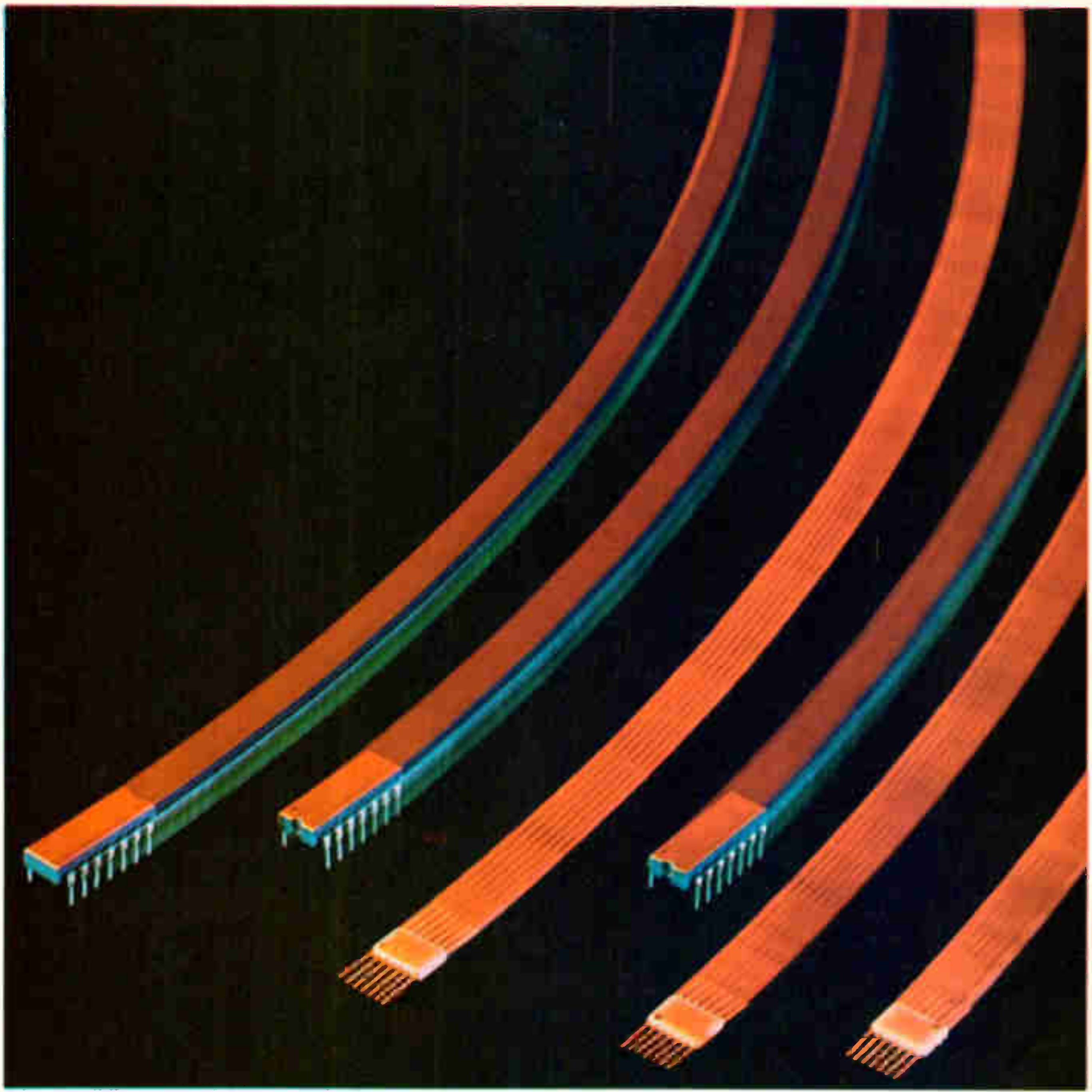
Computerized Electronics, School of Electrical Engineering, Cornell University, Ithaca, N.Y.; **Aug. 26-28.** $16.50 fee.

Call for papers

International Solid-State Circuits Conference, IEEE; Sheraton Hotel, Philadelphia, Feb. 18-20, 1970. **Oct. 17** is deadline for submission of abstracts and papers to Mr. L.D. Wechsler, General Electric Co., Electronics Park, Building #3, Syracuse, N.Y. 13201.

Transducer Conference, IEEE; National Bureau of Standards, Gaithersburg, Md., May 4-5, 1970. **Nov. 1** is deadline for submission of summaries to Dr. Robert B. Spooner, IMPAC Instrument Service, 201 E. Carson Street, Pittsburgh, Pa. 15219.

Geoscience Electronics Symposium, IEEE; Washington, D.C., April 14-17, 1970. **Dec. 1** is deadline for submission of abstracts to Mr. Ralph Bernstein, Chairman, Technical Program Committee. IBM Corp., 18100 Frederick Pike, Gaithersburg, Md. 20760.



Sprague Digital ICs. Illustration: Series 54H/74H in flatpack and DIP

Just arrived. Series 54H/74H. The fast ones.

Just about the fastest saturated logic circuits around. Series 54H/74H from Sprague. The whole family. Flip-flops and all.

Use them in arithmetic and processing sections, where speed really counts. Mix and match them with Sprague's standard Series 54/74.

Get off to a fast start with Sprague Series 54H/74H.

TYPICAL CHARACTERISTICS	GATES	FLIP-FLOPS
Propagation Delay	6 nsec	17 nsec
Power Dissipation	22 mW	80 mW
Noise Immunity	1 V	1 V
Temperature Range		
Series 54H	−55 to +125° C	
Series 74H	0 to +70° C	
Packages	DIP or Flatpack	

Call Sprague Info-Central (617) 853-5000 extension 5474.

Or call your Sprague industrial distributor. He has them on the shelf.
For complete specifications, circle the reader service number below.

SPRAGUE®
THE MARK OF RELIABILITY

PNP COMPLEMENTARY POWER SWITCHES AND AMPLIFIERS

This month, we're offering you 14 new PNP power switching and amplifier transistors. All built with our BI-MESAR™ technology. And all built to handle more power for less dollars.

Now we're up to any other power transistor manufacturer in the number of devices offered. And we're way ahead in quality.

PACKAGE	PNP	NPN COMPLEMENT
TO-3	2N3789	2N3713
	2N3790	2N3714
	2N3791	2N3715
	2N3792	2N3716
	2N4398	2N3771
	2N4399	2N3772
TO-5	2N4234	2N4237
	2N4235	2N4238
	2N4236	2N4239
TO-66	2N3740	2N3054
	2N3741	2N3054
	2N4898	2N4910
	2N4899	2N4911
	2N4900	2N4912

They're all on your Fairchild distributor's shelves in volume. And priced so you can afford to get Fairchild reliability into your circuits. Now.

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

THE GREAT FAIRCHILD POWER GRAB

THE GREAT FAIRCHILD POWER GRAB GOES ON!

Our bid for bigness in power transistors can only mean good things for you. Things like more of a choice in second sources, so you won't get halfway through a program only to get shot down by non-delivery. And things like the Fairchild name on hundreds of new power devices. So you know your systems will work better for less money. For years to come.

Here's a list of the new power devices we've put on our distributors' shelves so far in the Power Grab. If you need more information, use this form. Fill it in. Tear it out. Send it off. It's that easy.

PACKAGE	NPN DEVICE	INFORMATION, PLEASE
TO-3	2N3055	
	2N3232	
	2N3233	
	2N3234	
	2N3442	
	2N3713	
	2N3714	
	2N3715	
	2N3716	
	*2N3771	
	*2N3772	
	*2N3773	
	2N4913	
	2N4914	
	2N4915	
	*2N5038	
	*2N5039	
	2N5067	
	2N5068	
	2N5069	
	*2N5301	
	*2N5302	
	*2N5303	
	2N5732	
	2N5734	
TO-5	2N3439	
	2N3440	
	2N4300	
	2N4877	
	2N5336	

PACKAGE	NPN DEVICE	INFORMATION, PLEASE
	2N5337	
	2N5338	
	2N5339	
	2N5729	
TO-59	2N5346	
	2N5347	
	2N5348	
	2N5349	
	2N5477	
	2N5478	
	2N5479	
	2N5480	
	2N5730	
TO-61	2N2811	
	2N2812	
	2N2813	
	2N2814	
	2N4301	
	2N5313	
	2N5315	
	2N5317	
	2N5319	
	2N5731	
TO-63	2N3597	
	2N3598	
	2N3599	
	2N4002	
	2N4003	
	2N5733	

PACKAGE	NPN DEVICE	INFORMATION, PLEASE
TO-66	2N3054	
	2N3441	
	2N3738	
	2N3739	
	2N4910	
	2N4911	
	2N4912	
	*2N5427	
	*2N5428	
	*2N5429	
	*2N5430	

PACKAGE	PNP DEVICE	INFORMATION, PLEASE
TO-3	*2N3789	
	*2N3790	
	*2N3791	
	*2N3792	
	*2N4398	
	*2N4399	
TO-5	*2N4234	
	*2N4235	
	*2N4236	
TO-66	*2N3740	
	*2N3741	
	*2N4898	
	*2N4899	
	*2N4900	

*NEW THIS MONTH

NAME

COMPANY

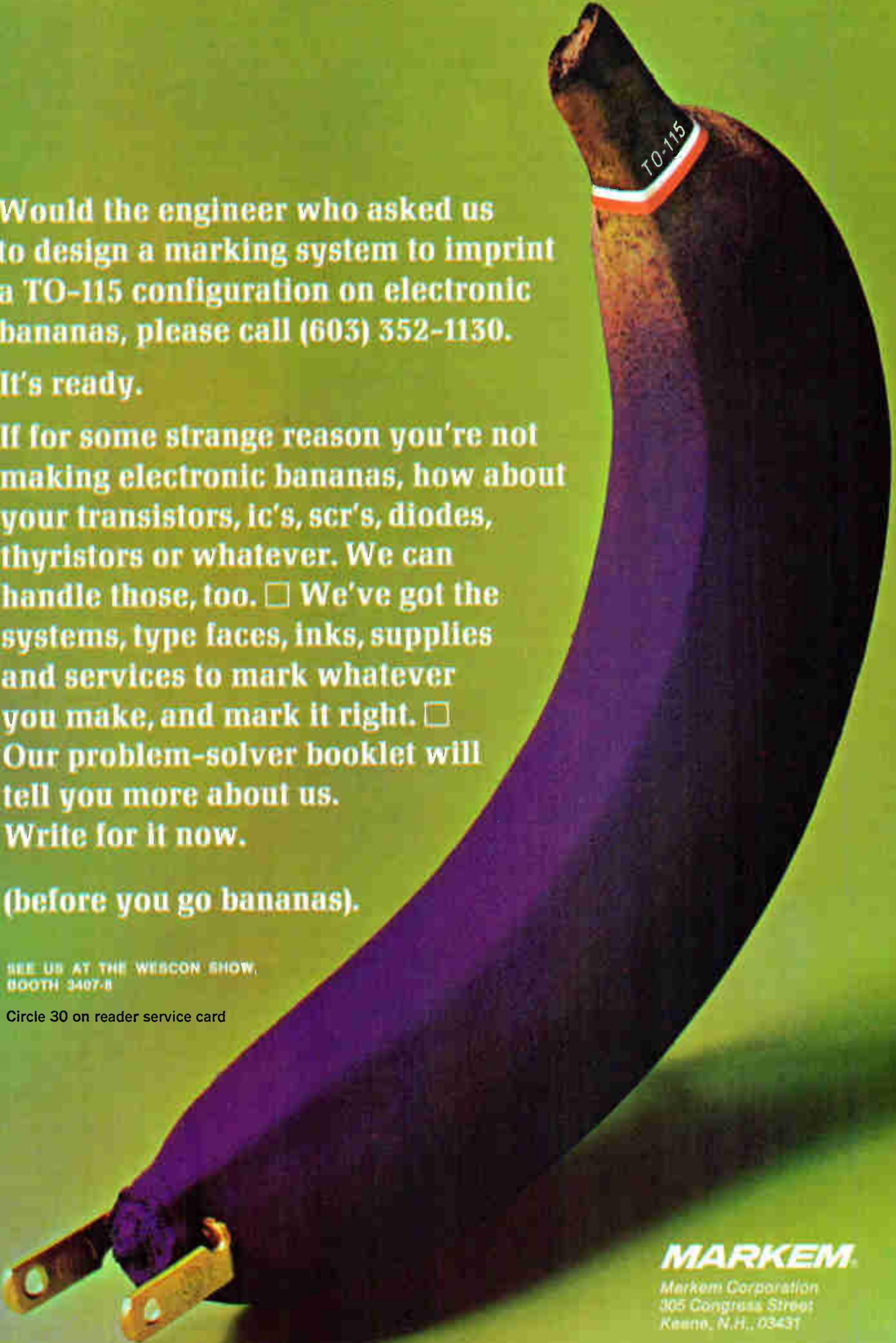
DEPARTMENT

ADDRESS

CITY

STATE ZIP

Circle 29 on reader service card



Would the engineer who asked us to design a marking system to imprint a TO-115 configuration on electronic bananas, please call (603) 352-1130.

It's ready.

If for some strange reason you're not making electronic bananas, how about your transistors, ic's, scr's, diodes, thyristors or whatever. We can handle those, too. ☐ We've got the systems, type faces, inks, supplies and services to mark whatever you make, and mark it right. ☐ Our problem-solver booklet will tell you more about us. Write for it now.

(before you go bananas).

SEE US AT THE WESCON SHOW,
BOOTH 3407-8

Circle 30 on reader service card

MARKEM

Markem Corporation
305 Congress Street
Keene, N.H., 03431

International Offices: Markem Europa N.V. Schiphol Oost, Holland; Markem U.K. Ltd. Rugby, Warwickshire, England

Editorial comment

Advanced technology helps chart growth

Pessimists may interpret this year's modest increase in electronics dollar volume [p. 107] as heralding a flattening of the market in the next few years. Such a conclusion would be a mistake. Simple extrapolation of the numbers in the fast moving electronics business seldom works. And at best, prognostication is a risky business; the most advanced techniques can't account for all factors.

Electronics markets cannot be gauged just by looking at projected equipment needs. Too often, customers don't know what they "need" simply because they don't know what's available. Obviously, market prognosticators would do well to base their projections on where advanced materials and devices can be expected to be applied, for advanced technology has an important bearing on tomorrow's outlook. Therefore, projections made by semiconductor makers to guide their own businesses are a valuable barometer—even though semiconductors account for little more than 5% of the total market.

Texas Instruments, whose predictions are well regarded, forecasts not only growth in the over-all market, but possibly a bigger share for semiconductors (about 7% by 1972). The increased share would stem, in part, from the burgeoning semiconductor content of such systems as advanced radars and infrared mappers.

There are good reasons for TI's optimism. For one thing, device makers and equipment people will be working closer together to devise new higher-performance systems. This will result in an emphasis on customized devices. For example, a big market for emitter-coupled logic will be in large, long-term computer programs for which circuits will be custom tailored. And an important end use of MOS devices will be in customized applications: digital communications for the military, and office machines and calculators.

The expanding custom market will be reflected in a change in the way of doing business. Jack Kilby, head of TI's customer requirements center, says the trend towards custom devices could lead to decisions—made jointly by device and equipment people—to design and build entire receiver front ends instead of standard mixers. It follows that an increasing number of electronics products will require no more than a few hundred identical parts per year. Thus the proliferation of standard devices will be minimized; instead, a few well-known devices or techniques will be combined or permuted to meet the specialized needs. Four of the seven growth lines upon which TI is concentrating fit the custom pattern. They are optoelectronics, advanced high-speed logic circuits (ECL), MOS circuitry, and medium scale IC's (TTL). (The others are single-diffused power transistors, computer diodes and diode arrays, and plastic-encapsulated transistors.) In the meantime, TI is moving toward the introduction of large-scale-integrated circuits, linear and microwave IC's, and semiconductor memories—product lines that also fit the custom pattern. These lines are expected to blossom in the 1970's.

Another important factor is the expanding industrial electronics market. An important development that helped open up this market was the plastic package; it started industrial users "thinking electronics." By the early 1970's, TI envisions the market for industrial semiconductors (for general purpose computers, instrumentation, and control systems, for example) at about $270 million.

It seems certain that the future of electronics will not be a linear extension of the past. It will be accelerated by the application of today's advanced semiconductor and materials technology. ■

No doubt about Apollo fallout

Engineers and scientists will argue for years about the quality and quantity of fallout from the Apollo program. Ironically, the effect least open to question occurred not in the U.S., but in Japan. It was the booming sales of color-tv sets to Japanese consumers. Those Japanese who back in May were lucky enough to see the moon in color and the predawn splashdown of Apollo 10 on color tv via Intelsat were enthralled. At that time the Mainichi Daily News reported that "millions of Japanese were glued to tv sets—and those not yet possessing color sets wished they had one—as they watched breathlessly for the Apollo 10 astronauts' safe return to earth." As a result of having had their appetites whetted by the amazing color transmissions from Apollo 10 and abetted by some extremely clever moon-oriented (Apollo 11) ad campaigns by Japanese set makers, the populace swarmed to set dealers, sending color-tv sales rocketing 80%.

Undoubtedly, the fallout's dollar value in far more significant areas, such as medical eletctronics monitoring techniques, will prove much harder to pin down. But in any event, it is difficult to argue with the statement by Ronald Philips, director of technology utilization for NASA: "There isn't any question that the [NASA-developed] technologies of the 1960's will be the realities of the 1970's." ■

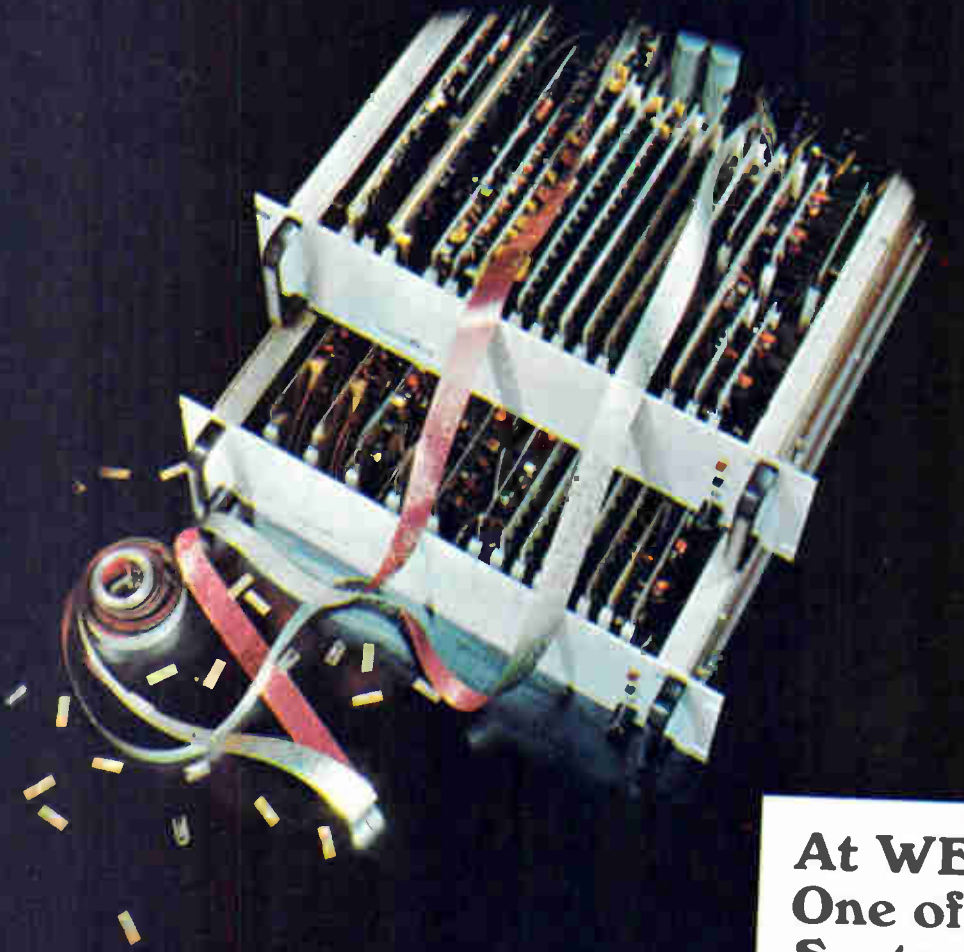
Here's the fastest, most accurate source of programmable pulses available anywhere. The new Datapulse System 140 generates rep rates to 100 MHz, pulse widths from 5 ns, and independently variable rise and fall times from 2 ns.

Your program sets the upper and lower levels of the output waveform to any values between +10v and −10v. Each level can be independently positioned with an accuracy of ±2% of programmed value ±20mv. Pulse amplitude (the difference between levels) may be varied from 50mv to 5v into a 50 ohm load. Accuracy is typically ±2% of value for the other programmable pulse parameters: rep rate, pulse delay, pulse width and transition times.

System 140 can be programmed from computer, punched tape, magnetic tape, or other logic sources. All pulse parameters are controlled by BCD inputs compatible with DTL logic levels.

For complete information contact Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, California 90230. Phone (213) 836-6100.

Tests fast ICs automatically: the only 100 MHz programmable pulser



DATAPULSE DIVISION

SYSTRON DONNER

At WESCON. One of 157 Systron-Donner instruments.

- Electronic counters
- Pulse generators
- Microwave frequency indicators
- Digital clocks
- Memory testers
- Analog computers
- Time code generators
- Data generators
- Digital voltmeters
- Spectrum analyzers
- Digital panel meters
- Microwave signal generators
- Laboratory magnets
- Data acquisition systems
- Microwave test sets

Circle 32 on reader service card

Electronics Newsletter

August 4, 1969

Air Force eyes standardization for electro-optics

The Air Force is finally trying to standardize its approach to defining the performance of electro-optical and infrared sensor systems. Goals are to unify the terminology that's used, develop realistic performance criteria, and set up procedures for making repeatable measurements.

The lack of common language is a prime reason, many feel, for the lack of success in developing and deploying electro-optical systems, particularly low-light-level television.

Work on developing the standard is being done largely in-house at the Avionics Laboratory, Wright-Patterson Air Force Base, Ohio. **Television, infrared and line-scanning systems are being tackled first, but radar systems will eventually be included.**

The Air Force hopes to hold a series of seminars with industry, probably starting in the fall, to exchange ideas and help develop the standards.

TI gears up for LSI; first bipolar devices due this month . . .

The first complete production line for LSI arrays at Texas Instruments will be set up in the new Houston plant around November. Presently, TI's LSI work is in the developmental and pilot production stages, divided about evenly between Dallas and Houston. Ultimately all of it will be moved to Houston [*Electronics,* March 17, p. 36].

This month TI will begin introducing an off-the-shelf line of its bipolar, discretionary-wired LSI. First device to be announced will be a digital differential analyzer. TI is tentatively planning to bring out about one LSI array product a month over the next several months. In the works are five LSI device types including a 1,000-bit shift register.

The primary aim in announcing these standard LSI arrays is to get across to potential customers TI's position that it has the ability to supply arrays now. **The company still sees at least 80% to 90% of the future LSI market as being custom-designed products.** Its LSI product line is aimed primarily at giving customers something they can feel and touch. TI gets customer resistance when it has nothing to show—something the company went through in the early days of integrated circuits.

. . . as company farms out MOS technology abroad

Texas Instruments is taking an unusual step—for it at least—in moving its MOS technology overseas. Normally, TI waits until it has a product in volume production before moving the technology to its foreign plants. But in the case of MOS, TI isn't waiting because it sees a big overseas market developing very fast. The traditional two- or three-year gap between the U.S. and other countries in designing new semiconductor devices into hardware isn't happening with MOS.

Engineers from TI's European and Far East plants are already hard at work with the company's MOS people in Houston. They will be taking the technology back with them "in the coming year" to gear up for the anticipated overseas business.

TI expects about half of the MOS business by 1972 to come from overseas. It sees the total market exceeding $150 million by that time, with about 70% coming in memory and custom logic devices for office machines and computers. It's this slice of the pie that's whetting TI's appetite. Company officials see the biggest MOS competition coming from the major semiconductor houses and the Japanese.

Electronics Newsletter

Sylvania to sell digital recorder?

What may be the world's fastest digital recorder is the object of negotiations between the developer, Sylvania Electronic Systems, and the potential buyer, Synergistics. **The system uses a modulated helium-neon laser to store data in 36 channels on 8 millimeter microfilm. Data-transfer rate is from 0 to 10.8 megabits per second—and could range upward to more than 20 megabits per second in future units.** It would have a photodiode readout.

A key application would be high speed, high density storage; 5,000 36-bit words per inch can be stored with the new system. This is as much as 90% more compact than magnetic tape.

As for why Sylvania is thinking of selling this recorder, **the major potential market for the recorder appears to be in commercial computer peripheral equipment, and apparently Sylvania doesn't want to enter this field with just a single product.**

Comsat considering eighth Intelsat 3

Failure of the latest Intelsat 3 to achieve orbit may turn out to be a blessing in disguise for TRW, builder of the $7 million communications satellites for Comsat. **Comsat recently ordered a seventh spacecraft because of earlier failures in the program, and may now end up buying yet another.** The decision on whether to buy an eighth will probably be made later this month. Only six of the satellites were procured originally.

Comsat is now pushing to get its next Intelsat 3, the sixth attempt on the pad at Cape Kennedy in time for a September launch. The July 25 launch failed when the satellite didn't achieve a proper transfer orbit. Presently, only two of the five satellites launched are operating.

Fast Fourier unit boasts capacity of 30-odd channels

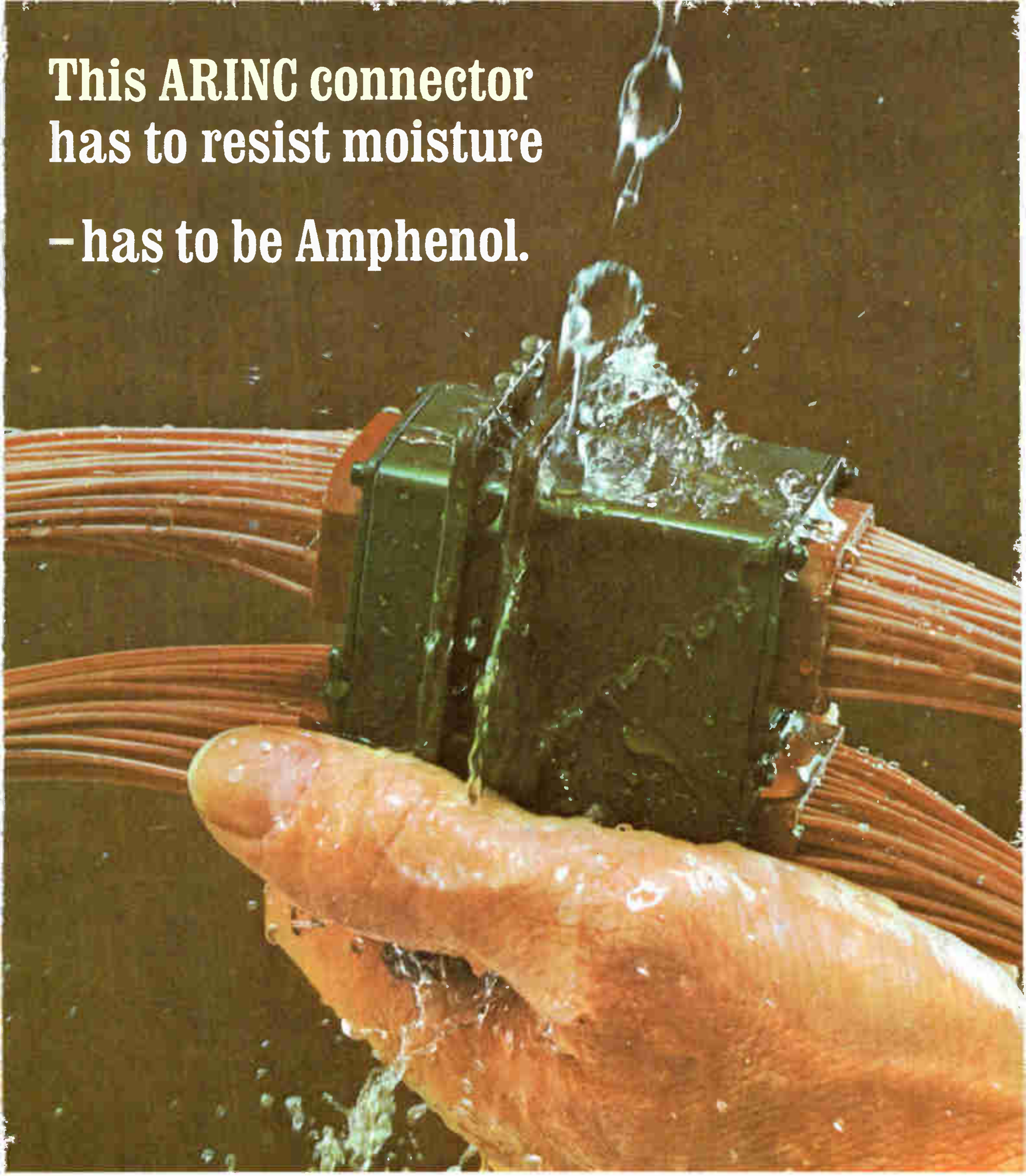
Computer Signal Processors Inc. is developing a faster, big brother to its CSS-3 fast-Fourier computer system [*Electronics,* April 14, p. 159]. Instead of building the new system, called the CSP-30, around a Varian 620I general purpose computer as it did on the CSS-3, the firm is developing its own processor. The emphasis is on getting as much speed as possible: TTL integrated circuits and five- to 12-layer printed circuits boards. **The digital signal processor will also handle more data channels, about 30-odd compared with the earlier model's standard one channel.**

A functioning machine should be completed by late September or early October. Software hopefully will be debugged by early 1970. It is expected to be priced at something below $100,000. Two systems already have been sold.

Addendum

A new Saugus, Mass., firm, Solid State Technology, is about to come out with a radio alarm that uses neither battery nor line power. **Based on a proprietary power system the company won't discuss, the alarm box generates its own power when a user opens the box's cover.** It also won't give the power or range of the signal. Pressing a button releases the energy as a tone coded, 150 megahertz, frequency-modulated signal which identifies both the location and type of emergency. A single receiver console can handle up to 9,999 separate alarm boxes. **The cost will be about $1,000 per unit, according to the company,** which hopes to carve out part of the fire alarm and roadside signaling systems market.

Circle 35 on reader service card →


This ARINC connector has to resist moisture
–has to be Amphenol.

Amphenol has added fixed contact, high density, encapsulated contact and pov

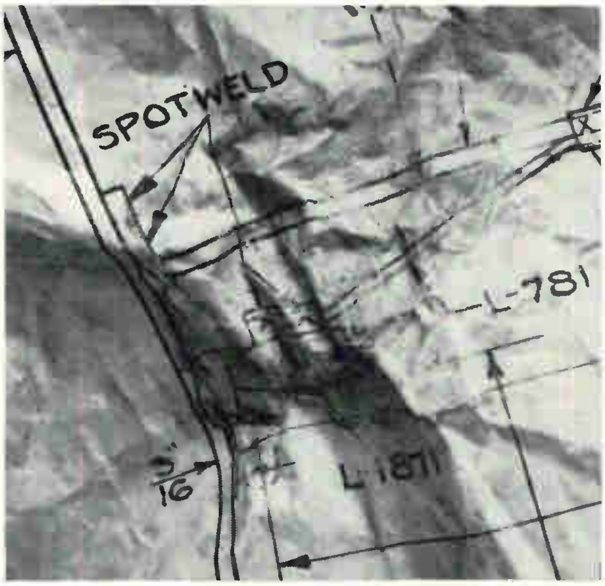
NOW AMPHENOL GIVES YOU A COMPLETE LINE of pin and socket connectors. We've added four new families to our original Poke-Home® and hard dielectric standards — fixed contact, high density, encapsulated contact and power/coax. And they'll intermate with the ones you're buying now.

EXPECT TWO BIG DIFFERENCES FROM AMPHENOL—availability and down-to-earth prices. We'll meet *your* delivery schedule and *match* prices with anyone.

SEND FOR A FREE WALL CHART showing all six families with a wide variety of pin configurations, contact types and dielectrics. Return the card in this ad or write Amphenol Industrial Division, 1830 S. 54th Ave., Chicago, Illinois 60650.

***Fixed Contact**—Fixed solder contacts with 2-piece glass-filled nylon insulator. **High Density**—Removable crimp Poke-Home® contacts with glass-filled nylon insulator. **Encapsulated Contact**—Removable crimp or solder Poke-Home® contacts with encapsulating nylon insulator. **Power/Coax**—Removable crimp or solder Poke-Home® contacts for either power or coax with glass-filled nylon insulator. **Original Poke-Home®**—Removable crimp or solder Poke-Home® contacts with nylon insulator. **Hard Dielectric**—Removable crimp or solder Poke-Home® contacts with diallyl phthalate insulator.

DIRTY LINEN



Keep that original safe. Make a second original on KODAGRAPH Wash-Off Film.

This old battered drawing on cloth was once a thing of beauty—the culmination of weeks of design and many hours on the drafting board. Yet pretty soon, with handling, staining, smudging, and flaking, it can look like this.

That's why it really pays to have your blueprinter make a second original on KODAGRAPH Wash-Off Film, ESTAR Base. Preserve the cloth master and drop the second original into your active file. It won't crack or yellow. Stains and fingerprints will wipe right off. You'll still be getting great white prints years from now.

Revisions are easy. You get rid of unwanted photographic lines on KODAGRAPH Wash-Off Film, ESTAR Base, with a drop of water and a touch or two of your eraser. Its matte drafting surface permits twice the erasures, yet accepts and holds pen-and-ink corrections smoothly.

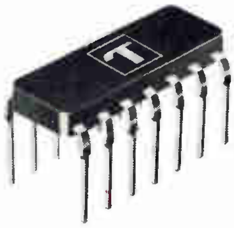
More details? Just contact your local Kodak Technical Sales Representative for a no-obligation, certified survey of your present operation ... and a look at all the smart KODAGRAPH Products available now. Or write us: Eastman Kodak Company, Business Systems Markets Division, Rochester, New York 14650.

Kodak

DRAWING REPRODUCTION SYSTEMS BY KODAK

Let's lay our cards on the table

When it comes to Series 54/74 TTL, Transitron holds a full deck . . . twenty-six Series 54 devices, in ceramic DIP (J) or Flat (F) packages, twenty-eight Series 74 devices, in ceramic DIP (J) or plastic DIP (E) packages. The 54/74J and 74E units are pin-for-pin identical, and all circuits in all packages are completely interchangeable with those of the original 54/74 manufacturer. Prices are competitive and we can deal you a pat hand right off the shelf.



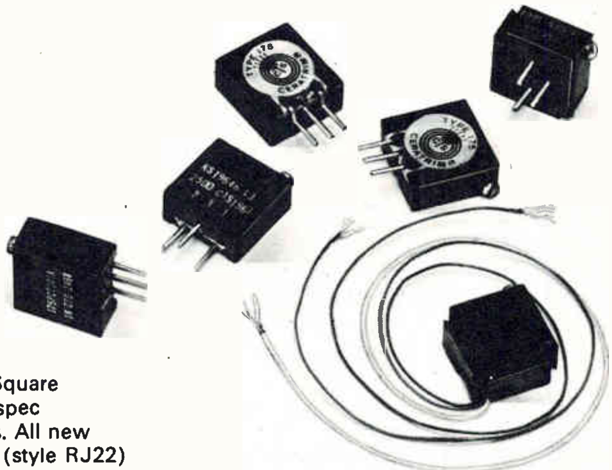
Ranging from basic gates to more complex functions such as adders, counters and shift registers, Transitron's family of TTL devices now numbers more than 450, including a broad range of Series I and Series II types.* This gives you breadth of choice virtually unmatched in the industry.

Find out what's in the cards for you.
Send for complete data and specifications
on the devices that interest you.

Transitron
electronic corporation
168 Albion Street Wakefield, Massachusetts 01880

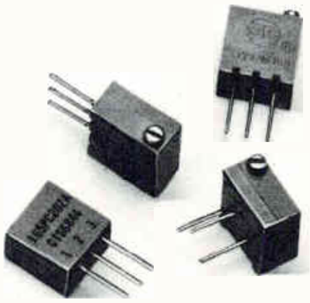
* Electrically and mechanically interchangeable with SUHL I and II.

new mil-performance square cermet trimmers ...from CTS



Now . . . with CTS Cermet Multi-Turn Square Trimmers you get Characteristic C Mil-spec performance for all military applications. All new series 165 (style RJ24) and series 175 (style RJ22) meet tough Characteristic C of Mil-R-22097C. These same environmental characteristics are available . . . at lower cost . . . for commercial and industrial applications.

Both small ⅜"-square series 165 and compact ½"-square series 175 trimmers assure infinite resolution over a 20 ohm to 2.5 megohm range . . . and power rating of ½ watt @ 85°C. TC ± 150 ppm/°C for 2k ohms and above. —0 +175 ppm/°C from 50 ohms through 250 ohms and —0 +250 ppm/°C from 500 ohms through 1k ohm. All available at no extra cost.



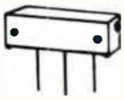
Low cost*, proven quality, and top performance—combined with ***fast distributor delivery***—make CTS your best industrial trimmer choice. Can't use one of our standard series? Ask how we can solve specific application problems. Call or write for complete details to CTS of Berne, Inc., Berne, Indiana 46711. Phone (219) 589-3111.

*Check these prices for 4-6 week production delivery. (Small quantities from stock)

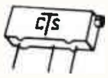
	Series 165		Series 175	
Quantity	25-49 (each)	1000 (each)	25-49 (each)	1000 (each)
Commercial (±20% Tol.)	$4.55	$3.25	$4.20	$2.95
MIL-type (±10% Tol., Char. C)	5.30	3.80	5.10	3.65

CTS CORPORATION
Elkhart, Indiana

Other CTS Cermet Trimmers include:



Series 185
1-¼" x .290" x .364"
multi-turn

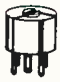


Series 190
¾" x .160" x .310"
multi-turn

Series 340
¼" x ¼" square x .270"
high—single-turn

Series 360
7/16" x 17/64" x 25/64"
single-turn

Series 385
11/32" round x .225"
high—single-turn



Series 660
⅜" round x ¼" high—
single-turn

Series 630
½" round x 13/32" high-
single-turn

Programmable.

Full-function programmability
DC to 50 MHz Counting Range
Universal counter / timer functions
BCD output
. . . all for only $1285

The new Monsanto Model 110A offers you a broader range of operational advantages than any counter/timer in its price range. Front-panel functions are tailor-made for programming with the Monsanto Model 501A Digital Programmer, or with virtually any other contact-closure or logic-level source.

Now consider these other features of the Model 110A: the full complement of counter / timer functions; dc to 50 MHz counting range; marker and gate outputs; provision for external time base; and BCD output. Plus the inherent reliability of Monsanto "4th generation" integrated circuit construction. Plus the 2-year Monsanto warranty.

Price of the Model 110A is $1285; of the Model 501A, $375. For a demonstration or technical data call your local Monsanto Field Engineering Representative or contact us direct. Monsanto Company, Electronic Instruments, West Caldwell, New Jersey 07006; (201) 228-3800.

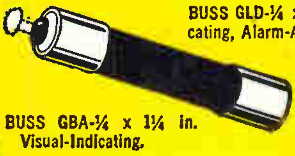
Circle 41 on reader service card

Monsanto

BUSS

THE COMPLETE LINE OF SIGNAL-INDICATING, ALARM-ACTIVATING FUSES AND FUSEHOLDERS

FOR USE ON COMPUTERS, MICROWAVE UNITS, COMMUNICATION EQUIPMENT, ALL ELECTRONIC CIRCUITRY



BUSS GLD-¼ x 1¼ in. Visual-Indicating, Alarm-Activating.

BUSS GBA-¼ x 1¼ in. Visual-Indicating.

BUSS ACH Aircraft Limiter, Visual-Indicating

HKA panel mounted holder, lamp indicating-signal activating, for ¼ x 1¼ in. BUSS GLD fuse.

¾ to 5 amp.

BUSS MIC-13/32 x 1½ in. Visual-Indicating, Alarm-Activating.

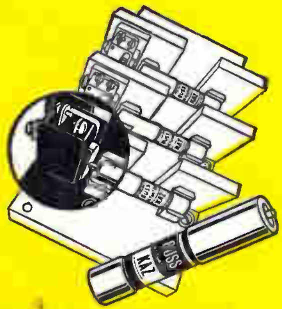
BUSS MIN-13/32 x 1½ in. Visual-Indicating.

HLD panel mounted holder, visual-indicating, for ¼ x 1¼ in. BUSS GBA fuses (or GLD fuses)

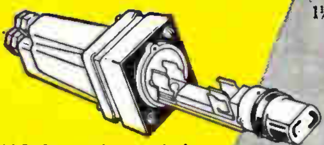
¾ to 5 amp.

HPC-C panel mounted holder, visual-indicating, for 13/32 x 1½ in. fuses.

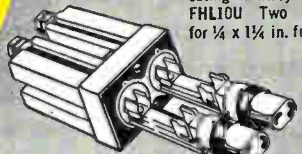
FNA FUSETRON Fuse 13/32 x 1½ in. slow-blowing, Visual-Indicating, Alarm-Activating. (Also useful for protection of small motors, solenoids, transformers in machine tool industry.)



BUSS KAZ Actuator 13/32 x 2 in. Signal-Indicating, Alarm-Activating Device. Use to call attention to the opening of a fuse of 50 amp or larger. Can be mounted "piggy-back" on large fuse or in special block with micro-switch. Ask for Bulletin KAFS.

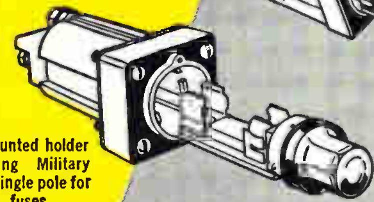


HGB-C panel mounted holder lamp indicating Military type FHL11U Single pole for ¼ x 1¼ in. fuses.

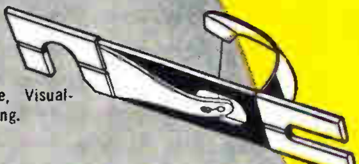


HGA-C panel mounted holder lamp indicating Military type FHL10U Two pole for ¼ x 1¼ in. fuses.

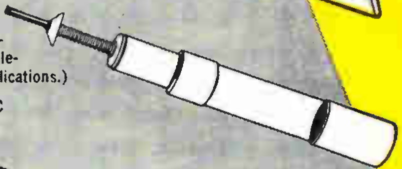
BUSS GMT and HLT holder, Visual-Indicating, Alarm-Activating.



HGC panel mounted holder lamp indicating Military type FHL12U Single pole for 13/32 x 1½ in. fuses.



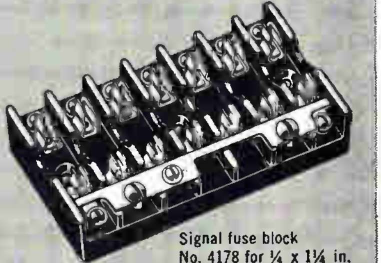
BUSS Grasshopper Fuse, Visual-Indicating, Alarm-Activating.



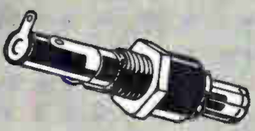
BUSS Series 70. Visual-Indicating, Alarm-Activating. (Used in telephone and similar applications.)

Ask for Bulletin 70S-C

Signal fuse block No. 3839 for 13/32 x 1½ in. indicating fuse.



Signal fuse block No. 4178 for ¼ x 1¼ in. indicating fuse.



HKL panel mounted holder, lamp indicating, for ¼ x 1¼ in. fuses.

Write for BUSS Form SFB

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

SUPPLIED THE ECONOMICAL WAY . . .
THRU DISTRIBUTORS

BUSS QUALITY
FUSES

"See Us at Booth 4321 at the Wescon Show"

Circle 42 on reader service card

STATIC SHIFT REGISTERS — Very mod, very new, very reliable. AMI/MOS shift registers are available *now*, in quantity, at very low prices to make your system very special in performance, price and predictability. Our Dual 100 plugs into existing systems pin-for-pin. Both dynamic and static shift registers are available, to get you from DC to 10 MHz. For details, write, call, or better yet, hop a jet and visit our new production facility — America's largest.

NOW IN PRODUCTION NEW SHIFT FAMILY

AMERICAN MICRO-SYSTEMS, INC.
3800 Homestead Road, Santa Clara, California 95051
Telephone 408-246-0330, TWX 910-338-0018
CUSTOM & STANDARD MOS ARRAYS/MEMORIES/REGISTERS/LOGIC

Circle 43 on reader service card

IC Testing?

MicroTest has canned it!

Revolutionary?
We don't know what else to call it!
A fast, accurate Universal Digital IC Tester with a built-in film strip projector. The IC circuit diagram, the test specifications, and even the logic levels on each pin for the 16 functional test sequences performed, are projected on the large front panel screen!

Operator-oriented? You bet! Just dial in the data on any of 15 ICs stored on the film strip. Read the specified voltages for each pin. Then set the voltages precisely, using the concealed front panel controls and the built-in digital voltmeter.

Now push the "go" button and zip through the automatically programmed functional tests in less than 16 milliseconds.

A test failure? That's where the Microtest 100-D really shines! The failure shows up as a light superimposed on the projected display.

Your operator instantly knows which test has failed, and on what pin the failure has occurred!

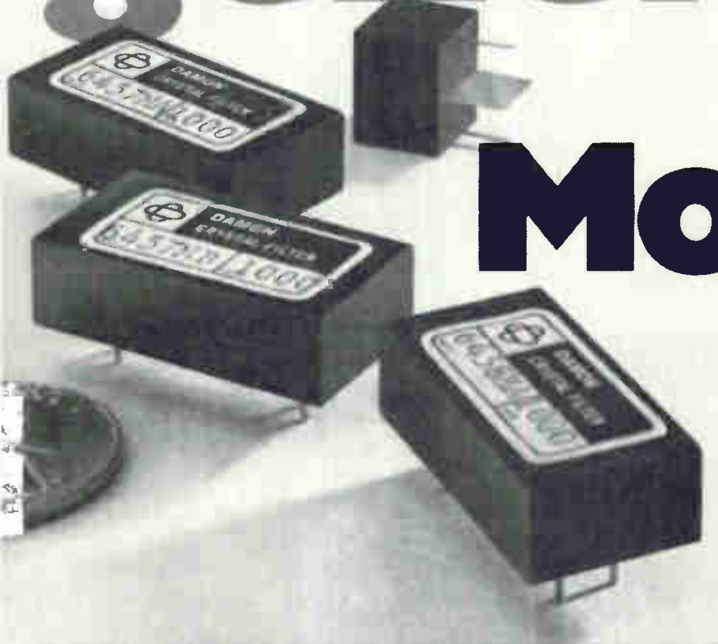
Write for our new, colorful Brochure.

MicroTest Corporation 9000 Winnetka Avenue Northridge, Calif. 91324 Telephone (213) 341-0080

DAMON ANNOUNCES...

The second generation in Monolithic Crystal Filters.

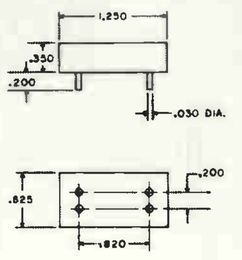
A new 7-pole monolithic crystal filter line that surpasses those previously available in shape factor and spurious mode suppression. Provides performance comparable to the highest state-of-the-art currently available with discrete filters – yet incorporates all of the inherent advantages monolithics have over conventional multi-component configurations. Now Damon provides the best of both worlds: critical performance, superior temperature characteristics, improved aging, small size, and significantly lower price. All are available in hermetically-sealed metal cases within miniature rectangular packages ranging in size from 0.080 cu. in. to 0.274 cu. in. Immediate off-the-shelf delivery of evaluation quantities. Damon also offers a wide variety of computer-assisted designs, but these take a little longer. Damon/Electronics Division, 115 Fourth Ave., Needham, Mass. 02194, Tel: (617) 449-0800.



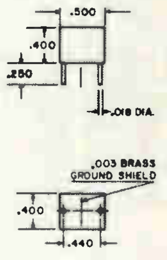
"STANDARD" 7-POLE MONOLITHIC CRYSTAL FILTERS

Model No.	6457MA	6457MB	6458MA	6458MB
Center Frequency:	10.7 MHz ± .7 KHz	10.7 MHz ± 1 KHz	21.4 MHz ± 0.7 KHz	21.4 MHz ± 1 KHz
Bandwidth, 3 dB:	6 KHz min.	15 KHz min.	6 KHz min.	15 KHz min.
Bandwidth, 60 dB:	18 KHz max.	40 KHz max.	18 KHz max.	45 KHz max.
Ripple, Max.:	1 dB	1 dB	1 dB	1 dB
Insertion Loss, Max.:	6 dB	6 dB	6 dB	6 dB
Spurious Returns:	> 55 dB down	> 50 dB down	> 55 dB down	> 50 dB down
Terminations (Resistive):	2.0 kilohms	5.1 kilohms	0.38 kilohms	1.3 kilohms
Ultimate Atten.:	80 dB	70 dB	80 dB	70 dB
Op. Temp. Range:	0°-60° C	0°-60° C	0°-60° C	0°-60° C
Case Size:	"A"	"A"	"A"	"B"

CASE "A"
0.274 cu. in.

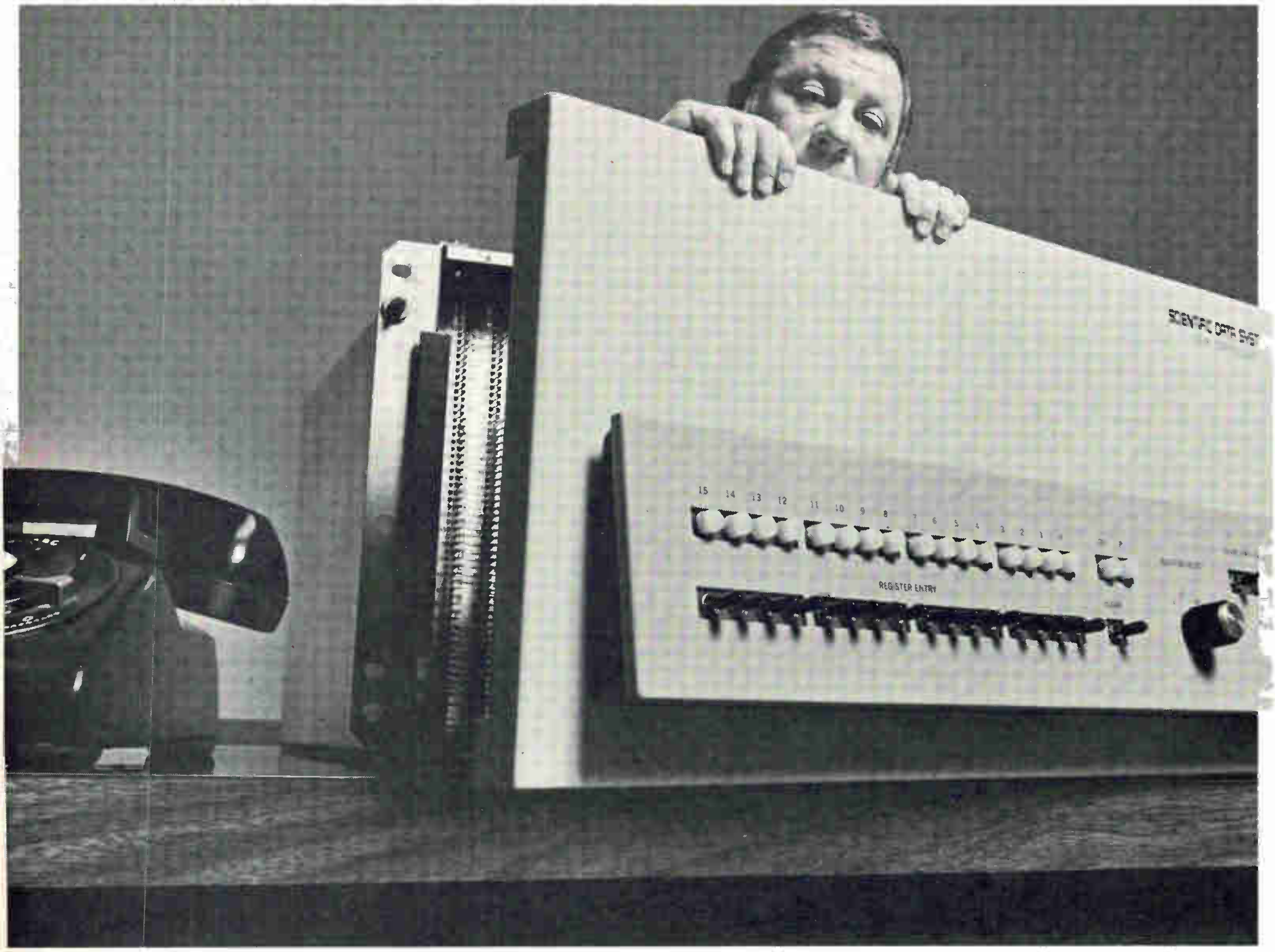


CASE "B"
0.080 cu. in.



SEE THE SECOND GENERATION IN MONOLITHIC FILTERS AT WESCON – BOOTH 5206.

DAMON



Our new mini-computers have built-in programmers.

Most small computers are designed for programmers. Ours are designed for people.

Just tell our 16-bit machines what you want done. The CE16 and CF16 will do it, because their "built-in programmers" (a comprehensive set of sophisticated instructions) let any engineer use them with ease. For example, the single instruction "scan memory" makes our machines compare a given number with the contents of the entire memory.

The CE16 and CF16 have 125 other heroic instructions that specify comprehensive maneuvers. So you give fewer instructions and use far less core memory than with any other small computer. Problem run times are shortened and Input/Output operations are simplified.

The CE16 and CF16 are designed to control and exchange information with a large number of external devices while doing related computation. Their "automatic I/O" enables them to talk back and forth between memory and a group of interrupting peripherals, in order of priority, without needing attention from the on-going program.

Automatic I/O isn't a high priced option. Neither is a teletype, nor three priority interrupts, one of which is indefinitely expandable. They're all standard. The only thing you might pay extra for is speed. The CF16 can do a fully signed software multiply in 42 micro-seconds. But it costs a little more than the CE16 which takes 126 micro-seconds (which isn't bad) for the same job.

Don't take our word for all this. Drop us a line asking for:

- A brochure with straight from the shoulder specs so you can compare.
- A representative with more information than could fit in a brochure.
- Or a meeting between our sales engineer and one from any competitor you want, at your office. The competition can even bring a programmer along. We won't have to.

SDS

Scientific Data Systems,
El Segundo, California

Circle 46 on reader service card

And now, aiming beyond the moon

Space stations and unmanned explorations of outer planets are high on NASA's list of goals for the next decade

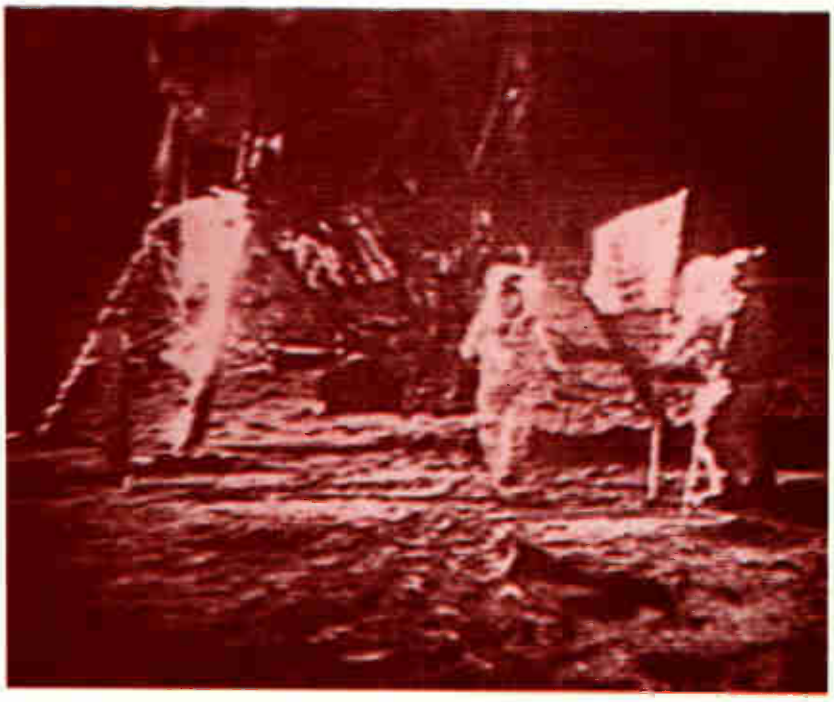
Even before it's incredibly successful Apollo 11 lunar mission had splashed down, NASA moved to capitalize on its new glory by disclosing plans to revitalize the slipped Apollo Applications Program with one major 1972 launch. By combining the Apollo telescope mount with its orbiting workshop into a single spacecraft, the agency not only encouraged industry interests but provided an interim answer to the question: What's next?

Though the final answer will come from the White House this fall following submission of the report of the President's special Space Task Group, NASA was promoting a favorable judgment by providing a public demonstration of its flexibility as well as an ability to economize on the battered Apollo applications effort.

Double shot. Both the Apollo telescope mount and the orbiting workshop will ride the same Saturn 5 booster; they'll be followed a day later by astronauts in an Apollo capsule. The astronauts will spend 28 days initially in the station, and an as yet unspecified number of revisits—lasting up to 56 days—will follow. The concentrated Apollo applications mission will use up NASA's committed manned-space money with the exception of a few lunar visits.

Meanwhile, NASA's long-term future is being assembled by the President's special group, which has until September 1 to deliver an outline on the proposed future of the agency. Composed of strong space advocates—Vice President Agnew heads it with NASA administrator Thomas Paine, Presidential science adviser Lee DuBridge, and Air Force Secretary Robert Seamans as voting members—the task group is expected to offer an

Lunar labors



How did the lunar electronics perform during the Apollo 11 mission? Pretty well, from all indications. For one thing, communications between the lunar surface and earth worked so well that RCA's umbrella antenna, which was to be set up only if the signal needed boosting, wasn't even used.

However, when the astronauts—as instructed—switched the LM's radar computer to its own power, the machine flashed its overload alarm. At that critical point, the flight controllers in Houston came close to aborting the lunar landing.

The jury still isn't in on the experimental packages left by the astronauts. The latest check of the passive seismic experiments package indicates that it is still producing usable data; however, the temperature of the unit was running high and its continued success was a day-to-day proposition.

As for the laser ranging experiment, a positive response was achieved by the Lick Observatory at Mt. Hamilton, Calif., but that was before the astronauts left the moon. However, there have been few bounces since, leading to speculation that the reflector may have fallen over, perhaps when the lunar module took off. The next try will be made by the McDonald Observatory at Ft. Davis, Texas, but not until the beginning of the next lunar night, early in August. Currently, the part of the moon where the reflector sits is moving into sunlight, causing enough noise (in the form of light) to smother a laser signal.

ambitious program for the next decade. Adding to bullish prospects for the report is the fact that NASA "task forces" have put together chapters of the report.

According to those close to the group, every attempt is being made to give the President a balanced report for him to use in charting a new course in space.

So as not to catch Congress off guard, members of the group's staff have been consulting with members of key Congressional committees on their recommendations. Nonetheless, the final decision on the contents of the report lies with the President, who seems to have Apollo fever himself. He recently predicted that by the year 2,000 people from earth would have visited "new worlds, where there is a form of life."

Sources in the White House say that four major project areas are being studied for the President's consideration. They are:

- **Shuttle splurge.** NASA would like to go ahead with its concept of a reusable manned space shuttle which would be used in conjunction with orbiting stations as well as on its own for earth resources, orbital astronomy, research laboratory, and manned lunar missions. General Dynamics, Lockheed, McDonnell Douglas, and North American Rockwell will deliver parallel studies in September. According to another study, prepared by the Institute for Defense Analysis, development costs would run to $2.14 billion—each vehicle would run about $40 million in production, and operating costs could run as high as $1.5 billion.

Should a green light be given, NASA feels it can schedule initiation of final design and development in early 1972 with initial flight testing in 1974 and operations commencing in late 1975. Much data has been given to the space task group. And, both Air Force Secretary Seamans and NASA Administrator Paine are pushing for the shuttle.

- **Unmanned plunge.** NASA planners would like to boost the relatively low $200 million to $300 million a year now being spent on unmanned planetary exploration to the $800 million to $900 million-a-year level by the mid-1970's and go over the billion-a-year level by 1980. (At the Office of Space Science and Applications, planners have discussed an idealized fiscal 1980 planetary budget which calls for $800 million for the "outer" planets and $400 million for the "inner" planets.)

Two Grand Tour missions to the outer planets, a Venus orbiter and "buoyant probe" mission, advanced solar orbiters and probes, several missions to Mercury, and planetary sample expeditions are among the ambitious lot of fly-bys, probes, and orbiters hoped for in the coming decade. The pacing item for all of this will be approval of the Grand Tour missions to the outer planets. NASA Administrator Paine and Presidential science adviser DuBridge have both expressed strong interest in the plan. Officials on the unmanned side at NASA concede that their grandiose plans will of necessity by tied to comparable plans of their manned counterparts. An historical point often raised: the Surveyor program was in financial trouble until it got irrevocably tied to the then emerging Apollo lunar-landing program.

- **Space station spectacular.** With the Air Force's manned orbiting laboratory now off the boards and the once mammoth Apollo Applications Program now neatly consolidated, the U.S. is sorely in need of a grand manned scheme. NASA is moving quickly on its proposed national space station which it would like to launch in 1975 for a decade of operation [*Electronics*, June 23, p. 149]. The project would be costly and, in general, able to keep the space program in good health. Such a program would also give NASA the experience and technology needed to get on with manned interplanetary exploration after the 1970's. At present, it is acknowledged to be the program NASA would most like to get approval for in the next decade.

Not to be overlooked in assessing the possibilities for the station is that astronaut Frank Borman, who heads a special task group at NASA to boost the station concept, has become a close associate of the President.

- **Applications additions.** Currently, NASA is spending about $250 million a year on unmanned earth orbiting satellite programs. NASA would like to gradually double this total by the late 1970's as it initiates and broadens satellite programs in meteorology, earth resources, communications, engineering, broadcasting, and navigation and traffic control. The least costly of the possibilities, an expanded applications program, probably has the strongest chance.

Hello, moon

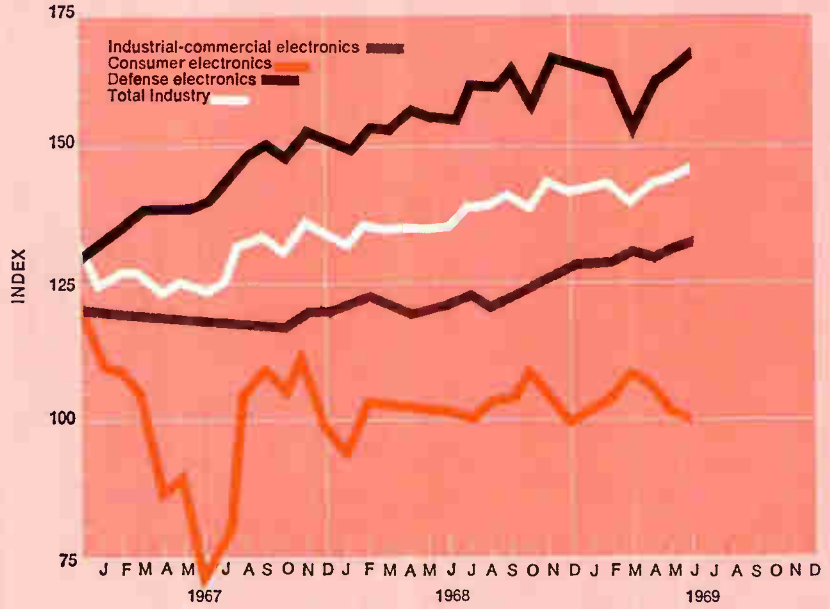
Compact. This is message disk for Apollo 11. It carries 87 messages at 1/200th size on a 1.5-inch disk of pure silicon.

After the moon—what? For the Sprague Electric Co. it could be information storage and retrieval, because when the firm got into the Apollo program at the last minute, it also may have gotten itself into a new market.

It all started when NASA requested messages from some 200 heads of state. The messages were to be reduced in size and left at Apollo 11's lunar module landing site. The usual vehicle for storing large amounts of text in small volume is microfilm, but it was apparent that microfilm wouldn't be able to withstand the radiation,

Electronics Index of Activity

August 4, 1969



Segment of industry	June 1969	May 1969*	June 1968
Consumer electronics	101.8	102.4	102.0
Defence electronics	168.8	165.4	154.4
Industrial-commercial electronics	133.9	132.1	122.8
Total industry	147.1	144.9	136.7

June's production index climbed to 147.1, up 2.2 points from the revised May figure and up a whopping 10.4 points from June 1968. Consumer production, however, was off slightly—0.6 point—from the previous month. But defense and industrial-commercial production took up the slack—defense rose 3.4 points, industrial-commercial climbed 1.8.

The drop in consumer production can be attributed, in part, to a sales sag in May. Compared with sales figures for May 1968, distributor sales to dealers of of color-tv sets fell 16.1% and black-and-white receiver sales dropped 11.4%. Auto radios were down 18.6% and home radios were off 17.9%. Console phonograph sales, however, provided a bright spot with a 9.5% increase. Color sales for 1969's first five months were up 9.5%.

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.

heat, cold, and near total vacuum of the moon's surface.

Pass it on. NASA headquarters gave the problem to its Electronics Research Center in Cambridge, Mass., which turned to Sprague. Gene G. Mannella, the center's director of advanced technology, says it thought of Sprague because the center wanted to utilize the photo-reduction techniques inherent in integrated circuit construction, though at the time Mannella and others envisioned an etched roll of metal foil as a space- and weight-saving vehicle. With lunar freight rates running at $22,000 to $23,000 per pound, weight had to be low.

Early in the course of a three-week, $7,000 effort, Sprague suggested that an etched silicon wafer carry the messages. According to Robert S. Pepper, Sprague's director of research, development, and engineering, a text reduced several hundred times and etched into a silicon dioxide coating on a silicon substrate retains more than enough detail clearly to delineate the center of the loop in the letter "e". Steel or aluminum foil wouldn't have allowed such resolution (or as much contrast) because their surfaces are much rougher.

Pepper feels that no great technological breakthrough went into the moon wafer; "We work here daily with IC's having geometries in the micron range. By taking added care, we have been able to reduce printing almost the diffraction limit of the ultraviolet light used to expose our photoresist plates—at 400 times reduction, the line widths approach 0.25 to 0.50 micron."

Tough. Now Sprague feels it may have a salable product. The metal-packaged wafer sent to the moon turns out to be impervious to almost any wear and tear it might normally encounter, including fire and explosion, since silicon's melting point is greater than 1,400°C.

Not only is the silicon system permanent but it packs data more tightly than the best microfilm, Sprague claims. A 1.5-inch-diameter wafer recording typewritten copy at 12 characters to the (original size) inch and 60 lines per page can hold about 600,000 words at the 200:1 size reduction used for the NASA disk. With 400:1 reduction, with thin wafers, and by etching both sides of a wafer 7 mils thick, packing densities of 97.2 million words per cubic inch are achievable, Sprague claims.

Thus a few hundred such disks might be used to store corporate records as a sort of poor man's Iron Mountain repository. Already, a large insurance company is interested in what Sprague is now calling its Microperm process.

Coming up. Microperm records are read with optical comparators or microscopes. For fast optical data retrieval, handling techniques might be adapted from microfiche systems. Electron-beam readout techniques might also be borrowed since they're more easily compatible with electronic data-processing and executive information systems.

Pepper feels that electron beams will probably be limited to the readout of information. "While it's theoretically possible to make higher resolution masks with electron-beam scanning, it doesn't look practical to me yet. I don't think the extra density would offset the extra cost and effort."

Manufacturing

Masked marvel

"Should Microelectronic Processing Be Done With Electron Beams?" That's the innocuous-seeming title of a Wescon paper to be given by Stephen Angello, a consultant for the Westinghouse Research Laboratories. The paper could revolutionize semiconductor masking operations.

William Hugle, president of Hugle Industries, the Sunnyvale, Calif., manufacturer of wafer-fabrication and semiconductor-assembly equipment, believes a masking machine incorporating the Westinghouse technique "will replace all the mask-making and masking equipment that now exists." Hugle has an exclusive agreement to manufacture and license the machine, which means it also has the not-too-easy task of making a production machine out of the Westinghouse development. William Hugle has guaranteed Westinghouse that his firm will complete its portion of the remaining development in less than 18 months.

No light. Electron beam projection is employed in a vacuum tube to transfer the mask image to a silicon wafer up to 2 inches in diameter. The mask is the photocathode, and the wafer is the anode. The wafer is coated with a resist material that is sensitive only to electrons and doesn't require the usual yellow light.

Angello explains that the simplest way to make the photocathode is to evaporate titanium over one face of a quartz window, transmitting ultraviolet light at 2,537 angstroms. The mask pattern is etched into the titanium, leaving etched openings where photoelectrons are to be emitted. The titanium is next oxidized, becoming titanium dioxide—which is a good absorbent of ultraviolet light at 2,537 Å. Palladium 40 x 10^{-10} meter thick is evaporated over the cathode face, which now bears a pattern of photo-emissive metal that is precisely the integrated circuit geometry to be exposed on the passivated wafer.

The means. This is a feasibility model of the electron tube to be used with electron-beam masking machine developed by Westinghouse to be built and sold by Hugle.

Ultraviolet light shines evenly on the back of the quartz disk, causing areas coated with palladium to emit photoelectrons having energy of a few tenths of an electron volt. A 10-kilovolt electric field, 100 microamperes per square centimeter, speeds the electrons to the anode; parallel to the projection tube axis a magnetic field of 1,060 gauss—generated by solenoids outside the tube—focuses electrons from one cathode point on a corresponding spot on the anode.

Pow! The entire wafer can be flooded with electron beams, exposing all the resist, in only 1 or 2 seconds. Donald Pedrotti, Hugle's vice president for engineering, says the proprietary photoresist can't be exposed by any kind of light. A solvent, also proprietary, dissolves any of the resist that has been struck by electrons. The photoemissive metal mask (cathode) and wafer (anode) are 1 centimeter apart in the 3-inch-diameter image tube now used by Westinghouse. The tube is pumped to a vacuum of 10^{-5} torr or less.

The mask is projected full size on the silicon wafer, eliminating equipment and labor needed to cut and strip ruby liths. Also unneeded are the huge and expensive cameras required to make an enlarged mask at, say, 100 times actual size; step-and-repeat cameras; and mask aligners. Mask aligners alone can cost more than $14,000 each, and a large semiconductor house can easily have as many as 10 of them.

William Hugle is understandably uncertain about the price of a machine that is possibly a year or more from completion; he estimates it will cost $150,000 to $250,000. But he points out that it could save almost $150,000 in mask aligners alone, plus another $150,000 for conventional mask-making equipment. Pedrotti predicts the electron-beam machine will cut the masking operation to about 5 seconds from 1 or 2 minutes and give better resolution—1 micron instead of the 2 microns of today's best optical projection techniques.

Companies

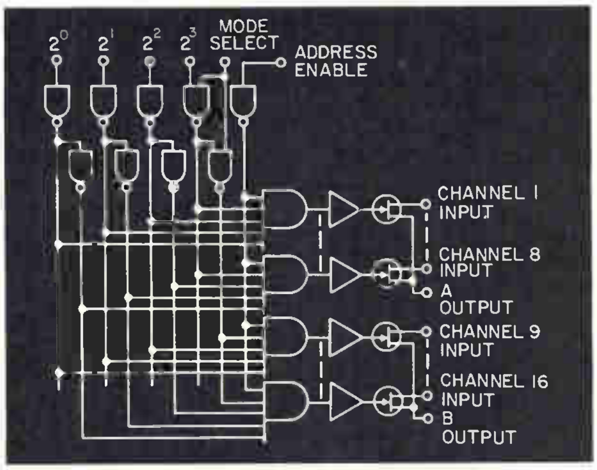
Expanding Novas

The Data General Corp. has a problem lots of companies would suffer gladly: growing pains. Having come up with what industry pundits figure is a good small computer, the Southboro, Mass., firm has proved that the machine is producable, and now sales are outstripping estimates.

The company moved from organization to product announcement in only six months, and has moved into production just as quickly. Harvey P. Newquist, director of manufacturing, says that the first Nova computer was delivered in February, and that almost 60 have

new

16 CHANNEL ANALOG MULTIPLEXER



The first LSI subsystem employing NPN's, PNP's and J-FET's in a monolithic structure.

- Bipolar signal handling range in excess of 20 volts
- Full military temperature range
- Lowest input leakage current
- Most versatile multiplexer with random access capability
  - 16 channel
  - Dual 8 channel
  - Differential 8 channel
  - Enable input for all channel blanking or address expansion
- TTL address decoding logic for TTL or DTL compatibility
- Complies with MIL-STD-883
- Off-the-shelf delivery

You get the BEST IC for the job from Radiation's fast expanding linear line.

P. O. Box 476, Lexington, Massachusetts 02173
Area Code 617, 862-1055

600 Old Country Road, Garden City, New York 11530
Area Code 516, 747-3730

2600 Virginia Avenue, N.W., Washington, D.C. 20037
Area Code 202, 337-4914

P. O. Box 30667, Dallas, Texas 75230
Area Code 214, 239-0378

6151 West Century Boulevard, Los Angeles, California 90045 • Area Code 213, 670-5432

260 Sheridan, Palo Alto, California 94306
Area Code 415, 321-2280

P. O. Box 37, Melbourne, Florida 32901
Area Code 305, 727-5430

RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION

See us at WESCON/69!
Booth 4503, 4, 5

Circle 51 on reader service card

Wrapping it up. Back panel of Data General's Nova computer being wirewrapped. This is final step in chassis construction; p-c boards are then plugged in and machine gets final check.

been shipped since. Production is now running at about a machine per day—and the rate is growing.

With 5,000 square feet of production area now in use, Newquist already foresees overflowing an additional unfinished 20,000-square-foot wing, and wants still another wing of the same size as soon as he can get it.

What happened. It seems that Data General's major premise—that small computer sales were limited by the industry's ability to produce —was correct.

Herbert J. Richman, marketing vice president, at one time figured that a list of 10 or 20 good customers, mostly original equipment manufacturers, would be a good year's work for calender 1969. As of July 10, Data General had about 75, with 60% to 70% of them OEM's.

Last year, when Nova was introduced, Data General spokemen were quietly—optimistically, they though—predicting sales of "maybe 200 machines in 1969." Richman now estimates that the figure will be exceeded. Others in the company hint at more than 250 machines this year, and 1,500 to 2,000 in 1970.

Backlog now stands at about 800 Novas, and Richman expects it to grow to about 1,500 by September 1970. Thus, it's easy to see where the squeeze is—in production capability—and why Newquist wants more space and people.

Salesmen. Several reasons are cited for Data General's fast growth, but OEM sales are most important. When you concentrate on OEM sales, "it's as if you employed a marketing organization eager to pay for the risk and overhead of selling your product," says Allen Z. Kluchman, marketing director.

Kluchman foresees OEM's accounting for at least half the small-computer business for the next three years or so, and adds that demand will continue to exceed supply during that same three-year period.

In agreement, Richman predicts a "nearly exponential sales growth rate through the end of 1970 at least." Richman is even altering his sales technique to prevent possible cash flow problems. "We're now demanding at least a 20% scheduled release on any large order. A firm ordering 100 machines had better be ready to apply the first 20 on time. We do not play banker —we want shipments and profits—cash flow, not backlog."

Sailing. But Data General already has bigger plans based on eventually going public. First priority is production development. But simultaneously, Richman plans to expand his overseas sales organization.

The company is already selling in Australia through an agreement with Fairchild, which acts as an OEM. Because of what Richman calls excellent sales in Canada, the firm plans to open an office there.

Data General may open offices in Common Market territory early next year. Until now, Richman has tried to stay out of Europe because of the difficulty of product support. He attributes much of the company's stateside sales success to such support.

Finally, the company already is budgeting for new product development. Data General's upcoming computer must be the worst kept corporate secret around, though no details about its capabilities or availability are given. Spokesmen say only that the new machine is to be a prestige model —and its code name, naturally, is "Supernova."

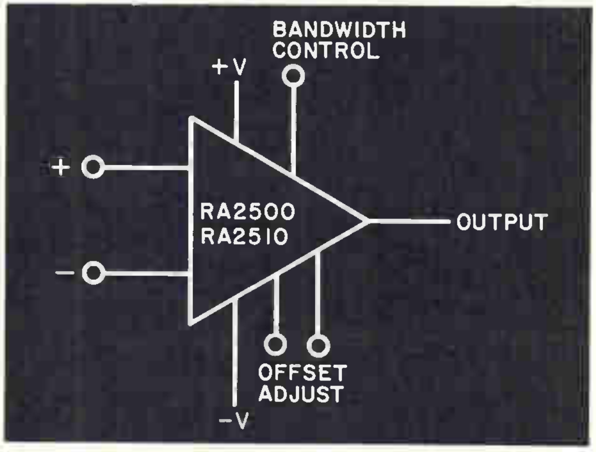
Computers

3-D guidance

Even before they deliver a development model of an air-to-surface missile guidance computer that's to cost no more than $2,500 in production [*Electronics*, Nov. 25, 1968, p. 52], engineers at Bunker-Ramo's Defense Systems division have convinced their sponsor to consider a three-dimensional coaxial interconnection scheme for a preproduction version of the computer. The scheme would shrink the computer from 220 cubic inches to 67 cubic inches, and, because it could be batch fabricated, cut the price.

The sponsor is the Avionics laboratory at Wright-Patterson Air Force Base. Albert Goldstein, manager of Bunker-Ramo's data equipment department, says the computer probably would be mechanized with the same kind of medium-scale integrated metal oxide semiconductors it's getting from General Instrument. The IC's are being mounted on four double-sided circuit boards for the present version of the computer, which is

new
HIGH SLEW RATE AMPLIFIER



- The highest speed fully compensated-stable at unity gain-Op Amp available today
- Full military temperature range
- Complies with MIL-STD-883
- Off-the-shelf delivery

	RA-2510	RA-2500
• Slew Rate (at unity gain)	±50v/µs min.	±25v/µs min.
• Gain	15000	35000
• Large Signal Bandwidth	500 KHz	200 KHz
• Gain Bandwidth	15 mHz	15 mHz
• Offset Current	20 nA	20 nA
• Offset Voltage	2 mV	2 mV
• Output Current	±20mA	±20mA
• Input Impedance	50 megohms	25 megohms

You get the BEST IC for the job from Radiation's fast expanding linear line.

P. O. Box 476, Lexington, Massachusetts 02173
Area Code 617, 862-1055

600 Old Country Road, Garden City, New York 11530
Area Code 516, 747-3730

2600 Virginia Avenue, N.W., Washington, D.C. 20037
Area Code 202, 337-4914

P. O. Box 30667, Dallas, Texas 75230
Area Code 214, 239-0378

6151 West Century Boulevard, Los Angeles, California 90045 • Area Code 213, 670-5432

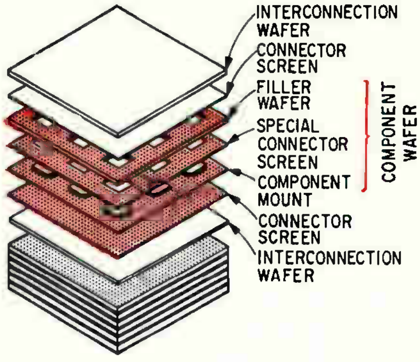
260 Sheridan, Palo Alto, California 94306
Area Code 415,321-2280

P. O. Box 37, Melbourne, Florida 32901
Area Code 305, 727-5430

RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION

**See us at WESCON/69!
Booth 4503, 4, 5**

Circle 53 on reader service card



Exploded. Intended for missile computer, arithmetic unit uses coaxial 3-D interconnection plan.

to be delivered to the Avionics lab next month.

Four chips. The associated bits of five different registers, and the associated logic to transfer signals among them, are put on one kind of chip. In addition, there is a full adder chip, a carry chip, and a central chip providing all the functions needed in the central part of the processor to interpret the instruction logic. The four will be carried over to the preproduction version, if it is funded; but the big change is in packaging, which has been in laboratory development at Bunker-Ramo for more than three years.

Howard Parks, director of the lab, won't discuss all the details of the 3-D coaxial scheme, but he's quick to point out that the interconnection method has been used previously to build a functioning 65-megahertz pseudo-random code generator.

Three basic wafers, thin slices of beryllium copper, are stacked to form the interconnection sandwich: a component wafer, bearing the MSI arrays, an interconnection wafer providing x-y plane interconnects, and a z-axis connector screen. The component wafer is made of three thinner wafers: a component mount wafer, a special connector screen, and a filler wafer. The last two have cutouts to accommodate the height of the package housing the array of wafers and interconnections.

This ceramic package replaces the conventional flatpack. Bunker-Ramo designed it with solder bumps on the bottom, and it's joined to the component mount slice of the component wafer by using reflow soldering. The component wafer, itself, has no interconnection between arrays. The 44 leads from the MOS die are fanned outside the periphery of the ceramic housing to points where they can be picked up by z-axis "slugs" in the connector screen and fed to the interconnection wafer in its sandwich.

Thar's gold. Connector screens, placed on both sides of the three-layer component wafer, are fitted with gold bumps on the outside surface to provide the z-axis interconnection. These screens provide 400 pin connections in just 1/100 cubic inch. Interconnection wafers are then added to the sandwich and come in contact with the gold bumps on the connector screens. The interconnection wafer contains one or more levels of coaxial wiring—but no active components—providing the x-y plane interconnections in a manner similar to that used in multilayer boards. When the three basic wafers are pressed together, the ductile-gold bumps do their job and make the z-axis interconnections.

The processor portion of the computer in the mockup includes 54 MOS arrays on six component wafers; two more component wafers are used—one for the computer's hybrid-clock circuitry and one for the conventional IC's that provide the interface between the high-threshold MOS arrays and transistor-transistor logic outside the processor. There are eight interconnection wafers and 16 connector screens, one of which goes to the outside world. This 32-wafer stack forms the processor for the computer.

The input/output section needs a separate stack. Both it and the 2,048-word plated-wire memory Bunker-Ramo is suggesting for the computer can use the 3-D planar coaxial interconnect method. Goldstein says the complete systems—processor, I/O and memory, all joined to a motherboard for connection to the outside world—can be housed in the sharply reduced space of just 67 cubic inches.

Avionics

L-1011's flight plan

The problem: give buyers of the Lockheed L-1011 airbus the option of utilizing almost any existing form of navigation. The solution: use a modular system that, in its simplest form, will handle en route and terminal area navigation while, in its most complex form, providing both area and long-range inertial navigation. Lockheed-California reportedly is nearing a decision as to what firm will develop the system [*Electronics,* July 7, p. 33].

The L-1011 will be wired to accept any of three modules, as optional equipment, coupled to the autopilot. The simplest version will have dual general-purpose digital computers with a total memory of from 6,000 to 8,000 words. Primarily for overland flights, this version will have, in addition to the computers, dual controls and displays, and dual data-storage units into which en route VOR/DME (very-high frequency omnirange/distance-measuring equipment) station data can be entered on punched cards or magnetic tape, depending on customer needs.

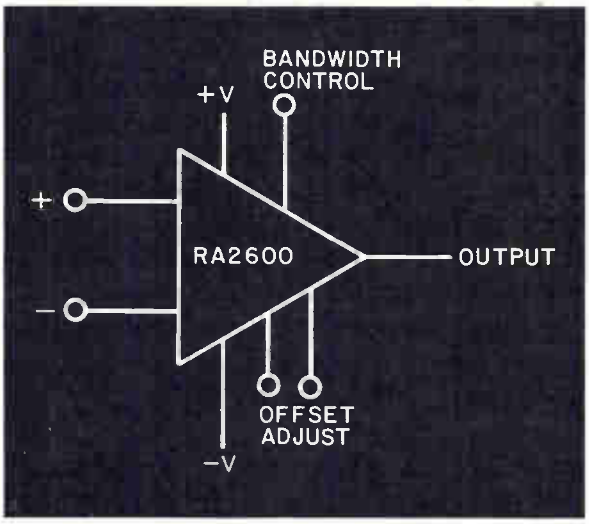
Fancy. The most sophisticated version will employ three advanced heading and attitude sensors—inertial platforms with their associated computers that "close the Schuler loop," says Wright—plus the two area-navigation computers. The platform computers will provide latitude and longitude, velocity, and drift angle (the difference between the aircraft's heading and the ground track) data.

Expected to be priced at about $100,000, this version will provide long-range transocean inertial navigation plus area navigation cheaper than today's usual triple set of Arinc Characteristic 561 inertial naviagtion systems, according to Wright. Arinc 561 inertial systems don't handle area navigation.

A third version has two advanced inertial platforms (sensors of the HAS-2 type) and two area-navigation computers. Primarily for short overwater flights that are out of VOR station range, this version will

new

HIGH INPUT IMPEDANCE OP AMP



- **Input Current = 3 nA**
- Input Impedance = 50 megohms
- Slew Rate (at unity gain) = ±5v/μs
- Gain = 200,000
- Gain Bandwidth = 12 mHz
- Short Circuit Protected
- Fully compensated (stable at unity gain)
- Full military temperature range
- Complies with MIL-STD-883
- Off-the-shelf delivery

You get the BEST IC for the job from Radiation's fast expanding linear line.

P. O. Box 476, Lexington, Massachusetts 02173
Area Code 617, 862-1055

600 Old Country Road, Garden City, New York 11530
Area Code 516, 747-3730

2600 Virginia Avenue, N.W., Washington, D.C. 20037
Area Code 202, 337-4914

P. O. Box 30667, Dallas, Texas 75230
Area Code 214, 239-0378

6151 West Century Boulevard, Los Angeles,
California 90045 • Area Code 213, 670-5432

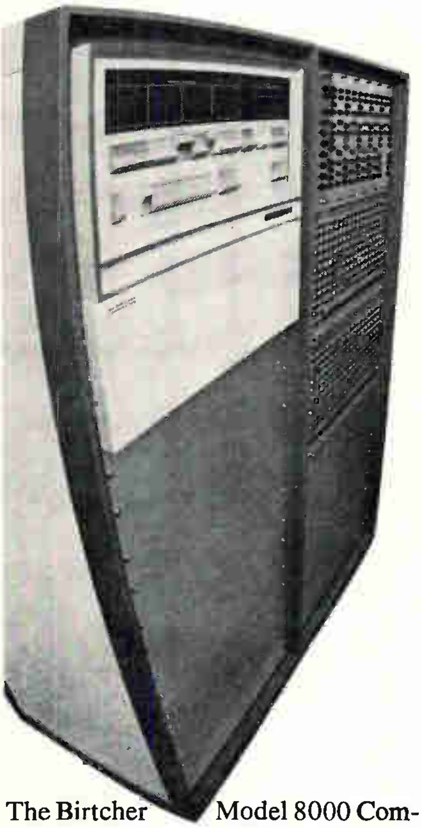
260 Sheridan, Palo Alto, California 94306
Area Code 415, 321-2280

P. O. Box 37, Melbourne, Florida 32901
Area Code 305, 727-5430

RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION

See us at WESCON/69!
Booth 4503, 4, 5

Circle 55 on reader service card



enable the L-1011 to receive attitude reference of an inertial-grade system. Area navigation here is a bonus. Presently, aircraft on such flights use vertical and directional gyros in addition to Loran-position fixing.

Ground decision. Readers will feed VOR/DME data to the computers before takeoff. The terminal-flight plan will include any of the six to eight standard approach patterns now used at domestic airports, and won't be called up until the crew has been informed about terminal navigation conditions by the ground controller, who will also select which of the approaches is to be used.

Standard hold points are used in congested terminal areas; those hold points can be preprogramed so that the plane will automatically hold at the waypoint. Or, the pilot can load the latitude and longitude of a hold point manually and orbit there until a controller orders him to resume his preloaded course.

