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95 The winds of change at IEEE and Intercon
11 Functional redundancy for system reliability
15 Cost tradeoffs in pluggable components

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Electronics

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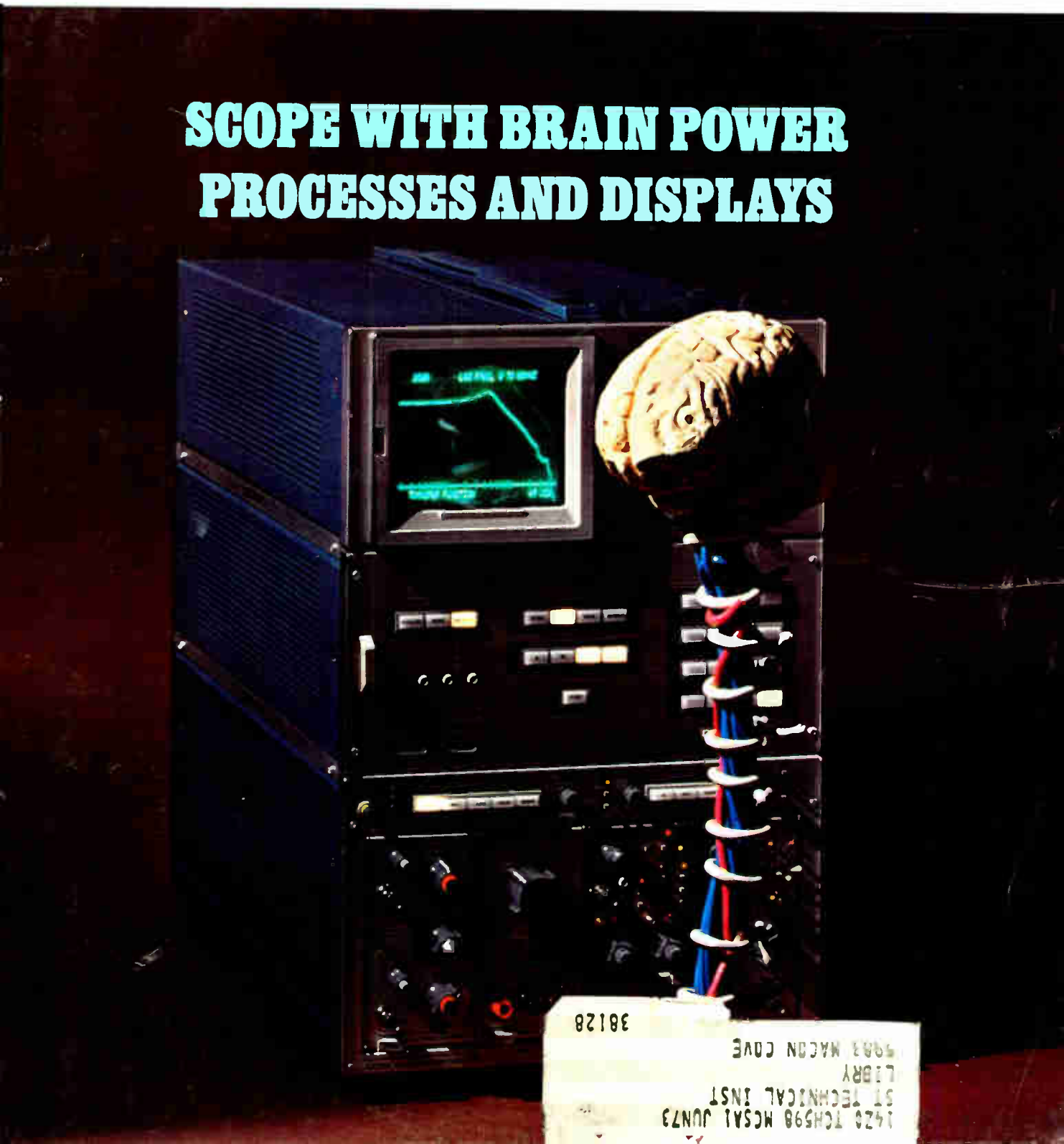

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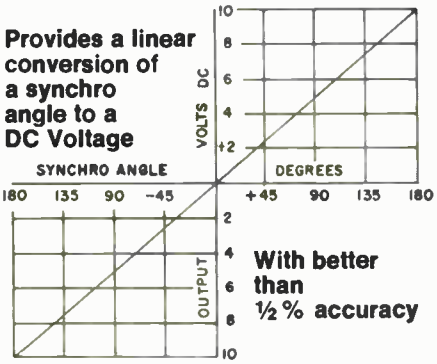

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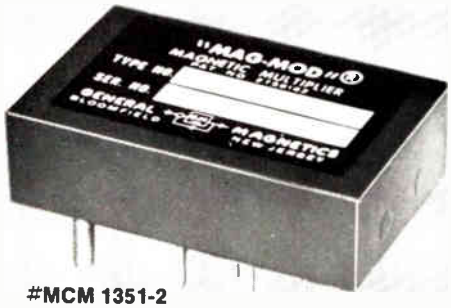

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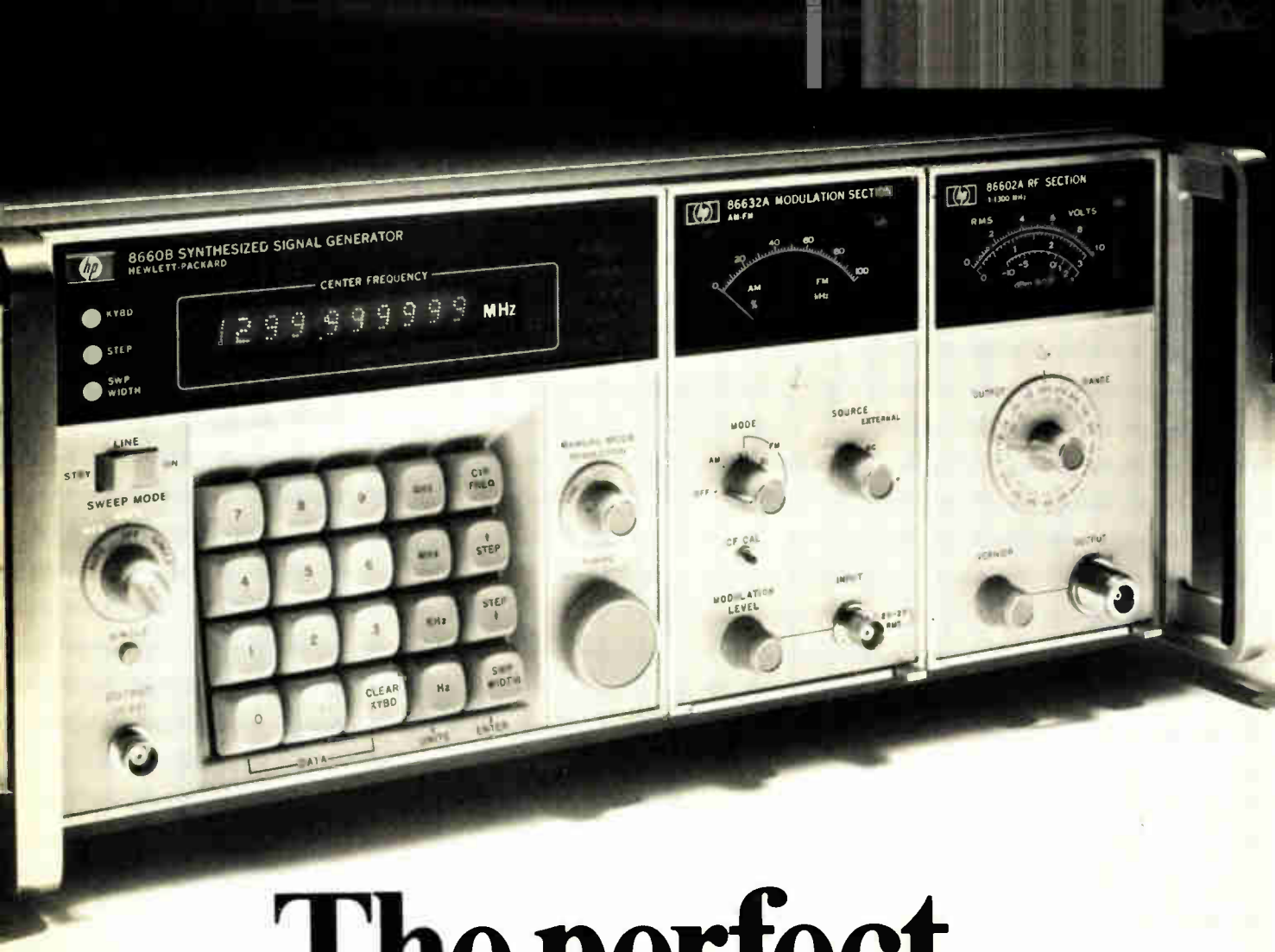

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SIGNAL GENERATORS

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Electronics
The International Magazine of Electronics Technology
Vol. 46, No. 6 • March 15, 1973

29 **Electronics review**
YOU AND YOUR CAREER: Gadfly returns to harass IEEE, 29
CIRCUITS: Chip inductor fits in hybrid circuits, 30
MEMORIES: AMS 4,096-bit RAM begins production, 30
NAVIGATION: Five satellites help to rescue Cousteau, 31
WORD PROCESSING: Office automation picks up speed, 32
MATERIALS: Thick-film switch developed for hybrids, 34
COMMUNICATIONS: Telemetry rides on all-digital system, 34
COMPUTERS: Message service added to Arpanet, 34
SATELLITES: Comsat reorganizes, 36
INDEX OF ACTIVITY: 36
DISPLAYS: Liquid-vapor turns on in display, 38
NEWS BRIEFS: 38
COMMERCIAL ELECTRONICS: Computer gives buses green light, 40
GOVERNMENT ELECTRONICS: Social Security seeks data net, 42

53 **Electronics International**
JAPAN: Digital brightness control for plasma panel, 53
Plasma display uses external memory, 53
SWEDEN: Thermistor senses CO, other gases, 53
GREAT BRITAIN: Ferranti markets control computer, 53
THE NETHERLANDS: IC adds chorus, tremolo to organ, 53

65 **Probing the News**
DISPLAYS: LED displays mount new attack, 65
MILTARY ELECTRONICS: Shore-integrated systems for Spruance, 68
GOVERNMENT: Are multinationals good? U.S seeks answer, 70
ELECTRONICS ABROAD: Selling to Peking is a challenge, 75

87 **Technical Articles**
SPECIAL REPORT: Eight EEs analyze their profession, 87
IEEE shifts its power behind career objectives of members, 95
INSTRUMENTATION: Digital interface adds power to scope, 98
DESIGNER'S CASEBOOK: N-MOS gate-bias circuit runs from 5 V, 106
Controlling duty cycle and rep rate independently, 107
Adding foldback resistor provides overload safety, 108
COMMUNICATIONS: Functional redundancy improves reliability, 111
PACKAGING: Selecting the optimum circuit-board package, 115
ENGINEER'S NOTEBOOK: Reverse-polarity LEDs show zero beat, 119
Computer plots curves on standard printer, 119

127 **New Products**
INTERCON '73 PRODUCT PREVIEW:
Storage unit adjusts for analyzer error, 127
5½-digit panel meters to bow, 128
Under-$3,000 generator has digital display, 128
Card stores transistor tests, 130
SUBASSEMBLIES: Active filter goes to 200 kHz, 137
INSTRUMENTS: Test system modules are programable, 143
SEMICONDUCTORS: Thin-film resistors put on multiplier chip, 149
PACKAGING & PRODUCTION: Analog tests are automated, 158
COMPONENTS: Terminators meet ECL speed requirements, 165
MATERIALS: 174

Departments
Publisher's letter, 4
Readers comment, 6
People, 14
Meetings, 20
Electronics newsletter, 25
Washington newsletter, 49
Washington commentary, 50
International newsletter, 55
Engineer's newsletter, 122
New literature, 178
New books, 187

Highlights

Cover story: A scope with brains, 98
A digital processor sandwiched between signal-acquisition and display units enables Tektronix' Digital Processing Oscilloscope (cover) to digitize analog waveforms and also to convert stored digital data into analog waveforms for display. The processor will act as an interface between scope and minicomputer.

LED displays take aim at desk calculators, 65
Manufacturers of the newest light-emitting-diode displays may soon be asking only $1 a digit on large-volume orders. In fact, the new, larger-digit models are already selling for about two thirds the prices of current LED displays, thanks to an economical semiconductor design.

Eight EEs discuss a changing profession, 87
In a rapidly developing technology, the electronics engineer finds adaptability more essential to survival than his constantly outdated experience, agreed an engineering panel organized by *Electronics* editors. A switch to management is one way to cope, starting one's own business is another.

IEEE moves to career-oriented activities, 95
A salary survey, a pension plan, and a Washington office that will inform legislators about engineers' needs—all these moves should revive members' confidence in the IEEE. The same realism is reflected in Intercon '73, which will be a two-floor show with specialized technical sessions.

And in the next issue. . .
Start of a series on minicomputers in action . . . selecting numeric display devices and drivers . . . flexible, high-density cable for microelectronics.

Readers comment

Lithocon tube travels

To the Editor: Your recent article, "Silicon-target storage tubes outdo direct types in versatility," [*Electronics*, Feb. 15, p.91], refers to the luggage-inspection system being bought by Pan Am from the Bendix Corp. It "incorporates a modified version of the PEP-400, an image-storage and scan-conversion terminal manufactured by Princeton Electronic Products Inc."

Some readers may have inferred that Bendix is the only company using Princeton equipment in such an application. However, Princeton sells image-storage and scan-conversion terminals based on its Lithocon silicon-target tube to all major manufacturers of such inspection systems, including American Science and Engineering in Cambridge, Mass., Philips Broadcasting in Montvale, N. J., and Baird Atomic in Bedford, Mass.

Wilburt M. Herbener
Princeton Electronic Products Inc.
North Brunswick, N. J.

Solid-state camera was earlier

To the Editor: "Solid-state camera uses photodiodes" [*Electronics*, Feb. 1, p.121] introduced the Reticon camera as the first production solid-state camera. In fact, Integrated Photomatrix Ltd. introduced the first self-scanned linescan camera system in February 1972, and this event was announced to all technical magazines in Europe and America. The C7000 series of linescan cameras was based on the IPL's self-scanned arrays with lengths varying from 16-by-1 to 256-by-1 photodiodes, spaced on 4-mil centers.

G. R. Parsons
Integrated Photomatrix Ltd.
Dorchester, Dorset, England

Father of the 4,096-bit RAM?

To the Editor: The article describing the new 4,096-bit random-access memory chip from Microsystem International of Canada [*Electronics*, Dec. 18, 1972, p.97] was excellent in all respects but one. No credit was given the design team I headed at Honeywell during 1970 and 1971, when a nearly identical 2,048-bit MOS RAM was developed. Honey-

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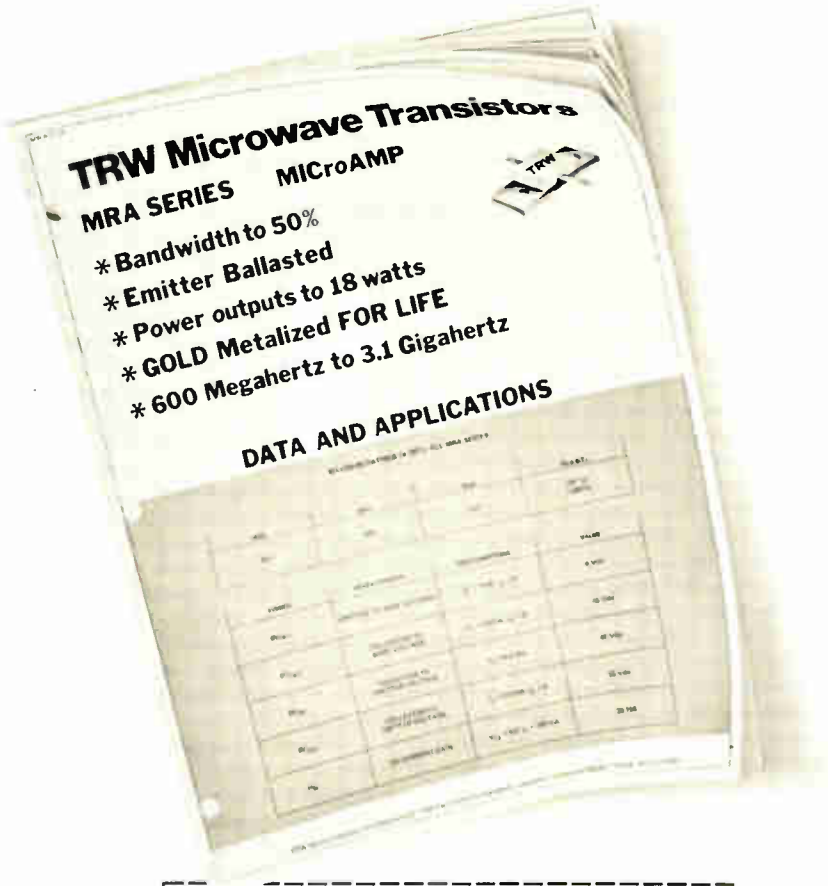

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Readers comment

well's RAM was described in December 1970 to many companies in the semiconductor industry for custom development. It was disclosed publicly at the International Solid State Circuits Conference in Philadelphia in February 1972.

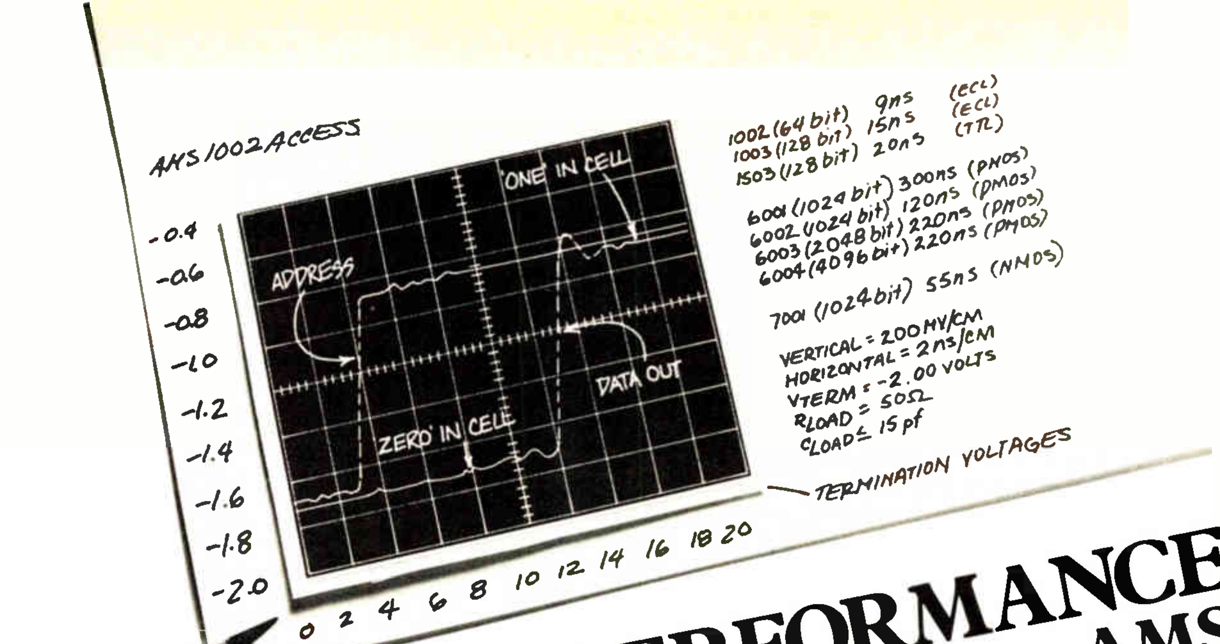
The inverting-cell concept, together with the data-control cell, polarity cell, or status cell, as it is variously called, was described during both the custom development and the Philadelphia conference. The exclusive or read/write scheme was also described.