Lockheed will offer three features as plus-in options: vertical guidance, automatic VOR/DME tuning, and a map display interface—although a moving map or cathode-ray tube display won't be provided initially in the L-1011. Vertical guidance is essentially computer control of letdowns from a preprogramed point to the next preset point. Automatic VOR/DME tuning will ease the crew's workload, particularly in terminal areas, by eliminating manual tuning.

Other options will permit inputs from such hyperbolic-navigation systems as loran, Omega, and Decca, and provision for linking to a two-way digital data link between the L-1011's navigation computer and a ground-control computer so that location information from the aircraft can be verified on the ground and digital commands sent back.

Up to 500. According to Frank Wright, department manager for system integration, the modular system in any of three versions planned will accommodate up to 500 VOR/DME station locations and up to 500 waypoints. Heading and distance to VOR stations, plus the L-1011's altitude over the checkpoints and its times of arrival, can be programed into the data storage unit, and filed with air traffic controllers.

Government

Keeping in touch

Despite John F. Kennedy's 1963 order calling for creation of a National Communications System (NCS), no one ever plugged the program in. To the contrary, there has been a "perpetuation" and "proliferation" of separate networks for accomplishment of "individual agency missions," according to the General Accounting Office (GAO). Thus the Congressional watchdog of federal spending says the time has come to make NCS a reality, taking away authority for the program from the Defense Communications Agency, with its conflicting interests, and turning it over to a restructured and strengthened White House Office of Telecommunications Management (OTM).

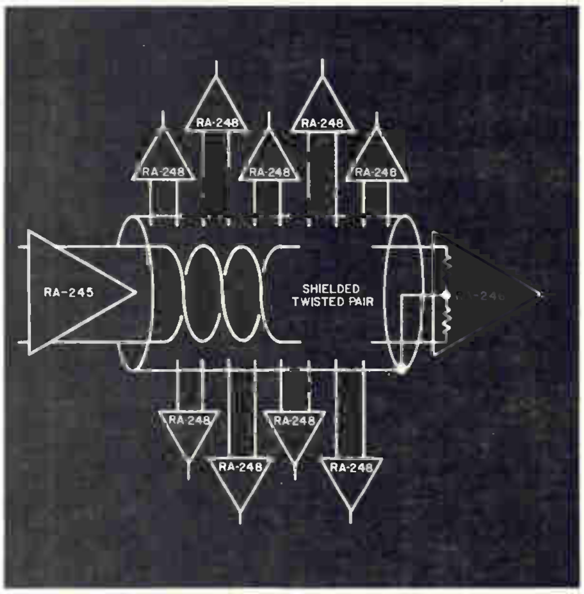
At stake are an estimated $3 billion in annual Federal outlays for "a wide variety of communications equipment, research, development, and services" exclusive of another billion spent on nonconventional systems such as those inside weapons. Of the total, about $1 billion goes for long-distance communications—principal area of NCS involvement—plus another $2 billion for specialized systems such as those used by NASA and the Defense Department.

Good timing. The GAO always has had a good sense of timing. At a time when Pentagon power is under attack from all sides, the GAO urges it be stripped of NCS responsibility; when Federal spending cuts are being called for, the accountants see potential economies in consolidating Federal communications; and just as James D. O'Connell is about to retire as OTM director, a reorganization and strengthening of his office is recommended.

The resurgent interest in U.S. communications interconnection during national emergencies was

new

PARTY-LINE RECEIVER



- 10 Party-Line Receivers driven by a line transmitter
- Balanced current mode eliminates switching transients
- Extremely low power consumption
- 3 circuits per package
- No standby power required for idle circuits
- Compatible with TTL and DTL
- Full military temperature range
- Complies with MIL-STD-883
- Off-the-shelf delivery

You get the BEST IC for the job from Radiation's fast expanding linear line.

P. O. Box 476, Lexington, Massachusetts 02173
Area Code 617, 862-1055

600 Old Country Road, Garden City, New York 11530
Area Code 516, 747-3730

2600 Virginia Avenue, N.W., Washington, D.C. 20037
Area Code 202, 337-4914

P. O. Box 30667, Dallas, Texas 75230
Area Code 214, 239-0378

6151 West Century Boulevard, Los Angeles,
California 90045 • Area Code 213, 670-5432

260 Sheridan, Palo Alto, California 94306
Area Code 415, 321-2280

P. O. Box 37, Melbourne, Florida 32901
Area Code 305, 727-5430

RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION

See us at WESCON/69!
Booth 4503, 4, 5

Circle 57 on reader service card

spurred by the Pueblo disaster, when the system failed at nearly every level. In fact, the President learned of the seizure only after the ship was already in a North Korean port. That foul-up demonstrated to Congress that communications capabilities had not been significantly improved since the 1962 Cuban missile crisis—which prompted the call for creation of NCS. Implied in the GAO assessment is that Kennedy erred in naming his trusted defense secretary, Robert McNamara, as executive agent for NCS and naming the Defense Communications Agency as manager.

One of the first jobs of the NCS, for example, was to have been unification of civil and military weather-data communications systems. Despite a recommendation in November 1963 for development of a digital, automatic weather and warning-to-airmen system, McNamara's office delayed the program a full year by ordering further studies. "As a result," contends GAO, "interim improvement programs of the FAA, Air Force, Navy, and the Weather Bureau increased in scope to the extent that establishment of a single system . . . as originally proposed . . . was no longer desirable." The judgment: a Pentagon failure since "separate weather networks continue to be operated by the various Federal agencies."

Busy signal. Again, the Pentagon set up its own Defense Telephone Service for its Washington, D.C., outgoing calls—an operation with some 37,000 working lines and 87,000 extensions in 178 buildings—rather than employ the facilities of the nonmilitary Federal Telecommunications Service operated by the General Services Administration. A later analysis of the Pentagon phone operation showed that approximately 1,000 overflow calls were being routed over commercial lines in busy periods, rather than over the nonmilitary system. Then should the Pentagon automatic voice network (Autovon) be interconnected with the nonmilitary system? An answer was sought by including the question in an AT&T study for the Defense Communications Agency, manager for NCS. The General Services Administration believes such an integration could save "millions of dollars a year," but adds that defects in the AT&T study plus a broadening of its scope are postponing a decision.

One of the most important specific issues still to be decided is the Kennedy Administration concept of NCS as an integrated trunk line system for nonsecure communications—"long haul, point-to-point communications which can serve one or more agencies." Such an integration effort was agreed to last year by 10 of the 11 participating agencies. The lone dissenter: the Defense Department.

Fresh approach. Since the major dissent to a National Communications System came from its manager, it is not surprising that the GAO now recommends a fresh approach to any interconnection of Federal communications—a look embracing the Atomic Energy Commission, FAA, State Department, NASA, Veterans Administration, and others beyond the Defense and General Services Administration systems.

In addition, GAO suggests that the Office of Telecommunications Management be upgraded in budget, stature, and responsibility and made responsible for NCS. One step would be to take the system out of the Office of Emergency Preparedness, and quadruple its budget to $12 million.

If the Nixon Administration buys the recommendation, as it now seems likely to do, this would mean another boost in the power of the Executive branch. Yet communications specialists believe that this compromise must be made to achieve a working National Communications System.

For the record

Digital torquerer. A prototype automated console that uses digital techniques for ground checkout of inertial instrumentation is being produced for the Air Force by the Autonetics division of North American Rockwell. Greater precision in

new

HARDENED SERIES 54H CIRCUITS

TTL

- Dual type D Flip-Flop
- Quad 2-Input NAND Gate
- Dual 2-Input AND – OR INVERT Gate
- Dual 4-Input NAND Gate
- Quad 2-Input AND – OR INVERT Gate
- Two orders of magnitude more resistant to radiation environment
- Dielectrically isolated
- Thin film resistors
- Optimized device geometries
- Low Z mono-metallic metalization system
    Aluminum interconnect
    Aluminum die attach
    Aluminum wire bond
    Aluminum package posts
- Compatible with 930 Hardened DTL product line
- Full military temperature range
- Complies with MIL-STD-883
- Off-the-shelf delivery

You get the BEST IC for the job from Radiation's fast expanding hardened circuit line.

P. O. Box 476, Lexington, Massachusetts 02173
Area Code 617, 862-1055

600 Old Country Road, Garden City, New York 11530
Area Code 516, 747-3730

2600 Virginia Avenue, N.W., Washington, D.C. 20037
Area Code 202, 337-4914

P. O. Box 30667, Dallas, Texas 75230
Area Code 214, 239-0378

6151 West Century Boulevard, Los Angeles, California 90045 · Area Code 213, 670-5432

260 Sheridan, Palo Alto, California 94306
Area Code 415, 321-2280

P. O. Box 37, Melbourne, Florida 32901
Area Code 305, 727-5430

RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION

See us at WESCON/69!
Booth 4503, 4, 5

Circle 59 on reader service card

Electronic slide rule with 11-digit accuracy

...and a memory too

You can produce logs and exponents instantly by simply touching a key on the Wang 360.

Wipe out all tediousness from technical, statistical and investment computations with the Wang 360 electronic calculator. Time consuming table look-up and interpolation is a thing of the past. Wang's unique approach to data manipulation enables you to generate $\sqrt{x}$, x^2, $\text{Log}_e x$ and e^x functions by simple key strokes. Instantaneous answers are displayed in large easy-to-read numerals with ten significant digits and **self positioning decimal** (you can specify a special trig keyboard if you need sin θ, cos θ, $\sin^{-1}x$ and $\tan^{-1}x$).

A special feature of the Wang 360 is its "scratch pad" memory system. Four extra storage registers hold constants, intermediate answers, or multiple results, for recall as you need them.

Wang's building block approach gives you add-on capability for **hard copy printout,** card programming, and expansion into the powerful 370 programmable computing sub-system.

For greatest economy, up to 4 keyboards operate concurrently from a briefcase-size electronics package. Cost of Model 360 is then as low as $1497.50 per station and Model 320 (without extra registers) $1282.50 per station.

Call your nearest Wang Office.

WANG
LABORATORIES, INC.

Dept. 8H, 836 North St., Tewksbury, Massachusetts 01876 • Tel. 617 851-7311

Call today!
(201) 272-7160
(203) 288-8481
(205) 881-5360
(206) 525-2000
(212) 682-5921
(213) 776-2985
(214) 361-7156
(215) 642-4321
(216) 333-6611
(301) 588-3711
(301) 821-8212
(303) 364-7361
(304) 344-9431
(305) 563-8458
(305) 841-3691
(309) 674-8931
(312) 297-4323
(313) 352-2144
(314) 727-0256
(315) 463-9770
(317) 631-0909
(404) 633-6327
(412) 366-1906
(414) 442-0160
(415) 692-0584
(502) 426-1116
(504) 729-6858
(505) 255-5775
(512) 454-4324
(513) 531-2729
(515) 288-5991
(516) 437-2500
(517) 835-7300
(518) 463-8877
(601) 982-1721
(608) 255-4411
(612) 881-5324
(614) 488-9753
(615) 523-8648
(616) 454-4212
(617) 851-7311
(617) 542-7160
(702) 322-4692
(703) 595-6777
(703) 359-6320
(713) 668-0275
(714) 276-8464
(716) 381-5440
(717) 236-4782
(805) 962-6112
(808) 536-5359
(813) 872-7347
(816) 444-8388
(817) 834-1433
(918) 747-0018
(919) 272-5683

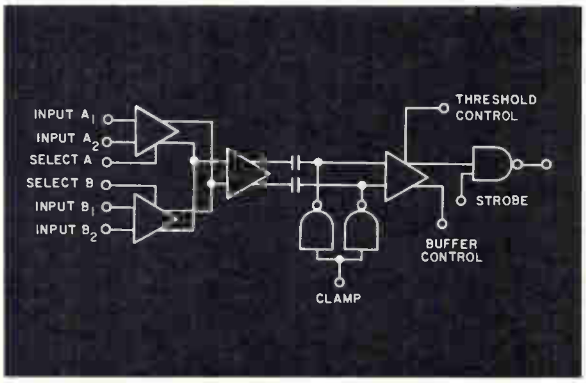
torquing inertial instruments is achieved by using a d-c square wave instead of a d-c current. Each half of a 50 cycles-per-second square wave, for example, is divided into 100 positive and 100 negative pulses, which can be varied in one-pulse increments. This permits the operator to take a surplus pulse from the positive side of the cycle and put it on the negative side. The pulse increments let him know, with great accuracy, how much current is being fed into the torquerers. An up/down digital counter with a variable time base was designed by the Itron Corp. to count the positive and negative pulses, and indicate the net pulsing. The use of digital techniques is said to eliminate hysteresis and drift associated with d-c current analog devices ordinarily used for torquing, and permits greater resolution.

Battle's over. The FCC has ruled that "urgent national requirements" warrant a crash program to complete a satellite communications earth station on Guam by November 1. Thus has the FCC settled the "Battle of Guam" in favor of RCA Global Communications and two other carriers despite the Communications Satellite Corp.'s opposition to the increased costs that will result—an increase it must share as half owner of the facility. RCA's teammates are ITT and Western Union:

Miss Bell to you. Newest AT&T tack to alter its somewhat rigid image is a series of "lively, lilting" radio commercials aimed at college students "to show that Miss Bell is where it's happening" and, of course, recruit a few kids in the process. Divorcing Ma Bell from the mother image will never restore her virginity, yet the company is encouraged by the campus radio station tests and their potential for swaying the "intellectual" 40% of the body collegiate which Miss Bell defines as largely liberal arts students who "are in college for more than a ticket to a good job" and "frequently lack the desire to understand our communications business."

new

PLATED-WIRE, HARDENED SENSE AMP



- The first application of linear and digital technology in one monolithic subsystem
- The RA-2540 system in a single chip performs the functions of a hardened differential amplifier and a hardened voltage comparator
- 1 mv signal sensitivity in high noise environment
- 10 ns access time
- Internal D.C. restoration
- Selectable dual channel
- Hardened
    Photo current compensation
    Dielectric isolation
    Thin film resistors
    Advanced device design
- Complies with MIL-STD-883
- Off-the-shelf delivery

You get the BEST IC for the job from Radiation's fast expanding hardened digital line.

P. O. Box 476, Lexington, Massachusetts 02173
Area Code 617, 862-1055

600 Old Country Road, Garden City, New York 11530
Area Code 516, 747-3730

2600 Virginia Avenue, N.W., Washington, D.C. 20037
Area Code 202, 337-4914

P. O. Box 30667, Dallas, Texas 75230
Area Code 214, 239-0378

6151 West Century Boulevard, Los Angeles,
California 90045 • Area Code 213, 670-5432

260 Sheridan, Palo Alto, California 94306
Area Code 415, 321-2280

P. O. Box 37, Melbourne, Florida 32901
Area Code 305, 727-5430

RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION

See us at WESCON/69!
Booth 4503, 4, 5

Circle 61 on reader service card

are better than ever: The Beckman 6155 Counter/Timer is now automatic to 525 MHz.

Beckman brings you a brand new plug-in addition to its counter...the Model 606 Prescaler for automatic counting to 525 MHz. No knobs to turn; no dial numbers to add. Results are read directly on the 6155's display, with direct BCD output of the total count.

If you buy a "plug-in" counter because you need expandability, today or tomorrow, Beckman offers a complete line of plug-ins today—*and* continues to provide *new expandables* for tomorrow's needs.

For complete information, contact your local Beckman office, sales representative or the factory direct.

Specifications

Model 6155 *Measurement Modes:* Frequency: 100 MHz (to 12.4 GHz with optional plug-in). Period: To 100 ns (to 1 ns or 10 ns with optional plug-in). Multiple Period Averages: 1 to 10^5 in decade steps. Ratio: X/Y with X = 0 to 100 MHz and Y = 0 to greater than 1 MHz. Pulse Width & Separation: (To 1 ns or 10 ns with optional plug-in). Voltage & Current: (Optional plug-in). Scaling: By decades up to 10^9. *Crystal Frequency:* 1 MHz. *Stability:* Better than 3 parts in 10^9 per 24 hours. (5 parts in 10^{10} per 24 hours optional). *Output Frequencies:* 0.1 Hz to 10 MHz in decade steps selected by front-panel TIME BASE selector. *External Frequency:* 1 MHz, 1V rms into 1000 ohms required at rear-panel BNC connector. *Display:* 8 inline digits of glow-tube display, 9th digit optional. *Signal (X input) Sensitivity:* 100 mV rms. *Digital Output:* Fourline, 1-2-4-8 BCD output at rear panel. Output compatible with Beckman 1453 Digital Printer. *Power:* 115/230 Vac, 50 to 400 Hz, 80 W. *Size:* 5¼ in. high, 16¾ in. wide, 19 in. deep. *Weight:* 30 lbs. *Price:* $2,450.
Model 606 *Frequency Range:* 1 MHz to 525 MHz. *Sensitivity:* 50 mV rms. 10 Volts rms (max.) or 50 Volts Peak. *Impedance:* 50 Ω. *VSWR:* ≤ 1.2. *Price:* $525.

Beckman INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
RICHMOND, CALIFORNIA • 94804

INTERNATIONAL SUBSIDIARIES: AMSTERDAM; CAPE TOWN; GENEVA; GLENROTHES, SCOTLAND; LONDON; MEXICO CITY; MUNICH; PARIS; STOCKHOLM; TOKYO; VIENNA

Pace's revolutionary new joint venture.

The complete Sodr-x-traction system •

Try it Yourself at WESCON Booth #2521

PACE's New Sodr-X-Traction System removes any soldered-in part without damage, including those previously thought to be impossible to remove.

The System provides Three distinct Modes of Operation in a variety of combinations. *Pressure*, *Vacuum*, or *Hot Air Jet* is applied through the heated tip for a controlled interval allowing parts to be removed cleanly and efficiently

The System solves rework problems dealing with: MICRO-MIN • Matrices • Multi-Layer • C.P.C.'s • I.C.'s • D.I.P.'s • Flat Packs • TO-Cans • Axial Lead Parts • Connectors • Terminals • Clinched and Unclinched Leads • • Multi-Pin Packs • Lap Joints • Thru-Hole Joints • etc.

Perform all Sodr-X-Traction and part replacement with one integrated system.

- Controlled Heating capacities to 1000°F
- Variable Temperature, Pressure, Vacuum, and Flow
- Self-Contained Portable Bench Top Package
- Power Sequences Variable and Controllable
- Quick-Connect Features

In-Line and Co-Axial Design Provides:

- Versatile access to workpiece
- Easily observable work action
- Non-Jamming path for clipped leads and molten solder
- Minimum Thermal Profile
- Balanced "Pencil-Like" Construction
- Precise positioning and manipulation
- Easy one-hand operation and familiar feel

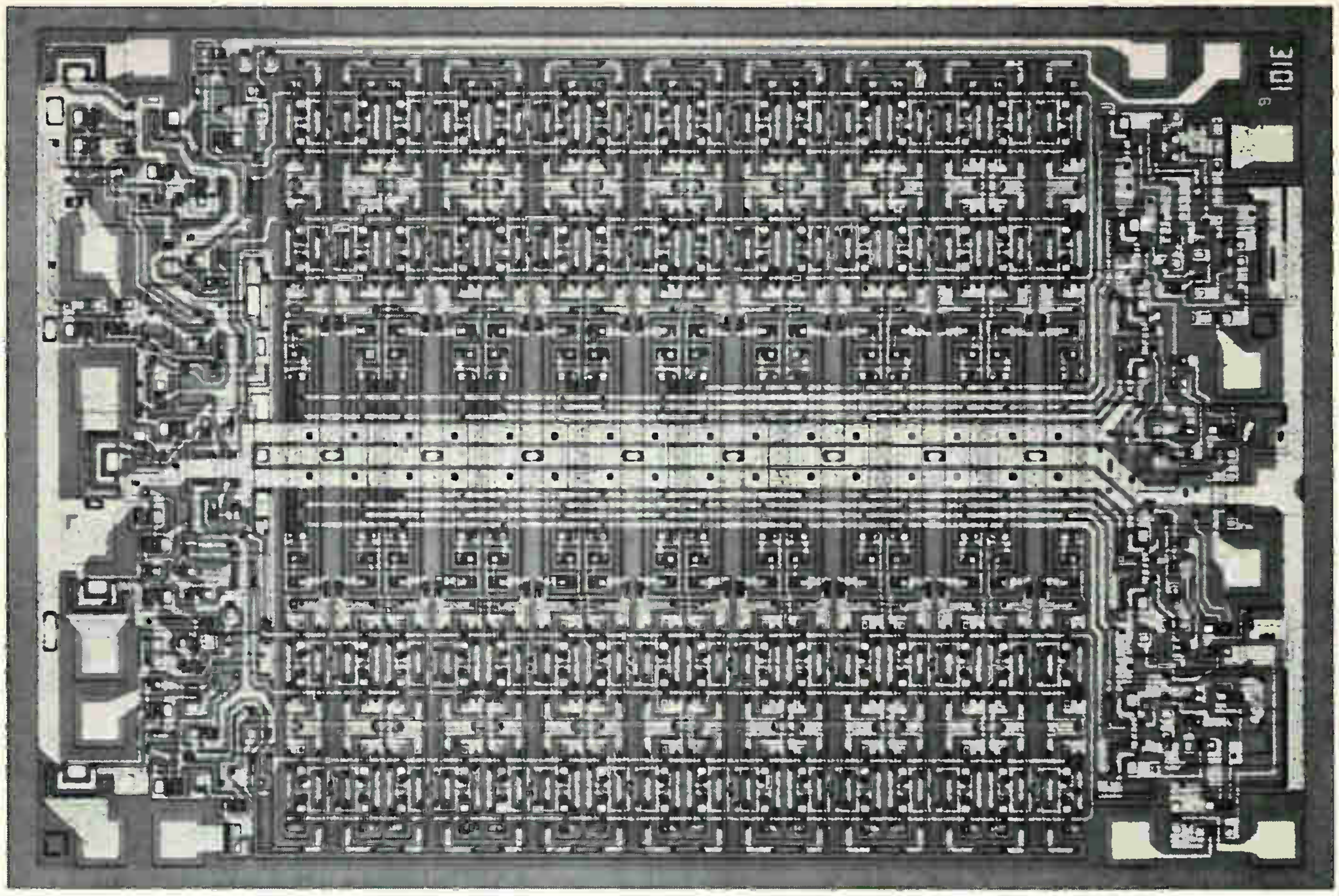
Solve your critical rework problems with the New Sodr-X-Traction System Call or write for more information

Sodr-x-tractor solves your rework problems.

PACE INCORPORATED 9337 Fraser St. Silver Spring, Maryland 20910 (301) 587-1696

Technology, Systems and Training for Rework, Repair, Modification and Experimentation

Pick a winner. We did. I-3101



Introducing the Intel Schottky Process Model 3101 Bipolar Scratch Pad Memory. 64 bits—16 x 4/fully decoded /50 nanoseconds access time/OR-tie capability/simple memory expansion through chip select input/6 milliwatts per bit power dissipation/16 lead D.I.P.

If you are interested in a winner, too, call your nearest Intel distributor.

Intel LSI memory circuits are available from 40 outlets throughout the United States and Canada. Call your local Intel distributor, Cramer Electronics or Hamilton Electro Sales, for instant service. If it is more convenient, you may write or call us collect (415-961-8080).

intel

INTEL CORPORATION, 365 Middlefield Road, Mountain View, California 94040/(415) 969-1670/Telex INTEL 34-8366
Regional Offices: 1741 Pitcairn, Costa Mesa, California 92626/(714) 545-8541
P.O. Box 206, Andover, Massachusetts 01810/(617) 536-0700

Circle 65 on reader service card

Pick a winner. We did.

Intel LSI memory circuits now available through our fine distributors, Cramer Electronics and Hamilton Electro Sales.

To place an order or obtain more information, call the most convenient office listed below. If it is easier, you may write or phone us collect (415) 961-8080.

ALABAMA	Huntsville	Cramer Electronics, 222 N. Memorial Parkway (205) 536-4493
ARIZONA	Phoenix	Hamilton Electro Sales, 1741 North 28th Avenue (602) 272-2601
	Tempe	Hyer-Cramer Electronics, 3300 S. Mill (602) 967-8786
CALIFORNIA	Culver City	Hamilton Electro Sales, 10912 W. Washington Blvd. (213) 871-0404
	Glendale	R & C Cramer Electronics, 608 Sonora Avenue (213) 243-6224
	Mountain View	Hamilton Electro Sales, 340 E. Middlefield Road (415) 961-7000
	Redwood City	Cramer Electronics, 695 Veterans Blvd. (415) 365-4000
	San Diego	Hamilton Electro Sales, 5567 Kearny Villa Road (714) 279-2421
	San Diego	R & C Cramer Electronics, 7969 Engineer Road (714) 279-6300
COLORADO	Denver	Hamilton Electro Sales, 1400 West 46th Avenue (303) 433-8551
	Englewood	Hyer-Cramer Electronics, 7895 E. Prentice Avenue (303) 771-5285
CONNECTICUT	North Haven	Cramer Electronics, 35 Dodge Avenue, Wharton Brook Industrial Center (203) 239-5641
FLORIDA	Ft. Lauderdale	Cramer Electronics, 4141 N. E. 6th Avenue (305) 566-7511
	Orlando	Hamilton Electro Sales, 419 27th Street (305) 241-5461
GEORGIA	Atlanta	Cramer Electronics, 3130 Marjan Drive (404) 451-5421
ILLINOIS	Addison	Hamilton Electro Sales, 920 S. Westwood Avenue (312) 543-8594
MARYLAND	Baltimore	Cramer Baltimore Inc., 922-24 Patapsco Avenue (301) 354-0100
	Baltimore	Hamilton Electro Sales, 8809 Satyr Hill Road (301) 668-4900
	College Park	Hamilton Electro Sales, 4915 Niagara Road (301) 935-5600
	Rockville	Cramer Electronics, 692 Lofstrand Lane (301) 424-2700
MASSACHUSETTS	Newton	Cramer Electronics, 320 Needham Street (617) 969-7700
MINNESOTA	Bloomington	Cramer Electronics, 8053 Bloomington Freeway, Suite 105 (612) 881-8678
MISSOURI	Hazelwood	Hamilton Electro Sales, 400 Brookes Lane (314) 731-1144
NEW JERSEY	Cedar Grove	Hamilton Electro Sales, 220 Little Falls Road (201) 239-0800
	Cherry Hill	Hamilton Electro Sales, 1608 Marlton Pike (609) 662-9337
	Pennsauken	Cramer Electronics, 7300 Route 130 North, Industrial Center, Bldg. 2 (609) 662-5061
NEW MEXICO	Albuquerque	Hyer-Cramer Electronics, 130 Alvarado, N. E. (505) 265-5767
NEW YORK	Elmhurst	Cramer Electronics, 96-10 23rd Avenue (212) 479-1380
	Rochester	Cramer Eastern Inc., 3259 Winton Road South (716) 275-0300
	Syracuse	Cramer Eastern Inc., Pickard Blvd., E. Molloy Road (315) 455-6641
	Syracuse	Hamilton Electro Sales, 222 Boss Road (315) 437-2641
NO. CAROLINA	Greensboro	Hamilton Electro Sales, 1023 E. Wendover Avenue (919) 275-9969
	Raleigh	Cramer Electronics, 3331 North Blvd. (919) 832-6441
OHIO	Cincinnati	Cramer Electronics, 666 Redna Terrace (513) 771-6441
TEXAS	Dallas	Hamilton Electro Sales, 2344 Irving Blvd. (214) 638-0900
	Houston	Hamilton Electro Sales, 1216 West Clay (713) 526-4661
UTAH	Salt Lake City	Hyer-Cramer Electronics, 1425 S. 2nd West (801) 487-3681
WASHINGTON	Seattle	Hamilton Electro of the Pacific Northwest, 2320 Sixth Avenue (206) 624-5930
CANADA	Toronto, Ontario	Cramer Electronics, 3077 Bathurst Street (416) 789-1937

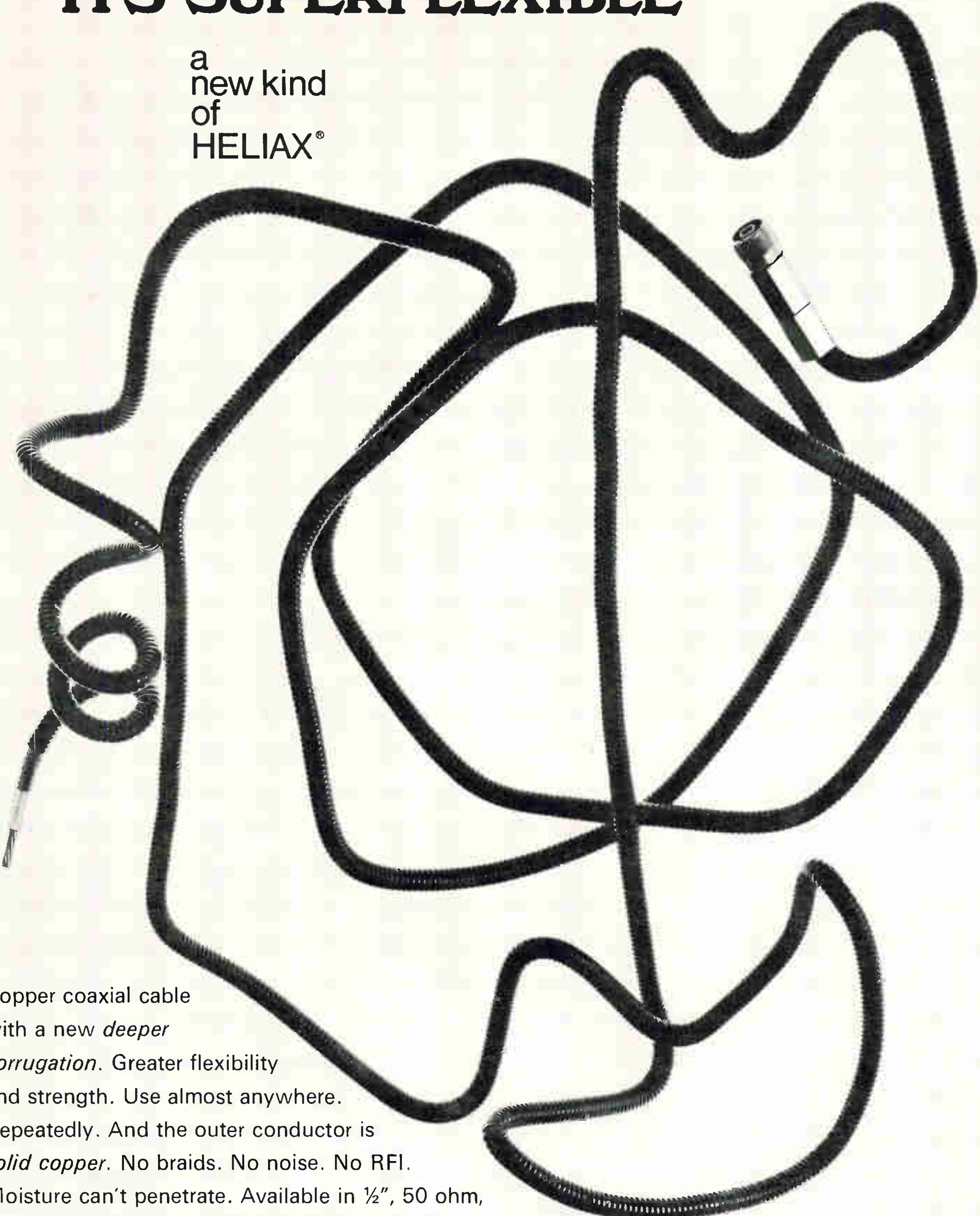
intel

INTEL CORPORATION, 365 Middlefield Road, Mountain View, California 94040/(415) 969-1670/Telex INTEL 34-8366
Regional Offices: 1741 Pitcairn, Costa Mesa, California 92626/(714) 545-8541
P.O. Box 206, Andover, Massachusetts 01810/(617) 536-0700

Circle 67 on reader service card

IT'S SUPERFLEXIBLE

a
new kind
of
HELIAX®



Copper coaxial cable with a new *deeper corrugation*. Greater flexibility and strength. Use almost anywhere. Repeatedly. And the outer conductor is *solid copper*. No braids. No noise. No RFI. Moisture can't penetrate. Available in ½", 50 ohm, foam dielectric, Type FSJ4-50. Connectors, Type N or GR-874. Like a sample? Communicate with Andrew.

12-68

ANDREW

CONTACT THE NEAREST ANDREW OFFICE OR ANDREW CORPORATION, 10500 W. 153rd STREET, ORLAND PARK, ILLINOIS 60462

Circle 68 on reader service card

Washington Newsletter

August 4, 1969

Philco to get DCA all-digital net award

Philco-Ford is about to be named winner of a two-part study for an all-digital defense communications system for the Defense Communications Agency (DCA). Teamed with IBM's Federal Systems division, Gaithersburg, Md., **Philco will define under the first phase the requirements for what insiders call "the ideal system for the late 1970's."**

In the second phase of the program, the team will identify the research, development, and hardware required to achieve the all-digital network by a process of evolution. **The $934,000 competitive contract gives the Philco-Ford/IBM team an inside track on future procurement, which could turn out to be one of the largest communications pacts ever made by the Defense Department.**

Among the losers: AT&T, RCA, Sylvania, Honeywell, and Communications & Systems Inc. AT&T promoted the study within the DCA but wanted to do it on a sole source basis—an approach the Pentagon is reluctant to take in these sensitive times for military spending.

NASA to fill five top slots

NASA is expected to get around to filling five of its top spots, including the Number 2 job of deputy administrator, now that things are settling down following the successful Apollo 11 mission. **A sixth slot—that of Apollo program director—will also need filling soon when Lt. Gen. Samuel C. Phillips returns to military service.**

Though NASA administrator Thomas O. Paine and others have been interviewing potential candidates, the buildup to the lunar mission has prevented any final selections. **Indeed, the agency is reportedly still awaiting receipt of a list of politically acceptable appointees.**

In addition to deputy administrator, the following NASA administrator jobs are open: Offices of Industry Affairs, Advanced Research & Technology, Organization and Management, and Technology Utilization.

White House wants civilian for OTM post

The Nixon administration, according to authoritative sources, has definitely decided that it wants a civilian to succeed Gen. James D. O'Connell (USA-Ret.) as director of the White House Office of Telecommunications Management. **In effect, the decision automatically rules out such highly-touted contenders for the job as Philco Ford's senior scientist Charles C. Mack, a retired Army colonel** [*Electronics*, June 9, p. 76], as well as the more recently mentioned retired Lt. Gen. Harold Grant, who is now director of telecommunications policy in the Office of the Assistant Secretary of Defense. Also reported to be no longer in contention is Washington consultant Fred W. Morris.

Speculation on industry candidates for OTM now centers around General Electric's Richard P. Gifford, chairman of the comprehensive and highly-regarded spectrum engineering study put out last year by the Joint Technical Advisory Committee set up by the IEEE and the EIA.

However, the articulate general manager of GE's communications products department had previously indicated to associates that he has no interest in Government service, and there are no signs his attitude has changed, particularly in view of reports that he is destined for bigger things within GE.

Whatever civilian is tapped, the White House decision is but one more indication that the Administration is being swayed by recommendations of many Government and industry authorities that OTM be restructured, given increased authority, budget, and responsibilities for determining and coordinating Federal communications policy. Most recent of these recommendations comes from the General Accounting Office, fiscal watchdog for Congress [see p. 56].

U. S. ready to install road guidance system

The Federal Highway Administration's Bureau of Public Roads is moving ahead with its electronic route guidance system (ERGS) and is seeking bids for the initial installation.

ERGS, a navigation aid for motorists, would put induction loops in the pavement, a transcriber and a computer at each intersection, and a transceiver and display unit in each vehicle. At the start of a journey a driver would set his receiver for a destination.

The upcoming purchase will include equipment for 50 vehicles and 100 intersections in the District of Columbia for the first large-scale test.

The Bureau of Public Roads has already completed a nationwide codebook directory for the system. For its part, the Highway Administration is planning to make money available to states wishing to install ERGS in the early 1970's.

NASA to ask for ATS-G ideas . . .

Within a month NASA will ask for proposals for experiments to ride with the Applications Technology Satellite-G scheduled for launch in 1974. **Proposals will be due in September with selection of experiments set for early next year.**

ATS project officials say they are looking for "far out" or "highly experimental" ideas for ATS-G. As of now, the satellite is scheduled to carry an advanced L-band transponder for aeronautical experiments as well as direct television broadcast equipment.

Meanwhile, NASA has also begun advertising for scientific experiments for its Viking missions to Mars in 1973. Equipment to detect life and measure the Martian atmosphere, as well as remote orbiting measuring devices, are being sought. Bids for Viking experiments are due October 20.

. . . and provides for some planning

Later this year the space agency's Applications Technology Satellite Program Office will kick off a new program called Advanced Applications Flight Experiments (AAFE) **which is intended to begin developing space applications experiments requiring long development periods.**

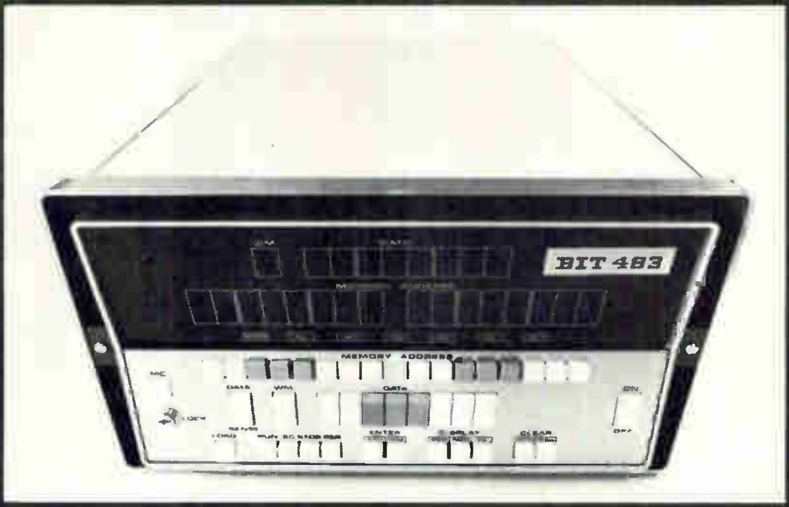
The idea will be to have researchers at work on a concept long before an assignment is made to a specific satellite. **Although initially intended for the ATS program, AAFE may also be applied to other satellites such as future Nimbus or ERTS craft.** Until now the procedure has been that requests for experiments go out only after a specific satellite program has gotten under way.

The AAFE program will be coordinated with the Office of Advanced Research and Technology as well as various NASA centers, as much of the work, at the beginning at least, will be done in-house.

Addendum

NASA has selected Aerojet General, Hughes, and GE to negotiate for an estimated $5 million award for a wideband laser communications experiment for the ATS-F satellite. The winner will develop satellite and ground equipment for the experiment [*Electronics,* Dec. 23, 1968, p. 103].

Goes like a son of a Bit.



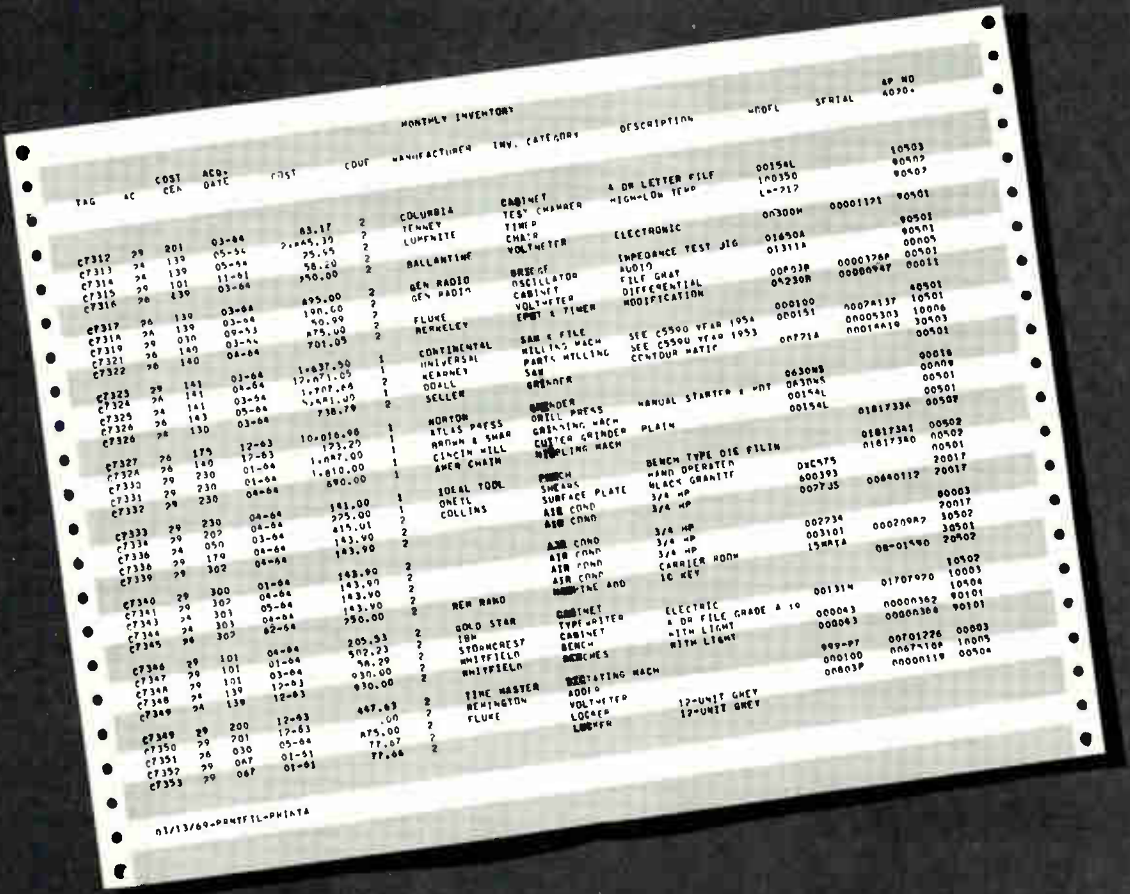
Eat dust, you other mini computers. Here comes the new BIT 483. A powerful general purpose digital computer with proven design performance and unparalleled problem solving capability. Its 350 nanosecond memory access time makes it one of the fastest computers around. And its other standard features make it the cost/performance champion of the minis. BYTE orientation. Variable word length. U.S.A. basic FORTRAN. Binary & decimal arithmetic. Cycle stealing data channel. Priority interrupt. A complete line of I/O options. The new BIT 483 is a thing of beauty. But it's no hot house flower child. It's the latest in a family of miniputers that have been carrying a giant load in the field for years. And it's sired by a company that's proved itself in the toughest proving ground in the world. The OEM market. We're a company that manufactures more than promises. We produce in volume and we service what we produce. So send for specs on the new BIT 483 and let's start talking prices. We guarantee they'll have you champing at the BIT.

bit

BIT, INCORPORATED
5 Strathmore Road
Natick, Mass. 01760

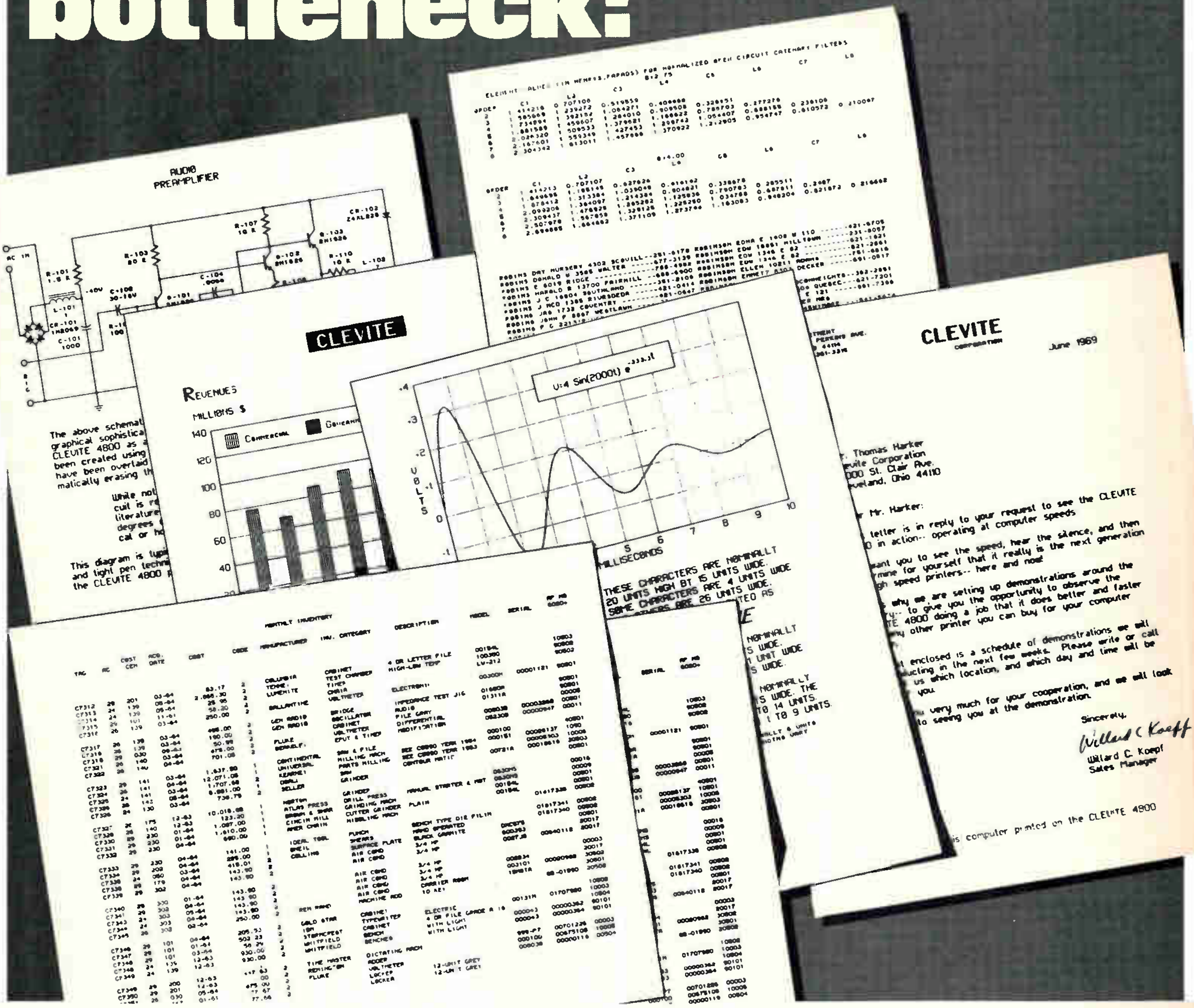
See the new BIT 483 in Booths 5514 & 5515 at the WESCON Show.

Unplug the compute



In the time it takes a line printer to pound out one oversize page of printout...

bottleneck!



The above schemat
graphical sophistica
CLEVITE 4800 as a
been created using
have been overlaid
matically erasing th

While not
cuit is re
literature
degrees
cal or ho

This diagram is typ
and light pen techn
the CLEVITE 4800 p

THESE CHARACTERS ARE NOMINALLT
20 UNITS HIGH BT 15 UNITS WIDE.
SOME CHARACTERS ARE 4 UNITS WIDE
SOME OTHERS ARE 26 UNITS WIDE.

CLEVITE
CORPORATION

June 1969

. Thomas Harker
evite Corporation
000 St. Clair Ave.
eveland, Ohio 44110

r Mr. Harker:

letter is in reply to your request to see the CLEVITE
0 in action-- operating at computer speeds

ant you to see the speed, hear the silence, and then
rmine for yourself that it really is the next generation
gh speed printers-- here and now!

why we are setting up demonstrations around the
ry-- to give you the opportunity to observe the
TE 4800 doing a job that it does better and faster
y other printer you can buy for your computer

t enclosed is a schedule of demonstrations we will
ducting in the next few weeks. Please write or call
us which location, and which day and time will be
you.

u very much for your cooperation, and we will look
to seeing you at the demonstration.

Sincerely,

Willard C Koepf

Willard C. Koepf
Sales Manager

is computer printed on the CLEVITE 4800

Clevite 4800 can whip out seven 8½ x 11's!

- Here . . . at last . . . is a printout device that will keep pace with the output capability of any computer on the market.
- It's Clevite 4800 . . . a totally new electrostatic hardcopy printer that delivers 4800 lines per minute. That's up to seven times the printout you can get from most line printers and from ten to twenty times the output of usual photographic hardcopy techniques. And the pages you get are a convenient 8½ x 11".
- Consider these other advantages:
  - *Alphanumerics and graphics*—words and pictures . . . simultaneously . . . directly from programmed computer input signal.
  - *Permanent paper*—special, high-contrast . . . won't curl, yellow or get brittle.
  - *The sound of silence*—infinitely quieter than impact line printers.
  - *Reliable*—no impact means less wear and tear on parts . . . less maintenance and little downtime.
  - *Economy*—priced at or below printers that can't come close to the performance.
  - *Versatility*—generates wide range of fonts from smallest matrix on up; in many weights, sizes and faces.

Talk about a breakthrough in computer printout and you're talking about Clevite 4800. Check with your computer people. Then check with us.

Clevite Corporation,
Graphics Dept., 37th & Perkins,
Cleveland, Ohio 44114.

Circle 73 on reader service card

CLEVITE

883.

		1-24	25-99	100-999
LM 101-883	general purpose op amps	$28.50	$23.00	$19.00
LM 101A-883	high performance op amps	51.00	41.00	34.00
LM 102-883	voltage follower op amps	28.50	23.00	19.00
LM 104-883	negative voltage regulators	36.00	29.00	24.00
LM 105-883	positive voltage regulators	28.50	23.00	19.00
LM 106-883	voltage comparators/buffers	33.00	26.60	22.00
LM 107-883	high performance compensated op amps	56.00	45.00	37.00
LM 709-883	general purpose op amps	10.35	8.65	7.40

PARTS NOW. Off the shelf. All Mil-Std-883 Linear ICs, straight from National's special 883 production and testing lines.

GET THE WHOLE STORY. Send for National's 883 Linear Software Package. A big, thick compilation of Mil-Std-883 literature. Includes detailed brochure on National's 883 program, specific specs on linear parts, full data sheets and price lists, plus complete 883 software—all the specs already written.

National/883

National Semiconductor Corporation
2975 San Ysidro Way
Santa Clara, California 95051

Please rush the big, thick, complete "883 Software Package" to

Name____________________

Company____________________

Address____________________

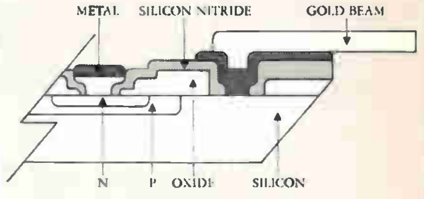
City________________Zip________

Everybody talks about beam lead.

Circle 77 on reader service card →

This is the dawning of the age of the leaded chip. In other words, sports fans, August is the month Raytheon uncorks beam lead, and the old semiconductor business will never again be the same.

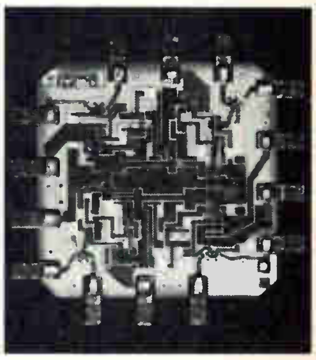
☐ Simply meaning that now you can buy semiconductor chips with leads already formed and integrally attached. This lets you control packaging, save system assembly time and boost reliability.



CROSS-SECTION OF TYPICAL BEAM LEAD CHIP

☐ Take a for instance. With a beam lead chip, bonding's a step, not a career. Every lead's bonded at once, whether you're working with diodes or LSI.

☐ And the chip stays healthier. Your operator can mash down on those little leads and cook them to a turn. The chip sits there, to one side of the action, calm, cool and uncracked.



☐ But there's more. Every beam lead chip sports a Silicon Nitride passivation coat to give it complete hermetic sealing at all junctions. Raytheon's wafer separation process exorcises that evil old chip-cracker, the scribe. Chips are separated by a delicate anisotropic etching process that eases those little babies apart with TLC. No more hidden cracks to surprise you in final testing, or after your system's been fired up for a week. And just to sweeten the pot, in case you *really* hate surprises, we can provide 100% chip testing against all AC and DC parameters at −55 to +125°C.

Type No.	Device (−55 to +125°C)	100-999
RM709	Op amp	$6.80
RG250	Expandable quad 2 input OR gate	4.05
RG220	Quad 2 input NAND gate	4.05
RG240	Dual 4 input NAND gate	4.05
RG200	Expandable single 8 input NAND gate	4.05
RG230	Quad 2 input OR expander gate	2.60
RF200	JK flip flop (AND inputs)	6.00
RF100	Dual JK flip flop (separate clock)	7.10
1N914	Fast switching diode	1.25
1N3600	High conductance fast switching diode	1.30
2N2484	Low level amplifier NPN	1.75
2N2605	Low level amplifier PNP	2.15

In segments of 5 chips only.
Commercial grade units at lower prices; delivery to start 4th quarter 1969.

☐ We're kicking off our Beam Lead Derby with an even dozen types, available in quantity from our exclusive beam-lead-franchised distributors, Avnet Electronics and Cramer Electronics. Later on you can buy our whole line in beam lead . . . TTL, DTL, linears, transistors, diodes.

☐ After that, onward and upward to multi-chip arrays, MSI, LSI and so on. Proving once again the wisdom of doing business with the company that puts its chips where its mouth is. Send for data, including Raytheon-approved list of sources for beam lead bonders. Raytheon Semiconductor, Mountain View, California. (415) 968-9211.

But we deliver it.

the fate of the "open" Reed Relay IS SEALED!

shown actual size

For almost the price and size of open types, this new Struthers-Dunn MRRK Series has all the advantages of conventional enclosed, magnetically-shielded reed relays.

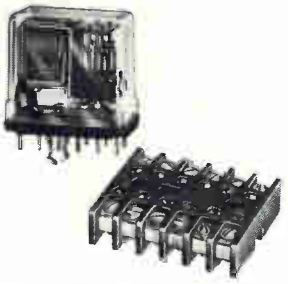
A new fast method of plastic sealing gives complete protection that your production department will really appreciate during mounting, soldering, and cleaning. Insulation resistance remains above 10^{12} ohms.

Only 0.66″ wide by 1.29″ long by 0.48″ high (including 4 standoff pads), the case accommodates single or double coils and up to 3 single-throw or up to 2 double-throw, miniature reed switches. Internal leads are welded to 0.1″ grid-space P/C terminals.

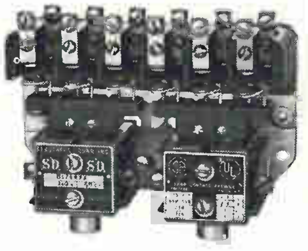
In stock now at Struthers-Dunn distributors in most popular configurations. For detailed information, request Data Bulletin B/3330 on the new MRRK Series. Check the Reader Service number shown below.

There's always more to draw on where you find the most to start with

World's Largest Relay Line
More than 5,348 different types! Sold through more than 100 franchised distributors! Get our Stock Relay Catalog 1010 for details on the most frequently-needed aerospace, reed, industrial, and special-purpose relays, contractors, and motor controls. Check the appropriate Reader Service number at right.



Largest Line Of Plug-Ins
This integrated line of general-purpose, latch, sequencing, and timing relays will save your wiring time, make control panels neater, cut costs. S-D socket terminals are all instantly accessible and on one plane. No complex multiple-level wiring! Send for full story. Check the proper Reader Service number at right.



More Ways To Reverse A Motor
No one else offers as wide a choice of motor reversing contactor designs for general and definite purpose applications up to 100 HP . . . including hoists, motor-operated doors, windows and elevators as well as machine tool auxiliaries. Details on request. Check the proper Reader Service number at right.

SEND FOR THIS DATA

Check numbers on the Reader Service Card for any or all the items of interest to you.

- # **497 MRRK Relay Bulletin**
- # 498 Stock Relay Catalog
- # 499 Plug-in Relay Bulletins
- # 518 Motor Control Catalog

S-D

STRUTHERS-DUNN, INC.
PITMAN, NEW JERSEY 08071

Not everyone needs a DVM that's good enough to calibrate other DVMs

Sure our Model 5700 is the most accurate DVM there is — 0.0025%. And the most stable — 0.0065% for a year. But if you don't really need a DVM that's good enough to calibrate other DVMs, don't buy it. Buy one of our 32 others instead.

We make them for labs and production lines, for use on the bench and in systems, militarized models, four digit DVMs and five, from $1150 to over $8000. (Actually, with our unique plug-in modules, you can create some 300 different configurations. For every imaginable application. To fit every budget.)

And no matter which of our other 32 you buy, you'll have a DVM made with the same meticulous care as our 5700. With many of the same circuits. By the same people. To give you the confidence you've come to expect from Dana.

Which one suits you best? Ask for the decision maker, our free brochure.

Dana Laboratories, Inc., 2401 Campus Drive, Irvine, California 92664.

DANA®

Circle 79 on reader service card

It took us years to develop the best stereo microscope.

Now give us a few minutes to prove it.

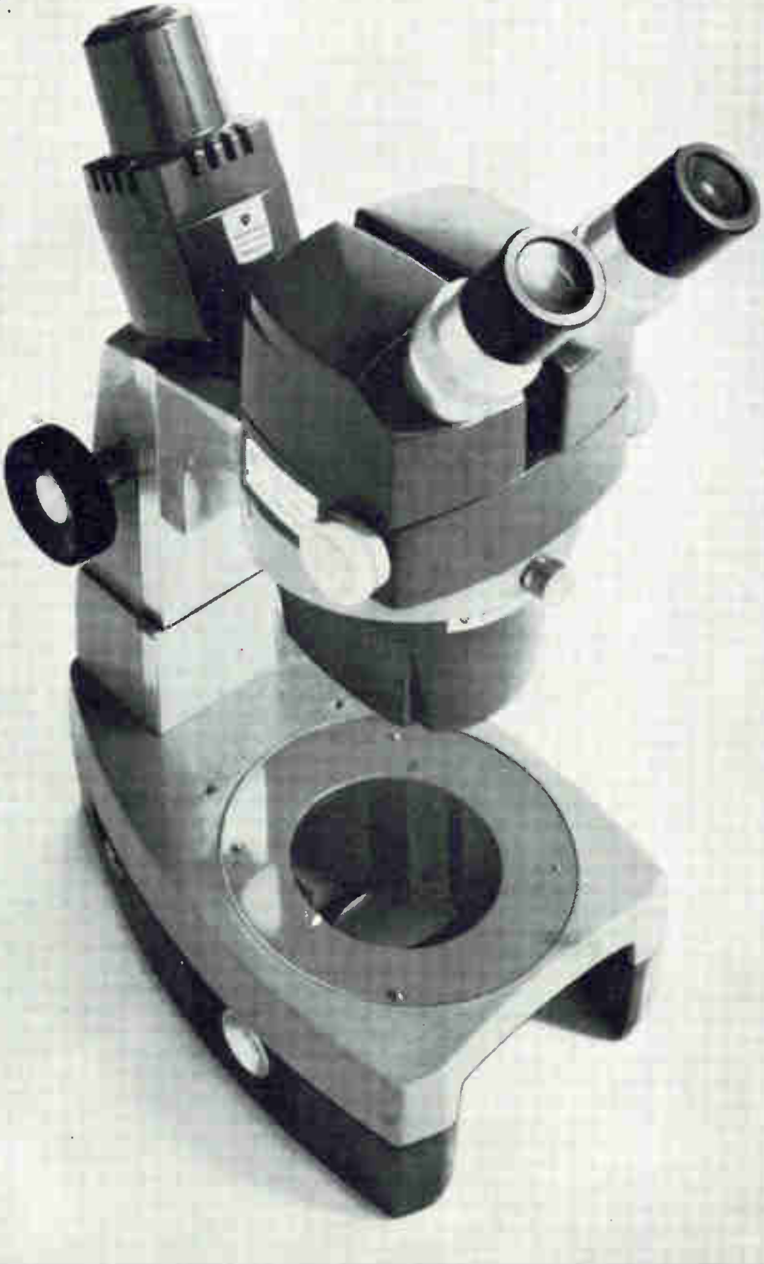
Let us compare our StereoStar/ZOOM to any stereoscopic microscope in your lab.

Our microscope offers high resolution, larger fields of view, greater working distance. We have as wide a magnification range as you're likely to need: a full 6 to 1 zoom range with magnifications from 3.5 X through 210 X. The zoom control knob is coupled—so that it's conveniently located on both sides, for either left or right-hand operation. And the entire head is easily rotatable through 360°.

135 years of optical excellence went into the AO StereoStar/ZOOM. Let us compare it to any stereo microscope in your lab. After all, if it's worth your money, it's worth your time.

Call your AO Representative. Or write for our convincing 24-page brochure.

AMERICAN OPTICAL
CORPORATION
SCIENTIFIC INSTRUMENT DIVISION • BUFFALO, N.Y. 14215



Need a helpful ally, taking on Mil-Spec contracts?

When it comes to military contracts, Brand-Rex can make getting the proper wire and cable the easy part of the job.

We offer an unusually broad range of products from tiny hook-up wires to mighty umbilical cables. Polyethylene, PVC, Kapton, Kynar, Teflon TFE and FEP are a few of the insulations we use regularly.

Brand-Rex's quality control procedures, well-known and accepted by military and aerospace people, simplifies meeting MIL, NAS and other requirements.

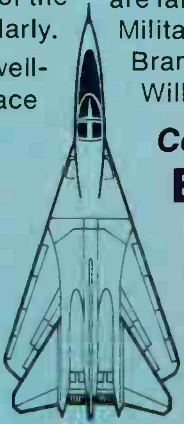
Need an ally in a tough market? Contact the people who've been there for years, supplying cable for practically every major missile system and space shot. Whether your cable requirements are large or small write for the new Brand-Rex Military Specification Wire and Cable catalog.

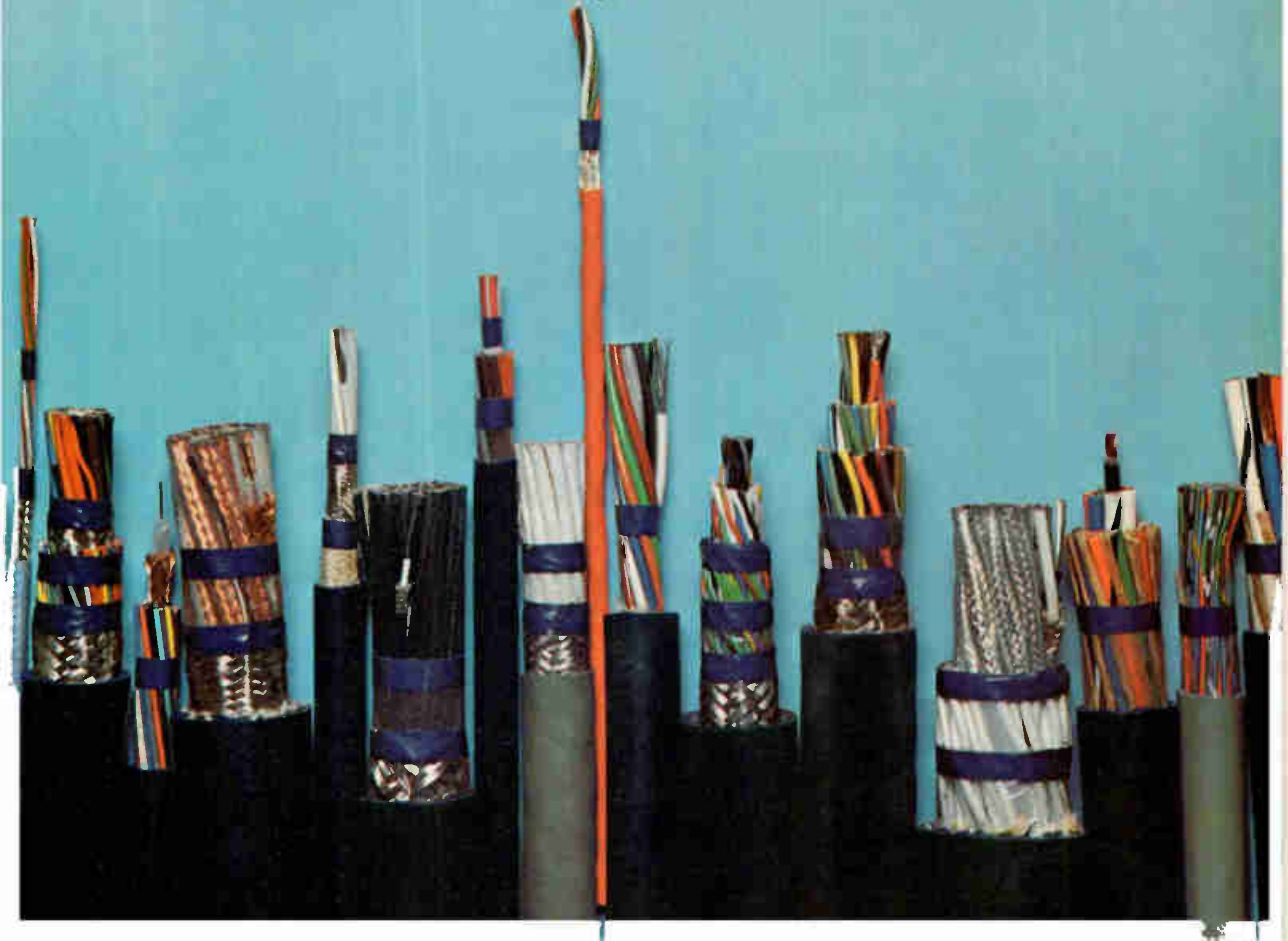
Brand-Rex Division, American Enka Corp.,
Willimantic, Conn. 06226, (203) 423-7771

Connect for tomorrow.

BRAND-REX

Circle 81 on reader service card





What this country needs is a good nickel cigar... and a ⅜" square industrial cermet trimmer.

★ Helipot has the trimmer for $3.50 list…

now available in local stock.

(But you'll have to find the cigar.)

Beckman

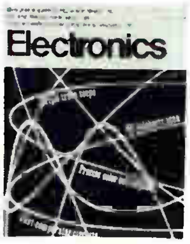
INSTRUMENTS, INC.
HELIPOT DIVISION
FULLERTON, CALIFORNIA • 92634

INTERNATIONAL SUBSIDIARIES: AMSTERDAM; CAPE TOWN; GENEVA; GLENROTHES, SCOTLAND; LONDON; MEXICO CITY; MUNICH; PARIS; STOCKHOLM; TOKYO; VIENNA

August 4, 1969 | **Highlights of this issue**

Technical Articles

Oscilloscope's changing face—red, green and blue traces
page 84



Resolution and aim are the important considerations when designing a three-gun cathode-ray tube like those used in color television sets into a three-channel oscilloscope. In a new unit, built with this kind of crt, the three electron guns scan the screen and a logic network fires the right ones at the right times. The results are sets of green, red, and blue dots forming the scope's traces. For good resolution there must be plenty of dots; display accuracy depends on convergence of the three electron beams. The multihued traces display a great deal of information that can be read and understood by professional engineers and laymen alike.

Building blocks are two-base hit for analog control computers
page 96

Analog computation may now prove preferable to digital techniques in control applications where 1% accuracy is acceptable. Raytheon has come up with an analog computer that promises to allow systems designers to take advantage of simpler and more straightforward methods. The machine works off just two basic modules—a function generator and a summing amplifier—built around monolithic linear IC's and discrete components on thick-film ceramic substrates.

Color tv gets badly needed face-lift
page 102

The changes in color hues that result when channels are changed or when cameras switch from live to taped coverage can be greatly minimized by a correction circuit in the receiver. A recently developed automatic-tint control, using gates controlled by the set's 3.58-megahertz oscillator and phase-shifting networks, senses color variations in the flesh-tone region and develops a correction signal to compensate for them in the chroma amplifier.

Electronics midyear markets report
page 107

Just past the halfway point, it looks like a pretty good year for the electronics industry. Defense and aerospace suppliers may be in for some disappointments during the period ahead as congressional budget cutters hack away at appropriations. Semiconductor houses, however, are rocketing along at a good clip as are concerns oriented toward industrial outlets. Computer makers and manufacturers of peripheral equipment are still riding a gravy train, and avionics outfits are eyeing lush new markets in traffic control. Consumer goods business is running at a high level, but producers are concerned about the rising tide of imports, particularly from Japan.

Coming

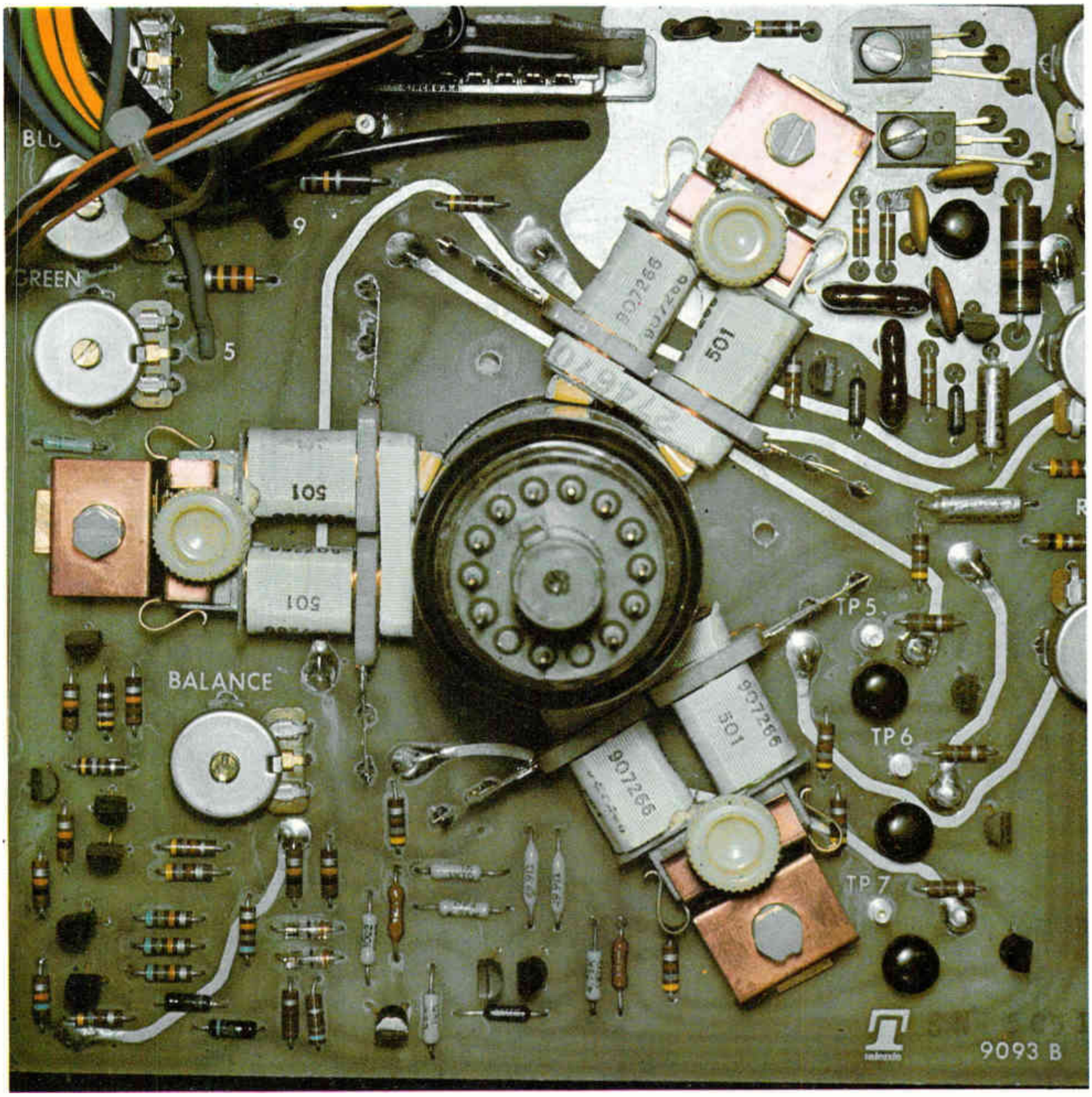
New slant on failure analysis

Having studied the matter, the Air Force has determined that when equipment breaks down as a result of the failure of a solid state component, the part in question has not, in many cases, been properly designed or inspected by the supplier.

Instrumentation

By Richard E. McCormick
Telonic Industries Inc., Laguna Beach, Calif.

Oscilloscope's changing face



- Magnets converge the beams from a three-gun crt
- High-speed vertical scan intensifies resolution
- IC comparators provide 15-nsec response time

—red, green and blue traces

Effectively locked out of oscilloscopes because of the thorny problems of aim and resolution, color is at long last being ushered through the door. Providing the key is a three-gun cathode-ray tube, standard in color-television receivers, that serves as the scope's display element.

Much more than merely having a pretty face, a color scope delivers a meaningful message. It's red, green, and blue traces display a great deal of information distinctly. More importantly, the information can be read and understood by engineer and layman alike. This readability could lead to oscilloscopes having a broader range of applications in which laymen, rather than technicians, are involved.

The crt's electron guns fire through a shadow mask at phosphors on the tube's face, with the beam from one gun striking only the red phosphors, the beam from the second gun hitting only the green phosphors, and the third beam striking only the blue phosphors. A deflection coil aims the guns vertically, while a second coil scans the guns horizontally. The firing of the right guns at the right times, thus producing the traces, is controlled by logic circuitry.

Since the traces aren't continuous lines—they're sets of dots on a raster—a high-frequency vertical scan is needed to achieve an illusion of continuity. In the approach taken by Telonic Industries Inc., 40 kilohertz was chosen as the scan rate.

Three magnets, each having one winding for vertical-correction current and another for horizontal-correction current, are clamped onto the neck of the crt to position the beams precisely so that they converge.

Putting it together

A power oscillator, phase-locked to the line frequency, generates a sinusoidal current in the vertical deflection coil. This current not only aims the electron beams, but also generates a beam-position voltage that is routed by a switching network to red, green, and blue comparator modules. These modules have pulse generators that trigger their associated guns. In addition to the position voltage, each module receives both a reference voltage and an input voltage from one of the three vertical channels.

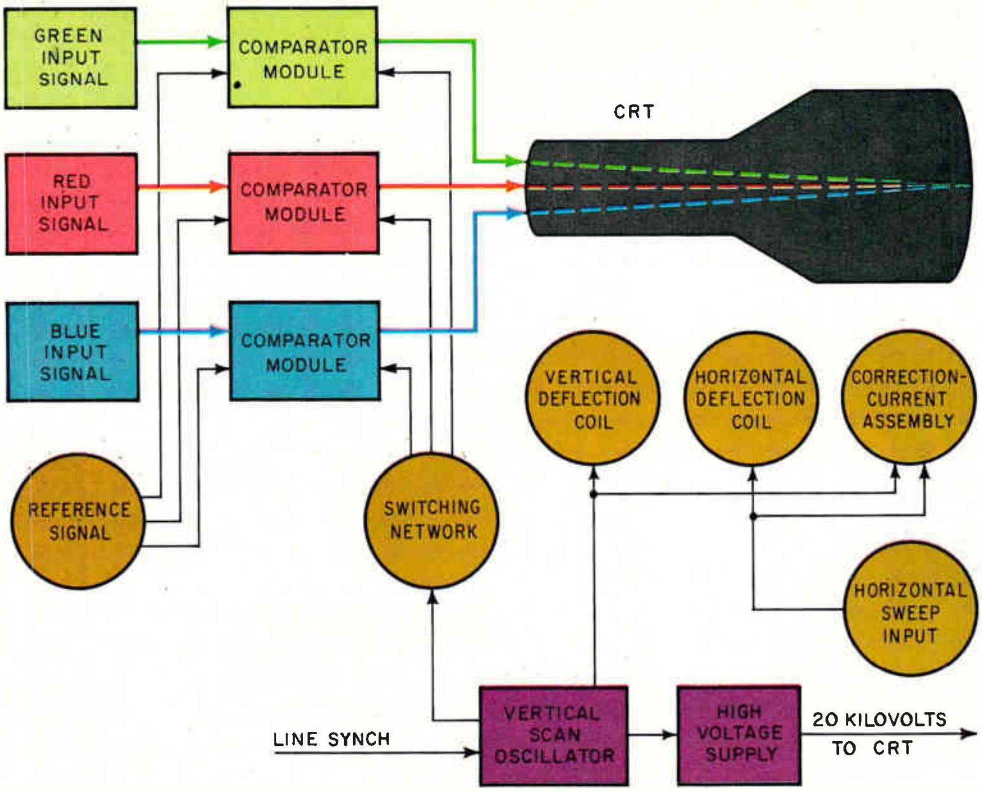
During the downward vertical scan, each comparator turns on its pulse generator when the comparator's input voltage equals the position voltage. The gun then fires, producing a dot. Thus, three dots—red, green and blue—are generated in the downward scan. During the upward scan, the input voltage is ignored. In its place, reference voltages which are preset, are compared with the position voltage. Three more dots are then generated. As the beams are deflected horizontally, three input traces and three reference lines are plotted.

Since the vertical sweep is sinusoidal, the beams move up and down at a continuously changing rate. But because the comparators, not the scanning system, determine the position of the dots, the nonlinearity of the scan has no bearing on the linearity of the trace. Only the point-to-point spacing between dots differs for each adjacent pair of dots.

Enhancing resolution

But since resolution of raster-type displays depends on the distance between the dots, the determining factors are the horizontal-sweep speed, the input's frequency and amplitude, and the vertical-

Three guns; one spot. If the color t-v tube (center) were left alone, its three electron beams wouldn't converge. But it's not alone. The trio of magnets surrounding the tube generate a continuously changing flux which ensures that the tube's electronic guns are always pointing at the same spot.



Channels of color. The horizontal and vertical deflection coils aim the three guns in an up-and-down left-to-right scan. During the downward scan each module compares its channel's input with the position signal coming from the switching network; when the two signals are equal the pulse generator fires an electron gun, making a colored dot on the screen. During the upward scan the position signal is compared with the channel's reference signal, and when these two are equal another dot appears. The correction-current assembly converges the beams from the three guns.

scan frequency. The distance between adjacent dots is given by

$$(1/f_s)(v_h)(m^2 + 1)^{\frac{1}{2}}$$

where f_s is the scan frequency, v_h is the horizontal sweep and m is the slope of the displayed signal. The slope increases when the input's frequency or amplitude increases.

There are two ways of enhancing resolution—one by lowering the horizontal speed, the input's frequency, or the input's amplitude, and the second by boosting vertical-scan frequency. The former approach, however, reduces the display's capability, and, in turn, the scope's. Thus, it's best to take the latter approach, not that it is without a drawback.

Unfortunately, flyback-type scans usually used with magnetically-deflected crt's aren't practical for high-speed scans; large voltages, which lead to breakdowns, are induced across the vertical amplifier's output transistors during flyback. In this scope, a resonant circuit reduces the voltage requirement for these transistors. This circuit, the 40-khz oscillator on page 87, is essentially a closed-loop network. To achieve oscillation, a square wave from a switching amplifier passes through an impedance-matching filter to a high-Q tank circuit comprising the vertical-deflection coil in series with a tuning capacitor. With the square wave having an amplitude of 45 volts, the resulting deflection current, i(t), is a 40-khz sine wave whose amplitude is about 0.7 amp.

It takes only 0.5 amp to deflect the beam to the top or bottom of the 10-inch-high screen, so there's a 40% overscan. Therefore, only the linear portion of the sinusoidal scan is used.

The coil, whose inductance is 15 millihenrys, has a peak voltage across it of about 2.6 kilovolts because

$$v = L\frac{di}{dt}$$

$$= L\frac{d}{dt}(0.7 \sin \omega t)$$

$$\cong 2{,}600 \cos \omega t$$

where

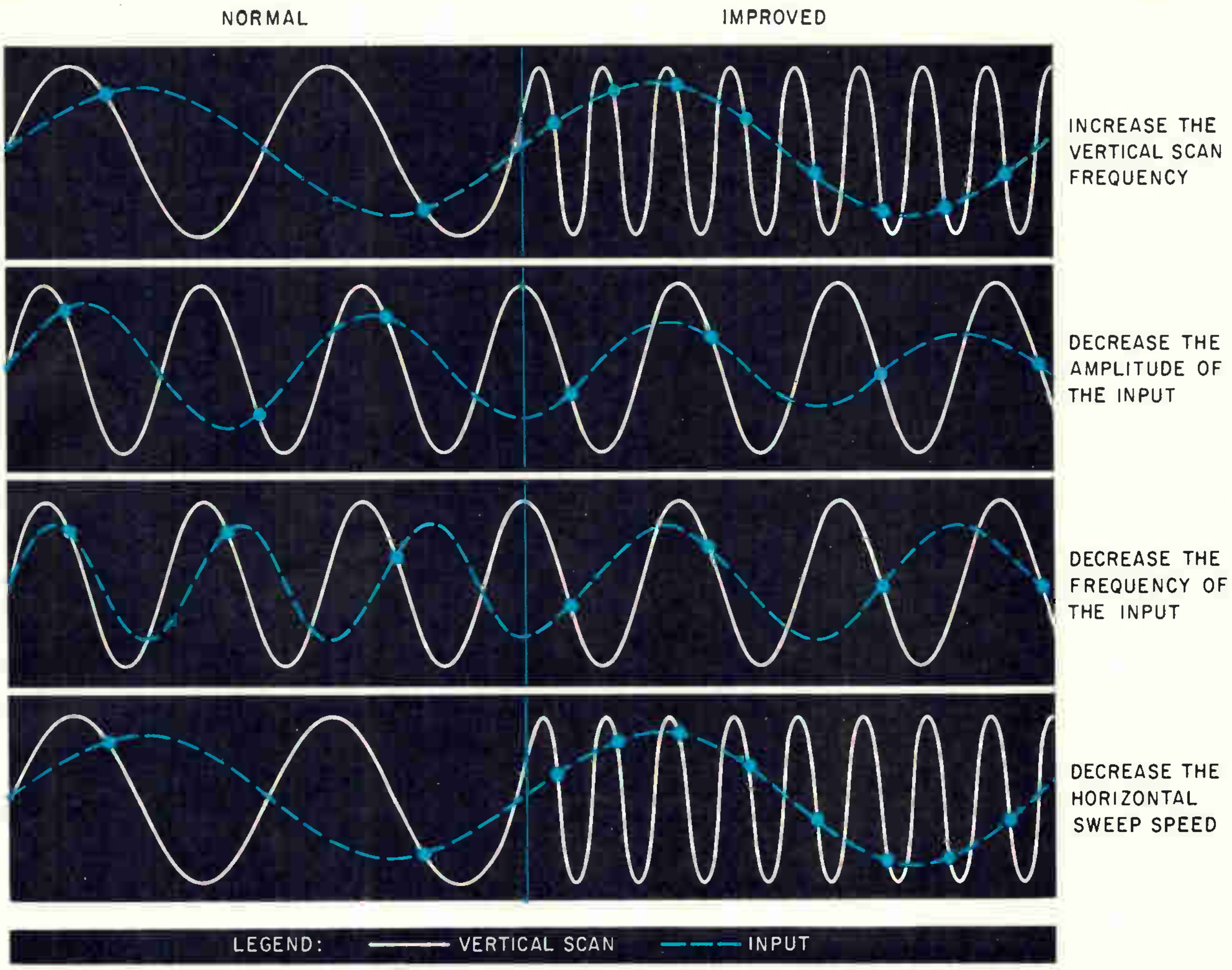
$$\omega \cong 80{,}000\ \pi$$

With a 15-mh deflection coil, the tank circuit needs a capacitance of 1,200 picofarads. Any high-Q tank circuit can be used as long as the tuning capacitor maintains the proper resonant frequency.

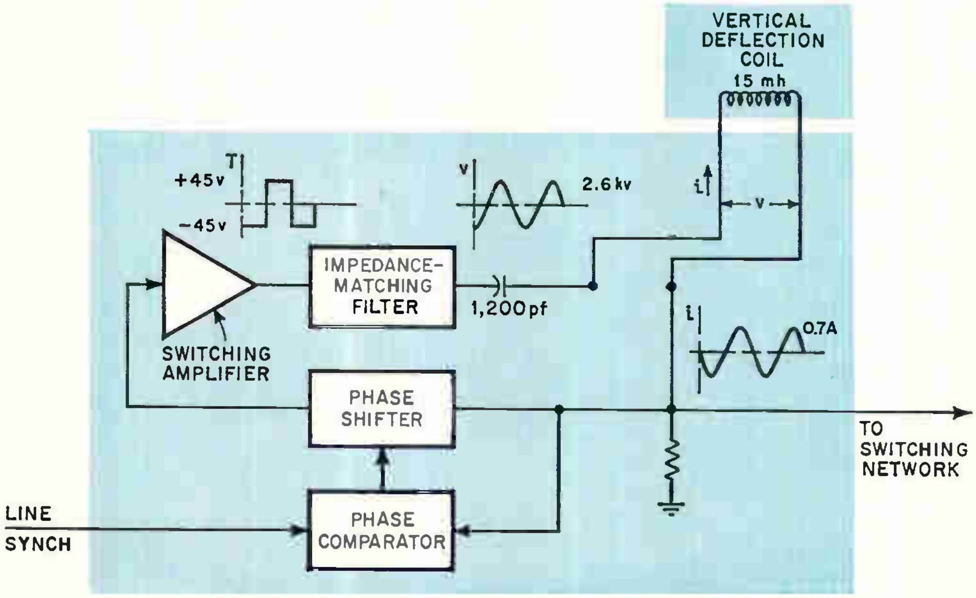
Stabilization of the scan frequency is achieved with a phase-locked loop. A phase comparator looks at the phase of the oscillator's output and that of the line voltage, and generates an error voltage proportional to the difference. This error voltage drives a phase shifter that adjusts the oscillator.

The 40-khz figure is a nominal value for the scan frequency. In reality, this frequency is an exact multiple of the line frequency. Thus, if the line frequency is 60 hertz, the scan frequency is 36,240 hz (the 604th harmonic); if it's 50 hz, the scan frequency is 36,200 hz (the 724th harmonic).

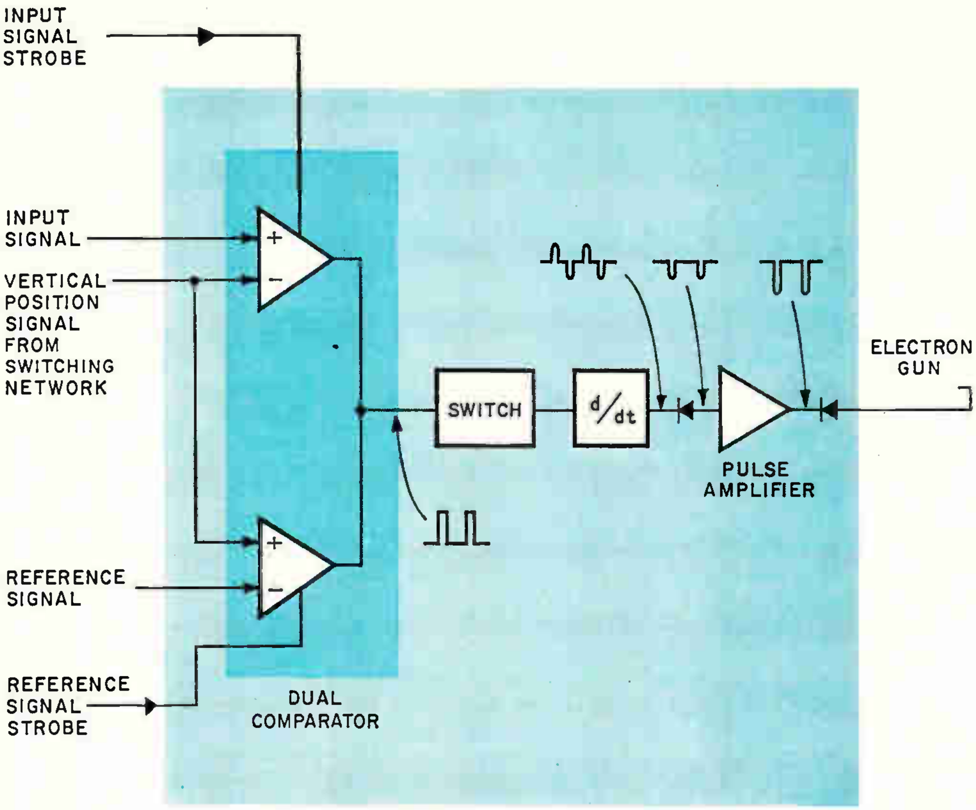
THE FOUR WAYS TO IMPROVE RESOLUTION



Dotting the cycle. Increasing the scan frequency or lowering the sweep speed or frequency of the input increases the number of dots generated during a single cycle of the input. Decreasing the input's amplitude doesn't change the number of dots per cycle; but the dots already there are closer together.