MTI, for one, has been shipping systems with the HIS 2,048-bit RAM for more than six months. The path of the Honeywell team has been followed by the engineering staff of Microsystems International, which is to be congratulated for having put on the market the first 4,096-bit MOS memory chip and for work in n-channel. However, credit should be given the team that developed the earlier device.

John Andrews
Memory Technology Inc.
Sudbury, Mass.

■ *One of the authors, Tom Ross, replies: When the history is written, the inverting-cell concept will likely be considered a milestone in RAM development. However, Microsystems' work in this area started in 1971, independently of the program sponsored by Honeywell. Naturally, the publication in the 1972 ISSCC of both the Honeywell paper and the modification described by Karp, Regitz, and Chov of Intel helped confirm the earlier decisions in favor of this cell.*

The main thrust of Microsystems' development work was in applying the basic cell and developing peripheral circuits suited to n-channel MOS. There cannot be a one-for-one relationship with p-channel here, principally because of the much greater body effect of substrate bias on V_T. The choice of an enhancement-mode n-channel process aggravated this problem. However, the decision is proving to be a sound one, both on grounds of manufacturing economy with common processing and in future chip-size reduction possibilities, since depletion layers move less far in the more highly doped substrate.



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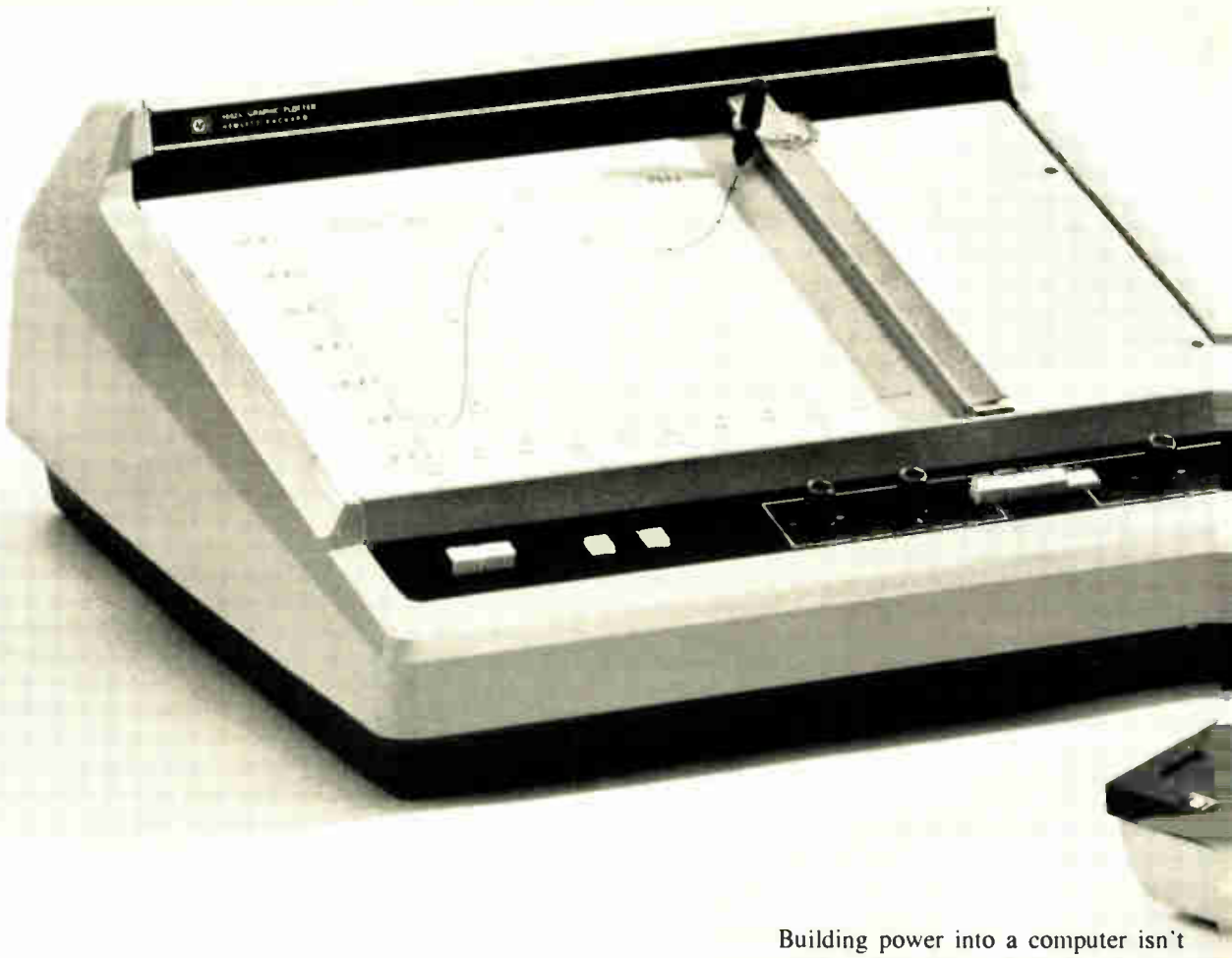

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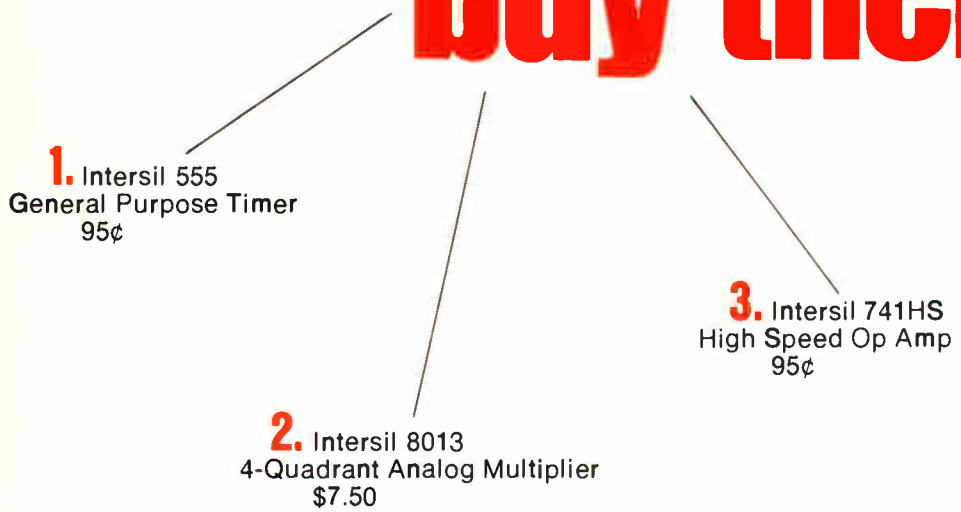

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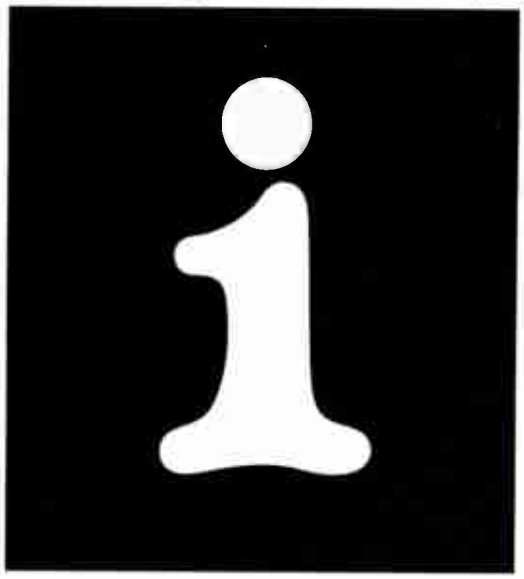

People

Longo and Reyes to head solid state areas at Fairchild

The reason given for the recent consolidation in Fairchild Semiconductor's solid-state divisions was the need to concentrate management attention on markets and technologies that are closely related and growing rapidly. So said Wilfred Corrigan, vice president and general manager for the Semiconductor Components group. And two of the men whose responsibilities have grown in the reorganization are Thomas A. Longo and Gregorio (Greg) Reyes.

Longo, a vice president, became general manager of the new Digital Products group, moving up from general manager of the Digital Products division. Reyes was named a vice president and general manager of the Discrete Products group; he had been general manager of the Discrete Products division.

Longo's group includes the Digital Products and MOS Products divisions. Roy A. Pollack, who had headed the MOS Products division, has resigned. Reyes has greater responsibility, too, as his group now combines the former Discrete Products and Microwave & Optoelectronics divisions.

Longo's long-term goal in his new job is to "be on the leading edge of production capacity and capability." He plans no changes in what he feels is a successful bipolar operation. But he will "look carefully" into MOS operations with an eye on manufacturing advancements, technical improvements, and new marketing techniques. Fairchild has not been nearly as successful in MOS as it has in bipolar devices.

Longo's confidence in bipolars stems from his former experience at Fairchild, which he joined as group director in 1970. He had supervised the development of TTL while he worked at GT&E. He also worked for Transitron's semiconductor operation from 1966 to 1970.

He points to the bipolar group's progress in Isoplanars at Fairchild, where "we created a revolution" by building a whole memory line in bipolars. Longo sees bigger and better things ahead for the Isoplanar, voicing plans to apply that technology to high-performance ECLs and to MOS. In addition, memory development will receive strong emphasis under Longo, who labels it a "very strong product line."

Longo is the son of an Italian immigrant, who was on his own at 13, had his higher education postponed, and worked as a supervisor in a plant facility at Western Electric for 27 years.

While an ensign in the Navy where he served from 1947 to 1950, Longo was sent to an electronics school, where he says his interest in the industry began. At that time, he already had a BA in physics from Purdue University, but he managed to add a BA in naval science while in the Navy. After leaving the service, he returned to Purdue to get an MA in physics and a Ph.D. in semiconductor physics.

When his wife and five children, ranging in age from 12 to 21, aren't occupying his time, the Fairchild executive is sailing. But Longo's oldest avocation is his 25-year practice of being his own investment analyst.

Reyes honchoes discretes. An equally strong picture is painted of

Movers. Greg Reyes (left) and Tom Longo took on new assignments in the reorganization at Fairchild. Reyes heads the Discrete Products group, Longo the Digital group.

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We solved their problems. Partly, because we're not newcomers. Five years and thousands of minicomputers later, we're still solving problems. Successfully. And economically. How about yours?

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President

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the newly elected general manager of the Discrete Products group. Reyes strikes visitors as a vital and outgoing man.

He came from National Semiconductor, where he was in manufacturing management from 1967 to 1968. He began at Fairchild as director of transistor operations, and in 1970, he became director for discretes and diodes. The following year, he was elected a corporate vice president and became division manager.

His job now, is to "continue with our major development efforts," he says. A trace of pique shows through Reyes' contention that discretes are not dead in any shape or form. "They're alive at Fairchild, and Fairchild is committed to them." He pinpoints next year as the one in which growth will occur in discretes because of the potential of the automotive and consumer markets.

Reyes says that one of his aims for Fairchild is for it to become "a true multinational company," by branching to Latin America and underdeveloped countries.

Reyes has recently moved into a new home in Saratoga, Calif., where he has lived four and a half years with his wife and 10-year old son. He leaves his home in time to be at the office by 6:30 every morning. To keep fit, he runs a mile a day, plays tennis, and makes week-end treks to the ski slopes in the Sierra Mountains.

When he finds time to sit down, Reyes prefers to read from the best-seller list, with a preference for history. In music, his tastes are as versatile as his energy in the rest of his activities, running the gamut from classic to rock.

A native Havanan, Reyes flew the coop at 17 to go to college in the U. S. His father, a former captain for Cuban Airlines brought the family to the U. S. in 1958—shortly before Castro's takeover.

Reyes, now a U. S. citizen, earned his BA in mechanical engineering at Rensselaer Polytechnic Institute, and then went on to receive his MA in management science from Stevens Institute of Technology.

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① The new Weston 4444.

The world's smallest 4-digit, autoranging multimeter. We call it the maxi-minimultimeter.

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Completely solid state. Circuitry is fully integrated around a dependable LSI chip, on only one substrate.

And here's the best part.

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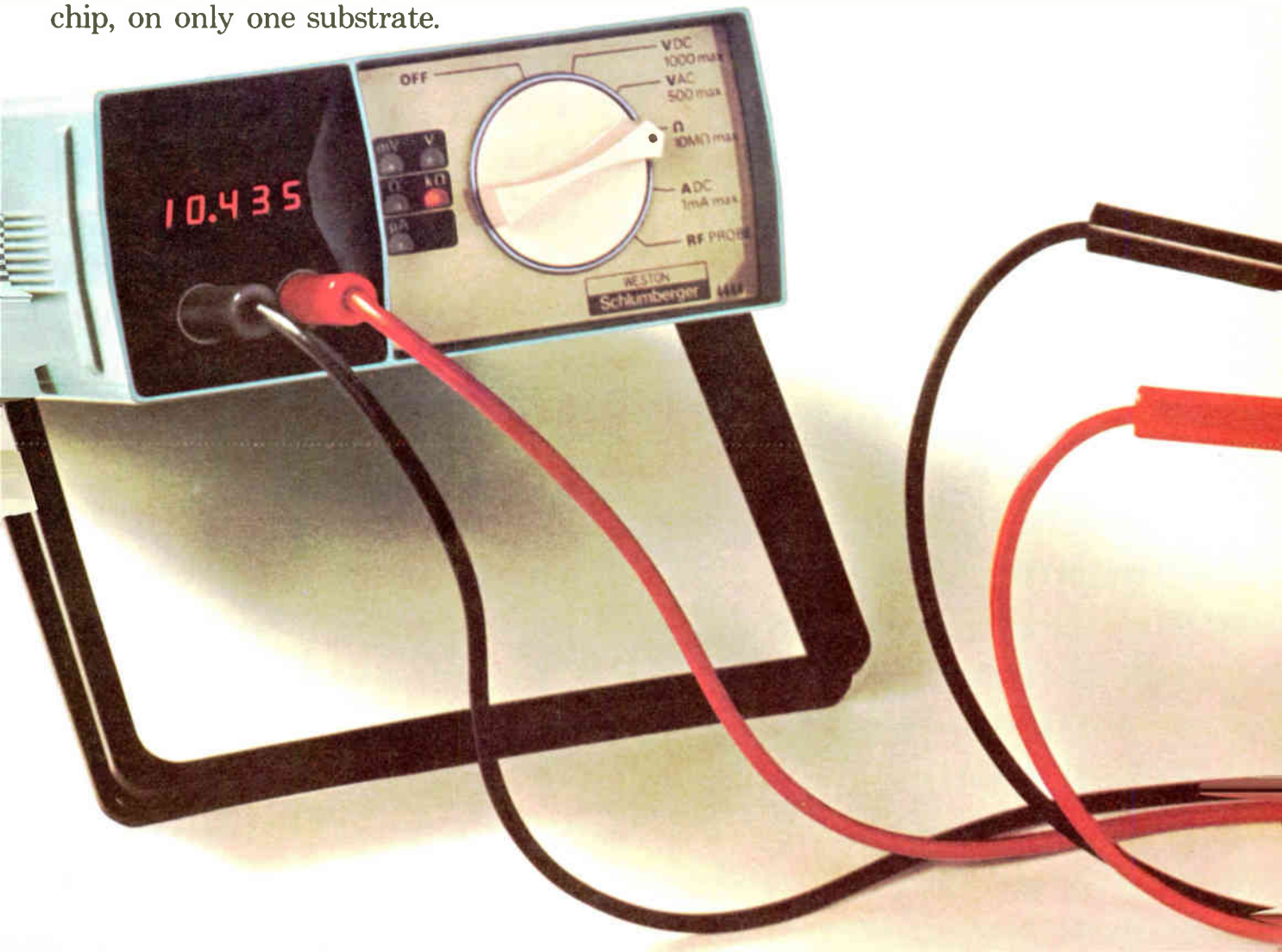
Sound like a lot? The 4444 can be yours complete—probes, leads, and fuses—for only $575. See your Weston distributor today. Or, return the reply card for more information.

Circle 209 on reader service card.



② The Weston Model 1295, the most reliable DPM ever made.

Pick one up. See how small it is. But feel that rugged construction. The 1295 is designed for demanding environments. Exceeds ASA C39.1 requirements. And, it's conservatively rated to operate at 60°C ambient.

Look inside. You'll find:

A. Digital circuits combined in a single, highly reliable MOS/LSI plug-in chip.

B. Only one circuit board. Carries both A/D and digital circuitry.

C. An all-solid-state non-blinking plug-in LED readout module.

D. Power requirements that are almost unbelievably low—only 2.5 watts.

The 1295 is available in three models—two bi-polar, 3½ digit DPMs and one with 2½ digits. All use the Weston patented Dual Slope conversion technique for exceptional stability.

And now for the best part—the one you can't see or feel. All of these Model 1295s are available in OEM quantities at less than $100. See them today at your nearby Weston distributor or service center.

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- ☐ #210. Model 1295 digital panel meters.
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Now tie quicker than ever before...