Up, down, and where. The vertical scan oscillator sends a 40-khz signal to the deflection coil where it aims the guns and to the switching network where it tells the modules the vertical position of the scan.



Strobe control. Each of the scope's three channels has a module. Its key element is the dual comparator, an off-the-shelf integrated circuit. Strobe signals turn on one of the IC's comparators during the downward scan and the other comparator during the upward scan.

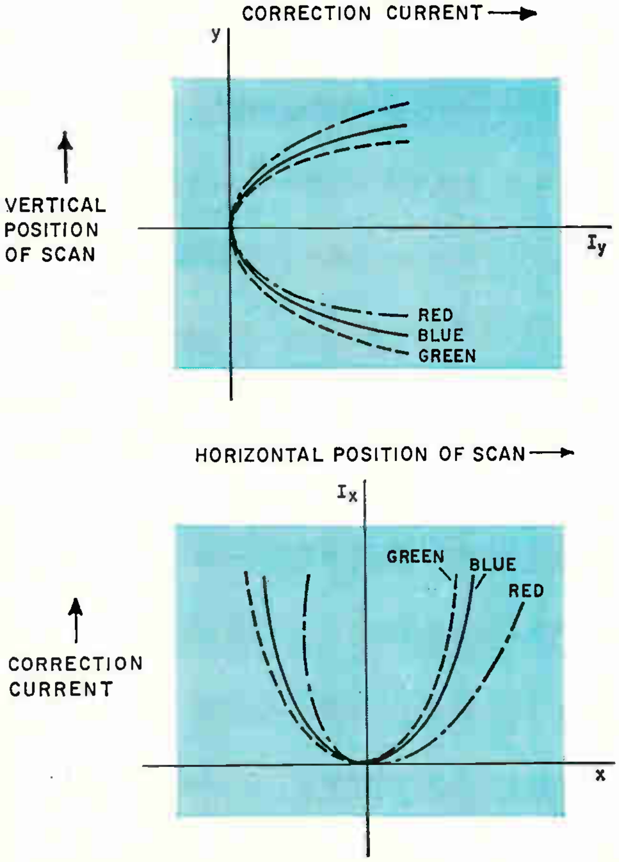
The reason that the vertical scan frequency is synched to the line frequency is to ensure that the display is stable when the horizontal sweep is also synched to the line, a common occurrence. Any low-amplitude high-frequency line transients are filtered out before the synchronous signal is generated.

One module per channel

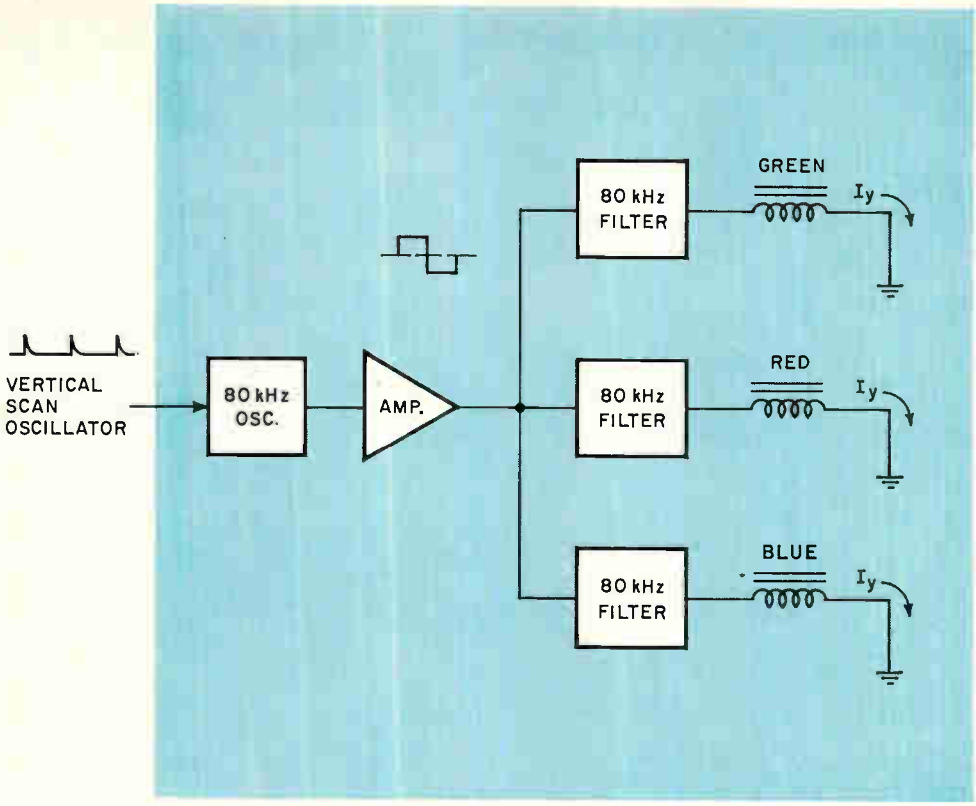
Although the channels produce different colors, the comparator modules are identical. Each has an integrated-circuit dual comparator and a pulse generator. One such module is shown above. Only 15 nanoseconds elapse between the time a comparator senses two voltages are equal and the time a pulse generator fires. This speed is necessitated by the 40-khz scan frequency.

To determine which of the IC's two comparators is connected to the output, a strobe is used. The voltage across the deflection coil switches the strobe between high and low logic levels at zero crossings of the coil's voltage. Since this voltage is 90° out of phase with the coil's current, the strobe is switched when the vertical scan is at its top or bottom. During the downward scan, the strobe line for the dual comparator is high, and the input voltage is compared with the position voltage; all reference information is ignored. During the upward scan, the strobe levels are reversed so that reference voltages are compared and signal information ignored. The comparator then drives a differentiator.

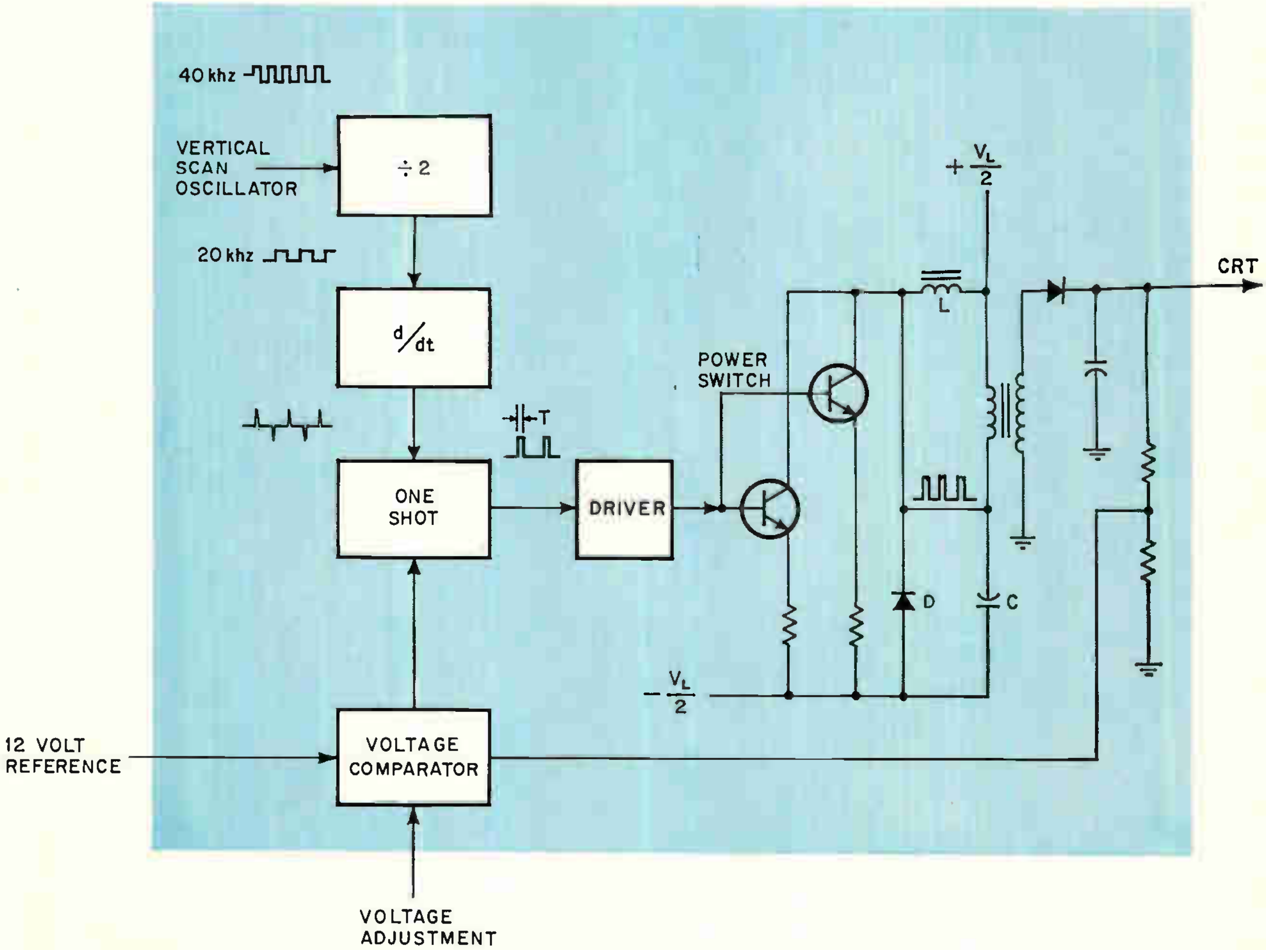
Negative spikes from the differentiator trigger a



Getting together. When the correction currents, which are functions of the scan's position, flow in the windings of the correction-current magnets the beams converge.



Getting the current. The vertical convergence circuits generates the I_y for each of the channels.



Tube power. Regulated to within 50 volts, the power supply delivers up to 20 kilovolts to the crt's anode.

pulse amplifier, which applies an 80-nsec, 200-volt negative pulse to a cathode.

Convergence

The solution to the convergence problem lies with a trio of magnets whose fluxes are determined by correction currents. Each gun, positioned in an equilateral triangle about the axis of the tube, is tilted slightly toward the axis. Thus, each beam strikes the shadow mask at the precise angle necessary to illuminate phosphor of only one color. Because the guns are positioned off axis and because the beams converge at the shadow mask rather than on the screen, each beam reacts differently to the magnetic flux generated by the deflection coil. Without the magnets, the traces wouldn't overlap when the same signal is applied to the input terminals of three channels.

Since there are three magnets, one each for the green, red and blue guns, there are six correction windings in all. For every given point on the tube's scan, there's a specific amount of current that must flow into each winding. These currents, determined empirically, are plotted as functions of the vertical or horizontal position of the scan on page 88. Besides the magnets, the correction-current assemblies have networks that generate the correction currents.

The plots are tilted parabolas whose general equation is

$$I = K_1 r^2 + K_2 r$$

where

I = correction current

K_1, K_2 = constants

r = amount of vertical deflection y or horizontal deflection x

To generate correction current, vertical deflection is considered first. The vertical deflection is directly proportional to the scan signal and is described by

$$y = K_3 \sin \omega t$$

where

K_3 = constant

Therefore,

$$I_y = \tfrac{1}{2} K_1 K_3^2 - \tfrac{1}{2} K_1 K_3^2 \cos 2\omega t + K_2 K_3 \sin \omega t$$

where I_y is the vertical correction current.

The first term may be neglected since it can be included in a static convergence adjustment. K_2 turns out to be quite small and may be approximated by adding a phase-shift term, θ, to the primary correction signal.
Therefore,

$$I_y = A \cos (2\omega t + \theta)\ t$$

where A is constant related to K_1, K_2 and K_3.

Providing this correction is a vertical convergence circuit, on page 89. Pulses derived from the vertical scan synchronize an 80-khz oscillator whose output is applied to three series-tuned 80-khz filters. The Q and center frequency of each filter are varied to set the individual A's and θ's to get the desired values.

Generating horizontal-correction current, however, isn't quite as easy. The horizontal deflection, x, depends on the horizontal sweep signal, which in this scope may be any waveform with frequency components from d-c to 1 khz. Therefore, the vertical-correction network is inadequate because it requires an unchanging input—a synchronous signal from the 40-khz oscillator.

What does the job is a d-c coupled circuit that rectifies the horizontal sweep input and then shapes it to fit the parabolic form of the curves. Added to this shaped waveform is whatever phase of the original signal that achieves the required tilt.

Regulating the power supply

The crt requires an anode voltage of approximately 20 kv at a current of up to 500 microamps. Any change in anode voltage causes not only a change in display intensity, but also a shift in both the horizontal and vertical beam position. Therefore, the tube's anode supply, on pg. 89, is fully regulated against changes in line voltage or load current. The supply generates pulses across a pulse transformer's primary by establishing a current in an inductor, L, and then rapidly switching off the current source so that the inductor current is forced to flow into a small capacitor, C. As the energy from the inductor flows into the capacitor, the latter charges to a very high voltage and the voltage appears across the pulse transformer's primary. After one cycle, oscillation is damped out by a diode, D, and the circuit is dormant until the inductor current is again turned on.

The supply is regulated by varying the on time of the power switch. If the switch is on for a period, T, the current in the inductor increases to a maximum, $V_L T/L$, where V_L is the voltage across the coil; the energy E_L contained in the inductor is $\tfrac{1}{2} L I^2$.
Substituting $V_L T/L$ for I gives

$$E_L = \frac{V_L^2\, T^2}{2L}$$

Since energy stored in a capacitor is $\tfrac{1}{2} C V_C^2$, where V_C is the voltage across the capacitor, it follows that $\tfrac{1}{2}(V_L^2 T^2/L) = \tfrac{1}{2} C\, V_C^2$, and the peak voltage across the capacitor will be $V_L T/(LC)^{1/2}$.

Note that if all other factors are held constant, the peak voltage is directly proportional to T. And in this supply T is a function of the output. A one-shot multivibrator, pulsed at 20-khz, controls the switch. The supply's output is compared with a 12-volt reference, and the error voltage controls the pulse length of the multivibrator. The output may be adjusted from 12 to 24 kv, and is regulated to within 50 volts. ■

Circuit design

Designer's casebook

Designer's casebook is a regular feature in Electronics. Readers are invited to submit novel circuit ideas and unusual solutions to design problems. Descriptions should be short. We'll pay $50 for each item published.

IC's take the "bounce" out of switches

By Victor Wintriss
Consultant, Norfolk, Va.

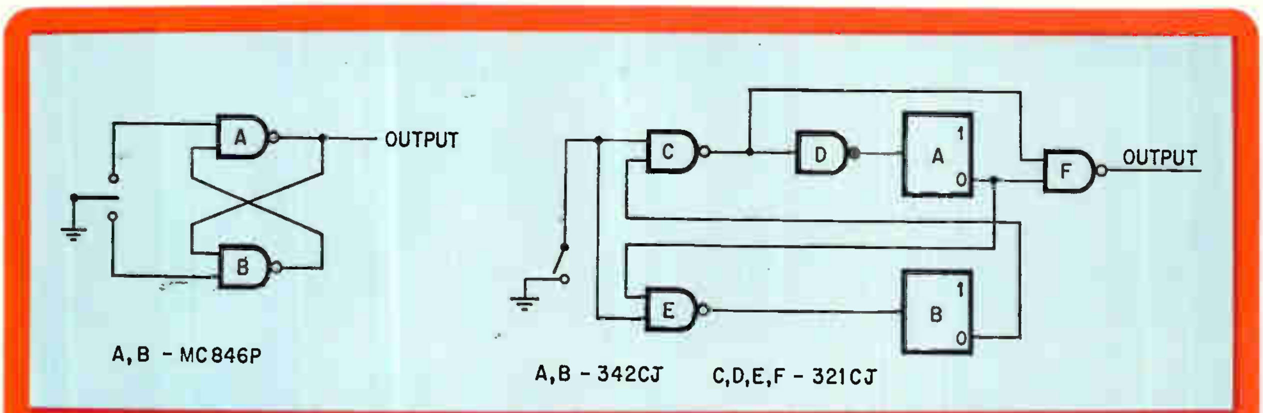
Transients from switch contact bounce cannot be tolerated in fast response circuits. Snap-action switches are the main offenders and are still very much in use today.

A simple method of eliminating bounce uses the NAND gate configuration shown on top. When the switch is moved to the contact forming B's input, B's output goes high. The high output of B is delivered to A's input and its output goes low. A's low output immediately locks B's input low, inhibiting any further transients of the switch from triggering B.

The only drawback to this circuit is that it uses a single pole double throw switch while many applications may use single pole single throw switches. For this purpose, the circuit at the bottom will do.

When the switch closes, E goes low and the one shot multivibrator B delivers a logic-0 pulse to C's input. The pulse width should be wide enough to suppress any closing transients from the switch.

With C low, A cannot be triggered and F's output remains low. When the switch opens, and C's input goes high, A delivers a pulse that keeps the input to E low, preventing further triggering of B and keeping F's output high for the durations of A's pulse width, which should be long enough to suppress any opening transients.



No spikes. The NAND gate circuit configuration shown on top can be used to eliminate transients from contact bounce in single pole single throw switches. In applications requiring double throw switches, the monostable multivibrator circuit below can be used.

IC-size phase detector doesn't need any inductors

By A. H. Hargrove
Bendix Corp., Baltimore, Md.

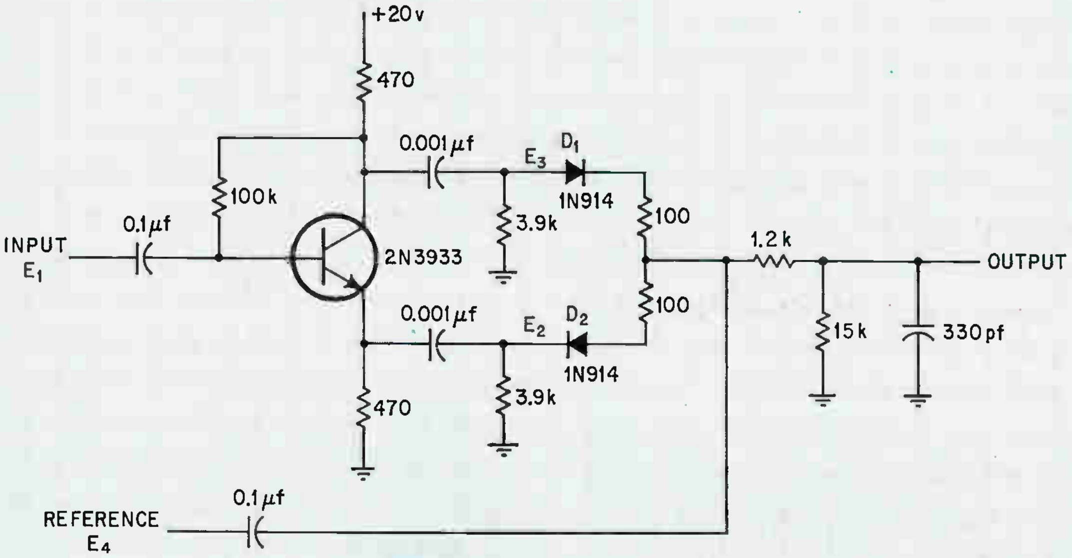
A phase-sensitive detector circuit can be built without the usual need for tuned circuits or transformers. By elminating the cumbersome transformers and inductors, the detector can be packaged as a micro-circuit and used with integrated circuits.

The circuit extracts phase and amplitude modulation data from 20-megahertz intermediate frequency signals. The wide bandwidth of the circuit allows it to operate at frequencies up to 30 Mhz.

Transistor Q_1 acts as a phase splitter to incoming signals, delivering the signal to the anode of diode D_1, and to the cathode of D_2 but 180° out of phase. The reference voltage E_4 is delivered to the opposite terminal of both diodes. A voltage proportional to the vector sum of the input signal E_1 and the reference signal is produced at the output.

When the input signal and reference voltages are in quadrature, the diodes produce equal and opposite voltages yielding zero volts at the output. The maximum negative voltage is generated at the output when the signals are 180° out of phase. The maximum positive voltage appears when the signals are in phase. As the reference is shifted through 360°, the output follows a typical detector curve.

If a limiter is used to lower the input signal's amplitude, the output will be a function of phase angle only, otherwise, amplitude changes appear.



Splitting the scene. Incoming signals are transmitted to both diodes simultaneously but 180° out of phase. The reference voltage combines with the input signal by vector addition to produce the output signal. The circuit was designed to handle frequencies up to 30 megahertz.

Inverted transistor switches precision d-c voltage

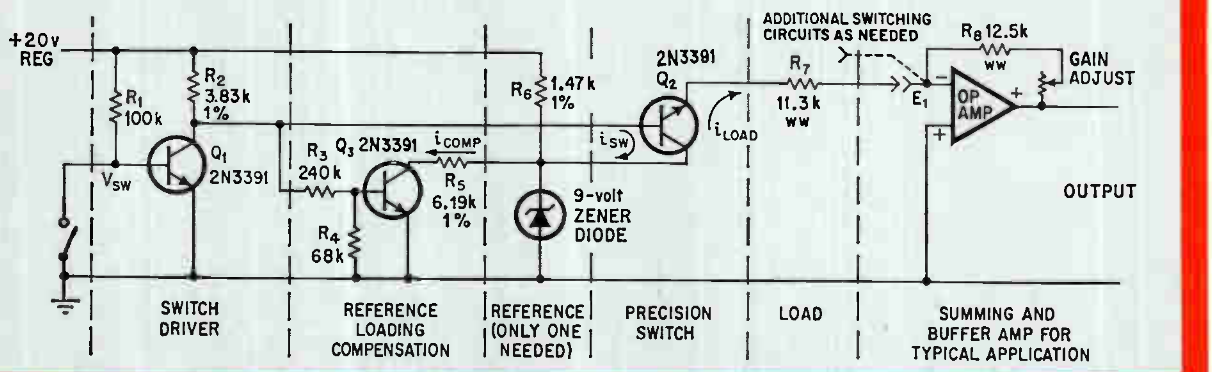
By George R. Latham 4th

Hewlett-Packard, Loveland, Colo.

A transistor with the emitter and collector connections inverted overcomes inaccuracies caused by contact resistance in cheap switches. In fact, contact resistance as high as one kilohm has no effect on the operation of a circuit using an inverted transistor.

With a well regulated power supply and a dropping resistor R_6, a precision d-c test voltage is set up across the zener diode. The test voltage is switched on or off by Q_2. R_7 acts as the load and can be used to feed a current summing junction such as E_1. The connection of Q_1 in the inverted mode provides a collector-to-emitter saturation voltage, V_{ce}, that is about one half that of the normal mode connection, because the beta for the inverted mode is approximately unity. The base current i_{sw} is chosen to be 3 to 4 times the load current in order to minimize V_{ce}.

The switch Q_2 is controlled by Q_1. When Q_1 is cut off, Q_3 and R_5 conduct causing a compensating current to flow, and the +20 volt source supplies base current through R_2 to turn on Q_2. Additional switching circuits may be added whenever necessary so that decimal or binary voltages may be formed. By choosing $i_{comp} = i_{SW} - i_{load}$, an inexpensive reference diode may be used in place of a low impedance active reference supply. Even though a typical 9-volt reference diode has an 18-ohm output impedance, the total current change through the diode is small due to the use of a compensating current. Thus high accuracy can be obtained economically.



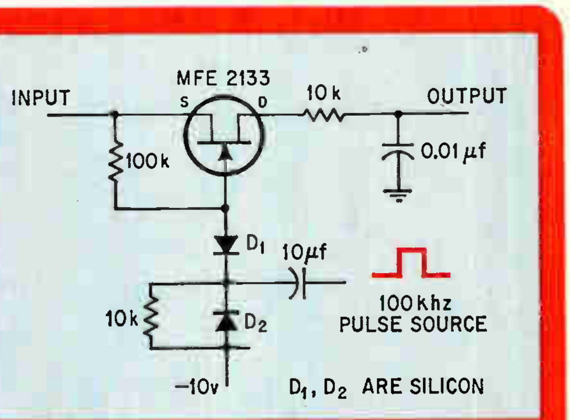
Accurate and economical. The +20 volt regulated supply and R_6 set up an accurate reference voltage across the zener diode while Q_2 connected in the inverted mode acts as a low contact resistance switch. Because a compensating current is employed, an inexpensive zener diode may be used.

Pulse-train duty factor controls RC filter

By L. L. Hamilton

Catholic University of America, Washington, D.C.

The availability of inexpensive digital integrated circuits and nearly ideal field effect transistor switches enables great flexibility in the design of analog circuitry by using the duty factor of a pulse train to control the frequency selectivity of a resistance-capacitance filter. This is accomplished by switching a field effect transistor and thus varying the circuit resistance. This method offers several advantages over linear FET resistance control including less dependence on the properties of the FET and reduced temperature sensitivity.



Tunable. The FET, acting as an ideal switch, controls the effective resistance in the circuit thus determining the corner frequency, f_c, of the filter.

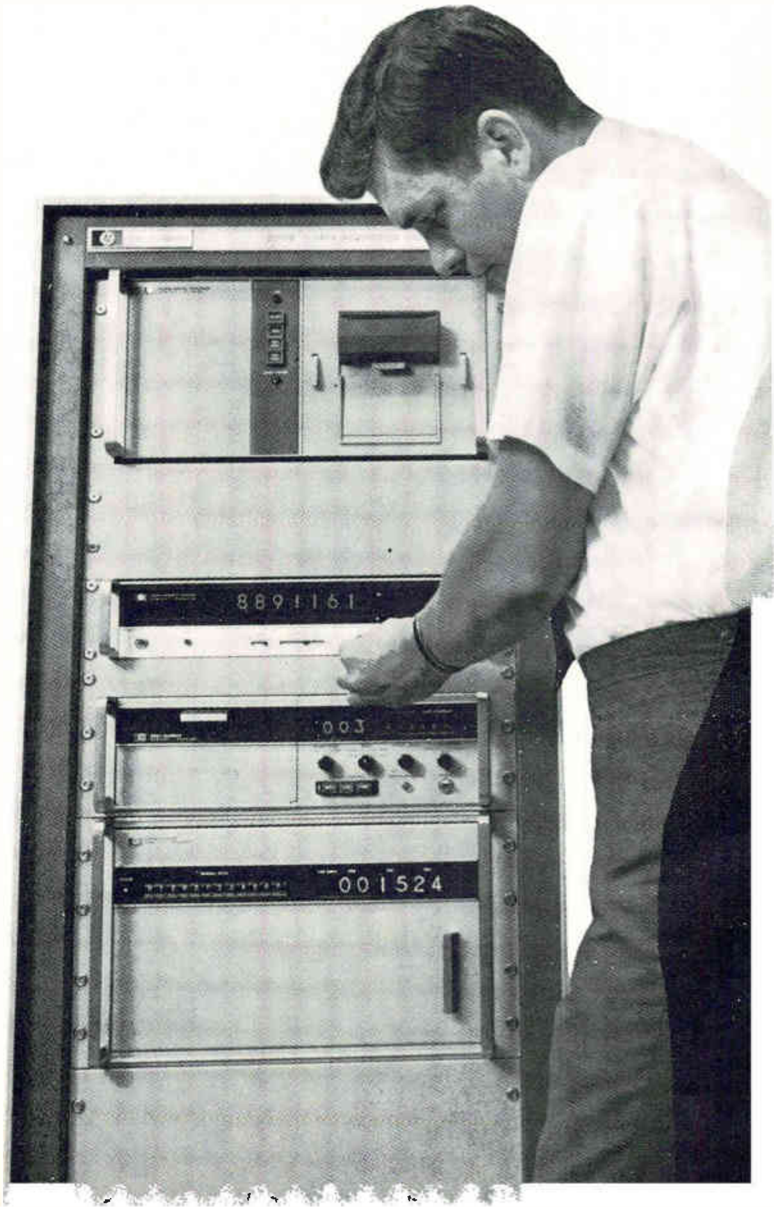
The FET is driven by a pulse width modulated source. D_1 decouples the switching signal from the FET during the positive pulse. Since the FET is a depletion mode device, no forward bias is required on the gate. D_2 is used as a d-c restorer. If the proper d-c level were available from the pulse source, the 10-microfarad capacitor, 10-kilohm resistor and D_2 would not be necessary. Using the arrangement shown, the effective resistance in the circuit becomes inversely proportional to the duty factor t/T, where t is the on time and T is the period of the pulse train. As the duty factor is varied from 1 to 0, the effective resistance ranges from R—10 kilohms in the circuit shown—to infinity, thus giving continuous control of the filter's corner frequency, $f_c = 1/(2\pi R_{eff}C)$.

On the left you see the HP 5323A Automatic Counter at work in a system. On the right is our HP 5325B Universal Counter, making a hard test easy.

The counters could easily be reversed. Because both are programmable and with either of them you can count up to 20 MHz in a system or on your bench. The one you choose depends on what you need.

The Automatic Counter has automatic range selection from 0.125 Hz to 20 MHz. And it needs no switching from frequency measuring mode for high frequency measurements to period measuring mode for accurate low frequency measurements. That's because all measurements are made in the period mode, and internal computing circuits invert the period measurements to frequency. Thus you get the speed and accuracy benefits of period measurements at low frequencies coupled with the convenience of direct readout in frequency at all frequencies. There's no accuracy penalty at any frequency. The 5323A has a score of other advantages built in. For instance, it can automatically measure the carrier frequency of pulsed signals. Some people buy the 5323A for bench and production line use because its simple, automatic operation and direct readout in frequency reduce errors, even with untrained users. It even keeps tabs on the user by refusing to display more digits than it should for a given measurement speed. For easy use in systems, it's programmable, of course.

These two counters make systems run smoother.



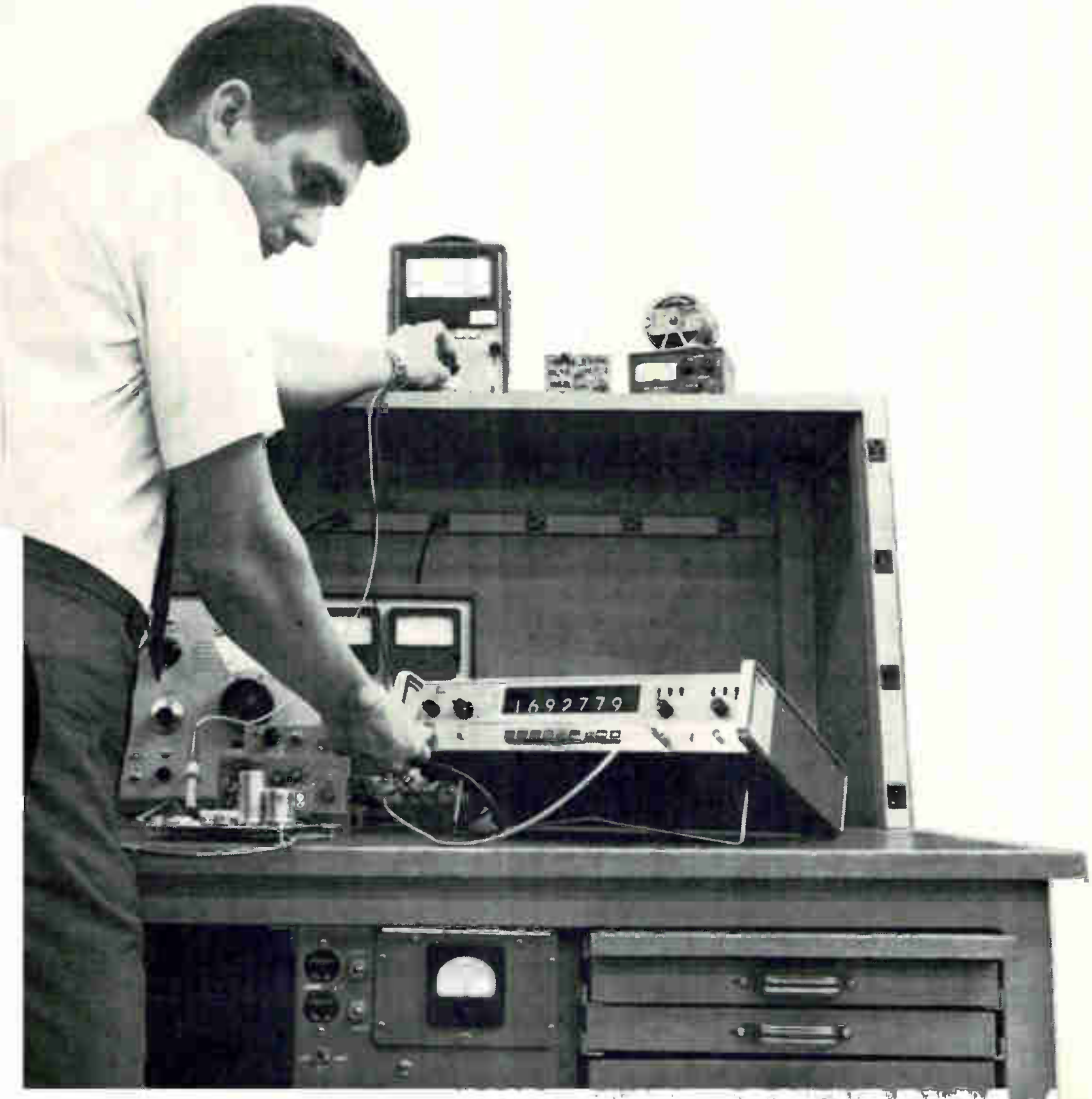
The Universal Counter is even more versatile but is less automatic. It will measure frequency to 20 MHz. time intervals from 100 ns to 10^{8}s. and period, multiple period, ratio and multiple ratio. It will totalize input events or scale an input frequency. Time interval stop and start signals can be from common or separate inputs. with separate trigger-level. slope and polarity controls for each. And its very narrow trigger-level threshold band. less than 1.0 mV. prevents false counts when the trigger level setting is marginal. In addition. the Universal Counter generates two types of oscilloscope markers. These not only mark the start and stop points of a measured interval, but can also intensify the entire measured segment. For easy use in systems. it's programmable, of course. The cost of this versatility for either system or bench use is $2150 for the 5323A and $1300 for the 5325B. Your local HP field engineer has all the details. So give him a call. Or write to Hewlett-Packard. Palo Alto. California 94304: Europe: 1217 Meyrin-Geneva. Switzerland.

HEWLETT hp PACKARD

ELECTRONIC COUNTERS

Circle 95 on reader service card

And tests run faster.



02909

Building blocks are two-base hit for analog control computers

Using only a couple of basic elements, new machine offers efficiency and directness of analog computation, plus the reliability and simple logistics of digital techniques

By Edwin Segarra and John F. Perkins
Raytheon Co., Bedford, Mass.

Digital techniques may be first in the hearts of control-systems designers, but in cases where 1% accuracy is acceptable, analog computation may prove preferable. Such methods are simpler and more straightforward in small control computers. Multiplication and the taking of sines and cosines require a lot more computation when handled digitally; moreover, the signals must be converted from analog to digital and back again.

The essential appeal of the digital art centers on the repetitive use of a few versatile elements like gates and flip-flops. Now, however, an analog machine developed at Raytheon's Missile Division promises to appeal on similar grounds; it works off just two basic modules—a function generator and a summing amplifier.

The modules contain monolithic linear integrated circuits and discrete components on thick-film hybrid ceramic substrates. There are no electromechanical components, such as resolvers and potentiometers—long the bane of analog computation because of their lack of accuracy and reliability.

The Raytheon machine, which solves missile control equations, can be used to advantage on other projects—for example, automatic pilots and process control systems. Among other things, the computer's function-generator modules multiply, divide, and find reciprocals, sines, cosines, arc sines, and arc cosines. The summing amplifier modules operate on these functions in response to the basic control equations.

The basic function generator, as shown opposite, consists of a differential comparator, a field-effect transistor switch, and an operational amplifier. The multiplication operation, $E_x E_y = E_o$, is based on the idea that the d-c component of a pulse wave is directly proportional to the amplitude of the wave multiplied by its pulse width x. If a precisely linear triangle wave E_A is applied to one input of the differential amplifier and a d-c voltage E_x is applied to the other input, the output will be a square wave whose pulse width is directly proportional to E_x and whose repetition rate is equal to that of the reference triangle wave.

The FET switch, controlled by the differential comparator output, gives a linear relationship between E_x and pulsewidth x. If the FET switch, in series with the E_y input signal, is connected to a summing op amp, then the output of the summing amplifier, expressed as a Fourier expansion, is:

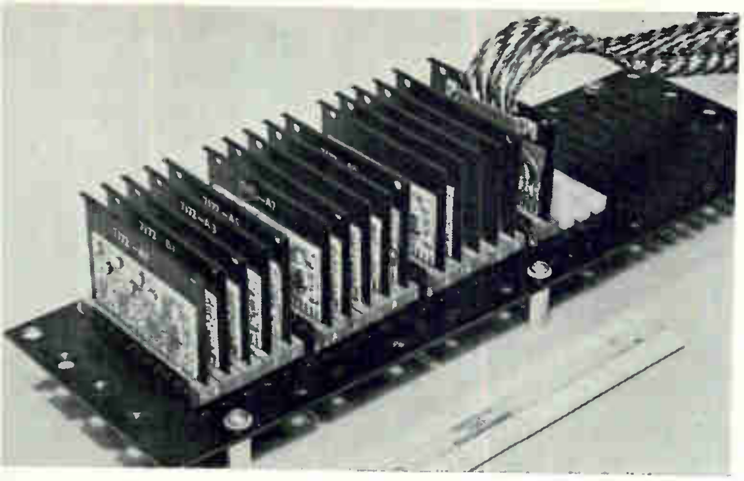
$$E_o = KE_y \left[\frac{x}{L} + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \sin n\pi \frac{x}{L} \cos n\pi \frac{E_y}{L} \right]$$

K is the ratio R_f/R_{in}. The other terms are defined in the circuit diagram and waveforms as shown at the top, right, on the opposite page.

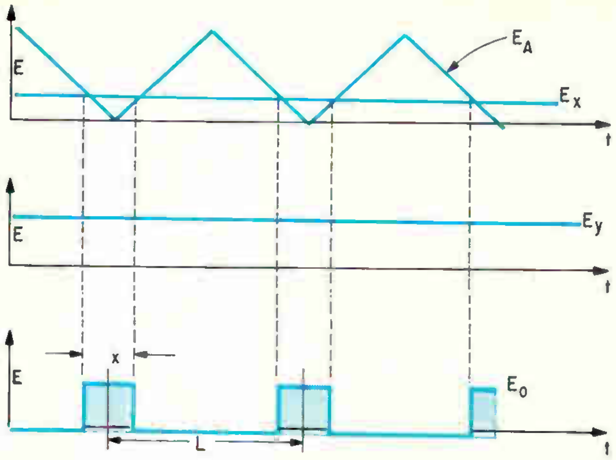
If the summing amplifier is designed to have an upper cut-off point at a rather low frequency, so that it acts as a low-pass filter to remove harmonics, the output signal will be proportional to the product of E_x and E_y:

$$E_o = KE_y \frac{x}{L} = K' E_y E_x$$

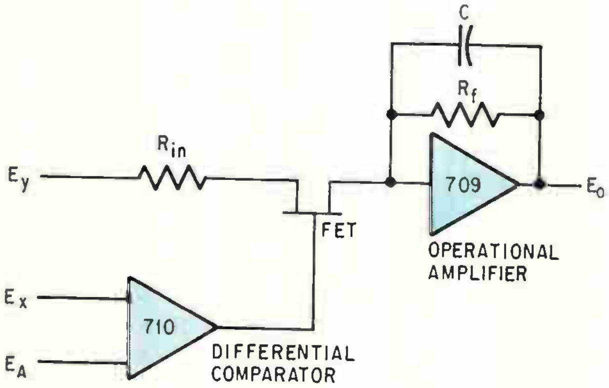
since x/L is proportional to E_x.



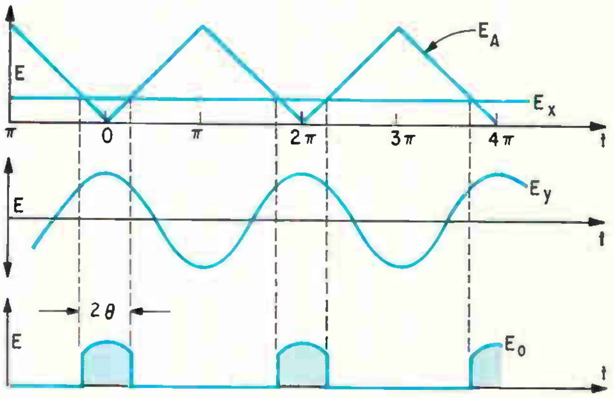
No moving parts. Instead of electromechanical components, missile-guidance computer uses hybrid analog circuits in "nafi" modules. Head-aim portion of computer is shown here.



Times table. To multiply quantities represented by E_x and E_y, a triangle wave is applied to the function generator, along with the multiplicands. The product is proportional to the shaded area under the output pulses.



Simple versatility. One of two basic circuits in Raytheon's analog computer, the function generator can multiply, divide, provide sines and cosines, and determine inverse trigonometric functions.



Sines of the times. To generate sin θ, the function generator requires a triangle wave, a signal E_x proportional to θ, and a cosine wave. Cosines can be generated by shifting zero crossover point.

The same configuration used for the multiplier—FET switch, differential comparator, and operational amplifier—can be used to generate trigonometric functions.

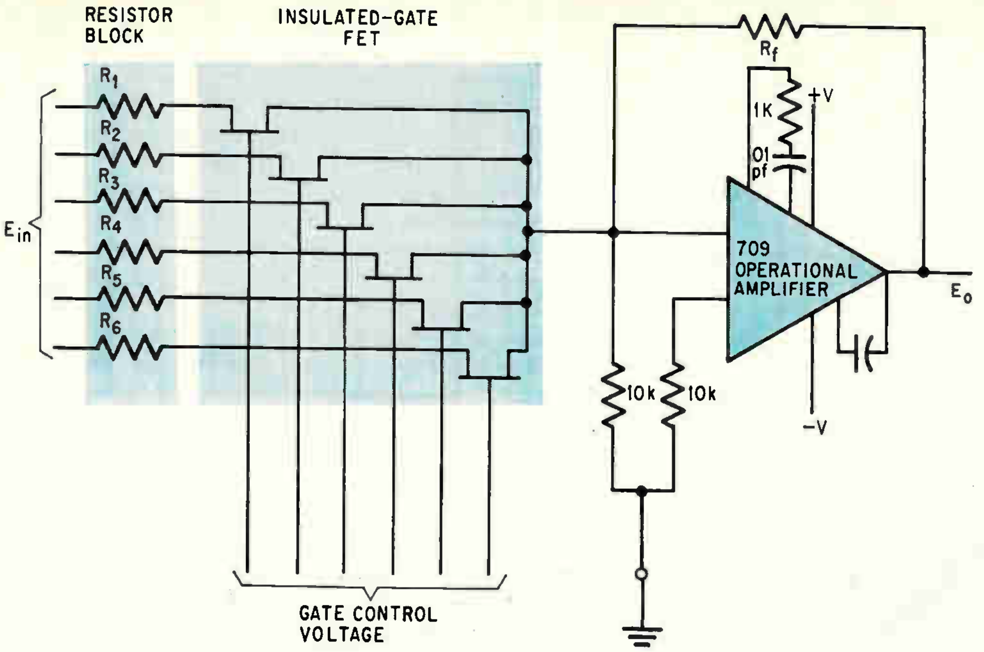
For example, to generate a d-c voltage proportional to sin θ, a triangle wave is applied to one of the differential comparator inputs and a d-c voltage proportional to the angle θ is applied to the other. The resulting waveform at the output of comparator is a periodic rectangular pulse whose width is directly proportional to θ, as shown in the lower right illustration.

The output is then used to turn the FET switch off and on. Since the d-c component of the chopped E_y signal is proportional to the area under the E_y waveform and to the pulse width and the pulse width is proportional to θ, the d-c output of the module is proportional to the integral of $E_y\,d\theta$. If E_y is a cosine wave, the d-c output is proportional to the integral of cos θ dθ, or:

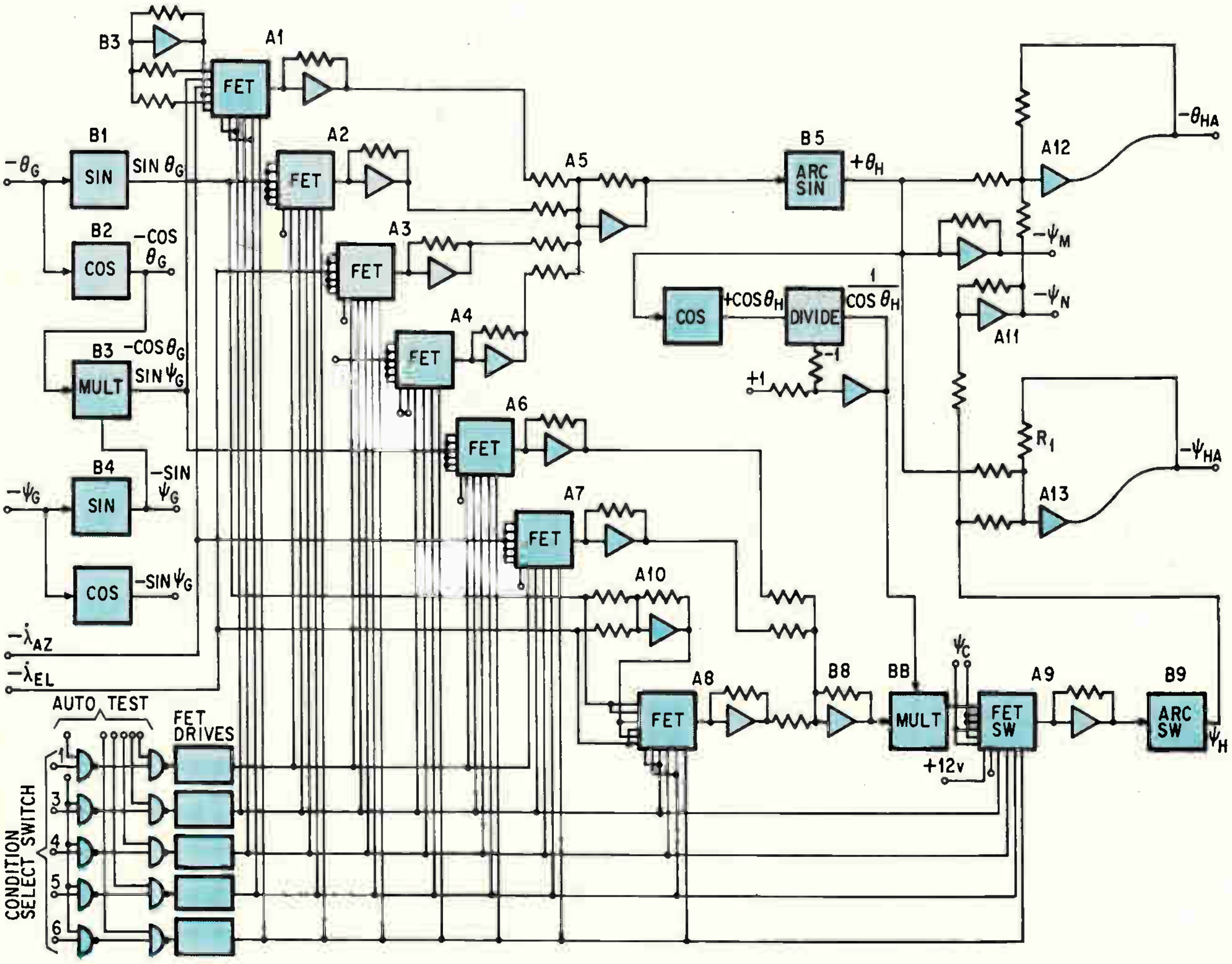
$$E_{o\,(dc)} = \frac{E_y}{2\pi}\int_{-\theta}^{\theta}\cos\theta\,d\theta = \frac{E_y}{2\pi}\sin\theta$$

To make the module generate cos θ, the zero point of the triangle wave is changed to coincide with the zero crosspoint of the E_y input instead of the peak.

To generate arc sin θ from a voltage proportional to sin θ, the triangular reference waveform is replaced with a precision sine wave; the sin θ d-c voltage is applied to the E_x input. The output of the comparator is thus a series of pulses whose width is proportional to the angle θ. In the FET, the pulses are amplified by a constant d-c voltage E_y. The amplified pulses are integrated in the



Multichannel. The summing amplifier uses a six-channel FET switch with various input resistors to adapt to different sets of input conditions.



Two plus. The head-aim portion of the Raytheon computer typifies the building-block approach. With the two basic modules—function generator (prefix B) and summing amplifier (prefix A)—it calculates complicated trigonometric equations.

operational amplifier to produce an output voltage proportional to θ.

In analog computations, it often happens that the terms in a summed expression are measured under different conditions. In such cases, it's necessary to normalize the terms; this can be done by adjusting the ratio of feedback-to-input resistance. In other words, a multiple-input summing amplifier must be externally controllable to adjust for changed input conditions.

To this end the Raytheon summing amplifier consists of an integrated op amp, an integrated six-channel FET switch, and a thick-film resistor block, as shown at the left. The output voltage of the summing amplifier is:

$$E_o = -\left[\frac{R_f}{R_1}E_1 + \frac{R_f}{R_2}E_2 + \frac{R_f}{R_3}E_3 + \frac{R_f}{R_4}E_4 + \frac{R_f}{R_5}E_5 + \frac{R_f}{R_6}E_6\right]$$

The voltage applied to the gate of each channel of the FET switch determines whether the channel is open or closed, so that any term in this equation whose associated FET is open equals zero. The values of the resistors are chosen to suit the function of the particular summing amplifier.

Raytheon has assembled its analog elements in a "head-aim" subsystem for a missile control computer to demonstrate the potential of the building-block technique. The subsystem, shown at the left, is similar to what might be used in an autopilot, for example, or, perhaps, in a process-control application involving gas flow.

The head-aim computer requires 13 gated-input amplifiers, nine function generators, and a waveform generator that provides triangular-wave and sine-wave references—both at 5 kilohertz—for the function generators.

The computer solves two equations, as shown in the panel at the right; it must solve these equations for the five different sets of conditions that are shown. The resistor blocks can be switched in to represent each condition.

The diagram, shown on the next page, represents the θ_{HA} and ψ_{HA} equations as calculated by the computer for condition 3. In all cases, the computer values are well within the maximum permissible error range of ±3.5°, even at the temperature extremes of −55° and +125°C.

Part and parcel

There are three sources of error, and each can easily be minimized:

- Offset voltage at the output of the IC operational amplifiers. A 709 op amp was used in the first building-block circuits. More recent versions of this IC offer lower offset and lower variation of offset with temperature; offset voltage variation can be kept within ±5 millivolts over the military temperature range.

Head-aim equations

$$\theta_{HA} = 0.707\,[\theta_H - \psi_H]$$

$$\psi_{HA} = 0.707\,[\theta_H + \psi_H]$$

where

$$\theta_H = \sin^{-1}[\sin\phi_{MO}(\cos\theta_G \sin\psi_G + 1.2\dot{\lambda}_{AZ}) + \cos\phi_{MO}\sin\theta_G + \cos\phi_{MO} - 1.2\dot{\lambda}_{EL} + E_C]$$

and

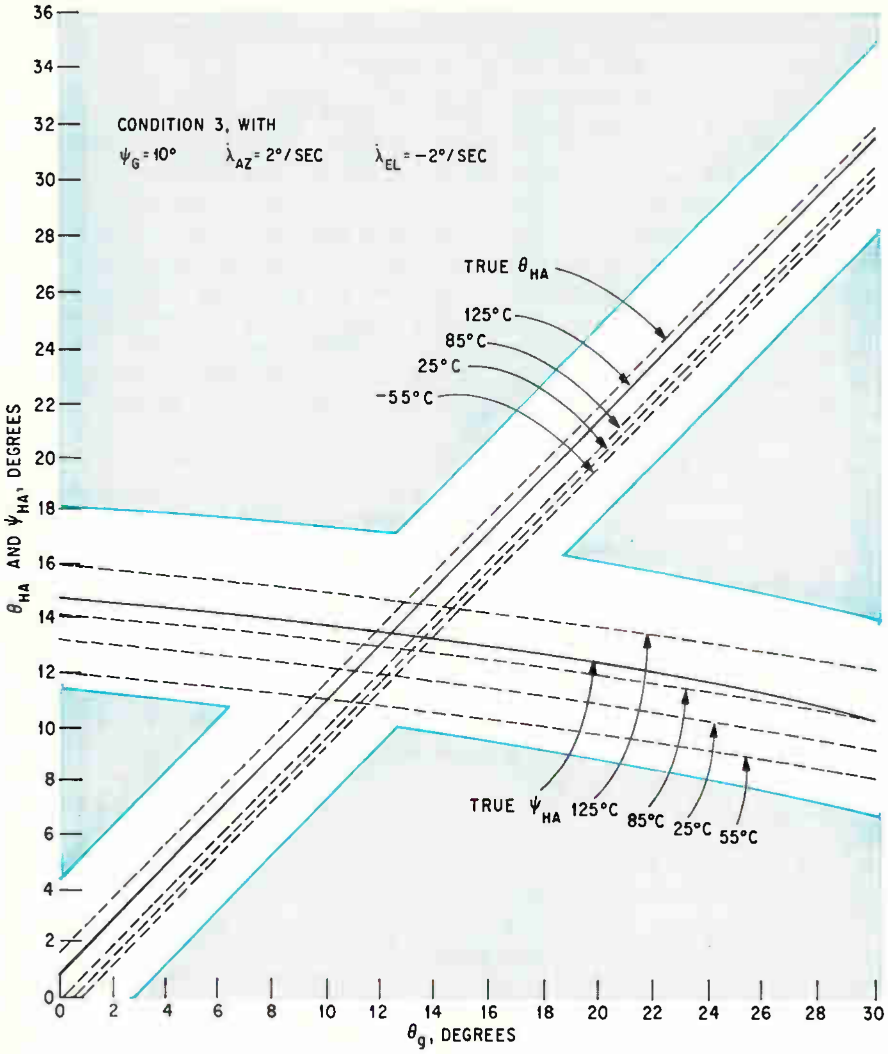
$$\psi_H = \sin^{-1}\left[\frac{1}{\text{Cos}\,\theta_H}\right][-\sin\phi_{MO}(\sin\theta_G + 1.2\dot{\lambda}_{EL}) + \cos\phi_{MO}\cos\theta_G\sin\psi_G + \cos\phi_{MO}\,1.2\dot{\lambda}_{AZ}] + \psi_C$$

Condition	ϕ_{MO}, degrees	ϵ_C, degrees	ψ_C, degrees
1	0	0	0
2	49	3.50	−0.45
3	−49	3.50	+0.45
4	49	2.11	−2.42
5	−49	2.11	+2.42

- Scaling error due to resistor deviations. The discrete input and feedback resistors used in the prototype head-aim computer are ±0.25%-tolerance components with rather large temperature coefficients. The scaling error could easily be reduced, since ±0.1%-tolerance resistors with low temperature coefficients are readily available.
- FET scaling error. The FET resistance adds to the input resistance. However, by taking the FET resistance into account when the value of the input resistor is selected, the change in slope of the summing amplifier output will be no greater than 0.5% over a 100°C change in temperature.

The total computer error depends on the number of computer functions that are cascaded. Use of ±0.1% resistors and ±5-mv-offset op amps would yield peak errors of 0.6% for a full-scale output of 1 volt or 0.2% for a full-scale output of 5 volts.

The percentage error is primarily due to op amp offset when 0.1% resistors are used, and it is not



Performance. The dashed line represents the computer's output for the head-aim equations at several temperatures. The heavy lines in color represent the maximum permissible deviation per military specs from the true value. Values are well within the allowable ±3.5° limits.

a fixed quantity—it depends on the input-voltage range. The percentage error is expressed as:

$$\epsilon = \frac{\text{offset (volts)}}{\text{full-scale voltage}} \times 100$$

when resistor error is neglected.

To assess the total errors for a complete computer would require analysis of the number of functions, their types, and scaling. But it's safe to say that any single computation can be done well within 1% over the military temperature range.

That 1% error applies to voltages, and therefore to multiplication and summing. Trigonometric-function errors depend on the range of angles used. A 1% error in the sine, for example, can cause as much as 8° of error if the angle is near 90°.

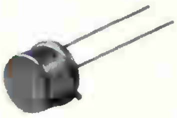
All the gated-input summing amplifiers used in the head-aim computer are identical except for the values of the input resistors, R_1 through R_6; all the function generators are identical except for input resistors R_1 through R_3. A total of 56 discrete resistors, in 14 different values, is needed for the 13 summing amplifiers.

Power requirements are modest. The head-aim computer draws only 9.05 watts, and the entire missile guidance computer (also built from the two basic modules) consumes only 37.715 watts. Allowing 3 watts for the reference waveform generator and assuming a power-supply efficiency of 50% (a conservative estimate), the total power consumption is 60 watts.

The Raytheon analog computer can test itself automatically. The built-in test circuits use the same modules developed for the computer itself. Checks involve switching known values of the input variables into the machine and comparing the resulting output signals with reference voltages that represent hand-calculated levels.

At the moment, each module is in the "nafi" package developed by the Naval Avionics Facility, Indianapolis. This configuration centers on a 40-pin connector with an attached mounting surface. However, the basic ceramic modules measure only 1 inch by 2 inches—about ⅓ the size of the nafi module. Obviously, if small size were crucial, some other packaging arrangement could be adopted to take advantage of the compactness of the Raytheon modules. ■

400 Hz RCA Triacs— ready to take over!



120-V line operation and
200- and 400-V repetitive peak
off-state blocking voltages

Up in the air about 400 Hz controls? Would you like to forget electro-mechanical relays or switches for such aircraft applications as lighting controls for cabins and running lights; heater controls; motor controls; hydraulic valve controls? RCA has the answer: new 400 Hz triacs ready for your evaluation and inclusion in your circuit designs. Look at the tabulation of units you can work with—at RMS currents from 0.5 A to 40 A and repetitive peak off-state blocking voltages of 200 V and 400 V—all designed for 400-Hz operation and available in two and three-lead modified TO-5, press-fit and stud type packages.

Ask your local RCA Representative or your RCA Distributor for details. For preliminary technical data sheets to aid in your evaluation of these units for airborne controls applications, write RCA Electronic Components, Commercial Engineering, Section RN8-1 Harrison, N. J. 07029.

MAXIMUM RATINGS

0.5 A I_{rms}—in 3-lead modified TO-5			
TA7654	200 V	10 mA	I_{gt}
TA7655	400 V	10 mA	I_{gt}
TA7656	200 V	25 mA	I_{gt}
TA7657	400 V	25 mA	I_{gt}
2.5 A I_{rms}—2-lead modified TO-5			
TA7671	200 V	25 mA	I_{gt}
TA7672	400 V	25 mA	I_{gt}
6 A I_{rms}—press-fit or stud			
TA7642	200 V	press-fit	
TA7643	400 V	press-fit	
TA7644	200 V	stud	
TA7645	400 V	stud	
10 A I_{rms}—press-fit or stud			
TA7614	200 V	press-fit	
TA7615	400 V	press-fit	
TA7616	200 V	stud	
TA7617	400 V	stud	
15 A I_{rms}—press-fit or stud			
TA7618	200 V	press-fit	
TA7619	400 V	press-fit	
TA7620	200 V	stud	
TA7621	400 V	stud	
25 A I_{rms}—press-fit or stud			
TA7646	200 V	press-fit	
TA7647	400 V	press-fit	
TA7648	200 V	stud	
TA7649	400 V	stud	
40 A I_{rms}—press-fit or stud			
TA7650	200 V	press-fit	
TA7651	400 V	press-fit	
TA7652	200 V	stud	
TA7653	400 V	stud	

RCA Thyristors

Circle 101 on reader service card

Color tv gets a badly needed face-lift

An automatic tint-control circuit cuts down the fluctuation in flesh colors by correcting phase errors before the chroma signal is demodulated

By Gene McLin and Paul Knauer

Magnavox Co., Fort Wayne, Ind.

Like a yo-yo on a string, a color-tv viewer has to get up constantly from his favorite easy chair to adjust the tint because of the fluctuations in the picture's flesh tones. These fluctuations—occurring principally when channels are changed or when cameras switch from live to tape—are more than a bother to viewers, they're a major headache to television engineers. And until now, no relief has been in sight.

But the picture is changing, and relief is indeed on the way—in the form of an automatic-tint control (ATC) circuit developed by engineers at the Magnavox Co. to correct phase errors. The circuit, which is included in some models of the set maker's 1970-line, may not always eliminate tint fluctuations completely, but it goes a long way toward reducing the ups and downs of viewers. And, hopefully, only Martians will be green-skinned, not humans. Magnavox' solution to the problem of how to compensate for the phase differences between one signal and another is to detect phase errors in the flesh tone region before the choma signal is demodulated, and then correct these errors automatically. The ATC circuit does this by sensing the phase difference between a reference burst and the color signal, and then developing a correction signal to restore the desired hue. The correction signal is generated by two gates—a yellow gate and a red gate—and a 3.58-megahertz switch, which turns on the gates at the proper signal phase.

Besides the switch and gates, the ATC circuitry—above right in block diagram form—includes a separate ATC switch, four phase-shifting networks and a color preference control.

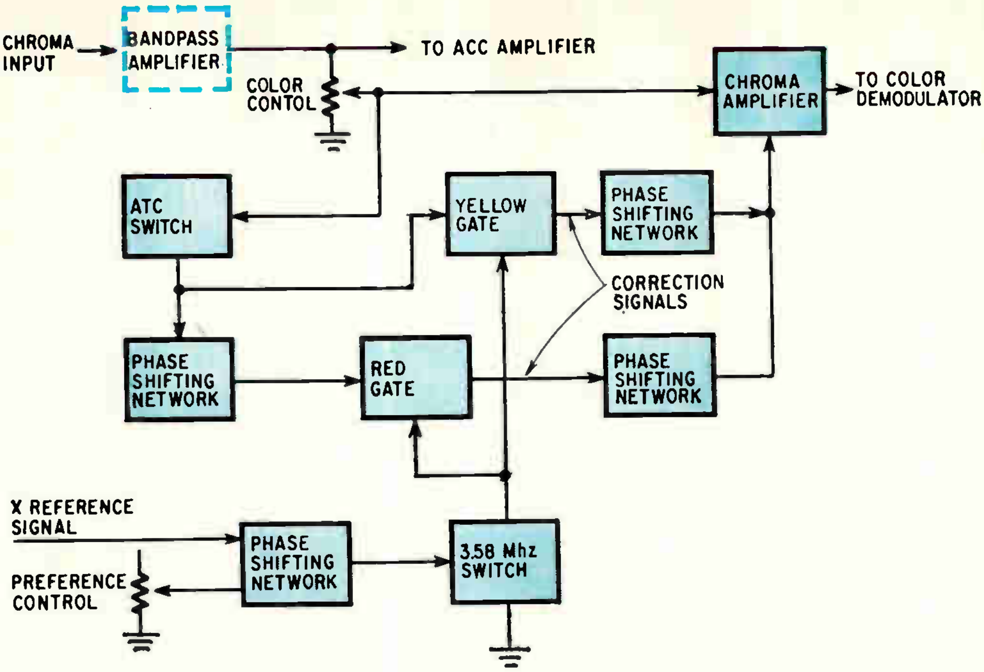
The chroma signal, picked off a bandpass amplifier, is simultaneously applied to the yellow gate and, after a phase shift, to the red gate. Each gate conducts when there's a chroma signal of a certain phase present and when the 3.58-Mhz switch is turned on by a reference signal, "X," from the tv set's 3.58-Mhz oscillator. A yellow chroma signal produces a maximum output from the yellow gate, but only a minimum output from the red gate. The opposite is true with a red chroma signal.

The yellow gate's output is phase shifted and applied to a chroma amplifier where it's combined with the original chroma signal to correct flesh tones that appear in the yellow or green areas. The red gate's output is also phase shifted, but in the opposite direction, and applied to the amplifier to correct flesh tones in the red or the magenta areas.

The changing colors

Regardless of hue, the chroma signal is a 3.58-Mhz sine wave voltage, as is the burst signal. The difference between one hue and another is established by the phase of their sine waves with respect to that of the burst signal. And since the positive peak of the reference burst sine wave is considered as 0° on a color-spectrum wheel, below right, different hues can be identified by the degree the positive peaks of their sine waves lead or lag the reference burst sine wave. Thus it can be seen that a yellow chroma signal, for example, lags the burst by 13°; a magenta signal lags by 119° and a green chroma signal lags by 299°. Therefore, a chroma signal of 0° has a greenish-yellow hue and is in phase with the burst.

Since some colors—particularly blue and green—are dominant, they cover wide segments of the color wheel. Slight phase errors are barely noticeable in those signals. Flesh tones, however, cover



Phase shifting. Before demodulation, the chroma signal is phase corrected in the gating circuits to restore the desired preset flesh tone. The yellow gate signal is delayed about 90°, while the red gate signal is advanced about 30°. Both signals are inverted 180° by the chroma amplifier.

a very narrow range in the orange portion of the spectrum. Here, slight phase errors have a major impact on the color-tv picture. Critical setting of the tint control is therefore necessary for satisfactory reproduction of flesh color, which, from the viewer's point of view, determines the quality of his picture.

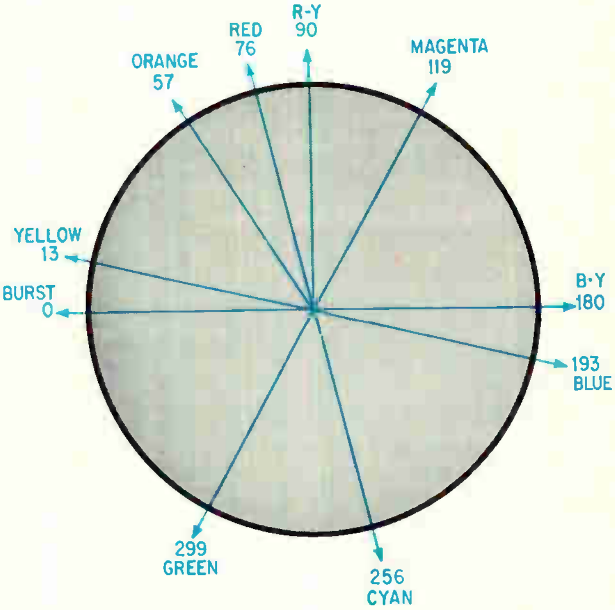
Flesh tones originate at a chroma-signal phase of 57°. When this phase, called the I vector, is moved closer to the burst phase, flesh tone takes on a greenish hue; shifted further away toward 90°, flesh tone becomes reddish. When the I vector is below 57°, the yellow gate generates a correction signal to bring the vector back to the ideal; when it's above, the red gate takes over to bring the vector back to 57°

Viewer in control

Although the correction signals themselves are generated automatically, the amount of correction is under the control of the viewer who is provided with an ATC switch and a preference control. The setting of the preference control determines the hue of the flesh tone after correction.

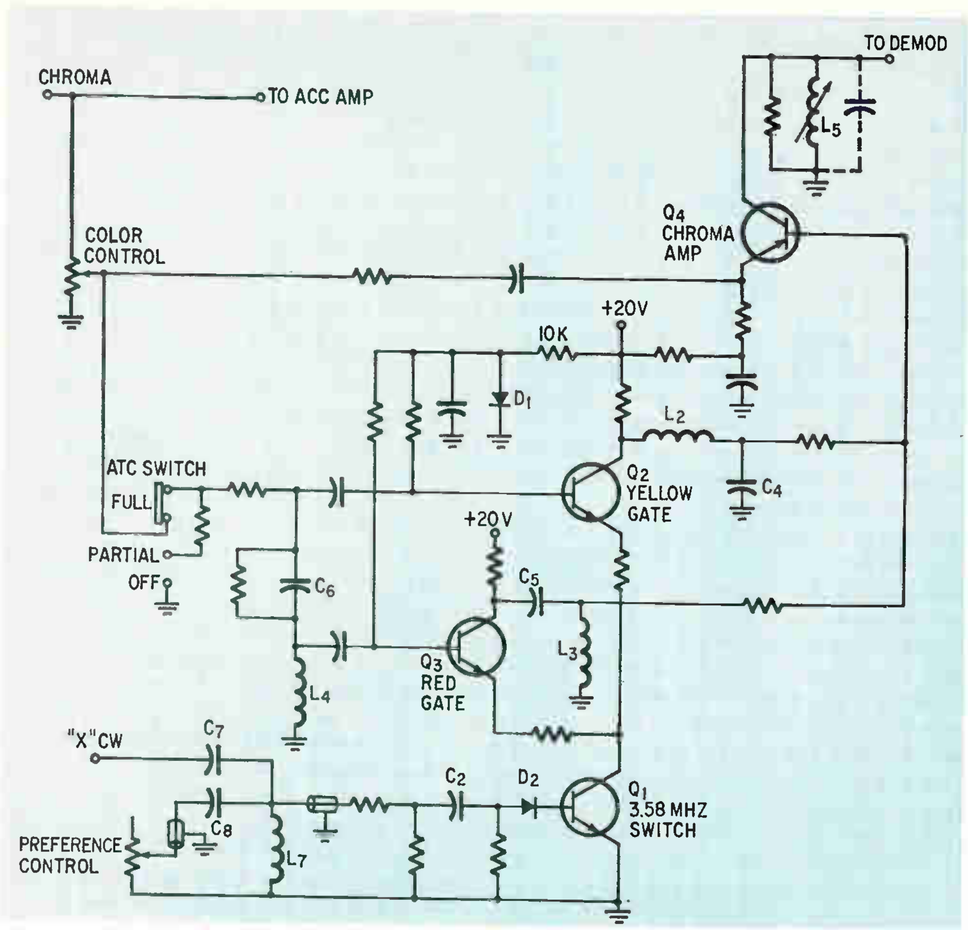
The ATC switch operates in two positions, either full or partial. With the switch in the full position, colors that fall within approximately ±30° of the I vector receive 100% correction—all colors are placed at the position of the I vector. Partial positioning of the switch, however, will yield only 50% correction for colors falling within this ±30° range. The correction signal is then coupled to the chroma amplifier, which also receives the original chroma signal through the wiper arm of the color control.

The setting of the color control determines both the amplitude of the original chroma signal and the amount of signal that is coupled to the red and yellow gates. As a result, changes in one automatically result in changes in the other, and the proper signal ratios are maintained. However, the amount of correction can be controlled by the ATC switch, which inserts one of two fixed amounts of attenuation in the signal path.

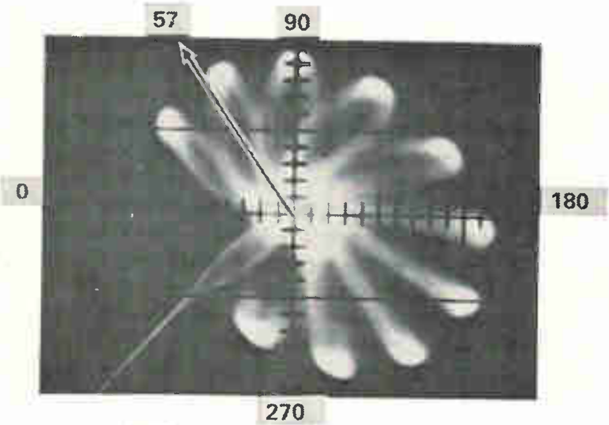


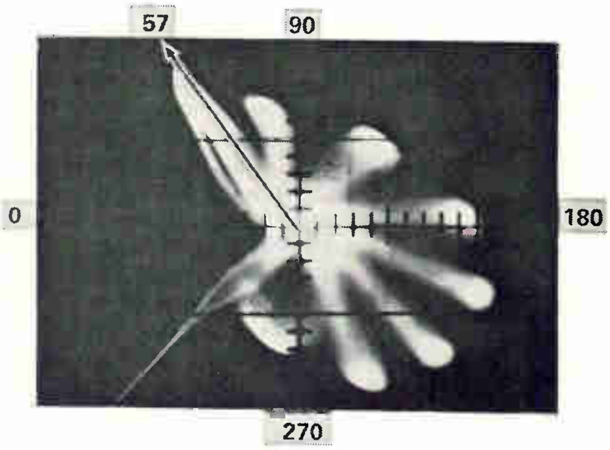
Color spectrum. Any hue may be identified by the number of degrees it leads or lags the burst 0°reference.

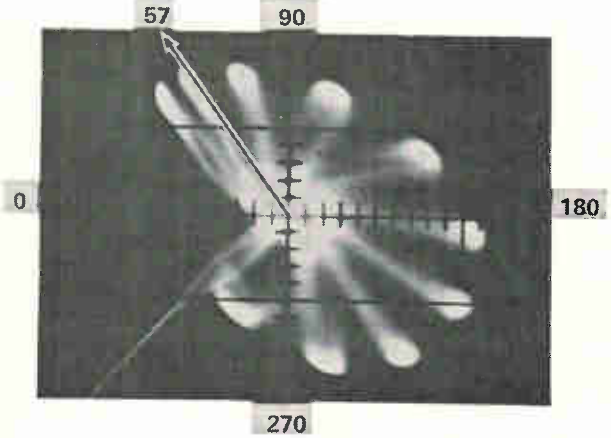
Forward bias for the gate transistors is obtained from a 20-volt power supply through respective 10-kilohm resistors and a diode. The diode, which is forward biased by the supply voltage, develops a 0.6-volt d-c drop. This voltage, insufficient to cause any appreciable amount of current to flow



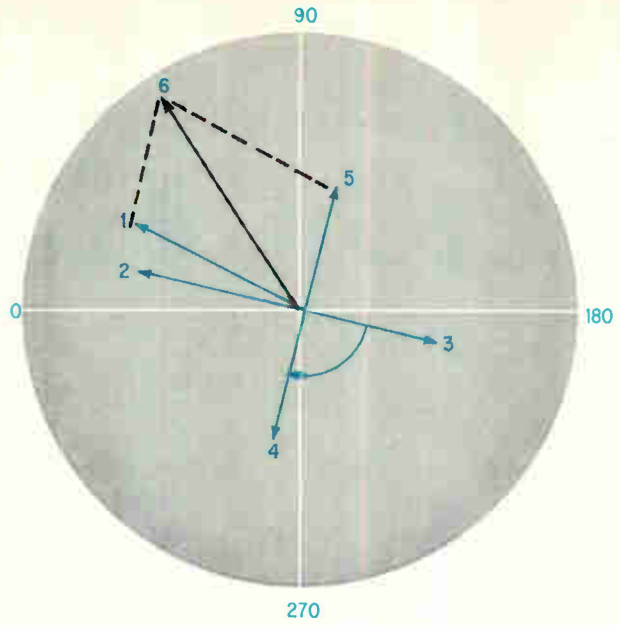
Tint control. The amplitude of the correction signal is made to track with changes in chroma amplitude by a common signal take-off point.







Vectorscope displays. The demodulated color bar patterns depict the phase relationships of the chroma signal color elements with respect to the burst signal at 0°. The flesh tone hues are at 57°. In the photo at top left, the vectors are 30° apart; the third bar, a predominantly red R-Y signal, is at 90°. The effectiveness of full tint correction is shown in the photo above where colors within ±30° of the flesh tone region —57°—overlap. In the photo at left, however, the bars on either side of the 57° vector are only partially pulled in, as required when the ATC switch is flipped to its partial position.



Vectors	Phase shift(°)	
1	27	Original chroma and signal input to yellow gate. Phase error is 30° toward yellow (57° −30°).
2	13	Sample time of yellow gate
3	193	Yellow gate output (13° + 180°). Base signal at turn-on time determines amplitude.
4	283	Collector signal delayed 90°.
5	103	Chroma amplifier inverts vector 4 180°. This is the correction signal.
6	57	Resultant of vectors 1 and 5 added in chroma amplifier.

Correcting for yellow. For a 30° error, the phase of the yellow correction signal at the chroma amplifier is about 103°. The red signal phase is 343° at the same point.

through the gates, is then applied to the base of the gates. Only when the gates' emitters are connected to ground through the 3.58-Mhz switch will the gates conduct with a chroma signal. Thus the switch determines when the chroma signal will be sampled. And, the phase of the "X" or reference signal is what determines when the switch turns on.

The phase of the "X" signal is approximately 90° with respect to the burst signal. In the ATC circuit, top left, a phase shifting network—comprising capacitors, C_7 and C_8, inductor L_7 and the preference control—advances the phase of the X signal to +13°. But this may be varied ±30° with the preference control, whose precise setting precise setting produces the desired flesh tone hue.

Because the switch conducts only on the positive half cycles of the X signal, the "on" time of the gates is relatively short. Also, the chroma signal at the base of the gates must be positive to produce a correction signal at the collector. Chroma signals between yellow and magenta, 13° to 119°, are positive-going during sample time and thus produce correction signals. Blue, cyan, and green signals, however, are in the negative portion of their cycles during sample time and their correction signals aren't produced.

The chroma signal is coupled directly to the yellow gate, and, after being advanced 90° in phase by capacitor C_6 and inductor L_4, the signal is applied to the red gate.

Maximum output from the yellow gate is obtained with a yellow chroma input signal because the signal is at its positive peak just as the gate turns on at 13°. But at the red gate, the yellow signal produces little output because it is advanced in phase. Thus, when the red gate is turned on at 13° the chroma signal is passing through zero and cannot forward bias the gate.

Similarly, maximum output from the red gate is obtained with a reddish chroma signal having a phase angle of 103°. The phase is shifted 90° to 13°. Thus, the chroma signal is at its peak when the red gate turns on at 13°. Little output is produced from the yellow gate because the chroma signal is passing through zero when the yellow gate conducts at 13°.

A vector display on opposite page points up the phase relationships of the 10 bars in a demodulated color-bar pattern. The bars are 30° apart. At the collector of the yellow gate, the first bar produces the highest output. The outputs of the second and third bars are progressively lower. At the collector of the red gate, the outputs of the third and fourth bars are about equal; the outputs of the remaining bars are progressively lower. There is no appreciable output from either gate for the last five bars for blue, cyan, and green.

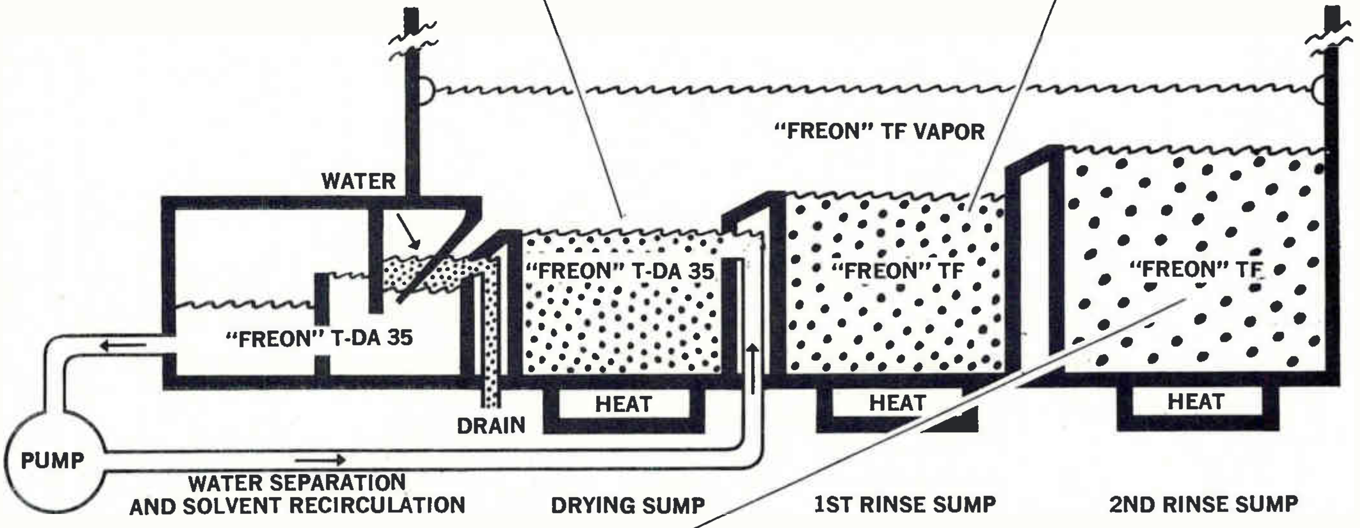
The red- and yellow-gate correction signals are inverted 180° and must be further shifted in phase before they are added to the original chroma signal. The yellow-gate signal is delayed about 90° by inductor L_2 and capacitor C_4. The red gate signal is advanced in phase about 30° by capacitor C_5 and inductor L_3. Both signals are again inverted 180° but this time in the chroma amplifier.

When flesh-tone hues shift from 57° toward yellow, the correction signal produced at 103° adds vectorially to the original chroma signal. When the ATC switch is at full, and the chroma error does not exceed 30°, the result is the ideal, 57°. When the hues shift toward red, the red-correction signal produced at 343° adds to the chroma signal to produce the ideal flesh tone. ■

Announcing the "Freon" Solvent Drying System. Dries water-wet parts spot-free at 118°F...in 3 easy steps.

1. Lower the parts into the drying sump containing FREON® T-DA35 solvent boiling at 118° F. Low-temperature boiling eliminates water spotting caused by the evaporation of water. (This system, using the high density of FREON, works by the displacement of water, rather than its evaporation.) No spotting of parts means fewer rejects. And the low-temperature operation also helps to protect delicate parts. The system is compatible with most plastics, elastomers and metals.

2. Remove the parts and allow the excess solvent to drain back into the drying sump. (The solvent is re-usable—no need to discard the solvent because it is saturated with water.) After draining, lower the parts into the first rinse sump containing FREON TF.



3. Remove the parts from the first rinse sump. Allow to drain and then place in the second rinse sump. Remove the parts and hold them in the vapor zone above the sump. When the dripping stops, remove the parts from the drying system. Parts will be completely dry, spot-free and immediately ready for further processing.

The whole, remarkably simple operation takes only a few short minutes. Furthermore, it is completely safe. FREON solvents are nonflammable, nonexplosive, nonirritating and low in toxicity. **For further information on the efficient, economical FREON Solvent Drying System, write: Du Pont Company, Room 7304-F Wilmington, Delaware 19898.**

FREON® SOLVENT Drying System
PATENTS APPLIED FOR

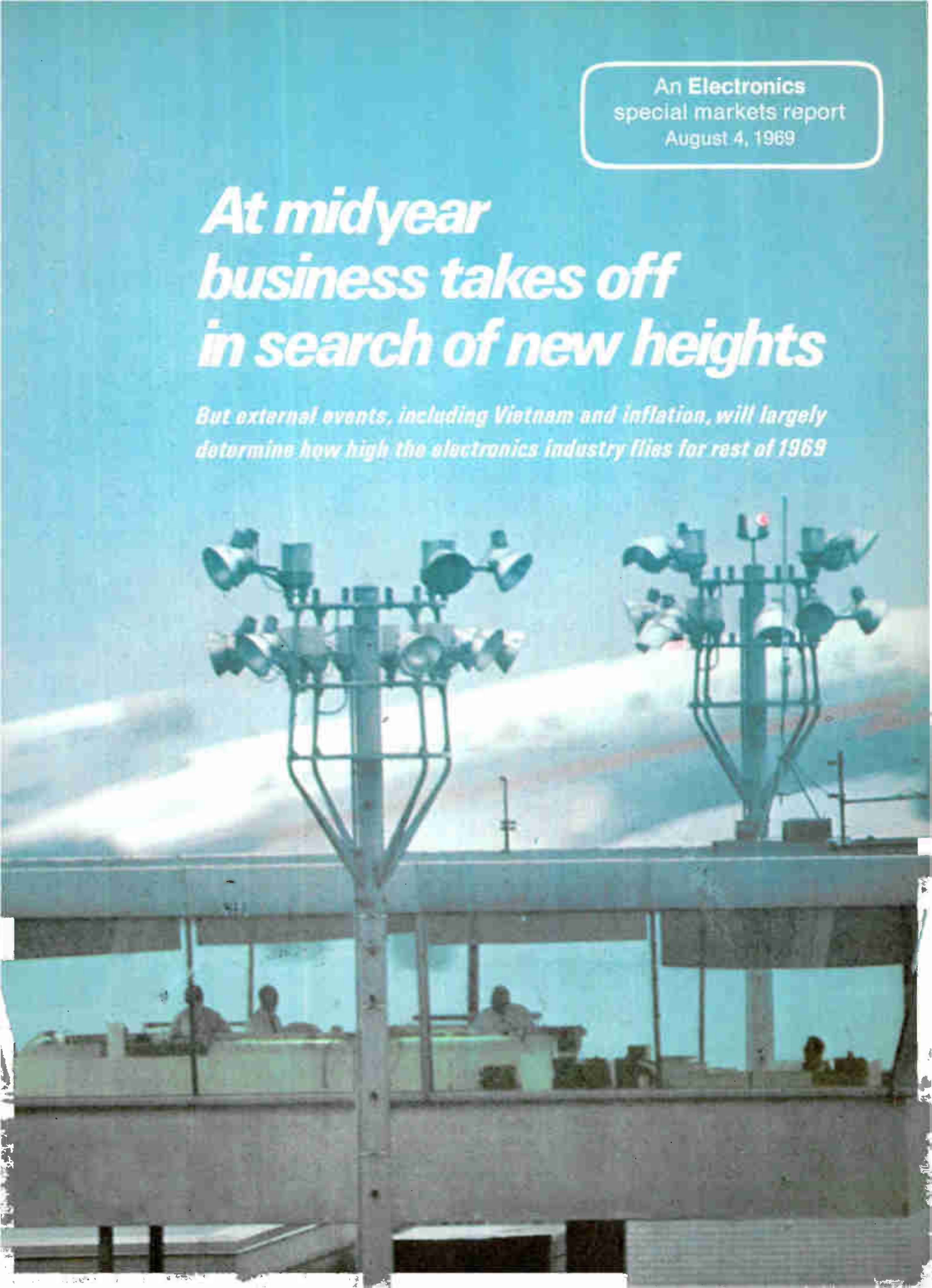
DU PONT REG U.S. PAT OFF **Freon®** solvents

®Du Pont registered trademark for its fluorocarbon cleaning agent.

An **Electronics**
special markets report
August 4, 1969

At midyear business takes off in search of new heights

But external events, including Vietnam and inflation, will largely determine how high the electronics industry flies for rest of 1969



Silvan setting. Small, rugged two-way radios like this Handie-Talkie unit from Motorola are increasingly popular with communications users as diverse as lumber companies and law enforcement agencies.

● When and if managers get around to toasting 1969, they'll probably reach for beer, rather than champagne. Just past the halfway point, it looks like a good year but far from a great one for the U.S. electronics industry: On the basis of preliminary data for the first six months, electronics is still expected to be a $25 billion business during 1969. This level represents a 6% or so improvement over the year-earlier performance, but 5% of the dollar gain is attributable to inflation.

Outlets directly or indirectly dependent on Government largesse have experienced rough going of late, and suppliers can look forward to more of the same. The voting public's disenchantment with, among other things, the war in Vietnam is triggering a shift in priorities atop Capitol Hill. Defense and aerospace contractors are getting decidedly the worst of it in skirmishes with politically sensitive budget cutters.