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WITH... BOURNS

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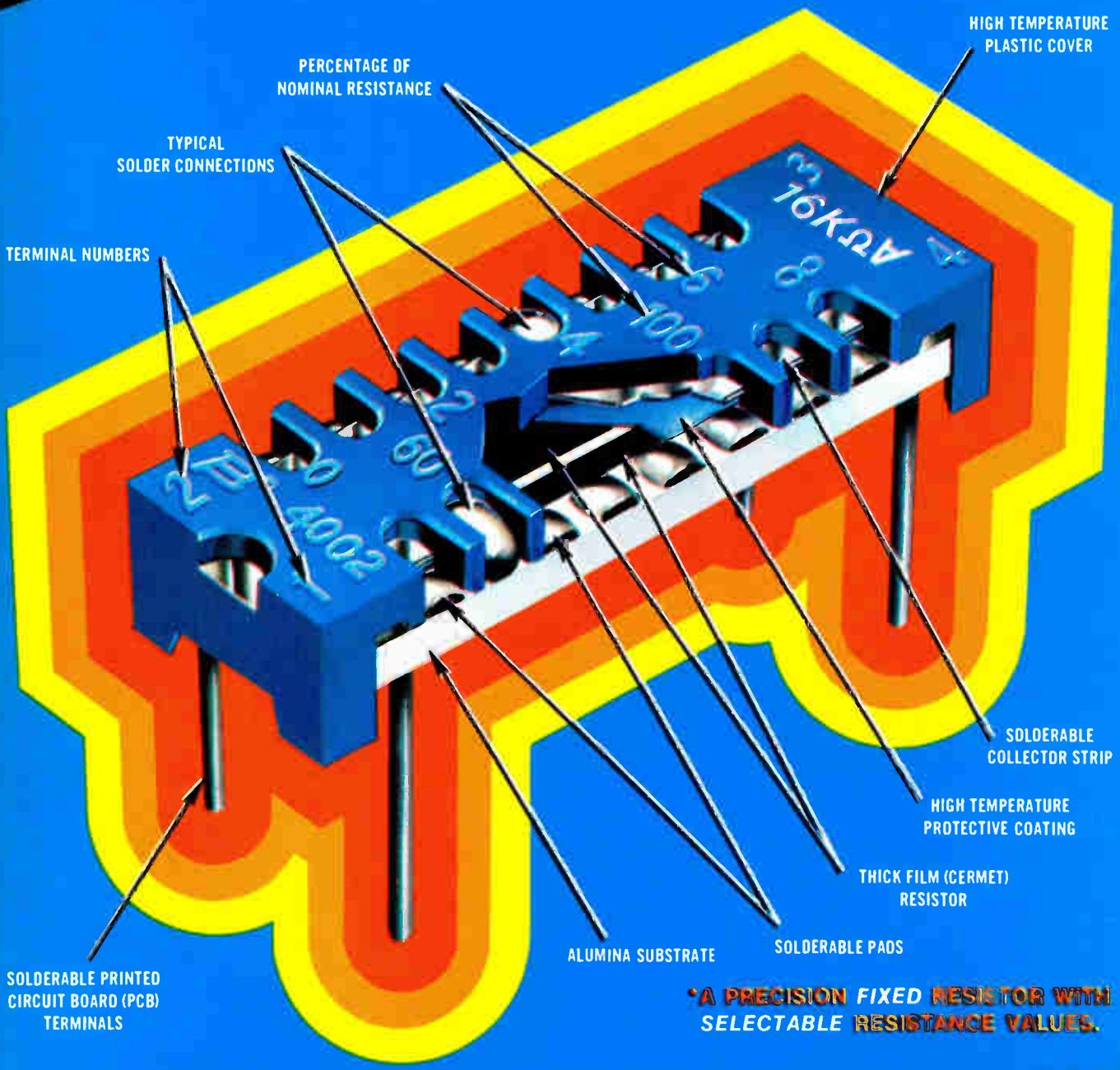
SELECTABLE FIXED RESISTOR*

90 SELECTABLE RESISTANCE VALUES IN 1 TINY UNIT.



*A PRECISION FIXED RESISTOR WITH SELECTABLE RESISTANCE VALUES.

BOURNS NEW...UNIQUE CONCEPT IN RESISTIVE COMPONENTS ALSO OFFERS

* *33 ohm to 1.25 megohm combined resistance range over 15 units*
* *Selectability within ±1% of required resistance value over the entire range*

BOURNS SFR™
SELECTABLE FIXED RESISTOR

- ... IS A STABLE, THICK-FILM, FIXED RESISTOR *WITH ADJUSTABILITY OF ±1% OR BETTER*
- ... REPLACES STANDARD FIXED RESISTORS IN APPLICATIONS WHERE FINAL RESISTANCE VALUE REQUIRED CAN'T BE PRECISELY DETERMINED AT THE DESIGN STAGE
- ... REPLACES "ONE-TIME ADJUST" VARIABLE RESISTORS IN APPLICATIONS REQUIRING LONG-TERM STABILITY
- ... RESISTANCE VALUE IS SELECTED, THEN *PERMANENTLY*, RELIABLY *SET* BY SOLDERING

LOOK AT THE $$ YOU SAVE ON INVENTORY!!

FOR EXAMPLE: Your application requires selection of individual resistance values from 550 ohms to 1000 ohms, or 40 different resistors at 10¢ each. One Model 4002 provides the same resistance selection within ±1% at 76¢*.

Result: **40 different resistor values: 40 x 10¢ = $4.00**
One Model 4002: 1 x 76¢ = .76

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After mounting on PCB; probe the COARSE and FINE adjustment taps (Figures 1 and 2) to determine the precise resistance required. Solder the selected taps (Figure 3) and the SFR RESISTOR is permanently set.

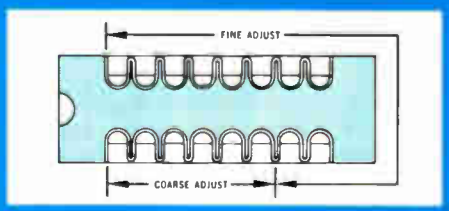

Figure 1


Figure 2


Figure 3

FOR COMPLETE DETAILS AND A BROCHURE:

- CONTACT YOUR LOCAL BOURNS REPRESENTATIVE.

FOR A FREE SAMPLE...write to the factory answering the following on your company letterhead.

(a) My application for the Bourns SFR Resistor is . . .
(b) It will replace (number) of fixed resistors in my inventory
(c) Approximate anticipated annual quantity usage: (number)

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Meetings

Annual Meeting, Association for Advancement of Medical Instrumentation: AAMI, Washington Hilton, Washington, D.C., March 21–24.

IEEE International Convention (Intercon): IEEE, Coliseum and Americana, March 26–30.

Reliability Physics Symposium: IEEE, Dunes, Las Vegas, April 3–5.

Southwestern IEEE Conference and Exhibition (Swieeeco): IEEE, Houston, Texas, April 4–6.

International Symposium on Circuit Theory: IEEE, Four Seasons Sheraton, Toronto, Ont., Canada, April 9–11.

International Magnetics Conference (Intermag): IEEE, Washington Hilton Hotel, Washington, D.C., April 24–27.

Carnahan Conference on Electronic Crime Countermeasures: IEEE, University of Kentucky, Carnahan House, Lexington, Ky., April 25–27.

Electron Device Techniques Conference: IEEE, United Engineering Center, New York, May 1–2.

National Relay Conference: NARM, Oklahoma State U., Stillwater, Okla., May 1–2.

Electronic Components Conference: IEEE, EIA, Statler-Hilton, Washington, D.C., May 14–16.

Naecon: IEEE, Sheraton, Dayton, Ohio, May 14–16.

International Symposium: SID Statler-Hilton, New York, May 15–17.

Measurement and Test Instrument Conference: IEEE, Skyline Hotel, Ottawa, Ont., Canada, May 15–17.

Electron, Ion, and Laser Beam Techonology: MIT and IEEE, MIT, Cambridge, Mass., May 21–23.

Aerospace Instrumentation Symposium: ISA, Frontier, Las Vegas, Nev., May 21–23.

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WCS is a powerful new tool for the OEM. By microprogramming the HP 2100, you can tailor it to your customer's specific application. In manufacturing, process control, medicine, you name it. And you can add WCS anytime. Now — or in the future. Even add it to your present installations.

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NEW: Uni-Guard Molded Coil Covers are now standard on most Guardian laminated, box-frame and U-frame solenoids.

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Paying the lowest price doesn't mean you're getting the lowest cost. Many fixed resistor brands lose their identification in the PC board cleaning process. Some don't have true colors to begin with. Or the color bands darken and become illegible from the heat produced in normal usage. The result is costly identification errors. Contrast this with the bright, crisp identification of Allen-Bradley's specially formulated paints. Baked on to resist aging, rough handling and solvents. Why gamble with questionable quality that can lead to unforseen costs? Learn the facts. Ask your nearest A-B distributor for our free booklet, "7 ways to tell the difference in fixed resistors." Or write Allen-Bradley Electronics Division, 1201 South Second St., Milwaukee, Wisconsin 53204. Export: Bloomfield, New Jersey 07003. Canada: Allen-Bradley Canada Ltd., Galt, Ontario. United Kingdom: Jarrow, County Durham NE32 3EN.

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Circle 24 on reader service card

Electronics newsletter

Rockwell to start silicon-on-sapphire production for ROMs

Rockwell Microelectronics, holder of basic silicon-on-sapphire MOS patents, has decided to start production of memories based on SOS. The first products will be read-only memories. **Rockwell has been supplying SOS-diode ROMs on a prototype basis,** and Charles V. Kovac, marketing vice president, says that this experience has verified the acceptability and economic feasibility of SOS. The ICs also offer the speed of bipolar devices, together with the low power requirement and high density characteristic of MOS LSI. Anticipating that the process will be particularly attractive to large-computer manufacturers, **he is now competing for a production contract, expected to be let by a major supplier before July 1.** Rockwell is also preparing another advanced process, nitride-passified MOS (MNOS) memories, which are proving vital in such equipment as cash registers.

Will Wescon weather WEMA's pullout?

The Western Electronics Show and Convention (Wescon) faces another crucial test—after the beginnings of a climb out of the doldrums last year—**with word that WEMA will no longer cosponsor the show with the IEEE.** WEMA's official line is that its withdrawal as a sponsor will make no difference to companies participating in the show. Ray L. Conlisk, a WEMA director, says his company, Systron-Donner Corp., and most WEMA members intend to continue their support of the show, scheduled for Sept. 11-14 in San Francisco. The show went through a few years of declining booth space during the recession, then stabilized at 520 booths last year, although attendance was up over the previous few years. Don Larson, general manager of Wescon and IEEE's Intercon, says both shows will continue to operate with the same management staffs.

Liquid crystals pass acid test

While the rest of the instrumentation world debates the viability of liquid crystals as display elements, Beckman Instruments Inc., Fullerton, Calif., is using the new devices in its latest digital pH meter—the pHasar I. The displays are actually part of a digital panel meter, a basic component of the pH meter. **The 3½-digit DPMs, which are made by Digilin Inc., Glendale, Calif., use liquid-crystal displays and MOS chips made by American Micro-systems Inc.** Beckman has released $180,000 worth of DPMs so far, and has taken delivery of 700 units.

National to market microcomputers

Although National Semiconductor Corp. plans to start selling complete microcomputer systems in May, a spokesman says the company is not going into the computer business. **The IMP-16, for 16-bit integrated microprocessor, will be sold as a complete, off-the-shelf item** to allow systems engineers to experiment with applications of National's GPC/P (general-purpose controller/processor) MOS-chip set before going into the laborious procedure of programing a specialized chip set.

The IMP-16, built with four 4-bit "slices" of the GPC/P is programed to run 42 standard routines when accessed through a teletypewriter or card reader. It will be described at the IEEE convention this month by George Reyling Jr., a National designer.

Electronics newsletter

Electronic systems move into tall buildings

Skyscrapers are getting electronic help. In Manhattan, a multiplexing system will be installed in the world's largest building, the World Trade Center, to control security, fire alarms, lights, heating, and air conditioning. American Multiplex Systems, Anaheim, Calif., has that contract. And in San Francisco, RCA has installed a computerized system in the Wells Fargo building to handle everything from security to heating, ventilation, and air conditioning. Skyscrapers are getting such systems because **they tremendously reduce and simplify the wiring of large buildings and they meet the latest fire regulations for tall structures,** which have resulted from the recent New Orleans hotel-fire disaster.

Heath to make varactor-tuned uhf-vhf color TVs

The Heath Co., Benton Harbor, Mich., will introduce a varactor-tuned uhf-vhf color television kit this fall [*Electronics*, Feb. 28, p. 95]. Eugene Fiebick, vice president of engineering, says that, even though the expensive varactor is used, **the new tuner will add no more than 10% to the price of the present top-end model, which sells for $595.** Meanwhile, it is reported by an executive of Hycom Corp., a firm backed by Japan's Sharp Corp., that Sharp is also evaluating uhf-vhf varactor tuning for its television line.

IEEE to hold meeting on employment practices

In an effort to develop mutually acceptable guides for the hiring and firing of electrical engineers, the IEEE plans to hold a special meeting of employers and employees in Chicago in May. **Basis for the session is a book called "Guidelines for Professional Employment of Engineers and Scientists,"** which has been prepared to establish a more or less standardized set of rules concerning employment practices. The idea is to provide a forum for EEs and company managers.

JVC America to build U.S. record factory

Joining the growing number of Japanese-owned companies setting up plants in the U.S., JVC America Inc. has announced that it will start manufacturing up to 250 CD-4 (discrete four-channel) custom master albums a month at a new West Coast facility. Production will start in April. The company already assembles hardware in this country. **JVC recently won a strong position in the U.S. record business for its four-channel system with the licensing of Warner-Elektra-Atlantic group,** said to be the largest record seller in America. RCA had previously joined the CD-4 side in competition with the CBS-SQ matrix-recording approach. In addition, 14 Japanese companies have been licensed to build CD-4 hardware in Japan.

Addenda

NASA-Ames Research Center is expected to award a contract in April for a 500,000-word memory, expandable to 1 million words for the system that includes the huge Illiac-4 computer. Word length will be at least 40 bits. Various technologies proposed have included MOS and bipolar arrays, as well as magnetic cores. . . . **Rockwell Microelectronics will begin delivery of single chips for electronic slide rules** to two companies this month. The ESRs are expected to be available by early summer. . . . The Garrett Comtronics Corp. will market **an electronic clock combined with a calculator,** dubbed "the incredible time machine."

DATEL Systems has done it again!

Datel Systems' minicomputer-compatible, data acquisition/distribution system solves the problem of on-line/off-line interfacing of analog signals to and from digital computers . . . once and for all.

A reliable and speedy system, it provides you the versatility to mix Analog Multiplexers, A/D's, Sample and Hold amplifiers and D/A's in virtually any configuration. Plug-in cards anticipate your expansion.

The System 256, which utilizes C/MOS (Complimentary Metal Oxide Silicon) logic throughout, *uses less power* than any unit currently available, yet *provides four times the channel capacity* . . . up to 256 single ended or 128 differential analog channels, 32 simultaneous sample and hold channels plus up to 32 D/A channels . . . and cost about half as much. Other features include — A/D-D/A Resolution to 14 bits; throughput speeds up to 100kHz.

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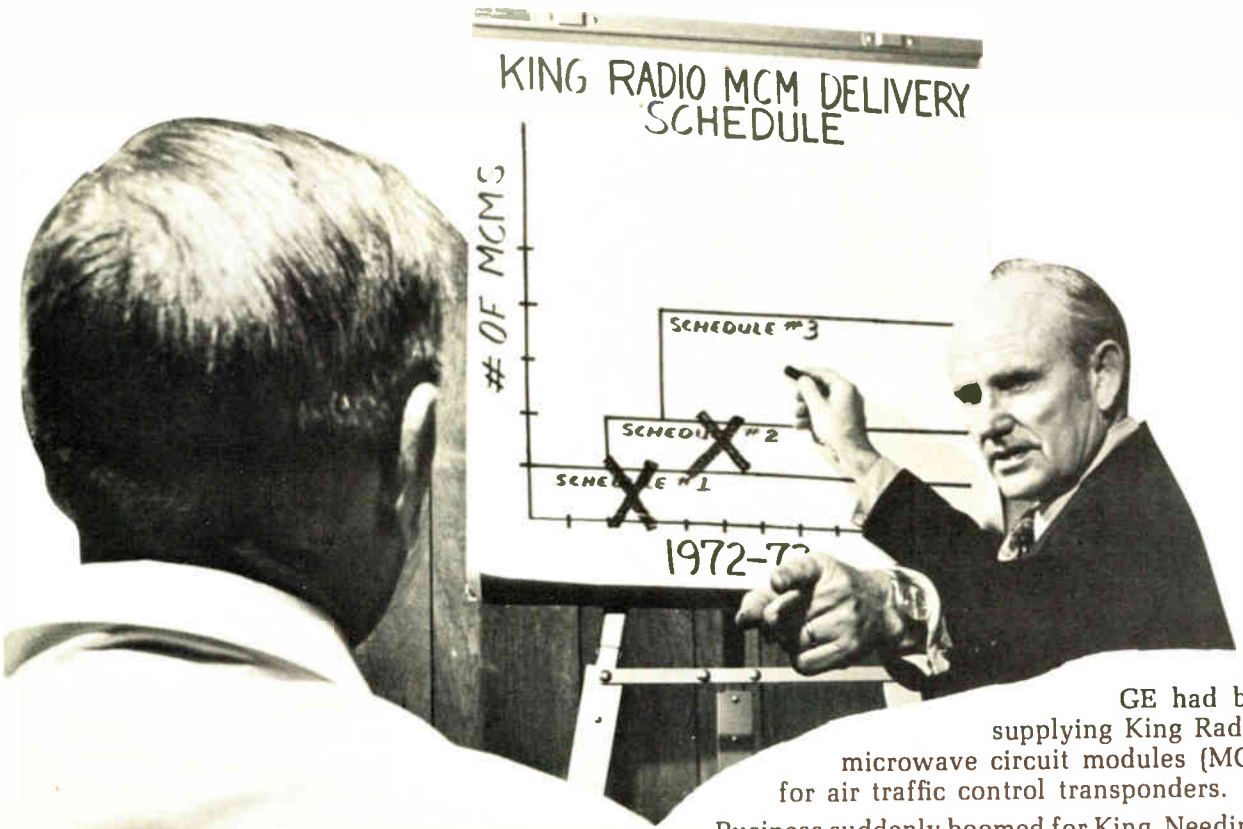
When a customer doubled and then redoubled his MCM needs, GE met both deadlines.



GE had been supplying King Radio with microwave circuit modules (MCM's) for air traffic control transponders.

Business suddenly boomed for King. Needing more MCM's, they doubled the number called for in the original contract — and gave us two weeks to deliver.

GE went to work for them. Clarence Reynolds, head of our MCM operations in Owensboro, Kentucky, expedited the job and sped up production schedules. People went on extra hours. We rushed delivery. And got the components to King on deadline.

Business kept growing for King. Before long they called us back and again doubled their order. And still gave us two weeks to deliver.

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Customers like King Radio need the components availability, pricing, and delivery they get with GE. That's why we're in business.

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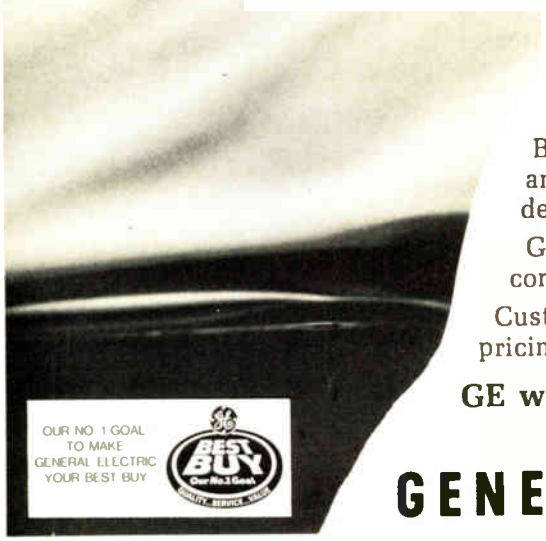


GENERAL ELECTRIC

Gadfly, holding banner of the working EE, returns to harass IEEE

Irwin Feerst has started a newsletter and come up with new proposals in a drive to change the IEEE

Irwin Feerst, the man who last summer bowed out of IEEE politics because he was unable to collect enough signatures to get on the presidental ballot, is back in action, needling the venerable institute in the name of what he calls the working EE.

His first move was to start a periodic newsletter that pounds at IEEE activities with the subtlety of a piledriver. The second installment is in the mails to his 1,000-name list of supporters, gathered during the year and a half that Feerst twice attempted to run for president [*Electronics*, Aug. 28, 1972, p. 56]. To show that his sometimes-abrasive sense of humor has also returned, Feerst at first requested a $1,000 grant from the IEEE to support his newsletter. Not surprisingly, his request was refused.

What he proposes. Much of what he proposes—accreditation by IEEE of engineering schools, restricted entry into the profession, opposition to a new IEEE headquarters building—is the same as before. However, Feerst has returned from visiting institute members around the country with some added causes to wave under the leadership's nose:

- *Shorten the work week.* This could be done by putting all EEs on a 10-hour-a-day, four-day week, so that the fifth day will either require hiring more engineers or recognizing that most EEs work overtime now, and they should be paid for it. An alternative would be to have four hours a week of company time devoted to study, formal and informal, so that EEs can keep up to date without sacrificing spare-time interests. It would benefit employers, since this specific plan should encourage new thinking and new-product development, Feerst says.
- *Register all EEs.* It's common knowledge, says Feerst, that companies use non-engineers to do design work. He proposes to make this practice illegal, similar to the way medical doctors and lawyers have restricted to registered professionals all aspects of their practice.
- *Debunk the engineer shortage reports.* Feerst and some of his backers angrily demand that IEEE come forward with a study to counter reports from the Engineers Joint Council that there is going to be a shortage of engineers. This, he states, is not the case, and it is hurting engineers already in the field, simply to keep engineering-school classes full.
- *Get portable pensions—now.* The IEEE is stalling on activating a portable pension by funding an unnecessary study, Feerst protests. The Chemical Society has done the work of organizing a pension that IEEE could have adapted. However, IEEE officers claim that they do not like certain aspects of the chemical group's plan, and they insist on getting a study to insure the best plan possible. [See p. 95 for a report on the IEEE's activities for 1973.]

Stinger. Irwin Feerst's proposals include shortening the engineer's work week and obtaining portable pensions.

When a discouraged Irwin Feerst dropped out of action last year, he pointed out that the money he had used to finance his activities had run out. How is he funding his present program? "Well, first, my wife got a raise, and second, I realized that things had not gotten better—only worse for EEs. So I can't stop," says the self-employed engineering consultant.

Quotes editorial. To prove his point that the IEEE is too slow and too cautious to act on behalf of EEs, Feerst quotes from a magazine editorial that says, in part, "No condition facing the industry is more important to the present and future prosperity of the art than the unemployment situation in which the average engineer finds himself. The institute has recognized this unsound employment condition by appointment of a special committee to study the problem. . . . Meanwhile there is much talk about organizing

the engineers for self-protection."

This editorial, Feerst moans, appeared in *Electronics* back in October 1933. □

Circuits

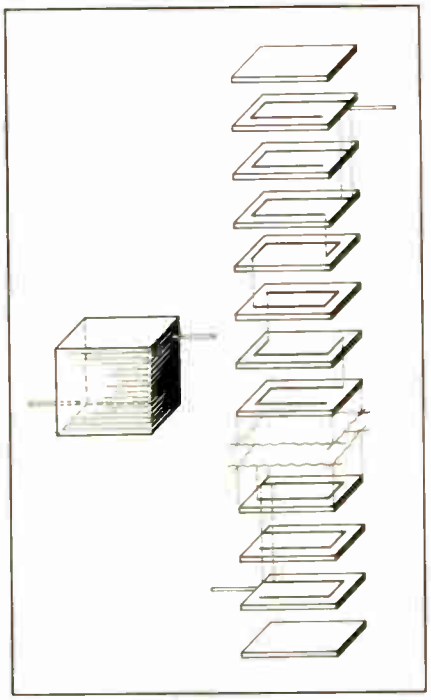
Chip inductor fits in hybrid circuits

Clever design has resulted in a monolithic chip inductor suitable for hybrid circuits. The unit, formed from a stack of U-shaped conductor patterns screened on a ferrite tape, solves the materials problems inherent in tiny wound coils and can achieve inductances three orders of magnitude greater than present screened inductors.

San Fernando Electric Manufacturing Co., San Fernando, Calif., has made the devices with inductances in the 0.1 to 6 microhenry range, Qs of 20 to 50, and size of 80 by 80 by 80 mils—smaller than many integrated circuits. Present screened inductors are limited to nanohenry values, while even the smallest wound coil is large compared to a hybrid circuit and suffers from reliability problems due to its small wire gauge.

San Fernando Electric uses technology much like that used for chip capacitors. The inductor is built up three-dimensionally, by stacking thin layers of tape that each have a U-shaped conductive segment on one side. Successive layers are arranged so that the first U appears, say, upright, the next lies on its side with the gap to the right, the next is upside down, and the next lies to the left. To create a coil, the ends of each U are linked to the ends of the Us above and below it through small holes drilled through the tape. Finally, the whole assembly is fired to form a monolithic structure, and leads are attached.

The development of the part required careful attention to materials and fabrication techniques, says M.C. Zyetz, consultant to the company. A suitable high-permittivity ferrite material is bonded with plasticizer to form a 1.6- to 2-mil-thick tape. The holes have to be drilled with great precision.



To make an inductor. A stack of U-shaped conductors screened on to a ferrite tape forms a 3-d inductor for hybrid circuits.

The resistance of the conductor must be kept low for high Q. Platinum, a commonly used nonreactive metal, has excessive resistivity for this application, and gold and silver have melting points too low to work well with most ferrites. San Fernando overcame this problem by developing ferrites that can be fired at 800° to 900°C, yet still provide acceptable permeability, temperature coefficient and Q at the desired frequencies (present materials are useful only up to about 50 megahertz). Maximum ferrite area within the coil provides maximum inductance. Preheating and firing of the inductor assembly appear critical to mechanical and electrical performance. Preheating, for example, requires as much as 7 days to remove the resin and resist.

Temperature coefficient of inductance is in the 100 to 500 part per million per °C range, and the inductors can handle about 1 ampere. San Fernando calls the devices Magna Chip. Future developments may include transformers, higher values and frequency operation. □

Memories

AMS 4,096-bit RAM begins production

Reports about solid-state memory development often stress the difficulty of the transition from 1,024-bit random-access memories to 4,096-bit RAMs. The most popular approach has been to work on a brand-new n-channel MOS concept, which has proved to be difficult.

But the designers at Advanced Memory Systems Inc., spent little time agonizing over a 4,096-bit RAM, now going into production at the AMS plant in Sunnyvale, Calif. To make the new AMS 6004, they simply doubled the capacity of the AMS 6003 2,048-bit RAM. And both are made by the same reliable high-threshold, metal-gate, p-channel process employed in the earliest MOS RAMs.

System designers who substitute the 4,096-bit RAM for the 2,048-bit version will find the transition easy, as well, claims Millard Phelps, AMS vice president. Both devices use the same 22-pin package, and they operate at almost the same speed and consume about the same power per bit. The AMS 6004 has not yet been completely characterized, but its access time is expected to be 350 nanoseconds and its cycle time 600 ns, or about 5 ns slower than the AMS 6003. Its operating power consumption is about 50 microwatts per bit. Most proposed 4,096-bit n-channel RAMs operate at about the same speed and consume two to four times as much power.

Although the 6004 is a natural extention of the 2,048-bit RAM the original AMS 6003 was not easy to design. Late in 1971, Honeywell Inc., invited several RAM manufacturers to develop 2,048-bit devices that could serve in transitional designs until 4,096-bit RAMs were sufficiently developed to replace the 1,028-bit RAMs then in general use.

Honeywell's specifications called for an MOS RAM with inputs and outputs operating at TTL-logic lev-

els. "The rest of the industry would have thought we were crazy, had they known we intended to stay with the high-threshold, metal-gate process," Phelps says. High-threshold MOS is not compatible with TTL, and the metal-gate process results in chips much larger than those made with the silicon-gate process.

AMS designers solved the TTL-compatibility problem by building TTL/MOS-level conversion circuitry into the chip—a unique design that AMS has patented. Honeywell bought the 2,048-bit design—the AMS 6003 is now being made in volume for Honeywell, Phelps says.

The 4,096-bit version contains the same basic circuitry around a double-size storage-cell array. Both RAMs have a single output, being organized as 2,048 by 1 and 4,096 by 1. One additional address-decoder stage was added and connected to a package pin that was unused by the AMS 6003. To substitute the 6004, it is only necessary to connect the additional address input.

Phelps admits the 6004 is large for a RAM—200 by 230 mils. This

Five satellites help to rescue Cousteau

In a dramatic look into the future of sea rescues and satellite-terrestrial exploration, a team of three U.S. Government agencies used five satellites to safely navigate ocean explorer Capt. Jacques Cousteau and his battered ship Calypso from the treacherous waters of Antarctica. In the tense final leg, Cousteau monitored the movement of ice floes, clouds, and weather conditions sent from the satellites to help him cross the dangerously unpredictable 500-mile passage to South America with his ship limping along on one propeller at five knots.

The silver-haired, aquiline explorer, in thanking the Government's efforts, predicts that, in the future, "exploration of the seas will be airborne and from satellites, surface ships, and undersea." Coordinated in Cousteau's mission were NASA's ATS-3 Applied Technology Satellite, the Nimbus-5, and ERTS-1 Earth Resources Technology Satellite; the National Oceanic and Atmospheric Administration's NOAA-2 and ESSA-8; and the Navy's fleet weather facility.

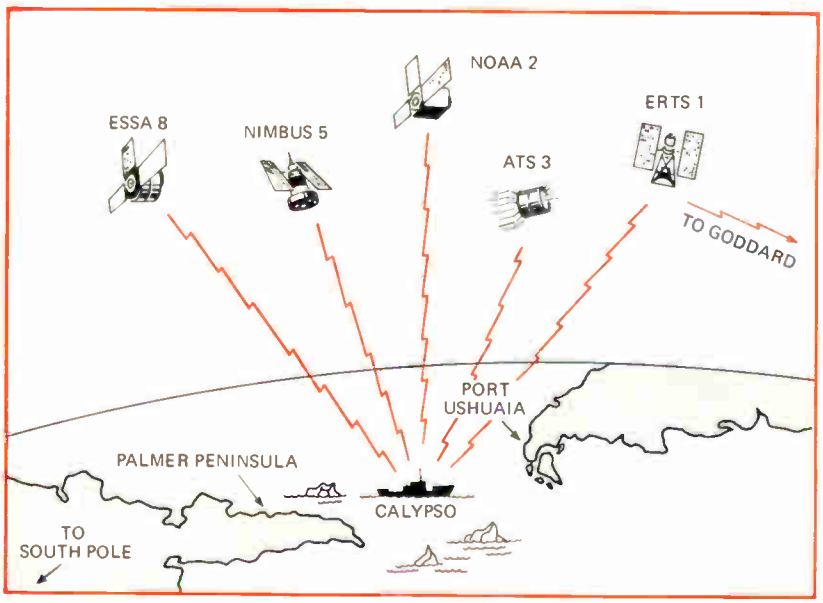
Cousteau's voyage began innocently enough as a vehicle to film a television special and as a joint scientific venture with NASA to "try to correlate what satellites can view with data from direct measurements of the quality of the sea." Data was sent via ATS to NASA's Ames Research Center, where a research team would compare Cousteau's measurements with data received from NOAA's weather satellites and ERTS-1. Also, Cousteau could receive microwave radiometer data from Nimbus-5 to steer his oceanographic vessel around ice fields and satellite-derived weather information via the ATS link.

Cousteau ran into trouble when "a blizzard was announced by satellite. But we never realized that it was that big." Within a short time, his 141-foot ship was buffeted by winds up to 80 knots. Trapped in Hope Bay, waiting out the storm, he circled for three days while his ship took a pounding from wind-pushed ice blocks and was under a constant threat of falling ice walls. One ice block disabled his port propeller, and another gashed a hole just above the stern waterline.

As the storm eased, Cousteau decided to make a run across Drake's Passage for Port Ushuaia, Argentina. The Navy's weather service superimposed satellite data on its weather charts to give the captain twice-daily 72-hour facsimile outlooks, which he describes as "fantastic and accurate." Finally, escorted by Chilean and Argentinian navy vessels, the Calypso putt-putted to safety.

"Never before in the history of my ship have we been watched by so many big brothers," the charming Frenchman comments.

"Captain Cousteau offered us an opportunity to try several things," says Leonard Jaffe, NASA's deputy associate administrator for applications, who adds that "satellite photography was used in a dramatic way." Cousteau hopes to undertake another joint venture with the agency. □



is the reason most designers do not use the metal-gate process for a 4,906-bit RAM—the rule of thumb is "the larger the chip, the lower the yield, and the higher the cost."

That objection to metal-gate really isn't valid, Phelps says. "The higher wafer yield more than offsets the lower yield of chips from each wafer." Of any memory-fabrication process, it requires the fewest steps. He adds that silicon-gate proponents don't realize that metal-gate processing has improved over the years and can now be controlled better than silicon-gate processing.□

Word processing

Office automation picks up sales, speed, competence, and competition

A new market in word-processing equipment is springing up among businessmen persuaded that, for many jobs, a minicomputer, CRT display, and punched or magnetic tape will do as well as—or better than—a secretary. Such equipment is part of automatic typewriting and/or text-editing devices.

Expected to be an $8 billion market by 1980, word-processing systems are already causing a title change: "secretaries" are becoming "operators," since the equipment involved is more closely related to automation than the old steno pad and manual typewriter. For one thing, it costs anywhere from $2,000 to $200,000. For another, it handles dictation, document preparation, form letters, filing, and in fact, just about everything except the office Christmas party.

Equipment sales picked up speed last year and should shift into still higher gear this year, say manufacturers. Typically, this market has attracted more competitors promoting new applications of electronics and has caught some older office-equipment suppliers with their green eyeshades showing. Market researchers Frost and Sullivan Inc. of New York reports that word processing was worth $1 billion in 1972. The firm estimates it will reach $2 billion by 1975 for the typewriter/dictation equipment, supplies, and services, as well as for new products and services.

The first major modification to the common word-processors, dominated by IBM's Selectric system, was the editing device, of which there are now several variations. Within the editing systems are various means of display, including high-speed printout and CRT. For all types, the aim is to improve productivity, claimed to be 50% to 75% better than manual methods.

One new firm in this field, Documate division of Index Systems Inc., Cambridge, Mass., has developed a novel editing system around a Nova minicomputer and featuring disk storage [*Electronics*, March 1, p. 26]. Documate time-shares three to 15 modified Selectric input/output terminals and a 132-column, 240-line-per-minute line printer for high-speed printout. This company has gone to disk storage because it increases capacity (2.5–10 million characters) and gives the computer room for the software necessary to safeguard data files and handle other chores. Price of this system ranges from $80,000 to $200,000.

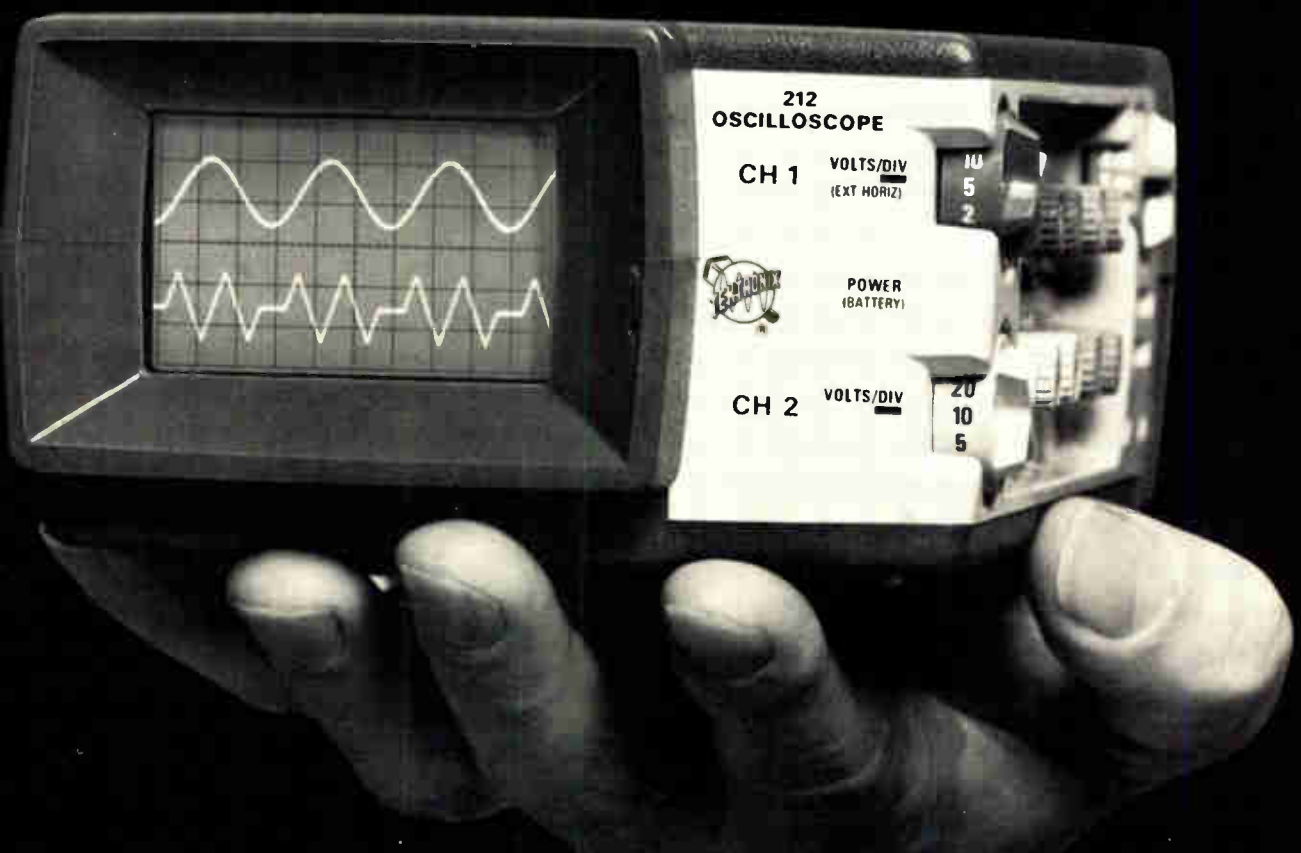
Cassettes. Another new entry has come from Linolex Systems Inc., North Billerica, Mass. Heart of the Linolex/WP is a programable microprocessor containing six read-only memories. This makes it possible to add specialized word-processing programs and data-processing jobs by inserting different tape-cassette programs. Selling for $17,900, it has a CRT display for editing documents in storage prior to printing.

Another newcomer with a word processor designed around a CRT is Lexitron, Chatsworth, Calif., with its Videotype. It has three 7,200-character memories that control data retrieval for the screen, buffer the stored data, and serve the printer after data has been dumped from the screen. The advantage of a CRT, the company claims, is the ability to pick out sentences or paragraphs from a document, make changes from a keyboard, and return to storage or printout without having to review a typed version. The Videotype sells for $17,500.

Like the Documate system, the Astrocomp developed by Information Control Systems Inc., Ann Arbor, Mich., takes word processing into the publishing business, as well as office correspondence. It is designed around a PDP-8/L minicomputer with the ability to input

Tape-cassette version. The word-processing system from Linolex Systems contains a programable microprocessor. Programs and routines are entered via tape casettes.

a handful of measurement solutions...