The FAA, long forced to subsist on short rations, may prove a bright spot in the Federal picture if a proposed $5.6 billion program to overhaul the nation's airways and terminals gets off the ground. But prospects must still be rated iffy since new taxes will be required. On balance, there's little in the way of Government-funded efforts to take up the slack resulting from cutbacks in military and space allocations. Despite the enthusiastic lip service paid the application of advanced technology to pressing societal problems, partially as a result of the Administration's struggle to brake inflation, only a few showcase projects have actually been underwritten. Over the longer run, the electronics and aerospace industries will play increasingly important roles in health, education, pollution control, urban renewal, and the like. But for the moment at least, pickings are slim.

The immediate outlook in the commercial, industrial, and consumer sectors is far rosier, albeit not without a few dark spots. Instrumentation houses, for example, have been hurt by the decelerating rate of gain in research and development outlays, but can look forward to a sizable pent-up demand for their wares. Industrial equipment suppliers, embracing integrated circuitry in a big way for the first time, are likewise hampered by such developments as continuance of the surtax and prospective suspension of the investment tax credit. But demand for their products and systems continues strong. In fact, within the next couple of years, the combined sales of industrial and commercial electronics concerns—including those of perenially prosperous computer makers—promise to exceed the total Government market—an eventuality that augurs well for the industry's future stability and profitability.

Consumers, notwithstanding a deteriorating stock market, inflation curbs, and tight money, continue to spend freely for electronic goods. The only problem from domestic producers' standpoints is that more of

Fundamentally, electronics is on solid ground as a result of semiconductor suppliers' achievements in integrated circuitry of all kinds

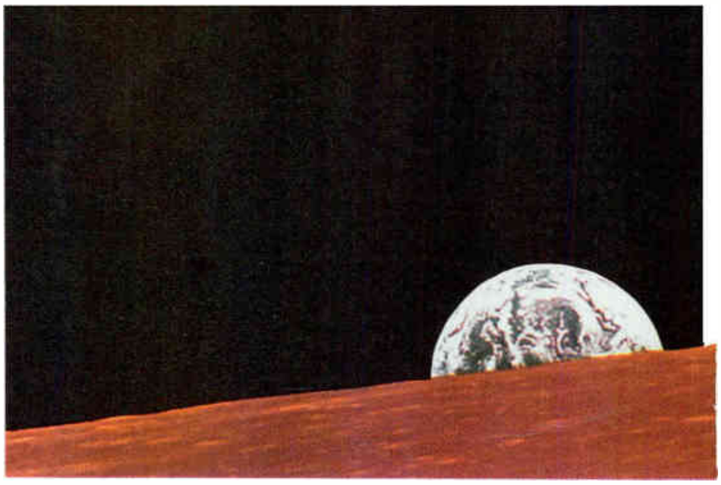
their purchases are labeled made in Japan. The industry as a whole is enjoying a far less favorable balance of trade, but the problem is acute in the consumer field.

Fundamentally, however, electronics is on solid ground as a result of semiconductor suppliers' remarkable achievements in integrated circuitry of all kinds. Market penetration continues to amaze even the most optimistic, and the best bet is that performance will outstrip projection by a wide margin for some time to come.

At the outset of 1969, Pentagon brass were looking forward to a year of transition during which R&D outlays would make an orderly transition from tactical to strategic projects. But a funny thing happened on the way to the Treasury. The Senate's Armed Service's Committee—headed by hawkish John Stennis (D., Miss.) —heavily edited the Pentagon's shopping list; the research, development, test, and engineering request was dropped 13% to around $7.2 billion. The outlook in the House is equally bleak; representatives, pressed by constituents outraged by the war and well-publicized cost over-runs, are also in a mood to blue-pencil military procurement requests.

The prospective slashes in RDT&E allocations for aircraft, missiles, ships, and tracked vehicles come as a real shock to Pentagon planners. The defense dollar buys about 25% less than it did five years ago because of spiraling costs and systems' increasing complexity.

Prelude. Astronauts Armstrong and Aldrin, first men on the moon, practice collecting surface samples at Manned Spacecraft Center in Houston. Lunar module is in the background.



Sequence. Astronauts Stafford and Cernan aboard Apollo 10's lunar module saw this earth rise from the moon's farside highlands.

And the significance of the pruning goes far beyond threats to the Safeguard ABM (antiballistic missile)—a $345.5 million item that squeaked through the committee by a 10-to-seven vote. Across-the-board cuts are going to hurt a lot of programs in a number of technologies. Moreover, it was evidently a miscalculation to assume, as many Pentagon strategists did, that economies achieved by "voluntarily" scrubbing the Air Force's Manned Orbiting Laboratory and the Army's AH-56A helicopter would mollify budget cutters.

The casualty list to date, in addition to MOL and the Cheyenne, encompasses 12 major programs. Left for dead or among the missing are such electronics-laden projects as SAM-D, the Army's surface-to-air missile; the E-2C, an updated electronic intelligence and picket aircraft for the Navy; and an underseas long-range missile system. Among the gravely wounded are the Navy's S-3A (VSX) antisubmarine warfare aircraft, the Air Force's airborne warning and control system (Awacs), the advanced manned strategic aircraft (AMSA), and the Mark II avionics system for the ill-starred F-111.

An imponderable in the current outlook for military spending is the imminence of arms control talks between the U.S. and Russia. Upcoming negotiations promise to be different in kind from those that led to such past agreements as the atmospheric nuclear test ban treaty and the nonproliferation pact. In fine, both sides seem sincerely interested in seeking a genuine freeze on further costly testing and deployment of offensive and defensive atomic weapons systems. At the moment, there's no telling how far-reaching or definitive agreements might be. But assuming some sort of accord is worked out within the next few years, the impact on electronics and weapons-systems supplier's would be substantial.

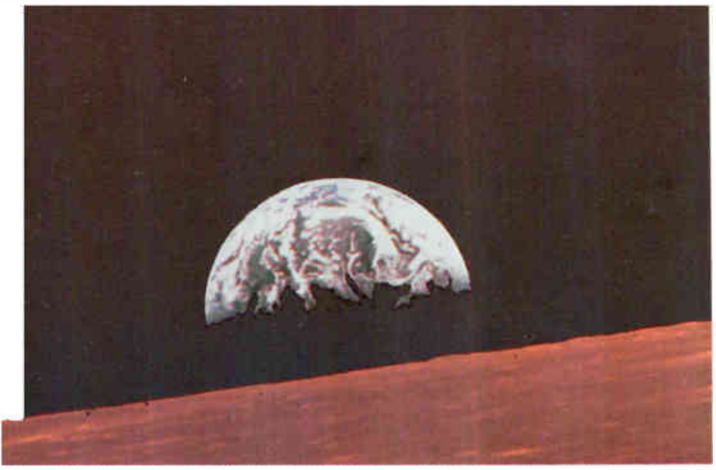
Space doesn't appear to offer much promise as a hardware outlet over the intermediate term. Though Apollo 11 has gone to glory, planners at the National Aeronautics and Space Administration still must chart a course for the 1970's—a task made no easier by the fact that the total space budget is in eclipse for the seventh straight year. Pending final adjustments, civilian and military agencies will have about $5.6 billion in new obligational authority and $5.7 billion to spend in fiscal 1970, which began July 1. This represents quite a comedown from, say, calendar 1966 when outlays reached $7.7 billion.

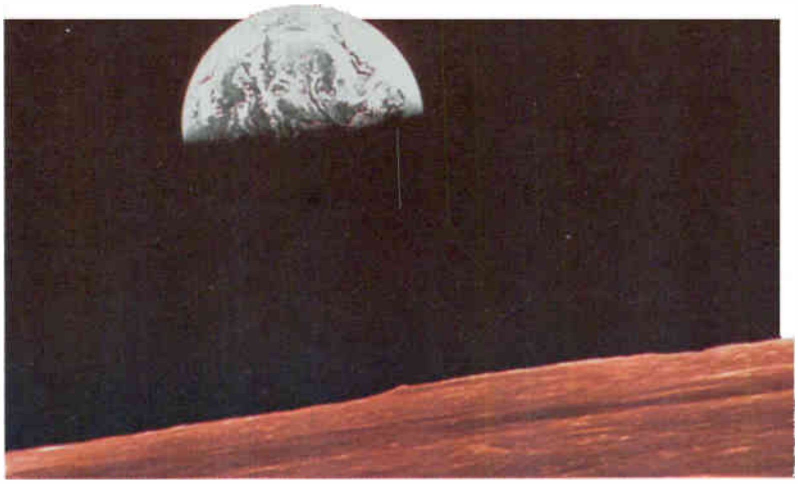
NASA's share of the pot is around $3.8 billion, over 20% below the amount originally requested last fall. The space agency has dubbed its short ration for fiscal 1970 "a holding budget." This may prove an optimistic assessment in light of requirements. Most of the money is already earmarked for Apollo flights, ongoing unmanned series of spacecraft, a few new unmanned starts, lunar exploration, and some facilities expansion. As a result, there's precious little seed money for 1970's projects.

Selected instrumentation markets*	In millions of dollars by quarters				
	1st	2nd	3rd	4th	Total
Spectrum analyzers	7.1	7.6	8.1	9.7	31.5
Signal generators	7.5	8.1	8.4	9.2	33.2
Sweep generators	4.0	5.0	6.2	7.1	22.3
Pulse generators	3.8	4.4	5.1	5.4	18.8
Oscillators	5.6	6.1	6.3	6.6	24.6
Waveform generators	3.3	3.4	3.6	3.7	14.0
Counters	8.7	10.2	9.6	9.9	38.4
Timers	19.8	21.2	19.0	23.9	83.9
Digital voltmeters	7.2	7.5	7.9	8.3	30.9
Impedance measuring equipment	7.3	7.8	8.3	9.0	32.4
Oscilloscopes (including access and plug-ins)	32.3	35.4	37.8	40.2	145.7
Recording instruments, digital & analog	12.4	13.3	13.7	14.0	53.4

*Includes microwave

Selected computer markets	In millions of dollars by quarters				
	1st	2nd	3rd	4th	Total
Digital computers, except process control, total	1,215.0	1,275.0	1,225.0	1,265.0	4,980.0
Analog computers, except process control	15.8	17.4	16.9	18.3	68.4
Electronic readout (digital displays and crt's)	41.2	43.8	43.5	45.7	174.2
Character recognition equipment (optical, magnetic, etc.)	39.8	42.3	41.7	43.9	167.7
Core memories	12.4	13.1	14.1	15.2	54.8
Magnetic tape machinery	17.7	19.4	18.6	20.6	76.3
Magnetic drum memories	7.8	9.6	8.9	10.7	37.0
Magnetic disk memories	38.0	41.7	40.9	42.2	162.8





What's more, only modest amounts of what's to be spent will wind up in the coffers of electronics concerns.

Manned space-flight activities, for example, will take a $2 billion chunk of the NASA budget. Most of this amount is earmarked for Apollo hardware and support. There is, however, $135 million for the Apollo Applications Program. This scaled-down project now encompasses a 28-man space workshop, a telescope mount for solar astronomy studies, and working-mission studies.

Applications efforts are slated for around $130 million. Of interest to aerospace and electronics companies are hardware allocations for Nimbus weather satellites E and F, two synchronous meterological satellites, applications technology satellites F and G, earth resources technology satellites A and B, and orbiting solar observatory H. Launch vehicles, the bioscience program, and physics and astronomy programs will account for the rest of the funds coming to the Office of Space Science and Applications. The Office of Advanced Research and Technology is down for nearly $280 million in fiscal 1970. But only about $34 million will go for electronics.

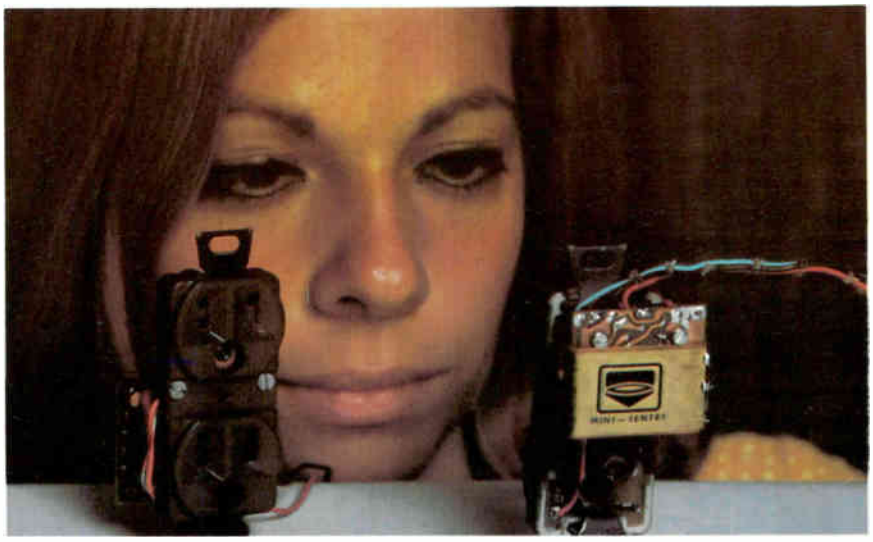
Military space spending, which topped $2 billion in fiscal 1969 will dip to about $1.9 billion this year. The brass are not dismayed, however, privately estimating Pentagon space spending will reach $3 billion within the next few years. The drop is largely attributable to cancellation of the Air Force's Manned Orbiting Laboratory program. Prior to MOL's demise, the armed forces expected to spend $2.2 billion. It's well worth the industry's while to sweat out such interim setbacks since about 60% of the military space dollar goes for electronics. There's no official breakdown, but the estimate is reasonable in view of the service's interest in surveillance and reconnaissance. As it happens, there's almost $160 million available for detection systems.

Another $870 million or so will go for support, including range instrumentation, satellite detection and tracking, and control networks, as well as research and development. Set for the biggest percentage increase in funding is the defense satellite communications system, which now encompasses 24 spacecraft and 29 ground terminals around the globe. Outlays will go from $71 million to $149 million.

Elsewhere on the Federal scene, FAA approval of area navigation to relieve air traffic congestion and the possibility that Congress will establish a multibillion-dollar fund for developing airports and airways make the midyear picture for avionics suppliers brighter than short-term indicators might suggest. Sales of general-aviation aircraft, which reached 6,880 units during the first six months of 1969, were 4% below year-earlier levels. And deliveries of commercial planes are at a virtual standstill as the airlines await the jumbo jets and airbuses.

But the Federal Aviation Administration's blessing of

Listening post. A flatpack linear IC drives gallium arsenide diode supplied by TI in this intrusion detection system offered by Laser Systems Corp. Diode emits modulated infrared beam received by silicon photodiode in a similar outlet across the room. System works with standard alarms.



In the picture. TTL is getting a workout in an increasing number of commercial and industrial applications. This alphanumeric generator uses MSI devices supplied by Texas Instruments.

Selected communications markets	In millions of dollars by quarters				
	1st	2nd	3rd	4th	Total
Land mobile	49.6	52.8	53.4	56.2	212.0
Microwave relay	30.4	32.4	31.3	33.7	127.8
Amateur equipment	7.3	8.7	7.8	8.8	32.6
Citizens band equipment	9.8	11.2	10.7	11.8	43.5
Facsimile	8.4	9.5	8.8	10.7	37.4
Telemetry	52.5	54.8	53.2	58.5	222.0
Modems	21.2	23.2	22.6	24.3	91.3

area navigation—belated though it may be—should generate a sizable outlet for a new type of avionics gear for both general-aviation and commercial craft. "The market will start slowly and then bloom, as was the case with transponders and distance-measuring equipment," says Victor Kayne, vice president of the Aircraft Owners and Pilots Association.

Computer-based area-navigation equipment allows a plane to operate along almost any air route provided it's within range of very-high-frequency omnirange (VOR) ground stations. The advantage is a straight-line flight path; the pilot does not have to waste time dog-legging from one VOR station to the next. Moreover, area navigation systems can furnish vertical guidance, as well as horizontal position information, permitting instrument approaches at airports not equipped with ILS.

"We'll ship as many units as we can produce, probably several hundred this year," says Gilbert F. Quinby, vice president, market planning at Narco Scientific Industries' Avionics division. The company offers a low-cost ($2,855) set—basically a course-line computer—designed for general-aviation craft. Commercial airlines are keenly interested in area navigation. Eastern, Mohawk, Continental, American, and United, among others, have been flight-checking various configurations.

The potential of area navigation for the airlines is apparent in the fact that the ATA is already calling for expanded use in a report issued last month. The organization's Air Traffic Control Systems Planning Group, which did the work, also recommends, among other things, early introduction of automatic digital communications into the air traffic control system to cut down on the voice messages cluttering the airwaves. Suppliers of digital gear got another boost in June when the data link subcommittee of the Airlines Electronic Engineering Committee met to consider a systems standard covering such parameters as data rate, modulation techniques, and error detection and correction schemes. Industry sources estimate that digital communications could be commercially operational as early as 1971.

But best of all, the Nixon Administration earlier this year made a dramatic proposal to establish a $5.6 billion fund for developing airways and airports and reducing terminal congestion over a 10-year period. The aviation subcommittee of the Senate's Committee on Commerce is now holding hearings on enabling legislation. The program would be underwritten by higher taxes on passenger tickets, air freight, and fuel. If all goes well, some $600 million would be invested in R&D, and $250 million would be spent annually for new equipment, most of it electronic. The balance would be available for building new airports and improving old ones.

In a field keyed, but not tied, to Government outlays—instrumentation—producers were predicting steady but

Exception. Sales of commercial broadcast equipment are about even with year-earlier levels. But RCA reports the TK-44A color camera, which it began delivering recently, is moving briskly.

unspectacular sales increases for their wares at the start of 1969. Many, however, have been chagrined to find the rate of gain even more unspectacular than planned as the year unfolded. War priorities are still siphoning funds from Government-supported research activities, social programs, and advanced defense and space systems. Since instrument purchases can generally be deferred, demand has softened significantly. Continuation of the Federal income tax surcharge and prospective suspension of the investment tax credit, along with a drop-off in orders from foreign outlets, have added to the difficulties. As a result, companies are scrambling hard for the available business. But a handicap from the marketing standpoint is the paucity of compellingly innovative new products to tempt cash-strapped customers. The trend to versatile, computer-based systems should, however, provide a handsome payoff over the longer run.

Roger Swanson, director of marketing at Weston's Instruments division, says: "We anticipated market growth of 1% to 2%. Instead, outlets for (pointer-type) panel meters, portable units, and aerospace systems were off about 10% industrywide. Everyone—the Government, original-equipment manufacturers, and distributors—cut back. The surtax is getting a lot of the blame, but I don't see any connection. We do, however, expect things to pick up from here on out."

Myron Pogue, manager of marketing at Monsanto's Electronic Instruments division, shares Swanson's optimism for the balance of the year, but he believes Administration tax moves have had at least a temporary impact on purchases. "The need for instruments is still there, however," he says. "Once people get over the shock, the market will recover again."

Among other things, the slowdown is attributable to the slackening pace of foreign sales because of European manufacturers' growing skills, according to Anthony Oliverio, vice president for sales at Keithley Instruments. To an extent, industry problems have been offset by price hikes, particularly on catalog items, he says. On balance, Oliverio is looking for a good year.

Congestion is beginning to account for a fair measure of the instrumentation field's current woes. At the IEEE show in March, for example, half a dozen companies unveiled new counters. And this month at Wescon, Dana Labs and General Radio, among others, will introduce new units; Monsanto will preview 5-digit and 9-digit counters with light-emitting diode displays.

The Laboratory oscilloscope market is likewise becoming crowded. Once the private preserve of Tektronix and Hewlett-Packard, this field is being eyed by Philips and Monsanto, which are readying 50-megahertz models for introduction. In the meantime, Tektronix is bringing out a whole new line of scopes, while H-P has come up with a 250-Mhz unit—the fastest lab unit available.

Computer makers during recent months—and years—have had things easier, contenting themselves with refinements, rather than innovations, on their fast-selling third-generation machines. Aside from the proliferation of bantamweight minimodels, most of the action's in peripherals. In this field, which is growing perhaps twice as fast as the main-frame business, there's been a spurt in low-cost crt displays with alphanumeric readouts.

From a business standpoint, the decision by the industry's colossus, IBM, to unbundle—sell software and support services separately from hardware—will have widespread, if immediately indeterminate, effects. Though the returns are not all in yet, it appears probable many of IBM's rivals will follow suit. One notable exception: Honeywell, which will stick with its pricing policies.

In memory technology, ferrite cores remain entrenched despite continuing improvements in plated wire and semiconductors. The cache concept, first implemented in IBM's System 360/85 machines early last year, promises to keep cores in the driver's seat for a while yet. A cache is a small fast unit storing data from locations most recently addressed. Since the processor is apt to want this information again, the cache greatly enhances systems performance. A number of computer makers are studying the possibility of using it in their machines.

Not so long ago time sharing was considered the wave of the future; at the moment, it's unquestionably a fact of life. The next step seems to be linking unlike machines into a versatile network as the Pentagon's Advanced Projects Research Agency is doing. Remote-access systems, going beyond time sharing to include systems with restricted language inputs, like Fortran-only and where the user's actions influence another's output—for example, airline reservation set-ups—are also on an upward track. Likewise, remote batch-processing installations in which users have quick, but not immediate, response

Mission to Mars. Mariner series of spacecraft is designed to study the red planet's surface and atmosphere, establishing a basis for further searches for extraterrestrial life.

Long shot. Apollo 10's command and service modules are photographed from the lunar module shortly after separation in moon orbit.

and cannot have independent and simultaneous use of the central processor, should continue to do well.

The computer boom is, of course producing an information explosion. One result is that terminal equipment in general and modems in particular are pacing the commercial communications market. Prior to the Carterphone decision, which permitted "foreign" attachments on phone lines, common carriers had a 95% piece of the modem action; lately, however, their share of this booming outlet has been closer to 65%. Annual volume, now around $91 million, is expected to exceed $155 million by 1972 as demand rises for digital systems.

Over the longer run, no more than 40% of the modem market is expected to be siphoned away from AT&T largely because of its extensive and unmatched service facilities. Another possible brake on independents' growth is the trend among major suppliers to build modems right into terminal systems.

In the meantime, AT&T's Picturephone, which can handle data, as well as voice and picture transmissions, has come through an initial check in which 40 sets were installed at Westinghouse. The results of this field test are being checked—a process which will take until mid-October. But a spokesman terms the Picturephone outlook "extremely favorable." Bell will, he says, be offering commercial service on a limited basis in metropolitan centers within two years.

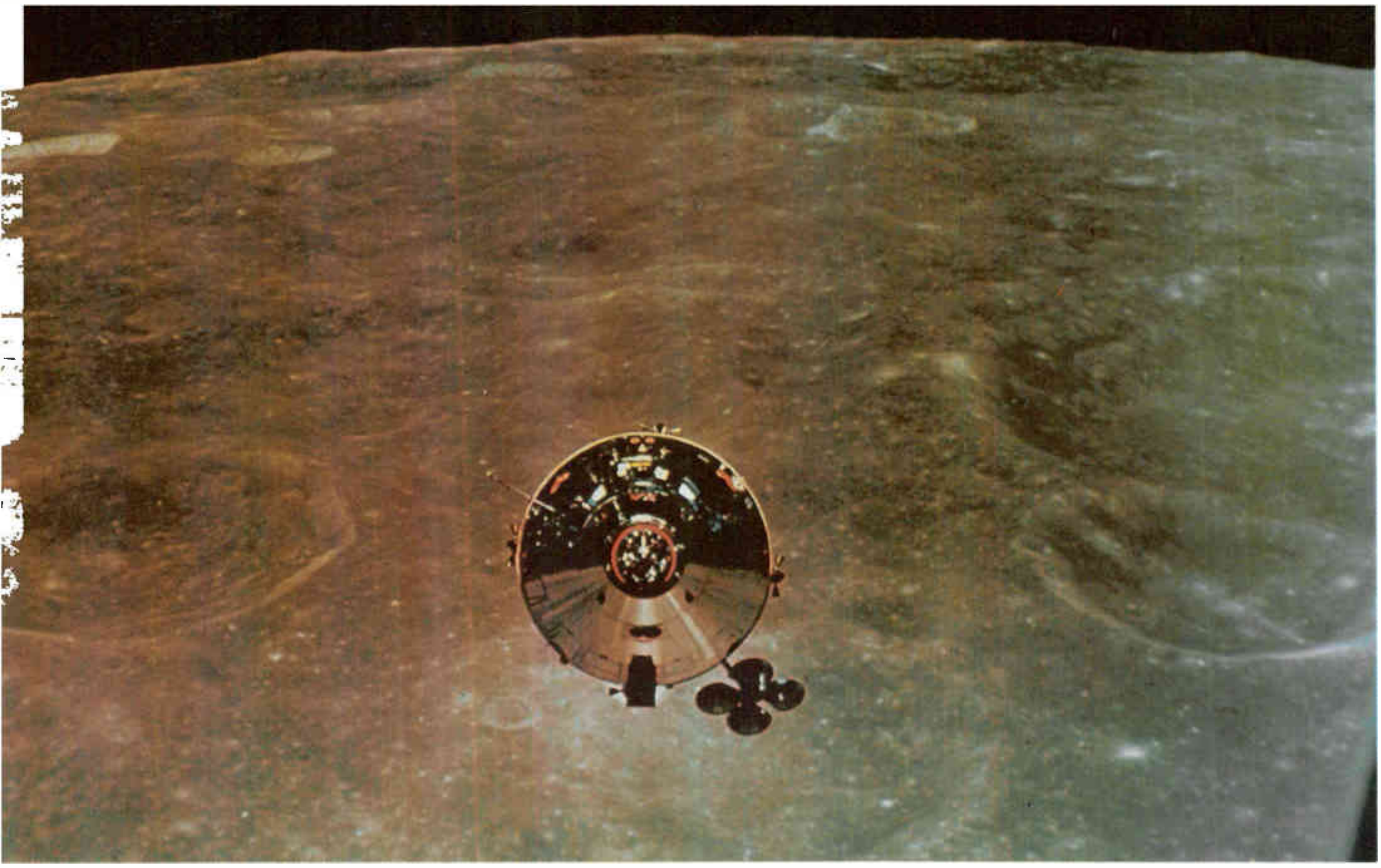
Land-mobile sets continue to move well. By 1980, the number of licensed transmitters, now about 2.5 million, will have tripled according to FCC estimates. Law-enforcement applications will account for a growing share of sales. In February, for example, New York City ordered 2,230 two-way radio sets from Motorola for its police department. These units, which sell for $700 each, are slightly larger than a pack of cigarettes and weigh less than a pound apiece.

In another area of the commercial field, integrated circuits continue to make gains in process-control and machinery applications. Industrial designers are accepting IC's at a surprisingly rapid rate, and semiconductor houses may have to revise their market forecasts upward. One of the reasons for the surge is the MOS read-only memory which is easy to use. Gene Carter, MOS product manager at National Semiconductor, says, "If a guy can write a truth table, he can use an ROM." In effect, a tiny, fixed-program computer on a chip, the ROM can control, for example, a milling machine, starting, stopping, and moving the cutting table.

The equipment designer supplies the IC manufacturer with the bit code for each address. The manufacturer programs the ROM accordingly by depositing metal interconnections on the chip; a gate electrode can be left open or closed depending on whether the bit it comprises is a 1 or a 0. Cost per bit for an MOS ROM is about 5 cents—low enough to entice designers in fields as diverse as construction equipment and displays.

Bipolar logic IC's are also on the best-seller list though controversy between advocates of high-level (15-volt) and low-level (5-volt) designs is still unresolved. Producers of high-level IC's like Amelco and Motorola claim greater noise immunity for their products and, hence, greater suitability for electrically noisy industrial environments. But such rivals as Fairchild and Texas Instruments say high-level logic is too expensive, contending that with easy and inexpensive shielding, low-level transistor-transistor logic can be noise-immune too.

Customers are giving aid and comfort to both sides. TTL shows every sign of becoming a workhorse in industrial control, and high-level logic continues to rack up enviable sales volume. "The growth of the market has been exponential," says Lane Garrett, a new products manager at Motorola, which goes both ways. "A year ago I made some economic predictions which I felt



were a little optimistic. But to date we're strictly on target, and the open orders are above expectations."

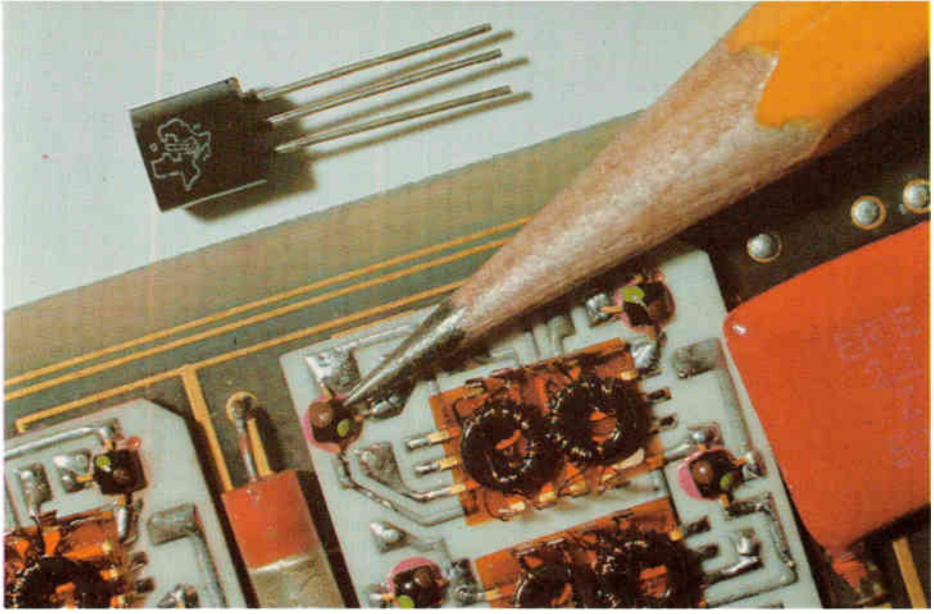
During the past six months, distributor sales of consumer electronics goods have also been growing at a fast clip. As it happens, however, the greatest gains were racked up by Japanese manufacturers; they've sold domestic importers twice as many television sets and 56% more radios, hi-fi components, and tape recorders, as well as 16% more radio-phono combinations than a year earlier. This invasion of a once-private preserve is causing deep concern among domestic manufacturers.

According to Masao Tsuchiya, executive director of the Electronic Industries Association of Japan, about 80% of the products displayed at the Consumer Electronics Show in New York during June were imports from Japan, or at least contained parts made in Japan. In addition, most of the American companies use Japanese-made components or subassemblies in their wares. Tsuchiya does not consider the status quo unduly one-sided. "Importers and executives at some of your largest electronics companies have told me that agitation comes from only a handful of companies who want a protective shelter at the expense of both the consumer and the growth of the industry," he says.

"That's jawbone music," retorts Victor H. Pomper, president of H. H. Scott, a top hi-fi component maker. "The Japanese government, by direct action and by subterfuge, effectively protects its domestic market from foreign competition. Whether it's automobiles, electronics, or computers, they do not allow foreign competition or capital unless the Japanese industry so thoroughly dominates a given area that foreign competition would not be a significant threat."

On the home front all-solid-state color sets aren't

Selected consumer electronics markets	In millions of dollars by quarters				
	1st	2nd	3rd	4th	Total
Monochrome tv receivers	115.0	110.0	135.0	120.0	480.0
Color tv receivers	556.0	542.0	606.0	580.0	2,284.0
A-m and f-m radios	72.8	79.3	75.3	78.6	306.0
Auto radios	87.4	89.0	86.2	84.4	347.0
Automobile tape players	8.7	9.2	8.6	8.1	34.6
Phonographs, total	125.0	115.0	162.0	139.0	541.0
Tape recorders, audio	44.6	47.8	46.7	48.9	188.0
Tape cartridges	32.1	34.9	33.2	35.2	135.4



Closeup. Hybrid circuits are giving semiconductor suppliers and users a real run for their money these days. This one from TI is used in a Honeywell 8200 computer because of the high current-switching capability required for core driving.

expected to flood the market any time soon. Marketing men agree consumers aren't quite ready to ante up $200 more to own one. As a result few top set makers are ready to tie up engineering talent on such a project. "Hybridization provides both performance and reliability without a premium," says Thomas H. Cashin, senior vice president at Sylvania. His opinion is shared by many industry colleagues. Nonetheless, for prestige several more firms, including Emerson Radio, will produce all-solid-state color sets in limited runs for next year's line. Clairtone Electronic, a Canadian outfit plans to invade the American market with a receiver next year.

And for the moment, electronic tuning has not lived up to its press clippings and won't replace standard switched systems for several years. Set makers contend cost is the big hurdle, but engineers point to the poor tracking performance of the tuner diodes as a big factor. Producers are now checking performance reliability against the higher costs involved with the hope of coming up with marketable configurations.

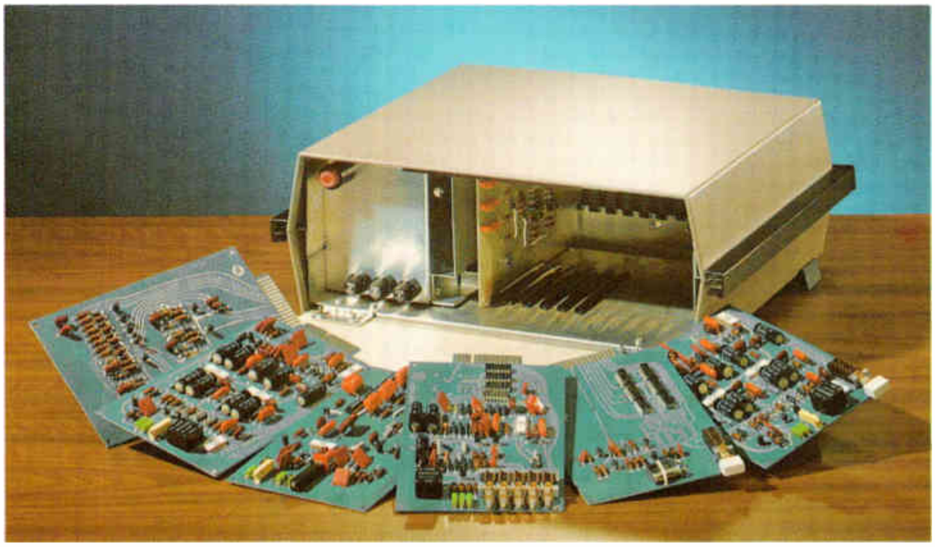
But failures in the realm of solid state are now more the exception than the rule. So far this year, dollar volume in integrated circuits is exceeding expectations, despite the depressing influence of military and space cutbacks, price reductions, and a disappointing linear market. The big reason is booming demand from the data processing industry, particularly suppliers of peripheral equipment. Texas Instruments expects total industry sales next year of $40 million in MOS IC's alone for small memories and terminal equipment.

TI's move in early June to slash prices on its 54/74 series of transistor-transistor logic precipitated similar reductions by other manufacturers. Despite the average 30% drop in unit prices for this family, market planners are confident larger orders will offset the revised loss.

Linear IC's have also suffered severe price erosion. Although unit volume is up sharply, total sales are up only a few percentage points. Moreover IC sense amplifiers are getting stiff competition from discrete devices, which computer makers, for example, prefer as an interface for core memories. The reason: IC's just haven't been able to match the performance of discrete components in this application.

But the longer term outlook is promising. National Semiconductor, for example, contends that price cutting made voltage regulators and op amps attractive for new equipment designs. Now that these designs are getting into production, demand will rise. For nine months, a source there reports, industry shipments of linear IC's hovered at just over 1.5 million units a month. But now, he says, it looks as though the market is finally taking off; shipments have risen to the two-million level during the last few months.

Softness in TTL and linear IC prices notwithstanding,



Best seller. Since the Carterphone decision, the hottest thing in the communications field has been modems. Among the units on the market is Ultronics' Series 2400 Data Pump, which receives and transmits synchronous digital data over voice-grade phone lines.

the average unit price for all IC's has remained firm at about $1.35. One reason is that medium-scale integrated circuits have become accepted and established. And since MSI contains many more functional cells than standard IC's, it commands a correspondingly higher price. "Just about every system that's being designed today incorporates MSI," says Don Winstead, marketing manager at Signetics. He estimates that 15% of the IC packages in such systems contain MSI circuits. TI's market projections support his estimate; MSI will account for 45% of the total TTL dollar sales this year. And by 1972, the level will be around 65%.

MSI is no longer an exclusively custom-design business. Products such as adders, decoders, counters, memories (one of the fastest growing lines, according to TI), shift registers, and multiplexers are now catalog items. MOS LSI, on the other hand, may be shifting in the opposite direction. TI's marketing staff, for example, believes that MOS may turn out to be "a custom, sole-source situation because of high development costs."

Plastic IC's, which have been cheerfully accepted by industrial and commercial users, have proved a big factor in the upsurge in orders. Now, despite all the controversy, there appears to be some hope that such devices stand a good chance of eventually being accepted by the military. Recent data—from field use as well as lab tests—has "documented that the military temperature range

Selected components markets	In millions of dollars by quarters				
	1st	2nd	3rd	4th	Total
Capacitors, electrolytic	41.4	43.8	48.2	55.6	189.0
Capacitors, all others	58.5	62.9	64.0	69.0	254.4
Receiving tubes	52.3	55.8	58.9	60.0	227.0
High-vacuum tubes	14.6	15.5	15.0	14.6	59.7
Gas and vapor tubes	4.8	4.5	4.3	3.8	17.4
Microwave tubes (klystrons, magnetrons, TWT's)	25.2	24.3	23.5	21.6	94.6
Tv picture tubes, black-and-white	25.3	26.6	22.0	20.1	94.0
Tv picture tubes, color	187.4	198.0	208.6	204.0	798.0
Filters, electronic	12.2	13.0	13.8	14.5	53.5
Microwave ferrite devices	6.0	6.6	6.3	7.4	26.3
Fixed resistors	55.8	59.2	62.7	66.3	244.0
Potentiometers	40.0	41.2	43.0	44.6	168.8
Solid state relays	4.3	5.4	7.0	7.7	24.4
Electromagnetic relays	30.4	31.7	34.0	30.4	126.5
Optoelectronic devices	7.1	8.2	9.0	10.5	34.8
Rectifiers, solid state	31.1	29.4	27.2	24.3	112.0

Selected semiconductors markets	In millions of dollars by quarters				
	1st	2nd	3rd	4th	Total
Transistors, silicon	74.3	71.7	68.2	63.8	278.0
Transistors, germanium	16.7	15.9	14.3	13.5	60.4
Transistors, field effect	4.2	4.9	6.0	6.9	22.0
Germanium diodes	5.7	5.2	4.9	4.5	20.3
Silicon diodes	43.2	41.7	39.3	37.8	162.0
Thyristors	15.6	16.2	17.0	17.6	66.4
Tunnel & varactor diodes	2.3	2.6	2.8	3.3	11.0
Zeners	14.1	14.3	14.5	14.9	57.8
Monolithic linear IC's (less than 12 gates)	20.7	22.3	24.6	26.4	94.0
Monolithic digital IC's (less than 12 gates)	78.6	81.1	84.3	87.0	331.0
Monolithic IC's, MOS	7.6	8.7	9.3	10.1	35.7
Thick-film hybrid circuits	10.7	12.5	12.8	13.8	49.8
Thin-film hybrid circuits	7.4	7.9	8.2	8.5	32.0
MSI devices (12 to 100 gates)	24.0	27.8	29.1	32.1	113.0
LSI devices (100 or more gates)	1.3	1.7	2.1	2.5	7.6

Preflight. Tiros operational satellite undergoes final checks before successful launch earlier this year. Spacecraft is ninth in weather-watch series operated by the Environmental Science Services Administration.

has no adverse effect on the plastic," according to one industry source. Other observers agree, noting contractors are ready, willing, and able to use plastic IC's, but are inhibited by the services' opposition.

Hybrid IC's, which are winning an increasing number of sockets in consumer goods and industrial equipment, are fostering sizable new outlets for chip capacitors and resistors that can be bonded directly to substrates. The market, currently worth about $8 million a year, could triple within the next 12 months or so, according to informed estimates. For example, Varadyne, which offers both chip capacitors and resistors plans to introduce passive hybrids in dual in-line packages for data processing and military systems. Other firms in one or both sides of this burgeoning business include Republic Electronics, the U.S. Capacitor Corp., Sage Electronics, and Allen-Bradley—all old-line suppliers of discrete devices.

Another component development that bears watching is a new tantalum nitride thin-film resistor from Western Electric. The patent-protected devices, available in a variety of values, are in production at the company's Winston-Salem, N.C. plant. (Western Electric is being pressed to license the development to other manufacturers.)

The ceramic-based component, produced with values from 100 ohms to 100 kilohms, is highly stable and corrosion resistant. Frequency response is equal to or better than most film-type units. For example, ⅛-watt devices, tested for more than 10,000 hours at 70°C showed only 0.02% resistance change for 500-ohm resistors and 0.11% change for values of 47 kilohms. By using a coplanar staple-lead arrangement, mounted on 0.25-inch centers, a density of more than 450,000 parts per cubic foot is possible. When power dissipation and costs are taken into account, these discrete resistors mounted on printed-wiring boards can compare favorably with either thick- or thin-film resistance networks.

Elsewhere in componentry, with companies like Texas Instruments, Motorola, RCA, Monsanto, and Hewlett-Packard now making light-sensing and light-emitting devices, demand for optical semiconductors is growing. These devices are being used in both discrete and monolithic units displacing mechanical relays, transformers, indicator lamps, brushless motors, and motor speed controls. TI estimates this market will be worth $50 million in 1969, believing it could grow to $300 million by 1973. In addition to large military outlets devices can also be applied in typewriter keyboards, automatic garage-door openers, photomultipliers, and alphanumerics. Because of intense demand and competition, manufacturers earlier this year were selling emitters for $10 apiece; they're now targeting unit prices of $3 to $5. If this level is reached, new markets should open for electro-optic devices, notably in cars and heavy machinery. ●

Excelsior. Tiros operational satellite heads for near-polar, sun synchronous orbit; craft surveys global weather conditions once every 24 hours, returning data and pictures to ESSA stations in Alaska and Virginia.

Register here:

In fact, there are lots of registers here. Because nobody but nobody makes more — or more magical — registers than Signetics.

Take our 8270/71. We pack more capability into it than any other 4-bit shift register on the market today. (Think a minute. Do you know another single one that's fully synchronous, with parallel, serial input or output? And a clock rate to 20 MHz? And a common reset line? And separate load and shift lines to eliminate clock skew problems? And a "HOLD" state to allow free-running clock?)

Then there's our 8275: the transfer register we call a quad latch. And 8276: our serial-in, serial-out, 8-bit shift register. Unlike competing devices, it's the only register that actually prevents the transfer of data from master to slave sections of all eight flip-flops! Result: it lets you "stop the clock" internally.

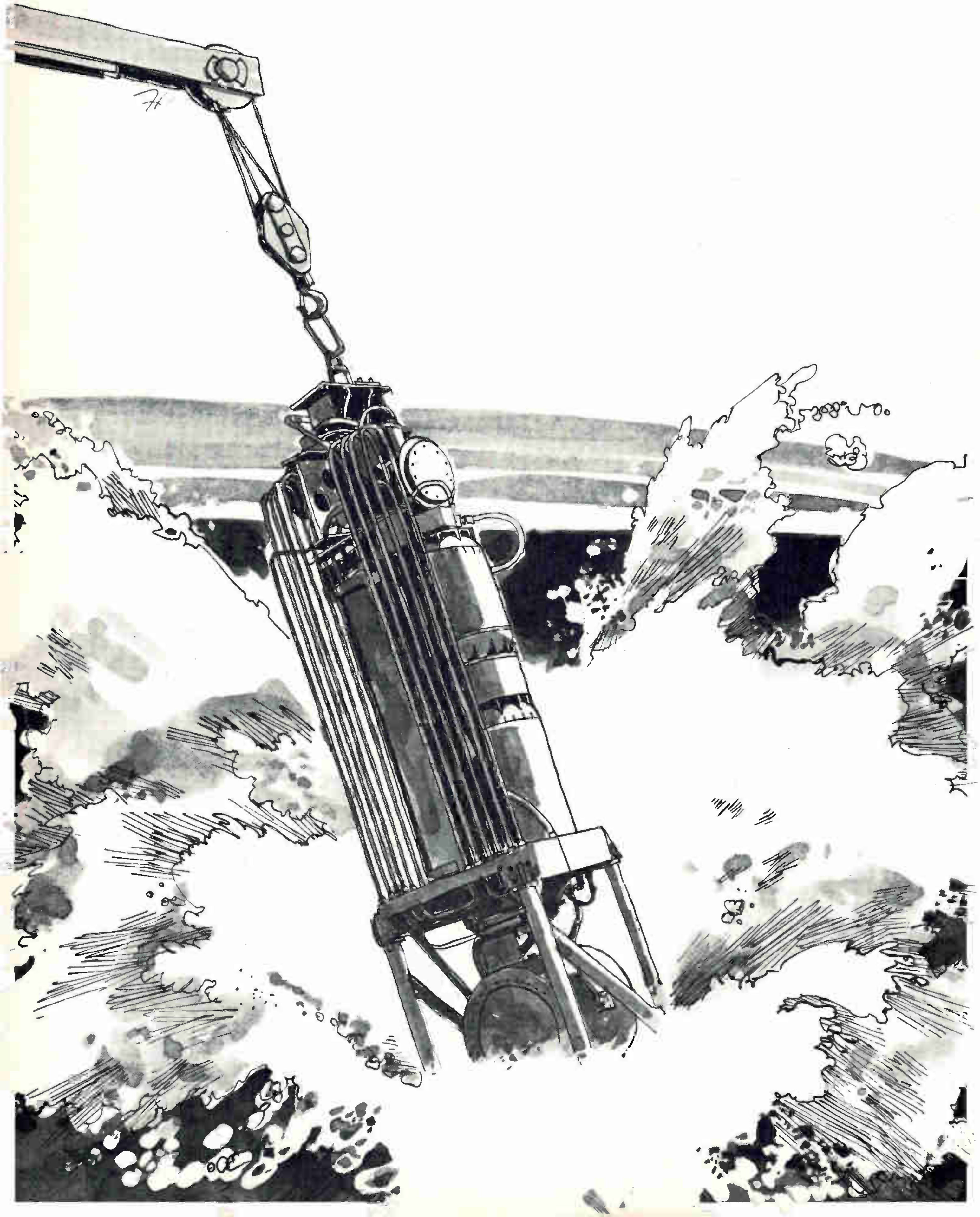
And coming soon: the 8200/01 dual 5-bit buffer register. Plus the 8202/03 10-bit buffer register! For specs, diagrams, other data on our magic-making family of registers, just register your interest — by dropping us a line.

Today. The sooner you register, the sooner we can win your vote!

More
complex magic
from
Signetics MSI

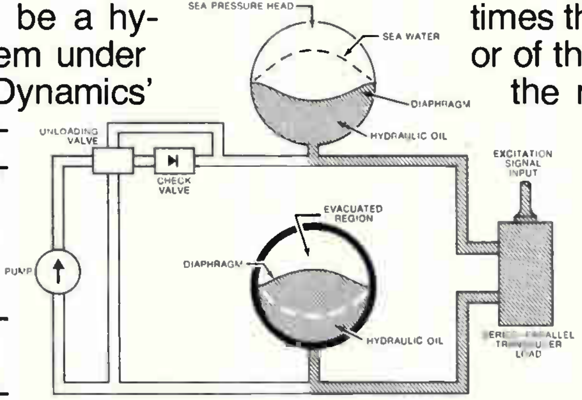
Signetics Corporation/811 E. Arques Ave., Sunnyvale, Calif. 94086/A subsidiary of Corning Glass Works

THE UNDERSEA POWER PLANT THAT GETS ITS POWER FROM THE SEA ITSELF.



Man has been going to greater and greater depths beneath the sea in recent years. To explore, and to work. And he has become increasingly concerned with finding new means for probing so alien an environment.

One of his most urgent needs is a reliable source of high peak power that will work most efficiently under the sea.



One answer promises to be a hydraulic energy storage system under development by General Dynamics' Electronics Division. It harnesses the enormous pressure of the sea itself.

Sea pressure delivers 10,000 horsepower. Figure 1 is a simplified diagram illustrating the principle utilized in the deep-sea energy-storage concept. The upper (transfer) vessel is a sphere partially filled with oil. A diaphragm separates the oil and the sea water, and the top of the sphere is open to the sea. The lower sphere is a conventional pressure vessel which is evacuated. The hydraulic device to be powered by the energy storage system is placed between the upper and lower vessel.

The complete system is located at depth in the ocean. Upon demand of the hydraulic device, the hydrostatic pressure existing in the upper vessel forces the oil through the device into the evacuated vessel. The hydraulic pressure across the device is largely constant throughout the discharge, since the hydrostatic pressure of the sea does not change, and since the lower vessel pressure does not change significantly.

As an example, at a depth of 12,000 feet in the ocean, a six-foot diameter sphere used for the lower vessel could enable over 10,000 hp. of flow energy to be sustained for 10 seconds; a 10-foot diameter sphere would sustain this power level for one minute. Other power levels and vessel sizes are illustrated in Figure 2.

Recharging the system by evacuating the sea water from the filled vessel can be accomplished with the aid of a small pump, operated by a mere trickle of power fed by cable from the surface, or by a power source self-contained in the undersea work system itself.

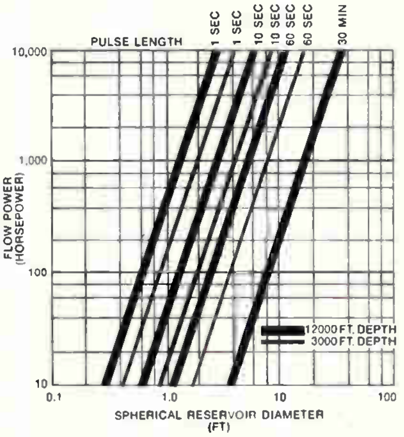
Long life independent of discharge rates. The advantage of General Dynamics' new concept is that it meets the need for high power discharges over short intervals of time at low cost. And that it can be recharged over a time interval at the demand of the user.

The system also shows promise of an extremely long life, regardless of the number of times this energy source is tapped, or of the rate of power delivery. In the much weaker electrochemical batteries that have had to be used in such applications, severe deterioration can take place after just a few cycles at high discharge rate.

A major role in opening depths to man's use. Right now at General Dynamics, sonar and underwater communications have the highest priority for application of this hydraulic-to-acoustic power conversion technique.

But this concept may soon be assisting in the search for minerals and operating everything from beacons to underwater drills as man's exploration of the sea moves forward.

Sea pressure head energy storage systems are just one example of our undersea work. General Dynamics builds nuclear submarines for the Navy, research and work submersibles, advanced sonar systems, microelectronic sonobuoy receivers, sonar calibration range systems, and ASW tactical displays. They all show what technology can accomplish when it's handed a problem. At General Dynamics we put technology to work solving problems from the bottom of the sea to outer space... and a good bit in between.

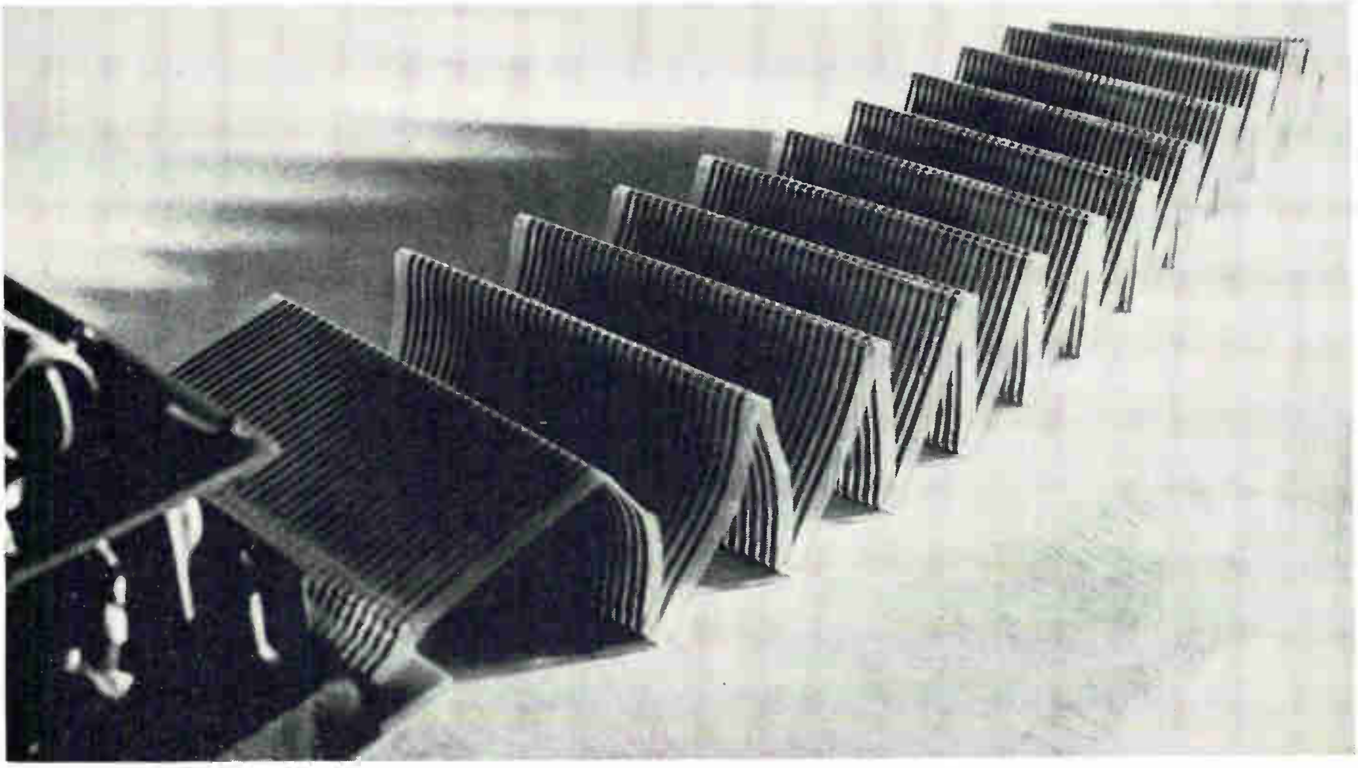


GENERAL DYNAMICS

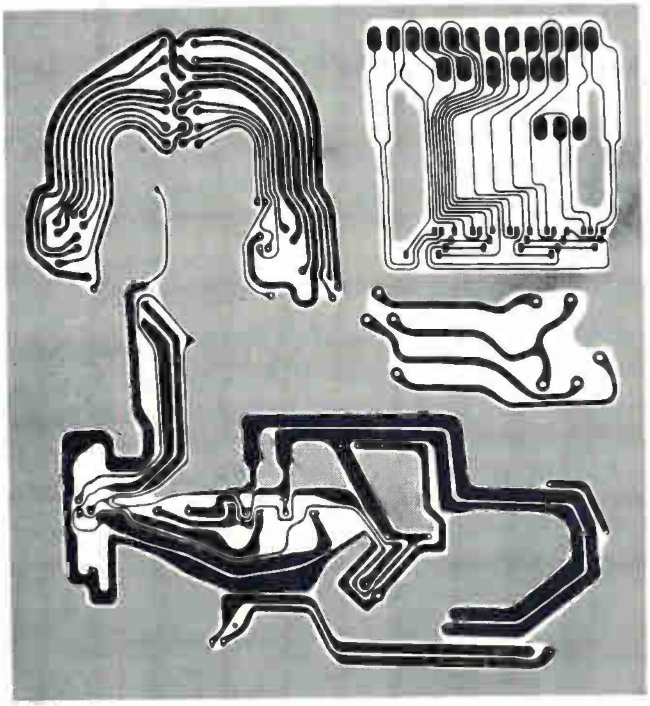
Additional technical information on the deep-sea energy storage system is available on request. Write: General Dynamics, Dept. 850, 1 Rockefeller Plaza, New York, N.Y. 10020.

Circle 121 on reader service card

Two suggestions for saving space, weight and money in electronic packaging . . .



1. Cerro-Flex® flat flexible cable.
2. Cerro-Flex® flexible printed circuits.



Design engineers responsible for packaging electrical and electronic circuits can save up to 60% in weight, up to 75% in volume and as much as 50% in installed cost with Cerro-Flex flexible flat cables and custom-designed printed circuits. And get more reliable circuitry, as well.

Cerro-Flex flat cables and circuits are available in a number of different insulating materials for a wide range of service conditions.

For more information, send for a copy of Catalog FC-167 to Cerro-Flex Products, Cerro Wire & Cable Company, Division of Cerro Corporation, 330 Boston Post Road, Old Saybrook, Connecticut 06475.

CERRO®
WIRE & CABLE

THE INCOMPARABLE PAN MAN RECEIVER

Unique performance features in a low-cost sweeping receiver that is compact and versatile

- **Receives AM, FM, pulse signals, 30 - 300 MHz**
- **High dynamic range**
- **Low noise**
- **High spurious signal rejection**
- **Digital readout of tuned frequency with Digital Automatic Frequency Control**
- **Versatile: for airborne, ship, mobile and fixed site applications**
- **Compact: only 8¾ inches high by 19 inches wide**
- **Costs a fraction of what you'd expect**

W-J reaffirms its leadership in the surveillance receiver field with the introduction of a superb new sweeping receiver system: the RS-160.

The system consists of the Type 205 Sweeping and Manual Receiver, the DRO-308 six-digit Frequency Readout with DAFC (digital automatic frequency control) and the SM-7301 five-inch Signal Display with beam intensification.

The receiver covers the 30-300 MHz range with four plug-in tuners. RF preselection consists of four tuned circuits in two coupled pairs which are voltage tuned using varactors. These circuits provide a high order of IF and image rejection and reduce intermodulation for signals outside the RF passband. The RF amplifier consists of a dual gate MOSFET followed by a junction FET in a cascode configuration for maximum selectivity. This configuration also provides a high reverse isolation to the local oscillator signal which is typically less than one microvolt at the RF input. A double-balanced mixer provides improved intermodulation characteristics, IF rejection and local oscillator leakage.

Each module is designed to operate with others in a system offering maximum versatility, compact, attractive design and low cost.

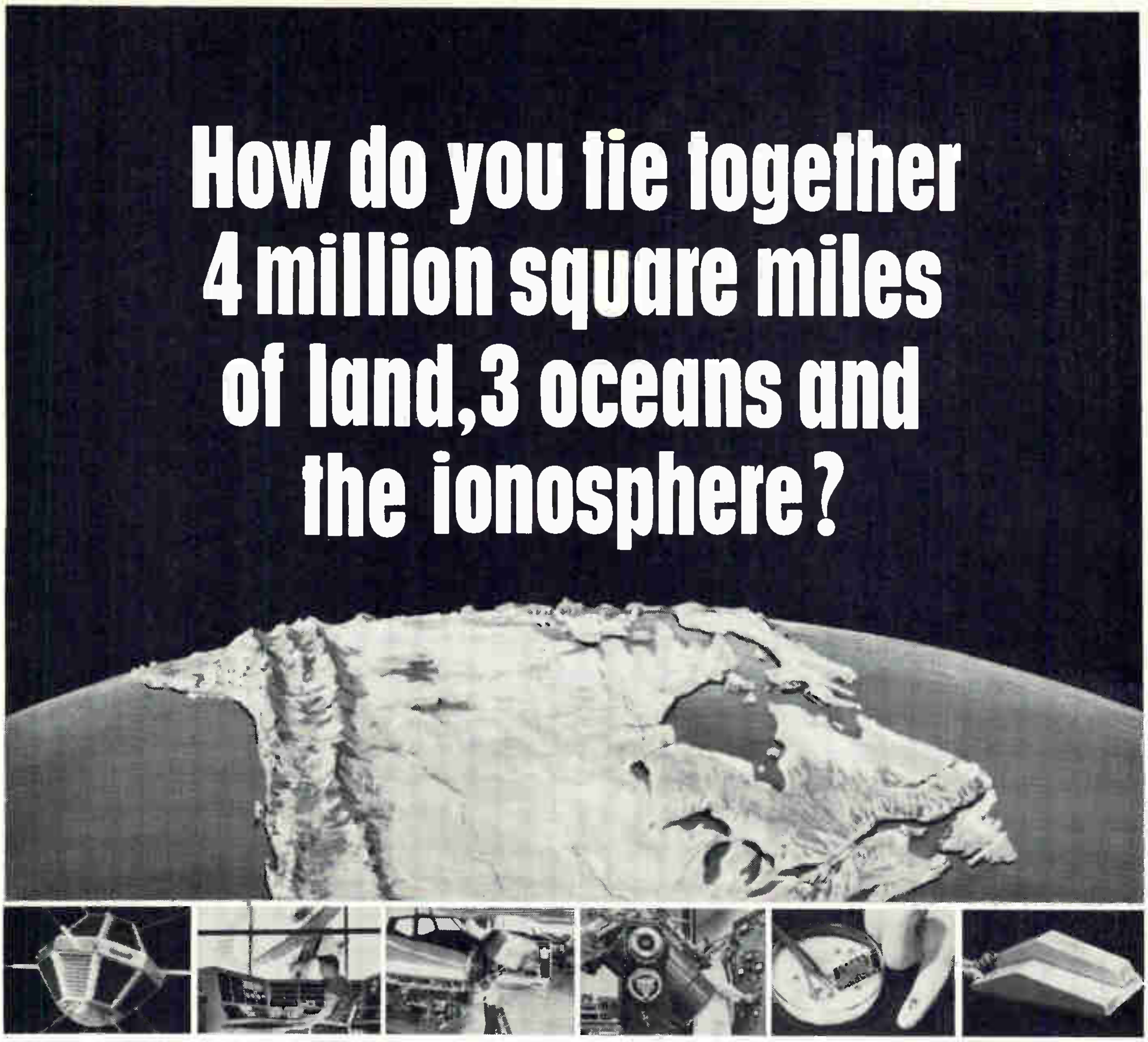
World's largest selection of receiving equipment for surveillance, direction finding and countermeasures

CEI DIVISION

WATKINS-JOHNSON

6006 Executive Boulevard, Rockville, Maryland 20852 • (301) 881-3300

Circle 123 on reader service card



CANADA does it electronically

The Canadian electronics industry has to tackle the big jobs—in communications alone, a 17,000 mile broadband system provides for message, broadcast and television transmission across Canada and into the far north. And no less than eighteen countries are using Canadian designed and manufactured microwave relay systems, many of them important military installations.

Not only does the Canadian electronics industry handle the big jobs, but it also specializes in short runs! Today new methods of miniaturization are being developed, particularly in the field of integrated circuits.

Fourteen leading Canadian electronics manufacturers will be exhibiting a broad spectrum of specialized electronic products at the **1969 WESCON in the Cow Palace, San Francisco, August 19-22.** Visit the display . . . find out how Canadian installation services, training programs and maintenance are tailored to fit any need anywhere.

Canadian companies exhibiting are:

Precision Electronic
Components Limited
TORONTO 15, Ontario

Muirhead Instruments Ltd.
STRATFORD, Ontario

ESE Limited
REXDALE, Ontario

Manitoba Export Corporation
WINNIPEG, Manitoba

Fototek,
Division of Hallcraft
Electronics Ltd.
WINNIPEG, Manitoba

Micro-Com Electronics Ltd.
WINNIPEG 4, Manitoba

Manta Industries Ltd.
WINNIPEG 4, Manitoba

Kameco Electronics Ltd.
MONTREAL 12, Quebec

Cramco Solder Alloys Limited
SCARBOROUGH, Ontario

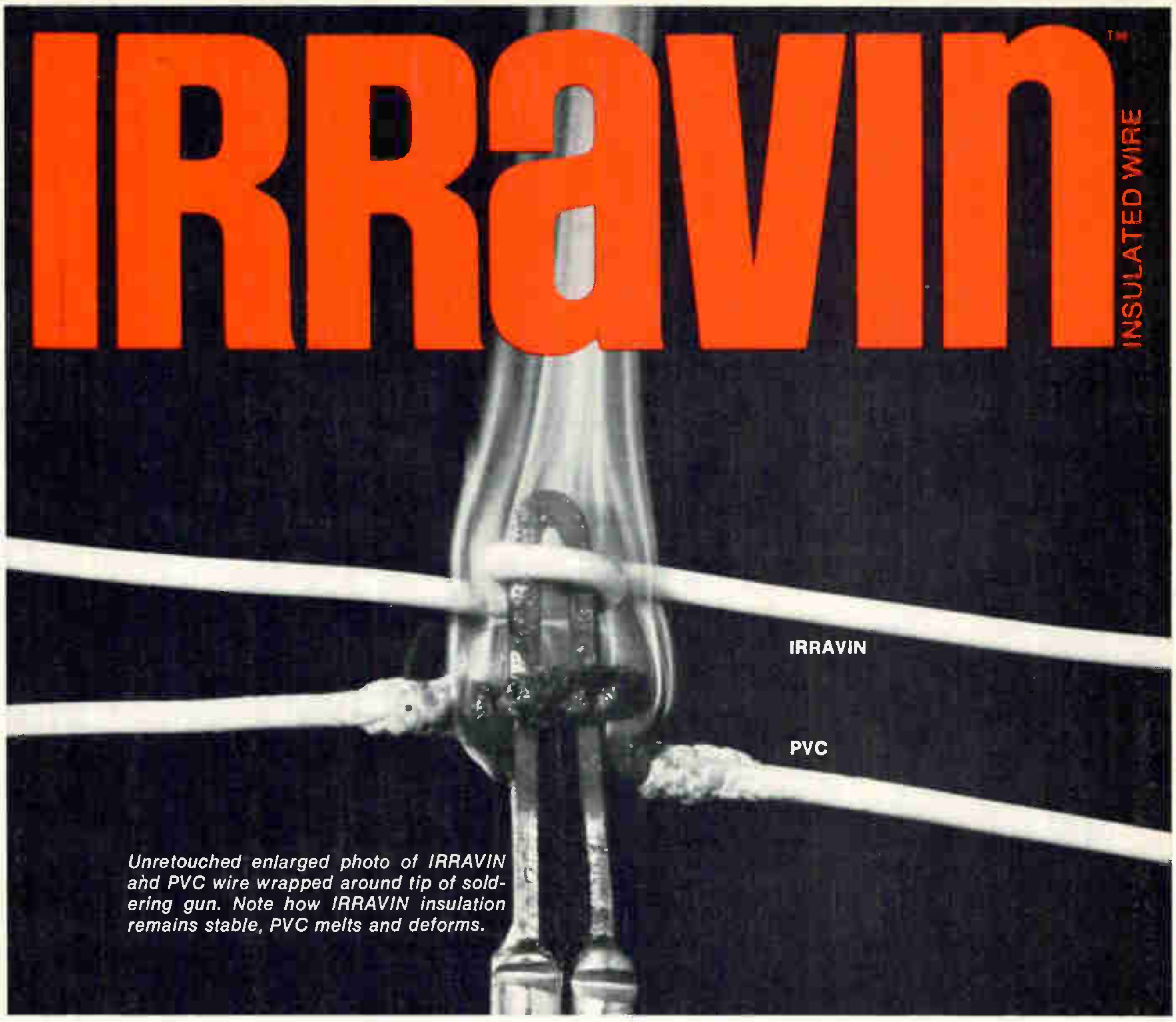
Ferritronics Limited
RICHMOND HILL, Ontario

Trim-Line Connectors Ltd.
WESTON, Ontario

Welwyn Canada Limited
LONDON, Ontario

Garrett Manufacturing
REXDALE, Ontario

Consul and Trade Commissioner, Commercial Division, Canadian Consulate General
One Maritime Plaza, Golden Gate Center, San Francisco, California 94111



Unretouched enlarged photo of IRRAVIN and PVC wire wrapped around tip of soldering gun. Note how IRRAVIN insulation remains stable, PVC melts and deforms.

Hot problem...cool solution.

IRRAVIN insulation won't melt, flow or shrink back.

This photo was made to demonstrate the solder iron resistance of IRRAVIN insulated hook-up wire, compared with ordinary PVC insulated hook-up wire. It's proof that low-cost IRRAVIN wire suits applications where heat, even direct hot solder iron contact, is encountered. IRRAVIN insulation won't shrink back, or deform. It stays in place to maintain insulation integrity.

IRRAVIN wire can be soldered in snug spaces, even when terminals are closely set. This, in addition to a small O.D., means space-savings, reduced rework and production time, less scrap.

To get the same product advantages of IRRAVIN wire you would have to specify wire that costs a lot more, two to three times more in fact! With IRRAVIN wire you not only save on time, space and waste. . . . you save on the initial cost too!

Don't just take our word for it. See for yourself with a sample.

It's yours FREE! Write ITT Wire and Cable Division, Surprenant Products, International Telephone and Telegraph Corporation, Pawtucket, Rhode Island 02862. In Europe: ITT Europe-Components Group, Lister Road, Basingstoke, Hants, England.

IRRAVIN—the wire that stops the grumbles.

SEE IRRAVIN Wire at
WESCON August 19-22
Cow Palace, San Francisco Booth 3808

WIRE AND CABLE ITT

Circle 125 on reader service card

3 exciting reasons to specify

DIGITEC

NEW 1

Model 262

Digital Multimeter

(AC, DC, ohms)

A most uncommon .1% Multimeter for those common, everyday measurements. A necessity for design and development, production, quality control, or anywhere that DC volts and current, AC volts, and ohms are measured. Battery pack available.

$375

NEW 2

Model 311

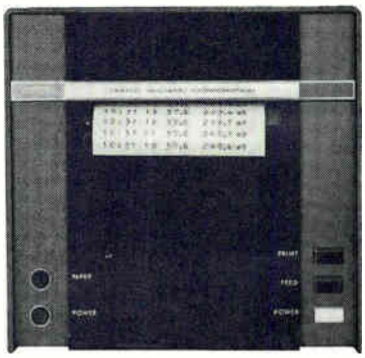
Precision Calibrator

(voltage & current source)

An .01% precision voltage and current Calibrator that serves as a working standard. In addition, the high current capability may be used as a lab source for developing those critical circuits so essential in electronics today.

$650

NEW 3



Model 691

21 Column Printer

(3 lines per second)

A Drum Printer which is expandable from 4 to 21 columns to satisfy your specific requirements. This versatile printer accepts all standard BCD inputs and provides 38 symbols along with "floating" decimal point.

starting at **$770**

DIGITEC® by UNITED SYSTEMS CORPORATION

918 Woodley Road • Dayton, Ohio 45403 • (513) 254-6251
Representatives Throughout the World

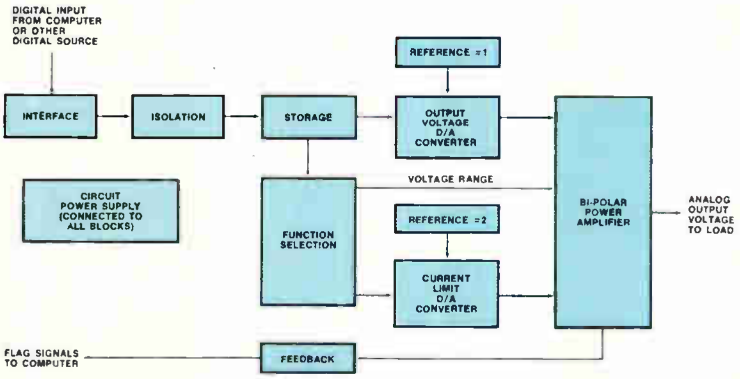
See us at booth
1024 and 1025
WESCON/69

For Complete
Specifications
request new
catalog D69A

Circle 126 on reader service card

Circle 127 on reader service card →

all this



in one compact package

Write for Digitally Controlled Power Brochure.

"See us at WESCON—Booth #5615-5618"

Digitally Controlled Power Sources Include Added Systems-Oriented Functions

Digitally Controlled Power Sources (DCPS's) are complete digital-to-analog links between a computer (or other digital source) and any application requiring a fast, accurately settable source of dc or low frequency ac power. Such applications generally require more than a programmable power supply or D/A converter with a power amplifier — the DCPS's include these added functions in a single compact trouble-free package:

INTERFACE Customized plug-in interface cards match the Digitally Controlled Power Source to the computer (8421 BCD or Binary).

ISOLATION All digital inputs are floating and isolated from the floating analog output, thus avoiding troublesome loops between the output ground and computer ground.

STORAGE Inputs from all digital data lines are stored upon receipt of a gate signal from the computer. Output levels are maintained until a new gate signal is received — thus, the computer is free to perform other tasks in the interval between voltage level changes.

FUNCTION SELECTION Selects the output voltage range, and isolates the three input bits to the current limit D/A converter.

OUTPUT VOLTAGE D/A CONVERTER Converts one polarity bit plus 16 BCD voltage bits or 15 binary voltage bits to an analog voltage for input to the power amplifier. Thus, resolution is 0.5mV for straight binary and 1mV for BCD operation.

REFERENCES Provide voltage for the Output Voltage and Current D/A Converters.

CURRENT LIMIT D/A CONVERTER Sets current limit of power amplifier to one of eight values.

CIRCUIT POWER SUPPLIES Provide all the necessary dc power — no external power supplies are required.

FEEDBACK Informs the computer when each programming operation is completed and when the output current is overloaded.

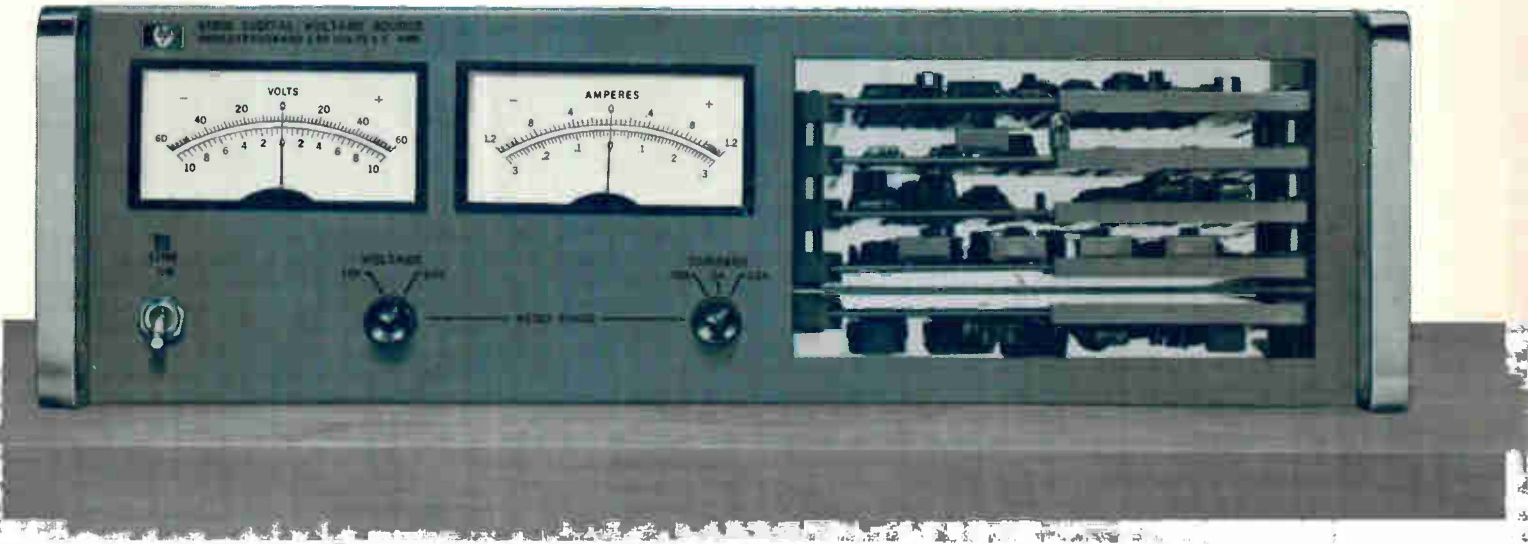
BIPOLAR POWER AMPLIFIER Programs either side of zero or through zero without output polarity switches or "notch" effects, with an accuracy of 1mV, 5mV, or 10mV depending on range and model. Outputs from —100V to +100V with currents up to 5A are available.

21904

HEWLETT hp PACKARD

COMPUTER INSTRUMENTATION

100 Locust Avenue, Berkeley Heights
New Jersey 07922 • (201) 464-1234



we're not only first in hybrid ICs...

we're also second...

NSC

power buffer

NH0002 ≡ NC0002

NH0002C ≡ NC0002C

MOS clock driver

NH0007 ≡ NC0007

NH0007C ≡ NC0007C

two phase clock driver

NH0009 ≡ NC0009

NH0009C ≡ NC0009C

FSC

lamp relay driver

SH2001 ≡ NC2001

SH2001C ≡ NC2001C

Westinghouse

voltage regulator

WC109T ≡ NC109T

GENERAL INSTRUMENT

General Instrument was the first to manufacture hybrid microcircuits. Since that time, some ten years ago, while others have entered the field, General Instrument has maintained its no. 1 position by providing not only the broadest, but the most advanced line of hybrid ICs available.

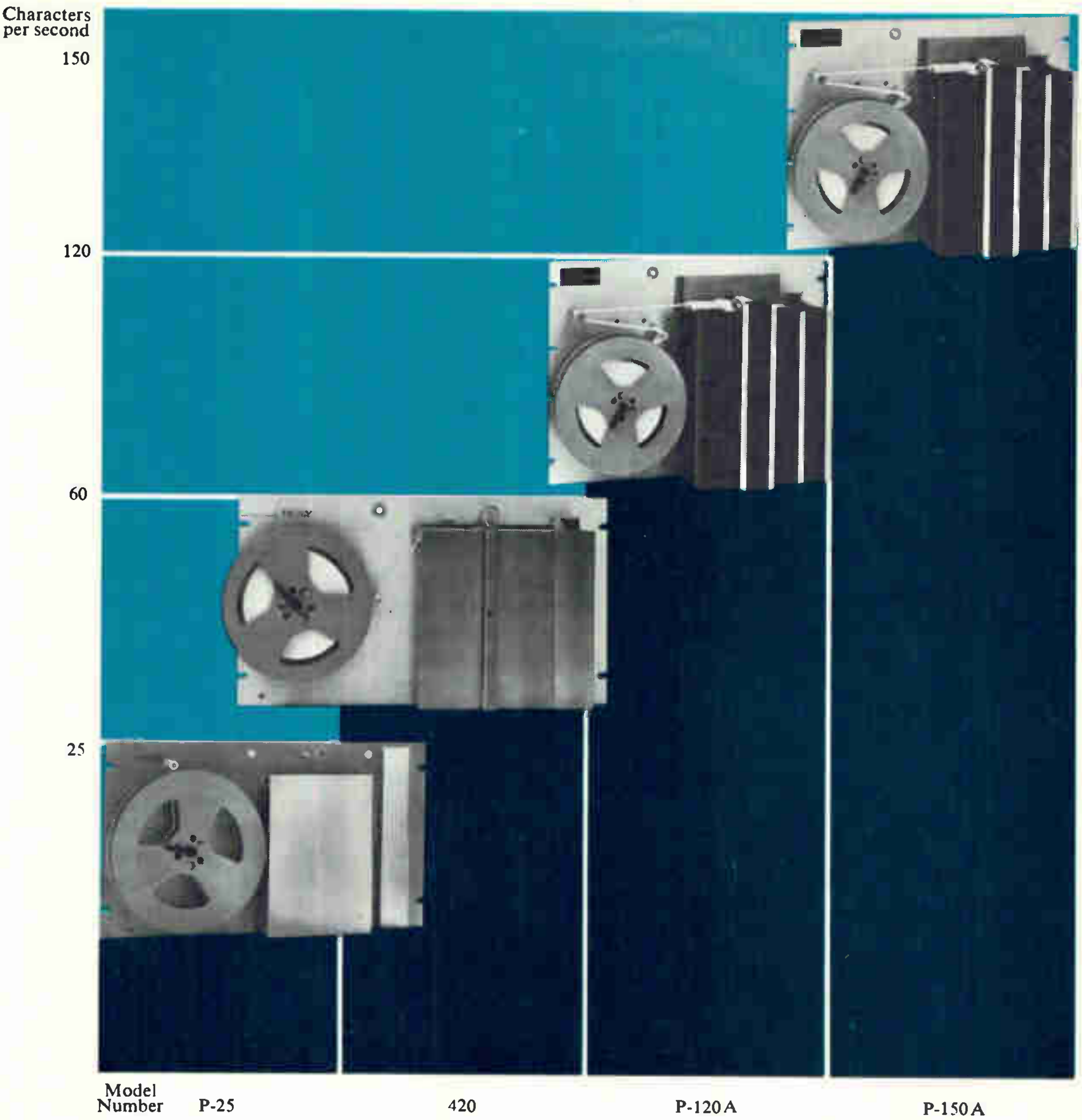
As a second source too, General Instrument is no. 1, in making available exact pin-for-pin replacements for some of the more popular hybrids being produced by other manufacturers in the field . . . such as those listed.

The above General Instrument hybrid ICs are immediately available from your authorized General Instrument Distributor.

For full information write, General Instrument Corporation, Dept. H, 600 West John Street, Hicksville, L.I., N.Y. 11802. (In Europe, write to General Instrument Europe S.P.A., Piazza Amendola 9, 20149 Milano, Italy; in the U.K., to General Instrument U.K., LTD., Stonefield Way, Victoria Rd., South Ruislip, Middlesex, England.)

GENERAL INSTRUMENT

GENERAL INSTRUMENT CORPORATION • 600 WEST JOHN STREET, HICKSVILLE, L. I., NEW YORK

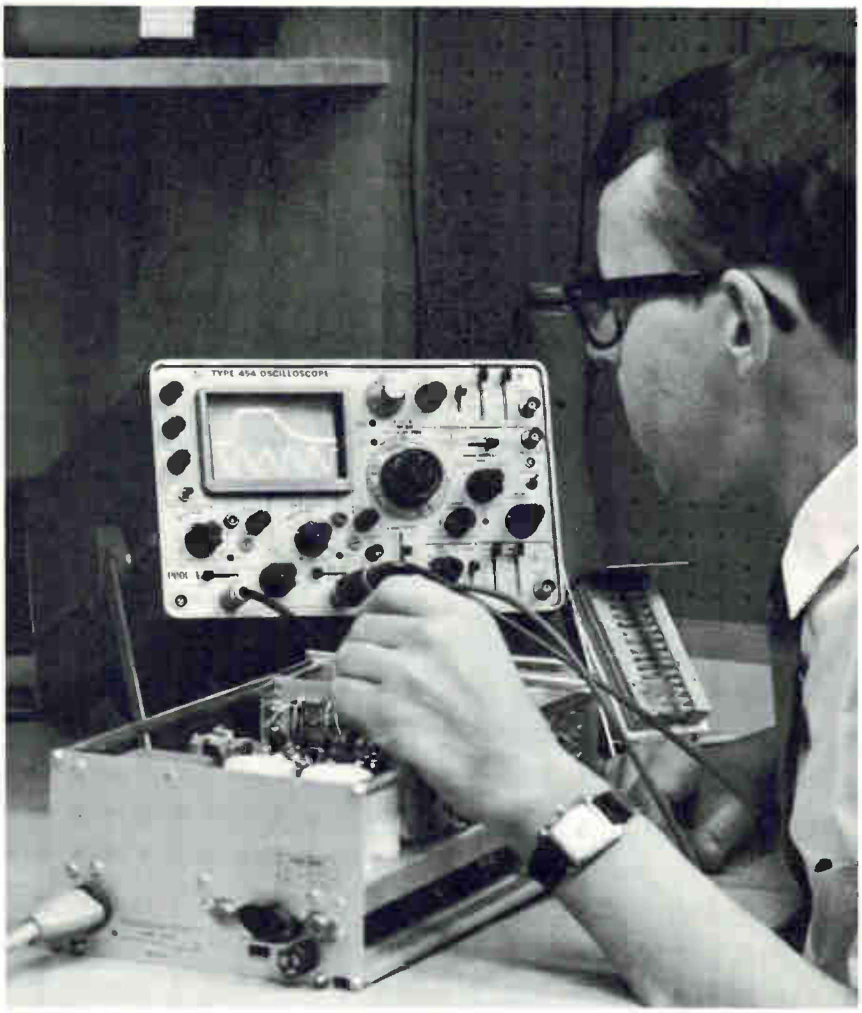

Characters per second
150
120
60
25
Model Number
P-25
420
P-120A
P-150A

truly portable

Tektronix Type 454 Oscilloscope

with 150 MHz bandwidth, 1.4 ns risetime, and high photographic writing speed.

The Tektronix Type 454 brings performance normally found only in laboratory oscilloscopes right to your measurement. 150 MHz bandwidth, versatile, rugged performance capability makes this instrument ideal for use in locations where portability is essential and work space is limited. This 30-lb. package even packs a complete set of accessories (including probes) in its snap-off front panel cover.



ADVANCED PORTABLE PERFORMANCE where you use it . . . at the probe tip—provides measurement of fast-rise pulses and high-frequency signals beyond the capability of most conventional oscilloscopes.

The DUAL-TRACE VERTICAL system provides displays at 5 mV/div with bandwidth of DC to 60 MHz, full bandwidth measurements (150 MHz) at 20 mV/div and full-sensitivity X-Y operation with phase difference < 3° from DC to 2 MHz.

DUAL TIME BASES triggerable at frequencies above 150 MHz permit conventional, delayed sweep or single-shot operation. For single-shot applications a photographic writing speed of 3200 div/μs (> 2500 cm/μs) is provided by the Type 454, C-31 Camera and 10,000 ASA film . . . without employing film fogging techniques.

The Type 454 meets temperature, humidity, vibration and shock tests which simulate environments "portable" instruments often encounter. For applications where permanent installation is required, a rackmount version is available.

Type 454 Oscilloscope (complete with accessories)	$2925
Type 454 Oscilloscope (Rackmount)	$3010

U.S. Sales Prices FOB Beaverton, Oregon

Your Tektronix Field Engineer will demonstrate the Type 454 in your application at your convenience. Please call him, or write: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

TEKTRONIX

Tektronix, Inc.

committed to progress in waveform measurement

Videofile puts lawmen in the picture

Los Angeles County Sheriff's Department installs automated information storage and retrieval system from Ampex to keep track centrally of its voluminous records

Documentary evidence, according to a story now making the rounds, proves that paperwork is a lot more likely to bury the country than the Russians. The situation does have amusing aspects, but it's no joke for those contending with current record levels.

The Los Angeles County Sheriff's Department, for example, has the staggering task of maintaining 18 million individual case, fingerprint, and photograph files that are increasing at a 13% annual rate. Not too surprisingly, the snowed-under agency, which has officers requiring up-to-the-minute information scattered throughout one of the nation's largest metropolitan areas, decided some sort of automated storage and retrieval help was required. After investigating the matter, it decided on Videofile, a sophisticated assemblage of hardware developed by the Ampex Corp. that's just now winning a secure foothold in commercial and government markets.

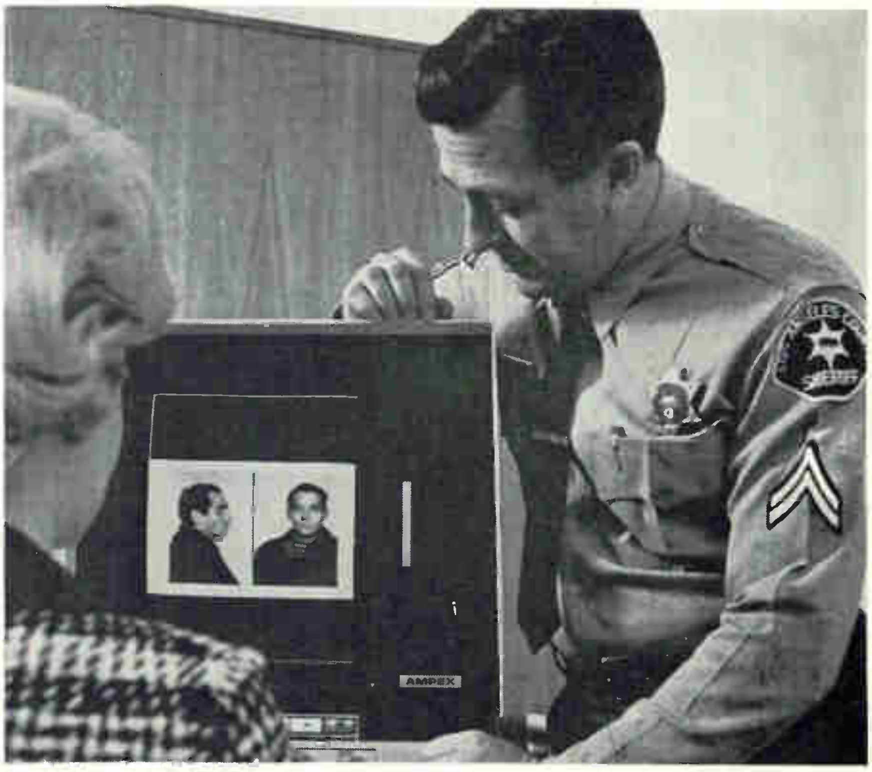
Essentially, Videofile is a computer-controlled system built from modular elements, including: high-performance cameras for input; tape for storage; tape transports for search; and display monitors and electrostatic printers for output. The hardware can be combined in a number of different ways to satisfy varying requirements. With Videofile, any document in a master file can be viewed on a television screen or electrostatically printed out in a matter of seconds by simply pressing a few buttons. Since the original is not removed, it's available for inspection by any other interested party. In addition, documents can be erased, relocated, or replaced electronically without disturbing the basic file.