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from all types of format and output to CRT, typewriter, high-speed printer, and automatic typesetters or photocomposers. Depending on the number of terminals, selling prices range from $34,000 to $89,000. □

Materials

VO_2 switches could drop hybrid costs

A new temperature-sensitive thick-film material developed by Du Pont lets active switches be deposited on hybrid circuit substrates much like conductors, resistors, and capacitors. It could lead to lower production costs by eliminating separate semiconductor switches and their bonding.

E. I. Du Pont de Nemours and Co. has already used the material, called Tyox, to demonstrate functions like thermal and voltage-overload protectors, thermostats, motor-speed controls, and plasma-display drivers. David W. Roe, new products development manager for the Electronic Materials division in Wilmington, Del., estimates that the screened switches could reduce the cost per function from 5 to 10 cents to 1 to 3 cents. The technique seems especially suitable for inexpensive consumer products.

Hot switch, cool switch. The active element of Tyox is vanadium dioxide, a compound that switches from a semiconductor to a conductor at about 70 C. This change, which can be produced by externally applied heat or by self-heating from an electric current, reduces resistance by two-thirds. This phenomenon could not be put to practical use previously, since VO_2 breaks down in most environments at high temperatures. But Du Pont added other proprietary materials to permit processing at 760 C in air, as required for conventional thick-film production. Thus, the material can now be screened and fired with the rest of a circuit.

The resistance of a screened switch depends on its size and shape. In typical applications, a 1-mil-thick layer of Tyox has an off resistance of 300 kilohms per square, and an on resistance of 300 ohms per square. The practical on resistance ranges from about 150 ohms to 300 kilohms.

Specs. In self-heating applications, the material exhibits a threshold voltage of about 12 volts per mil of element length and a threshold current of 50 microamperes/mil of element width. For practical sizes, this would permit switching voltages of 60 volts to 20 kilovolts, and switching currents of 0.25 to 1.25 milliamperes.

The switching action can occur in 10 microseconds, with turn-off in 100 μs, depending on the size and the substrate. The device can be biased to a chosen temperature below 70 C for applications such as thermostats. Power controlled is about 15 milliwatts/mil^2, a practical range of 15 mW to as high as 10 watts.

Roe says that encapsulation doesn't appear necessary in most applications, and resistance drift in thermal switching has been under 5% for 2,500 cycles for 100-by-200-mil devices, and under 13% for 10-by-20-mil ones. □

Communications

Telemetry rides on all-digital system

Following the trend toward digital systems in data-acquisition and industrial telemetry, Analog Devices Inc.'s Modular Instrumentation division, Norwood, Mass., has introduced a set of five data-exchange modules that give the system designer an effective means of transmitting remote data in all-digital form to a central processing point.

Predominately analog data from remote sites has been usually gathered and transmitted in analog form, and multiple channels of analog data time-shared a single analog-to-digital converter at a central point.

The all-digital approach, according to the company, is now feasible because of the sliding costs of a-d converters, coupled with the availability of the data-exchange modules. The new modules use standard ASCII characters to interface directly with a teletypewriter or computer.

The five modules that comprise the Serdex (serial data-exchange) series are a serial transmitter, a serial receiver, two modules that serve multiplexing functions, and a clocking module. These modules can transfer two-way information over twisted-pair lines up to 10,000 feet long. Positive 5-volt power is required.

In announcing the new product line, Ray Stata, the company's president, identifies a market of over $100 million a year for industrial data-acquisition systems, with which the all-digital modular approach will compete. □

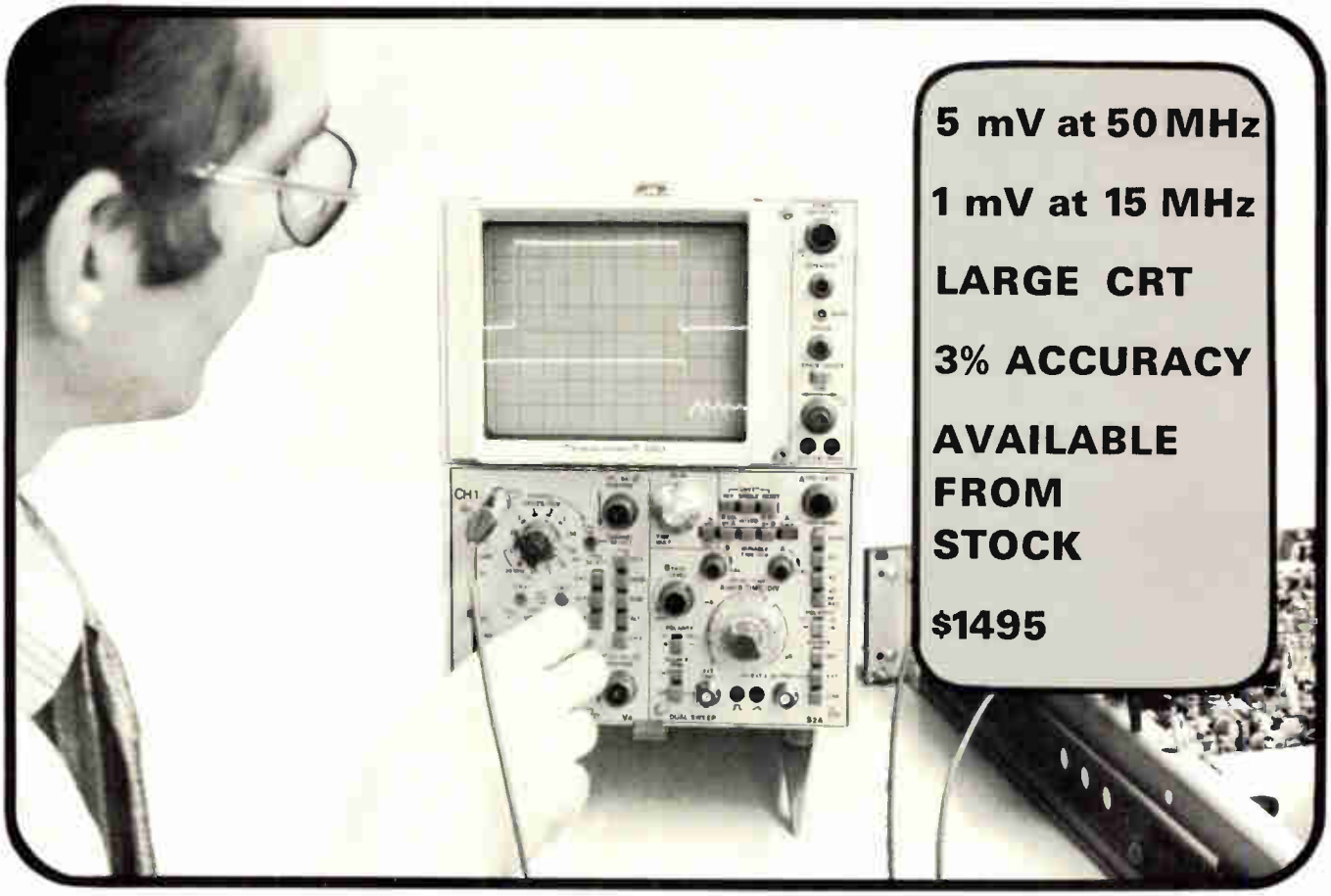
Computers

Message service added to Arpanet

Message service—the routing of information to a single individual or each individual on a list—is the latest application of the Advanced Research Projects Agency's computer network, Arpanet [*Electronics*, Dec. 20, 1971, p. 44]. According to Lawrence G. Roberts, director of information-processing techniques at ARPA, the service has replaced the telephone in much of the Advanced Research Projects Agency's routine communications.

While the concept is old, the application is new and, said Roberts, speaking at the recent 1973 Computer Conference in San Francisco, "We've found it to be dramatically effective." It not only eliminates many interruptions of important work but also simplifies transmission of messages to staff members who are traveling. Furthermore, same-day delivery is almost always assured, even to a long distribution list, while much secretarial

MORE VALUE IN TELEQUIPMENT DUAL-TRACE OSCILLOSCOPES



$1495 makes the D83 the lowest-priced 50-MHz oscilloscope available today.

You can select either a dual-trace or differential vertical plug-in. The 5 mV to 20 V/div (1 mV with X5 gain) dual-trace plug-in offers 5 operating modes including alternate, chop, and algebraic add. Differential deflection factors range from 50 μV to 10 V/div with a CMRR of 100,000:1 at 50 μV/div. Both plug-ins are accurate within 3%.

15,000-Volt CRT accelerating potential ensures bright displays of even low rep-rate signals in high ambient light. The large 8 x 10-div CRT (1.22 cm/div) allows you to view dual-trace displays from several feet.

The dual time-base incorporates delayed sweep; mixed sweep and single-shot. Sweep ranges extend from 100 ns (10 ns with mag) to 2 sec/div in 23 steps, accurate within 3%. Full trigger source selection is provided.

Standard convenience features include: a 1% calibrator; "Trace Locate" button for quickly determining the position of an off screen display; and gate and sawtooth signal outputs.

The TELEQUIPMENT line is backed with the same warranty as other TEKTRONIX products, and is marketed and supported through an international network of TEKTRONIX Field Offices, Service Centers, Distributors, and Representatives. Call your nearest office, or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005. A new catalog showing the entire TELEQUIPMENT line is available on request.

Part of the Telequipment line from Tektronix, Inc.

For a demonstration circle 34 on reader service card

typing is eliminated.

It's one more demonstration that, as Arpanet grows, more and more unexpected uses for it show up. Roberts predicts that the message service has so many advantages that it may eventually occupy as much as 50% of the network capacity. To incorporate it required only the addition of some relatively simple software, for editing, cataloging, and filing the messages.

One observer, however, comments that this use of the network is expensive because of the storage facilities required for text of messages en route and in process. "ARPA can do it because it has the money," he says, "but the non-Government users would find this application difficult to justify." Roberts, however, estimates it costs 10 cents for transmission of each message plus another 40 cents for storage costs. □

Satellites

Comsat reorganizes, Navy gets a Marsat

The Communications Satellite Corporation (Comsat), Washington, D.C., had hardly finished creating a new subsidiary to handle its domestic business before the new company received its first order: a $28 million Navy contract to build an interim two-ocean maritime satellite (Marsat) system. From this system the company also expects to develop the commercial version of Marsat that the shipping industry has been clamoring for [*Electronics*, Feb. 1, p.50].

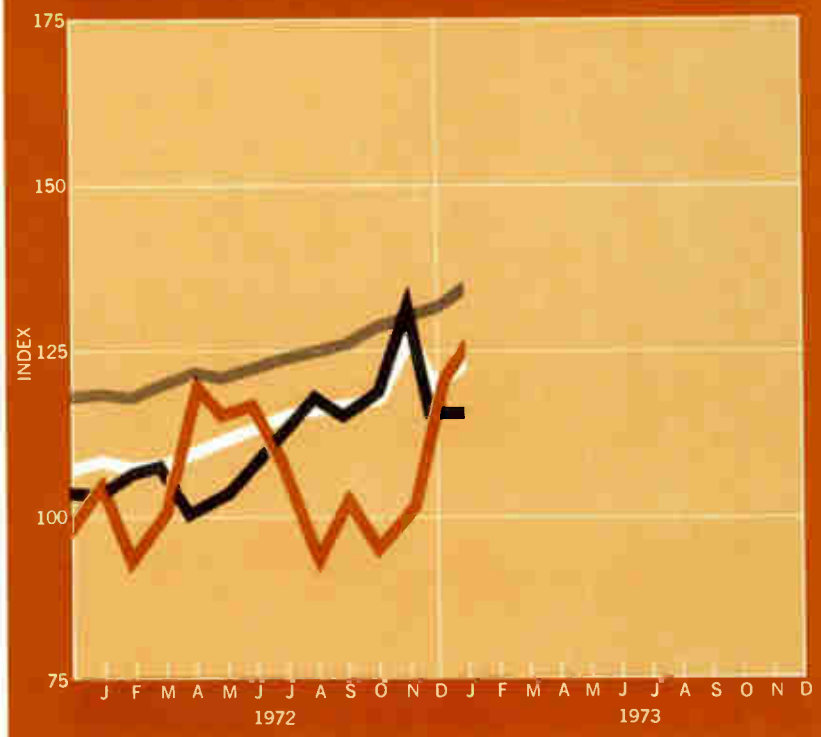
Awaiting anticipated Federal Communications Commission approval, plans call for the Navy and civilian maritime interests to share the multifrequency $70 million system for two years, beginning Sept. 1, 1974. By then, the Navy will have switched over to its Fleetsatcom system, and the company plans to operate Marsat solely as a commercial system.

Comsat is negotiating with Hughes Aircraft Co. for "three new birds heavily based on Telesat technology" (the Canadian domestic satellite system), says a company official. Besides the satellites, which will have a five-year life, the $70 million system includes two earth stations, one on each coast, and tracking, telemetry and command facilities.

The satellites will use three separate uhf transponders, a company official adds: uhf (240–400 megahertz) for secure Navy links between satellites and terminals; L band (1.535–1.660 MHz) for commercial links between the ships and satellites; and C band (4 and 6 gigahertz) for satellite-to-earth station communications, including tracking, telemetry and command. Comsat says it will later provide the maritime industry with all the details about its service.

John A. Johnson was named president of Comsat General Corp., the new domestic subsidiary. George P. Sampson will head another new division, International Systems division, which will oversee Comsat's programs with Intelsat, the Inter-

Electronics Index of Activity



Segment of Industry	Jan '73	Dec '72*	Jan '72
Consumer electronics	127.2	121.1 r	105.4
Defense electronics	116.6	116.6 r	104.7
Industrial-commercial electronics	135.7	132.5 r	119.4
Total industry	124.3	122.3 r	109.3

r = revised

The index inched up 1.6% in January. This second straight monthly increase left the index a healthy 13.7% above last year's level. Consumer electronics was 20.7% higher than in January 1972, defense electronics 13.4% higher than last year's level, and industrial-commercial electronics was also 11.7% above the January 1972 level.

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

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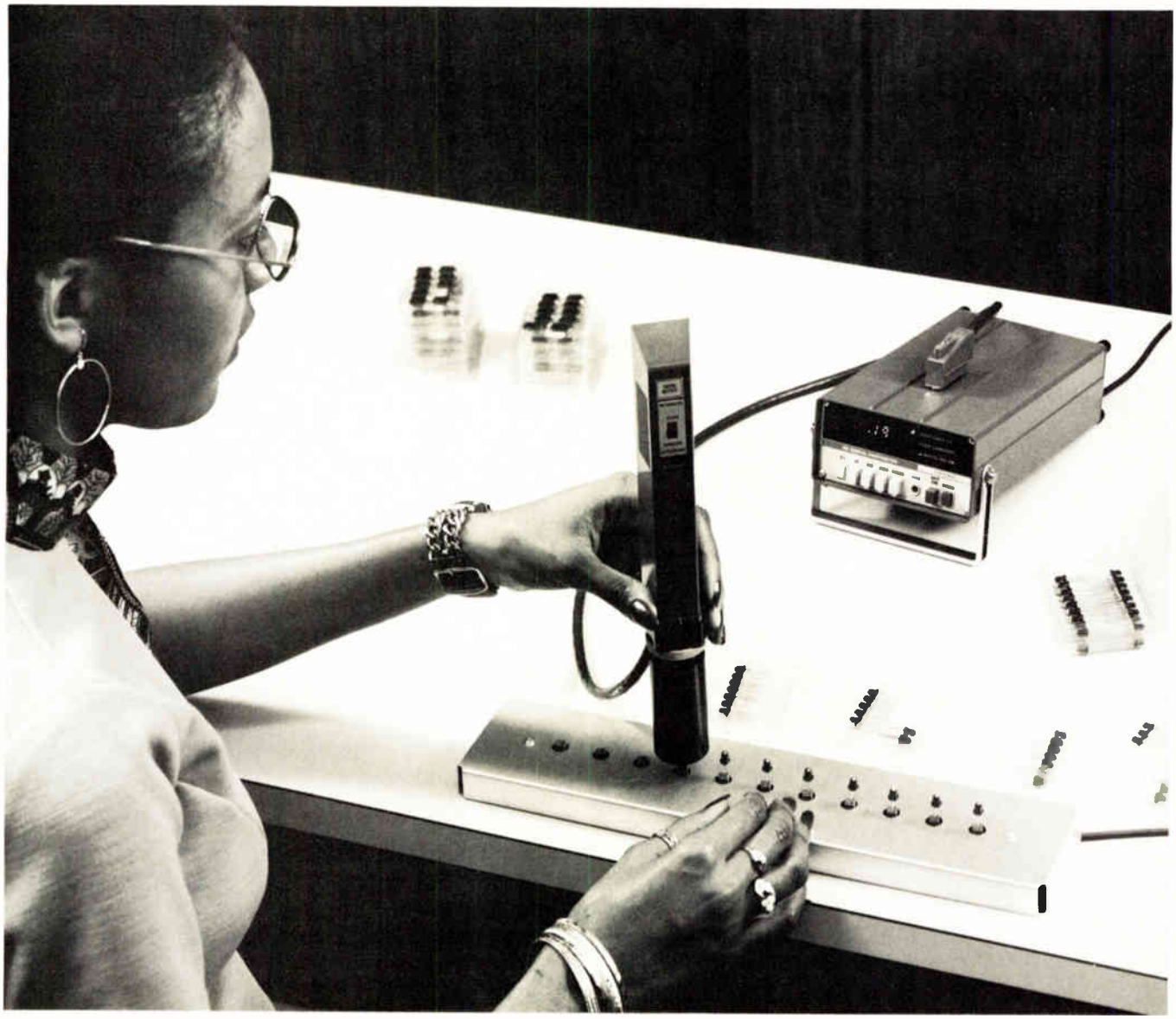

Costs can be reduced and product quality improved by matching, sorting, and Q.C.'ing LED's quickly and economically. With our Photometer you can measure your LED light output with a sensitivity accurately matched to the CIE photopic curve. Probes are available to measure spectral output in the red (600 to 710 nm) and yellow/green regions.

The LED package is designed for quick and accurate measurements. An adapter spaces the LED from the sensor allowing the reading in footcandles or lumens/m^2 to be converted to millicandelas by moving the decimal point. Three adapter inserts are supplied to accomodate common size LED's, and can easily be modified for other LED configurations. Ambient light is excluded, and baffles within the adapter prevent internal reflections.

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Displays

Liquid-vapor turns on in display

If a sheet of glass is frosted on one side and a bit of turpentine is smeared on the roughened surface, the wetted portion becomes transparent, while the rest of the glass remains translucent. In simple terms, this describes the operating principle of a new display technology, the liquid-vapor display.

According to its developers at Princeton Material Science Inc., Princeton, N.J., the new approach has a lot going for it. The display is reflective, and it can be constructed simply—two sheets of glass can be placed one behind the other with the back side of the front one roughened and the rear sheet painted black. Between the sheets is a reservoir of liquid—anything from turpentine to carbon tetrachloride.

Advantages. The display is potentially simple and inexpensive to manufacture, says George W. Taylor, vice president for research and engineering. The front panel has an X-Y electrode-addressing matrix sputtered onto its rough side, and, in contrast to liquid-crystal films, which must be laid down with great uniformity, the new system allows production variations.

With the electrodes off, the display panel is transparent. Accessing a pair of X-Y electrodes creates a white spot as the liquid is vaporized at the crossover point. This occurs with the same speed as with liquid crystals—from 1 to 10 milliseconds. This is good enough for such flicker-free displays as television screens with a frame rate of about 30 per second. Turnoff time, or return to the transparent state, varies with the liquid used, but again, it is approximately equal to that for liquid-crystal displays.

An experimental model turns off

News briefs

Technology and society—IEEE's new bag
The IEEE has formed a new ad hoc committee, called Social Implications of Technology (C-SIT), to study the social responsibility of engineering, the interaction between technology and society, and the impact of technology on society. The group wants to provide a forum for such subjects as electronic warfare, pollution, communications and transportation, and electronic surveillance. C-SIT will also publish a newsletter covering its activities.

Nadge net to be fully spread by summer
The 3,000-mile arc of installations in NATO's computerized air-defense system is scheduled for completion this summer. Eighty of 84 sites that make up the NATO Air Defense Ground Environment (Nadge) system have been completed, and the system began operation in Western Europe last month. Nadge consists of a chain of stations stretching from the Arctic Circle to Asia Minor. Each site is equipped with early-warning radars and air-traffic sensors, connected by a data-communications network to computerized control centers and ground-to-air missile facilities. Hughes Aircraft Co., Los Angeles, Calif. has provided systems management and supplied the computers for Nadge.

Fast fax uses TV net
A new facsimile system that can transmit an 8-by-8-inch fingerprint card in about 30 seconds with about 2,000 lines of resolution is being evaluated by the New York State Division of Criminal Justice Services. The system, called Intravision, uses the broad bandwidth of the state's educational television network instead of telephone lines to transmit a page of printed record or half-tone graphics in a second. In contrast, a facsimile system normally requires four to six minutes for a similar transmission over telephone lines. The Intravision system was developed by Data-Plex Inc., New York City, with its own funds.

NCR pares jobs, pushes electronics
Although recent announcement of 1,800 layoffs by National Cash Register Co. is generally attributed to corporate streamlining and belt-tightening, in view of the firm's unsatisfactory 1972 financial results, the move also underscores NCR's late, but now fully committed transition to electronics. More than half of the 1,800 jobs will be pared from the Dayton-based Financial Systems division, which produces the NCR 270 electronic bank terminal with about 30% of the labor required for its mechanical predecessor. NCR will also spend some $4 million to renovate and update the same facility.

The rest of the layoffs, "including quite a number of white-collar jobs," will come from the Dayton headquarters staff, say company spokesmen. Other divisions, including the Retail Systems division in nearby Cambridge, Ohio, and the San Diego-based Data Processing division will not be affected.

ATS-F to test millimeter waves
Hughes Aircraft Co. has delivered a millimeter-wave communications system for launch aboard the NASA ATS-F satellite in spring of 1974. The equipment will test propagation of signals in the 20-to-30-gigahertz band, which is highly susceptible to rain, hail, snow and other atmospheric conditions. If the frequencies prove usable, they could greatly increase the width of the radio spectrum for space communications.

Philco-Ford wins NATO satellite contract
Philco-Ford's Western Development Laboratories has edged out Hughes and TRW to build two communications satellites for the NATO phase III space communications-satellite system. The fixed-price-incentive contract is for $27.7 million.

The floppy disk that works

There are several floppy disks on the market today—and, no doubt, more to come. But there's only one that works reliably—today. Only one that's available for quantity delivery—today.

And, only one that costs as little as $500 in OEM quantities—today. That one is the Diskette™ from Innovex.

A square disk that doesn't spin,

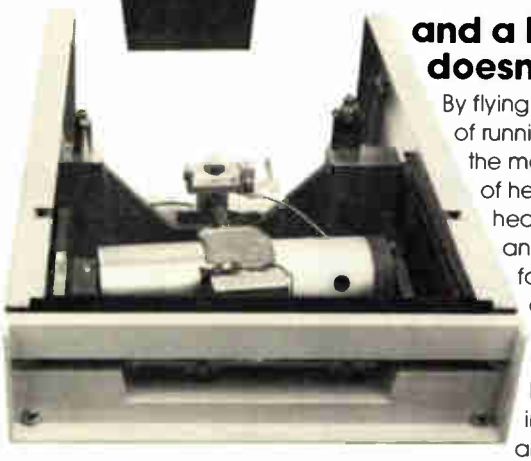
Rather than trying to read and write data on a flexible spinning disk, the Diskette leaves the disk stationary and spins the head instead. In fact, the Diskette cartridge isn't really a disk at all but rather a sheet of evenly tensioned computer tape in a rigid plastic frame. (Life tests so far show single track media life is in excess of 3 million passes; cartridge life in excess of 25 million passes.)

Floppy, not sloppy.

In concept, the floppy disk is beautiful. The performance of a disk, the convenience of a cassette and a price range that says everybody can afford one. But only the Diskette can deliver these attributes plus proven, day-in, day-out reliability. In short, the Diskette works better because it works differently from any other floppy disk.

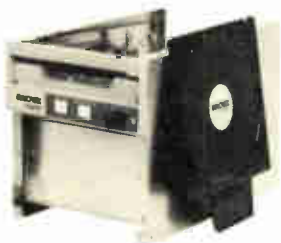
and a head that doesn't wear out.

By flying the head instead of running in contact with the media, the problems of head "wear-out", head static charge and early media failure simply don't exist. (Life tests show a head life in excess of 3000 hours.) An inexpensive motor and belt drive are all it takes to spin the head. A foolproof stepping motor moves the head from track to track.



Look at the performance

Capacity	
per track	26,900 (single record)
per diskette cartridge	1,291,200 bits
Density (Phase Encoding)	
bit density	2,000 bpi (inner track)
number of tracks	48 data tracks plus parking ramp
sectors per track	8 nominal, user selectable
Transfer Rate (Phase Encoding)	
bit rate	172,000 bits/sec.
Access Time	
track to track	5ms
settling time	25ms
latency	75ms avge. (400 RPM)
Dimensions	9⅜" wide
	10" high
	14½" deep plus ⅝" bezel
Weight	19½ Lbs



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in 10 ms. The display built by Taylor is 3 by 4 inches, about oscilloscope size, or the size of some displays for data-entry consoles. Taylor has already used the display successfully to show seven-segment numerals, and now he is working on the letters of the alphabet, which demand more complex addressing.

Like phosphor-based systems, the liquid-vapor display can produce a gray-scale. Taylor varies translucency by modulating the X-Y signals in either amplitude or time. For 16 discrete levels of gray-scale, he proposes a somewhat more complex multi-electrode addressing system.

With slightly more complex internal construction, the display can emulate a CRT storage tube. An electrode matrix on the display surface boils off a thin coating of the liquid where desired, and this vapor passes through a port and into a reservoir, where it condenses. To clear the screen, the liquid in the reservoir is heated until it vaporizes and recondenses on the display surface.

Picture-frame TV? Flat-screen TV is a potential application for the display. With the combination of low potential cost and relatively lower voltage requirements than CRT-tube systems, liquid-vapor screens may become attractive to television-makers. The flat surface of the new system would automatically eliminate the barrel and pin-cushion distortion that are characteristic of the CRT, and the reflective display wouldn't dim in ambient light.

The display can be addressed by either alternating or direct current, and there appears to be no fatigue problem because the liquid-vapor display operates by momentarily boiling off and recondensing minute volumes of its liquid. In contrast, liquid-crystal displays, especially if actuated by dc, can lose their effectiveness in time.

And about 2 watts at 50 volts easily controls each square centimeter of display area when trichloroethylene is used. Operating liquids with lower vapor pressures could increase efficiency and further reduce power requirements. Although the system uses more power than liquid crystals, it uses less than light-emitting diodes. It also uses more power than CRTs, but at lower voltages. Someday the liquid vapor display may become a competitor in large-screen applications, but this awaits further research. □

Computers can give buses green light

Evaluations begin in April of a new computerized bus priority system that lets bus drivers hold the green light for themselves at downtown Washington, D.C. intersections. Besides relieving traffic congestion during the Capital's frantic rush hours, the operational testbed will provide information for other cities wanting to use similar systems.

The system allows a driver to signal a traffic-light controller at an intersection whether his is a "through" or a "stop" bus, explains Juri Raus. Raus is program manager for the Federal Highway Administration, which is sponsoring the effort jointly with the D.C. Department of Highways and Traffic. If a through bus is close enough to an intersection, the system will hold a green light that is within 10 seconds of changing. If a stop bus approaches, the system won't hold the light unless the bus already has picked up passengers and is close enough.

What's inside. Built as part of the city's $5 million traffic-light control system [*Electronics*, Feb. 1, p. 74], the bus priority system consists of five basic units: a two-way steering-column switch, a bus-mounted two-frequency transmitter, an antenna embedded in the street, a solid-state module in the traffic-signal controller, and a Xerox Data Systems Sigma 5 computer to correlate the bus signals with over-all traffic-signal operations, Raus explains.

The driver's signal is picked up by the antenna in the street 210 feet from the intersection and is relayed to the signal controller. A similar antenna mounted on the other side

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Electronics review

of the intersection signals the system when a bus passes through. About 450 buses, and 112 intersections will be equipped with system electronics.

Sperry Rand was over-all system contractor, and TRW composed the software. The $100 bus transmitters for the system are built by Edo-Aire, Fairfield, N.J. □

Government electronics

Social Security seeks big data net

A mammoth national data communications system is being sought by the Social Security Administration, and industry responses to its requests for proposals are due March 15. The agency has to handle a skyrocketing number of claims and queries, the direct result of liberalized Social Security Act benefits enacted by the last Congress.

The SSA says its telecommunications workload will jump 80% within one year. Forced to move quickly, the agency expects to award a contract in April with operation to begin Jan. 1, 1974.

Called the Social Security Administration Data Acquisition and Response System, the network would link 463 field offices with the agency's IBM 370/165 computer complex in Baltimore, Md. Included in the network would be 771 terminals, seven message concentrators, and message-switching gear over Government-provided communications lines. The cost of the system won't be known until the RFPs are in, but one knowledgeable Government source estimates it will be about $3 million to $4 million.

As it gears up for its increasing workload, the agency has proposed a system option for the data network—an expanded network with the capability of adding 400 to 500 more field offices and handling up to 40,000 queries a day with a 30-second average response time. Under a five-year lease-purchase plan, the winning contractor will install and maintain the network. □

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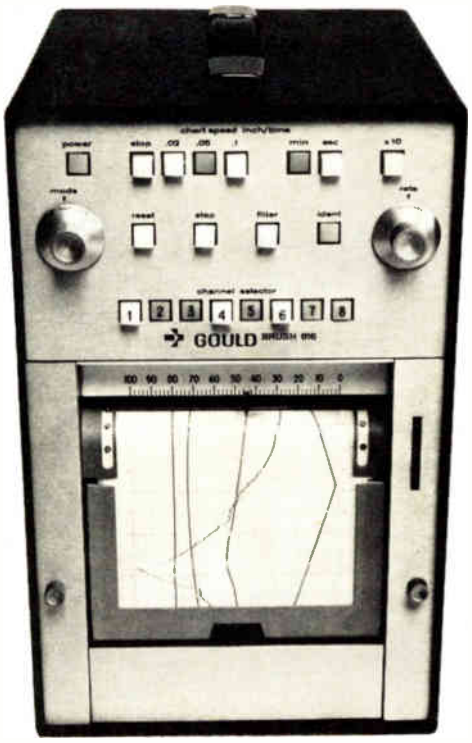

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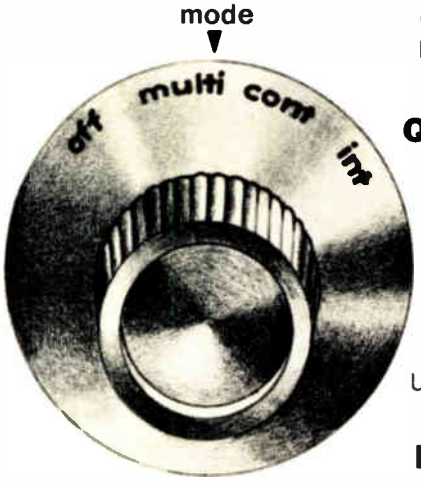

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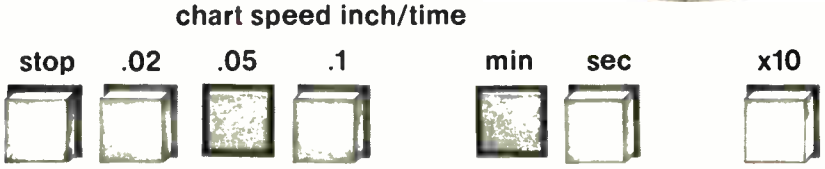

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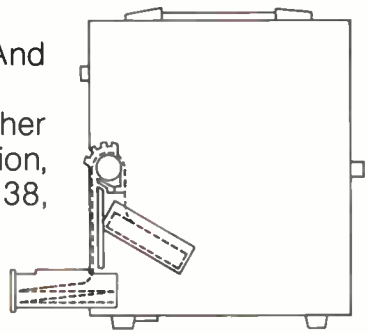

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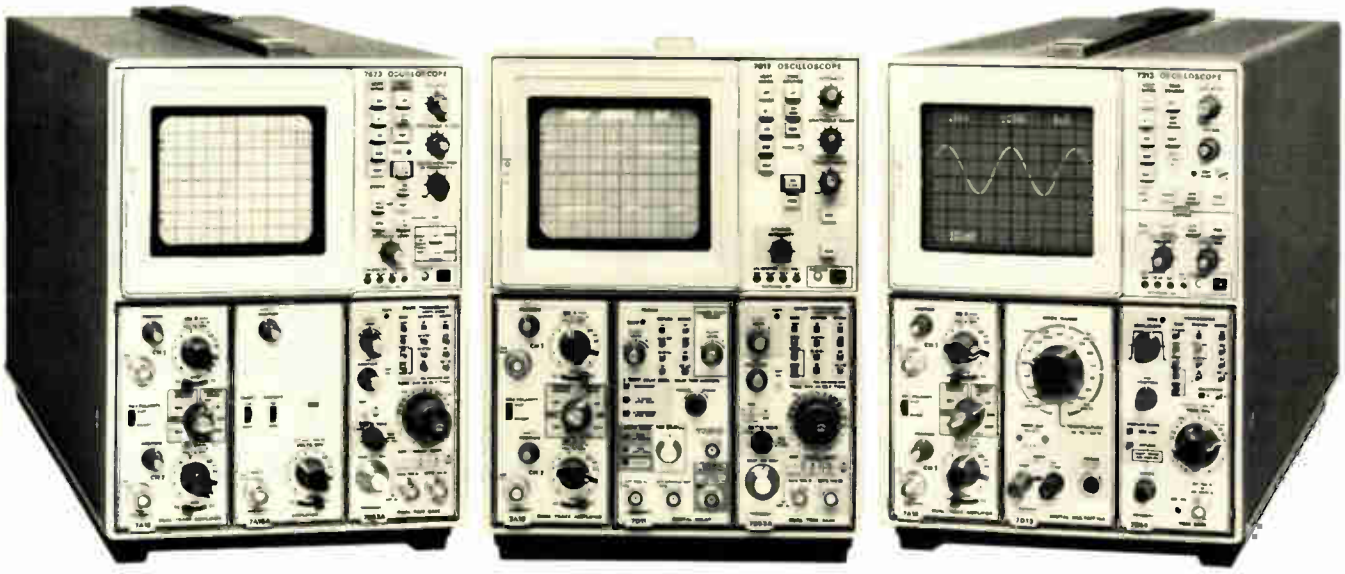

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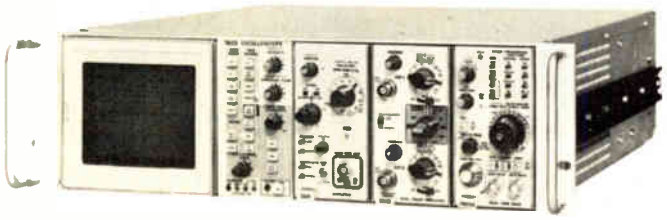

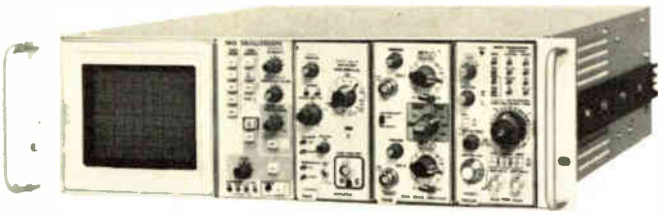

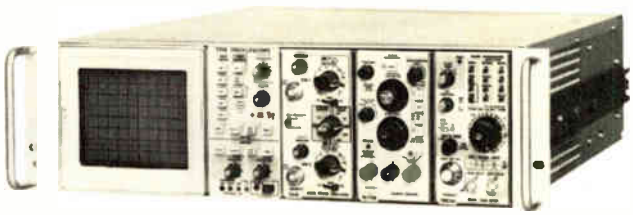

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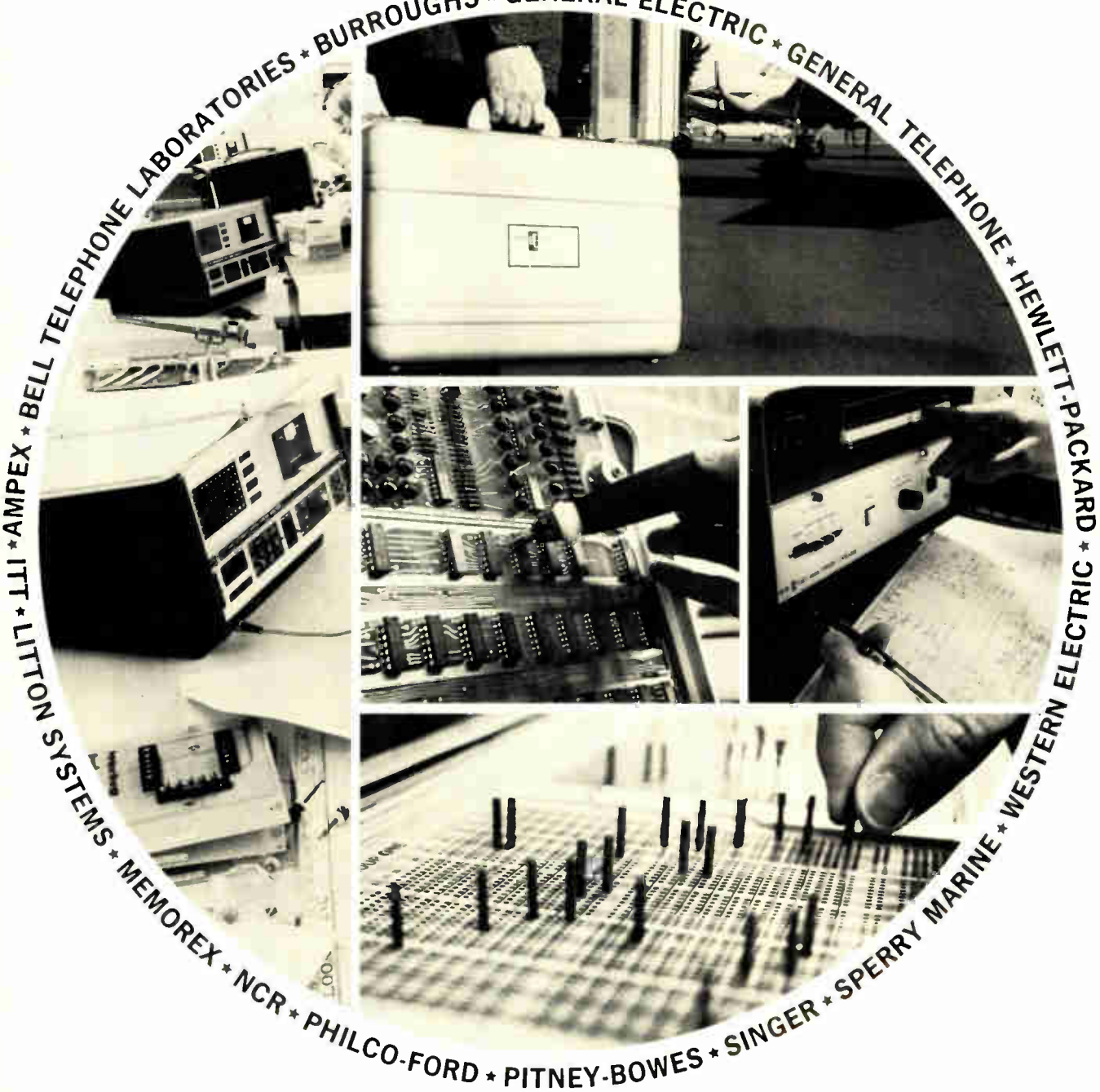

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Washington newsletter

FAA has new plan for interim microwave landing system

In a move to get free of its dogfight with six competing manufacturers, the **Federal Aviation Administration in the next few months will probably issue requests for proposals** for an interim microwave landing system, say agency sources. After evaluating the rival technological approaches, the FAA would select one to serve as the national standard for the interim system—and, the companies say, open up a vast market at private airports. **The winning company would have to let the others also produce its system,** an arrangement which agency reasoning holds is speedier than an actual flyoff of competing systems.