When Ampex decided a few years back to get into the automated information storage and retrieval field, it seemed probable that in-house talents in magnetic tape recording, television, data processing, and related technologies would make development work easier than proved to be the case. "When we started, we thought that we could adapt existing equipment to a much greater extent than actually proved possible," says Charles Steinberg, general manager of the company's Videofile Information Systems division.

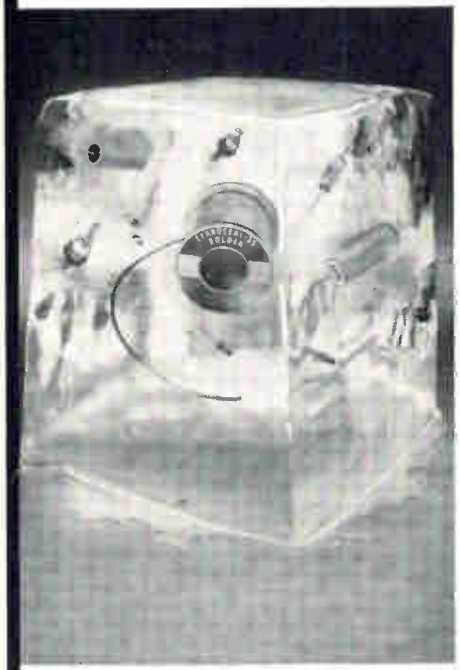
End and means

The transport on available video tape recorders, for example, couldn't shuttle back and forth at the rate demanded by the system. The specified search rate is 380 inches per second, using 2-inch tape. A single reel might have 20 pounds of tape, twice the mass which high-speed digital transports normally have to handle. Acceleration from zero to 380 ips and comparable deceleration had to be achieved within 1.9 seconds. In addition, the transport had to be able to read digital addresses during the search.

In order to meet these design goals, Ampex had to combine the rotating-drum head technique developed for vtr's with the single-capstan, vacuum-chamber techniques used for digital tape record-



Mug shot. Los Angeles County Sheriff's Oracle system can make stored records, including identification photographs, immediately available.



Files on parade

The investment of time, effort, and money required to develop an automated information storage and retrieval system is so great, the Ampex Corp. has made the initial market soundings virtually unchallenged. The company has had the basic tool—the video tape recorder—for over a decade, but only now, after sinking over $8.5 million into R&D is it beginning to win any substantial sales acceptance for its Videofile system.

Last year, Ampex installed a system for handling waybills at the Southern Pacific Railroad. And this spring, it made the biggest single sale in Ampex's history when it signed up the Los Angeles County Sheriff's Department for a $5.6 million system to handle law-enforcement records.

The division itself has grown from 100 employees to over 400 during the year it has been housed in its own building, a 100,000-square-foot facility in Santa Clara, Calif., a few miles south of the main Ampex plant. The marketing department alone now numbers 48—a far cry from the days when it consisted solely of Robert A. Miner, currently product marketing manager. The division is not yet profitable, but General Manager Charles Steinberg says that it will be within a year. And, he adds, by the mid-to-late 1970's, it will be generating sales of some $300 million a year. (Ampex's total sales for fiscal 1969, which ended April 30, were $280 million.)

Head start. Catching Ampex will not be easy, because a Videofile system is not simply a vtr with ancillary support gear. For example, the cost of the nine units in the Los Angeles system is only $375,000; the rest of the money is for buffers, monitors, cameras, printers, and displays. Moreover, Ampex is gobbling up some big customers. It has booked $18 million worth of orders since Videofile was introduced in May of 1966; the Los Angeles Oracle system is its eleventh sale.

Among the other customers are the Sandia Corp., which will use its system for engineering drawings; the American National Insurance Co. of Galveston, Texas; and American Republic Insurance, a Des Moines, Iowa, accident and health firm. There are also a number of Government agencies and commercial prospects that Ampex prefers not to discuss. In this category is the National Aeronautics and Space Administration, whose Huntsville, Ala., facility bought the first Videofile system for a parts reliability file. NASA never had the money to run the system, and has never used it, since the program for which it was intended was cancelled. "That was a real blow to us," Steinberg says candidly. "It hasn't helped our marketing." He is quick to add, however, that the system worked just as Ampex said it would.

ing equipment.

The camera was an equally thorny problem; it required much higher resolution than conventional video units since the documents it would be called upon to scan would not always be in the best of shape. Accordingly, Ampex devised a new vidicon with a two-inch target for the camera, which itself had 1,280 scan lines (15 frames per second), as against 525 for commercial broadcast equipment. Moreover, since the camera is normally operated by personnel who are not technically trained, it had to be extremely simple.

The monitor for the camera also had to be redesigned with dynamic focus on both axes to meet resolution specifications in the corners of the display.

In order not to tie up the transport while a document is being printed out, Ampex developed a buffer system—basically a disk recorder that records an entire document in 1/15 second, and then plays it back into the printer in 3.2 seconds.

Stopgap

But the disk recorder is different from those commonly used as computer peripheral equipment. To eliminate head wear, these machines do not bring the recording head into contact with the disk. However, because of the high video bandwidth of the Videofile system (7.2 megahertz), Ampex could not use this technique. Minute changes in the gap between head and disk would affect the recording.

In the Ampex system, head and disk are kept in contact by a jet of air. The pressure is higher during the short record time, and lower during the relatively long print time. Head life for any one track on the disk is 1,000 hours.

The company's buffer technique has already produced some commercial fallout; it is the heart of Ampex's stop-action video system that has made the instant replay popular on televised sports shows. Steinberg says that the camera, too, will undoubtedly be adapted into a hands-off unit for broadcast tv systems.

Even the printer is new design (although Honeywell uses a similar technique for its 1-megahertz oscillograph). The disk recorder drives a cathode-ray tube which has a fiber-optic face plate; hard copy, if required, is printed out on electrostatic paper.

Case study

The $5.6 million Videofile—dubbed Oracle for optimum record automation for court and law enforcement—that Ampex is selling the Los Angeles Sheriff is expected to cut record-keeping costs by 40%. It's designed to shave maximum retreival times from a day or so to five minutes. Moreover, when the system is completely installed in mid-1971, the amount of floor space required for file storage will be reduced from 40,000 to 3,000 square feet, according to Capt. James C. White, of the Los Angeles Sheriff's Department Technical

Test. Videotape transport is checked by technician on Ampex assembly line.

. . . in the detective bureau, waiting time for files wastes $10,000 a month . . .

Services division. "About $1.5 million will be saved each year in filing clerk salaries alone," says White. "The staff will be cut from 152 to 30."

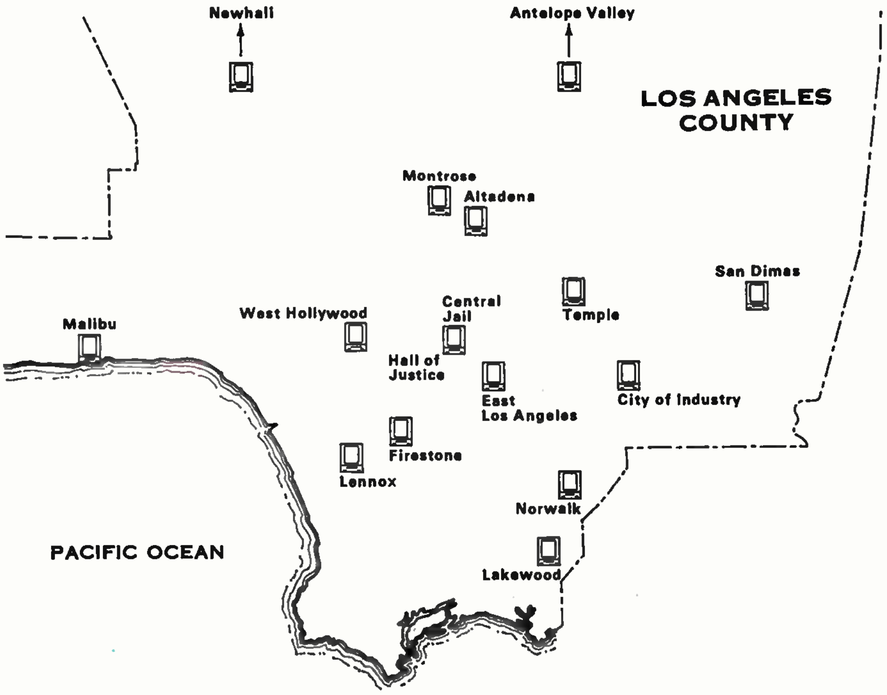
White explains that the cost in delays with the present set-up is far greater than $1.5 million, since this amount doesn't take into account the filing space to be saved and the time investigative officers spend tracking down a particular file. "In the detective bureau, for example, waiting time for files is now costing us about $10,000 per month," he says.

Give-and-take. Oracle will store law-enforcement records, including fingerprints and photographs at a central location in the County Hall of Justice in downtown Los Angeles. Filing consoles and television monitors located at 15 branch sheriff's stations will permit field officers to remotely put case reports, fingerprints, and other documents into the master file. Agents will also be able to retrieve documents from the master file for video display at any of the remote locations.

Equipment in the Hall of Justice will include two filing sections, nine videotape transports, 21 video buffer sections, 36 television displays, two paper copy printers, and two system control sections. Outlying facilities are equipped with filing consoles and television displays. Microwave links for the system, including a relay station atop nearby Mount Wilson, will be constructed at an additional cost of about $1.5 million. Maintenance chores will be handled by Ampex, on a contract basis, at a cost of $44,000 per month.

The system, as installed, allows a 15% expansion of remote stations, and a 40% capacity boost for the central file without the need for additional equipment. About 380,000 new documents will be added to the file each month; current requests from various sources for file information average 100,000 per month.

Unfortunately, requirements covering the preservation of legal documents may prevent the best use of Oracle for some time to come, according to White. "We now have to keep most papers in a dead file for two years, and certain legal documents for a longer period of time, but we're trying to get legis-



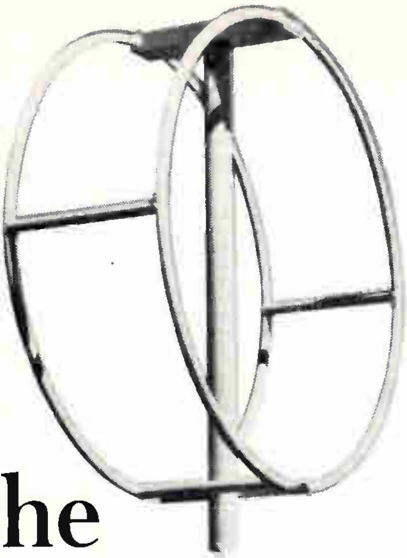
Network. Central file in Los Angeles Sheriff's Oracle system is downtown in Hall of Justice; 15 outlying stations have tv monitors and input gear.

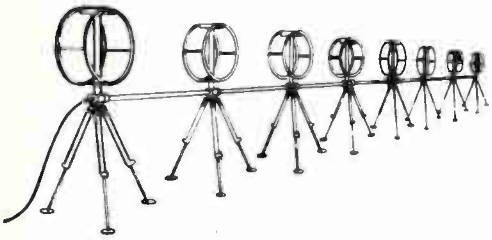
lation passed in Sacramento that would eliminate some of these strictures," he says.

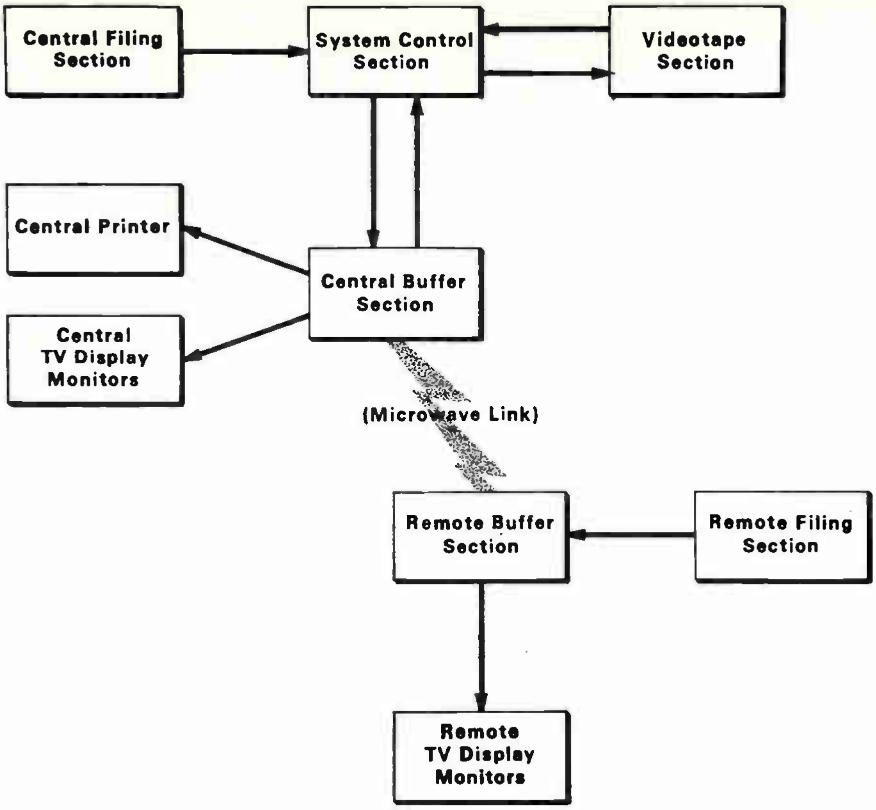
Dirty work. The possible loss of vital documents as a result of accidental tape erasure, fire, or other catastrophes will be guarded against in Los Angeles by making duplicates of master tapes and storing them at other locations. White concedes that erasure of tapes by accident or design "could result in the loss of some documents." But he points out: "The county is already losing a lot by misfiling now. I would estimate that the Videofile system is 150 times more secure than the set-up we have now."

An Ampex source concedes that electronic doctoring of files is possible. But, he points out, it's likewise possible to tamper with written documents. And company officials who cite enough statistics on the economy's paperwork to fill more than a few tapes note that the Southern Pacific—the first commercial Videofile customer—is now destroying waybills once they're on tape. In any case, fewer employees will have access to Oracle than the current system which permits a person to simply go to a file and read it. The Videofile will provide additional security for intelligence, personnel, and administrative files by recognizing only those input requests for information that originate from authorized video monitor locations.

Clues. Fingerprints can be stored and retrieved by Oracle information system.



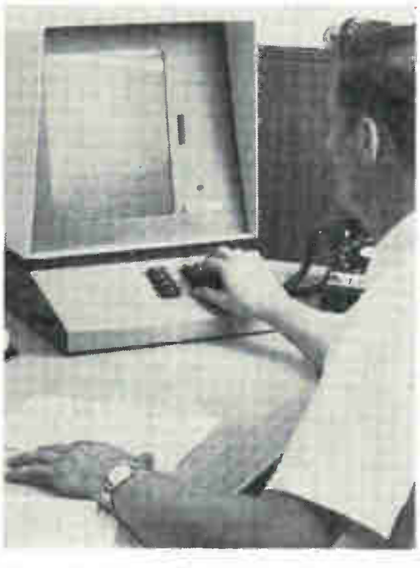




Modus operandi. Block diagram illustrates how outlying station of the L.A. County Sheriff's Department will file and retrieve records, using Videofile.

White believes that other uses for the system will develop with use. Among them:

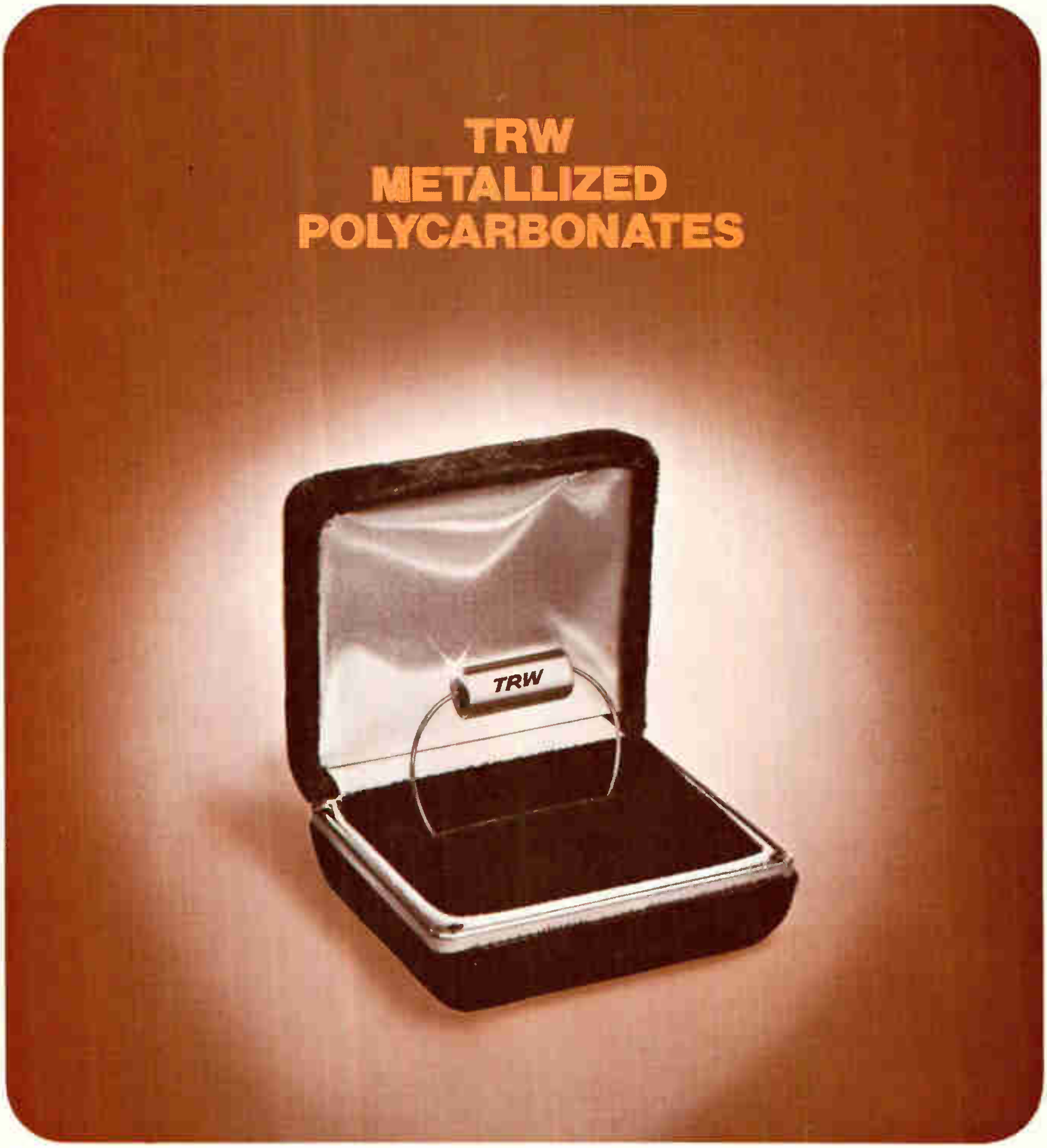
- Quicker identification of criminal suspects by using physical descriptions for composite photographs to retrieve "mug shots" from the file for viewing by the victim on a video display.
- Secure emergency communications during riots or civil disturbances when normal radio channels can't be used by using the system to display simple coded messages to and from outlying stations.
- Rapid filing of photograph negatives without making prints; reversing polarity on the video screen would permit immediate viewing.



Workaday. Videofile can display or print out written documents on file.

Los Angeles County Sheriff Peter J. Pitchess says two additional stations will be added to the system in 1972. He predicts that Oracle will ultimately be expanded to include the courts as well as other local, state, and Federal agencies. Right now, other Los Angeles county departments are interested in the sheriff's installation. "But it may be that for a straight archival job the Videofile would be too expensive," says White. "It will, however, meet our special needs for a high-resolution, quick retrieval system."

Ampex cites independent time-and-motion studies that show an automatic data storage and retrieval system becomes economic for a file of 20 million documents (about 1,500 four-drawer cabinets) when 1,400 or more documents are taken in and out each day.



...good things come in small packages

A 10 mfd 50 volt type X483 capacitor measures a scant .670" x $1\frac{15}{16}$". It's hermetically sealed and provides outstanding temperature stability and electrical properties. Meets all MIL-C-18312 and MIL-C-19978 requirements.

Type X483 are advanced technology capacitors tailor-made for advanced technology applications. Values from .001 to 10 mfd, 50, 100, 200 and 400 volt.

Contact TRW Capacitor Division, Box 1000, Ogallala, Neb. Phone: (308) 284-3611. TWX: 910-620-0321.

TRW®

Circle 137 on reader service card

Only one man in a thousand needs this kind of flexibility in a phase angle voltmeter...

(the other 999 breathe easier knowing it's there.)

One to four-frequency operation with ± 5% bandwidth. Plug-in modules enable frequency additions or change in the field without recalibration.

Direct readout of total voltage (fundamental plus harmonics); *fundamental voltage; in-phase voltage;* and *quadrature voltage.*

Tolerates up to 10x full scale overload without slightest loss of voltage or phase angle accuracy.

Direct readout of *phase angle.*

Measures from 300 μV to 300 V in 13 ranges with ± 2% FS accuracy, <1 μV nulling sensitivit

Options of isolated reference and isolated signal inputs.

The North Atlantic Model 214A Phase Angle Voltmeter (shown with optional bench trim kit) is another example of North Atlantic Industries' leadership in versatile and elegant phase sensitive instrumentation and controls.

For additional rewarding details, call a field-engineering representative (see EEM) or call or write North Atlantic Industries, Inc., Terminal Drive, Plainview, Long Island, N.Y. 11803. (516) 681-8600.

NORTH ATLANTIC
industries, inc.

EE's—names to conjure with

To keep their engineering and managerial talent happy, or at least content, electronics concerns devise elaborate series of job titles and hierarchies

By Peter J. Schuyten
Staff writer

New corporate status symbols—executive washrooms, reserved parking spaces, and dining room privileges are among the better known—are getting harder to come by. But Martin-Marietta may just have one—an executive barbershop. Top engineers and managers at the company's Orlando, Fla., plant have to pay for a clipping, but they have the satisfaction of knowing that their success becomes more visible with every snip of the shears.

Few electronics or aerospace companies have gone to the same lengths to provide their treasured technical talent with such an obvious reminder of having made it. Nevertheless, most have taken the problem at least tacitly into consideration, devising ingenious series of job titles to cover their work forces.

This ploy is, however, not without problems. Many personnel experts admit the difficulties are akin to those involved with more obvious perquisites. Recognizing merit without offending the rest of the workaday engineering staff is a very tricky proposition. Further complicating matters is the fact that no two firms use precisely the same system of callouts. What at one company is a top technical slot spot, say senior engineer, might at another be simply the third of seven rungs on the corporate ladder as it is at the Lockheed Missile & Space Co. in Sunnyvale, Calif.

Moreover, an engineer cannot easily determine the status of colleagues at rival concerns. While technology, marketing, and even production facilities may be strikingly similar throughout, job titles are a very mixed bag indeed. It's especially tough on the personnel director who must decipher and

Bustle and a Peck

Many electronics companies, particularly the larger ones, are structured to the point where an engineer—no matter how brilliant or imaginative—must dance to the tune piped by the personnel department. At the same time, however, there's usually at least one story at these same concerns about the engineer who couldn't or wouldn't be stopped by formal guidelines on his way to management.

David B. Peck, now a vice president of planning and development at the Sprague Electric Co—a free-form sort of firm—offers a case in point. During his 25-year career there, he's held 10 different positions. And although he followed a dog-leg path to his present spot, Peck maintains that each one of the nine other jobs has proved valuable to everything he does in the tenth.

Starting out an an engineer, Peck proved adept at writing his own patents and soon became a patent engineer—a spot where he got his first management exposure.

In succession, Peck's next jobs were: chief services engineer, an administrative post in the company's research labs; contract administrator, where he prepared R&D proposals and negotiated and supervised the work; manager for new product development, more of a technical than an administrative assignment; chief engineer for electrolytic capacitors, a job that combined both technical and administrative responsibilities; and manager of the Special Products division.

At this point, Peck joined upper management, becoming vice president for special products and later vice president for engineering, subsequently moving on to his current spot. "Even though my present job is mainly administrative, I still do creative things involving new products and new concepts," he says. As for his next job, Peck says: "Maybe one of these days I'll find something I can do weli and settle down."

interpret the entries on a prospective employee's resume to determine his qualifications.

Blanket coverage

There are of course, exceptions. A number of organizations, notably research laboratories, deliberately avoid visible trappings, using but one working title for the entire engineering force—member of the technical staff (MTS). A spokesman at RCA Laboratories, where this policy is practiced, says that engineers, especially those engaged in pure research work prefer not to compete for job titles. As a rule, he claims, they're willing to stake their professional prestige on achievement. The rewards, he adds, center largely on salary and publication of technical papers.

A source at Bell Telephone Laboratories, which also uses the MTS system, points out that companies prefer going this route when possible because it's easier to keep track of everybody. "And nobody's nose gets out of joint," he says.

The Mitre Corp., an Air Force affiliate in Bedford, Mass., is another firm that uses the MTS designations. However, a fledgling engineer signing on with the firm passes through two preliminary positions. Successively he's a technical aide and technical assistant before becoming a member of the technical staff; the process can take as long as five years to complete.

To the letter. The Watkins-Johnson Co., a Palo Alto, Calif., producer of microwave IC's, tuners, receivers, and instrumentation, has added a slightly different wrinkle to the MTS gambit. Every one of the company's engineers is a member of the technical staff. But there's a tagline—a letter from A to E—which designates not only the engineer's responsibility but also his salary range and, to some extent, his experience. Thus, a Watkins-Johnson MTS in the A grade would have the same responsibilities and make about as much as a junior engineer at a larger firm.

"The whole point of the set-up is to allow us as much flexibility as possible without at the same time demoralizing our staff by flaunting promotions," says a source.

Flexibility tends to be a function of size. As a rule, larger concerns are relatively more hidebound than smaller ones like Watkins-Johnson. However, the large firms generally offer the assurance of steady promotions based on seniority. In addition, there are what might be called two distinct ladders to the top—one for management and one for technical personnel. In theory at least, the engineer who wishes to stay strictly on the technical side can do so without losing the high salaries and prestige that usually are associated with management. "Let's face it," says a source at a large aerospace company. "A lot


Structured. At Lockheed, engineers' careers follow well-plotted paths; there are paths to the top on both the technical and managerial sides.

Separate paths

Most technology concerns have devised separate hierarchies for engineers and managers. Among the more representative is the Lockheed Missile & Space Co. of Sunnyvale, Calif. As is the case with many other firms, a beginner usually spends several years in a strictly engineering capacity before a decision is made as to which road he will follow. Graduate EE's start with the title of associate engineer, a level at which they're little more than apprentices or interns, according to a Lockheed source. From there, they progress to engineer and to senior engineer—a process that may take as long as six years.

At Lockheed, a senior engineer is considered a real journeyman capable of planning and working on major systems. In rare cases, he might even run an entire test program. As a rule, however, this kind of work is handled by the engineering specialist—the next position in the structure. Referred to by their specialties—for example, reliability engineering specialist or research engineering specialist—these men have about nine years experience and earn between $12,000 and $17,000 a year. This is a pinnacle, or leveling-off point, for most engineers. But it can also represent a way station for those going into management.

The first step along the management path is group leader. Supervisors in this category are responsible for between 12 and 15 people and make anywhere from $13,000 to $23,000 depending on the complexity and importance of the project. Department manager is the next rung at Lockheed; the engineer/manager heads a staff of 100 or more and earns as much as $28,600. The top spot in the line is manager; responsibilities and authority vary with the importance and scope of the project as do salaries which range from $18,700 to $31,900.

Technical side. For the man who wants to stay in engineering the first step after engineering specialist is staff engineer—"a job that rates an office." Pay scales correspond to those for a group leader. Senior staff engineer is the next stop. Senior staffers are considered more expert in their area and report to a higher level of management than their staff colleagues. Salaries run as high as $25,000.

At the highest levels on the technical side at Lockheed are the consulting engineer and senior consulting engineer; the top salary for the latter is $32,000—about equal to wages for the top job on the management side. Men in this group usually hold Ph.D.'s.

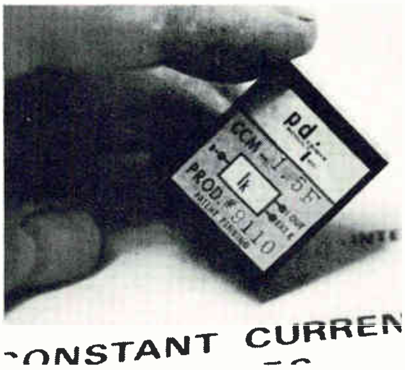
of engineers either are not cut out for or don't want to go into management. But we've still got to give them some kind of incentive."

Separate tables

More often than not, however, there's a gap between theory and practice. An engineering manager at a medium-sized instrument maker with a dual title structure sums things up this way: "We preach separate but parallel, without always practicing it. While the salary range for so-called parallel positions may be the same, the boys in management somehow always seem to be at the high end of the range. The engineers are usually in the middle."

One good index of corporate flexibility is how frequently, if at all, engineers skip a rung on the hierarchical ladder. At Martin-Marietta, for example, neither technical nor managerial personnel can skip a grade. The only way around this is for an engineer to leave for a job at another company and return at a higher level. However, says a company source, this has a negative effect on the morale of those "who are loyal and stay. It almost looks like a reward for cutting out; the practice is discouraged as much as possible." Incidents at Martin are relatively infrequent because it is the only company of its kind in Orlando, and an engineer seeking this kind of leap-frog advancement must be willing to go to the trouble of moving out of town and then back again.

Random action. At the other end of the spectrum are companies like the Sprague Electric Co. in North Adams, Mass., Keithley Instruments Inc., in Cleveland, and the Scam Instrument Corp. in Skokie, Ill., where skipping rungs is permitted and even encouraged. A Sprague source says: "A guy can



Recognition. At IBM, outstanding engineers are singled out as IBM Fellows and given total freedom to pursue any lines of research that interest them.

sure as hell skip rungs on the way up; it's fairly common. Although we're a big company, we try to operate with the flexibility of a small one." In fact, Sprague, according to this man, has no formal rationale for its title scheme. Instead, procedures have developed haphazardly. "We've just never gotten around to sitting down and drawing up a chart," he says.

But one problem seems to crop up regularly in the case of engineers moving from one company to another. Often, they're not satisfied with new titles simply because they carried little, if any, status on the premises of their erstwhile employers.

Robert Bradley, vice president for engineering at Scam Instrument says, "Our hardest problem is relating our title structure to an engineer moving over from another company. We try to explain that there are good opportunities at Scam, but engineers seem much more conscious of such details today—probably because titles are so marketable."

Rewards. Westinghouse is another firm with a fellowship program for engineers.

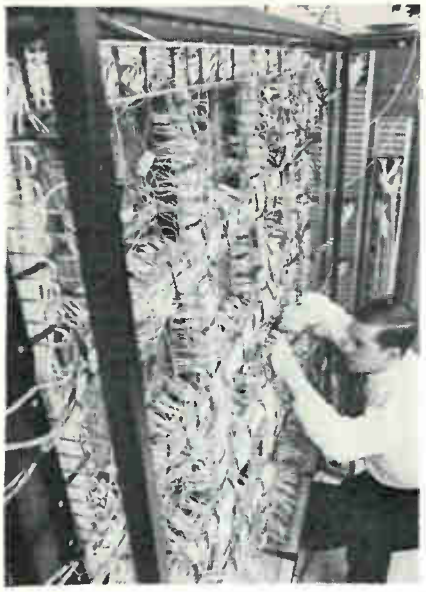
Send money

Most firms won't invent titles to satisfy newcomers. At least one company, however, has been known to hang the title systems engineer on recent arrivals frequently enough to defy the laws of chance. "It's an easy way to keep people at a company," says a personnel man.

Another approach is outlined by a source at Litton's Data Systems division: "Generally we just use money. I can only recall four occasions in the past 10 years where we wanted a guy so badly that we dreamed up a phony title to get him."

Similar in kind is the problem encountered by firms bringing supervisory people from the outside. But here the difficulty is not so much in satisfying the newcomer with a title or money as it is keeping the people who'll work for him happy.

Lockheed-Georgia, for example, tries to maintain a policy of promoting from within by training back-up people for each supervisory engineering position. But it's sometimes faced with a situation where it has to bring in a new man. In such cases, the firm usually starts him off in a technical spot more or less equivalent to the supervisory job he will eventually fill. The idea is for him to absorb Lockeed procedures and methods, subsequently being transferred lat-



E pluribus. There have been only 36 IBM Fellows since the company began.

terally to the management side.

Hail fellow. Then, there are companies which reserve special titles for outstanding engineers. Perhaps the best-known example is the IBM Fellow. Appointed by the chairman of the board, an IBM Fellow is given total freedom to do such research as he pleases. The appointment is for a five-year period but can be renewed. The objective is to recognize outstanding achievements. But there's a practical aspect as well; the company believes that freeing exceptional engineers from supervisory restraints increases their productivity. There have only been 36 Fellows in the history of the company.

Other firms using the title fellow include RCA, Westinghouse, and Mitre. In the case of the latter concern, the designation is for an engineer who is on a leave of absence to continue his education and not for exceptional merit. Although it doesn't use the title fellow, Litton Data Systems also honors exceptional engineering merit with a title sources at Litton says is roughly the equivalent—member of the senior technical staff. According to one company source, "These are people who are used internally as across-the-board consultants in their particular specialty."

Martin-Marietta also has a similar honor called principle staff engineer; only a dozen or so of 2,600 people at the company are accorded this honor. ■

Programming was pretty slow...
Now, the Beckman 6401 is programmable to 136 MHz

In the Model 6401 Programmable Counter and Timer, Beckman offers a general purpose laboratory and production instrument that does what you want it to, at a price you can't resist...$1375.

The 6401 provides direct frequency measurements to 136 MHz and complete programmability from contact closures. And the 6401 makes new measurements that were "unheard" of in the Good Old Days—like pulsed RF frequency or burst frequency measurements and period measurements from both channels for calibrated phase timing.

Timing measurements are a breeze with the exclusive trigger point monitor lamps in the 6401 for optimum attenuator and trigger adjustments. And maximum utilization of field replaceable IC's assures highest reliability and the lowest cost of ownership.

The 6401 is provided in a compact 3½" rackable package to conserve systems panel space, with 1-2-4-8 BCD outputs and scope markers as standard features. Options for serial input and output data, for nine digit display, and oscillator options with stabilities to 5 parts in 10^{10} per 24 hours are available.

Regardless of what "programmable" meant in the good old days, take advantage of what Beckman has to offer today. For complete information, contact your local Beckman office, sales representative or the factory direct.

Specifications

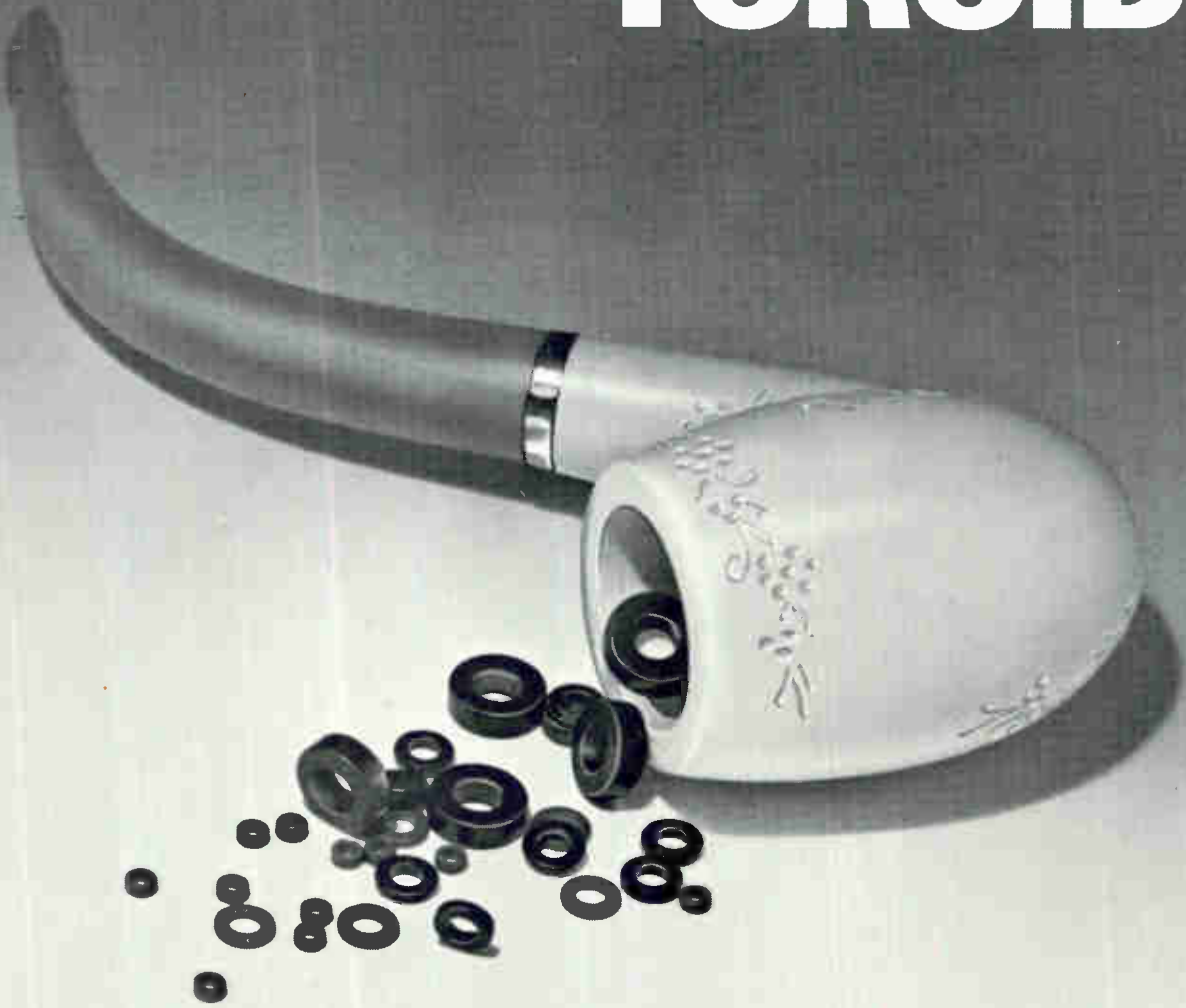
Measurement Modes: Frequency: Input A, 0-136 MHz; Input B, 0-10 MHz. Burst Frequency: 0-136 MHz. Time Interval: A to B, 0.1 μsec to 10^8 sec. Period: Input A, 0-10 MHz. Period Average: Input A, 1 to 10^8 in decade steps. Ratio: (Fx ÷ Fy) x M with Fx = 0 to 136 MHz, Fy = 0 to 10 MHz, M = 1 to 10^8. Totalize and Scale: Input A, 0-10 MHz scale; 136 MHz count, 1 to 10^8 in decade steps. *Sensitivity:* Inputs A & B, 100 mV rms. *Crystal Frequency:* 10 MHz. *Stability Aging Rate:* Temperature: 2.5 x 10^{-6} from 0°C to 50°C; Line Voltage: 1 x 10^{-7} for ± 10% line voltage change. *Oscillator Output:* 10 MHz. *External Oscillator Input:* 10 MHz. *Time Base Output:* 3 V p-p. *Display:* 8 digits with overflow indication. Storage ON-OFF. Sample Rate: fast recycle and .1 sec to 10 sec display. Gate Lamp. *Remote Programming:* by switch closure to ground; BCD data at rear panel. *Temperature:* 0-55°C. *Power:* 115/230 V ± 10%; 50-400 Hz. *Price:* $1375. *Options:* ACL: Laboratory Stability Oscillator, 3 parts in 10^9 per 24 hrs; $400. ACN: Ultra-high Stability Oscillator, fast warm up, 5 parts in 10^{10} per 24 hrs; $800. 9 digits: $100. Rear Inputs (A and B): $50.

Beckman

INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
RICHMOND, CALIFORNIA • 94804

INTERNATIONAL SUBSIDIARIES: AMSTERDAM; CAPE TOWN; GENEVA; GLENROTHES, SCOTLAND; LONDON; MEXICO CITY; MUNICH; PARIS; STOCKHOLM; TOKYO; VIENNA

THE 5000 PERM TOROID



NO LONGER A PIPE DREAM

That's right. 5000 initial permeability. And we mean it!

Perhaps your designs for pulse transformers have gone up in smoke for want of a powerful enough material. Well, now you've got it. And then some. Stackpole Ceramag® 24H ferrite material.

Ceramag® 24H is a precision engineered product. Exact processing, density checks, rigid kiln controls and precise sintering. You get more out of it simply because we put more into it.

Here are a few more conservative characteristics. Maximum permeability, 6900. Typical. Saturation flux density, 4100 gauss and residual magnetism of 850 gauss. If curie point is significant to your operation, how about one of 175° C. Then there's temperature coefficient. Ceramag® 24H goes + 0.700% / ° C at –25° C to 25° C and –0.450% / ° C at 25° C to 75° C. And all of this with a disaccommodation factor of 1.4 x 10^{-6}.

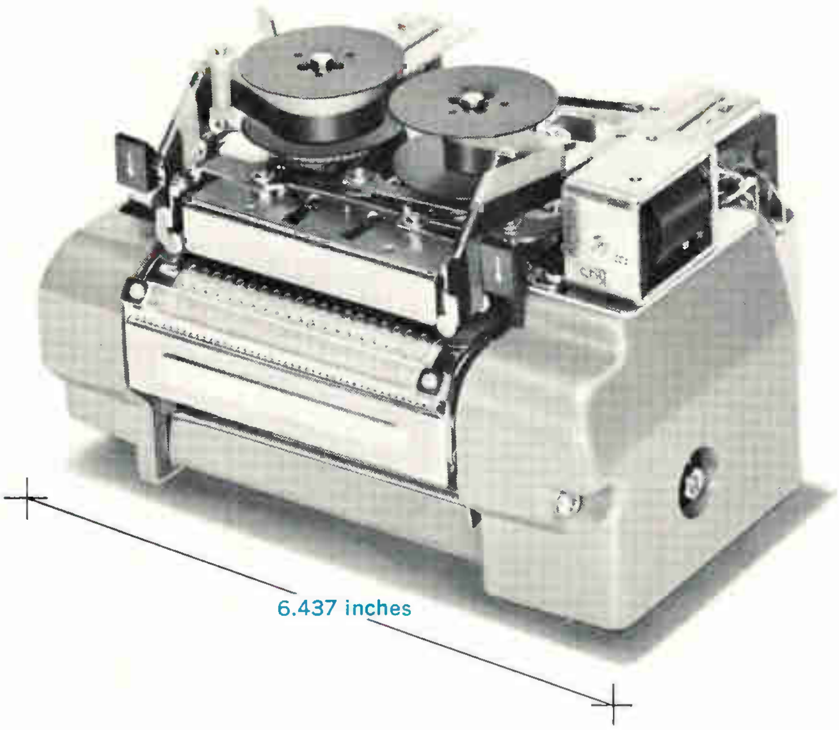
Ceramag® 24H is ready. Are you? Drop us a line and we'll send you some even more interesting facts about this fantastic new material. And the charts to prove it. Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Ph: 814-834-1521

STACKPOLE®
Electronic Components Division

ALSO A LEADER IN THE MANUFACTURE OF QUALITY FIXED COMPOSITION RESISTORS

BIG CAPABILITIES IN A SMALL PACKAGE: *SUWA* SEIKO PRINTING MECHANISM

See it at WESCON '69



- ∗ Ideal printing speed
- ∗ Simplified structure assures durability, reliability
- ∗ Low power consumption
- ∗ Wide range of applications
- ∗ Low cost, high performance
- ∗ Compact size

Be sure to see this Printing Mechanism on display at WESCON '69 in San Francisco, August 19-22. Booth Nos. 3615, 3616. And remember, big things can come in small packages.

Manufacturer:
SUWA SEIKOSHA CO., LTD.
289 Kamisuwa Suwa-shi, Nagano-ken, 392 Japan
Sales Agents in the U.S.A. & CANADA
C. Itoh & Co., (America) Inc.
New York:
245 Park Avenue, New York, N.Y. 10017
Tel: 986-7900 (Area code 212)
Los Angeles:
One Wilshire Bldg. (Suite 805), Wilshire at Grand, Los Angeles, Calif. 90017
Tel: MAdison 7-3175 (5 lines) (Area code 213)
Other Offices:
San Francisco, Chicago, Montreal, Toronto, etc.

Circle 146 on reader service card

High-performance Pen Pals

Honeywell's 530 X-Y Recorder: true differential input and proven reliability . . . for under $1250.

Our 530 X-Y Recorder not only records low-level signals from any source, grounded or floating, it records them so efficiently and so reliably, you can depend on it, day in and day out.

And for good reason. This 530 X-Y Recorder has the same kind of improved snap fit pen assembly (with a polished sapphire tip), carriage assembly and cable arrangement that have made our model 550 and 560 Recorders the standard of the industry.

You'll be happy to know, too, that the Honeywell 530 X-Y Recorder is so simple to operate that even your non-echnical people can learn to use it. And yet, it delivers igh speed (30 in/sec. on X-axis, 20 in/sec. on Y-axis) nd common mode rejection up to 130 db; offers a rouble-free vacuum holddown; and accepts either 8½" 11" or 11" x 17" paper.

Honeywell's 540 X-Y-Y' Recorder: a two-pen recorder with double capability for a price less than $2100.

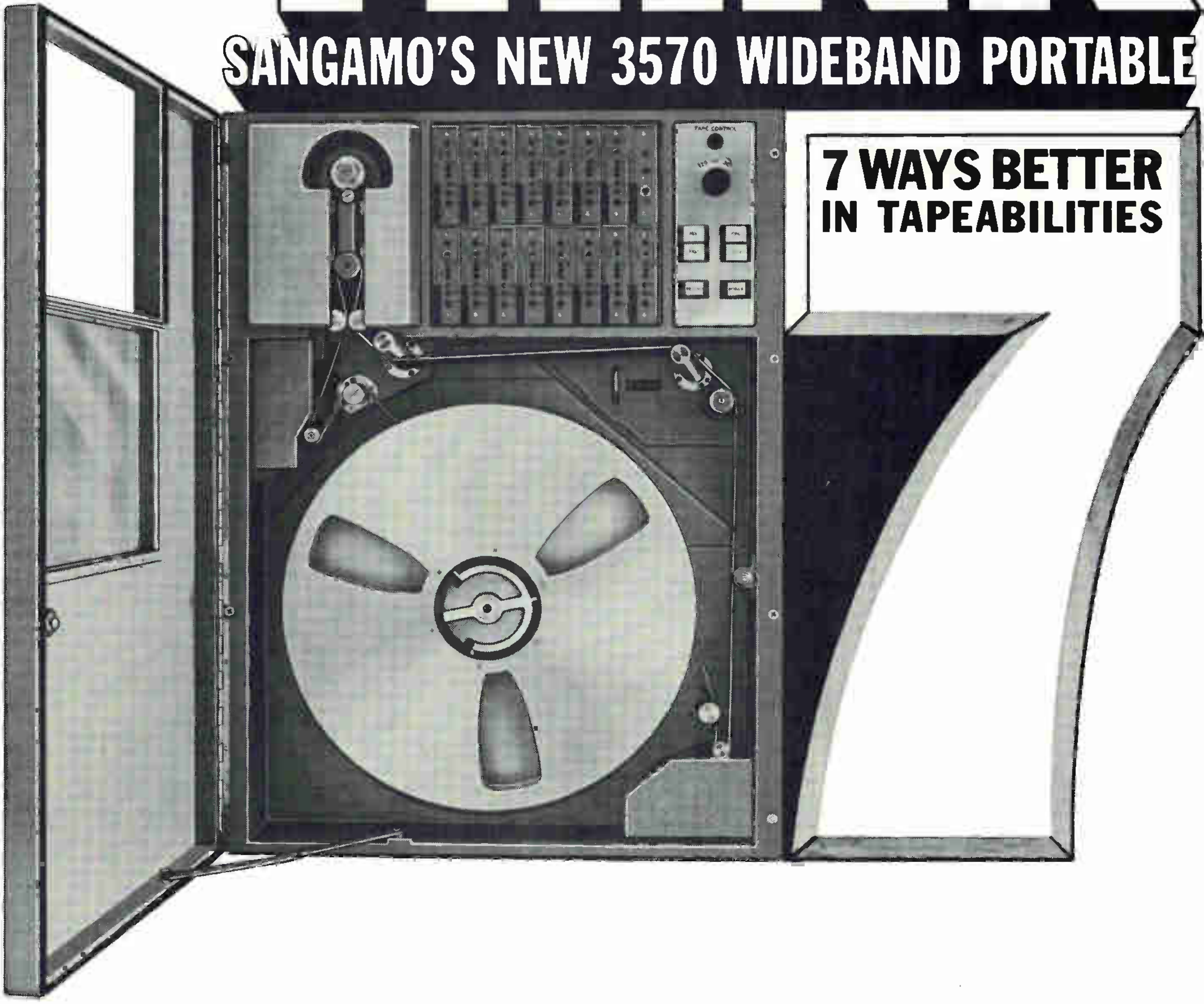
Even though our 540 X-Y-Y' Recorder costs less, it doesn't give you any less. In fact, it's operating characteristics are almost identical to our 530 Recorder, giving you the exact same true differential input, the same proven mechanical design features, the same unsurpassed reliability. Plus it offers 30 ips. slewing speed on each axis and 1 megohm input impedance on all calibrated ranges, as well as when operating at variable sensitivity. It also provides one millivolt sensitivity (each axis), a stylish appearance, vacuum holddown, and will accept either 8½" x 11" or 11" x 17" paper.

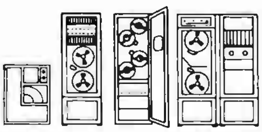
For more information on either of these new X-Y recorders, write or call (collect) Roy Washburn, 303-771-4700, Honeywell Test Instruments Division, P.O. Box 5227, Denver, Colorado 80217.

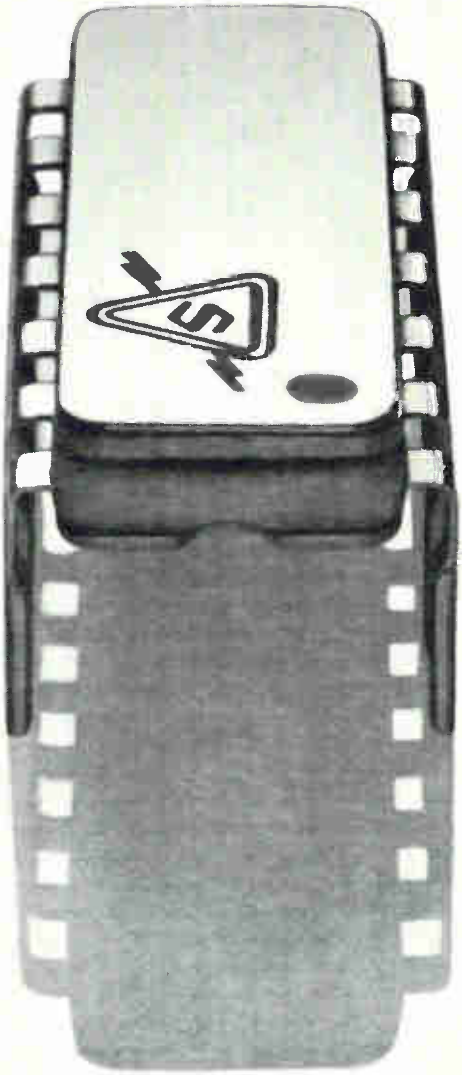
Honeywell

ee us at WESCON, Booths 1306-1309

Honeywell engineers sell solution







Here are two kinds of SUHL circuits. A fast one and a slow one.

Everybody knows that SUHL TTL is a great high-speed logic circuit.

Sometimes they forget that it's great in slow-speed systems, too.

SUHL TTL has better speed/power ratios than most other logic forms at any speed.

At low speeds, SUHL TTL gives you superior current-sinking capability. And you don't have the loading problems associated with other logic forms.

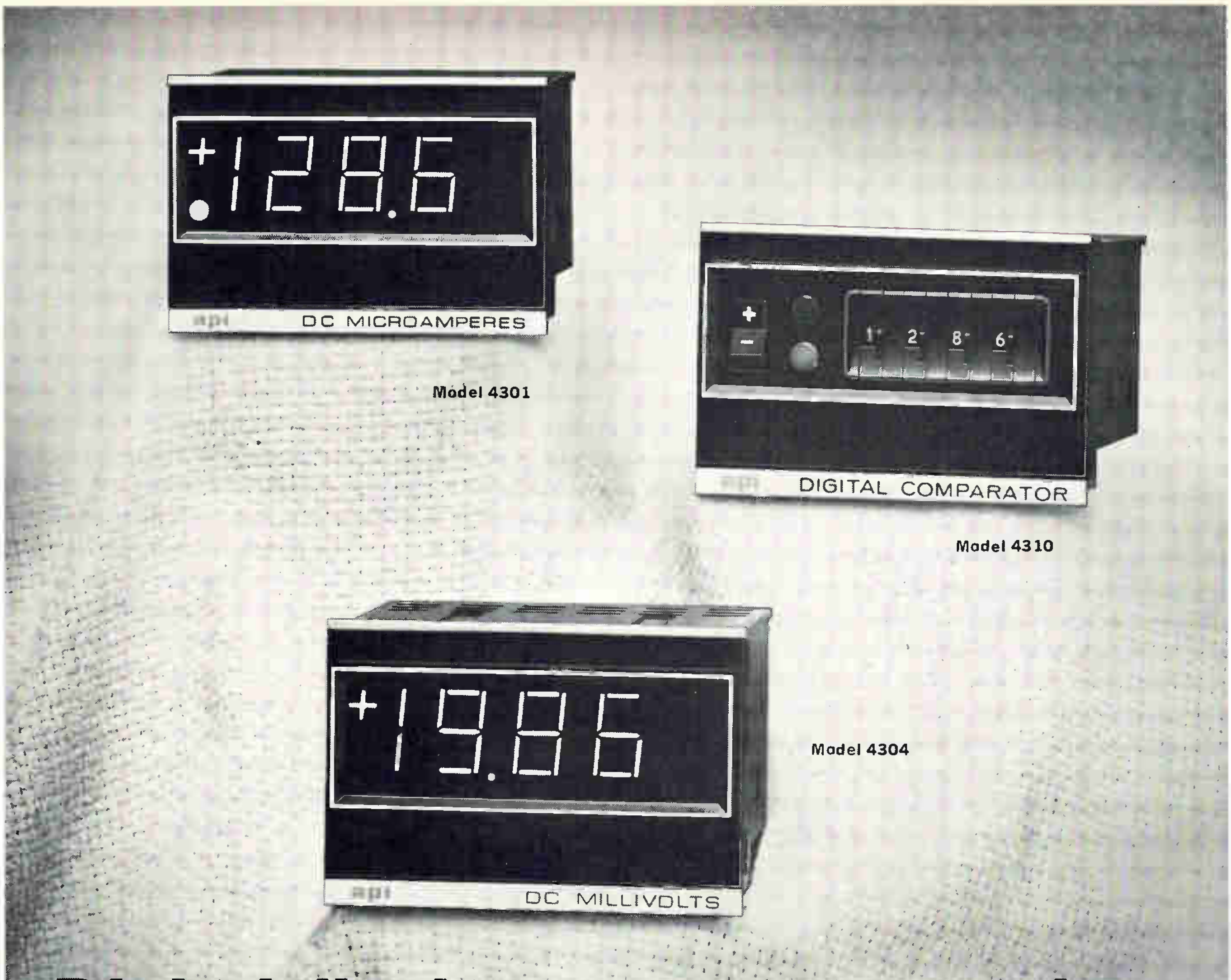
Input/output leads are isolated, and you get a wider choice of configurations in SUHL TTL.

And then there's price. You don't pay a premium for SUHL speed. SUHL prices are competitive with slower speed circuits.

Which makes SUHL TTL the logical choice for any system, fast or slow.

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS

Sylvania Electronic Components, Semiconductor Division,
Woburn, Massachusetts 01801.



Digital display + exact comparison

...a new team from API

API now teams digital panel meters with matching digital comparators to bring you large up-front display plus precise limit control at prices that compete with lower accuracy analog instruments.

Digital panel meters

Model 4301—Range: 0-130 mV to 0-1000 V. Price: $175.

Model 4304—Range: 0-199.9 mV to 0-199.9 V. Price: $195.

Standard features: • autopolarity • 0.1% accuracy • BCD output • dual slope integration • 1½" behind panel • separable power supply

Digital comparator

Model 4310—Four-digit. Price: $165.

Standard features: • BCD input 1-2-4-8 • algebraic comparison • logic output • 2 amp relay contact • visual lamp indicators • adjustable thumbwheel limit • fixed limit • remote programming

For the full story on what's new in digital instrumentation, ask for *API Digital Products Data.*

For low-cost multi-decade displays, API offers 7-bar segmented displays with counter, storage and decoder-driver. Mounting hardware available for displays up to 14 digits.

Wescon Booth No. 1404-05

api

INSTRUMENTS CO.
Chesterland, Ohio 44026 • (216) 729-1611

If Custer had General Electric Computer Time-Sharing Service . . .

. . . it might have been Sitting Bull's last Stand.

With a terminal in his orderly room (you can put one anywhere), he could have foreseen the disaster on paper and achieved a real victory. Too bad he risked all on instinct alone. Fortunately, you don't have to take chances when you solve your business problems.

Whether your job is *risk analysis* (like Custer's), *product design, sales forecasting* or *market research,* if it involves tedious and costly calculations, GE Time-Sharing Service can help you get the right answers faster and easier than any other method. How? By offering you immediate access to a problem-solving computer.

. . . It's easy to learn (GE does the training). It grows with you (we have hundreds of ready-to-use computer programs). It's inexpensive (you only pay when you use the service). And, it is from General Electric, world leader in Time-Sharing Service, already serving over 100,000 people like you.

More facts? Call toll-free: 800-243-0355 (In Conn: Call collect 853-3600) or write General Electric, Box 291-49, Schenectady, N. Y. 12305. Outside U.S.A., write: Canadian GE Information Systems Dept., 214 King St. West, Toronto 1, Ont./Australian GE Pty. Ltd., 103 York St., Sydney, NSW 2000/European Information Service Operation, G.E.T.S. Co., 42 Ave. Montaigne, Paris 8e, France.

Information Systems

World Leader
In Time-Sharing
Service

GENERAL ELECTRIC

Circle 151 on reader service card

Would your family like it if you took a job at Hughes in California?

It's easy to find out.

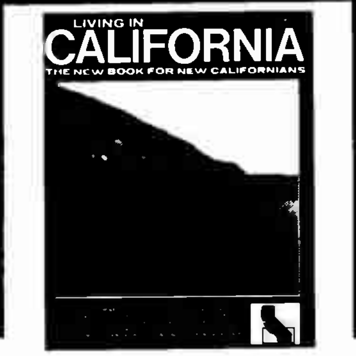
Let's exchange resumes.

Ours includes a 126-page book on Southern California. Do you want to know about living costs? Weather? Taxes? Cultural advantages?

Want to know how to pick a hilltop homesite? How to catch a shark? What to expect on your driver's license test? How much it costs to build a pool? How reading is taught in the public schools?

It's all here, in a good book about a good life. (You'll also find California isn't mere tinsel and glitter. Actually one-fourth of America's physicists live here. So do one-fourth of the members of the National Academy of Sciences and almost half of America's Nobel Prize winners.)

And of course Hughes has a story too. You can imagine the benefits of working with the men who designed Surveyor, Syncom and dozens of other highly advanced systems. We've gathered lots of material for you—facts on everything from



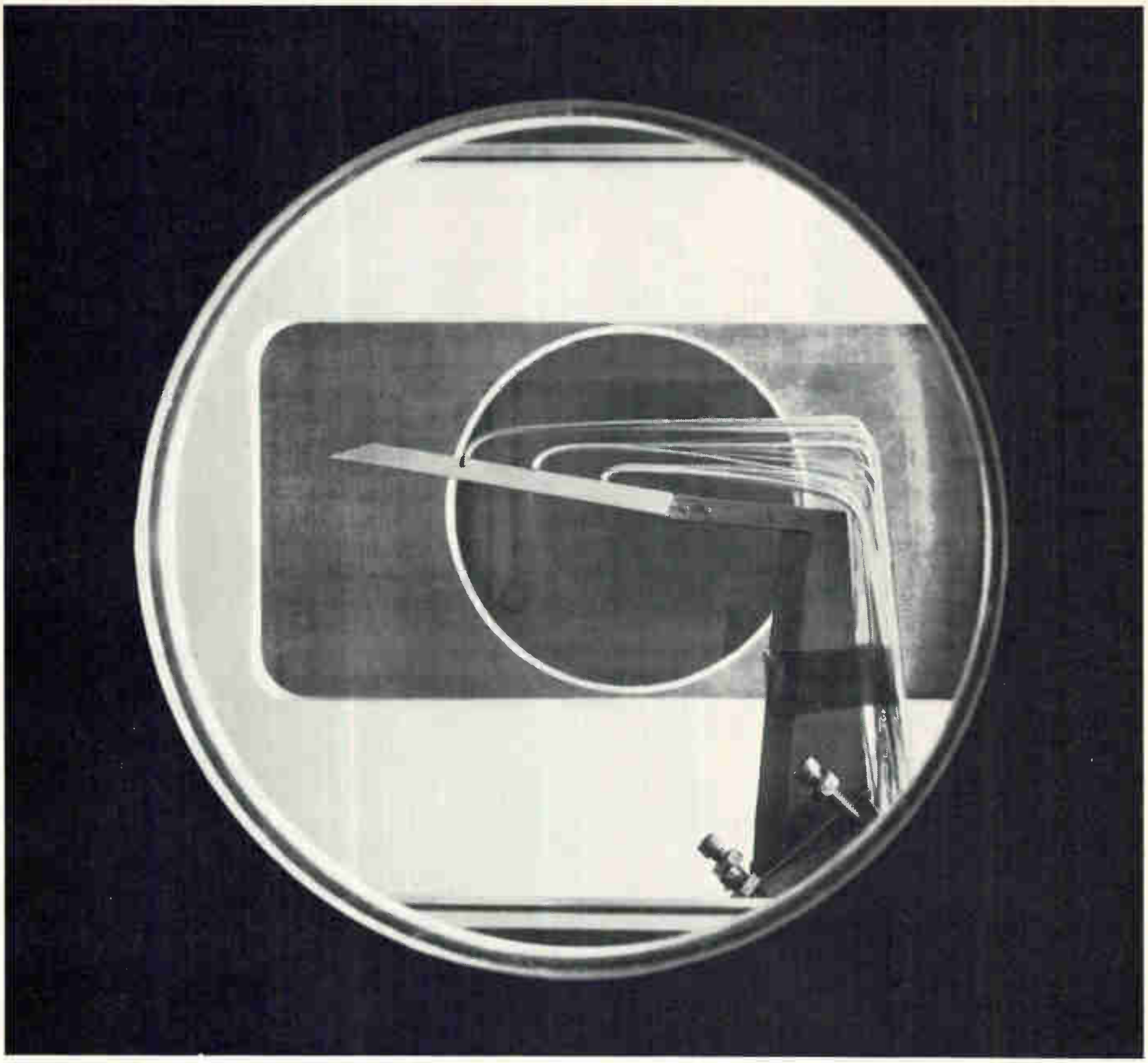
If you're an E.E. from an accredited university with 2 or more years of professional-level experience applicable to aerospace research and development technology, please send us your resume.
We'll send you ours by return mail.

Mr. Robert A. Martin
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Boulevard
Culver City, Calif. 90230

U.S. citizenship is required
An equal opportunity employer—M&F.

HUGHES

HUGHES AIRCRAFT COMPANY



Who's got time to program this test?

Testing a wing section at speeds to Mach 4 is a complicated experiment. You need a computer just to control the instruments and keep up with the data they generate. But most engineers haven't got time to be programmers. So HP developed DACE—a data acquisition and control executive designed to get your computer system on the air in minutes.

With DACE you can direct your system from task to task in clock-controlled real time, scheduling the parameters you want measured, converted, computed, compared, displayed, stored or controlled—in the order you want. You can also interrupt through the keyboard to query a value or change a parameter, without recompiling your program.

Ask your HP field engineer how HP systems with DACE can shorten your test procedures. Or write for our DACE bulletin. Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT PACKARD

DATA ACQUISITION SYSTEMS

06902

Circle 153 on reader service card

The test our tester flunked.

Six months ago, when we came out with our Model 1410 op amp tester, we called it "the most comprehensive, definitive, easy-to-use tester on the market today."

Which it was. And still is.

But: it couldn't test comparators.

So now we've come out with a brand-new tester. Which *can* test comparators. And we call it—with a burst of poetry—our Model 1420.

(The reason we don't bother showing the 1420 is this: it's almost a look-a-like for the 1410. Except it isn't blushing.)

Like the 1410, our 1420 is a snap to operate. You simply insert a program board, and push a button marked "test." Blink, blink, blink: the machine runs through 14 rugged tests.* And, if a device fails any one of them, you know to what degree—because a screen lights up to tell you in percentage figures!

No fiddly knobs, no mysterious meters. In fact, both testers are so easy to use, a secretary can handle them. Any secretary. Even yours.

If you don't care about comparators, the 1410 is your baby. (It'll handle 75% of the linear IC's around today.) Otherwise, you want the new 1420, which takes care of 90%. And if you opt for options, the 1400 series has a host: classification, data logging, automatic handling, computer calculated program values, 1% or 5% program boards, environmental testing.

The price? So low for both models, our cost accountants are still grumbling.

Put these statements to the test... by writing for specs, prices, addendum on the whole Signetics line of testers. Better yet, call collect to Marketing, Signetics Measurement Data Division, (415) 961-9384, for the name of our nearest distributor.

Please, please do it.

Otherwise, this ad will flunk.

*The fearsome fourteen... 1) power consumption overrange (greater than 200%), 2) power consumption (less than 200%), 3) offset voltage (source resistance zero ohms), 4) offset voltage (source resistance programmed), 5) + supply sensitivity, 6) – supply sensitivity, 7) common mode rejection, 8) bias current, 9) offset current, 10) gain (programmed light load), 11) gain (programmed heavy load), 12) noise, oscillation, 13) + slew rate, 14) – slew rate.

Signetics
MEASUREMENT/DATA

"SEE US AT WESCON—
UNIT F"

Signetics, Measurement/Data, 341 Moffett Blvd., Mountain View, Calif. 94040/A subsidiary of Corning Glass Works

Circle 155 on reader service card→

Facts.

The Mark 260 delivers more of them...with less fuss, bother and cost...than any other oscillograph you can buy.

Facts start with accuracy.

And the Mark 260 is about as accurate as you can get. We *guarantee* 99½%. So when you're looking at the chart of a Mark 260, what you see, is fact. We owe it all to a fool-proof position feedback system that enforces pen position all the way across the chart. There are no springs, no strings. Or any of the other tricky mechanisms that you'll suffer with in other recorders.

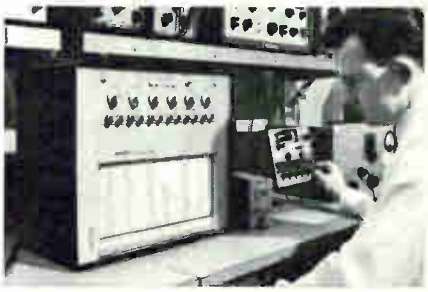
Those traces you see are a lot more than just accurate. They're crisp and clear and reliable from one edge of the chart to the other. They won't smudge or smear. (And you can chalk *that* up to a patented pressurized ink-writing system that puts the trace into the paper and not just on it.)

You can forget about recalibration problems, too. We took care of that little nuisance at the factory. So change those settings to your heart's delight. The Mark 260 will keep right up with you. And save you piles of time and piles of chart paper in the bargain.

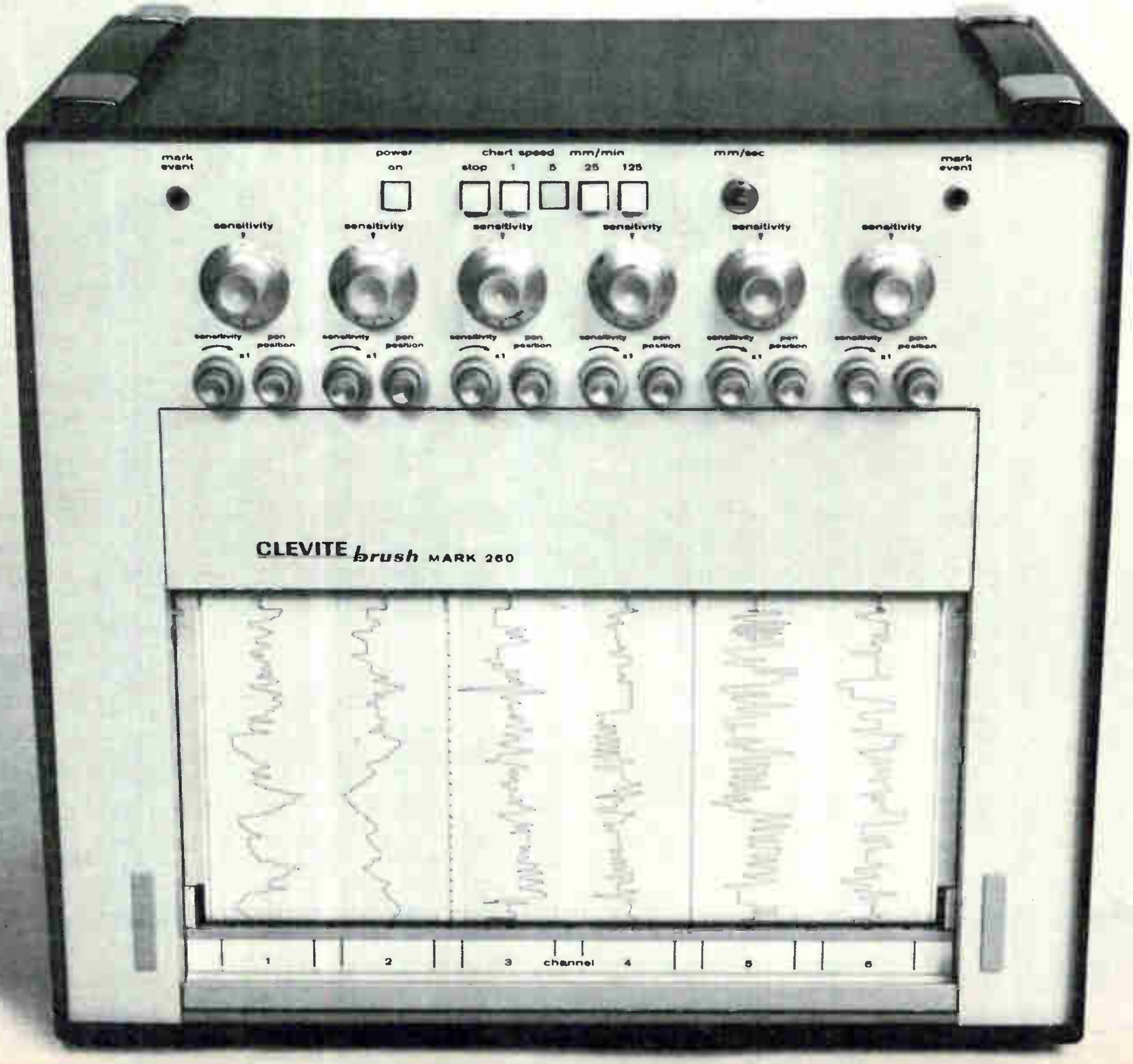
That's what you get with a Mark 260. It's the go-anywhere, do-anything 6-channel recorder by Brush. At a price per channel that will surprise you.

More facts. Less fuss, bother and cost.

Ask your Brush representative for a demonstration. Or write for Mark 260 Bulletin 942-2: Clevite Corporation, Brush Instruments Division, 37th and Perkins, Cleveland, Ohio 44114. We'll include one of the most comprehensive handbooks on signal conditioning you'll ever find.



CLEVITE BRUSH




Let your fingers do the walking.
Yellow Pages

For electrical contacts, as in medicine,

It pays to go to a specialist

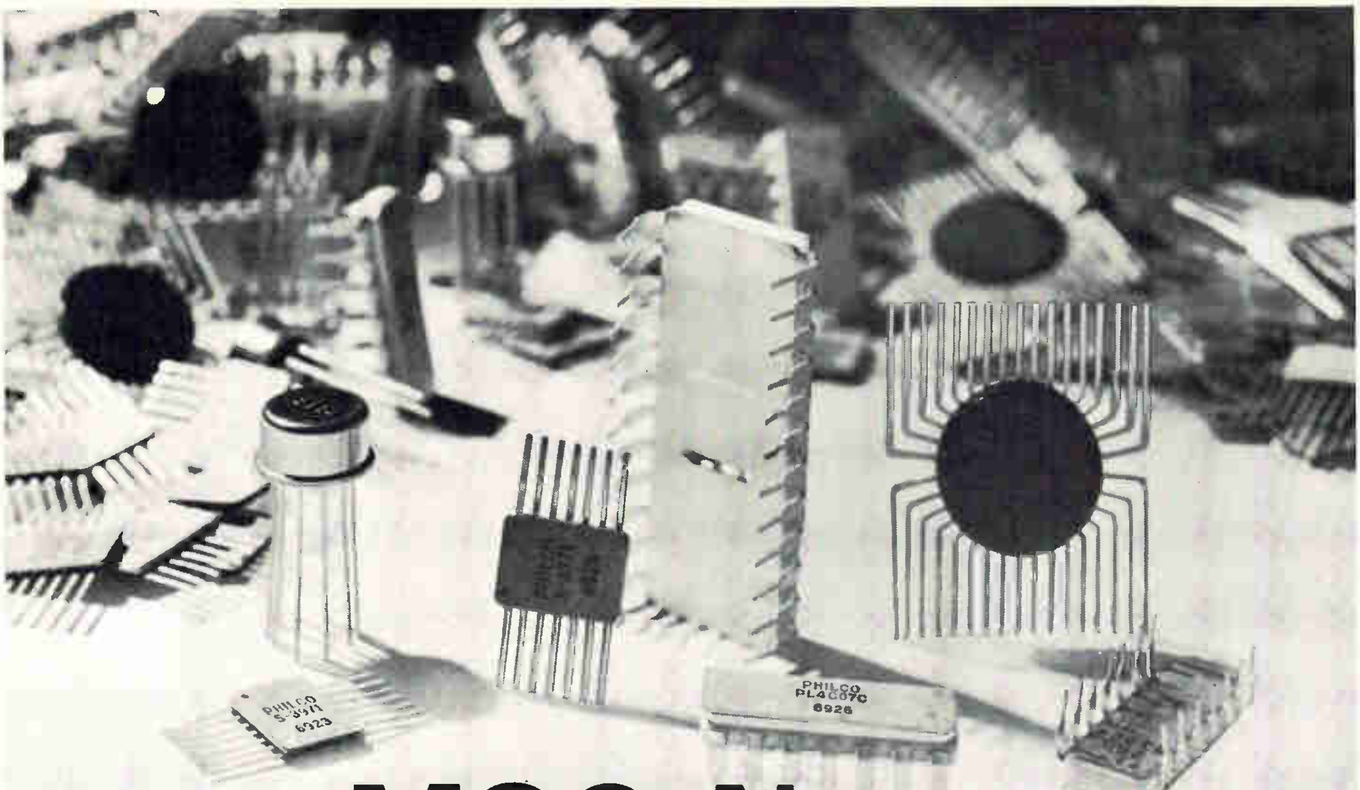
A major operation requires a whole team of specialists. So too, it takes a team of specialists to design contacts. Configuration, materials, electrical performance, contact design and manufacture is complex. That's why Deringer believes it takes 100% concentrated effort to give our customers the best in electrical contacts, contact subassemblies and assemblies. Let Deringer be the doctor. Contact us today. We'll send one of our contact specialists right away.

DERINGER

METALLURGICAL CORPORATION

1250 Town Line Road (Rt. 60) Mundelein, Illinois 60060

Circle 157 on reader service card



MOS. Now.

20 standard Philco types are ready to ship from stock.

Our line of standard production MOS integrated circuits keeps growing broader every day. From our Lansdale plant, one of the largest MOS facilities in the country, you can now get instant delivery of many of the devices that you'll need for your next generation designs. For example:

- Shift registers; including the longest (256 bits) and the fastest (5MHz clock) commercially available in production quantities.
- Compatible gates, up to 2MHz clock, in a variety of configurations.
- Binary counters . . . 16-channel sequential/random access multiplexer . . . 1024-bit dynamic read-only memory, programmed to your bit pattern; off-the-shelf model is a sine look-up table.

Many more are being readied for production. When you want MOS *now,* we're the people to see. Write or call MOS Marketing, Philco-Ford Microelectronics Division, Blue Bell, Pa. 19422. (215) 646-9100.

the better idea people in MOS

PHILCO Ford

Device	Description
pL4C07C pL4C07AC(1)	7-stage binary counter 7-stage binary counter
pL4G10C pL4G10AC(2)	Hex 2 input NOR + 2 inverters Hex 2 input NOR + 2 inverters
pL4G11C pL4G11AC(2)	Dual 4 input NOR + dual 5 input NOR Dual 4 input NOR + dual 5 input NOR
pL4G12C pL4G12AC(2)	Dual 9 input NOR Dual 9 input NOR
pL4S16C	16 channel multiplexer
pL5R32C	Dual 8/16-bit shift register
pL5R40C	Dual 20-bit shift register
pL5R100C	Dual 50-bit shift register
pL5R96C	Dual 48-bit shift register
pL5R128C pL5R128AC(3)	Dual 64-bit shift register Dual 64-bit shift register
pL5R250C pL5R250AC(3)	250-bit shift register 250-bit shift register
pL5R256C pL5R256AC(3)	256-bit shift register 256-bit shift register
pM1024C	1024-bit read-only memory

(1) Clock rate 500KHz (2) Clock rate 2MHz
(3) Clock rate 5MHz

If all systems aren't "GO" after the computer's moved, you know who's going to hear about it.

If you'd just as soon skip a spicy conversation with the Data & Systems people, have a quiet one with Allied instead.

Allied Van Lines has highly-trained professionals who know just how to move your electronics equipment—safely and on schedule.

And our Electronic Vans are just as good as our personnel. They have a special bracing that keeps your computer from shifting . . . an air suspension system that soaks up jolts and bumps along the way.

Call the highly-trained Allied Agent in your area.

ALLIED VAN LINES

We make the kind of moves you never hear about

Circle 159 on reader service card

You're Invited.....

Dear Sir :

As an engineer, we'd like to introduce you to TDK's High Density Ferrite. These newly available series of Mn - Zn and Ni - Zn high density ferrites are 10 times more void-free (less than 1% total void, intracrystalline and boundary).

Hard (Vickers 600) and adapted to precision machining, the new ferrites are superior even to single-crystal ferrite where cost and magnetic properties (particularly radio-frequency characteristics) are major concerns.

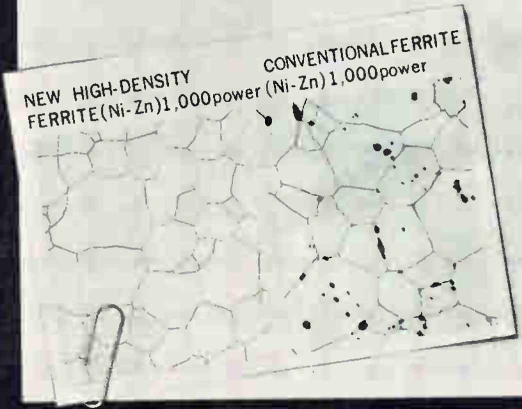
For single and multi-track magnetic head used in computers and the like, and also for many other ferrite devices involving close-tolerance machining High Density TDK Ferrites are the logical choice of every engineering designer.

We invite you to more closely examine TDK ferrites and other products at booth 5009 at WESCON '69 (from August 19th. through the 22nd.)

Most sincerely,

Fukujiro Sono

Fukujiro Sono
President
TDK ELECTRONICS CO., LTD.



Wescon '69 at the Cow Palace, San Francisco, August 19-22
TDK Booth: 5009, Science Systems and Communications area

Write to MH&W for full technical data and information on applications
Representative in U.S.A. & Canada for Ferrite Core for Communications
MH&W INTERNATIONAL CORPORATION
280 Midland Avenue, Saddle Brook, N.J. 07662
Phone: (201) 791-6277 (212) 244-0695

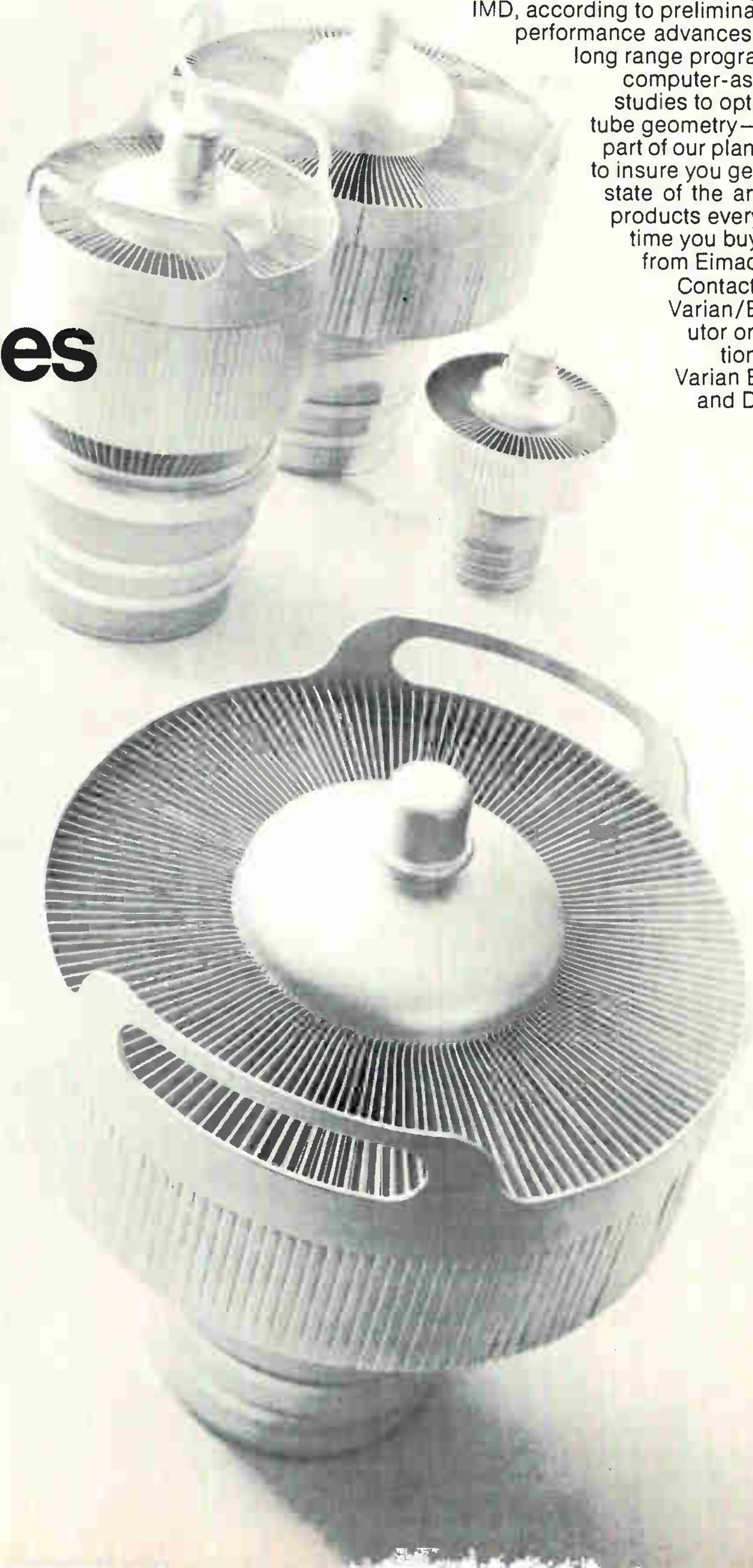
TDK
TDK ELECTRONICS CO., LTD.
2-14-6 Uchikanda, Chiyodaku, Tokyo, Japan

In the power tetrode field we're defining the state of the art by demonstrating intermodulation distortion better than any other known tubes. In 1966 we introduced the 4CX1500B, a 1.5 kW tetrode with the highest linearity then known: better than −40 dB 3rd order IM distortion. Since then we produced the 4CX600J, a 600 watt tube with −45 dB 3rd order IM products—without feedback—and later a 5 kW tetrode with the same figure. Now the latest tetrode in our program, a 15 kW tube, exhibits −40 dB 3rd order IM products. We can show IM distortion improvements from 10 to 20 dB in a practical quiescent plate current range.

Other tetrodes now under development will deliver up to 40 kW with linearity as high as −45 dB IMD, according to preliminary data. Such performance advances are part of a long range program employing computer-assisted design studies to optimize internal tube geometry—all part of our plan to insure you get state of the art products every time you buy from Eimac.

Eimac®
division
of varian

Contact your nearest Varian/Eimac distributor or ask Information Operator for Varian Electron Tube and Device Group.



No tetrodes with higher linearity.

all our customers are huMMMing...

Easy-to-use series MMM microminiature connectors with crimp removable contacts

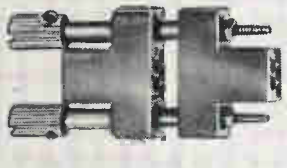
Choose:
5, 7, 9, 11, 14, 18, 20, 23,
26, 29, 34, 44, 50 and 75
contact sizes on .094 centers

We've added extra versatility to these connectors by making them interchangeable with Continental's Series MM-22 fixed contact type. Another feature is the rugged, three-tine tension spring clutch on both pin and socket contacts to provide maximum holding area between contact and molded block.

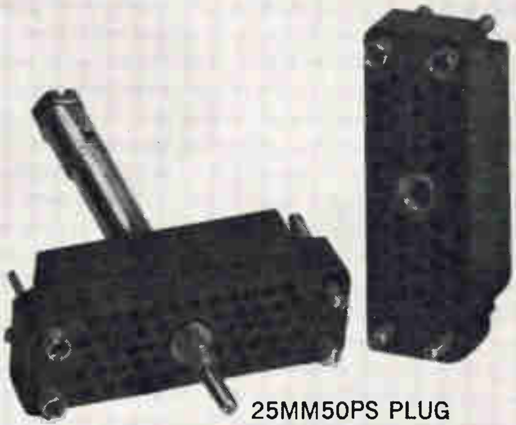
For a complete 28-page catalog covering our entire line of removable contact connectors for solderless wiring, write to Advertising Department, Continental Connector Corporation, 34-63 56th Street, Woodside, N. Y. 11377. Or phone (212) 899-4422 for immediate action.

ILLUSTRATIONS ACTUAL SIZE

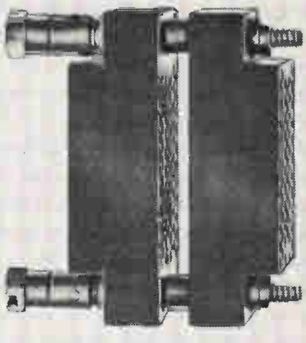
PIN AND SOCKET CONTACT



MMM5PSK PLUG
MMM5SS SOCKET
WITH SCREWLOCKS



25MM50PS PLUG
25MM50S SOCKET
CENTER SCREWLOCK



MMM75PSK PLUG
MMM75SS SOCKET
WITH SCREWLOCKS

For the Sales Representative Nearest You, See Our Listings in EEM and VSMF Directories.

CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE, NEW YORK 11377

Scopes to take product spotlight when curtain lifts for Wescon '69

Tektronix stresses improved readout, flexibility in new line; H-P unveils high-frequency model; Philips features low drift; Monsanto planning entry

It looks like the year of the oscilloscope. And nowhere will that be more evident than at the Cow Palace in San Francisco where Wescon will be held Aug. 19-22.

Tektronix Inc. will display a complete new family of scopes; the Hewlett-Packard Co., moving into the high-frequency end of the business, will show its 250-megahertz model [*Electronics*, July 7, p. 90]; Philips will exhibit a low-drift scope; and the Monsanto Company will talk about its entry into the commercial-oscilloscope business later this year.

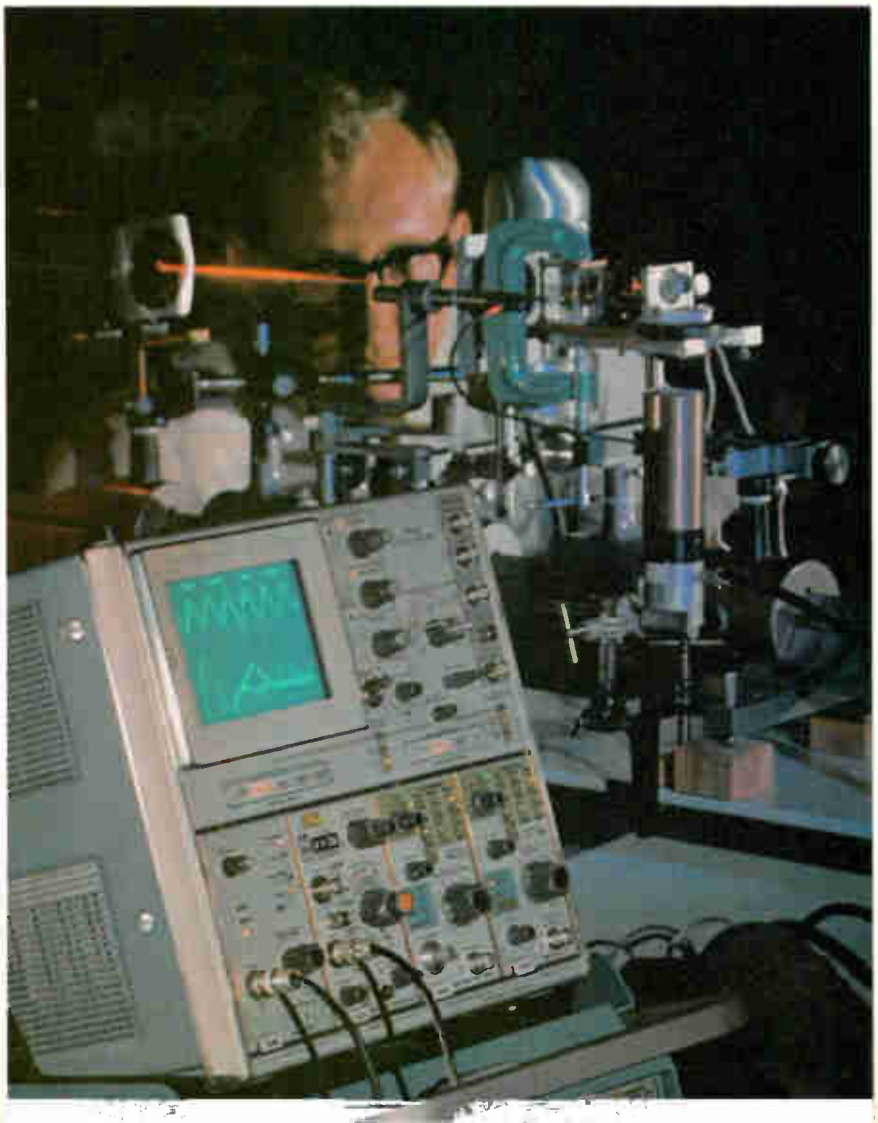
The ubiquitous Tektronix type 545 oscilloscope, which is to be found at enough laboratory benches and test stations to make the company's rivals gnash their teeth with frustration, is about to become obsolete. In fact the whole line of Tektronix scopes, under development since the early 1950's, will be succeeded late this year by two new series that embody a redesign from the component level up. The new series, with plug-ins and ancillary gear, fall into four groups:

- The top-of-the-line 7000 series, including two mainframes and four horizontal and eight vertical plug-ins;
- The non-plug-in series 5000, embodied initially in a low-frequency (1 megahertz), dual-beam unit dubbed the R5030;
- Two cameras, the C-50 and C-51, which automatically select the proper shutter speed and f number for a given ASA film speed and scope luminance;
- Two probes—the 10X P6053, with a rise time of 1.2 nanoseconds or less, designed primarily for the 7000 series; and the slower, dual attenuation (X1 and X10) P6052, designed primarily for low-frequency scopes.

The top model, the 7704, will sell for $2,500; the 7504, $2,000; and the R5030, $1,850.

All of the new mainframes provide parameter readout, so that Polaroid photos will carry their own calibration. The 5030 has the same type of fiber optic readout that Tektronix introduced last fall in the type 576 curve tracer [*Electronics*, Oct. 28, 1968 p. 149]. The 7000 series mainframes have a time-shared cathode ray tube that can display two traces and put the parameters at the top of the screen

Experiment on display. Tektronix 7504 oscilloscope displays two traces during an experiment in light modulation at Pacific University.



Family gathering. The new line of Tektronix scopes includes two mainframes, plug-ins, cameras, and probes.

as well for the viewer.

New meaning. With the series, Tektronix introduces a new kind of catalog code, in which every number refers to a characteristic of the instrument. In the 7704 mainframe, for instance, the first digit notes that the scope accepts plug-ins, the second refers to vertical bandwidth (150 megahertz; the number 7 covers 150-300 Mhz), the third to special features and the fourth to the plug-in compartments.

In fact, Tektronix has gone to great lengths to code the instruments for easier understanding and use. The front panel is color-coded: salmon refers to current functions, grey to voltage, green to triggering, blue to mode, red to variables, and yellow to special functions.

The new scopes do not offer any spectacular improvement in performance. "Our biggest objective was to incorporate a number of new ideas that we couldn't put into the old series," says Oliver Dalton, manager of the conventional instruments group. Readout was one of those ideas; even more important was system flexibility. "Previous instruments had only one plug-in hole in the y axis," says Dalton. "Also, dual-trace scopes are big sellers, but the customer had only one or two dual-trace amplifiers. Now he has a complete choice of a combination of instruments, with current and voltage plug-ins, high speed, and increased sensitivity."

Some of the new instruments outperform the old ones, but these improvements were part of a natural progression, Dalton says. Tektronix could not advance too fast and still serve its existing market, for which the present instrument line is obsolescent. The new instruments are generally the top end of a new line. "Functionally," Dalton says, "they replace all but the storage scope—but because of their relatively high price, they replace only the top of the line. In the future, we will place emphasis in three main areas: low price, new measurement capability (or the ability to make measurements easier), and higher performance."

Easy to use. The R5030 is a low-frequency instrument, but its features are in some ways as remarkable as those of its stablemates. It is a high-sensitivity (10 microvolt) scope designed for use by technicians not familiar with electronics —in mechanical and biomedical fields, for instance. The design goals were maximum display area and ease of operation, says Russ Fillinger, head of the group that designed it.

Because the scope operates at only 1 Mhz, Tektronix was able to use a big crt; it measures 6½ inches diagonally, and the graticule divisions are 1.27 centimeters wide, versus 1 cm on most scopes. Almost 50% of the usable area of the R5030's front panel is taken up by the crt face. "How many volts it takes to move the beam across the face in a given amount of time is mostly a matter of power," Fillinger says. "I can find transistors that can swing a large number of volts; the 5030 takes 250 volts, side to side. At higher frequencies, we would have to do the same job with 50 volts."

More important to users not trained in electronics is the fact that the 5030 is triggered automatically. A peak-to-peak trigger circuit senses plus and minus excursions of the waveform and sets a level control at the same range. The circuit will trigger on either positive or negative slopes. A modification of a Schmitt trigger, it is contained in two integrated circuits built by Tektronix.

In house. Half of Tek's manufacturing capacity is now devoted to components, including IC's. The company builds all its own cathode-ray tubes, metal printed front panels, knobs and relays, three kinds of switches—lighted push-buttons, cams for multifunction switching, and a new push-push calibration switch—all printed circuit boards, coils, and special purpose IC's.

For the 7704, it developed a power supply that does not use a bulky iron coil transformer; in addition to saving weight (the unit weighs about 10 pounds, compared to 25 pounds for conventional types), the new power supply operates at 70% efficiency, versus 50% for transformer units.

These home-grown components have given instrument design engineers a great deal of freedom. Logic signals for the plug-ins, for instance, are generated by in-house integrated circuits.

Both series of scopes are designed for ease of use. The R5030, for instance, can operate in a YT mode, where the beam is driven vertically against time, or an XY mode; in the latter mode, all lights go out on the time section of the front panel, indicating that the user no longer has control over the time base. When a current probe is being used, none of the lamps on the grey voltage section of the front panel will light. The probes have identity buttons, so that if more than one is used, the proper trace can be indicated.

Holds the spot. The instrument has automatic focusing, to control spot size. The focus control and intensity control pots are ganged in opposition on a single shaft; as grid drive increases, and tries to increase spot size, the focus control tries to decrease it, so that the spot size remains constant, while the intensity of the spot may vary.

The 7000 series accepts vertical and horizontal plug-ins on mainframes that contain the power supply, the calibrator, the crt, and the control circuits. Since the internal amplifier is dual channel and electronically switched, the units can combine two vertical channels. It can take a real-time plug-in and a sampling plug-in at the same time. Tektronix anticipates that the two new mainframes will be the start of a whole new series of instruments; for instance, it will bring out a spectrum analyzer plug-in.

Deflection parameters are displayed by interrupting the trace in bursts of 200 microseconds per character. Characters are generated by five 65-mil square IC's, 10 symbols to a die. Like many Tek IC's, they are totally dissimilar from conventional character generators. Each die has 1,440 emitters that serve as a coordinate system to pick out the eight breakpoints required to generate a seven-stroke character. To trace out the whole figure, instead of producing a simple eight-dot display, Tek uses a resistive ladder network connected to the bases of the coordinate-forming transistors. By properly biasing the network, a point of maximum potential can be made to propagate along it, the position of which is controlled by an external scanning voltage.

Truly dual. The two sets of vertical deflection plates give true dual-beam operation, in either an alternating mode, in which the beam makes one sweep for each channel, or a chopped mode, in which one small segment of each channel is traced at a time.

Tektronix, Inc., P.O. Box 500,
Beaverton, Ore. 97005 [303]

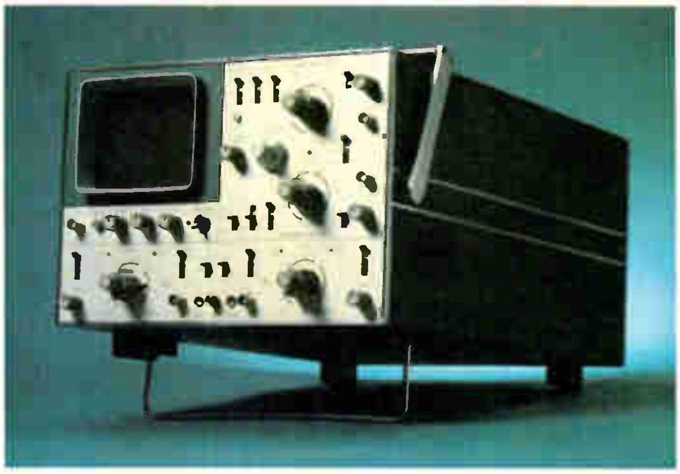
Chopper network fights scope drift

Traces on oscilloscopes are notorious drifters. Turn on a scope, center its trace, and then let the instrument alone. The trace starts moving slowly, usually imperceptibly, up or down until it's finally off the screen. The higher the sensitivity setting, the faster the trace disappears. Besides being annoying, this trace drift is a source of error.

Traces float away because of the drift of the d-c amplifiers that handle the scope's input. No such charge can be lodged against the two d-c amplifiers in the PM 3250, Philips Electronic Instruments' new dual-trace scope. A chopper-controlled network steadies the amplifiers to the point where the scope, according to Philips, is virtually drift free. By "virtually," Philips means that the 3250's traces move no more than a fraction of a millimeter in 24 hours.

Drift is one thing the 3250 can ill afford because of its sensitivity. The maximum is 200 microvolts per centimeter, and with this order of sensitivity any amplifier drift would send the trace flying off-screen.

When its sensitivity is in the μvolt range, the scope has a 5-megahertz bandwidth. If the selected sensitivity is 2 millivolts per cm or poorer, the bandwidth is 50 Mhz.



Steady. Dual-trace scope drifts no more than a fraction of a millimeter in a day, seldom requires adjustments to rebalance amplifiers.

Drift varies with sensitivity. When the scope user picks 200 μvolts, the trace drifts 1 mm in 24 hours. When the setting is 2 mv, the daily drift is 0.5 mm.

Because of its low drift, the 3250 doesn't need any screwdriver adjustments for amplifier balancing. Another control it doesn't have is "Astigmatism;" it's not needed because Philips engineers made sure that when the user changes the beam intensity, he doesn't throw it out of focus too.

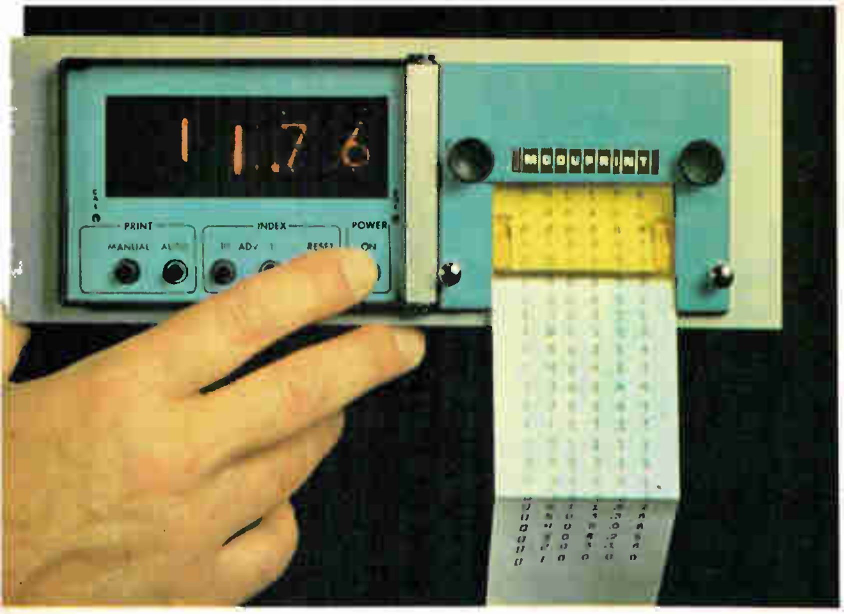
Fans are not found in the 3250 either. The scope, since it draws only 50 watts, can cool itself by convection. Credit for the low power drain goes to field effect transistors and integrated circuits used in the scope.

"Where other people are still using transistors, we have IC's," says a Philips engineer, "and all the inputs have FET's."

A printed-circuit delay line applies a 50-nanosecond delay to input signals instead of the 160-nsec delay used in earlier vhf oscilloscope circuits. The shorter delay means that pulse leading edges can be displayed with minimum distortion.

The 3250's price is $2,175. A few dozen scopes will be available this year, but delivery of large orders won't begin until January 1970.

Philips Electronic Instruments, 750 South Fulton Ave., Mount Vernon, N.Y. 10550 [304]



Show and tell. Combination of dvm and printer comes in portable or rack configuration for display and readout of repetitive measurements.

Printer, dvm in thrift pack

Free, one digital voltmeter with every printer you buy. That, in a sense, is the offer of Practical Automation Inc. Its PDM 611 is a 3½-digit voltmeter combined with a six-digit printer. The price of the whole package is $550, about what a printer alone usually costs.

Credit for the low price goes solely to the printer. "The dvm is just a standard unit, no different than anybody else's," says Practical Automation's Maurice Teichner, "but I can turn out a printer every 15 minutes. Except for the screws, everything in it is stamped or molded."

Such talk could arouse questions about the printer's reliability. But, says Teichner: "It's as rugged as any printer built; we'll guarantee it for half a million operations."

In keeping with its image of thrift, the PDM has no such frills as automatic ranging and polarity indication. In fact, a given instrument has only one range and accepts inputs of only one polarity.

The PDM's choice of ranges runs from 0.1999 volt to 199.9 volts and from 19.99 microamps to 199.9 milliamps.

Although Practical Automation suggests sending the instrument back to the factory for range-changing, the company agrees that the job can be done by a technician. All that's involved is changing two resistors, moving a ground connection in the display-tube assembly, and changing two modules in the printer.

The dvm's accuracy is 0.1% ±1 digit, and its stability is ±0.2 times the lowest digit per °C on the lowest voltage and current range. Meters set to one of the higher scales have a stability of ±0.02. Overloads of 100 times full scale don't damage the meter, and the 60-hertz rejection ratio is 20 db.

The printer's six columns consist of two for index numbers and four for data. Also printed on each line is a decimal point.

The printer works either manually or automatically. When the user pushes the MANUAL button, a pulse is sent to the print solenoid. When the AUTO button is down, the solenoid is fired after every encoding; the printer's maximum rate is three lines per second.

Also on the instrument's front panel are pushbuttons that reset and advance the index. And for those who don't want an index, Practical Automation has a PDM with a four-digit printer; price of this unit is $500.

The PDM comes in either a half-rack package, in which the dvm sits beside the printer, or in a portable package in which the printer is on top of the meter. In a rack mount, the PDM is 3½ by 8 by 8½ inches; the portable package is a bit larger.

Practical Automation Inc., Trap Falls Road, Shelton, Conn. 06484 **[310]**

Associative memory on a chip

One of the drawbacks of semiconductor content-addressable or associative memories has been price. Although custom devices have been built, the memory cells were on one device, and the associated logic—word drivers, sense amplifiers, and match detectors—each required separate chips. Signetics Corp. has developed what it describes as the first integrated-circuit associative memory available as a standard product and marketed at a reasonable price [*Electronics*, Jan. 20, p. 44].

The company expects the memories to be used as an interface between low-speed main frame computer memories and high-speed buffer registers, addressing the main frame memory through the buffer. A typical application foreseen by Ury Priel, who designed the devices, is the generation of data lists. The content-addressable memory can be presented a set of indicators that serve to identify the desired list, and have it dumped from the main memory into the buffer. The data can be read out from the buffer possibly 10 times faster than it could be from the main memory.

Two versions are available. The S8220 is intended for industrial temperature ranges from 0° to 75°C and will sell for $13.31 in quantities of 100 or more; the S8222, designed for the full —55° to 125°C range, is priced at $32 each for lots of 100 or more.

The two devices differ also in their associate delay times and power consumption. For the S8220, the typical associate time—the time required to detect a match or mismatch answer, depending on whether or not a like bit is stored within the memory cell—is 20 nanoseconds at 25°C and 5 volts. Maximum power dissipation is 590 milliwatts at 25°C and 5.25 volts.

The S8222 has a typical associate time of 35 nsec under the same conditions, but dissipates only 300 milliwatts maximum.

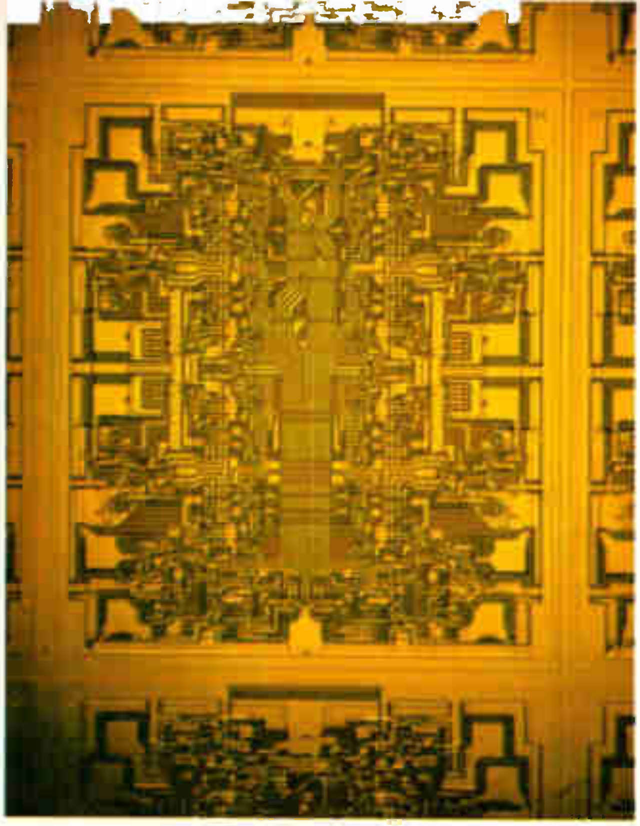
Both memories grew out of internal programs to develop advanced integrated subsystems, says Thomas McCarthy, advanced digital products supervisor. And even though each of the 90-by-100 mil chips contains about 100 gates, Signetics is describing them as medium-scale integrated devices. They combine all the formerly separate logic with the memory cells on one chip. Circuit structure is based on transistor-transistor logic designs, making the devices compatible with TTL and diode-transistor logic input-output levels.

Each of the 8-bit arrays incorporates the addressing logic and eight identical memory cells organized as four words, each two bits long, expandable in both bits and words by interconnecting a number of the devices without the need for additional logic.

The units can also perform write-only and read-only functions. Both are available in either a 16-pin ceramic flatpack or a 16-pin silicone plastic dual in-line package.

Typical readout time for the S8222 is 35 nsec at 25°C and 5-volt levels; write-in time under the same conditions is 80 nsec. For the S8220, readout time is 30 nsec and write-in time is 40 nsec.

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086 **[307]**



All in one. Content-addressable memory, including the associated logic, is on single chip for high-speed data retrieval tasks.

IC's help simplify multimeter

Last March, the Data Technology Corporation introduced at the IEEE Show a 4½-digit voltmeter that had two principal advantages—low price ($695) and small size (3¼ inches high and a half-rack wide). Now the firm has put a 5½-digit multimeter into the same package, through extensive use of integrated circuits and simplified design.

More to the inch. Through use of integrated-circuit logic, versatile 5½-digit voltmeter is built into a half-rack package.

In making basic d-c measurements, the model 370 is accurate to ±0.0025% of reading and ±0.001% full-scale. Without any options, it costs $2,400. In accuracy, the company says, the 5½-digit machine that is closest has a rating of 0.003% of reading, ±0.001 percent full-scale, and costs $3,150 without options; in price, the closest sells for $2,450, has an accuracy of ±0.005% of reading, according to Data Technology Corp.

Seven options—including autoranging, a-c volts measurement from one to 750 volts, ohms measurement from 100 ohms to 10 megohms with a resolution of one milliohm, and ratios to 0.99999:1—

bring the model 370 price to a total of $3,790.

Binary coded decimal outputs and remote control are options that cost anywhere from $150 to $500 in other 5½-digit multimeters; these features are built into the model 370 at the basic price.

Everything but the power supply for the 5½-digit machine is newly designed, says technical director Stephen Ammann. Only six circuit boards are used in the basic d-c measuring machine, which covers the range from 100 millivolts to 1,000 volts in five steps.

Both transistor-transistor logic and diode-transistor logic IC's are used, which helps reduce the unit's size, and so does the use of the input amplifier as the integrating amplifier. Two separate amplifiers are normally required for these functions, and Ammann says Data Technology has eliminated a source of drift, error, and cost by combining these amplifiers.

For analog-to-digital conversion, the model 370 accomplishes self-zeroing by a feedback loop from the integrating amplifier to the zero detector, keeping all the instrument s amplifiers at the most recent threshold to begin a new reading. Thus, the effects of drift on the amplifiers are cancelled after each reading.

Ammann points out that the self-zeroing feature eliminates the need for elaborate temperature control, such as Peltier cooling, to hold down the temperature drift of the input stages and the zero detectors.

Delivery time for small quantities of the model 370 is 60 days.

Data Technology Corp., 1050 E. Meadow Circle, Palo Alto, Calif. 94303 [312]

Calibrator booster reaches 1 kv Over range of 10 hz to 110 khz

More muscle—Calibrator, at top, has 10 times more range when connected to the amplifier (shown with its cover removed).

Who knows? The maker of your a-c voltmeter says that, when set on its 1,000-volt scale, the instrument has an accuracy of 0.1%. How do you check it? "Till now, there haven't been many calibrators that could deliver 1,000 volts; and at frequencies over 20 kilohertz, there hasn't been anything," says Fred Hanson, a design engineer at Hewlett-Packard Co.'s Loveland division. But, thanks in part to Hanson's design work, things have changed in calibration work.

About a year ago, HP introduced the 745A, a calibrator whose maximum output is 110 volts rms and whose frequency range is 10 hertz to 110 khz. Now the calibrator has a helper. The new 746A amplifier boosts the calibrator's maximum output to 1,100 volts rms and doesn't decrease the frequency range. The amplifier's price is $2,000 (the calibrator costs $4,500).

A pair of cables connects the two instruments. One brings the calibrator's output to the amplifier, and the other carries feedback and logic signals.

The 746A consists of a class A amplifier whose gain is 10, followed by a buffer amplifier that is driven by a pair of follower amplifiers. Using a class A amplifier instead of transformers, says Hanson, precludes the generation of meter-mangling spikes.

All the voltage amplification is done by the class A stage; the rest of the circuitry boosts the output's current. When set between 100 hz and 110 khz, the 746A delivers 63 milliamps; when below 100 hz, the output is a linear function of frequency. At 10 khz, the output is 6.3 milliamps.

A resistive divider across the

. . . circuit checks unit during brief warmup . . .

746A's output helps with the regulation. It picks off 1/1,000 of the output and sends this voltage back to the calibrator where it's compared with a voltage proportional to the voltage set by the user. The error signal adjusts the calibrator's output.

The result of this feedback control is that the amplifier's accuracy is 0.2% from 10 hz to 20 hz, 0.05% from 20 hz to 50 hz, 0.02% from 50 hz to 20 khz, and 0.05% from 20 khz to 110 khz. The total distortion is 0.05%, and if the line voltage changes 10%, the output changes 0.001%.

When voltages get into the kilovolt range, safety becomes a major design consideration. The 746A doesn't have interlocks because, says Hanson, "Interlocks are usually cheated anyway." Instead, the 746A's high-voltage areas have plastic covers with holes big enough for a probe but too small for a finger.

The amplifier warms up in 30 seconds. During this time, a logic circuit inside the amplifier checks the instrument out. If everything is alright, the circuit turns on the calibrator and flashes a "ready" light. Even then, the high voltage isn't available at the amplifier's output. For safety's sake, the user must push buttons, one on the amplifier and the other on the calibrator to get the high voltage.

When the calibrator-amplifier combination is set to the 1,000-volt range, the output can be set in 1-millivolt steps between 100 and 1,000 volts.

Specifications
(745A/746A combined)

Range	Resolution
1 mv	0.1 to 1.1 mv in 1 nv steps
10 mv	1.0 to 11 mv in 10 nv steps
100 mv	10 to 110 mv in 100 nv steps
1 v	0.1 to 1.1 v in 1 µv steps
10 v	1 to 11 v in 10 µv steps
100 v	10 to 110 v in 100 µv steps
1,000 v	100 to 1,100 v in 1 mv steps

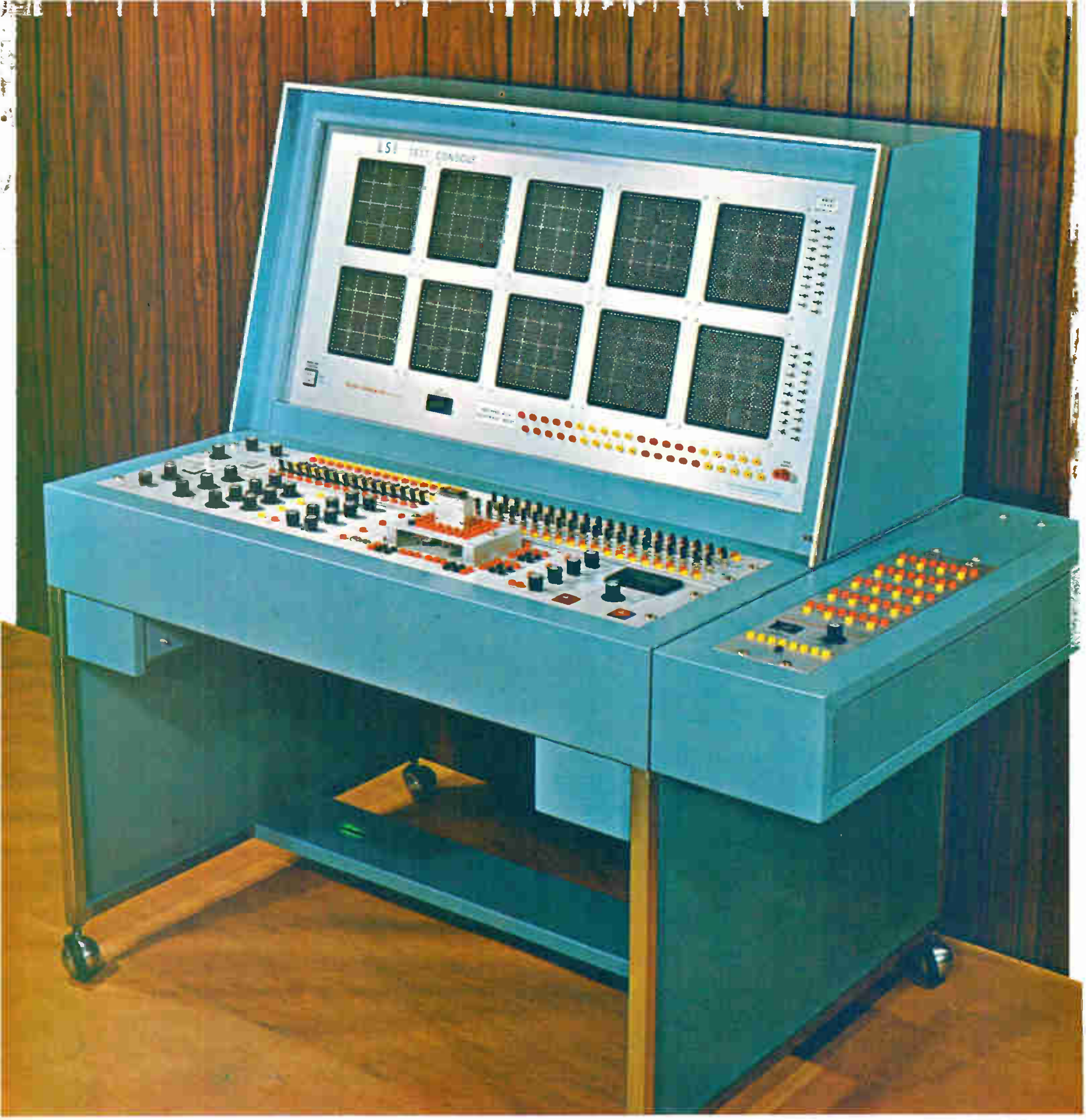
Load capability

1,000 pf or 50 ma on 1 mv to 100 v ranges (50 ma allows 800 pf at 100 v, 100 khz)

1,000 pf or 63 ma on 1,000 v range (63 ma allows 100 pf at 1,000 v, 100 khz)

746A operating temperature 0 to 55°C

Hewlett-Packard Co., Loveland Div., 815 Fourteenth St., S.W., Loveland, Colo. 80537 **[314]**


LSI TEST CONSOLE

Op amp tester analyzes the no-go

Inspection tool. Tester not only screens out substandard op amps, but it helps quality-control engineers to determine why the devices are failing.

For speed and high volume, go/no-go tests are fine, but most of the time engineers need to know why the no-go signal flashes thumbs down on a string of devices. An added complexity is the fact that devices like operational amplifiers must be given a dozen or more tests.

The Philbrick/Nexus Research's model 5104 automated op amp tester is designed to answer the speed/volume needs of quality control and quality assurance and give quick answers to the no-go question through provisions for fine tuning the test parameters every time the op amp fails to meet preset standards. In addition, every step the tester makes, as well as all of its test results, can be picked off and used for data logging, automatic running and handling, binning, oscilloscope display—even computer control.

The model 5104 automatically scans through 14 tests in about two seconds. It takes on both bipolar and field effect transistor devices and disregards their construction, whether discrete, hybrid or monolithic.

Analysis. The 5104's automatic testing is not only fast, it's considerate of the engineer who must pick up the pieces when the no-go light shines. Go or no-go decisions are made after each test. Thus, if an op amp fails test seven, say, the 5104 stops, the no-go lamp flashes, and the test results are displayed on a meter.

If he is in doubt, the engineer can call up the standard for a go indication with a "verify" button beside the meter panel. This way he can compare in engineering units—volts, amperes, or decibels, not percent readings as offered on some machines—the actual with the desired performance. At the same time he can verify test conditions to catch tester errors.

With the 5104 in this so-called "hold" mode, a trouble-shooting engineer can alter test parameters to see what's needed to make the device pass muster. Load resistance, common mode voltage, and output voltage swing can be adjusted, and the resulting meter deflections can give an idea of just where the trouble is.

Although the 5104 would seem tailored to outgoing inspection applications, it's also designed for incoming tests. Fresh from the factory, it's equipped to check for gain, oscillation, common mode and power supply rejection, output voltage swing, common mode voltage, input offset voltage and current, input bias current, and current drain without an input present.

There also are three extra buttons that increase the flexibility of the 5104 to encompass almost any desired test. These can be connected to back panel terminals and used to add any tests the user might desire, or if multiplexed testing is used, to slip several added tests into the sequence of operations.

If, for example, a slew rate measurement is desired, it could be wired into the 5104's scanned test sequence through one of these push buttons. Then when the scan button is pressed, slew rate would be tested as part of automatic sequence. And like standard tests, slew rate also could be done separately by pressing the button assigned to it.

Outputs. Performance indicators also are piped to back panel terminals. Meter voltage, polarity, and scaling are available, making for easy data logging with a relatively slow printer. With this data is a code identifying each particular test, and the op amp's output itself in case it's to be viewed on an oscilloscope.

Outputs for a clock, go and no-go indications, and a relay power supply ease interfacing with automatic handling equipment. And for added tests there is an input for the "advance" signal that the instrument needs in order to move to the next test.

A complete set of test selection lines is piped out to the back and would allow simple computerization of the 5104. But about the only value of computer control, the company points out, would be to allow fast selection among the several tests available.

Philbrick/Nexus plans to sell the 5104 for less than $4500, about $2,000 below its nearest competition. The lower price is the result of taking advantage of the modules already developed as part of P/N's product line. Also, P/N uses a relatively low cost analog meter instead of a digital readout and binary-coded decimal outputs, which would cost up to $1,000 more.

Slew rate isn't included in the standard package, partly because P/N engineers figure that this is an infrequently needed measurement in the markets they aim to serve—QC and QA—and partly to keep the price down. A company spokesman says $500 was cut from the price by foregoing slew rate measurement.

Delivery will take two months.

Philbrick/Nexus Research, Allied Drive, Dedham, Mass. 02026. **[309]**

IC's slim flight-line meter

Traveler. Compact multimeter is portable and can be powered by a battery pack in field operations.

Hauling a bulky digital multimeter from service point to service point can become a taxing chore. And small battery-operated multimeters generally lack the accuracy and versatility required in avionics and computer testing.

Engineers at Lear Siegler's Cimron division had field and flight-line engineers in mind when they designed the model 6453 battery-pack digital multimeter. The 4½-digit multimeter with interchangeable d-c and a-c measurement options weighs 10 lbs., and is 8¼ by 3½ by 12 inches. It measures d-c and resistance with an accuracy of ±0.01% full scale, ±0.01% of reading at 23°C, ±2 degrees. Reference stability using a compensated zener reference is 0.01% for 90 days. Low level d-c measurement down to 100 millivolts, optional on other low-priced instruments, is standard. Plus or minus voltage is automatically displayed, with autoranging for all functions. The basic instrument at $985 includes five d-c ranges, 100 mv to 1,000 volts, with a 20% overrange.

Input resistance is high, 10,000 megohms at 10 volts. Common-mode rejection is 120 decibels at d-c, and 120 db up to 1 kilohertz. The measurement rate is 1 or 4 per second, with the rate selectable through a front panel control.

An optional a-c converter costs $245 and has four a-c measurement ranges from 1 to 1,000 volts. Bandwidth is 50 hertz to 100 khz with maximum voltage ratings of 500 volts from 50 hz to 50 khz, and 250 volts from 50 khz to 100 khz. A-c overrange is 10%. The temperature coefficient for a-c measurement is ±0.002% and input impedance is 1 megohm ±5% shunted at 100 picofarads. Absolute accuracy at 25°C ±5 degrees is 0.2% full scale at 50 hz to 20 khz; 0.5% full scale at 20 khz to 50 khz; and 1% full scale at 50 khz to 100 khz.

Five ranges of resistance measurement, from 1 kilohm to 10 megohms, can be added to the model 6453 as a $185 option. An optional remote printout, using diode-transistor logic and selling for $175, makes the instrument compatible with systems applications. All front-panel control and display functions of the model 6453 are remotely programable.

The meter operates at 105 volts to 125 volts a-c, 60 cycles or 24 volts d-c. The battery pack, which has the same dimensions as the multimeter, is mountable beneath the multimeter case or can be carried separately. Four rechargeable 6-volt, 8-ampere-hour lead-oxide batteries supply d-c power.

Company engineers say extended d-c battery pack operation is made possible through use of a Digivac phosphorous display tube that operates on 24 volts, with only 1½ volts on the cathode.

Approximately 80% of the instrument's circuits are monolithic IC's, and the rest are hybrid thin-film assemblies.

The number of calibration adjustments required has been reduced 50% over comparable units through the use of thin-film circuits in the input attenuator. Improved temperature stability attained by substituting hybrid circuits for discrete components is reflected in the unit's small number of calibration points—only five.

Settling time for the input amplifier is 150 microseconds. The quick reading capability stems from using the same amplifier as that in Cimron's more expensive models.

Delivery time is 30 days.

Cimron Division, Lear Siegler, Inc., 1152 Morena Blvd., San Diego, Calif. 92110 **[308]**

Heavy-duty bonding automated

High-power semiconductor devices require special considerations in wire bonding. Ultrasonic bonding is normally employed, and the large-diameter wire is often bonded to the power transistor or silicon-controlled rectifier die by a hand-held ultrasonic horn. Wire cutoff is frequently done manually. But with the increasing demand for power devices, and particularly multi-chip power circuits, there is a need for automating the bonding process, says William Hugle, president of Hugle Industries, Inc. His company will try to fulfill that need with its newly developed model 1350 heavy-mil bonder.

Hugle says the machine is the first production tool to bond wires up to 10 mils in diameter to individual power devices. He also expects it to be a boon to users making hybrid thick-film circuits with power dice.

The basic machine bonds automatically or manually, and sells

See us at WESCON
Booth #1040-1046

Ideal Constant Current

Like Having 2,500,000,000 Ohms in Series With 2,500,000 Volts

Independent Voltage Limit — preset your voltage, light warns when complying voltage limit is reached.

Excellent Resolution — 0.02% of range setting, three decades of ranges.

Precise Regulation — 25 ppm down to 1 microampere output.

Patented Guard Circuit — prevents leakage paths and voltage monitoring from degrading output.

Unlike many so-called "constant current" sources, the new CCB Series has the necessary high impedance, non-capacitive output. There is essentially no stored energy to dump, delaying response to programming or load changes. Patented Guard Circuit allows the output voltage to be monitored, externally, without degradation. Further, the new CCB Series permits you to preset current and voltage before connecting your load.

Two models are now available: the 6177B at 0-500 mA, 0-50V; the 6181B at 0-250 mA, 0-100V. Either can be remote programmed (resistance or voltage) with an accuracy of 1% or better.

Other operating features are: Transient recovery time of less than 200 μsec for output recovery to within 1% following a full load change; programmed speed of less than 500 μsec. from zero to 99% of programmed current output; resolution of 0.02% of the range switch setting; rms ripple less than 80 ppm of range.

Both Constant Current Sources are 3½" high half-rack size, weighing 10 lbs., and are priced at $425.00. For additional specifications, contact your local HP sales office or write: Hewlett-Packard, New Jersey Division, 100 Locust Avenue, Berkeley Heights, New Jersey 07922 . . . In Europe, 1217 Meyrin-Geneva.

Additional Constant Current/Voltage Models For Higher Current . . . less sophistication

3 MODELS
0 - 3A
Up to 50V

9 MODELS
0 - 3A
Up to 320V

HEWLETT hp PACKARD

POWER SUPPLIES

21906

Powerful. Bonder can handle heavy wire for high-power semiconductors, has controls for either manual or automatic operation.

for $4,800. Work holders for such packages as TO-5, TO-18 and TO-66 headers cost an additional $150 each.

Both wire feed and cutoff can be done automatically by a pneumatic system under solid-state logic control. The wire is fed by a series of pressure rollers through plastic tubing to a set of pneumatically controlled jaws that break the wire after the bond is made.

The operator can set the machine to make one bond and break the wire, or she can do as many stitch bonds manually as she needs in sequence before she triggers the wire cutter. In the automatic mode, the wire is cut off every second bond. She can choose either to have a predetermined wire length fed out automatically or, by using a manual override button, determine the wire length herself. Motorized search-level positioning can be operated manually with finger-tip control, or can be done automatically. Both search positions are independently selectable.

With optional tooling, the machine can bond wire up to 20 mils thick. When bonding wires greater than 10 mils in diameter, problems arise because the wire is too strong for conventional ultrasonic bonding tools. "You can't pull-break a 15-mil wire or you'll damage the power device," product manager Jan Anderson points out.

To overcome this problem, Hugle engineers worked with tool makers to develop a specially shaped tungsten carbide bonding wedge with cutoff assistance built into it. The wedge notches the wire to ease the job of the pneumatic jaws. The pivots on which the tool rides can be destroyed if the energy is transmitted through them rather than through the tool.

For these reasons, tools to handle wire greater than 10 mils are another $150 option with the model 1350. And by buying an extra logic card and bonding head for the machine, the user can accommodate small-diameter wires—down to 1 mil. Hugle believes this $698 option will be useful for laboratory or prototype work encompassing the range from 1 to 20 mils.

Delivery time for the standard 10-mil-wire bonder is approximately four weeks.

Hugle Industries Inc., 625 N. Pastoria, Sunnyvale, Calif. 94086 **[311]**

Nitride deposited uniformly

Silicon nitride passivation and metal oxide semiconductors are becoming increasingly intertwined because nitride lowers the threshold voltage of MOS devices. Makers of bipolar integrated circuits like nitride, too, principally for its protective properties.

But proponents of MOS are becoming disenchanted with the usual equipment employed to deposit nitride—horizontal epitaxial reactors or diffusion furnaces—because they're not happy with the uneven thicknesses of the passivation layers.

To solve the problem, Applied Materials Technology Inc. has developed two horizontal chemical vapor deposition reactors that uniformly deposit either silicon nitride or silicon dioxide—or both—on semiconductor wafers. The firm does it without the use of radio-frequency induction heating systems, which AMT president Michael McNeilly says create bothersome fields, take up twice the floor space, and cost $10,000 to $12,000 more than his company's AMN-710 and AMN-720. Both reactors use infrared heat sources, consisting of a series of high-intensity mercury halogen lamps.

McNeilly points out that the reactors are not intended for customers putting down oxide passivation layers alone, but for those depositing oxide-nitride sandwiches or nitrides alone. The company is billing the reactors as total passivation systems that will deposit oxides from silane and carbon dioxide at 900° C, or nitrides from silane and ammonia at 700° to 850° C to form the usual oxide-nitride sandwich employed with MOS devices.

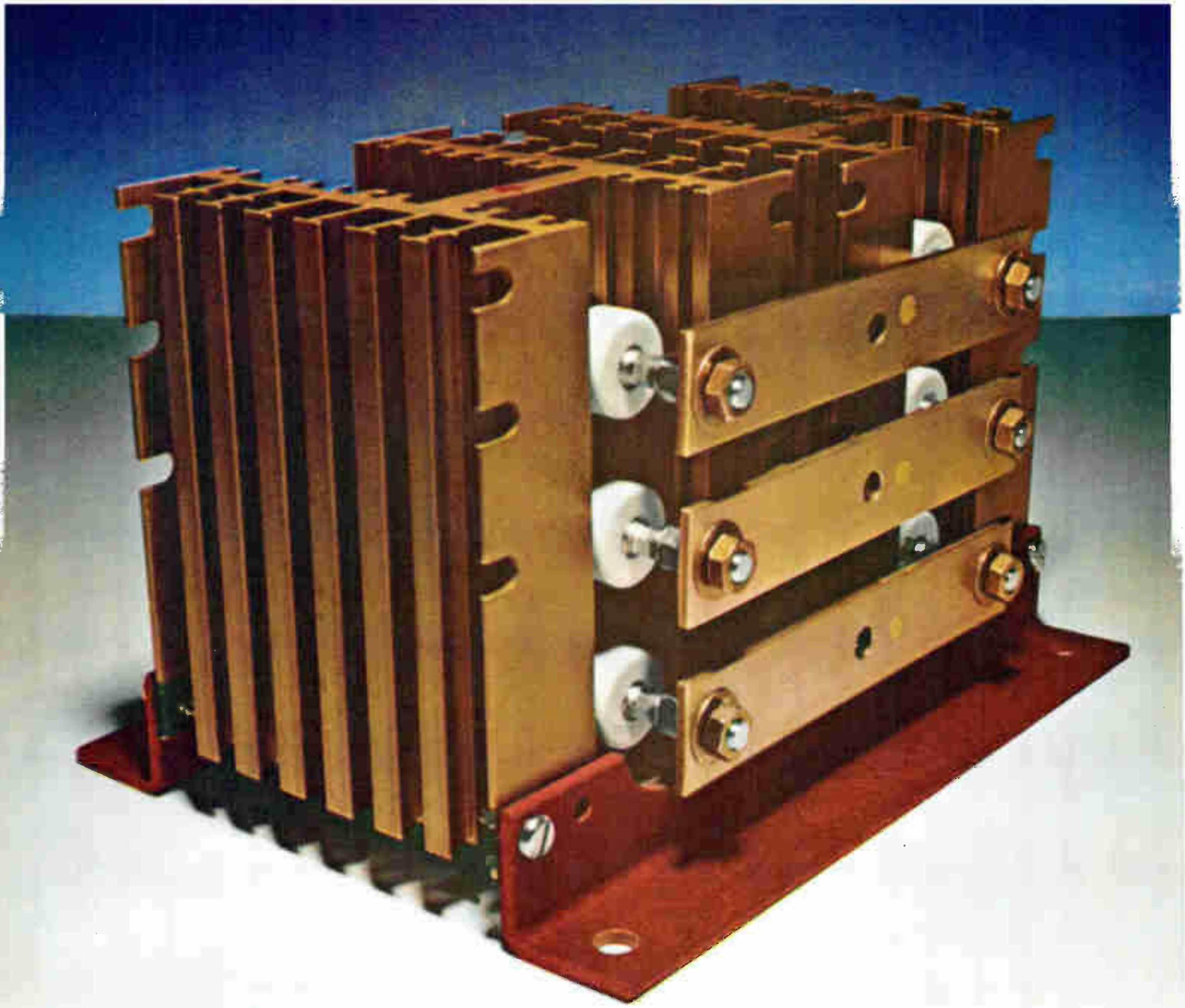
The AMN-710 is considered a small-scale unit for a customer to use in developing his process. It accommodates 10 to 12 wafers two inches in diameter; the AMN-720 can handle 20 to 24 of the same-size wafers in each of two stations in a single run. The smaller, single-station machine sells for $15,000; the AMN-720 for $38,000 to $48,000, depending on the degree of automation desired.

The larger machine will handle 100 to 150 two-inch wafers an hour, depositing nitride layers up to 1,000 angstroms thick. Oxides or nitrides can be grown in the same unit without taking the wafer holders out of the reactor station. Work stations of the AMN-720 can be operated simultaneously or independently, using the same heat source. To do this with an r-f deposition system would require a second power supply costing about $20,000, according to McNeilly.

Further, the 720 can provide six independent temperature zones in which the temperature can be closely controlled.

Delivery time is 8-10 weeks.

Applied Materials Technology, Inc.,
2999 San Ysidro Way, Santa Clara,
Calif. 95051 **[313]**



Try me.

Whether you build stacks or buy 'em... we'll show you how Westinghouse Gold-Line rectifier assemblies yield more power per dollar.

Send for the proof.

After you've tried our assemblies, you'll ask yourself why you bother to build.

Because Westinghouse Gold-Line rectifier assemblies give you simplified design and standardization; fewer parts; bonus output amps.

And you'll save on inventories, parts, labor, testing, rejects and down-ratings. What's more, we guarantee the current rating of Gold-Line rectifier pre-assembled packages. They're compact in design with a wide range of distinct current and voltage ratings and circuit configurations.

Let us analyze your real costs, and prove that Westinghouse can save you money. But first write for our 54-300 catalog and our 54-021 price list. You'll see how our stacks stack up. Then you'll try us. Write Westinghouse Semiconductor Division, Youngwood, Pa. 15697.

You can be sure... if it's

Westinghouse

SC-1-69

Circle 176 on reader service card

Metal-vapor laser goes commercial

Spectra-Physics' helium-cadmium ion unit emits in blue and ultraviolet; air-cooled system is rugged, simple to operate; RCA to market similar product in fall

Product development of the metal-vapor laser took less than three years to accomplish.

The first of this new class of light amplifiers to go to market is a helium-cadmium ion unit developed by Spectra-Physics. It produces a brilliant blue 50-milliwatt beam at 4,416 angstroms and also an ultraviolet emission which the company claims is the shortest wavelength ever produced c-w. This is a 10-milliwatt beam at the 3,250-angstrom line.

The He-Cd laser, considered the first new type to be developed since the neodymium-doped yttrium-aluminum-garnet laser was introduced three years ago, is simple in operation, promises high reliability, and is expected to be relatively low in price eventually. Its only competitor in the blue and uv bands is the argon laser, that is cumbersome and less efficient.

The He-Cd device is expected to have initial applications primarily in photochemistry and biochemistry. Early work on this and other metal-vapor lasers was done at Bell Telephone Laboratories and at RCA, in addition to Spectra-Physics. RCA plans to announce the first in a family of metal-vapor lasers next month. It will have a 10-milliwatt output at 4,416 Å and 3,250 Å. RCA officials say they hope to extend the company's three-year warranty to these new lasers.

Rugged and easy to use, the Spectra-Physics system operates from a standard 115/230-volt 50/60-hertz power source and is designed for industrial applications as well as for the research laboratory. Efficiency is 0.2%; predicted lifetime is 3,000 hours. Much of the system was patterned after the firm's He-Ne laser.

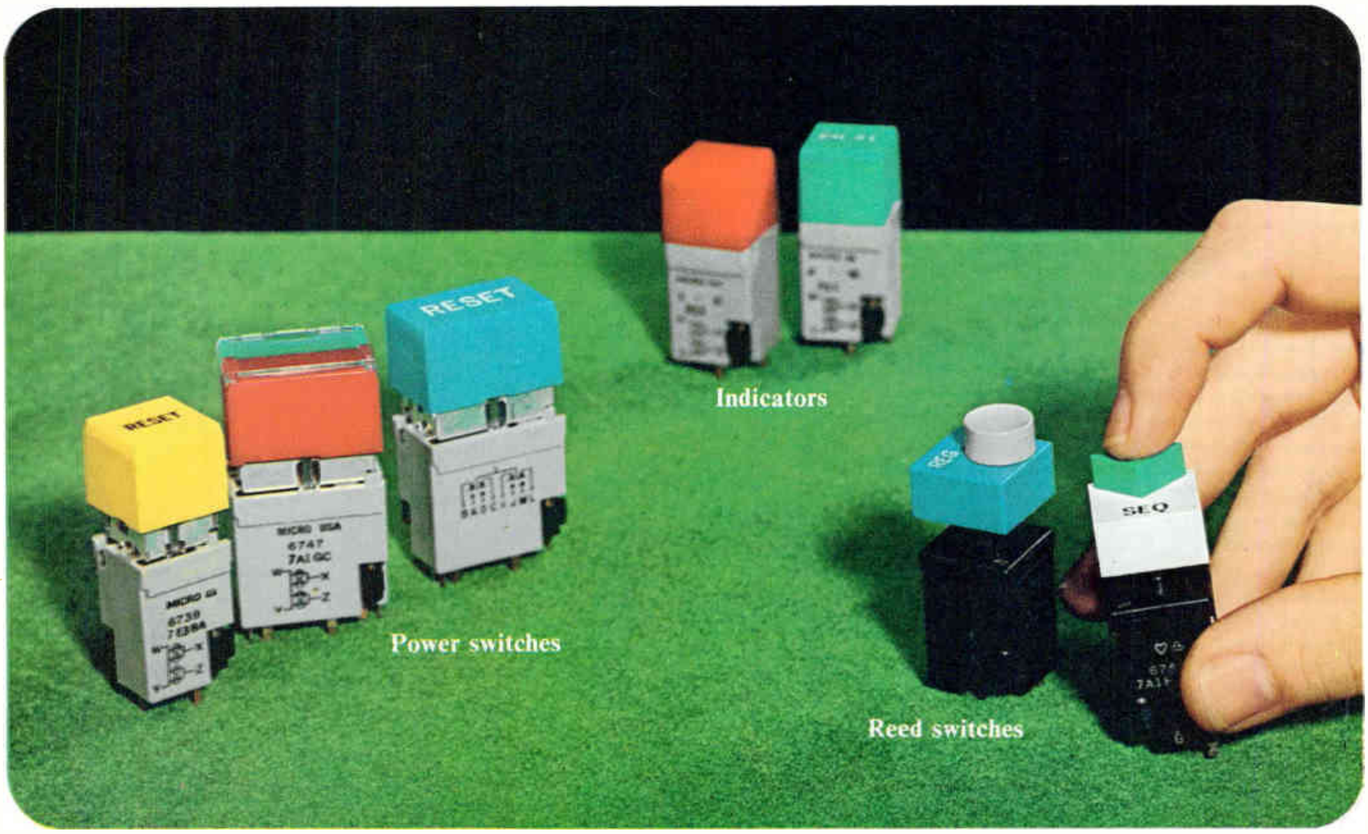
Spectra-Physics began the search for an efficient c-w blue laser light source about two years ago. At that time, experiments with metal-vapor lasers (tin, zinc, and cadmium) at laboratories were revealing the potential of cadmium.

Air cooled. "We were looking for an air-cooled laser which could put out short wavelengths in the blue and uv regions," says Jon Tompkins, product manager. "We began thinking seriously of cadmium when researchers at the University of Utah reported cadmium's lasing potential early in 1967. When we first decided to try cadmium we knew we could get the 4,416 Å to lase, but only after obtaining this wavelength did we realize the possibilities of the line at 3,250 Å. I think we were the first observers of this beam." The 3,250-Å line was first predicted by William Silvfast of Bell Labs.

Work with a cadmium laser continued at Bell Labs, Murray Hill, N.J. There scientists displaced cadmium "pellets" along the bottom of the tube and heated the entire

New blue. Beam from helium-cadmium laser strikes an organic solution in a flask, causing fluorescence. The metal-vapor system is expected to be used initially in biochemistry and photochemistry.

KB matrix-mount pushbutton line now offers the reliability of reed switches



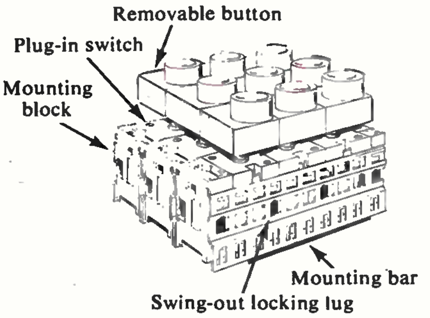
A new reed keyboard switch has been added to the KB line of matrix-mounted pushbuttons. Now, hermetically sealed reed contacts offer full protection from contamination and provide extremely long life.

These new plug-in reed switches are highly versatile: a choice of momentary or alternate-action; 1, 2, 3 or 4-pole contact arrangements; turret terminals allowing either direct wiring, plug-in wiring to connector blocks, or mounting on printed circuit boards; optional alternate-action electric trip.

Besides the new reed switches, the KB line includes a variety of 5-amp power switches: lighted or unlighted, 2 or 4-pole contact arrangement, momentary or alternate-action. Also matching lighted indicators. Reed switches, power switches, indicators and spacers can be inter-mixed and arranged to suit your requirements. Choose from a variety of shapes, sizes, and colors of buttons and pushbars to fully customize the appearance of your panel.

The KB plug-in pushbuttons and matrix-mounting system provide unequalled flexibility in keyboard or panel arrangement. You can assemble and wire a complete matrix at the bench. The box-girder matrix mounts in one panel cutout and requires no additional support.

For full details, call a Branch Office or Distributor (Yellow Pages, "Switches, Electric"). Or write for Bulletin 70.

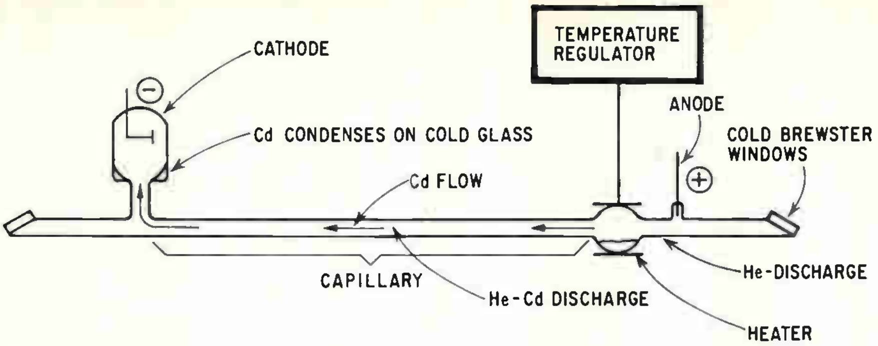


MICRO SWITCH

FREEPORT, ILLINOIS 61032

A DIVISION OF HONEYWELL

HONEYWELL INTERNATIONAL • Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, Japan.



Key technique. Regulation of temperature and voltage helps maintain a uniform metal vapor in capillary, the thin section of the tube.

tube in order to vaporize the cadmium and create lasing of the ion. However, as with most metal-vapor lasers, the major problem was that the rapid buildup of metal concentration gradients caused the beam to break down.

So, while the transitions in cadmium looked interesting, the problems associated with maintaining uniform distribution of vapor proved a major hurdle.

"Cataphoresis, the movement of particles with lower ionization potential toward the cathode, is proportional to the ion current," Tompkins points out. "In large-diameter tubes, a back diffusion would cancel the cataphoresis effect and prohibit the buildup of large cadmium concentration gradients. But since the back diffusion is proportional to the tube diameter and small-diameter tubes are in fact the most convenient for use in lasers, this diffusion is almost insignificant compared to the cataphoresis. Consequently, the large gradient buildup quickly destroyed the proper mixing ratio for lasing."

At the heart. The solution of this gradient problem came from S-P's Dr. John Goldsborough with his successful development of a plasma tube about a year ago. This tube forms the heart of the new laser. Measuring 2.5mm in diameter, it uses special techniques to control the cataphoresis flow and thus maintain a uniform metal vapor throughout the discharge.

The cadmium is heated with a simple resistance heater at the anode and, once vaporized, flows through the tube and condenses on cold glass at an enlarged section of the tube near the cathode.

Two things are done to insure optimum concentration of the cadmium vapor in the laser's capillary, the thin section of the tube. A regulator keeps the heated cadmium at the desired temperature, and the tube voltage is lowered as soon as the vaporized cadmium is present in the helium discharge.

As the heater works and cadmium is vaporized, the tube voltage begins to drop, thus reducing the output of the heater. The discharge maintains a high enough temperature in the plasma tube so no cadmium forms on the inside of the tube. The controlled flow of cadmium ions also reduces condensation on the Brewster windows.

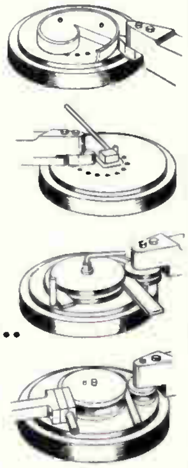
Point the way. The short wavelengths point the way to several new laser applications. The 4,416 Å and 3,250 Å lines can be used in the field of microfluorescence. The lines can also be focused on extremely small areas, so more select samples can be used.

For biochemists doing cell experimentation, the uv line makes it possible to bombard specific chromosomes in the cell nucleus. The 3,250 Å line also widens the scope of photochemical experimentation because its energy is greater than the bonding energy in many organic compounds.

In the study of particle scattering, the shorter wavelengths are extremely efficient. The 3,250 Å line has a relative scattering efficiency almost 7 times greater than the argon-generated 4,880 Å line and more than 14 times that of the 6,328 Å wavelength put out by the He-Ne laser.

Production of the new laser is scheduled to begin this month, with first deliveries in the fall. The price is just under $8,000.

Spectra-Physics, 1250 W. Middlefield Rd., Mountain View, Calif. 94040 **[338]**


New components

Phototransistor gives coupler high gain

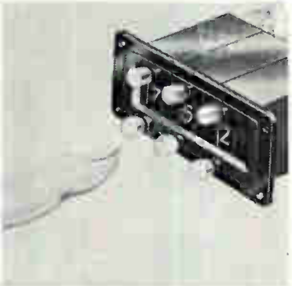
Optical switch consisting of light-emitting diode and npn silicon planar unit isolates relay noise and spikes; molded plastic package keeps price down

Unwanted spikes, voltage transients, and ground currents are problems often encountered in switching circuits using digital integrated circuits and relays. One method for eliminating these problems is to use optically-coupled photoresistors and photodiodes. Since the circuits are optically coupled, relay noise and spikes are isolated and cannot be reflected into other parts of the circuit.

Monsanto, which has been marketing both photodiodes and photoresistors, is expanding its product line to include a phototransistor pair. Called the MCT-1, it consists of a gallium arsenide light-emitting diode coupled by a light pipe to an npn silicon planar phototransistor.

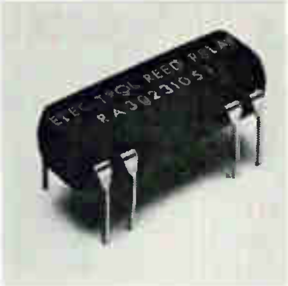
An electrical input signal drives the light-emitting diode which generates photons proportional to the input signal. The photons trigger the light-sensitive phototransistor, and this delivers an electric current at its output.

The advantage of using a phototransistor as the coupling element is the much higher current transfer ratio between the pair—30% as compared to 0.2% for a photodiode. The high built-in gain of the MCT-1



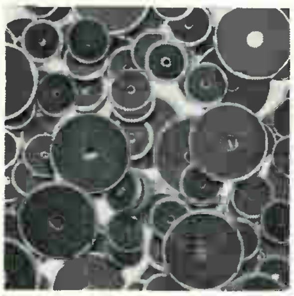
Add/subtract miniature pushbutton switch MPB/AS-27000 is for space-saving military and industrial uses requiring high reliability and long life (over a million operations). It comes in decimal, binary, and binary with complement outputs, and with internal lighting if desired. Special codes on request. Chicago Dynamic Industries Inc., 1725 Diversey Blvd., Chicago. [341]

Relay AZ-530 requires less than ½ in. mounting height. Its high pressure spdt contact, rated for loads to 1 amp, enables it to switch capacitance or lamp loads with current spikes that would normally weld the contacts of reed relays. It has a sensitivity of 125 mw pull-in and insulation resistance of over 10^{11} ohms. American Zettler Inc., Randolph Ave., Costa Mesa, Calif. [342]

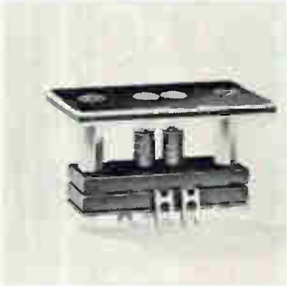


IC compatible reed relays are designed to be used with standard dual in-line packaging and flatpack techniques. They feature dual terminals for all inputs and outputs and total encapsulation to meet military environmental specifications with a temperature range of from −55° to +85° C. Switching speeds are faster than 500 μsec. Elec-Trol Inc., P.O. Box 1, Saugus, Calif. [343]

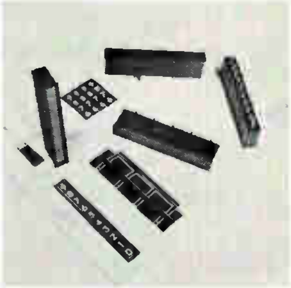
Micro-finish glass substrates for integrated circuit mask applications are flat within 20 μ in. per linear inch. Made of low expansion alumino-borosilicate glass, the substrates are suited for use with metal films such as chromium and can be thermally cycled to improve the glass-to-metal bond. Substrates cost $5 each in sample lots. Corning Glass Works, Corning, N.Y. 14830 [344]



Feed-through, monolithic ceramic capacitor series VF-K1200 offers the filter designer a wide range of dielectrics and voltages. Capacitance range is 0.01 μf to 1.5 μf. Dissipation factor is less than 2.5%. Voltage range is 50 to 400 v d-c. Electrodes are silver (fuse bonded). Temperature range is −55° to 125° C. Varadyne Inc., 1805 Colorado Ave., Santa Monica, Calif. [345]



Multi-lamp strips provide multiple-indicator lamp panels for machine tool control, data display and other industrial applications. Actuated by individual power sources or connected in series with busses, the strips come with lamps mounted on ¼-in. centers. Average cost for standard panels is $1.50 per installed lamp. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543 [346]



Digital strip indicators series 68020 are lighted readouts that display "0" through "9" in single or multiple decades. Units snap into panel cutouts and provide a built-in appearance. Light sources are T-1¾ flange based lamps, incandescent or neon (10 lamps per decade), which are front panel replaceable. Cartelli Technology Inc., 41-10 102nd St., Corona, N.Y. 11368 [347]

Precision ladder switch has a typical switching speed of 380 nsec. Miniaturized to fit two switches into a sealed TO-8 can, the hybrid circuits come in 8 basic types to meet a variety of requirements. Offset voltages are prebalanced to two ladder current ranges: 1.6 ma to 3.5 ma or zero to 1.6 ma. Maximum offset is ±2 to ±4 mv. Mepco Inc., Morristown, N.J. [348]

←Circle 180 on reader service card

. . . optical unit can act as solid state relay . . .

makes the circuit directly compatible with integrated circuits as well as transistors.

Isolation between input and output is 10^{11} ohms with 2,500 volts breakdown and 3-picofarad coupling capacitance. The pair switches between 2 and 12 microseconds depending on the load and collector current. The frequency range extends from d-c to 300 kilohertz, and output rise and fall times are typically 2 microseconds.

The optical switch can be used wherever high-speed isolation-switching functions must be performed. It can replace isolation transformers, couple IC logic elements such as DTL and TTL, serve as a link between analog to digital converters, or as a solid state relay.

Monsanto is offering the devices for prices ranging from $20 each in small quantities to $10 in quantities of 1,000 or more. The circuits are packaged in low-cost, high-volume molded plastic packages.

A similar unit is sold by Texas Instruments: The TIXL 101-103 sells for prices ranging from $70 each in small quantities to $20 in large quantities. The electrical specifications are similar to those of Monsanto but units are hermetically sealed.

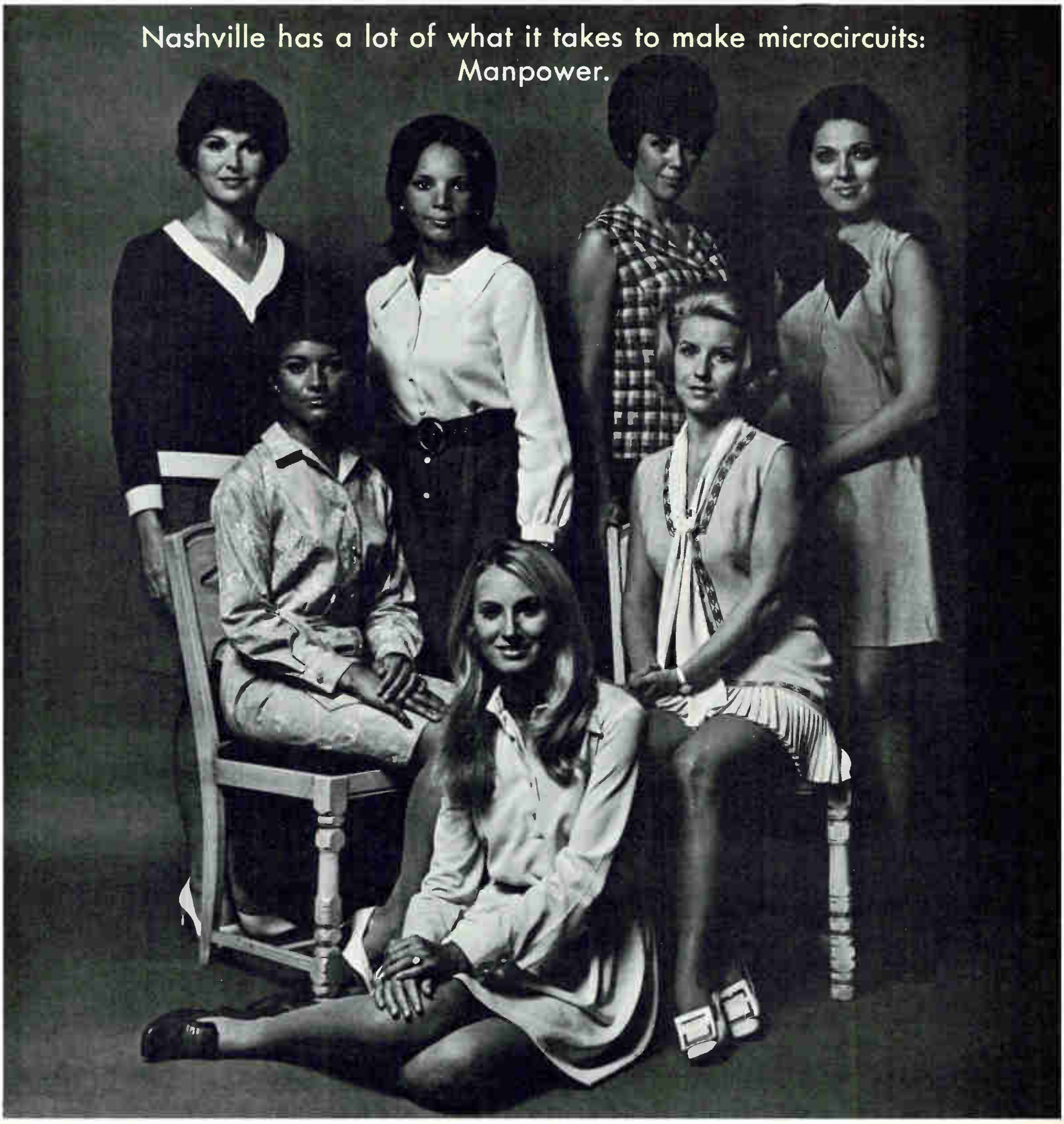
The MCT-1 will be competing with optical switches that use incandescent lamps and cadmium cells. These devices are slower, decay rapidly from heat, and are not compatible with integrated circuits.

Specifications at 25°C

Light-emitting diode	
forward voltage	1.3 v typical 1.5 v max
reverse current	0.15 μa typical 10 μa max
Detector	
breakdown voltage	
collector to emitter	30 v min
emitter to collector	7 v min 12 v typical
collector dark current	2 na typical 75 na max
Coupled	
d-c current transfer ratio	20% min 35% typical
bandwidth	300 khz typical
breakdown voltage	2500 v min
LED to Detector	
resistance	10^{11} ohms typical
rise and fall time	2 μsec typical

Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. [349]

Nashville has a lot of what it takes to make microcircuits: Manpower.



A strong female labor force. That's the kind of manpower you want to assemble microcircuits. And that's the kind of manpower available in substantial numbers . . . and at payroll savings . . . in Nashville.

If you build a microcircuit branch plant here, we will train your manpower free at our technical-vocational schools. Have them ready to begin work the day your plant opens. And Nashville's 14 colleges and universities — including Vanderbilt University Engineering School — can supply top research and management talent.

That's not all.

Nashville is located in the center of what will be a prime microcircuit market in the 1970's — the growing South and Midwest.

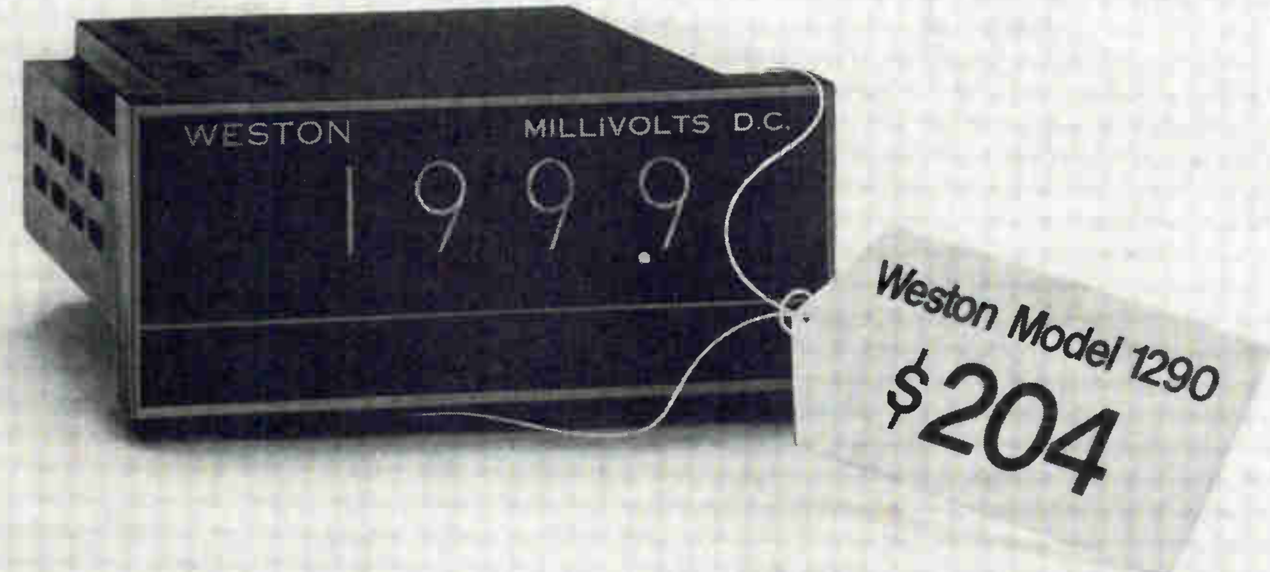
In fact, Nashville has everything it needs to be a great microcircuit center. That's why we think you should write or call the Nashville Area Chamber of Commerce, Nashville, Tennessee 37201. Phone 615 — 256-5171.

Then bring your plant down here. And take us for all we've got.

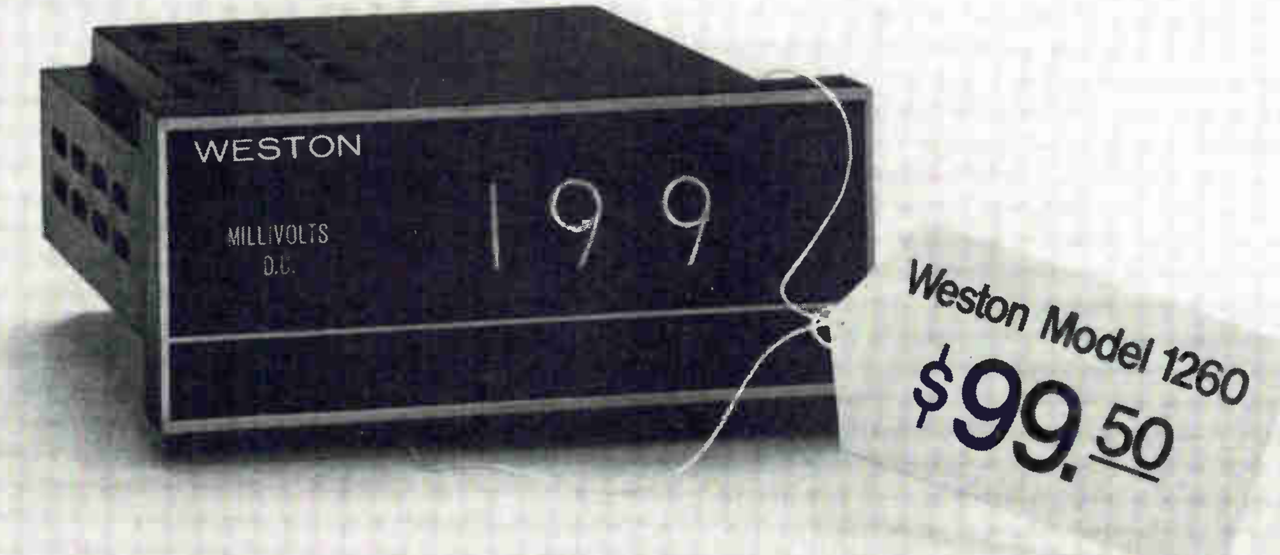
NASHVILLE ✚

Circle 183 on reader service card

This is the world's smallest all-pluggable DPM.



Then there's our less expensive model.



We brought out our 3½-digit compact DPM* just last March. It's the one that plugs into a panel slot only seven inches square, and pulls out for servicing or replacement. If you need the accuracy of 3½ digits, Model 1290 is still your best buy. But if you can settle for a digit less, you can have our new Model 1260 at less than half the price. Don't be fooled by the price tag, though . . . there's nothing "cheap" about this 2½-digit version. Housed in the very same plug-in case and fully compatible with its more sophisticated brother, Weston Model 1260 offers 0.5% ±1 digit accuracy—with far greater resolution capability than mechanical movements provide. Full scale reading is 199, with 25% over and under-range capability, remote command signal and Weston's usual high rejection characteristics. In addition to the convenience of front panel pluggability and circularly polarized viewing, we've included front panel calibration as a built-in bonus feature on the 1260. Write to the originators of the DPM. WESTON INSTRUMENTS DIVISION, Weston Instruments, Inc., Newark, N.J. 01774.

a Schlumberger company

WESTON®

Prices for Models 1290 and 1260 based on quantities of 25.

*U.S. Pat. 3,051,939 and patents pending.

Mixers have low intermodulation distortion

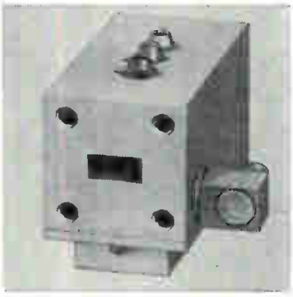
Three models of double-balanced units cover 10 khz to 1000 Mhz; Schottky barrier diodes provide uniformity, low noise figure

In the old days, nobody paid much attention to the r-f signals, says Robert Sproul, vice president and director of engineering at Lorch Electronics. "If a mixer did a good job of isolating the local oscillator's signal from the i-f output, everything was alright. The difference in frequency between the r-f and the i-f signals was so great, it didn't make much difference how much of the r-f got through. But with the frequency schemes people are using today, you have to be able to keep the r-f out too."

And that's what a double-balanced mixer does, isolate the i-f output from both the r-f and the i-f inputs. Sproul's company makes these mixers and at Wescon will show two new ones that feature low intermodulation distortion. "The 217/218 has very low distortion and the 234/235 has extra low distortion," says Sproul. "We almost ran out of superlatives."

By "extra low," Lorch means that the 234/235 produces third order intermodulation distortion levels of —160 dbm for two tones of —30 dbm. And the corresponding distortion level for two 0 dbm tones is —70 dbm. The 217/218 series

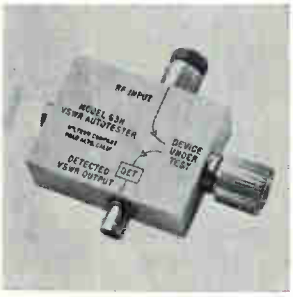
Solid state, crystal controlled pulsed r-f source model S-1001 is a 150-watt unit that covers a frequency range of 100 to 500 Mhz. Frequency stability is rated at ±0.005% and duty factor at 10% maximum. Unit operates from a +28 v d-c power supply and in a nominal temperature range from −40° to +71° C. Aerodyne Industries Inc., Willow Grove, Pa. 19090 [401]



Millimeter diode switches series 750 are designed to operate in the 26.5-40 Ghz band. Spst and spdt types are available. Center frequency for the spst switch is 33 Ghz; bandwidth, ±3%; insertion loss, equal to or less than 1 db; isolation, equal to or greater than 30 db; switching speed, 10 nsec; price, $800. Control Data Corp., 400 Border St., East Boston, Mass. 02128 [402]

Waveguide band reject filter model FC-1383R consists of two 5-section resonators and one 2-section resonator. Pass band is 7,950 to 8,210 Mhz with phase linearity of ±2° maximum and insertion loss of 0.3 db max. Rejection at 7,986 to 8,004 Mhz is 25 db minimum. The unit measures approximately 12 inches long. Gombos Microwave Inc., 40 Webro Rd., Clifton, N.J. [403]

Waveguide and coaxial filters, series FW and FC respectively, are computer designed with precisely controlled phase characteristics. They are available in L through X band and as fixed tuned or tunable units. Model FW4-7.2 covers 7.2 to 8.5 Ghz. Model FCW-1.8 covers 1.8 to 2.3 Ghz. RHG Electronics Laboratory Inc., 94 Milbar Blvd., Farmingdale, N.Y. [404]

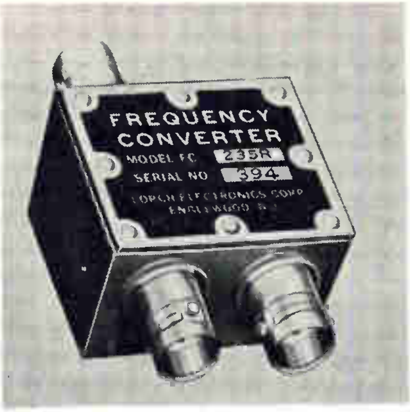


Vswr Autotester model 63N uses the APC-7 precision 7 mm r-f connector and covers the frequency range of 10 Mhz to 4 Ghz with 40 db directivity. The swept frequency vswr measuring range is 1.02:1 to 30:1 using the calibrated vswr oscilloscope graticules supplied with the bridge. Price is $445; delivery, three weeks. Wiltron Co., 930 E. Meadow Dr., Palo Alto, Calif. 94303 [405]

Frequency synthesizer 300A provides stable, coherent signals at frequencies from 1 to as high as 12.4 Ghz. Frequencies can be selected manually by 7 digital switches. Tuning can also be digitally programed by a 4-wire BCD ±5 v input to each digit. Resolution is 10 khz. Power output is 15-30 mw min. in each of 4 bands. Micro-Power Inc., 25-14 Broadway, L.I.C., N.Y. [406]

R-f calorimeter 6070 measures power in 50-ohm coaxial systems up to 5,000 w with 3% typical accuracy. Units are available with 1⅝ in. EIA flanged connectors. Power is quickly and precisely determined from input-to-output temperature differential at a constant flow rate. Vswr is 1.1 max. (d-c to 1 Ghz); 1.2 to 2 Ghz. Bird Electronic Corp., 30303 Aurora Rd., Cleveland [407]

U-shaped, single channel X-band rotary joints series 13-4000 cover the frequency range of 7 to 10 Ghz. The terminations are standard WR-112 waveguide. A typical model, such as the 13-4001, operates over the 7 to 8 Ghz range with 0.20 db insertion loss and a vswr of 1.15:1. Peak power is 250 kw. Eastern Microwave Corp., 139 Swanton St., Winchester, Mass. 01890 [408]



Good mix. Double-balanced mixer offers low distortion.

has a third order intermodulation distortion level of —145 dbm for two input tones of —30 dbm.

The 2-db compression point occurs at an input level of +19 dbm for the 234/235 series. And the 217/218 series reaches the 2-db compression point at +12 dbm.

Sproul says no other mixers of equivalent price have such low distortion. "Of course you can go to a FET mixer and do a lot better," he admits, "but that's a lot more money too." The 217/218 and 234/235 are made with Schottky diodes, and are priced at $130 and $200 respectively.

The two different model numbers refer to different packaging. The 217 and 234 have pins for plugging the mixer into a circuit board. The 218 and the 235 have connectors.

All four models have noise figures that vary between 6 and 9 db, depending on the frequency. Isolation depends on frequency too; for both r-f and i-f signals, the isolation ranges between 30 and 70 db.

The 217 and the 218 come in frequency ranges of 10 kilohertz to 100 megahertz, 200 khz to 500 Mhz, and 2 Mhz to 1,250 Mhz. The ranges of the 234 and 235 are 10 khz to 100 Mhz, 500 khz to 400 Mhz, and 2 Mhz to 1,000 Mhz.

Sproul feels that this company's new mixers will be of particular use in two areas because of their low susceptibility to intermodulation distortion. One area is in the front end of wide dynamic range receivers and the other is in frequency synthesizers.

Lorch Electronics Corp., 105 Cedar Lane, Englewood, N.J. 07631 **[409]**

the little things that count... in the Big Time.

Sub-miniature and miniature **events counters** and **elapsed time indicators**... with such high reliability that they set the industry's standards. With such myriad capabilities that they lend themselves perfectly to state-of-the-art applications: Space exploration; communications equipment; aircraft controls; computer technology; automated systems; laboratory procedures. Think of your own applications. If you require a little counter to tell you *how many*...or a little timer to tell you *how long*...chances are you're ready for the Big Time.

For additional information, contact:

APOLLO TIME... by GENERAL TIME

SPACE AND SYSTEMS
DIVISION

GENERAL TIME
Progress in the World of Time

1200 HICKS ROAD, ROLLING MEADOWS, ILL. 60008 / (312) 259-0740

BITE INDICATORS • ROTARY SWITCHES • TRIMMER POTENTIOMETERS • ELAPSED TIME INDICATORS • EVENTS COUNTERS

tough glass sealing jobs are Fusite's favorite

(easy glass sealing jobs run a very close second)

Actually Fusite's engineering, production, and quality control are geared for more difficult assignments involving hermetic terminals, glass preforms, coatings, powders, and granules. So remember—if it's a tough job, phone Fusite immediately; if it's a cream puff, wait five minutes, then phone Fusite. Call (513) 731-2020 or write Fusite Corporation, 6000 Fernview Avenue, Cincinnati, Ohio 45212. Overseas plants in Puerto Rico, Holland, West Germany, and Japan.

FUSITE

GLASS-TO-METAL HERMETIC TERMINALS
GLASS PREFORMS, COATINGS, POWDERS & GRANULES

See us at
WESCON/69
Booth 2608

He-Ne laser gets fine-tuning jobs

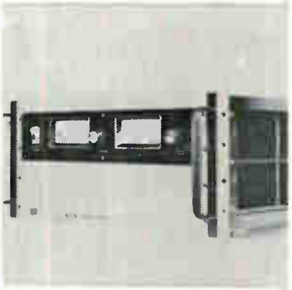
Gas unit made to emit at 10,600 angstroms where it can inspect neodymium-doped glass laser rods and align oscillator-amplifier chains

The closest thing to a workhorse among lasers is the helium-neon gas unit. Its power requirements are not demanding, it's easy to operate, and its continuous-wave output makes it useful in jobs from holography to ultrafine distance measurements. Plumbers depend on the He-Ne laser to align long stretches of pipe, and civil engineers use it to help drill straight tunnels for transit projects.