Meanwhile, the companies are exerting **tremendous pressure on the agency, in particular, by calling for help from their congressional delegations.** However, the FAA says it's pointing toward the best and cheapest system. Companies involved are: Boeing, Cutler-Hammer's AIL division, Raytheon, Singer's Kearfott division, Tull Aviation Corp., and Texas Instruments in association with Thomson CSF.

Bell rate revisions stir FCC opposition, prolonged action

On American Telephone & Telegraph Co.'s request to restructure its private-line rates, watch for Federal Communications Commission action to be prolonged—perhaps a year or more—by **opposition building within the Common Carrier Bureau staff as well as among the specialized common carriers.** AT&T's wish to drop national rate averaging in favor of a dual-rate system, with lower rates for high-density routes, has led the commission to request a full set of supporting data from the company. And the specialized carriers are charging AT&T with subsidizing competitive services from its telephone monopoly.

FCC public utilities specialist Paul Darling reflects one FCC attitude: "I can't overemphasize how important this issue is, since **it affects not just the specialized carriers, but all users of the nation's telephone services.**" From the manufacturers' viewpoint, tariff cuts by any carrier will eventually expand the data-communications market.

Compromise seen on proposed laser safety standard

Laser manufacturers hoping to change **proposed power levels on continuous-wave lasers used in classrooms and construction** are looking toward a scheduled March 26 meeting of an advisory committee on radiation standards as court of last resort. The Bureau of Radiological Health, which will submit its draft standards to the committee, **has wanted to hold such lasers to 1 milliwatt**—a level that industry and the Electronic Industries Association charge is excessively conservative. But indications are that the bureau, which is restudying its position, may **compromise by permitting up to 5-mW lasers for construction use,** but keep the lower level for classroom lasers. Some makers grumble that if the bureau doesn't relent, they'll sue it for overstepping its statutory authority.

Addenda

The FAA will be calling for industry comments on the plan it's soon to make public for **integrating area-navigation equipment into the national air-traffic-control system** [*Electronics*, March, 1, p.25]. . . . An increased use of pollution-monitoring and sensing equipment is predicted by **the Environmental Protection Agency, whose fiscal 1974 monitoring budget has jumped to $12 million** from last year's $2 million.

Washington commentary

America's multinationals: innocents abroad?

There is an analytic thread running through the U.S. Tariff Commission's recent examination of multinational corporations which suggests that many of America's electronics multinationals are innocents abroad—particularly when it comes to deriving maximum profit from the licensing of their technology (see p. 70).

Ironically, at a time when there is much sound and fury building within the Congress, labor, and industry, about the role of the multinationals, or MNCs, the 930-page analysis by the Tariff Commission appears to have gone largely unread. The study received only superficial treatment in the press when it became available in the last month, and has attracted precious little attention since.

In a capital where several 100-page analyses on one subject or another are released almost daily, the Tariff Commission's poor press is understandable. Yet it is nonetheless regrettable. The report not only treats a subject that is of increasing importance to America and its industries in their relations with the rest of the world, but it takes a powerful and potentially dreary mass of data and presents it with a perception and wit rarely found in a Government document. For the industrial and financial consulting community's number crunchers, moreover, there is table after table of new numbers on electronics trade and investment by multinationals. In short, the report is not only worth reading; it is readable.

Losing on licensing

Consider, for example, the following three excerpted items as they relate to multinational operations in electronics:

■ Item: the procedures by which firms establish "prices" at which technology is transferred are almost notoriously non-economic. In the case of direct transfers to foreign affiliates, "pricing" may depend less on the value of the technology transmitted than on the over-all financial strategy of the firm. Yet the pricing of indirect transfers as well is an imprecise art. The foreign licensee may be willing, in the end, to pay a sum equal to his (secret) expectations of profits to be earned by the use of the technology in an uncertain future.

Prospective licensors frequently put such a low value on the prospective licensee's expectations that the income from a license is viewed as a sort of windfall. Firms with such views will take what they can get for a license without arguing too hard for a higher price. The essential point, therefore, is that technology transfers are rarely, if ever, priced according to rigorously applied present-value discount techniques.

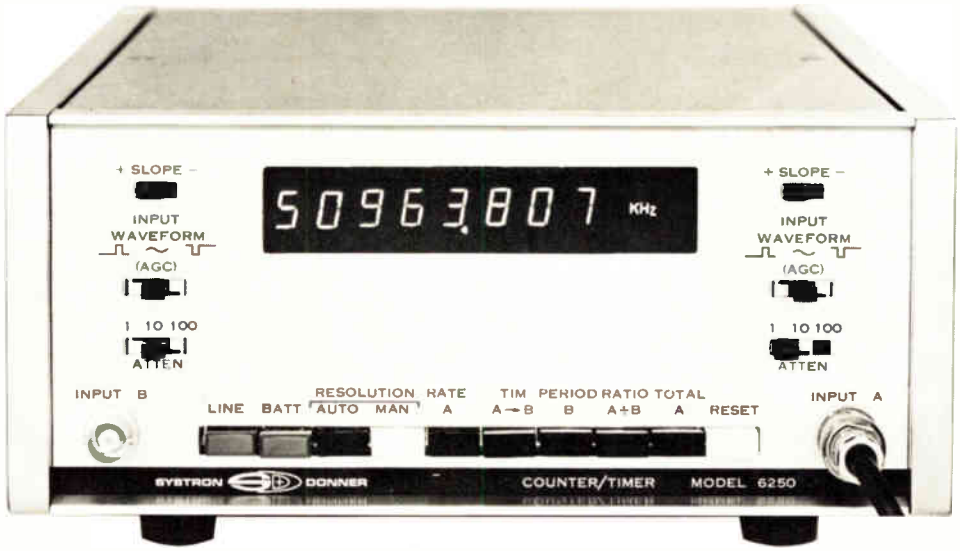
■ Item: is U.S. foreign direct investment a "complement" or a "substitute" for investment at home? One sub-question that lies behind this query is whether, in the absence of the U.S.-based MNC, the foreigner would have stepped in to fill the gap. . . . One cannot answer this "what might have been" question in any definitive way. But some of the numbers . . . suggest strongly that there was no deficiency in foreign savings with which a duplication of the MNCs' investment might have been financed. A crucial question hinges on how much of the investment of U.S.-based firms was financed abroad anyway, and the estimates . . . fairly well settle this question by showing that sources other than the United States provided well over 80% of the fixed and working capital requirements of all U.S.-owned affiliates in 1966–70, and nearly 90% of the requirements of manufacturing firms. . . . In brief, the Americans have done it largely with foreign savings, a point which is by no means lost to some Europeans who view the growing presence of the U.S.-based MNCs with apprehension, if not alarm.

Americans as xenophobes

■ Item: to the extent that, after all the numbers are recorded and analyzed, one is prepared to think that traits peculiar to American business and finance are important factors in the MNCs' success abroad, he may be tempted to go rather too far towards an argument that U.S. nationality is a sine qua non or at least a primary ingredient for success in international business. . . . Such an argument, of course, would lead to a conclusion that the foreigner could not have duplicated the MNCs' performance in any significant degree.

The error in this line of reasoning is its xenophobic element, which proceeds from recognizing certain characteristics that have contributed to the MNCs' success, to falsely claiming too much exclusivity for them. Evidence to the contrary abounds. A study of the fortunes of U.S. foreign trade quickly reveals that foreign competition is real. Foreign-owned MNCs' investment in the U.S. economy, in direct and successful competition with U.S. firms, has commenced to grow faster than the U.S. direct investment abroad. In many of the less developed countries, foreigners—especially the Japanese—are turning in a performance, as MNCs, that is decidely superior to that of the Americans.

—Ray Connolly



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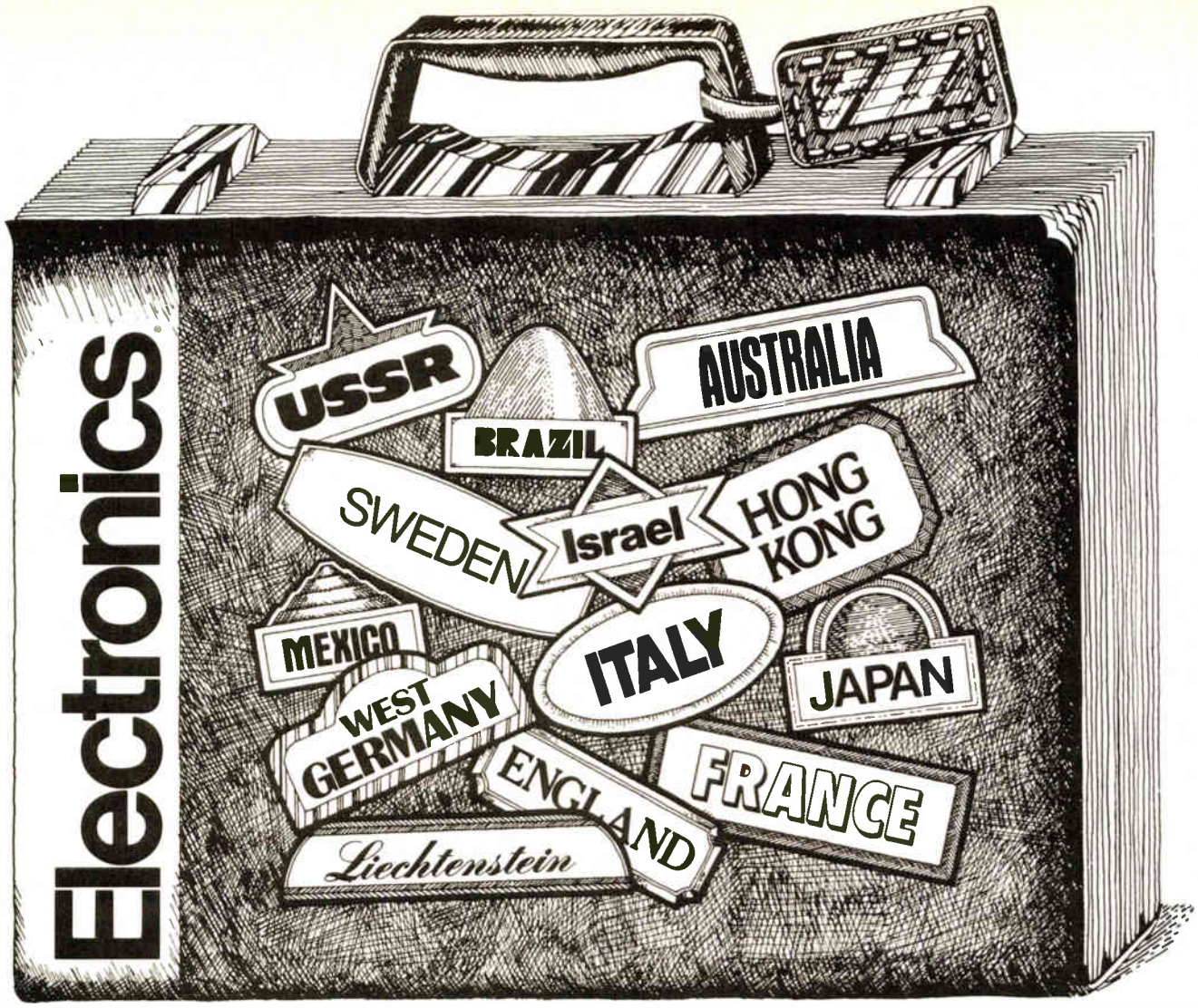

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Plasma panel modulates display brightness digitally

With its unusual digital brightness modulation, a new plasma panel should find applications as diverse as displaying computer output and television programs. Developed at the Central Research Laboratories of Mitsubishi Electric Corp., the panel will hit the market as a computer output display sometime this year. The TV version, though, will be slower in coming to the market.

The key to the panel's development is a time-modulation system that operates within the time period of a television frame. It permits digital brightness control of an ac-drive display of the type initially developed at University of Illinois. Like other panels of this type, the Mitsubishi display has inherent memory capability. Despite a continuous stream of alternating positive and negative driving pulses, the individual crosspoints of the panel remain off until they are turned on, remaining so until they are turned off.

Operation. An equal amount of light is emitted from each crosspoint that is on for each pulse of the ac drive. If it is on for a whole frame, one crosspoint would look twice as bright as one turned off half way through a frame and four times as bright as one turned off one-quarter of the way through. Using time-division multiplex, Mitsubishi engineers have achieved this brightness control—as well as higher brightness than many previous matrix displays because individual crosspoints emit light during many TV lines.

Rather than following a strict binary-coded weighting in its prototype display, Mitsubishi uses a weighting of one, two, four, four. The picture is sampled for the one and four weightings on first field of each frame and for the two and four weightings on the second field.

During the first field of a frame, the analog values along each horizontal line are coded in an analog-to-digital converter. A gate selects only the "four-weighting" and "one-weighting" values to be displayed during that field. The four-weighting values are delayed in a shift register used as a delay line. The one-weighting values are fed directly into the X-scan circuit, which is another shift register that changes the time displacement of signals for various portions of the line to a distance displacement along the vertical lines of the matrix.

When the process has been completed for all points on the horizontal line, the signals for all points along the line are transferred simultaneously to the matrix. When the signal is high, the corresponding crosspoint for that vertical line is turned on. The process is then repeated for the next line, while the line just written continues to emit light at the turned-on crosspoints.

After a length of time corresponding to one unit of brightness, all points on the first horizontal line receive a turn-off signal. A bit later, the delayed four-unit brightness signal is written in, and the on crosspoints emit light for each driving pulse. The difference now is that the delay until the turn-off signal is four times as long. □

Sweden

Thermistor senses CO, other gases

Swedish regulations on the maximum carbon monoxide in working places are among the toughest in the world—50 parts per million. This stringent rule led a Swedish engineer to design an electronic CO detector, which has quickly been adopted by a wide range of industries—because it costs a lot less than conventional chemical analyzers and detectors and requires very little maintenance.

Now the Swedish developer, Harry Rudberg, is eyeing export markets as working-condition regulations start to tighten up in most industrial countries. His device, known as CO-Smoke-410, employs as the detecting unit a catalytic semiconductor, which is mounted as one arm of a Wheatstone bridge. As the CO content of the air increases, the resistance in the catalytic element changes.

Catalyst. The basic amplifier is designed to handle three detectors, but the amplifier can be expanded to accept input from a large number of detectors. Rudberg say that some factories in Sweden are using 30 to 40 detectors.

The catalyst is a semiconductor thermistor, which Rudberg will describe only as being made of a mixture of metal oxides. Its resistance varies to provide a deflection of 0 to 4 milliamperes, with the lowest range indicating 0 to 50 ppm. By varying the resistor, the range can be extended to 1,000 ppm.

Rudberg says the semiconductor thermistor is much more sensitive than platimum-wire resistors, which are used primarily for signalling explosive quantities of gases, usually 10,000 ppm. The thermistor is heated to about 300°C, where it is sensitive to the catalytic combustion of the CO.

The detector will also sense the presence of other gases, including hydrogen, chlorine, and propane. The detector will not differentiate—but users generally know what gases they have to worry about. Where CO is a problem, the sensors are located about 5 feet from the floor, since CO rises. Where propane might be a problem, the sensor would be at floor level. □

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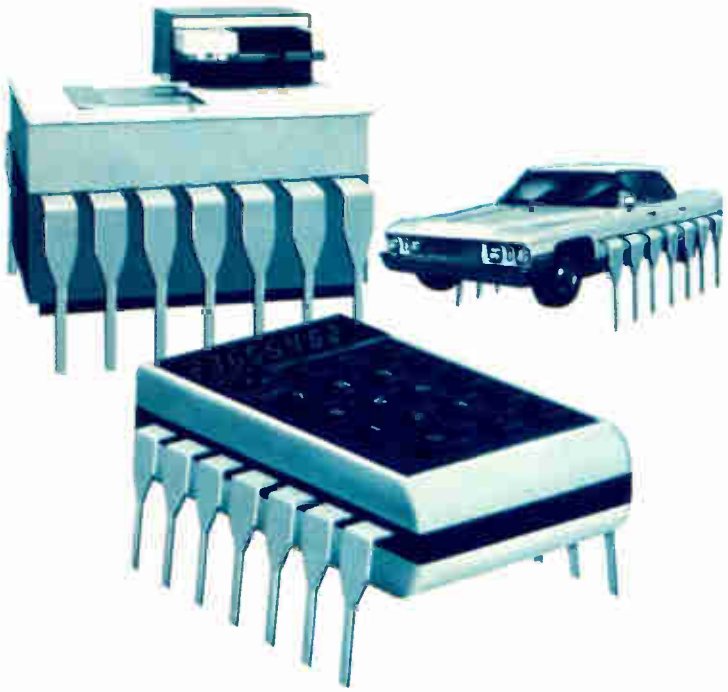

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Japanese companies back import easing —by 1976 . . .

Japan may liberalize—that is, decontrol—computer imports by 1977 and integrated circuit imports by 1976. These proposals were included in a plan submitted by industry organizations and executives of Japan's six computer manufacturers to the Japanese government. They also proposed that foreign companies should be able to invest up to 50% in computer software ventures by 1977. Prime Minister Kakeui Tanaka had earlier expressed his intention of liberalizing computer imports, and **the companies wanted to win government over to their plan before it comes up with one that is less favorable.**

This plan, which marks the first time that the industry viewpoint has not excluded import liberalization in the forseeable future, was submitted against the background of a decision at last year's Hakone conference to allow U.S. manufacturers to capture up to 50% of the domestic market with computers either built in Japan by IBM or imported by other companies. Liberalization of capital investment of up 50% for the manufacture of computers will take place in August 1974 and of imports of know-how and software related to computer hardware will take place in July 1974.