It is also used to align neodymium-doped glass lasers, but since these are tuned for 10,600 angstroms rather than the standard helium-neon line at 6,328 angstroms, the process is awkward and often inaccurate. This alignment problem has been eliminated by a new He-Ne laser that emits at 10,600 Å. Designated the model 101S, it was developed at the American Optical Co.

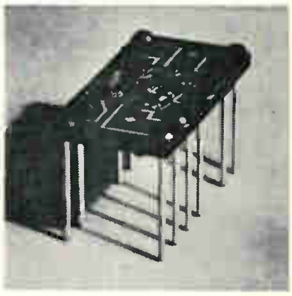
"The 101S is a laser for researchers," says its developer, Robert A. Wallace, senior research physicist. "Its wavelength will allow inspection for flaws, dopant concentrations, bubbles, and potential hot spots in Nd-doped laser rods. Its output also is at the proper wavelength for easy alignment of such

Analog-to-digital converter ADC-F combines successive approximation methods and single card modularity to achieve complete 10-bit conversions within 1 μsec. Differential linearity is within ±½ least significant bit, and relative accuracy is 0.05% for the 10-bit unit, 0.2% for the 8-bit version. Analog Devices Inc., Pastoriza Division, 221 Fifth St., Cambridge, Mass. [381]



Three 10,000-w power supplies each measure 12½ x 20 x 19 in. Model SCR40-250 is rated 250 amps at 40 v adjustable to zero volts; model SCR50-200, 200 amps at 0-50 v; and model SCR-100-100, 100 amps at 0-100 v. Inputs for all are 208, 220, or 480 v, delta or wye connected, 60 hz. Electronic Measurements Div. of Rowan Industries Inc., Oceanport, N.J. [382]

Parametric d-c power supply PDC incorporates the Paraformer which operates as a preregulator providing ¼% regulation to the basic d-c unit, as well as more than 60 db filtering. Units offer ±0.001 v line regulation, 25 μsec response time, 250 μv ripple, and complete transient suppression. Prices start at $375. Wanlass Instruments, 1540 E. Edinger Ave., Santa Ana, Calif. [383]



Seven segment light-emitting numeric is an all-semiconductor visible device for use in readouts. Called MAN-1, it is fabricated from red light-emitting Ga As phosphide. Each of the numeric's segments consists of two half segments in series which require only 3.4 v d-c at 0.02 amp for a typical brightness of 200 ft-lamberts. Monsanto Co., 10131 Bubb Rd., Cupertino, Calif. [384]

Fiber optic readouts series 900 are available with either solid state or incandescent light sources. They utilize a high intensity dot pattern which conforms to the latest human engineering standards. They are designed to meet the requirements of MIL-E-5400 and MIL-R-39027. Character size is 0.420 x 0.220 in. Master Specialties Co., 1640 Monrovia, Costa Mesa, Calif. [385]

Miniature power supply model PCA-5/500 is capable of mounting directly on p-c cards and contains an IC regulator for delivering highly regulated 5 v power to other circuitry. Total regulation is better than 0.05% for both line and load variations. Size is 2.5 x 2.5 x 9 in. Price is $75 in small lots. Arnold Magnetics Corp., 11264 Playa Court, Culver City, Calif. 90230 [386]

Miniature, f-m transmitter-receiver combinations series MLT/MLR Mini-Link provide a basic microwave relay link capability for tv, wideband telemetry and multichannel telephony. They are available at frequencies from 0.7 Ghz to 8.4 Ghz with transmitter output powers up to 4 w. Differential phase is ±0.5°. RHG Electronics Laboratory Inc., 94 Milbar Blvd., Farmingdale, N.Y. [387]

Voltage multiplier for color tv replaces the h-v rectifier tube in the horizontal deflection circuit. It delivers 25,000 v to the picture tube without radiating x-rays. Together with a proper flyback transformer, the output voltage wave shape is approximately sinusoidal with a width of 11 μsec at 15,750 hz. General Instrument Corp., 65 Gouverneur St., Newark, N.J. [388]

Inspector. He-Ne laser at 10,600 A is valuable optic-alignment tool.

complex optical cavities as found in Nd-laser oscillator-amplifier chains."

It was an oscillator-amplifier application that triggered development of the 10,600-Å He-Ne laser in the first place. A 10,600-Å He-Ne laser already has been used as a master oscillator in such chains. This makes possible a hybrid system having the modal purity and coherence length of gas lasers, coupled with the high power of glass systems.

Wallace adds that, formerly, "it was necessary to align these chains of mirrors, isolators and Nd-doped rods with the 6,328-Å red light of ordinary He-Ne lasers—then interpolate for fine adjustments because the wavelength was so far from neodymium's infrared wavelength. With 101S, it's a one-step job."

Building it wasn't that simple. There are two other strong lines near the desired 10,600-Å line, and they had to be blocked out; one is at 10,789 Å and the other at 10,844 Å. These are in addition to suppression of the 6,328-Å line.

The eventual solution came in the form of a pair of ultrasharp cutoff mirrors that form the ends of the 101S's optical cavity. They allow light at the undesired wavelengths to pass through while reflecting and relaying light at 10,600 Å.

Output power of the 101S is low—usually about 0.5 milliwatt—but ample for inspection and alignment. Minimum output is 0.25 mw, and the maximum is 1.0 mw.

Price is about $3,500; delivery takes two to three months.

The American Optical Co., Mechanic St., Southbridge, Mass. 01550 **[389]**

business trips rule out evening classes?

here's a practical way to update your knowledge of electronics

Are irregular hours, travel and family obligations keeping you from attending classes—even though you worry about becoming technically obsolescent? Check into the Special Programs in Electronics for Engineers developed by CREI, the Home Study Division of the McGraw-Hill Book Company.

These are not simply courses, but comprehensive programs in advanced electronics offering major electives in such fields as: Communications Engineering, Aeronautical and Navigational, Television Engineering, Automatic Control Engineering, Missile and Spacecraft Guidance, Radar and Sonar Engineering, Nuclear Instrumentation and Control, Computers.

Industry-recognized CREI Programs make it possible for you to catch up on new developments in electronics through study in your own home, at your own pace, your own schedule. Free book gives complete information and details of technical material covered. For your copy, mail coupon below or write: CREI, Home Study Division, McGraw-Hill Book Company, Dept. 1872H, 3224 Sixteenth St., N.W., Washington, D.C. 20010.

Founded 1927

CREI

Accredited Member of the National Home Study Council

CREI, Home Study Division, McGraw-Hill Book Company
Dept. 1872H, 3224 Sixteenth St., N.W.
Washington, D.C. 20010

Send me free brochure describing CREI Programs in Electronics for Engineers.

NAME________________ AGE______

ADDRESS________________

CITY________ STATE________ ZIP CODE______

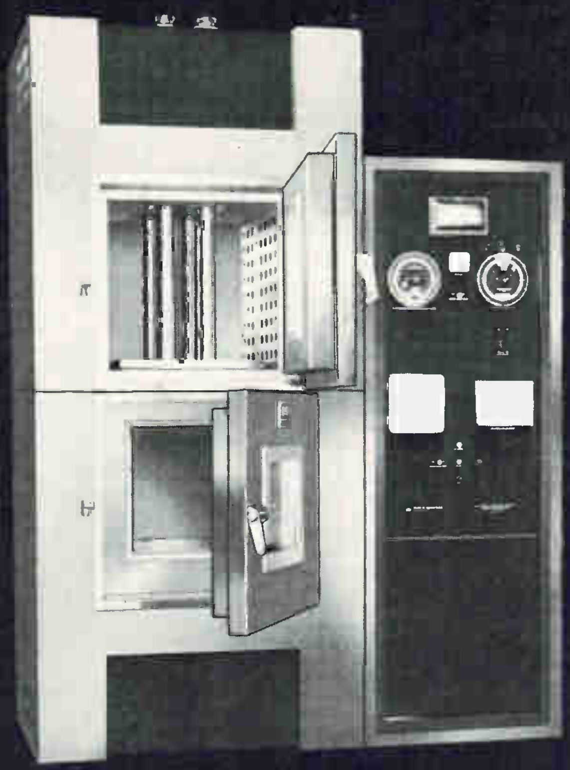
COMPANY________________

TITLE________________

Circle 191 on reader service card

THERMAL SHOCK TEST CHAMBERS

FOR MIL. STD. 202C



(AND FOR TOUGH INDUSTRIAL SPECS, TOO)

The Dual Thermal Shock Test Cabinet shown is designed specifically to meet Mil. 202C, Method 107B, Conditions A, B, C and F. Another, a 3-Stage Thermal Cycling Test Cabinet, meets Method 102A, Preferred Conditions C and D, of this Mil. Spec. Still other Blue M Thermal Shock Test Chambers are available to meet specific in-house requirements of companies testing commercial components and products. Our unique capabilities in this exacting field are exemplified by the chamber shown.

It consists of separate hot and cold chambers, each with its own control system and mechanical horizontal air-flow system. A 2.3 cu. ft. work chamber moves vertically from the lower cold chamber to the upper heat chamber as required by the spec. Cold chamber uses CO_2 or LN_2 to reduce incoming load to —55°C. or —65°C., and is under control of reliable solid-state instrumentation. Heat chamber uses the patented POWER-O-MATIC 60® Saturable Reactor Proportioning Control for unmatched accuracy and dependability. Overtemperature protection is standard. Transfer of work chamber between hot and cold chambers is fully automatic.

All Blue M Thermal Shock Test Chambers assure reliable, in-spec performance based on sound, advanced engineering. (The 3-Stage Chamber, for example, meets easily specifications with only *one* chamber instead of two as is customary.) Only the finest materials, components and instrumentation are used — adding assurance of quality to top performance.

If your testing program includes work with thermal shock equipment — to Mil. Specs. or to your own — it will pay you to come to the pioneer and recognized leader in this precise field. Write: *Blue M Engineering Company, A Division of Blue M Electric Company, Corporate Headquarters, Blue Island, Illinois 60406.*

BLUE M

Circle 192 on reader service card

IC's shrink digital printer's size, weight

Multifunction circuits also cut price of readout device for voltmeters, counters, and data acquisition equipment

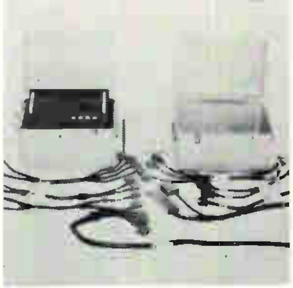
Multifunction integrated circuits have been applied to a digital printer intended for instrumentation applications, making it about one-tenth the size and weight and half the cost of similar printers.

The new unit, developed by California Electro-Scientific, will be shown at Wescon. It can be connected to any of a wide variety of digital readout instruments, such as voltmeters, frequency counters, and data acquisition equipment. It's available with a floating decimal point if desired, and with either positive or negative logic signals in either of two voltage ranges. The input data is binary-coded decimal in the 8-4-2-1 code.

The 12-digit version weighs four pounds and sells for $920, as compared with 30 pounds and $2,053 for an 11-digit Hewlett-Packard 562A or 50 pounds and $1,645 for a 10-digit Franklin 800 printer. Each of the CES machines is also available with a smaller number of digits in its output; for a six-digit printout, the weights and sizes are respectively 3 pounds and $660, 27 pounds and $1,553, and 47 pounds and $1,415. Regardless of the number of digits, the three printers' vol-

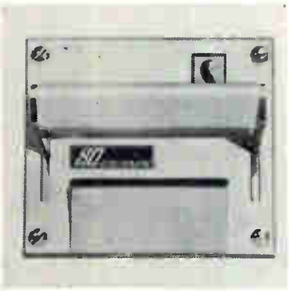
Digital recorder model DL620A contains a front panel presettable real-time clock; an 18-channel analog multiplexer; an analog to digital converter; a cartridge magnetic tape system with associated tape drive unit; plus all necessary logic and power supplies. System accuracy is 0.05% over 0° to 40° C. Metrodata Systems Inc., Box 1307, Norman, Okla. [421]

True digitally programable millivolt calibrator model MV-100P is programed from BCD logic signals. Various programers may be used, such as: punch tape, punch card, incremental magnetic tape readers, or key board. Full scale output voltage is 166.65 mv. Resolution is 10 μv. Accuracy is ±0.015% of setting +5 μv. Electronic Development Corp., 423 W. Broadway, Boston 02127 [422]



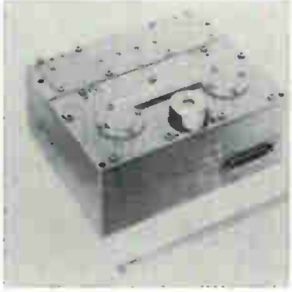
Computer simulator model CS-5001 provides manual operation and control of interface units when they are disconnected from the main digital computer. It consists essentially of six 16-bit registers, 3 addressable buffers, clock and control circuitry, 32 relay drivers, and 16 complementary word drivers. American Computer Technology Inc., Shirley Ave., Northridge, Calif. [423]

Tape-to-card converter called Edityper can be interfaced to the IBM 029 keypunch. It will convert BCD coded paper tape to Hollerith coded cards at a speed of 18-20 columns a second under program control Alphanumerics are fix-wired, and codes indicating functions and programs can be plugged in by the user. Epsco Inc., 411 Providence Highway, Westwood, Mass. 02090 [424]



Static card reader Mark II is for 80-column tab cards. Misreads are completely eliminated because the unit includes a positive orientation and positioning system. It features remote sensing of the Hollerith code on the card, and closes full-wiping, switch contacts at every one of the 960 electrical cross-points. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543 [425]

Data terminal 1051 bridges the gap between portable terminals with dial-up capabilities only and permanently located desk-structured, multiunit terminals providing automatic data transmission as well. The unit is compatible with 360 systems and can replace 360 data terminals or operate with them without software charge. Intercontinental Systems Inc., Palo Alto, Calif. [426]



Magnetic tape recorder model 10-236 has operating environmental capabilities that suit it for limited space applications such as torpedoes and rockets. It features tape speeds from 7½ to 120 ips. It has a tape capacity of 300 ft of 1 mil Mylar instrumentation tape, and can accommodate ½-in. or 1-in. tape widths. Genisco Technology Corp., Compton, Calif. [427]

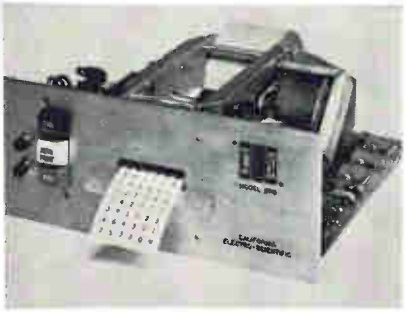
Automatic digital data acquisition systems series 5400 provide test and process data in ready-to-use computer-compatible form without need for intermediate manual data reduction steps. Up to 1,000 data-input channels are accommodated with scanners which expand in 10-channel increments. Prices start at $4,500. Vidar Corp., 77 Ortega Ave., Mountain View, Calif. [428]

umes are respectively 300, 3,300, and 1,950 cubic inches.

The small size and weight and the low cost are due largely to the use of multifunction IC's, all mounted on a single circuit board. Other improvements are in the mechanism that turns the print drum and in the use of 60-hertz alternating current to drive the drum, move the paper, and energize the printing solenoids. Thus the printer is free of large and expensive precision motors and direct-current power supplies.

The small printer can be combined in the same package with measuring instruments whose output it prints.

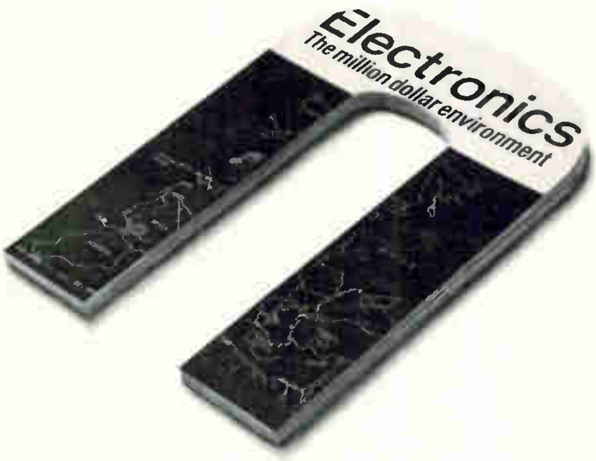
The printer is completely self-contained, requiring only a cable to the measuring instrument; the cable would contain four wires for each digit position printed, plus one wire for functions such as print command, paper advance (for blank spaces between successive printouts) and data hold (to shut out new data inputs during a print cycle). In addition, one wire per digit position is required for the optional floating decimal point feature. Thus the cable could contain as many as 63 wires.



For the record. Small printer can be designed into a combined package with measuring equipment.

A single output line is printed in 400 milliseconds; the maximum print rate is thus 2½ lines per second—somewhat slower than competitive machines. For continuous operation, the printer is limited to one line every five seconds, or to a burst of 50 lines at the maximum rate followed by an idle time of at least one minute. Faster operation presumably leads to overheating.

California Electro-Scientific, S. Grand Ave., Santa Ana, Calif. 92705 **[429]**


Electronics
The million dollar environment

Specify ITT Series 7400 and Series 9000 Circuits

Last time you ordered TTL circuits, you had to choose between the reliability of ceramic packaging and the economy of plastic. Now you don't have to make that choice anymore.

ITT will ship you ceramic dual in-line 7400 series and 9000 series circuits immediately—at a price competitive with plastic. Ceramic 5400 series circuits are only slightly higher than their plastic counterparts. These are top quality circuits, 100% DC and dynamically tested before shipment. They're mechanically and electrically compatible with the Series 7400 and Series 9000 circuits of other manufacturers. Don't make a trade-off between price and reliability—let your ITT salesman or stocking distributor show you how to avoid it. ITT Semiconductors is a Division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida 33407, Phone 305/842-2411.

semiconductors ITT

FACTORIES IN FLORIDA • MASSACHUSETTS • ENGLAND • FRANCE • GERMANY • PORTUGAL • AUSTRALIA

Video i-f amplifier goes on a chip

Two-stage circuit with 53-decibel power gain opens the way for widespread use of IC's in black-and-white and color tv sets

Television-set makers say there are two main reasons why they're dragging their feet when it comes to replacing discrete components with integrated circuits: IC's still cost more than discretes, in spite of recent price slashing, and they generally don't perform any better. "Maybe the use of IC's is a good marketing ploy," says one engineer, "but we don't think that's a good enough reason for a changeover."

Semiconductor producers aren't about to debate these points in the open, since the set makers are still their biggest customers. "They're coming around," says a Motorola Semiconductor spokesman. "They started with the sound section, and moved to the chroma demodulator. We're betting the video i-f amplifier will be next," referring specifically to his MC1352P.

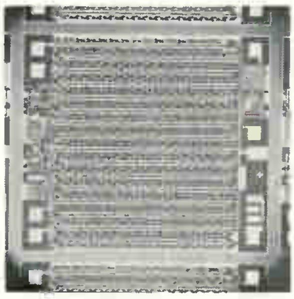
Designed for use as the first and second video intermediate-frequency stages of a black-and-white or color tv set, MC1352P is an IC consisting of an automatic gain control section and an i-f signal amplifier that's subdivided into a bias and output section.

The agc section requires a gating pulse, a reference level, and a com-

Hybrid hot-carrier diodes 5082-2810/11 have low junction capacitance (1.2 pf), high forward conductance (20-35 ma at 1 v), and low turn-on voltage (410 mv). These, plus near absence of recovery time, provide excellent rectification efficiency well into the microwave range. Piv is 20 v (2810) and 15 v (2811). Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. [436]

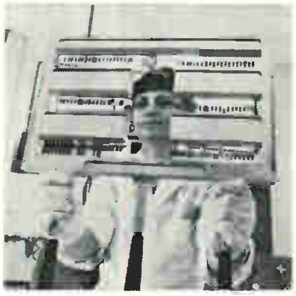
Planar p-i-n switching diode VSD-211 offers a typical switching speed of 10 nsec, and will operate over a wide dynamic range of r-f series resistance from 1.4 to 15,000 ohms. It will perform efficiently over a frequency range from 1 to 18 Ghz, depending upon r-f power and package parasitics. It operates from −65° to +175°C. Varian, Salem Rd., Beverly, Mass. [437]

Silicon high-power transistors with collector-emitter voltages up to 300 v come in the JEDEC TO-3 package. They feature power dissipation at 25° C of 350 w, extremely low saturation resistance (as low as 0.30 ohm) as well as low leakage currents and thermal impedance. Maximum collector current is up to 30 amps. Solid Power Corp., 440 Eastern Pkwy., Farmingdale, N.Y. 11735 [438]

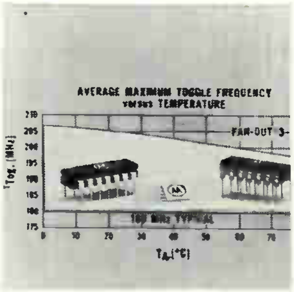


Dynamic MOS shift register EA1205 is a 256-bit device that utilizes a one-phase, 9-v, low input capacitance clock. At 1 Mhz operation, 4 packages of the EA1205 can be driven by less than 2 mw of one-phase clock power. Unit comes in TO-100 or hermetic dual in-line packages. Price (100-999, TO-100) is $30 each. Electronic Arrays Inc., 501 Ellis St., Mtn. View, Calif. [439]

Silicon controlled rectifiers 2615 and 2605 will operate at a junction temperature of 150° C. The 2615 has a forward current of 200 amps rms and is rated at 125 amps half-wave average. The 2605 has a forward current of 275 amps rms and is rated at 175 amps half-wave average. Both have guaranteed dv/dt of 300 v per μsec. Westinghouse Electric Corp., Box 868, Pittsburgh [440]



Plastic silicon rectifiers series R have piv's ranging from 200 to 1,000 v. Average rectified forward current is 1 amp at 100° C. Maximum d-c reverse current at piv is 2 μa at 25° C, 100 μa at 100° C. Maximum forward voltage at rated current is 1 v at 25° C. Maximum operating and storage temperature is −65° to +150° C. Scientific Components Inc., Linden, N.J. [441]



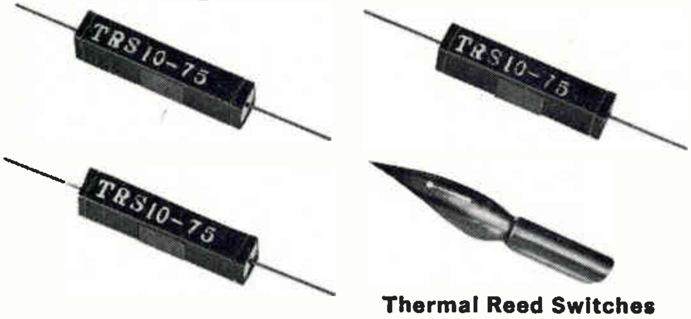
Master-slave type D flip-flop MC1034 toggles at rates in excess of 180 Mhz. It is for use in high speed counter and shift register applications. Both a direct set and a direct reset inputs are provided. Features include an output loading factor of 25, and a worst case maximum propagation delay of 6 nsec at −25° C. Motorola Semiconductor Products Inc., Phoenix. [442]

Pnp transistors 2N5455 and -6 are for saturated and nonsaturated switching uses. They have a turn-on time of 20 nsec max. and turn-off time of 30 nsec at this collector current. Switching times are excellent from 10 ma to 500 ma. Units feature 450 Mhz minimum frequency at 30 ma and 6 pf max. capacitance at 10 v. Fairchild Semiconductor, Mtn. View, Calif. [443]

Tokin, the Ferrite Core People, have a surprise for you at WESCON/69*

Eight great shows in one!

We are introducing brand new. Really new—these three items are making their *world debut.*



Thermal Reed Switches

Thermal Reed Switch. Reed switch combined with unique THERMORITE® sensor. Detects overheating, -cooling. Explosion proof. Ideal for operations involving explosive gases or corrosive fluids.

Fan Stop Detectors. Thermal reed switch opposite heat element. Blower failure causes heater to close switch, generate warning signal. A must for computer power sources; peripheral equipment.

Electronic Thermo Detector. Digital thermo sensor. Solid construction; ideal temperature-change detector in fluids or gases.

Magcoder

And

Tokin's MAGCODER, a shaft encoder functioning through magnetic saturation of a ferrite core. Valuable as an analogue-to-digital converter. 10000 rpm.

Pulse Transformer. Dual-in-line type and most modern of its kind.

Plus an array of ferromagnetic pot cores—which we make more of (and better) than anybody.

Tokin's Booth Number is 3617. See you at WESCON '69!

Tokin

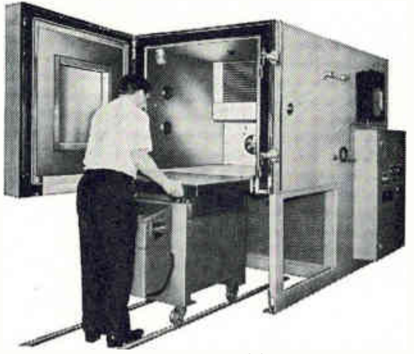
Tohoku Metal Industries, Ltd.

Koei Bldg., 10-13, 7-chome, Ginza Chuo-ku, Tokyo, Japan
Telephone: Tokyo 542-6171 Cable Address: TOHOKUMETAL TOKYO

Main Products: Ferrite Cores, Memory Cores, Memory Matrices, Ferrite Magnetostrictive Vibrators, Pulse Transformers, Permanent Magnets (Cast, Ferrite), Tape Wound Cores, Bobbin Cores, Magnetic Laminations, Fe-Co Alloys, Sendust Cores

Circle 198 on reader service card

Faster, easier set-ups with



advanced "AGREE" chambers

Tenney's "AGREE" Chambers have always offered the utmost in performance to meet and exceed all test levels of MIL-Std-781A. Now you also get the utmost in operator convenience. Tenney's exclusive "Redi-Seal" (patent applied for) provides a soft cushion of foam to seal between the chamber and L.A.B. or comparable vibration testing machines. No more cumbersome diaphragms...no removable chamber sections...just roll the table in place. Save set-up time. Fully automatic operation of chamber, vibrator, and test item. Make it easy for yourself. For complete information on the latest in "AGREE" testing, write or call

Tenney
ENGINEERING, INC.
1090 Springfield Rd., Union, N. J. 07083 • (201) 686-7870
Western Div.: 15721 Texaco St., Paramount, Calif. 90723

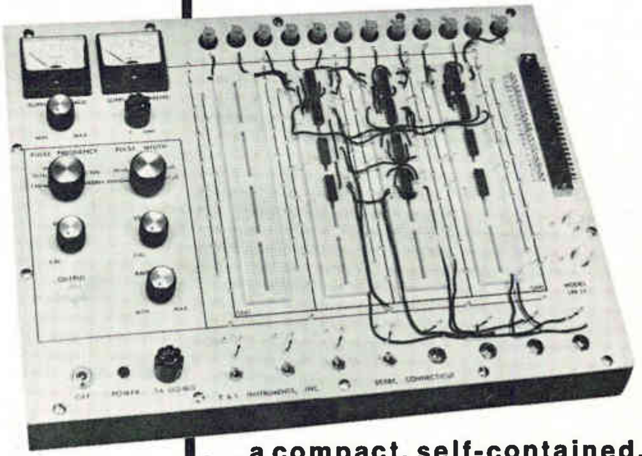
487

Circle 242 on reader service card

Now
For The First Time

You can completely design, layout, construct and test your most intricate new circuitry with the dynamic

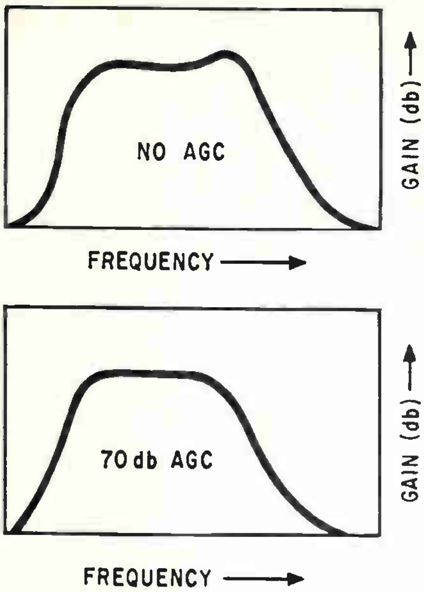
elite 1



. . . a compact, self-contained, general-purpose Electronic Testing Laboratory for $650.00

EL Instruments Incorporated
61 First Street, Derby, Connecticut 06418 Telephone 203-735-8774

Circle 243 on reader service card



Smoother. I-f gain curve (below) is flattened by 70-db gain control.

posite video signal for operation. For a particular video level and d-c reference setting, the gating section maintains the proper voltage across the external agc storage capacitor. The capacitor charge is delivered to the circuit coincidentally with the gating pulse. The amount of charge is determined by the video signal amplitude relative to the d-c reference level.

The i-f amplifier section input operates at constant emitter currents to maintain the input impedance independent of the agc action. The input signal can be applied either single-ended or differentially for a-c. The output amplifiers are fed from an active current source to maintain constant quiescent bias to hold the output admittance nearly constant. The collector voltage for the output amplifier is supplied through an external center-tapped tuning coil.

Typically, the MC1352P provides a power gain of 53 decibels at 45 megahertz, and has an agc range greater than 65 db. The output signal change for a 60 db i-f input signal change is 0.3 db, and the forward transfer admittance is 3 db down at 60 Mhz. Reverse transfer admittance is dominated by 1.0 micromho, typical.

The MC1352P is packaged in a dual-in-line plastic case and priced at $2.75 in lots of 100.

Motorola Semiconductor Products Inc.,
P.O. Box 955, Phoenix, Ariz. **[444]**

For just $1.05/sq. ft. this versatile building can be your new plant!

Only one of 80 modern buildings in a rapidly expanding Midwest industrial community called Lincoln Air Park West, this structure is available for immediate long-term, low-cost lease.

Lincoln Air Park West is centrally located in Lincoln, Nebraska, the state capital and home of the State University, and adjacent vocational schools. This fine Park is close to Interstate 80 and U.S. 6 and 34 and is just steps away from the Midwest's best-equipped all-weather jet runway. An inviting residential area of 1,000 housing units borders The Park and at present offers as an extra attraction an immediately available female labor supply totaling upwards of 250 women. Itek, American Lear Jet, Brunswick Corp., Geigy Chemical, Western Paper and Mobil Chemical are a few of 34 leading firms already located in Lincoln Air Park West.

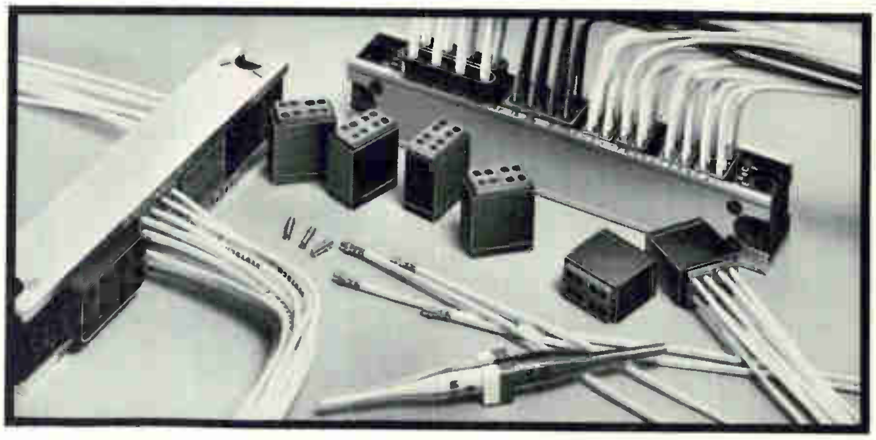
BUILDING 310
Gross Area: 36,531 sq. ft.
Construction: 1-story steel frame.
Ceiling Height: 20 ft. minimum in shop; 11-ft. in office area.
Year Built: 1961
Utilities: 480 volt, three phase, secondary electrical service; 4" water main; 6" sewer; 1" natural gas line.
Heat: Central steam
Air Conditioning: 90 ton

LINCOLN AIR PARK WEST

For action, phone (402) 435-2925 or write for our new expanded facilities report.

LINCOLN AIR PARK WEST • P.O. Box 1743, Lincoln, Nebraska 68501

Circle 241 on reader service card

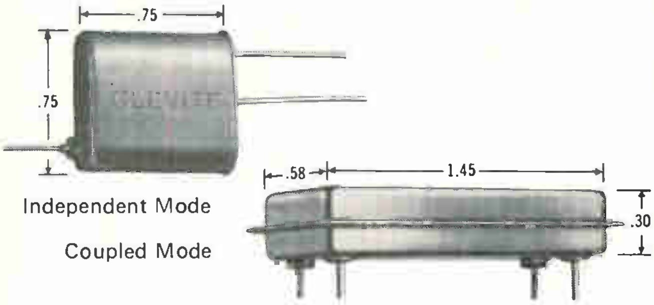


KING OF THE COMMONERS! A termination device that requires only one common assembly procedure and one common tool and that's compatible with a common integrated system makes a lot of sense. In this regard, the Deutsch Terminal Junction is the king! It's your best means of commoning, busing together, or joining two or more circuits. And look at the cost saving... almost two-thirds less. And look at the efficiency and versatility. No splicing, soldering, wrapping or lugging. If you want to add on, you just **do** it. Extra plugs-ins are ready and waiting. You can turn Deutsch Terminal Junctions upside down, sidewise, or what have you. Hail to the King! Still another component of ITS... the Deutsch Integrated Termination System.

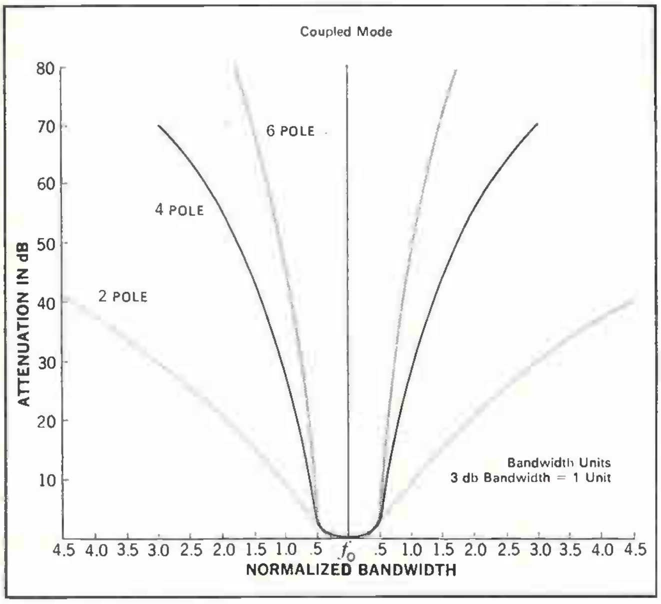
DEUTSCH ELECTRONIC COMPONENTS DIVISION
Municipal Airport • Banning, California 92220 • Telephone: Area Code 714 • 849-6701

COPYRIGHT, 1969 DEUTSCH ELECTRONIC COMPONENTS DIVISION

Going to IC's? Or Higher IF's?



Go two ways with Monolithic Quartz Uni-Wafer® Filters



Go independent mode. Go coupled mode. You can go either mode with monolithic Clevite Uni-Wafer® filters. They're smaller and more reliable (fewer interconnections) than conventional filters.

Clevite Uni-Wafer filters are ideal for matching IC circuitry in communications receivers operating in the VHF and UHF frequency ranges as well as in telemetry, radar and aerospace systems.

They are 2, 4 and 6 pole crystal filters with a choice of center frequencies ranging from 8 MHz to 75 MHz. They've been developed using Clevite's advanced engineering techniques and Clevite's original thin film approach to quartz filters. In this concept, arrays of resonators are achieved on a single quartz wafer with resonator isolation and spurious suppression controlled by the trapped energy principle.

So if you're going to IC's or higher IF's, go Clevite Uni-Wafer filters. They're available in both independent and coupled mode.

For more information and complete specification data, write: Clevite Corporation, Piezoelectric Division, 232 Forbes Road, Bedford, Ohio 44146.

CLEVITE

Circle 200 on reader service card

OVER

1,000,000 SIZES

MILITARY CASES

COMBINATION • TRANSIT • INSTRUMENT

MIL-T-945A, T-4734, T-21200, STD-108, C-4150

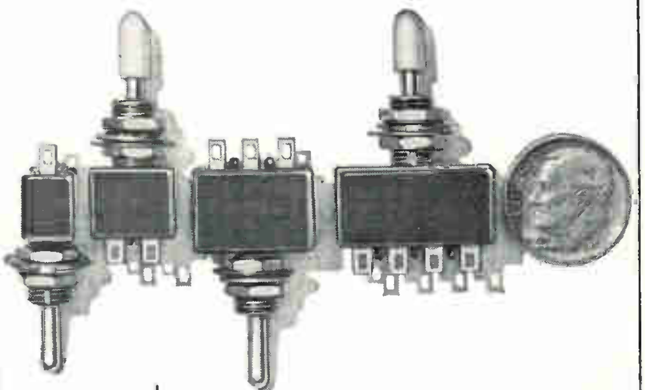
Choose from over 1,000,000 variations in dimensions, proportions, metals, finishes, and custom accessories. Whatever your need, the MM (multi-measure) method gives you high production savings even on custom runs as low as 25 units. Send your print or requirements. Manufacturers representatives in all major cities.

SEND FOR FREE CATALOG & DIMENSION SPECIFICATION SHEETS.

mm ELECTRONIC ENCLOSURES, Inc.
111 Bloomingdale Rd., Hicksville, N.Y. 11801 • 516-935-9400

Circle 244 on reader service card

SUBMINIATURE TOGGLE SWITCHES



SPDT
DPDT
3PDT
4PDT

Designed to meet the highest standards of reliability, C&K's quality subminiature toggle switches combine maximum performance with small size! They feature rugged construction, simple mounting, excellent appearance, and long, trouble-free operation!

A competitively-priced, made-in-America product. Write for literature today!

C&K COMPONENTS, INC.
quality electro-mechanical products
103 Morse Street, Watertown, Massachusetts 02172
Telephone: 617 926-0800

C&K also manufactures a quality line of magnetic code converters, timers and logic elements.

See C&K at the WESCON Show Booth #4811.

Circle 245 on reader service card

New semiconductors

IC processes color signals

Philco-Ford's tv market entry combines chroma demodulators, oscillator

A color-processing circuit for tv is the latest entry of Philco-Ford's microcircuits division in its push for a larger share of the consumer entertainment products market.

The monolithic integrated circuit, designated CP 1060-A, combines the functions of chroma amplifier, a 3.58 megahertz reference generator, buffer, and X and Z chroma demodulators on a single chip. All that's required for operation is a frequency-selective crystal and suitable inductive elements.

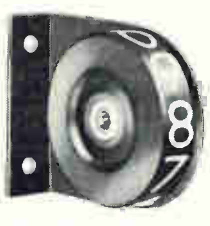
The IC can be hooked up in an automatic-phase-control loop, an injector-locked oscillator, or crystal-plus-amplifier reference system by choosing the appropriate external circuit components. And it provides a wide choice of demodulation angles, independent phase detection, and color reference phases.

Supplied in a 14-lead, dual-in-line package, the CP 1060-A operates with a supply voltage of 14-30 volts d-c, at 15 milliamperes. Operated in an APC loop, it provides a 12-volt peak-to-peak phase detector reference voltage, a 7-volt peak-to-peak color kill detector reference voltage, and a color difference output voltage of 5 volts, p-p. It also provides an oscillator frequency control of 300 hertz/volt, a pull-in range of ±240 hertz, and a hold-in range of ±350 hertz.

The CP-1060-A is now being produced in Lansdale, Pa., where the division in recent months has consolidated its domestic IC production facilities. However, the company says it plans to shift production of the circuit later to its IC plant in Taiwan.

Sample quantities of the CP 1060-A are available immediately from stock at $1.50 each.

Microelectronics Division, Philco-Ford Corp., Lansdale, Pa. 19422 **[445]**



FAMOUS MAGNELINE® QUALITY

NEW COMPACT SIZE!

NEW LOW PRICE!

Shown actual size

Patwin's Series 18000 indicators operate from pulsed DC voltages in decimal form to display digits or symbols. They have the same reliability, readability and memory as other MAGNELINE models but are more compact and lower in price. The new indicators are only .29" wide and .92" high yet digit size is a full ¼ inch. Unit price is $33.80 in quantities of 100.

The Series 18000 has many applications in aviation and general instrumentation, especially where extreme reliability and low maintenance cost are important. Open construction of the unit gives instrument designers a wide choice of mounting methods. Full information available from Patwin, 41 Brown Street, Waterbury, Connecticut 06720. Telephone (203) 756-3631.

PATWIN®
DIVISION OF UNITED-CARR
UNITED-CARR INCORPORATED • A SUBSIDIARY OF TRW INC

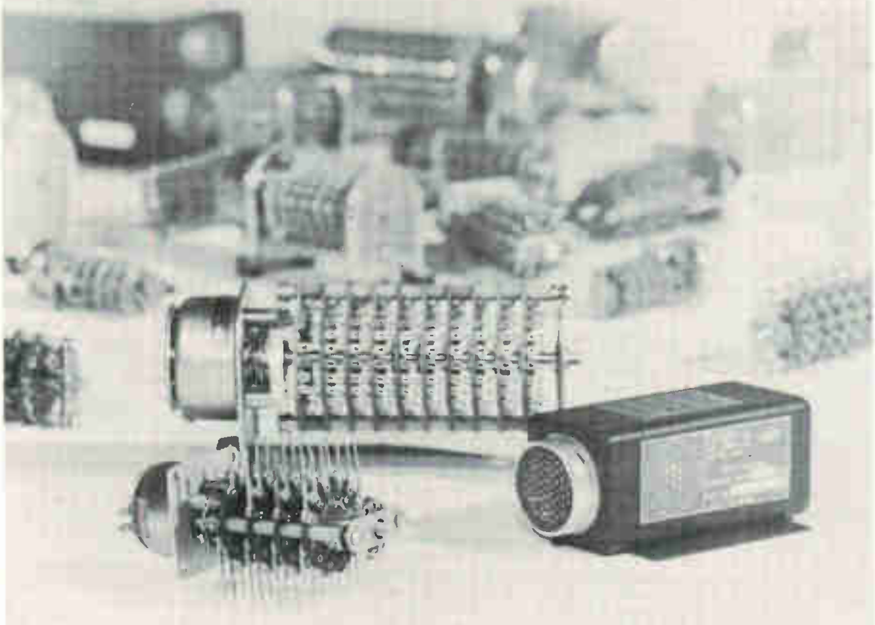
WATERBURY,
CONNECTICUT 06720

Circle 246 on reader service card

the Solderless Hermetic! Up to now, hermetic connectors meant soldered contacts. Solder meant smoke, and — **more important** — operator training, time, uninspectable connections, the danger of unreliability, **and** high costs. Now... Deutsch brings you the solderless rear-release hermetic connector! Not only can you now insert and remove contacts in seconds, but also without any of the old problems of precision soldering. Meets Mil Spec performance requirements. Compatible in contact crimping, terminating, installing and tooling techniques with all components of the Deutsch Integrated Termination System (ITS). Why not break your smoking habit. Write for your Hermetic Data File or contact your local Deutschman.

DEUTSCH ELECTRONIC COMPONENTS DIVISION
Municipal Airport • Banning, California 92220 • Telephone: Area Code 714 • 849-6701
COPYRIGHT, 1969 DEUTSCH ELECTRONIC COMPONENTS DIVISION

Circle 201 on reader service card



New Books

Special region

An Introduction to the Theory of
Microwave Circuits
K. Kurokawa
Academic Press Inc., 425 pp. $19.50

Through a discussion of microwave circuit theory, this book, based on a first-year graduate text used in Japan, aims to present the reader with some basic ideas and mathematical techniques. Other branches of engineering and science should also find this information valuable.

The author defines the microwave region as the range of frequencies extending from 1 to 100 gigahertz. He also claims that the techniques of transmitting and controlling electromagnetic power, and the methods used to analyze it are quite different from the techniques used outside that range. At lower frequencies, for example, waveguide structures used at microwave frequencies are now impractical because of the extremely large structural dimensions required. And at frequencies above the microwave range—infrared or optical—the waveguides are impractically small.

In general, the author reasons that it's difficult to solve Maxwell's equations under appropriate boundary conditions. And even if a formal solution is easily gotten, interpreting the results can be so complicated that no useful information can be extracted from it. Moreover he approaches microwave circuits in much the same way as one would approach conventional circuit theory—where resistance, capacitance, and inductance are defined without actually specifying the physical structure or material used. First, the relations between voltage and current at each of the elements are clarified, then the properties of these elements in a complex network are analyzed as a combination of the effect each element contributes.

The microwave circuit framework includes any electromagnetic phenomena that can occur inside a hollow region surrounded by conducting walls; particular emphasis is placed on their effect on the various propagating modes of electromagnetic fields in the hollow regions. However, electromagnetic waves in free space and those along a dielectric rod or coated wire are not discussed.

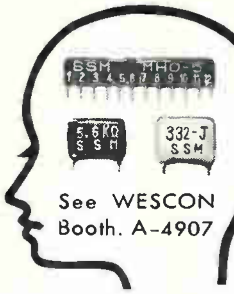
In chapter 1, several conventional circuit theory techniques that have particular relevance to microwave circuit theory are reviewed: the theory of transmission lines, bilinear transformations, and power waves. Chapter 2 reviews vector analysis and looks at the fundamental properties of electromagnetic fields. Chapter 3, after discussing the general theory of waveguides and waveguide modes, studies the eigenvalue problem in some detail taking into account the completeness of eigenfunctions. Chapter 4 examines resonant cavities using a similar eigenfunction approach, and in chapter 5, the various properties of waveguide junctions are analyzed using matrices.

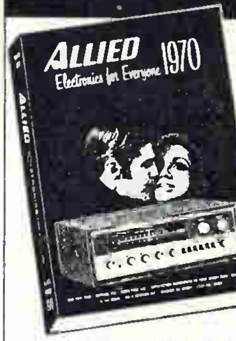
Chapter 6 discusses the coupling between traveling waves and the electromagnetic fields that exist in cavities, and presents some interesting applications of eigenvalues. Although the major emphasis of chapter 7 centers on the evaluation of the noise performance of linear amplifiers, the problems of unconditional stability and unilateral gain are also considered. In addition both negative-resistance parametric amplifiers and tunnel-diode amplifiers are studied. Chapter 8 discusses a circuit-theoretical analysis of electron beams that throws light on some properties of practical interest in most electron tubes, such as klystrons and traveling wave tubes. The last chapter on oscillators uses a simplified model to account for the nonlinearity of the device. It ends with a discussion of oscillator noise and of injection locking oscillators.

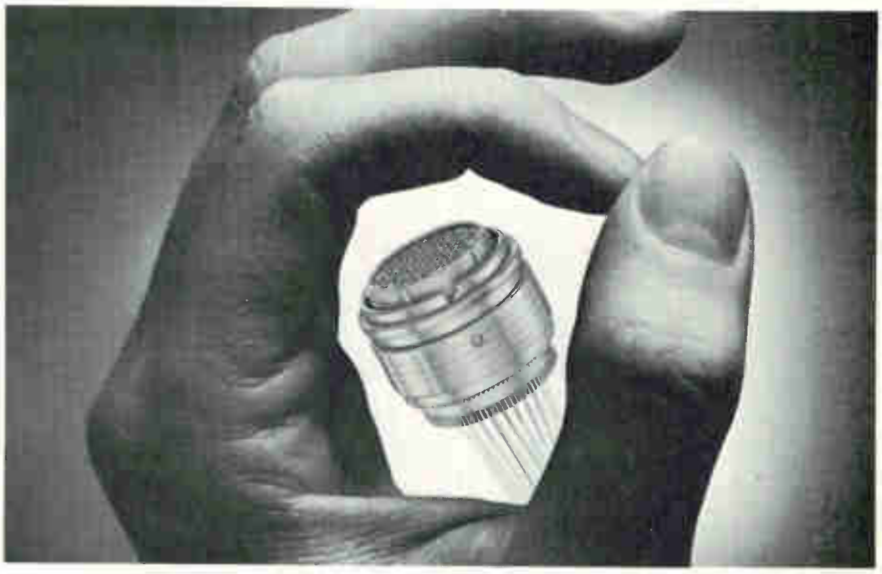
Recently Published

Signal Theory, L. E. Franks, Prentice-Hall, Inc., 311 pp., $12.95

Geared to first year engineering graduate students with some knowledge of linear systems, probability, and random variables, this book presents a step-by-step development of the signal space concept and its application to practical engineering problems. It emphasizes the physical rather than mathematical interpretation of the concept, and delves into discrete signal representations, random-signal processes, integral transforms, and signal properties.







Technical Abstracts

Clean up

An adaptive equalizer for tv channels
E. Arnon
Northern Electric Co.
Ottawa, Canada

Distortions on coaxial cable lines can mess up color tv signals. This is particularly true for longhaul cable systems (200 miles) which because of their time-varying nature cannot provide the flat response required to maintain high quality tv signals over the transmission distance. Manual equalizers could be used, but they have to be changed every time signals are switched to different routes. As a result they provide little help because adjustments must be made too frequently and take too long.

The solution—an automatic equalizer that consists of a transversal filter—which corrects for delay and amplitude distortions without need for human adjustments. It's applicable to any tv baseband channel and offers the possibility of high grade transmission at lower cost.

The equalizer works this way. At the transmitter a reference pulse is inserted once per frame in the tv signal. This pulse is locked to a 4.6 megahertz crystal oscillator.

The received reference-pulse waveshape is sampled at a rate of 9.2 Mhz; then each sampling point is compared with the corresponding stored reference level. And if the pulse height differs by more than 0.2%, equalizer circuits are activated to correct errors.

The equalizer corrects for both delay and amplitude distortions of 6 decibels, and phase distortions of 105 nanoseconds were reduced to 0.1 db and 8 nsec respectively. The equalizer is capable of handling distortions as large as 7.5 db and 200 nsec.

Actually the equalizer is a 20-tap, 10-megahertz delay line with each section consisting of an equalized length of cable and an isolation circuit to provide a tapping point. The Nyquist rate 1/9.2 Mhz is used to determine delay between adjacent taps—109 nsec. Wideband digitally controlled attenuators control the settings; high stepping rate and fast settling time are achieved by

SCIENCE/SCOPE

A new electronically-scanned airborne radar antenna, the U.S. Navy's first high-performance, X-band multimode, phased-array system, is now undergoing evaluation at Hughes. It has a 36-inch-diameter flat reflecting surface with 2400 radiating elements, and offers distinct advantages over mechanically-scanned gimballed antennas. It is designed for air-to-air search, multiple target tracking, terrain following and avoidance, and ground mapping.

A faster method for measuring the thermal insulating value of sandwich panels for portable shelters, developed recently at Hughes, cuts test time to only two to four hours instead of the three or four weeks previously required.

TV's "instant replay" technique is being used in a military design work study by Hughes engineers. They are using TV cameras to record the operation of command-and-control systems aboard U.S. Navy attack aircraft carriers. The video tape is edited to obtain the complete sequence of operations of various systems, then played back repeatedly for analysis. This enables the Hughes team to suggest improvements in both operating procedures and system design.

A multi-channel, crystal-controlled microwave source developed by Hughes makes it as simple to change channels on airborne data link, radar, and microwave communications systems as to change programs on a TV set. Twelve models are available in the frequency range of 800 to 9600 MHz, each with a choice of four (or even more) discrete frequencies. Modular, EMI-shielded construction permits .005% frequency stability and exceptionally low harmonics.

Safe landings in fog that normally would close an airport may be just around the corner. A Hughes-developed infrared imaging device called FLIR (Forward Looking Infra Red) turns the infrared scene ahead of the aircraft into a real-time display like a TV picture. Initial studies indicate that it may be possible to make safe landings when visibility is as short as 220 feet, depending on the nature of the fog, by using the FLIR in conjunction with existing ILS landing aids.

Hughes needs experienced engineers: Microcircuit, digital communication system analysis, computer systems, digital systems test, signal processing, circuit design, missile guidance & fuze, radar systems, SAF ordnance specialists, real-time and weapon system programmers. B.S. degree, two years related experience, U.S. citizenship required. Please write: Mr. J.C. Cox, Hughes Aircraft Company, P.O. Box 90515, Los Angeles 90009. Hughes is an equal opportunity employer.

A technique for cooling precision-regulated power supplies by immersing the circuits in a coolant has been developed by Hughes engineers. Total size is much reduced and there are no moving parts. The coolant isolates the circuits from airborne contaminants, damps vibration stresses, and has high dielectric strength. One power supply has operated without failure during a seven-year period of round-the-clock testing.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

Circle 205 on reader service card

using solid state linear switches and transient compensating circuits.

Also, since a large number of active circuits that contribute to the over-all noise are used in the equalizer circuits, a special effort was made to minimize any noise build-up. The signal to total noise ratio achieved is 77 db.

Presented at the International Communications Conference, Boulder, Colo., June 9-11.

G-line revisited

Surface wave corridors
Theodore Hafner
Surface Conduction Inc.
New York

Renewed interest is expressed in the G-line, a single-wire transmission medium for sending and receiving communication signals along highways and railways. G-line is a practical tool capable of serving areas requiring broad bandwidth, large channel capacity, and freedom to expand without interference from other communications media. It has been described as a private wave space because it's essentially a nonradiating coaxial line with the outer conductor removed and therefore does not require regulation by the Federal Communications Commission.

Surface wave transmission can be explained by referring to a coaxial cable. If the diameter of the outer conductor of a coaxial cable is increased, the transmission line loss is reduced and at the same time some of the field lines between the inner and outer conductors return to the inner conductor without ever reaching the outer one. If the distance between the inner and outer conductors is made large enough, then all of the field lines will terminate along the inner conductor. Now, since the wave will be propagated only along the surface of the inner conductor, the outer conductor can be omitted for all practical purposes.

These surface wave transmission lines have the advantages of radio transmission and wire transmission of signals, with very few of their disadvantages. While coaxial cable

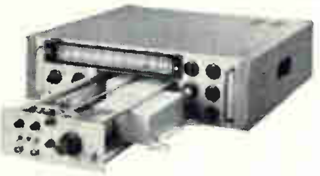
Look to the future. Plug-In Oscillators for use above 1 GHz and with multi-octave coverage coming soon.

From Alfred Electronics a new 10 MHz to 1 GHz Solid State Sweeper.

It's the nicest thing that ever happened to your swept and single frequency measurements.

Front plug-in sweeper—maximum flexibility. The new Model 6151 Sweep Oscillator with Oscillator Plug-In Units gives you swept and stable single frequency coverage from 10 MHz to 1 GHz. Here is a sweeper with two independent sweeps, three single frequency outputs which also include the Accentuated Comb Marker.

Compare output power—100 mw or 2.24 volts. The 100 mw (2.24 volt rms) into 50 Ω leveled output allows this sweeper to be used in place of signal generator amplifier combinations.



Model 6151 shown with plug-in drawer capable of holding all dc to 1 Gc oscillators.

Sawtooth or triangular. Sawtooth sweep with fast flyback. Triangular sweep provides forward and return sweeps of equal duration for hysteresis and memory measurements.

"SEE US AT WESCON"

Complete independence of controls. The exclusive Alfred slide rule dial includes F_1 start and F_2 stop, F_0 and △ F controls. F_1 and F_2 controls pass each other for up or down sweep. △ F sweeps around the F_0 frequency and is accurately calibrated in frequency.

Unique F_0 control. Serves as frequency marker, the center of the symmetrical sweep, and as a single frequency.

Choice of three preset single frequencies. A single frequency output may be set with the F_1, F_2 and F_0 controls for precise component evaluation.

Choice of leveling. Internal or external leveling.

Modulation for every application. Internal 1 KHz squarewave for reflectometer and SWR measurements and 1 KHz sine wave for amplifier response testing. Model 6151 also may be externally amplitude and frequency modulated.

Accentuated Comb Markers. The optional Accentuated Comb Markers use crystals to generate precise and stable 1, 5 and 25 MHz signals for frequency identification during swept operation. Amplitude of the 1 MHz and 5 MHz is respectively 1/3 and 2/3 of the 25 MHz marker.

Prices

1. **Basic Oscillator**	6151	$1290
2. **Plug-In Drawer** 10 MHz - 1000 MHz	6151-1	$140
with Attenuators, DC—1 GHz, 0-50 dB in 1 dB steps	Option A1	250
with Marker, Comb, 1, 5, 25 MHz	Option M1	375
3. **Oscillator Modules**		
10 to 20 MHz	Q01	$200
20 to 50 MHz	Q02	200
50 to 125 MHz	Q03	200
125 to 250 MHz	Q21	250
250 to 500 MHz	Q22	250
500 to 1000 MHz	Q23	900

For a Demonstration and Complete Information

Please call your local full service Alfred Sales Engineer (listed in EEM) or write Alfred Electronics, 3176 Porter Drive, Palo Alto, California 94304. Phone: 415-326-6496. TWX: 910-373-1765.

ALFRED ELECTRONICS

Circle 207 on reader service card

is free from FCC regulations, its high loss and narrow bandwidth still make it unattractive. Many amplifiers are required to counteract cable losses, and the over-all signal-to-noise ratio is decreased. Radio transmission, on the other hand, has lower loss and broader bandwidth than coaxial transmission, but it uses the public air space and is therefore controlled by the FCC. The G-line has a loss of approximately 8-10 decibels per mile at very high and ultra high frequencies and a bandwidth of at least 200 megahertz.

The field around a G-line can be extended to adequately cover a highway or railway. Any objects moving in the field will disturb it and the distance to that object can be determined. Because of these field properties, the G-line, in addition to acting as a low-loss transmission line, can sense the position and speed of nearby objects.

Presented at the International Communications Conference, Boulder, Colo., June 9-11.

Simple subtraction

Noise reduction in wideband atmospheric receiving systems

W.L. Taylor, H.M. Burdick, and L.W. Eichacker
Institute of Telecommunication Sciences
Boulder, Colo.

Low-frequency receiving systems operating in the range from a few hertz to several kilohertz are often bothered by interference from electric-field noises and harmonics from 60-hertz power lines. And electric noise fields may be generated by corona discharges, lightning, variations in the line current, and high power radio emissions.

There are several methods that can be used either individually or combined to increase the signal-to-noise ratios by 40 decibels or more. All of them do so by reducing the electric field noise in low frequency receiving systems.

One such method uses a noise-bucking circuit, consisting of a vertical electric antenna that responds to signals plus noise, and an electrostatic antenna that responds only to noise. The noise is

then subtracted from both the signal and the noise bucker circuits so that only the signal remains.

The vertical electric antenna used was a ¼-inch diameter monopole, 2 meters in length supported by a high input-impedance antenna coupler. The voltage at the base of the antenna was calculated to be 0.55 that of the vertical electric components for the radiation, induction, and electrostatic fields.

The electrostatic antenna was a 1-meter aluminum strip, 12 centimeters above a ground plane and 1 centimeter above a shielded antenna coupler input. The voltage supplied to the antenna coupler was 0.049 that of the electrostatic field component and 0.0038 that of the radiation and induction components.

Assuming the noise is composed of the electrostatic field E_v for the vertical antenna and E_e for the electrostatic antenna, then equal noise voltage is obtained when $0.55E_v = 0.049E_eg = 0.049E_vgr^3$ where g is the relative gain of the two antenna couplers and r is the distance ratio to the noise source for the two antenna systems, assuming that the electrostatic term varies as the inverse cube root of distance. With $r = 4$, $g = 0.175$ for the antenna coupler outputs to be equal. The electrostatic term of the noise can thus be canceled by the differential amplifier in the noise bucker.

Presented at the International Communications Conference, Boulder, Colo., June 9-11.

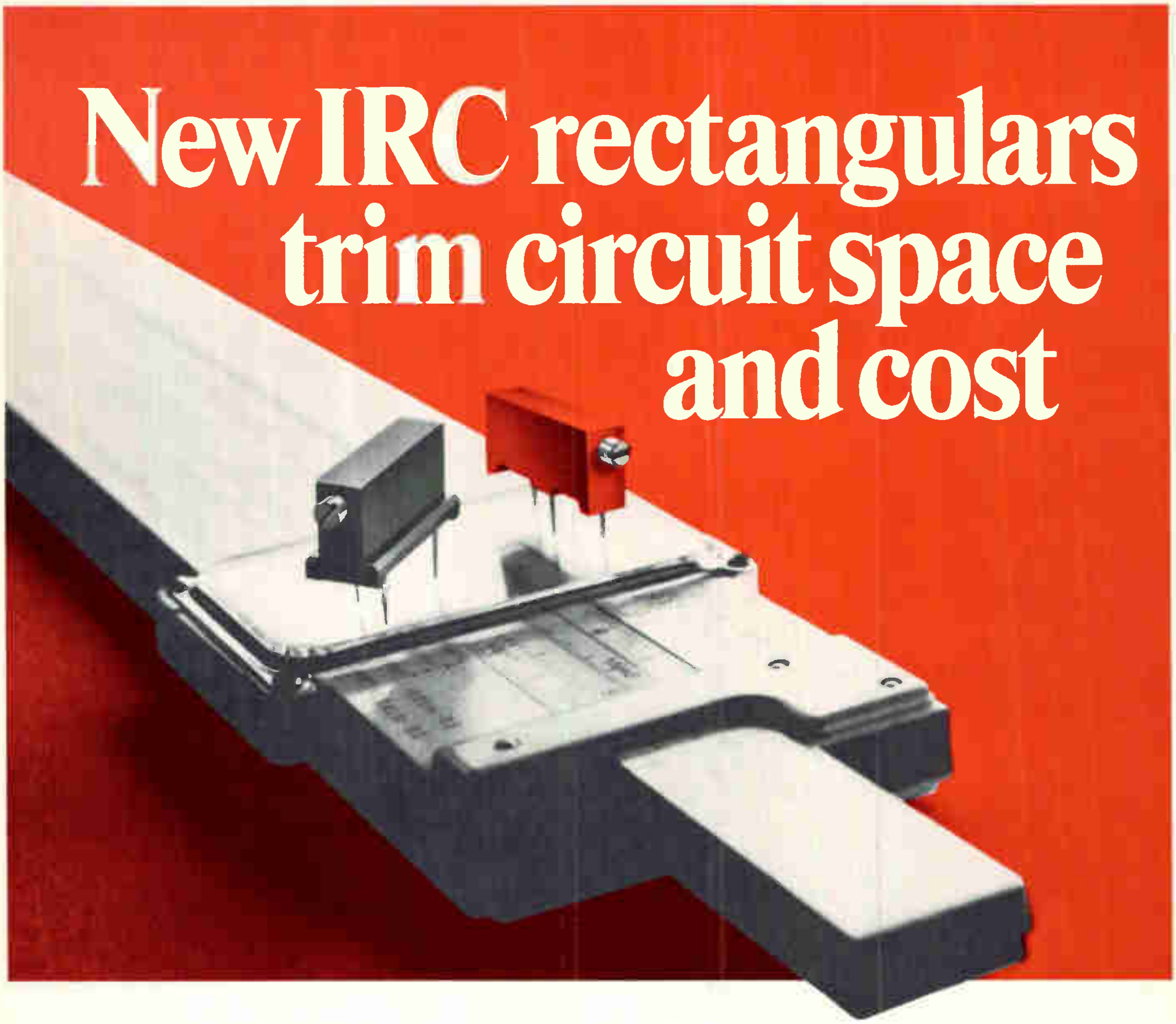
Brighter light

Electronic color separation with laser light sources
D. Meyerhoter, A.W. Stephens and J.J. Walsh
RCA
Princeton, N.J.

Printing multicolor images requires a plate for each color ink being used. The plate itself is generally produced photomechanically from color separations. In the past, the color separations were made by imaging the multicolor original through appropriate filters.

Now color separations can also

New IRC rectangulars trim circuit space and cost



Metal Glaze and Wirewound types

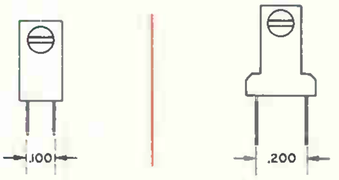
These ¾-inch-long rectangular trimmers are made and perform like bigger, more costly units. Only IRC offers a miniature general-purpose unit with these features:

- All-metal adjustment shaft that eliminates breakage or distortion, even under repeated use.
- Silver brazed terminations on Metal Glaze and Wirewound types end resistance buildup associated with pressure connections.
- Ultrasonic bonding of the housing into a one-piece unit that is free of seams or laps.
- Resistance to normal board washing. Units sealed to MIL-R-27208 are also available.

Metal Glaze Type 950 has a rugged, thick-film element that provides excellent high-frequency characteristics and infinite resolution over the entire resistance range of 100Ω to 1 megohm. ¾-watt @ 25°C. ±10% tolerance.

Precision Wirewound Type 900 has a long-wearing precious metal wiper spring that reduces noise and contact resistance. 1 watt @ 40°C. 100Ω to 20K. ±10% tolerance.

PIN CONFIGURATIONS



WIREWOUND	**METAL GLAZE**	**WIREWOUND**	**METAL GLAZE**
900-20 Std.	950-20 Std.	920-20 Std.	970-20 Std.
910-20 Sealed	960-20 Sealed	930-20 Sealed	980-20 Sealed

Immediate delivery from stock or from IRC Industrial Distributors. For information and prices write:

IRC St. Petersburg Division of TRW INC.
2801 72nd St., North, St. Petersburg, Fla. 33733

IRC

DIVISION OF TRW INC.

Circle 211 on reader service card

be produced photoelectrically using color scanners—high quality facsimile machines. These separate light from a scanned original into various spectral groups. By replacing the light sources now used in these machines with a laser, it is possible to increase scanning speeds, use lower sensitivity recording films, and obtain greater enlargement capability. A color correction computer in the fascimile machine drives an electro-optic modulator which modulates the light intensity; and by electronically pulsing the correction signal from the computer, a screened halftone image can be directly generated.

Increasing the radiance of the light source increases the speed of the scanning unit. A high temperature tungsten source will do the job but the tube life is drastically shortened by the higher temperature required. However, lasers with coherent light and essentially infinite radiance reduce this disadvantage. They are now becoming available with power supplies similar to those required for arc lamps, and with comparable efficiencies. The smallest lasers generally available produce about 1 milliwatt of coherent light. And even allowing for losses in the filters and optics the laser offers 100 times more power in a focused spot than the tungsten source.

The output of the conventional scanner is a continuous tone image. One subsequent processing step can be eliminated if screening is performed on the scanner and a halftone image produced. This requires dots of varying sizes to be exposed on a photographic film. Electronic modulation of dot size can best be accomplished by modulating the amplitude of a light pulse with a suitable energy density profile and exposing a high contrast film. Since high contrast films are not sensitive enough to be used with ordinary pulse modulated light that's currently available from a tungsten lamp, the necessity of using a laser as a source is again demonstrated.

Presented at the International Communications Conference, Boulder, Colo., June 9-11.

When you want electronic test equipment fast–but not for keeps–

rent it!

Immediate delivery anywhere in the United States — that's reason enough for renting when you're faced with emergencies, trying to handle peak loads or interested only in a "one shot" test. For the longer haul, there are the questions of tying up operational capital and of writing off the costs of maintenance and obsolescence. For additional information, write, wire or phone Electro Rents today, the most complete source in the country for renting the equipment you need when you need it.

MAIN OFFICES

California: 4131 Vanowen Place
Burbank, Ca. 91504 (213) 843-3131

New Jersey: 17 Park Place
Paramus, N.J. 07652 (201) 265-7500

WRITE FOR NEW CATALOG

Electro Rents

Representatives and other offices in principle cities throughout the US.

Circle 249 on reader service card

---

80 MHz WIDEBAND RF POWER AMPLIFIER

MODEL RF-805

- 10 Watts Output into 50Ω
- 0.1 Volts In — 22.5 Volts Out
- .05 MHz to 80 MHz Broadband
- Low Distortion
- Solid State
- Flat 47 db Gain

The RF-805 is a solid state amplifier, broadband from .05 to 80 megahertz, which produces ten watts with —30 db harmonic and intermodulation distortion. Lower distortion is available at lower output levels. Gain is 47 db minimum, constant within 1 db, so that full output is developed with less than 0.1 volt at the 50 ohm input. Accurate output metering and overload protection is provided.

The RF-805 will raise the power of most manual and swept tuned signal generators and thus extend the usefulness and versatility of available signal generators. Receiver testing, wattmeter calibration, antenna testing, RFI testing, attenuator measurements, and filter and component testing will be aided with the use of this equipment.

R F COMMUNICATIONS, INC.
1680 University Avenue • Rochester, N. Y. 14610

Circle 250 on reader service card

Audio Video PHASE METER

DIFFERENTIAL INPUT PERMITS MEASUREMENTS OF BALANCED LINES WITHOUT GROUNDING ONE SIDE

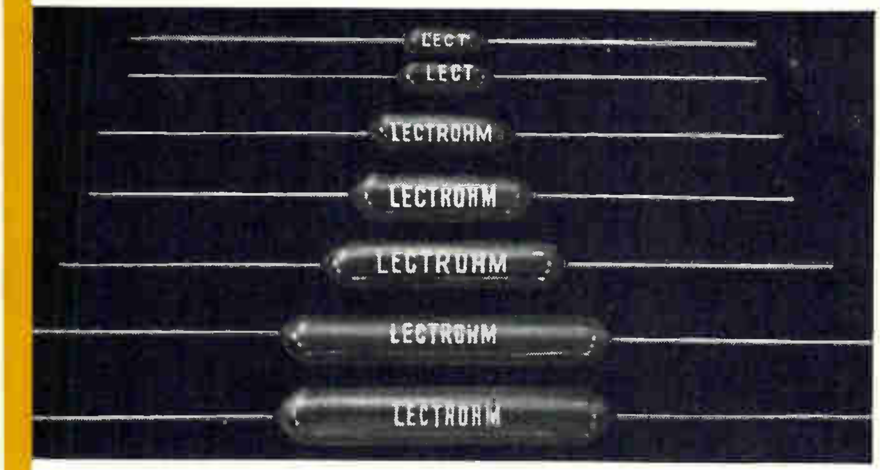
- MAKE READING WITH 0.1° RESOLUTION at any phase angle over full 360° range at any frequency 10 Hz to 2 MHz.
- METER OFFSET in 10° steps permits the measurement of any phase angle with 0.1° resolution.
- +180° SWITCH permits measurements around 0° or around 180° to to solve the problem of the angle of instability.
- VOLTAGE OUT directly proportional to phase permits digital phase readout on an external digital voltmeter.
- ACCURACY of phase output is 0.1° ±0.3% of phase angle being measured permits exacting measurements.
- HIGH SENSITIVITY with input range from 1 mV to 100 volts minimizes need for external amplifiers.
- CALIBRATION MAINTAINED even with large amplitude fluctuations of the test signal. All solid state construction.

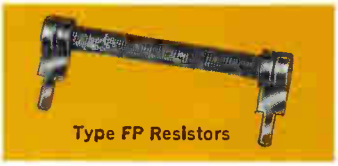
Price $1190 ($995 for single ended input version) digital readout and 2 Hz versions also available.

WILTRON COMPANY FOR BETTER ELECTRONICS MEASUREMENTS

930 E. MEADOW DR. • PALO ALTO, CALIF. 94303 • (415) 321-7428

Circle 213 on reader service card





New Literature

Pushbutton switches. Arrow-Hart Inc., 103 Hawthorn St., Hartford, Conn. 06106, has published a folder introducing Adapt-a-Switch lighted pushbutton switches, non-illuminated pushbutton switches, and indicators.
Circle **317** on reader service card

Capabilities brochure. Datatron Inc., 1562 Reynolds Ave., Santa Ana, Calif. 92705, has issued a 16-page capabilities brochure describing its range of data acquisition systems, timing instrumentation, testing services, and equipment **[318]**

D-c motors. Newman Co., Motor Division, 36-770 Cathedral Canyon Dr., Cathedral City, Calif. 92234. A two-page data sheet describes a new line of Marx d-c motors that feature low cost, small size, high torque, low voltage and immediate availability. **[319]**

Chemically created circuitry. Ansley Division of ACI Inc., Park Ave. and Ridge Rd., Perkasie, Pa. 18944, offers a 12-page brochure describing its complete capability for producing all types of chemically created circuitry. **[320]**

Magnetic tape system. Data Division, Genisco Technology Corp., 18435 Susana Rd., Compton, Calif. 90221. Portability in data recording is highlighted in a four-page brochure on the 10-126 magnetic tape system for severe environment applications. **[321]**

Resistor trimming bridges. Teradyne Inc., 183 Essex St., Boston, Mass. 02111. A 12-page brochure describes a line of resistor stop-and-test bridges specifically designed for use in the trimming of thick-film resistors. **[322]**

Removable contact connectors. Continental Connector Corp., 34-63 56th St., Woodside, N.Y. 11377. A data sheet covers a line of new microminiature connectors with wire crimp termination removable contacts. **[323]**

Silicone elastomer. Technical Wire Products Inc., 129 Dermody St., Cranford, N.J. 07016. Data sheet EMC-850 features the emi/rfi shielding, sealing, grounding and static discharge capabilities of a conductive silicone elastomer called Consil. **[324]**

Laser and maser modulators. LAD Electro-Systems Inc., 7 Commercial St., Hicksville, N.Y. 11801, has issued a data sheet describing laser and maser modulators that provide from 0.025 to 10,000 joules per pulse. **[325]**

Stepper motors. Haydon Switch and Instrument Inc., 1500 Meriden Rd., Waterbury, Conn. 06720. Bulletin 31300 describes a new line of two-wire stepper motors. **[326]**

TTL integrated circuits. Texas Instruments Inc., P.O. Box 5012, Dallas

New Literature

75222. An 80-page brochure provides data on three transistor-transistor logic IC series—the standard 54/74, the high-speed 54H/74H, and the low-power 54L/74L. [327]

Nickel cadmium batteries. NIFE Inc., Copiague, N.Y. 11726. Booklet AG-700 gives a technical analysis of the pocket plate nickel cadmium storage battery as applied to industrial standby service. [457]

Electronic console. Dunbar-Nunn Corp., 1108 Raymond Way, Anaheim, Calif. 92801. An illustrated six-page brochure describes the Unitrol electronic console for emergency vehicles. [328]

Digital data acquisition. Vidar Corp., 77 Ortega Ave., Mountain View, Calif. 94040. "How To Make Measurements Automatically" discusses the importance of data acquisition in various disciplines and the advantages of automatic data handling over chart recorder/visual/manual methods. [329]

Noiseless potentiometer. Clairex Electronics Inc., 1239 Broadway, New York 10001. A frictionless, stepless, heatless, and noiseless potentiometer is described in Vol. 5, No. 2 of Photocell Forum. [330]

Variable inductors. Sangamo Electric Co., P.O. Box 359, Springfield, Ill. 62705, has available an engineering handbook (bulletin 5104) covering the type NV-4 communications grade, variable inductors. [331]

Permanent-magnet d-c motors. Rotamec Inc., 6315 Arizona Pl., Los Angeles 90045, has released bulletin M300 illustrating and describing its line of Super 1¼ permanent-magnet d-c subminiature motors. [332]

Data sets. Lynch Communication Systems Inc., 695 Bryant St., San Francisco 94107, offers a product bulletin on the L2103A and L2103F solid state data sets. [333]

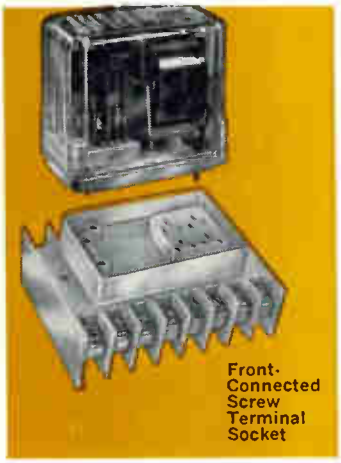
Advanced urethane system. Conap Inc., Allegany, N.Y. 14706, has issued technical bulletin P-127 containing complete information on the use of the Conathane EN-2 system for such applications as potting or encapsulating strain-sensitive devices and coating printed circuits. [334]

Transistor sockets. Robinson-Nugent Inc., 800 E. Eighth St., New Albany, Ind. 47150. Fabricated and molded transistor sockets are featured in a broad line catalog. [335]

Industrial electronics. Texas Instruments Inc., Box 5012, Dallas 75222. Twenty-two page bulletin CB-100 features a number of case histories that point out how industrial companies

Standard and Miniature
Reed Relays

Special Design
Reed Relays



Front-
Connected
Screw
Terminal
Socket

COMPET: Brain Child

CS-22C

Compet CS-22C. Sharp's high I.Q. problem solver for fast-moving engineers and scientists. The quiz kid so light you can carry it anywhere. Yet the IC construction provides instant answers to a wide range of simple and complex calculations with maximum efficiency.

Silently calculates up to 14 digits and 6 decimal places. Has a memory bank for wide calculation versatility. Carries out exponent and mixed calculations instantly. Automatic successive multiplication and division by a constant. Automatic decimal system, round off and credit balance. Memory indicator and over capacity error light.

Try it. CS-22C. One demonstration and you'll know why Sharp leads the field.

SHARP

HAYAKAWA ELECTRIC CO., LTD. Osaka, Japan

U.S. Subsidiary: SHARP ELECTRONICS CORP. 178 Commerce Road Carlstadt, New Jersey

"Sharp Has a Way of Making it Better"

Circle 216 on reader service card

NEW ALTERNATE ACTION PUSH BUTTON SWITCHES

(Push-On, Push-Off)

...the Reliable Ones by Grayhill

250,000 operations – WITHOUT A MISS.

- SPDT, SPST
- 1/4 Amp., 115 VAC resistive
- Totally enclosed
- Space saving - .937" behind panel
- Momentary action counterpart available

For your Grayhill Engineering Catalog offering complete technical data — contact

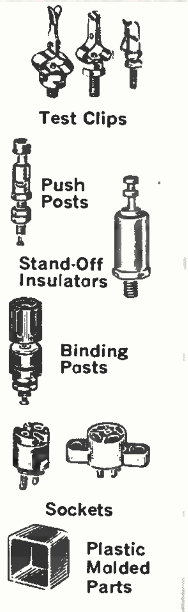
Grayhill INC

523 Hillgrove Avenue
LaGrange, Illinois 60525
Area Code 312, Phone 354-1040

...the Difference Between Excellent and Adequate

Circle 251 on reader service card

FOR EXCELLENCE IN TERMINATION HARDWARE SPECIFY GRAYHILL



Test Clips
Adjustable tension, threaded studs or plug in bases, various sizes.

Push Posts
Plunger action lets you connect and disconnect quickly and easily, assures positive contact.

Binding Posts
Screw type or spring loaded, banana plug or stud mounting, single or multiple units, with various colors for circuit identification.

Stand-Off Insulators
High dielectric strength, low loss insulation, low moisture absorption, various mounting styles.

Sockets
Lamp or transistor, various colors, various mountings including printed circuit.

Custom Molded Parts
Tight tolerances provide you with "assembly ready" units. Thermosetting plastics to meet most specifications.

For your Grayhill Engineering Catalog offering complete technical data — contact

Grayhill INC

523 Hillgrove Avenue
LaGrange, Illinois 60525
Area Code 312, Phone 354-1040

...the Difference Between Excellent and Adequate

Circle 252 on reader service card

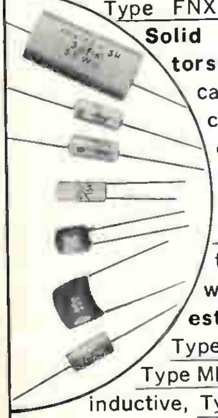
STABILITY & QUALITY

SOLID TANTALUM CAPACITORS FOR HYBRID ICs -"MICROCAP"-

Capacitance exceeding 10,000 picofarads obtained despite miniature size. "MICROCAP" features excellent heat resistance, solderability and mechanical strength comparable to conventional discrete components, for easy use in hybrid integrated circuits.

Specifications:
Operating Temperature Range: —55°C to +85°C
Standard Voltage Rating: 6.3, 10, 16, 20, 25, 35 VDC
Standard Capacitance Value: .001 to 22MFD (E6 series)
Standard Capacitance Tolerance: ±20% (M)

MATSUO'S other capacitors include: **Metallized Polyester Film Capacitor:** Type FNX-H mylar wrapped. **Solid Tantalum Capacitors:** Type TAX hermetically sealed in metallic case, Type TSX encased in metallic case and sealed with epoxy resin, Type TSL encased in metallic case and sealed with epoxy resin. **Polyester Film Capacitors:** Type MFL epoxy dipped, Type MFK epoxy dipped, non inductive, Type MXT encased in plastic tube, non inductive.



For further information, please write to:
MATSUO ELECTRIC CO., LTD.
Head Office: 3-5, 3-chome, Sennari-cho, Toyonaka-shi, Osaka, Japan
Cable: "NCCMATSUO" OSAKA Telex: 523-4164 OSA
Tokyo Office: 7, 3-chome, Nishi-Gotanda, Shinagawa-ku, Tokyo

Circle 253 on reader service card

New Literature

have dramatically improved their designs by using solid-state electronics. [466]

Rectifiers and diodes. Unitrode Corp., 580 Pleasant St., Watertown, Mass. 02172. Forty-page catalog C-159 covers a line of controlled avalanche, fused-in-glass rectifiers, zener diodes, and MIL-type devices. [336]

R-f power measurement. Bird Electronic Corp., 30303 Aurora Rd., Cleveland 44139. Short form catalog SF-69 lists nearly all the coaxial load resistors, absorption wattmeters, and directional wattmeters stocked by the company for r-f power measurement. [468]

D-c power supplies. Dressen-Barnes Electronics Corp., 250 N. Vinedo Ave., Pasadena, Calif. 91107, has available a short form catalog containing specifications, dimensions and prices on 631 d-c power supplies, overvoltage protectors and filters. [337]

Signal storage tube. Warnecke Electron Tubes Inc., 175 W. Oakton St., Des Plaines, Ill. 60018. A four-page brochure features the RW-6EM high resolution (2,000 tv lines), dual gun, electrical signal storage tube. [338]

Digitally controlled power. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. 94304, offers a 22-page brochure dealing with the characteristics and applications of digitally controlled power sources. [446]

Coil winding service. James Electronics Inc., 4050 N. Rockwell St., Chicago 60618, has issued a facilities report detailing an automatic programed coil winding service. [447]

Optical incremental encoder. Sequential Information Systems Inc., 66 Saw Mill River Rd., Elmsford, N.Y. 10523. A four-page product bulletin describes the company's optical incremental encoder series 25D. [448]

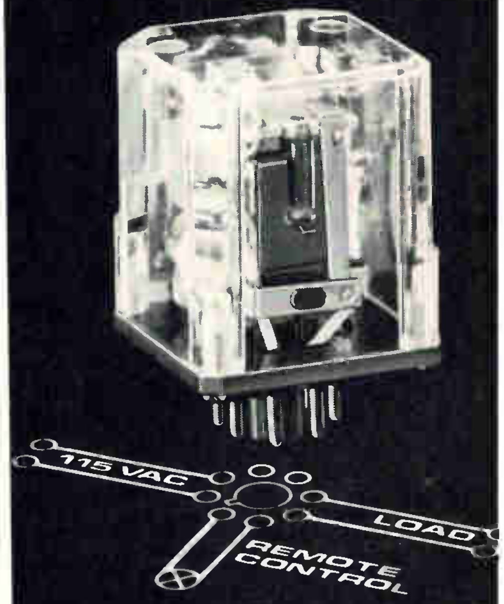
Ruggedized tape transports. Genisco Technology Corp., 18435 Susana Rd., Compton, Calif. 90221. Ruggedized tape transports for a wide variety of severe environment applications are described in a short form bulletin [474]

High-temperature inks. Aremco Products Inc., P.O. Box 145, Briarcliff Manor, N.Y. 10510. Product bulletin 530-534 is a single-page data sheet describing high-temperature and corrosion-resistant inks. [449]

High-power hybrids. Silicon Transistor Corp., East Gate Blvd., Garden City, N.Y. 11532, has released a four-page illustrated brochure on its diversified line of high-power hybrids. [450]

Coaxial cable delay lines. Phelps Dodge

the impossible
ALCOSWITC



Since when does ALCOSWITCH mak
relays? Since we learned how to mak
the impossible switch. All we've don
is to combine a step-down transforme
and a relay in a single core, all i
miniature.

If your product operates on 115 VA
and has possibilities of remote opera
tion chances are you could use thi
ALCOSWITCH-RELAY!

Refer to the figure below: by simpl
shorting the remote control leads "xx
the flux path changes thereby closin
the relay armature.

The only product in the world of thi
type that allows you to control up t
600 watts remotely, safely, and eco
nomically.

Whether you manufacture hi-fi ampl
fiers, electric fans, vacuum cleaner
projectors, thermostat controls, co
sumer appliances or industrial equi
ment, you may have a need for thi
revolutionary switching product.

If you are seeking a marketing a
vantage for your products, we will b
happy to assist you by suggesting o
of our ALCOSWITCH- RELAYS.

ALCO
ELECTRONIC PRODUCTS, INC.
Lawrence, Massachusetts 01843
"See us at WESCON 5120"
Circle 217 on reader service card

World Fair

nuclex 69

2nd International Fair and Technical Meetings for Nuclear Industries

6th to 11th October 1969
Basel, Switzerland

Secretary nuclex 69
CH-4000 Basel 21 Switzerland
Phone 061 32 38 50 Telegrams nuclex Basel
Telex 62 685 fairs ch

Circle 218 on reader service card

Speed-up Wire Marking with a KINGSLEY Wire & Tube Marking Machine *right in your plant!*

Write for Details

Now you can *permanently* mark wire or tubing directly on the insulation... quickly... economically–right in your own plant!

Cut costs and speed production with the same machine that has consistently proven so successful in the aircraft/missile field.

KINGSLEY MACHINES
850 CAHUENGA • (213)469-7243
HOLLYWOOD, CAL 90038

A-207

Circle 254 on reader service card

TRANSTECTOR
CIRCUIT PROTECTOR

prevents transients from causing "unexplainable" circuit failures.

Don't blame circuit failures on bad luck.

Voltage transients can cause circuits to fail or suffer undetected and progressive damage.

Transtector* circuit protector, a new solid state device, senses transients within nanoseconds, absorbs the surge and resets itself. Gives continuous protection for tubes, transistors, diodes and integrated circuits.

Find out about Transtector Systems from M&T Chemicals Inc., 3025 W. Mission Rd., Alhambra, California 91803.

*Trademark of M&T Chemicals Inc.

(213) 283-9278

M&T Chemicals Inc.
SUBSIDIARY OF AMERICAN CAN COMPANY

Circle 255 on reader service card

New Literature

Communications Co., 60 Dodge Ave., North Haven, Conn. 06473, has published a four-page catalog describing representative examples of coaxial cable delay lines. [477]

Analog computer. Astrodata Inc., 240 E. Palais Rd., Anaheim, Calif. 92803. A 16-page illustrated brochure describes the Comcor 550 analog computer. [452]

Quartz crystals. K-W Industries Inc., P.O. Box 508, Prague, Okla. 74864, has released a bulletin containing a list of quartz crystals in the range from 50 khz to 200 mhz. [453]

D-c/a-c converters. Carter Motor Co., 2711 W. George St., Chicago 60618. A complete line of d-c to a-c rotary converters is presented in a condensed catalog. [454]

Metalized polyester capacitors. Engineered Components Co., 2134 W. Rosecrans Ave., Gardena, Calif. 90249, offers catalog C/4-69 describing a line of 50-volt Flat-Pak, axial and radial lead metalized polyester capacitors. [455]

Laser optical components. Oriel Optics Corp., 1 Market St., Stamford, Conn. 06902. A 26-page catalog section on laser optical components includes a wide variety of precision substrates and high efficiency laser coatings. [456]

Clutches and brakes. Stearns Electric Corp., 120 N. Broadway, Milwaukee 53202. Fully assembled, ready to install electric clutches and brakes are described in 16-page bulletin 536. [485]

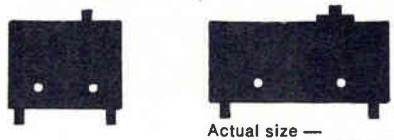
Remote batch computer service. Westinghouse Information Systems Laboratory, 2040 Ardmore Blvd., Pittsburgh, 15221. Four-page bulletin DB24-450 provides information on a problem-oriented remote batch computer service called RITS (Remote Input Terminal System). [458]

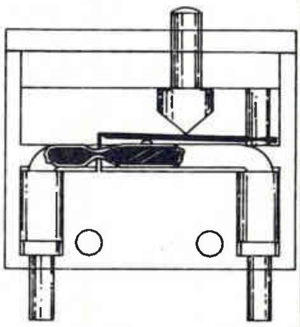
F-m/f-m telemetering modules. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. 91343. A 40-page catalog describes f-m/f-m telemetering modules including voltage controlled oscillators, d-c amplifiers, d-c signal isolators, frequency to d-c converters, tone oscillators, pressure transducers, and laboratory telemetering system. [459]

Measurements survey. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304. Application Note 93 is a comprehensive 60-page survey of measurements that can be made with the company's multichannel analyzers. [460]

Ceramic substrates. Bourns Inc., 3231 Kansas Ave., Riverside, Calif. 92507, has available a product bulletin on high


f=15-145mm 1:2.5 No 200
MADE IN JAPAN
145
75
2825





New Literature

alumina ceramic substrates now being produced by the facility. **[461]**

Proximity voltmeter. Victoreen Instrument Division, 10101 Woodland Ave., Cleveland, Ohio 44104. A two-page data sheet highlights features of the model 5051 proximity voltmeter, in addition to providing complete specifications and useful engineering information. **[462]**

Miniature switches. Alco Electronic Products Inc., P.O. Box 1348, Lawrence, Mass. 01842, has released a 20-page catalog featuring an expanded line of miniature electronic switches and keyboard assemblies. **[463]**

High alumina ceramics. Diamonite Products Mfg. Co., Shreve, Ohio 44676, offers a new edition of "Standards of the Alumina Ceramic Manufacturers Association for High Alumina Ceramics". **[464]**

Log circuits. Analog Devices Inc., 221 Fifth St., Cambridge, Mass. 02142. A 12-page application note discusses logarithmic feedback principles and circuits for use with operational amplifiers. **[465]**

Thermal shock test. Blue M Engineering Co., 138th & Chatham St., Blue Island, Ill. 60406. Twelve-page brochure 693 describes the company's expanded line of thermal cycling and shock test equipment. **[466]**

Instrument knobs. Radial Controls, 2555 E. 55th Place, Indianapolis 46220. An eight-page catalog covering over 50,000 different instrument knobs includes dimensions, price and choice of color. **[467]**

Electromagnetic circuit protectors. Airpax Electronics, Cambridge, Md. 21613. Twelve-page bulletin 16E-16 describes an economical line of panel mount, single and multipole electromagnetic circuit protectors. **[468]**

Tape readers. The Superior Electric Co., Bristol, Conn. 06010. A four-page brochure illustrates and describes Slo-Syn photoelectric tape readers. **[469]**

Count controller. Automatic Timing & Controls Inc., King of Prussia, Pa. 19406, has issued bulletin 310 describing the series 310D impulse count controller **[451]**

Rear projection readout. Shelly Associates Inc., 111 Eucalyptus Dr., El Segundo, Calif. 90246. Bulletin 69-002 details the BDR-90 ultraminiature rear projection readout. **[478]**

Emi filters. Erie Technological Products Inc., 644 W. 12th St., Erie, Pa. 16512, has published a catalog sheet on the series 1211 hermetically sealed, miniature, low pass emi filters. **[470]**

Teletypewriter loop module. Quindar Electronics Inc., 60 Fadem Rd., Springfield, N.J. 07081. Product data sheet PDS-2-18 describes the QTL-8 teletypewriter loop module. **[471]**

Supervisory process control. The Foxboro Co., Foxboro, Mass. 02035. Bulletin L-29 describes the SPC/400, an inexpensive, supervisory digital computer control system. **[472]**

Insulated flat wire. Tapecon Inc., P.O. Box 4741, Rochester, N.Y. 14612. Data sheet IFW-119 covers insulated flat wire, its specifications, forms, and numerous applications. **[473]**

Quartz filters. Clevite Corp., 232 Forbes Rd., Bedford, Ohio 44146, has available a data sheet on its standard line of independent mode monolithic quartz Uni-Wafer filters. **[482]**

Precision switches. Cherry Electrical Products Corp., 1650 Old Deerfield Rd., Highland Park, Ill. 60035, offers its "Design Engineer's Precision Switch Selector Guide", accordion-folded to pocket size. **[475]**

Controlled environment systems. Bendix Automotive & Automation Co., P.O. Box 893, Dayton, Ohio 45401. Catalog IN-7103-669 covers Modulab controlled environment systems. **[476]**

Temperature sensors. Pennsylvania Electronics Technology Inc., 1397 Frey Rd., Pittsburgh, Pa. 15235. Technical data 68-9 describes the use of Positemp sensors for liquid level and temperature control. **[477]**

Wheatstone bridges. James G. Biddle Co., Plymouth Meeting, Pa. 19462. Bulletin 71-11 describes Wheatstone bridges for a wide range of high-resolution resistance measurement. **[483]**

Indicators. Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634, has published an eight-page brochure on the modular series V-5A indicators, for use with transmitters to indicate process variables or measure vacuum, pressure, differential pressure, and temperature directly. **[479]**

Terminating sets. Lynch Communication Systems Inc., 695 Bryant St., San Francisco 94107, has available a product bulletin on the 2TN15 and 2TN16 coil-type, four-wire terminating sets. **[480]**

Miniature connectors. RF Components Division of Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543. A technical data sheet describes the SRM series of stainless-steel, gold-plated miniature connectors. **[481]**

BIG ADVANCES Come in Small Packages

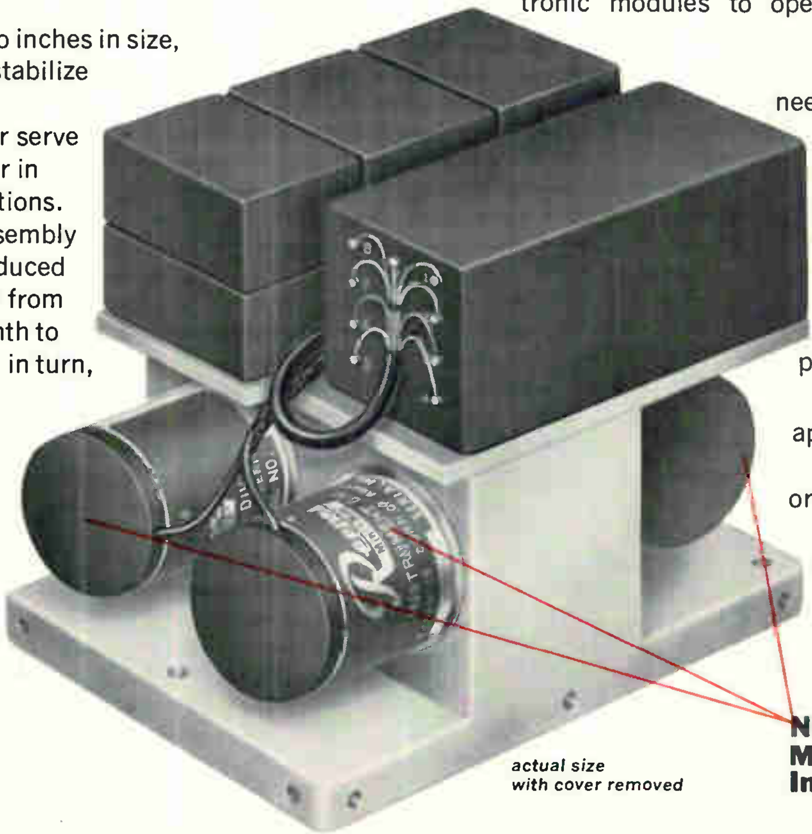
Now... Reeves has developed the highly accurate subminiature heaterless Mini-RIG Integrating Gyro... and the full capability for packaging it as a self-contained sub-system.

The Mini-RIG development represents a major advance in reliability, cost reduction and performance, in the field of subminiature high-volume inertial sensors.

Only one inch by two inches in size, the Mini-RIG can stabilize short-mission-time inertial platforms or serve as an inertial sensor in strap-down applications. Automated gyro assembly techniques have reduced final assembly time from the normal one month to **one work-day!** This, in turn, has minimized the possibility of contamination and maximizes reliability. Reeves has full packaging capability, too. For example, the illustration shows a typical compact three axis rate package especially designed for aircraft missile and satellite system applications. It is system-engineered to provide the necessary accuracy and to meet the most stringent environmental requirements of outer space. Within its 30 cubic inch volume are three Mini-RIG Rate integrating gyros **plus** all necessary electronic modules to operate the entire package.

What are your special needs for subminiature gyro packages and sub-systems? Reeves can meet them! Our engineers working within the Total Systems Concept, will isolate the problem areas and provide the most practical solutions for them.

For complete data and application information call (516) 746-8100 ext. 540, or write Component Division, Reeves Instrument, Garden City, N.Y. 11530.



actual size
with cover removed

NEW! REEVES Mini-RIG® Integrating Gyro.

Reeves®

INSTRUMENT DIVISION DCA *DYNAMICS CORPORATION OF AMERICA / GARDEN CITY, NEW YORK 11530*

Circle 223 on reader service card

Solid State Power Conversion Specialists

Pratt & Whitney Aircraft, world's leading producer of dependable jet engines, is currently engaged in an intensive program of research and development in fuel cells. One indication of our progress is the successful performance of P&WA fuel cells in Apollo spacecraft. Another is the cell being developed for various commercial applications under the sponsorship of a group of companies in the gas industry.

In connection with this program we have several career openings affording groundfloor opportunity for qualified specialists. Specifically, we are looking for engineers with 6 to 12 years background in solid state conversion, preferably with 2 to 3 years experience in inverter design. The work is unusually challenging and the group small enough for individual contributions to be obvious.

Areas of activity include:

1. Design and development of low cost commercial inverters in the 5-500 KVA range.
2. Power section and logic design; input and output filter analysis.
3. Overall control analysis.
4. Circuit analysis programs using ECAP, CIRCUS and SCEPTRE.
5. Conventional 60 HZ and high frequency pulse width modulation based on SCR's.

Please send resume and salary requirement to Mr. H. M. Heldmann, Professional Placement, Office A-46, Pratt & Whitney Aircraft, East Hartford, Connecticut 06108. An equal opportunity employer.

Pratt & Whitney Aircraft

U
DIVISION OF UNITED AIRCRAFT CORPORATION
A

CIRCLE 966 ON READER SERVICE CARD

TECHNICAL DIRECTOR

Electronics Materials

Diversified billion dollar consumer/industrial manufacturing company needs a person to identify trends and relevant materials technology in the microelectronics field, determine opportunities, help prepare related objectives, plan for budgets, and serve as technical advisor and consultant to operating staff.

Requirements: Some industrial experience and familiarity with materials technology in the field of microelectronics. Should have knowledge of crystallized glasses and substrates, and integrated circuits, both monolithic and hybrid. Ph.D. required in EE, Electronics, Physics, or related area.

A Career Position: Located in Toledo, Ohio with excellent starting salary commensurate with ability, education, and experience, plus all the fringes you'd expect. Submit resume in confidence to . . .

E. A. Brinkley
Specialized Recruiting — Dept. A
OWENS-ILLINOIS, INC.
P. O. Box 1035, Toledo, Ohio 43601

An Equal Opportunity Employer

CIRCLE 967 ON READER SERVICE CARD

ENGINEERS

The leader in the field of amorphous semiconductors and originator of Ovonics offers challenging engineering positions for qualified individuals with hardware design experience in computer memory, logic, or display subsystems.

ENGINEERING MANAGEMENT—Assistant to the Director of Engineering, with major responsibilities in the development of new products, including circuit design, testing procedures, and marketing evaluation and representation. Should be hardware-oriented with engineering project management experience in a computer oriented field.

ELECTRONIC DESIGN ENGINEERS—Responsible for the design, development and testing of new products incorporating amorphous semiconductor devices. Outstanding opportunities for creative designers with hardware experience in memory, logic, display, or automatic testing systems.

Top salaries and excellent fringe benefits for those who qualify. Please submit your resume to the Personnel Dept.

E
C
D

Energy Conversion Devices, Inc.
1675 W. Maple Rd., Troy, Mich. 48084

An Equal Opportunity Employer

CIRCLE 968 ON READER SERVICE CARD

ELECTRONICS DESIGN ENGINEER

An opening exists in a university laboratory for an electronics engineer capable of assuming the design and development responsibility for instrumentation to be used in the fields of cosmic rays and space physics. The instrumentation will involve photomultipliers, image tubes, data digitization, digital and analog signals, and telemetry.

Experience with logic and fast pulse circuitry as well as knowledge of the latest integrated circuit technology is necessary.

Contact

R. W. Huggett or S. D. Verma,
Physics Department,
Louisiana State University,
Baton Rouge, Louisiana 70803.

An equal opportunity employer

CIRCLE 973 ON READER SERVICE CARD

SYNERGISTICS INC.
Ikon Data Systems Division

ELECTRONIC ENGINEERS

LOGIC DESIGN

Expansion of our R-D department has created challenging opportunities for engineers with digital logic design experience, to join a team of professionals who are advancing the state of the art in data acquisition and processing techniques.

Ikon Data Systems is a small, very progressive company offering excellent working conditions, and benefits, plus the opportunity to live, work and play in the beautiful Pacific Northwest.

Please send resume of education and background experience to

Mr. D. Hoffmann:
IKON DATA SYSTEMS
2708 2nd Avenue
Seattle, Washington 98121

CIRCLE 974 ON READER SERVICE CARD

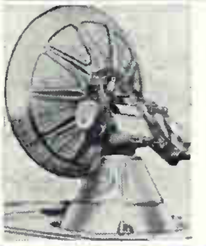
POSITION VACANT

Sales/Application Engineer—EECO's Newly formed division has outstanding growth opportunity for Sales/Application Engineer in Air Transport Products Group. Applicant should be familiar with major air frame manufacturers, domestic and foreign airlines. Successful candidate will be assigned account responsibility primarily in the area of Custom Controls for Passenger In-Flight Entertainment. Prefer BSEE with several years electro-Mechanical design or marketing experience. The Electronic Products Division has approximately 450 employees engaged in the design and manufacture of a broad spectrum of electro-mechanical and electronic products. Please send resume & salary history in confidence to: Electronic Engineering Co. Electronic Products Division 1601 E. Chestnut Avenue Santa Ana, Calif. 92702. Attn: Miss Sue Webb, Personnel Department Telephone: (714) 547-5651. Equal Opportunity Employer.

SEARCHLIGHT SECTION

• CLASSIFIED ADVERTISING • BUSINESS OPPORTUNITIES
• USED OR SURPLUS EQUIPMENT

AUTOTRACK MOUNT



360 degree azimuth, 210 degree elevation sweep with better than 1 mil. accuracy. Missile velocity acceleration and slewing rates. Amplidyne and servo control. Will handle up to 20 ft. dish. Supplied complete with control chassis. In stock—immediate delivery. Used world over by NASA. USAF, MP-61-B. Type SCR 584. Nike Ajax mounts also in stock.

PULSE MODULATORS

MIT MODEL 9 PULSER 1 MW—HARD TUBE
Output 25kv 40 amp., 30kv 40 amp. max. Duty cy .002. .25 to 2 microsec. Also 5 to 5 microsec. and .1 to .5 microsec. Uses 6C21. Input 115v 60 cycle AC. Mfg. GE. Complete with driver and high voltage power supply. Ref: MIT Rad. Lab. Series, Vol. 5, p. 152.

2 MEGAWATT PULSER
Output 30 kv at 70 amp. Duty cycle .001. Rep rates. 1 microsec 600 pps. 1 or 2 msec 300 pps. Uses 5948 hydrogen thyratron. Input 120/208 VAC 60 cycle. Mfr. GE. Complete with high voltage power supply.

250 KW HARD TUBE PULSER
Output 16 kv 16 amp. Duty cycle .002. Pulses can be coded. Uses 5D21, 715C or 4PR60A. Input 115 v 60 cy. AC $1200 ea.

18 MEGAWATT PULSER
Output 150KV at 120 amps. Rep rate: 50-500 PPS. Pulse length: 5 msec. 15KV 120 amp. into pulse transformer. Rise time 1.5 msec. Filament supply 5V 80 amp. incl. 17.5KV 1.5 amp DC power supply. Input: 220V 60 cy AC.

INDICATOR CONSOLES
AN/SPA-4A, PPI 10", range to 300 mi.
VJ-1 PPI 12", Range to 200 mi.
VL-1 RH1 12" to 200 mi. 60K ft.

SCR 584 AUTOTRACK RADARS
Our 584s in like new condition ready to go, and in stock for immediate delivery. Ideal for telemetry research and development, missile tracking, satellite tracking. Fully Desc. MIT Rad. Lab. Series, Vol. 1, pps. 207-210, 228, 284-286. Comp. Inst. Bk available $25.00 each.

ANTI-AIRCRAFT GUN MOUNT
Will handle 6,000 lbs. rapid slew through 360° azimuth, 180° elevation. Mobile.

MICROWAVE SYSTEMS

200-2400 mc. RF PKG
Continuous coverage, 30 Watts Cw nominal output. Uses 2C39A. Price $575.

L BAND RF PKG.
20 KW peak 990 to 1040 MC. Pulse width .7 to 1.2 micro sec. Rep. rate 180 to 420 pps. Input 115 vac incl. Receiver $1200.

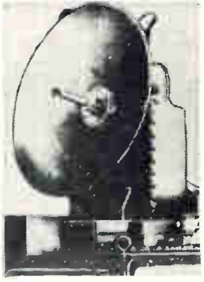
200-225 mc RADAR SYSTEM
1 Megawatt output. 200 nautical mile range for long range detection of medium and high altitude jet aircraft as well as general search. AN/TPS-28.

SURVEILLANCE DRONE RADAR SYSTEM
X-Band tracking system with plotting boards. Type AN/MPQ-29. Drone also in stock.

5 MEGAWATT C-BAND
Klystron RF package delivering nominal 5 megawatt pulse RF. Complete with pulser and power supply.

500 KW L BAND RADAR
500 kw 1220-1359 msc. 160 nautical mile search range P.R.I. and A scopes. MTI. thyratron mod 5J26 magnetron. Complete system.

AN/GPG-1 SKY-SWEEP TRACKER
3 cm. automatic tracking radar system. Complete package with indicator system. Full target acquisition and automatic tracking. Input 115 volts 60 cycle New. In stock for immediate delivery. Entire System 6' long, 3' wide, 10' high. Ideal for Infrared Tracker, Drone Tracker, Missile Tracker, R. & D.



C Band Autotrack
1 Megawatt 10 ft. Parabola, Sperry.

40 KW TRANSMITTER
4 to 21 MHZ. 40 kw Telegraphy, 30 kw Voice, can be SSB. New condition. Two systems in stock. Excellent rf source, broadcast or point-to-point.

Radio-Research Instrument Co.

45 W. 45th St., New York, N.Y. 10036 ▪ 212-586-4691

CIRCLE 969 ON READER SERVICE CARD

Somebody—
Somewhere

needs your idle equipment! Reach that buyer quickly and economically thru the

"SEARCHLIGHT SECTION"

The meeting place of Used Equipment Buyers and Sellers

WE WANT TO BUY . . .

Surplus U.S.A. Equipment.
Write for our list of wants.
Top prices paid.

L. H. ALTARAS
33 Brazennouse St., Manchester 3, England

CIRCLE 970 ON READER SERVICE CARD

ELECTRON TUBES

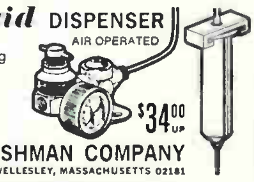
KLYSTRONS • ATR & TR • MAGNETRONS
SUBMINIATURES • C.R.T. • T.W.T. • 5000-6000 SERIES
• SEND FOR NEW CATALOG A2 •

A & A ELECTRONICS CORP.
1063 PERRY ANNEX
WHITTIER, CALIF.
696-7544

CIRCLE 971 ON READER SERVICE CARD

Minifluid **DISPENSER**
AIR OPERATED

for miniature potting and encapsulating



Available in 3 sizes
6cc - 12cc - 30cc

$34.00 UP

PHILIP FISHMAN COMPANY
7 CAMERON ST., WELLESLEY, MASSACHUSETTS 02181

CIRCLE 972 ON READER SERVICE CARD

Watch—

the *Searchlight Section*
for *Equipment Opportunities*

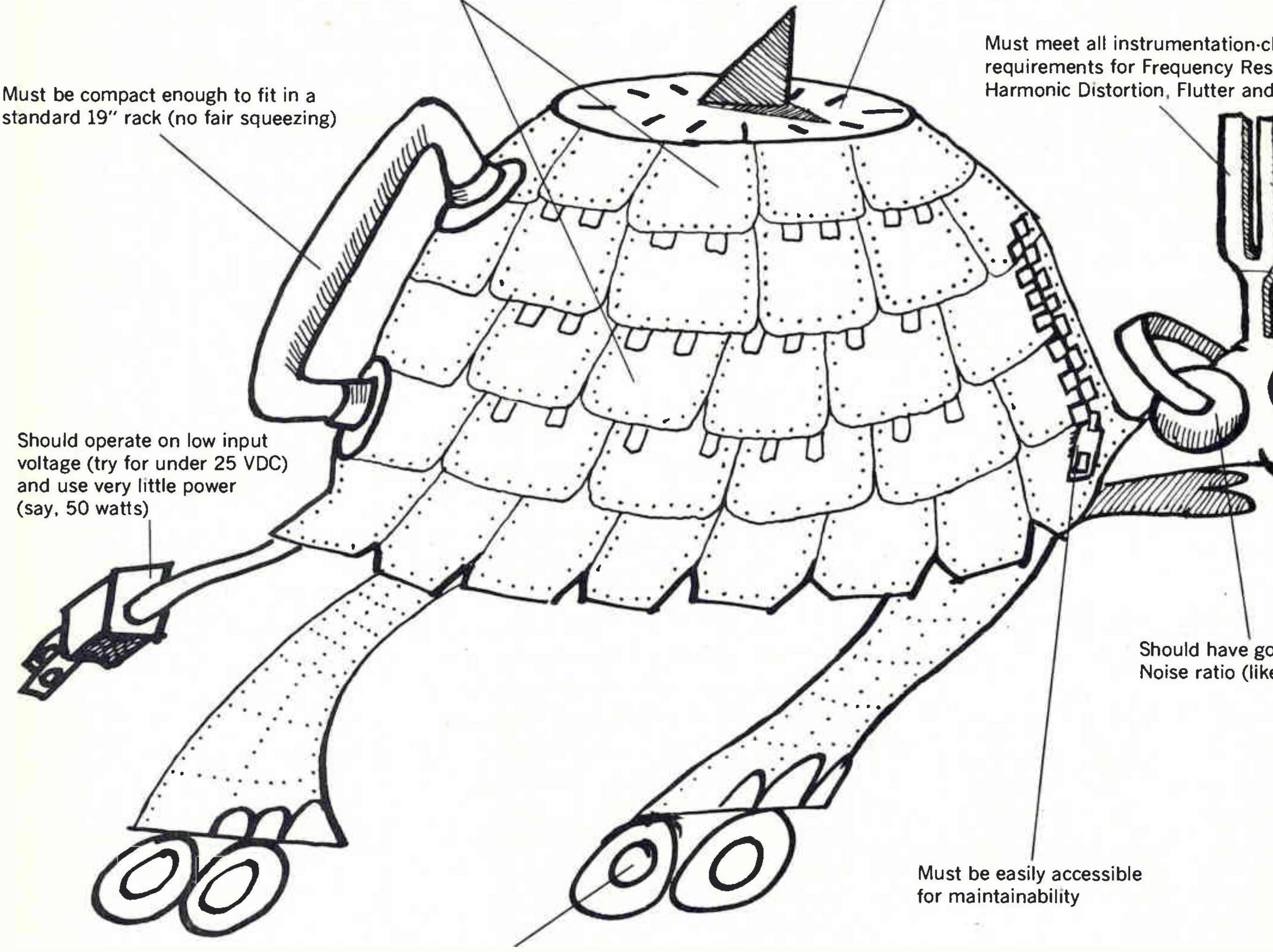
The ideal communications monitoring recorder, according to a recent survey of users:

Should have the ability to record at least 1.5 hours/cartridge automatically on Command Logic; up to 72 hours automatically on Sequential Logic

Would provide the recording capability of 12 two-channel audio recorders in one compact package

Must meet all instrumentation-class requirements for Frequency Response, Harmonic Distortion, Flutter and Wow

Must be compact enough to fit in a standard 19" rack (no fair squeezing)



Should operate on low input voltage (try for under 25 VDC) and use very little power (say, 50 watts)

Should have good Signal-to-Noise ratio (like, 36dB)

Must be easily accessible for maintainability

Would have tape speeds up to 15 IPS (IRIG Standards, naturally) and use standard 7" reels with 1800 feet of ¼" tape

The ideal communications monitoring recorder, according to Leach:

The MTR-5000

Our new MTR-5000 is an already-packaged spec-for-spec match of the prototype (above). And more. Available today in 4 cartridge 5-track or 12 cartridge 2-track configurations. For complete specs, write Leach Corporation, Controls Division, Department A, 717 N. Coney Avenue, Azusa, California 91702. (213) 334-8211.

Circle 226 on reader service card

International Newsletter

August 4, 1969

Soviet Union seeks to import color tv plant

Russia is shopping for a color television plant. The Japanese company, Sony, had been asked by the Soviet Union to set up an entire plant capable of making the sets for the newly consumer-products conscious Russians. Sony president Masaru Ibuka says the proposal was made during his recent trip to the Soviet Union. Ibuka says he turned down the request because his company does not have enough production capacity to meet its own needs at present, let alone export production equipment.

Separation first, marriage next?

Look for France's biggest electronics firm, Thomson-Brandt, to try for an out-and-out merger with the major French electrical equipment maker, Compagnie Generale d'Electricite.

The two recently signed a preliminary market-splitting agreement [*Electronics*, July 7, p. 185]. Informed sources say it eventually will be broadened to exclude competition altogether, with CGE turning over its sizeable—and lucrative—radio-tv production to Thomson-Brandt.

Government officials were fully behind the companies' plan to split the electronics and heavy electrical equipment markets. Now, they are saying privately that a full merger would be "desirable" and the "logical outcome" of the deal—and officials of the two companies don't exclude the possibility. **A merger could take years to work out, or the firms could spring a surprise announcement, in typical French fashion, at any time.**

Microwave oven sales begin to cook in Japan

A new price break, the third in less than a year, is heating up the Japanese microwave oven market. **The latest cut in sales price, down to $272 for a 550-watt unit, was made last week by the two biggest oven vendors, Hayakawa Electric Co. and Matsushita Electric Industrial Co.**

Microwave cooking promises to follow the growth curves of stereo hi-fi sets, color television and air conditioners. In 1965, microwave oven production was a slim 3,000 units. Last year, 50,000 were made. **At midyear, sales for 1969 look as if they will reach 200,000 and the manufacturers are gearing up for sales up to half a million next year.**

With volume production, microwave ovens from Japan are sure to spill over to export markets. Already Hayakawa is planning to go after the U.S. market. The company says its ovens have passed all the necessary tests, including Underwriters' Laboratories, Federal Communications Commission, and Public Health Service requirements, and should begin showing up in American stores by November.

Nordek may join electronics industry of four nations

Denmark, Finland, Norway, and Sweden may work together on research, development, and production of electronic equipment if a proposal in a draft treaty for a Nordic Economic Union, called Nordek, is accepted.

The treaty covers a wide range of economic, commercial and technical areas, including the creation of a Nordic Customs Union. Although there are some major points of disagreement, most observers feel that the prime ministers of the four nations will work out a compromise when they meet in October and that the Customs Union, at least, will be formed.

If the Customs Union is agreed upon, it would not affect import duties on electronic components and equipment. **Since the Scandinavian area is dependent to a large degree on imported components, the Customs Union**

would make it simpler for foreign nations to do business. Customs and tariff paperwork would be reduced, and central warehousing could be established to serve the entire area.

The proposals for cooperation include studies to see just what—if any—joint efforts must be made to insure industry's making full use of electronics; the formation of a Scandinavian Institute for Electronic Technology; and the reorganization of the electronics industry itself through mergers and the creation of larger, better financed producers.

British fast memory development stalled

Now that International Computers Ltd. is the only reasonably certain outlet for the next generation of large, fast, British-made computer-memory stores, development of alternative fast stores is being cut back. **International Computers is apparently opting for the plated-wire store, which puts the Plessey Co. in line as the main—and possibly only—supplier** [*Electronics,* June 9, p. 201]. Standard Telephones and Cables Ltd. now has no plans to manufacture its 250-nanosecond destructive-readout waffle-iron store, despite its claimed advantages of low capital investment and high production yields. And Mullard Ltd. has shelved development work on its proposed 800,000-bit, 150-nanosecond magnetic thin-film store. Mullard says it simply sees no significant outlet for the store until the mid-1970's.

Spare the franc and spoil the market

French electronics markets will shrink this fall—and further still next year—thanks to a government "disinflation" program aimed at cooling the overheated economy and saving the franc. **The government is immediately blocking half of all unspent 1969 plant and equipment credits of state agencies—$800 million in all—to be released only when inflationary pressures subside.** And President Georges Pompidou has vowed his 1970 budget will rise by only 6%, the smallest increase in a decade and no real increase at all if inflation continues.

This year's budget block will likely hit makers of measuring instruments and data processing equipment. An example: France's major research body, Centre National de la Recherche Scientifique, is having $11.4 million lopped from its budget and says two-thirds will come from planned lab equipment purchases.

Makers of audio-visual and telecommunications equipment are breathing easy, though, since **the two priority sectors of education and telephone expansion are exempt from both this year's budget freeze and next year's belt-tightening.** And consumer electronics firms are cheered by Pompidou's resolve to increase neither taxes nor credit terms, in order to avoid social unrest. But plant investment will taper down. A government survey shows that industry plans to up its capital outlays next year by only 16%, against the whopping 26% jump expected this year.

ESRO expands launch program

It looks like there will be at least two more Western European satellites. **The European Space Research Organization plans to launch two more scientific satellites** to follow the four due to be sent up in the next three years. The first, set for mid-1974 will investigate cosmic rays. The second, more ambitious, will come a year later. It will park in stationary orbit and contain ten experiments from many European countries, ranging from electromagnetic field measurement to particle-flux sensing.

Electronics **New subscription application**

Please start my one year subscription — 26 issues — for only $8!

☐ CHECK HERE FOR 3 Years $16 — *Saves me $8!*
FOREIGN RATES ON REQUEST

☐ Payment Enclosed
☐ Bill Me
☐ Bill My Company

SUBSCRIPTION INCLUDES 1,200-PAGE ANNUAL BUYERS' GUIDE ISSUE

Name ______________________ Title ____________
Please Fill In All Spaces

Company ______________________

Company address ______________________

City ______________ State ________ Zip code ________

Specific Product manufactured ______________ or Service performed ______________

Are you involved in the specification of electronic or allied products? ☐ Yes ☐ No

Please check your department or function:

☐ Design ☐ Research, development ☐ Production, operation, maintenance

☐ Other (please describe) ______________________

Above rates apply only to those professionally engaged in electronics technology.
All others, $25 per year.

14-50910

Electronics **New subscription application**

Please start my one year subscription — 26 issues — for only $8!

☐ CHECK HERE FOR 3 Years $16 — *Saves me $8!*
FOREIGN RATES ON REQUEST

☐ Payment Enclosed
☐ Bill Me
☐ Bill My Company

SUBSCRIPTION INCLUDES 1,200-PAGE ANNUAL BUYERS' GUIDE ISSUE

Name ______________________ Title ____________
Please Fill In All Spaces

Company ______________________

Company address ______________________

City ______________ State ________ Zip code ________

Specific Product manufactured ______________ or Service performed ______________

Are you involved in the specification of electronic or allied products? ☐ Yes ☐ No

Please check your department or function:

☐ Design ☐ Research, development ☐ Production, operation, maintenance

☐ Other (please describe) ______________________

Above rates apply only to those professionally engaged in electronics technology.
All others, $25 per year.

14-50910

First Class
Permit No. 42
Hightstown, N. J.

Business reply mail

No postage stamp necessary if mailed in the United States

Postage will be paid by McGraw-Hill, Inc.

Electronics

P. O. Box 514
Hightstown, N. J. 08520

Subscription department

First Class
Permit No. 42
Hightstown, N. J.

Business reply mail

No postage stamp necessary if mailed in the United States

Postage will be paid by McGraw-Hill, Inc.

Electronics

P. O. Box 514
Hightstown, N. J. 08520

Subscription department

Odd batch of light-emitting diodes yields a bonus: negative resistance

Hayakawa's GND, made by a simple process, works at room temperature; inherently fast, the four-layered device offers wide range of applications

Serendipity is still an important element in electronic advances. In the latest triumph of accident over planning, engineers at Japan's Hayakawa Electric Co. stumbled onto a simple process for making negative-resistance light-emitting diodes that work at room temperature. Now the company is busily developing applications, ranging from optical computing circuits to communication devices that make use of what promises to be a cheap, versatile new component.

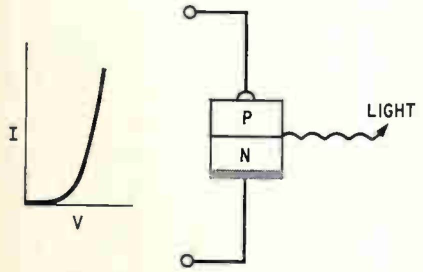
Actually, there may be more to serendipity in this case than mere accident. The manager of the Hayakawa division in which a negative resistance diode was found is Tadashi Sasaki, formerly plant manager at the Kobe Industries Corp., where the Esaki diode was discovered. At Hayakawa, he pushed to get a diode R&D project going in his industrial electronics division. And, it was the presence of technicians and equipment capable of deciphering the perplexing test results that led to the discovery of the new diode.

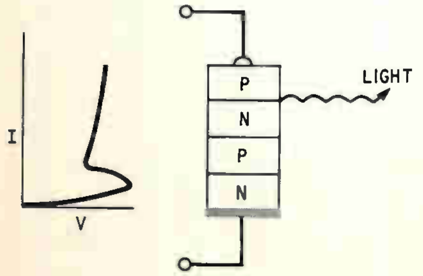
Process change. The new diode was discovered after engineers complained of strange displays on test oscilloscopes after a change in the production process for the company's gallium arsenide light-emitting diodes. Puzzled, they looked further, found that some diodes had been formed with four layers rather than the two they were supposed to have. And these layers were being produced in a single liquid epitaxial process using only one impurity—silicon.

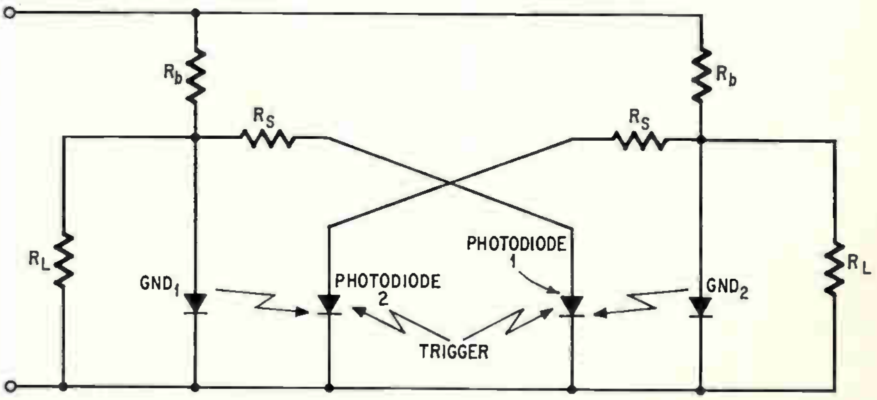
Silicon can act as either a p-type or n-type impurity depending on process conditions. The engineers found that slight temperature changes in the process were causing the growth of a structure with a 30 micron n-substrate, followed by a 5 micron p-layer, a 5 micron n-layer, and a 100 micron p-layer.

Naturally enough, Hayakawa is not releasing proprietary details, but it claims to have fully understood the process vagaries and can produce the desired characteristics with a high yield. The company has dubbed the new diode the GND, for gallium negative-resistance diode, and plans to unveil it at Wescon later this month.

Other devices of this general type include a p-i-n device developed by T. Yamamoto of Shizuoka University in 1964; a p^+pn device developed by General Electric in 1964; a p^+pn device developed by IBM also in 1964, which shows negative resistance at 77°K but not at room temperature; a p-n-n-p device developed by RCA in 1967, which gives laser radiation and a light output that isn't directly pro-







Accentuating the negative. In standard light-emitting diode, current rises with voltage. Hayakawa's device shows negative resistance area. Infrared radiation is emitted at the upper pn junction. Device is adaptable to use as a flip-flop because it can function as a light amplifier with inverting characteristics. In many circuits, the device operates in the same manner as a neon bulb.

portional to current; and a pnpnpn device developed by RCA last year that also gives laser radiation. The operation of devices having intrinsic or p+ layers depends on the filling up of deep levels which is a relatively slow process.

Most of these devices have a conversion efficiency into infrared output one to two orders of magnitude lower than GND. And many of the devices require several processes for fabrication—for example, diffusion for IBM's device—in contrast with a single epitaxial process for the Hayakawa device.

Speedy. In addition to being simple to produce, the Hayakawa device is inherently fast and easy to design with. It operates by transistor action, a fast mechanism if parameters are correct. Infrared output amplitude at 9,000 angstrom units is about 50% higher than similar light emitting diodes without negative resistance when both are operated at the same power. GND has a high efficiency of two to three percent. The device is easy to use because it operates at room temperature, and because it does not operate by laser action. Thus its light output is strictly proportional to current over the operating range.

In harness. The device should be suitable for an extremely wide range of applications because of the combination of direct electrical input, infrared optical input through a phototransistor or photodiode, and electrical or optical output. When operated with optical input and either optical or electrical output, the circuit functions as a four-terminal circuit rather than as a two-terminal circuit like the Esaki diode or simple pnpn diode, and much greater circuit versatility is available.

Applications listed by Hayakawa include amplifiers, oscillators, logic circuits including flip-flops for use as memories and computer logic and pattern recognition, d-a and a-d converters, light switching elements, optical communications, optical displays including those teamed with new fluorescent materials that convert infrared to visible light, and optical computers.

Great Britain

Digital approach

It may be a decade before the next generation of aircraft instrument landing systems is in use, so there's still plenty of scope for improvement of present systems. And there's room for improvement because current ILS equipment uses analog techniques and has the usual drawbacks of analog hardware compared to digital equipment: the need for careful matching of components during manufacture and susceptibility to temperature variation, input signal variation, noise and drift with use.

To cut down these problems while leaving most of the existing equipment intact, Roy Thomason of the College of Aeronautics at Cranfield has developed a digital airborne ILS signal processor which will work with the existing ground transmission and aircraft instrument display equipment.

Digitizing. Thomason's ILS processor is a black box which, in principle, merely replaces the present analog black box in the aircraft. Thomason claims that his device is drift-free, unaffected by temperature, and insensitive to input signal variation and noise. In addition it is likely to be cheaper to build because, while component costs should be the same as for analog, manufacturing costs should be lower because there will no need for careful matching of components and signal channels. Further, it should be very much smaller and lighter.

So far, Thomason has a workbench system operating and undergoing tests. He will start airborne tests in the fall. The first description of the system was presented last week at a conference on digital methods of measurement at Kent University.

The analog way. In present ILS systems, the airborne equipment compares 90 hertz and 150 hertz tones which are amplitude modulated onto a vhf carrier transmitted to the aircraft from the ground along the correct course line. The tones are filtered out of the composite signal with iron-cored filters, the depths of modulation measured, and the outputs fed to a center-zero microammeter. If the modulation depth is the same, the aircraft is approaching down the center of the course line. Any difference will unbalance the microammeter and deflect the horizontal or vertical instrument pointer on the pilot's display. Accuracy requires that both signal channels maintain identical performance characteristics, and for precision, it is the filters which need the most careful attention. Losses must be identical over the input voltage and operating temperature range. The iron cores must therefore be thermally aged and selected before assembly.

In Thomason's digital system, the parallel channels and filters are discarded, and the difference information is derived directly from the composite demodulated input.

The composite input waveform is complex, but the difference in-

Small talk. The Starphone, by Britain's Standard Telephones and Cables Ltd., is called the world's smallest one-piece radio-telephone. IC's and solid-state switching hold size down, but big innovation is a pulsed long-life power supply that allows the use of a match box sized rechargeable battery. Switched on waiting reception, the receiver pulses on and off. It doesn't lock on permanently until it detects incoming signal. Thus, in standby, battery life is 8 hours.

formation is contained in less than 30% of it. The operative portion is a recurring minor rise and fall, with a mean peak height when the aircraft is on course center line and with a linear increase or decrease of peak height when the aircraft is off to one side or the other. Thomason uses this part of the waveform to produce a series of pulses proportional to instantaneous amplitude, feeding the pulses into a d-c output count-and-hold circuit, which in turn drives the conventional cockpit indicator. Thomason points out that because it uses less than 30% of the waveform compared with 100% in the analog system, the digital version gets a bonus improvement in signal-to-noise ratio.

Gauging the slope. In the rising portion of the waveform, the variation in slope is more pronounced than the variation in amplitude, so Thomason uses waveform slope to control pulse output. A clock-pulse generator feeds pulses into a J-K flip-flop. If the slope of the wave is increasing, the flip-flop passes an increasing proportion of its output through its positive output. If the slope is decreasing, an increasing proportion goes through the negative output. Only the positive-pulse output is counted for transmission to the count-and-hold circuit.

For the flip-flop to pass pulses through its positive output in proportion to the slope of the waveform, it is given a feedback signal corresponding to the signal amplitude at the last clock pulse. This signal is compared with the instantaneous incoming signal, and the error, positive or negative, determines which flip-flop output is connected.

Thomason has a long-term plan to take advantage of the digital output of his system to drive directly a new type of digital cockpit instrument consisting of a dot matrix of luminescent solid state diodes. Two straight luminescent lines, one horizontal and one vertical, crossing in the center of the matrix will show that the aircraft is on course center line. Movement of each line to a parallel position to right or left and above or below will indicate degree of deviation.

Canada

Telling volumes

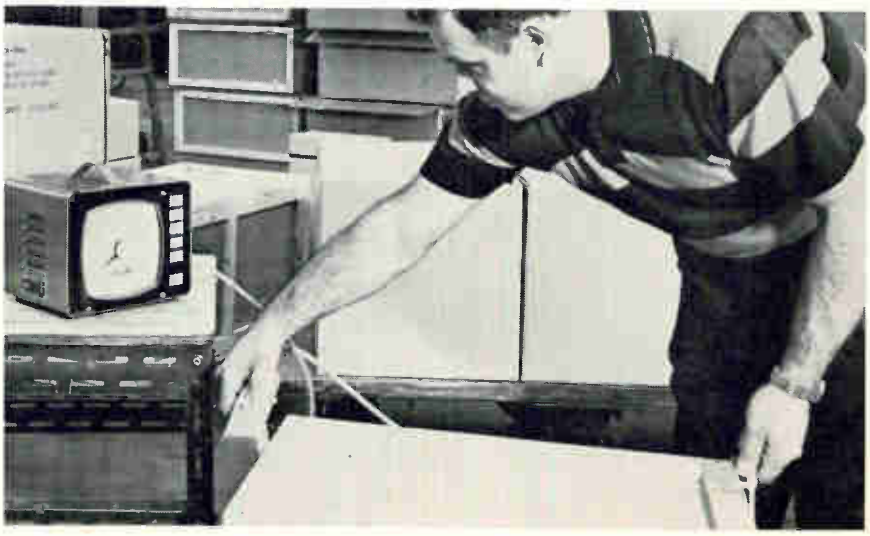
In this jet age, it's a bit out of the ordinary when a railroad develops a cargo handling device and has airlines running to it with orders. That's just what happened, however, with an electronic volume measure developed by the Canadian National Railways.

Canadian National, along with most other railroads, was losing money when large, but light-weight packages filled up its valuable boxcar space because freight tariffs in Canada, like those in the United States, were based on weight only. The Canadian railroads decided to switch over to a combined weight and volume tariff that would give a better return on bulky shipments.

Almost immediately, however, they were faced with the need for something faster than a tape measure to give speedy three-dimensional measurements. Canadian National came up with an electronic tape measure that automatically integrates the three linear measurements and gives a visual readout of the calculated volume. Once representatives of Air Canada saw the device, now made under license by CAE Industries of Montreal, they ordered 30 units as part of a $100,000 contract.

The device, which CAE calls the Volumeter, has two main parts—a measuring probe and a display unit. The measuring probe contains a roll of nylon-covered steel wire 5 feet long. The probe is held at one edge of the package to be measured and the end of the wire pulled out to the opposite edge. The spool is connected to a potentiometer connected in a bridge circuit. The circuit's output is a voltage proportional to the logarithm of the length measured. When an operator presses a switch on the probe, the voltage is stored in a capacitor in the main unit. Each of the three dimensions has a capacitor which is filled sequentially by an automatic stepping relay circuit. When the third dimension has been recorded, the sequencer connects the three capacitors in series. The added voltages are proportional to the logarithm of the volume. In the original Canadian National version, this voltage was amplified and displayed using a logarithmic scale voltmeter calibrated in cubic feet.

Further Steps. The streamlined CAE version goes a couple of steps further. The company has added an analog to digital converter that drives a digital display. In addition, by pressing the appropriate pushbuttons, the operator gets a direct reading of the equivalent weight, based on either international air freight regulations, which



Automated tape measure. Uncoiling steel wire in hand-held probe turns potentiometer which delivers a voltage proportional to dimension.

call for a standard chargeable density of 8.9 pounds per cubic feet, or domestic regulations, which set a chargeable density of 6.9 pounds per cubic feet. The readout is four digit, with a decimal point after the third digit.

The instrument, which costs $2500, can be readily incorporated into more elaborate systems. It has been used in conjunction with an electronic scale to determine actual density of shipments. And it may be possible to use the volume data to feed automatic bill generating and freight charge calculating equipment.

West Germany

Components booming

When Germany's economy turns up from a slump, it does so with a bang. A year or two ago the average company there was happy just to stay level. Now it looks as if everybody from Bonn to Berlin is going to be very disappointed if sales aren't up well over 10%. Half way through the year giant Siemens AG sees full year sales up about 20%. Medium-sized Standard Elektrik Lorenz AG predicts an 11% rise in profits.

While all parts of the electronics industry are cashing in on the boom, it's the components sector that is in the most ferment. The unexpectedly high demand for both consumer and industrial electronics is generating so much pressure that suppliers of components, both domestic and foreign, are forcing through major expansion plans.

Revised upwards. Semiconductor components are among the hottest selling devices with the total market likely to reach $125 million this year—considerably higher than $100 million most people had originally predicted for 1969. Consumption of integrated circuits alone could top the $25 million mark, and is sure to rise at a 15 to 20% rate annually at least until the early seventies.

To cope with the expanding semiconductor market, manufacturers are feverishly setting up new factories or are enlarging existing facilities. Siemens, for example, is currently adding a 6-story building containing nearly 65,000 square feet of floor space to its main semiconductor plant at Munich. The building has been set aside solely for activities in the IC field. Other companies, including AEG-Telefunken, Valvo GmbH, and Intermetall, an ITT subsidiary, are busy expanding production lines and equipping research labs. Texas Instruments Deutschland GmbH in June opened its second plant in Germany. Located at Ingolstadt, it will employ 500 people and turn out plastic-encapsulated transistors. And the company is spending $2 million to enlarge its existing plant at Freising.

Knocking on the door. West Germany's semiconductor market is also bringing new companies to the scene. Fairchild Semiconductor, a major U.S. producer not yet manufacturing in Europe, intends to concentrate its European production and sales at a new complex in Wiesbaden. When completed in 1972, the 120,000 square-foot plant will house 1,000 employees making diodes, transistors, and IC's. Limited production will begin early next year.

What's more, Fairchild's erstwhile partner is going into Germany. SGS Deutschland GmbH, a member of the Societa General Semiconduttore group of Milan, opened its first plant in Germany last month. "Because of the expanding Germany semiconductor market it's necessary to set up SGS Deutschland as the largest member of the group," says Renato Bonifacio, managing director of SGS. One quarter of the group's profits will come from sales by its German company. The new plant at Wasserburg has a production capacity of 22 million transistors and up to 2 million IC's a year.

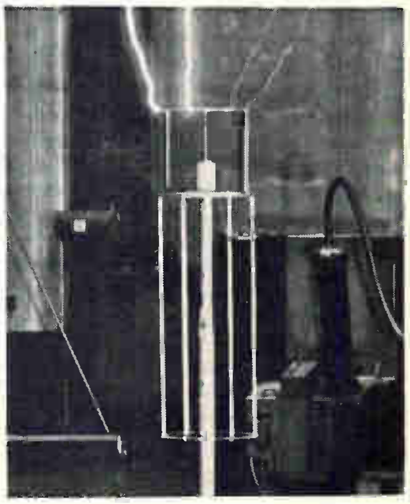
Setting the stage

Transistorized antennas, a center of controversy on both sides of the Atlantic for more than two years, are finally headed for production.

Rhode and Schwarz, West Germany's big commercial communications and testing equipment maker, is readying an air-traffic-control antenna that incorporates a transistorized active stage. But Rhode and Schwarz may not be alone for long. Other companies are considering transistorized stages for both automobile-radio antennas and television antennas.

Called the Meinke antenna, the transistorized stage was developed in 1967 by the Institute for High-Frequency Research at the Technical University of Munich, which is headed by Hans H. Meinke. And almost from the outset, the Meinke antenna and other subminiature integrated antennas were caught up in a barrage of criticism. [*Electronics*, June 12, 1967, p. 145]. Some critics said the devices would suffer from cross modulation; others thought there would be degradation in signal-to-noise ratios; and still others said performance would be impaired because of lack of directivity.

Pushing ahead. Rhode and Schwarz has overcome these drawbacks real or imaginary, and is finishing tests on prototypes preparatory to serial production later this year. The company says results of tests thus far have been excellent. There is no degradation attributable to the active elements. Proof, according to the company, is the antennas low noise, good cross modulation behavior and insensitivity to atmospheric disturbances, including lightning.



A hit. Active antenna, under test here, finally heads for market.

Electronics advertisers

August 4, 1969

Adams & Westlake Co. Jai Herbert Advertising	26
□ **Alcatel** Agence Rene Sicard	5E
Alco Electronic Products, Inc. Marketronics Advertising	217, 219, 221
Alfred Electronics Bonfield Associates	207
Allen-Bradley Co. Fensholt Adv. Agcy.	23
Allied Radio Corp. Marvin H. Frank Co.	203
Allied Van Lines, Inc. Young & Rubicam, Inc.	159
American Microsystems Jordan Advertising	43
American Optical Corp. Fuller & Smith & Ross, Inc.	80
American Telephone & Telegraph Co.— Yellow Pages Cunningham & Walsh, Inc.	156
AMF-Alexandria Division Applied Cybernetics E.G. White Adv., Inc.	134
Anaconda American Brass Co., Fabricated Metal Goods Div. Wilson, Haight & Welch, Inc.	17
□ **Ancrona Corp.** Wilhelm Bacher Werbung	6E
Andrew Corp. Fensholt Adv., Inc.	68
■ **A.P.I. Instruments** George Z. Griswold Adv.	150
Atec, Inc. Helme Assoc., Inc.	169
Automatic Control Div., Cook Electric Co. Sander Rodkin Adv. Agcy., Ltd.	215
■ **Barnstead Co., Div. of Sybron Corp.** Creamer, Trowbridge, Case & Basford, Inc.	194
Beckman Instruments, Inc., Electronic Instrument Div. Hixson & Jorgensen, Inc.	62, 144
■ **Beckman Instruments, Inc., Helipot Div.** N.W. Ayer/Jorgensen/MacDonald, Inc.	82
Belden Corporation Fensholt Adv., Inc.	18, 19
Birtcher Corp., The Guerin, Johnstone, Gage, Inc.	56
Bishop Graphics, Inc. Sol R. Shein Adv.	140
Bit, Inc. Hill, Holliday, Connors, Cosmopulos, Inc.	71
■ **Blue M Electric Co.** South Suburban Advertising	192
Brand-Rex Creamer, Trowbridge, Case & Basford, Inc.	81
■ **Brush Instruments Div. of Clevite Corp** Carr Liggett Adv., Inc.	155
Bunker-Ramo Corp., The, Amphenol Div. Marsteller, Inc.	35, 36
■ **Burndy Corp.** The Gravenson Group, Inc.	209
■ **Bussmann Mfg. Div. of McGraw Edison Co.** Henderson Adv. Co.	42
Cambridge Thermionic Corp. Chirurg & Cairns, Inc.	180
■ **Cerro Copper & Brass Co.** Feeley & Wheeler, Inc.	132
Cerroflex Products, Cerro Wire & Cable Co. Rochford, Inc.	122
■ **Chassis-Trak, Inc.** Quinlan Keene Peck & McShay, Inc.	206
C & K Components, Inc. Van Christo Associates	200
Clevite Corporation-Graphics Department Carr Liggett Advertising	72, 73
■ **Clevite Corp., Piezoelectric Div.** Carr Liggett Adv., Inc.	200
Cohu Electronics, Inc.	212
Continental Connector Corp. Dunwoodie Associates	162
■ **Cosmicar Optical Co., Ltd.** Matsushita, Inc.	220
CREI, Home Study Div. of the McGraw-Hill Book Co. Henry J. Kaufman & Associates	191
■ **CTS Corporation** Reincke, Meyer & Finn, Inc.	40
Damon Engineering, Inc. L.K. Frank Co., Inc.	45
Dana Laboratories, Inc. Smith-Klitten, Inc.	79
Dearborn Electronics, Inc., Sprague Electric Co. Div. Harry P. Bridge Co.	190
Delevan Electronics Corp. Stahlka, Faller & Klenk, Inc.	204
Deringer Metallurgical Corp. R.B. Advertising	157
Deutsch Company Smith & Hemmings Advertising	199, 201, 203
Di-Acro Corp., Div. of Houdaille Industries, Inc. Charles E. Brown Adv. Agcy.	179
DuPont de Nemours & Co., Freon Div. N.W. Ayer & Son, Inc.	106
■ **Eagle Signal Div. of Gulf & Western Co.** Feeley & Wheeler, Inc.	9
Eastman Kodak Co., Business Systems Markets Div. J. Walter Thompson Co.	37
EL Instruments, Inc. Froehlich Advertising Services	198
Elasco-Eastern, Inc. Harold Schuman Studio	7
Eldorado Electrodata Corp. of Concord Moore-Mayhew Advertising	235
Electro Rents Larry Courtney Co.	213
Electronic Industries Association of Japan Pace Adv. Agcy.	195
■ **Elgenco, Inc.** Wesco Advertising	175
E/MC Electronics/ Management Center Ries Cappiello Colwell, Inc.	222
E. M. I. Electronics Canada, Ltd. Greiner Harries Maclean, Ltd.	136
Fairchild Controls Dunwoodie Assoc., Inc.	143
Fairchild Semiconductor, Inc. Chiat/Day, Inc.	28, 29
■ **Fusite Corporation** Weber, Geiger & Kalat, Inc. Adv. Agcy.	188
General Dynamics Young and Rubicam, Inc.	120, 121
General Electric Co., Information Services Dept. Robert S. Cragin, Inc.	151
■ **General Instrument Corp., Semiconductor Products Div.** Norman Allen Associates	128
General Radio Co. Horton Church & Goff, Inc.	2nd Cover
Government of Canada— Trade & Commerce Ronalds-Reynolds & Co., Ltd.	124
■ **Grayhill, Inc.** Merchandising Adv., Inc.	216
Groov-Pin Corp. Feeley & Wheeler, Inc.	174
Hayakawa Electric Co., Ltd. Dai-Ichi International, Inc.	216
■ **Hewlett Packard, Frequency & Time Div.** Lennen & Newell, Inc.	94, 95
■ **Hewlett Packard, Loveland Div.** Tallant/Yates Advertising	6
■ **Hewlett Packard, Microwave Div.** Lennen & Newell, Inc.	1
■ **Hewlett Packard, New Jersey Div.** McCarthy, Scelba & DiBiasi Adv. Agcy., Inc.	127, 173
■ **Hewlett Packard, Palo Alto Div.** Lennen & Newell, Inc.	153
■ **Hewlett Packard, Rockaway Div.** Culver Adv., Inc.	22
■ **Hewlett Packard, San Diego Div.** Lennen & Newell, Inc.	2
■ **Honeywell Test Instruments Div.** Campbell Mithun, Inc.	147
Howard Industries, Inc. K & A Inc. Advertising	3rd Cover
Hughes Aircraft Co. Foote, Cone & Belding	154, 205
Hysol Corp. Barber & Drullard, Inc.	186
INTEL Bonfield Associates	64, 65, 66, 67
■ **International Crystal Mfg. Co.** Robert V. Freeland & Associates	210
IRC, Div. of TRW, Inc. Gray & Rogers, Inc.	211
Itoh (C.) & Co., Ltd. Dentsu Adv., Ltd.	146
I.T.T. Metrix Promotion Vente Publicite	133, 135
ITT Semiconductor Div Neals & Hickok, Inc.	196
ITT Wire and Cable MacManus, John & Adams, Inc.	125
■ **JFD Electronics Co., Components Div.** Delphi Adv., Inc.	208
Johnson Co., E.F. Martin Williams Adv.	24
Kingsley Machine Co., Aero Space Div. Brown, Clark & Elkus, Inc.	218
■ **Leach Corp.** Chiat/Day, Inc.	226
Lectrohm, Inc., a Subsidiary of Cook Electric Co. Sander Rodkin Adv. Agcy., Ltd.	214
Ledex, Inc. Yeck & Yeck, Inc.	202
Lincoln Air Park West Swanson, Sinkey, Ellis, Inc.	199
□ **Marconi Instruments, Ltd.** Taylor Adv., Ltd.	10E
Markel & Sons, L. Frank George Moll Adv., Inc.	39
Markem Corp. Creamer Trowbridge Cas & Basford, Inc.	30
■ **Matsuo Electric Co., Ltd.** Daiko Adv., Inc.	217
Mechanical Enterprises White Adv., Inc.	220
Microdyne Instruments, Inc. Industrial Public Relations, Inc.	175
■ **Micro Switch, Div. of Honeywell** N.W. Ayer & Son, Inc.	178
Microtest Corporation Data Communications Associates	44
■ **MM Electronics Enclosures Inc.** Berin/Pecor Inc.	200
Monsanto Company Michel Cather Inc.	41
M & T Chemicals Inc. Marsteller Inc.	218
■ **Murata Mfg. Co. Ltd.** AMO Inc.	219
Nashville Area Chamber of Commerce Noble-Dury and Associates Inc.	183
National Semiconductor Corporation Hall Butler Blatherwick Inc.	74, 75
North American Electronic Systems Div. Educational Computer Corp. George Moll Advertising Inc.	170
■ **North Atlantic Industries Inc.** Ross Roy of New York Inc.	138
Nuclex 69 Mosse-Annoncen AG	218

■ For more information on complete product line see advertisement in the latest Electronics Buyer's Guide

□ Advertisers in Electronics International

Electronics Buyers' Guide

George F. Werner, Associate Publisher
[212] 971-2310

Robert M. Denmead,
Midwest Regional Manager
[312] MO 4-5800

William A. Capuzzi,
New York, New England District Manager
[212] 971-3793

Regina Hera, Directory Manager
[212] 971-2544

Thomas M. Egan, Production Manager
[212] 971-3140

Circulation Department

Isaaca Siegel, Manager [212] 971-6057

Research Department

David Strassler, Manager [212] 971-6058

Advertising Sales Staff

Frank E. LeBeau [212] 971-6464
Advertising Sales Manager

Wallis Clarke [212] 971-2187
Advertising Sales Service Manager

Donald J. Austermann [212] 971-3139
Promotion Manager

Warren H. Gardner [215] LO 8-6161
Eastern Advertising Sales Manager

Atlanta, Ga. 30309: Michael H. Miller, 1375
Peachtree St., N.E.
[404] 892-2868

Boston, Mass. 02116: William S. Hodgkinson
McGraw-Hill Building, Copley Square
[617] CO 2-1160

Cleveland, Ohio 44113: William J. Boyle, 55
Public Square, [216] SU 1-7000

New York, N.Y. 10036
500 Fifth Avenue
James R. Pierce [212] 971-3615
John A. Garland [212] 971-3617
Michael J. Stoller [212] 971-3616

Philadelphia, Pa. 19103:
Jeffrey M. Preston
Warren H. Gardner,
6 Penn Center Plaza,
[215] LO 8-6161

Pittsburgh, Pa. 15222: Jeffrey M. Preston,
4 Gateway Center, [412] 391-1314

Rochester, N.Y. 14534: William J. Boyle,
9 Greylock Ridge, Pittsford, N.Y.
[716] 586-5040

Donald R. Furth [312] MO 4-5800
Midwest Advertising Sales Manager

Chicago, Ill. 60611: Kenneth E. Nicklas
Ralph Hanning 645 North Michigan Avenue,
[312] MO 4-5800

Dallas, Texas 75201: Richard P. Poole, 1800
Republic National Bank Tower,
[214] RI 7-9721

Houston, Texas 77002: Robert Wallin,
2270 Humble Bldg. [713] CA 4-8381

Detroit, Michigan 48226: Ralph Hanning,
856 Penobscot Building
[313] 962-1793

Minneapolis, Minn. 55402: 1104 Northstar
Center [612] 332-7425

St. Louis, Mo. 63105: Kenneth E. Nicklas,
The Clayton Tower, 7751 Carondelet Ave.
[314] PA 5-7285

James T. Hauptli [415] DO 2-4600
Western Advertising Sales Manager

Denver, Colo. 80202: David M. Watson,
Tower Bldg., 1700 Broadway
[303] 266-3863

Los Angeles, Calif. 90017: Ian C. Hill,
Bradley K. Jones, 1125 W. 6th St.,
[213] HU 2-5450

Portland, Ore. 97204: James T. Hauptli,
Don Farris, 218 Mohawk Building,
222 S.W. Morrison Street,
Phone [503] 223-5118

San Francisco, Calif. 94111: James T. Hauptli,
Don Farris, 255 California Street,
[415] DO 2-4600

Pierre Braude Tel: 225 85 88: Paris
European Director

Paris: Denis Jacob
88-90 Avenue Des Champs-Elysees, Paris 8

United Kingdom and Scandinavia

London: Oliver Ball, Tel: Hyde Park 1451
34 Dover Street, London W1

Milan: Robert Saidel, Roberto Laureri Jr.
1 via Baracchini Phone 86-90-656

Brussels: Denis Jacob
27 Rue Ducale Tel: 136503

Frankfurt/Main: Hans Haller
Elsa-Brandstroem Str. 2
Phone 72 01 81

Geneva: Denis Jacob
1 rue du Temple Phone: 31 95 60

Tokyo: McGraw-Hill
Publications Overseas Corporation,
Kasumigaseki Building 2-5, 3-chome,
Kasumigaseki, Chiyoda-Ku, Tokyo, Japan
[581] 9811

Osaka: Akihiko Kamesaka, McGraw-Hill
Publications Overseas Corporation, Kondo
Bldg., 163, Umegae-cho Kita-ku [362] 8771

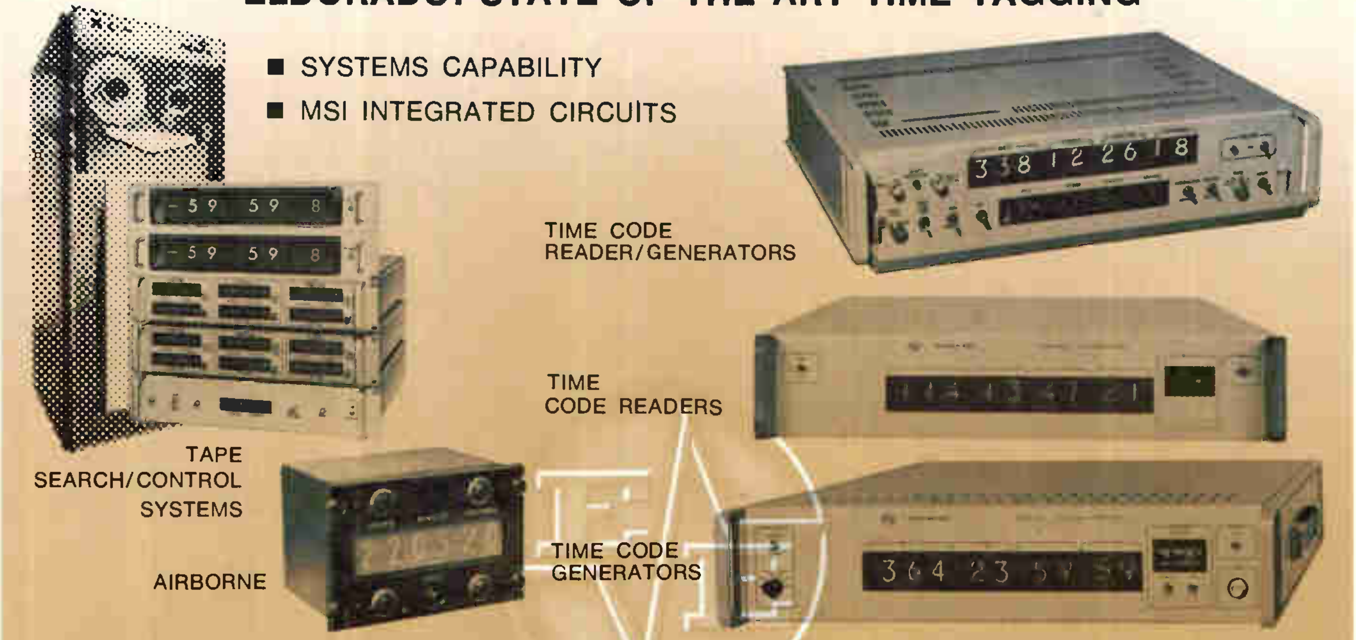
Business Department

Stephen R. Weiss, Production Manager
[212] 971-2044

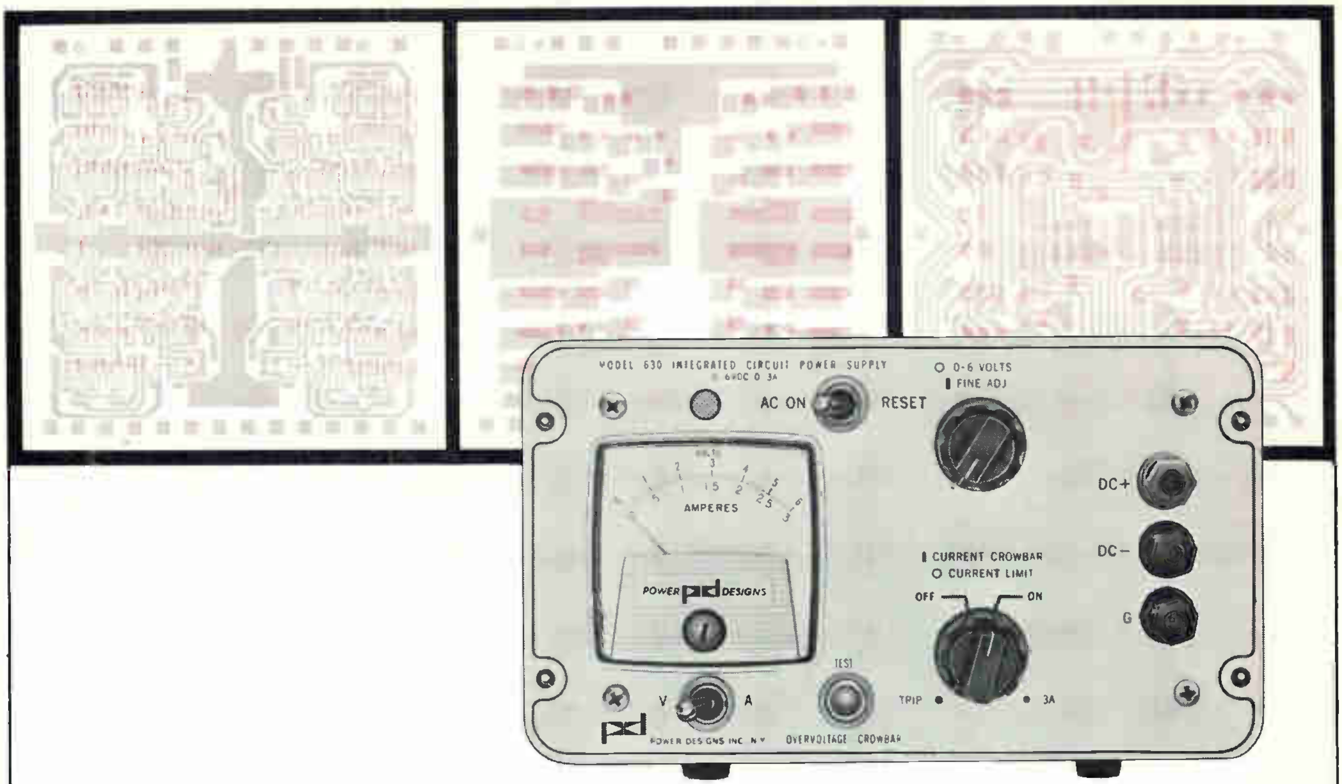
Thomas M. Egan,
Assistant Production Manager [212] 971-3140

Dorothy Carmesin, Contracts and Billings
[212] 971-2908

Frances Vallone, Reader Service Manager
[212] 971-2865



TIME CODE READER/GENERATORS
TIME CODE READERS
TAPE SEARCH/CONTROL SYSTEMS
AIRBORNE
TIME CODE GENERATORS



POWER SOURCE

FOR

INTEGRATED CIRCUITS

Tracking Overvoltage / Overcurrent Crowbar

Protects expensive IC systems against voltage surges or current runaway.

- **0-6 VDC, 0-3 A** – Continuously adjustable with a resolution of 1 millivolt.
- **Overvoltage Crowbar**– Operates in 10μs to limit output to 0.6 V plus 10% of set level.
- **Overcurrent Crowbar** – Operates with current limit control to discharge 95% of stored energy in output capacitor when current exceeds preset levels.
- **Current Crowbar Switch**—Permits choice of self-restoring overload operation or lock-up of power supply output under load failure.
- **All the Features of a high quality laboratory DC source:** 0.01% regulation, 0.001 V P-P ripple, 25μs recovery time, remote programming and sensing, front and rear access terminals, etc.

WRITE FOR SPECIFICATIONS

MODEL 630
$\$149^{50}$
FOB WESTBURY, N. Y.

POWER DESIGNS PACIFIC, INC.
3381 JUNIPERO SERRA • PALO ALTO, CALIFORNIA
415-321-6111 TWX: 910-373-1251

POWER DESIGNS, INC.
1700 SHAMES DRIVE • WESTBURY, N.Y.
516 EDgewood 3-6200 TWX: 510-222-6561

SEE US AT THE WESCON, BOOTH 1020 AT THE ANNEX

Electronics reader service

Use these handy post cards for more detailed information on: products advertised, new products, new literature.

Circle the number on the Reader Service post card that corresponds to the number at the bottom of the advertisement, new product item, or new literature in which you are interested.

Please print clearly. All written information must be legible to be efficiently processed.

If someone has beaten you to the post cards, you may obtain the needed information by writing directly to the manufacturer, or by sending your name and address, plus the Reader Service number, to Electronics Reader Service department.

All inquiries from outside the U.S. that cannot reach Electronics before the expiration dates noted on the Reader Service post card, must be mailed directly to the manufacturer. The manufacturer assumes all responsibilities for responding to inquiries. Electronics merely provides and clears requests for information from inquirer to manufacturer.

Correct amount of postage must be affixed for all mailings from outside the U.S.

To subscribe to or to renew Electronics

Fill in the "For Subscriptions" area on the card if you desire to subscribe to or renew your present subscription to Electronics. Send no money. Electronics will bill you at the address indicated on the Reader Service post card.

Multi-product advertisements

For information on specific items in multi-product advertisements which do not have a specific Reader Service number indicated write directly to manufacturer for information on precise product in which you are interested.

Warning: The Post Office now requires your ZIP CODE on all mail. Please include your ZIP CODE number when filling out your reply card.

16 *For employment inquiries fill in home address. August 4, 1969 Card Expires October 4, 1969 14

Name ____________________ title ____________

Company* ____________________

Address ____________________

City ____________ State ____________ Zip Code ____________

For Subscriptions
☐ new ☐ renewal
☐ 3 years $16.00
☐ 1 year $8.00

1	20	39	58	77	96	115	134	153	172	191	210	229	248	267	286	305	324	343	362	381	400	419	438	457	476	495	514	962
2	21	40	59	78	97	116	135	154	173	192	211	230	249	268	287	306	325	344	363	382	401	420	439	458	477	496	515	963
3	22	41	60	79	98	117	136	155	174	193	212	231	250	269	288	307	326	345	364	383	402	421	440	459	478	497	516	964
4	23	42	61	80	99	118	137	156	175	194	213	232	251	270	289	308	327	346	365	384	403	422	441	460	479	498	517	965
5	24	43	62	81	100	119	138	157	176	195	214	233	252	271	290	309	328	347	366	385	404	423	442	461	480	499	518	966
6	25	44	63	82	101	120	139	158	177	196	215	234	253	272	291	310	329	348	367	386	405	424	443	462	481	500	900	967
7	26	45	64	83	102	121	140	159	178	197	216	235	254	273	292	311	330	349	368	387	406	425	444	463	482	501	901	968
8	27	46	65	84	103	122	141	160	179	198	217	236	255	274	293	312	331	350	369	388	407	426	445	464	483	502	902	969
9	28	47	66	85	104	123	142	161	180	199	218	237	256	275	294	313	332	351	370	389	408	427	446	465	484	503	951	970
10	29	48	67	86	105	124	143	162	181	200	219	238	257	276	295	314	333	352	371	390	409	428	447	466	485	504	952	971
11	30	49	68	87	106	125	144	163	182	201	220	239	258	277	296	315	334	353	372	391	410	429	448	467	486	505	953	972
12	31	50	69	88	107	126	145	164	183	202	221	240	259	278	297	316	335	354	373	392	411	430	449	468	487	506	954	973
13	32	51	70	89	108	127	146	165	184	203	222	241	260	279	298	317	336	355	374	393	412	431	450	469	488	507	955	974
14	33	52	71	90	109	128	147	166	185	204	223	242	261	280	299	318	337	356	375	394	413	432	451	470	489	508	956	975
15	34	53	72	91	110	129	148	167	186	205	224	243	262	281	300	319	338	357	376	395	414	433	452	471	490	509	957	976
16	35	54	73	92	111	130	149	168	187	206	225	244	263	282	301	320	339	358	377	396	415	434	453	472	491	510	958	977
17	36	55	74	93	112	131	150	169	188	207	226	245	264	283	302	321	340	359	378	397	416	435	454	473	492	511	959	978
18	37	56	75	94	113	132	151	170	189	208	227	246	265	284	303	322	341	360	379	398	417	436	455	474	493	512	960	979
19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380	399	418	437	456	475	494	513	961	980

16 *For employment inquiries fill in home address. August 4, 1969 Card Expires October 4, 1969 14

Name ____________________ title ____________

Company* ____________________

Address ____________________

City ____________ State ____________ Zip Code ____________

For Subscriptions
☐ new ☐ renewal
☐ 3 years $16.00
☐ 1 year $8.00

1	20	39	58	77	96	115	134	153	172	191	210	229	248	267	286	305	324	343	362	381	400	419	438	457	476	495	514	962
2	21	40	59	78	97	116	135	154	173	192	211	230	249	268	287	306	325	344	363	382	401	420	439	458	477	496	515	963
3	22	41	60	79	98	117	136	155	174	193	212	231	250	269	288	307	326	345	364	383	402	421	440	459	478	497	516	964
4	23	42	61	80	99	118	137	156	175	194	213	232	251	270	289	308	327	346	365	384	403	422	441	460	479	498	517	965
5	24	43	62	81	100	119	138	157	176	195	214	233	252	271	290	309	328	347	366	385	404	423	442	461	480	499	518	966
6	25	44	63	82	101	120	139	158	177	196	215	234	253	272	291	310	329	348	367	386	405	424	443	462	481	500	900	967
7	26	45	64	83	102	121	140	159	178	197	216	235	254	273	292	311	330	349	368	387	406	425	444	463	482	501	901	968
8	27	46	65	84	103	122	141	160	179	198	217	236	255	274	293	312	331	350	369	388	407	426	445	464	483	502	902	969
9	28	47	66	85	104	123	142	161	180	199	218	237	256	275	294	313	332	351	370	389	408	427	446	465	484	503	951	970
10	29	48	67	86	105	124	143	162	181	200	219	238	257	276	295	314	333	352	371	390	409	428	447	466	485	504	952	971
11	30	49	68	87	106	125	144	163	182	201	220	239	258	277	296	315	334	353	372	391	410	429	448	467	486	505	953	972
12	31	50	69	88	107	126	145	164	183	202	221	240	259	278	297	316	335	354	373	392	411	430	449	468	487	506	954	973
13	32	51	70	89	108	127	146	165	184	203	222	241	260	279	298	317	336	355	374	393	412	431	450	469	488	507	955	974
14	33	52	71	90	109	128	147	166	185	204	223	242	261	280	299	318	337	356	375	394	413	432	451	470	489	508	956	975
15	34	53	72	91	110	129	148	167	186	205	224	243	262	281	300	319	338	357	376	395	414	433	452	471	490	509	957	976
16	35	54	73	92	111	130	149	168	187	206	225	244	263	282	301	320	339	358	377	396	415	434	453	472	491	510	958	977
17	36	55	74	93	112	131	150	169	188	207	226	245	264	283	302	321	340	359	378	397	416	435	454	473	492	511	959	978
18	37	56	75	94	113	132	151	170	189	208	227	246	265	284	303	322	341	360	379	398	417	436	455	474	493	512	960	979
19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380	399	418	437	456	475	494	513	961	980

16 *For employment inquiries fill in home address. August 4, 1969 Card Expires October 4, 1969 14

Name ____________________ title ____________

Company* ____________________

Address ____________________

City ____________ State ____________ Zip Code ____________

For Subscriptions
☐ new ☐ renewal
☐ 3 years $16.00
☐ 1 year $8.00

1	20	39	58	77	96	115	134	153	172	191	210	229	248	267	286	305	324	343	362	381	400	419	438	457	476	495	514	962
2	21	40	59	78	97	116	135	154	173	192	211	230	249	268	287	306	325	344	363	382	401	420	439	458	477	496	515	963
3	22	41	60	79	98	117	136	155	174	193	212	231	250	269	288	307	326	345	364	383	402	421	440	459	478	497	516	964
4	23	42	61	80	99	118	137	156	175	194	213	232	251	270	289	308	327	346	365	384	403	422	441	460	479	498	517	965
5	24	43	62	81	100	119	138	157	176	195	214	233	252	271	290	309	328	347	366	385	404	423	442	461	480	499	518	966
6	25	44	63	82	101	120	139	158	177	196	215	234	253	272	291	310	329	348	367	386	405	424	443	462	481	500	900	967
7	26	45	64	83	102	121	140	159	178	197	216	235	254	273	292	311	330	349	368	387	406	425	444	463	482	501	901	968
8	27	46	65	84	103	122	141	160	179	198	217	236	255	274	293	312	331	350	369	388	407	426	445	464	483	502	902	969
9	28	47	66	85	104	123	142	161	180	199	218	237	256	275	294	313	332	351	370	389	408	427	446	465	484	503	951	970
10	29	48	67	86	105	124	143	162	181	200	219	238	257	276	295	314	333	352	371	390	409	428	447	466	485	504	952	971
11	30	49	68	87	106	125	144	163	182	201	220	239	258	277	296	315	334	353	372	391	410	429	448	467	486	505	953	972
12	31	50	69	88	107	126	145	164	183	202	221	240	259	278	297	316	335	354	373	392	411	430	449	468	487	506	954	973
13	32	51	70	89	108	127	146	165	184	203	222	241	260	279	298	317	336	355	374	393	412	431	450	469	488	507	955	974
14	33	52	71	90	109	128	147	166	185	204	223	242	261	280	299	318	337	356	375	394	413	432	451	470	489	508	956	975
15	34	53	72	91	110	129	148	167	186	205	224	243	262	281	300	319	338	357	376	395	414	433	452	471	490	509	957	976
16	35	54	73	92	111	130	149	168	187	206	225	244	263	282	301	320	339	358	377	396	415	434	453	472	491	510	958	977
17	36	55	74	93	112	131	150	169	188	207	226	245	264	283	302	321	340	359	378	397	416	435	454	473	492	511	959	978
18	37	56	75	94	113	132	151	170	189	208	227	246	265	284	303	322	341	360	379	398	417	436	455	474	493	512	960	979
19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380	399	418	437	456	475	494	513	961	980

Reprint service

All Electronics editorial matter available in reprint form:

For reprints of special reports and feature articles see list on right side of this page. Send your order to Electronics Reprint Department at the address indicated. To expedite mailing of your order for single reprints please send cash, check or money order with your order. Allow 3-4 weeks for delivery.

Bulk reprints of editorial matter can be ordered from current or past issues. The minimum quantity is 100 copies. Prices quoted on request: call 212-971-2274, or write to address below.

Warning: The Post Office now requires your **ZIP CODE** on all mail. Please include your **ZIP CODE** number when filling out your reply card.

3

First class
Permit no. 42
Hightstown, N. J.

Business reply mail
No postage stamp necessary if mailed in the United States

Postage will be paid by

Electronics
Reader service department
Box 444
Hightstown, N. J. 08520

2

First class
Permit no. 42
Hightstown, N. J.

Business reply mail
No postage stamp necessary if mailed in the United States

Postage will be paid by

Electronics
Reader service department
Box 444
Hightstown, N.J. 08520

1

First class
Permit no. 42
Hightstown, N. J.

Business reply mail
No postage stamp necessary if mailed in the United States

Postage will be paid by

Electronics
Reader service department
Box 444
Hightstown, N.J. 08520

To order reprints or for further information, please write to: **Electronics Reprint Department, 330 West 42nd Street, New York, N.Y. 10036.**

You may order any of the below listed reprints by key number. Discounts on quantities over 10.

Key no. **R-01**	**Computer-aided Design: Part I, The Man-machine Merger.** 16 pages. $1.25.
Key no. **R-04**	**Multilayer Circuit Boards: Sharpening An Imperfect Art.** 7 pages. 50¢.
Key no. **R-05**	**Topology Cuts Design Drudgery.** 12 pages. 50¢.
Key no. **R-06**	**Report on Japanese Technology: Sony.** 20 pages. 50¢.
Key no. **R-010**	**Special Report on Large Scale Integration.** 54 pages. $1.50.
Key no. **R-011**	**Medical Electronics** (1967). 8 part series, 44 pages. $1.25.
Key no. **R-012**	**Special Report on Gallium Arsenide** 17 parts. 32 pages. $2.00
Key no. **R-016**	**Special Report on The Transistor: Two Decades of Progress.** 48 pages. $1.50.
Key no. **R-017**	**Special Report on Ferrites.** 16 pages. $1.00.
Key no. **R-018**	**European Electronics Markets 1969** 20 page forecast report with a 6 page foldout. $1.00
Key no. **R-019**	**U.S. Electronics Markets 1969** 32 page forecast report with 4 page foldout. $1.00
Key no. **R-020**	**1968 Electronics Index to Technical Articles and Authors** Free.
Key no. **R-021**	**Infrared Detector Characteristics.** 23 x 11 inch fold-out chart. 50¢
Key no. **R-87a**	**The Packaging Revolution in Microelectronics. Parts I through VI.** 64 pages. $2.00.
Key no. **R-79**	**MOS Integrated Circuits.** 12 pages. 50¢.
Key no. **R-78**	**The Overlay Transistor.** 15 pages. 50¢.
Key no. **R-75**	**Biotelemetry.** 2 part series, 16 pages. 50¢.
Key no. **R-64**	**Field Effect Transistors. Parts I, II, and III.** 64 pages. $1.00.

Now that you're surprised at how different this Howard fhp motor looks on the *outside*, let's talk about *output:*

When Howard rates a motor 1/20 hp, we're not about to underpower your system with a 1/25 hp motor. We've always True Rated our fhp motors this way.

Now engineers and designers are finding that a carelessly overrated or underrated motor can cause system problems. And they want no part of either. That's why engineers look to Howard for True Rated fractional horsepower motors. . . . and they get them. Our computer guarantees it. And your products benefit.

Next time you look at the outside of a Howard motor, you won't find mod painting. You will find that if the label says 1/20 hp, we don't mean 1/25 hp. Or 1/15 hp, either.

Get the complete Howard True Rated story. Find out in detail why it makes no difference that all fhp motors *look* alike. It's the output that counts. Write or call Howard for Fractional Horsepower Motor Information Packet EL89.

MSL

HOWARD

HOWARD INDUSTRIES
MSL INDUSTRIES, INC./MOTOR GROUP
2420 18th STREET, RACINE, WISCONSIN 53403
414-632-2731 TWX 910-271-2387

Circle 901 on reader service card

Here's 15 A to 50 A Performance for your High-Speed Switching Circuits.

Now, RCA brings you high-speed, high-current switching in four of the industry's newest high power units—2N5671 and 2N5672 in regular TO-3 case available in production quantities, and developmental types TA7337 and TA7337A in modified TO-3 case (two 60-mil pins) available on a sampling basis.

These high-current transistors now make available for industrial and commercial users a state-of-the-art combination of high performance and reliability originally dictated by the rigid requirements of aerospace.

All four devices are characterized by double-diffused, double-epitaxial design techniques. As a result, you get reduced saturated switching times, increased current handling capability, and low saturation voltage. These silicon transistors have enhanced second breakdown capability under forward and reverse-bias conditions... backed by safe area operating curves.

Among the applications for these units: switching control amplifiers, power gates, switching regulators, DC-DC converters, DC-AC inverters, DC through RF linear power amplifiers and oscillators.

Check the chart for some of the key parameters of these four new types. Then ask your local RCA Representative or your RCA Distributor for prices and delivery details.

Unit	V_{CEO}(sus) (V)	I_C (A)	V_{CE}(sat)	f_T MHz	t_{on}
2N5672	120	30	0.75 V @ 15 A	50	0.5 μs @ 15 A
2N5671	90	30	0.75 V @ 15 A	50	0.5 μs @ 15 A

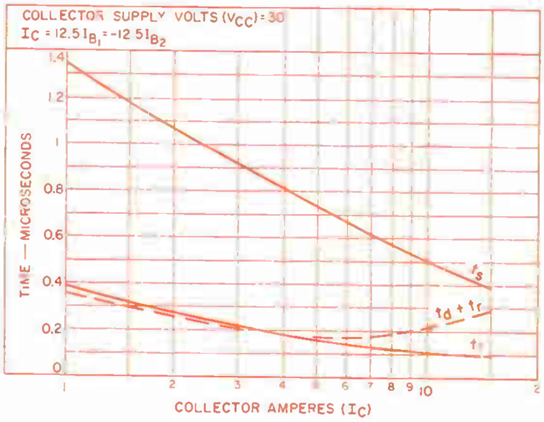
Above types available *now* in production quantities.

Unit	V_{CEO}(sus) (V)	I_C (A)	V_{CE}(sat)	f_T MHz	t_{on}
TA7337A	120	40	1.2 V @ 40 A	50	1.0 μs @ 40 A
TA7337	90	50	1.5 V @ 50 A	50	1.0 μs @ 40 A

Above types available *now* in sample quantities.

RCA

We know transistors like the back of our hand.



Typical saturated switching characteristics for types 2N5671 & 2N5672

For technical data, write: RCA Electronic Components, Commercial Engineering, Section IN8-1, Harrison, N.J. 07029.

Circle 902 on reader service card