. . . but ask for subsidies in return

In return for going along with the liberalization, the industry representatives asked for massive infusion of government money to make the industry competitive by the deadline. **For development of computers, the industry representatives asked for a subsidy of about $271 million** during the fiscal years 1974 through 1976, in addition to the $131 million already planned for the fiscal years 1971 through 1974. They also want a subsidy that will give Japan Electronic Computer Co.—the government-sponsored joint venture of the six computer makers that buys computers from manufacturers and rents them to users—availability of $231 million at a rate of 3.5% to purchase computers. Although JECC now gets part of its funds from government banks at interest rate of 6.5%, its average cost for operating funds is in the order of 8%. **The industry also asked for $38 million for development of software and $27 million for development of integrated circuits.**

Paris show will be scene of remote CAD demonstration

The Paris Components Show will be used by Thomson-CSF for the first public demonstration of its new remote computer-aided design service. **During the show's April 2-7 run, the company will have a functioning terminal at its stand** connected with the CAD facilities that its semiconductor division has built up in the Paris area and at its plant near Grenoble. The service will first be offered to engineers within the Thomson Group, but by next October the company plans to have terminals in the design offices of outside companies. **The Salon des Composants this year will be followed by an instruments and control show, which starts on April 11.**

British IR imager uses yellow LEDs

Hawker Siddeley Dynamics Ltd. has nearly completed the prototype of a battlefield infrared imager that **combines high resolution with a wide field of view,** qualities that are normally irreconcilable. For detection, it uses a Mullard cadmium-mercury-tellurium 30-element vertical array. **Each element feeds a diode in a similar linear display array, which is**

made of high-brightness yellow-emitting gallium phosphide diodes supplied by Plessey Co. Mounted in a rotor, 11 germanium corner-cube prisms scan the scene across the detector array. Each prism is angled to place its 30-line image under the preceeding 30 lines, producing a 330-line picture. In the same rotor, 11 glass prisms turn the instantaneous LED output into a binocular lens image approximately 2 inches wide by ⅝ in. deep, with resolution reaching about 1,000 lines.

High performance depends critically on three factors, Hawker Siddeley Dynamics men say. First is high-brightness LEDs, because each diode must traverse the image width 11 times, so fast the eye sees only a complete frame. Second, dense packing of the prisms in the rotor is needed to cut dead time between scans. Third, an HSD technique, using bucket-brigade delay lines, integrates instantaneous detector response and response at two preceeding instants. **This technique, in effect, diminishes detector element size in relation to wavelength and doubles resolution.**

Sony to make TV sets in Britain

Sony is moving production of color TV sets for the British and possibly some Continental European markets to a new plant at Bridgend, South Wales, which Sony hopes will be operating within a year. The plant will **turn out about 5,000 Trinitron 18-inch receivers a month initially, possibly rising to 10,000 later.** Last year, Sony imported about 35,000 Sony sets into England. The company says it hopes to import only tubes and a few very specialized components from Japan, though local component shortages may affect this. It will also use only a handful of Japanese on its staff.

Lufthansa's computer will do more than just book seats

Lufthansa, the West German airline, has put into service what it says is the most advanced seat-reservation system in Europe. **At the heart of the $25 million system are two Univac 494 computers, to which more than 1,200 terminals** will be connected before the end of this year. Terminal locations are at Lufthansa offices in 19 German cities, in several other European cities, and in New York. By 1975, the two computers at Frankfurt will tie together 1,500 terminals. In addition to its job of handling seat reservations, monitoring capacity status, and giving information on connecting flights, **the system also will be used in flight-path planning, for computer-aided instruction of airline personnel, and as a Telex exchange system.** The computers will later be programed to give details on hotels, currency rates, and other passenger services.

Japan looks to buy two Univac radar systems

An impending order from Japan for two advanced radar-terminal systems from Univac is part of Prime Minister Kakuei Tanaka's contribution to the defense of the dollar. The sale will be to Mitsubishi Electric Corp., which will be prime contractor, and there is good chance that Mitsubishi will supply the digitizer and the displays. The radar units will probably be supplied by Tokyo Shibaura Electric Co. Until Tanaka decided to help in defending the dollar, the Japanese government was in the process of evaluating a prototype system developed by Mitsubishi Electric and using a Toshiba radar. **The two terminal systems to be ordered will be installed at Haneda, which is Tokyo's international airport, and Itami Airport at Osaka,** by end of fiscal 1974.

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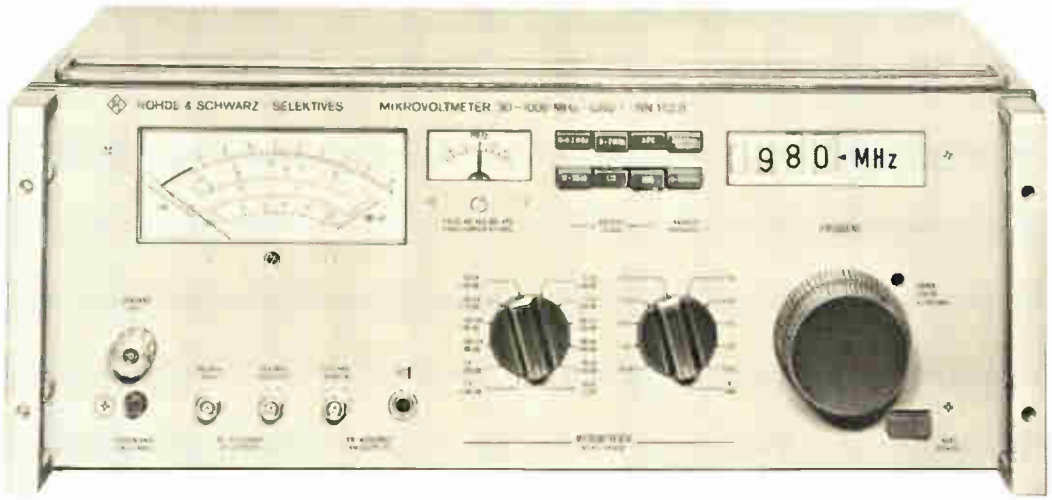

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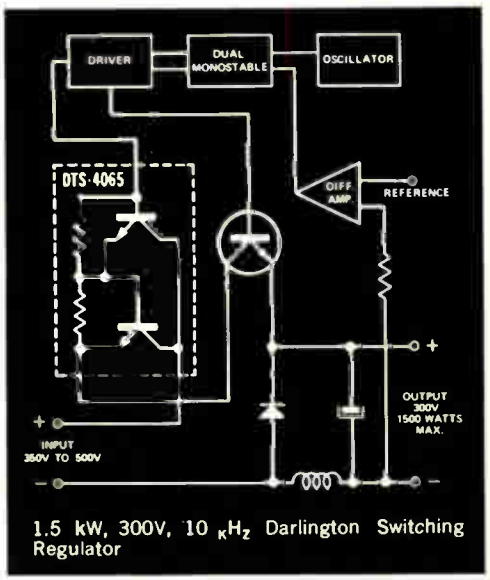

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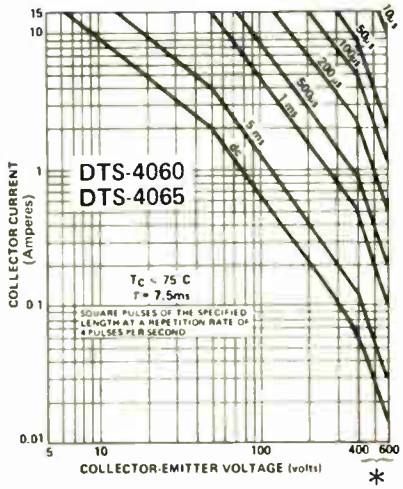

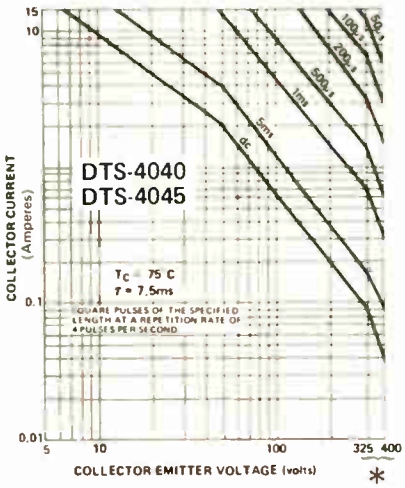

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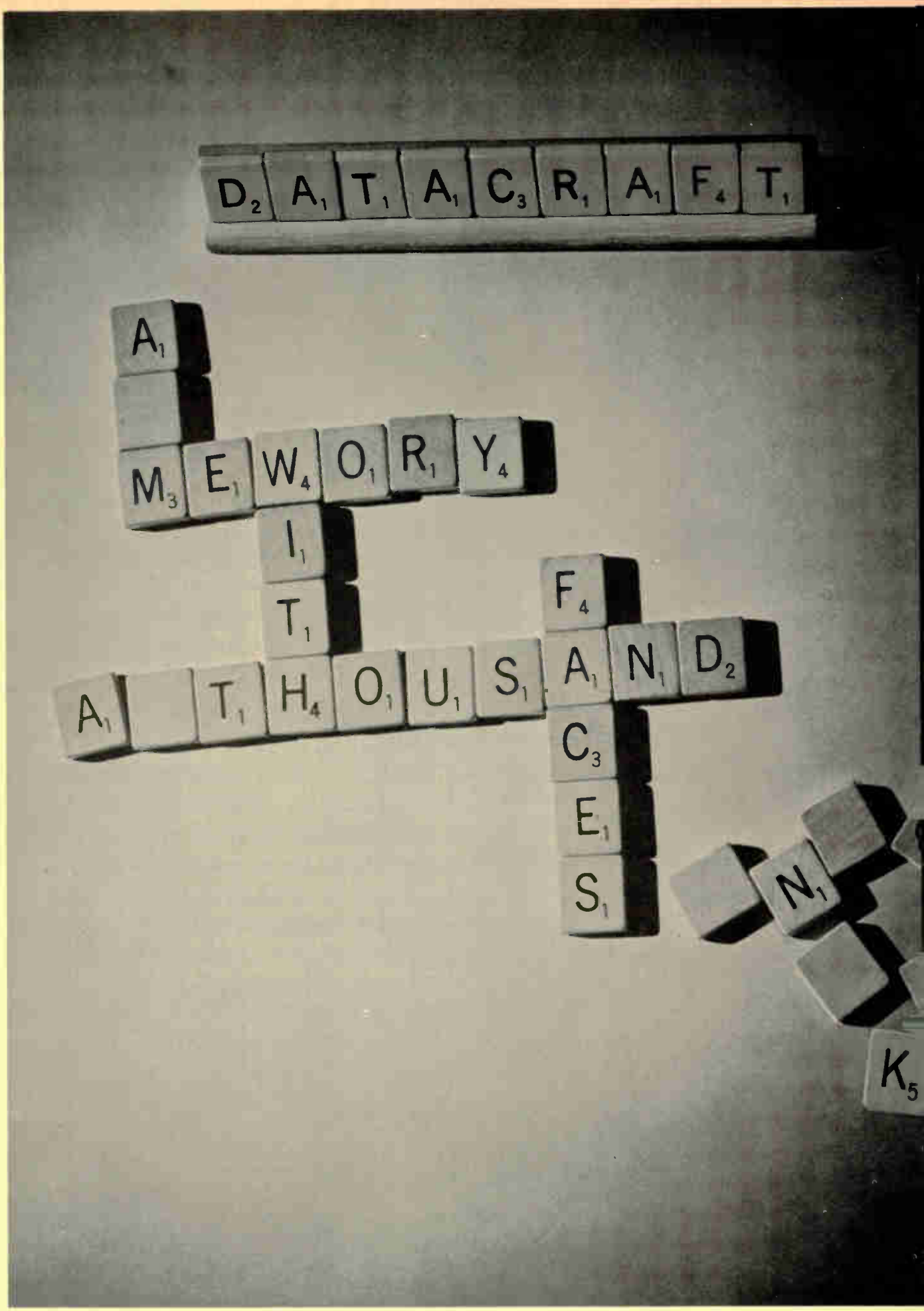
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LED displays mount new attack

Manufacturers bring out larger digits and lower prices in attempt to displace fluorescent, gas-discharge rivals from desk calculators

by George Sideris, San Francisco bureau manager

The markets now dominated by fluorescent and gas-discharge panels are coming under attack by manufacturers of seven-segment, light-emitting-diode displays. In the last few weeks, the three companies in the vanguard—and at least three more are about to follow them—have proclaimed new large-digit designs and immediate price cuts. They're also vowing to meet the $1-a-digit price of panels in high-volume production.

All the companies involved credit the present price cuts to design improvements. But all are also hoping to entice large orders from desk-calculator producers, who require an estimated 30 million to 50 million digits a year. In fact, the $1 target assumes that calculator sales will push volume up enough to warrant extensive automation of assembly lines, since all the designs require assembly of seven or eight chips at least.

Cheaper, easier to read. But even if desk-calculator sales do not soar, the new LEDs should sell widely for point-of-sale equipment, industrial control panels, electronic instruments, and television channel indicators. They are not only a dollar or more cheaper than the widely sourced MAN 1 type of display made by Monsanto and used in instruments since 1969—they are also easier to read.

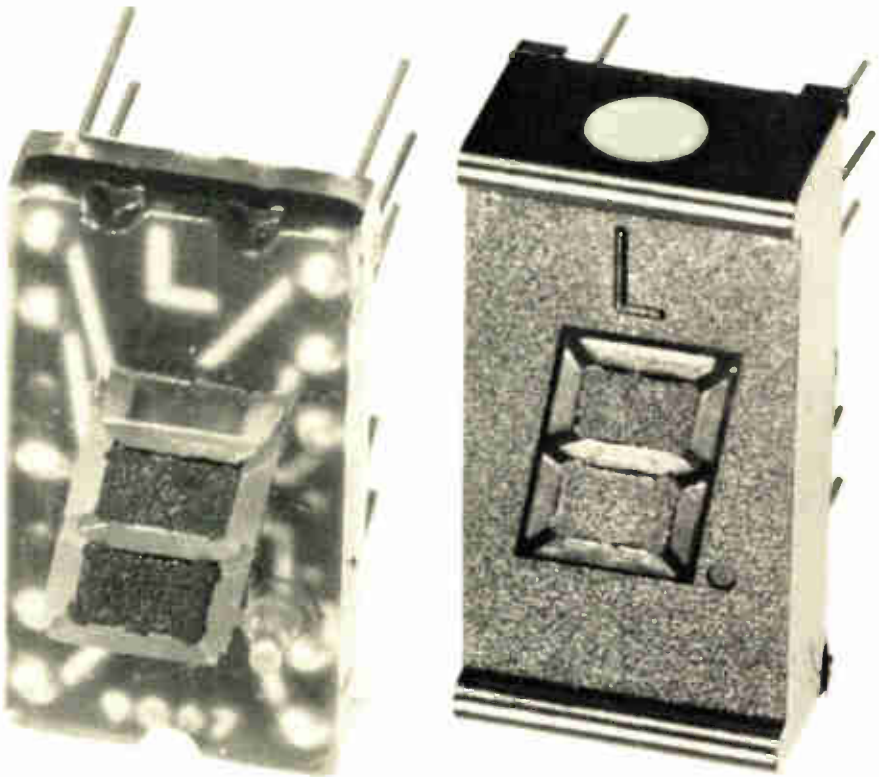
They borrow a design idea from gallium-phosphide displays. Instead of the usual multidiode bars of red-emitting gallium arsenide phosphide, a single, tiny chip of the material shines behind a plastic body, so that it forms a softly glowing segment on the display face. The technique conserves the amount of semiconductor needed, and so reduces semiconductor costs by as much as 85%. It also allows the chips to be diced from the wafers processed for single-diode LED indicator lamps. Moreover, digits can easily be a quarter to a third of an inch high, as compared with MAN 1's 0.19 in.

With bar-segment costs drastically reduced, small-quantity list prices have plummeted as much as 40%. The large-quantity, negotiated-price range appears to be shifting to $1.50 to $3 a digit, compared with the previous range of about $2.50 to $4 a digit. All the companies with new designs expect that high-volume prices should bottom out at about $1 this year or next.

The vanguard. The companies in the lead are all neighbors on the San Francisco peninsula—Fairchild Discrete Products group, Litronix Inc., and Monsanto Electronic Special Products division.

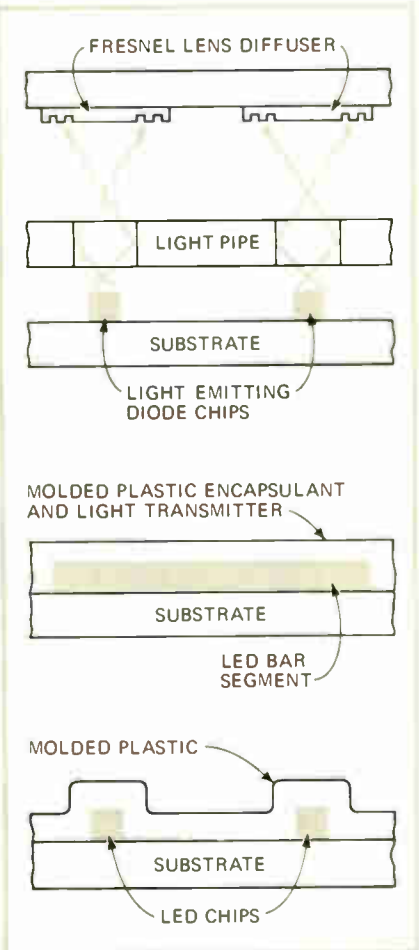
Fairchild has been using automated production equipment since last year to assemble the FND-70, a ¼-in., common-cathode design. The chips are bonded to a metal lead frame, much like other plastic-packaged semiconductor devices. Thomas Hinkelman, marketing manager of the Fairchild group,

Light cap. Litronix, in its new Data-Lit line of displays, has mitered corners of the segments. Digit fits under black plastic cap that hides substrate, provides contrast.



says the price will drop this month to $2.50 in 1,000-unit lots and $1.85 in 10,000-unit lots. It previously listed at $3.60 and $2.90, which, Hinkelman says, was on the edge of being competitive with panel displays. In LED displays, lower drive-circuit and power-supply costs are said to help offset the higher cost per digit.

Perhaps unaware of Fairchild's pricing plans, the other leaders have been introducing new designs near the old FND-70 price levels. Monsanto, for one, formally introduced its MAN 7 at $4.95 (100 to 999 units) and reduced the MAN 10 from $9 to $5.65. Both are ¼-in. versions of the common-anode MAN 1. They use reflector-like light pipes to collect the light from the chip and spread it over diffuser segments. The assembly consists of a ceramic substrate for the chips and two molded plastic parts. The MAN 10 is brighter than the MAN 7. Richard Greene, Monsanto product manager, expects the list price to fall about 60% "at maturity."



Spreading the light. Three methods obtain bar-shaped segment: reflective light pipe and Fresnel lens or diffuser (top); plastic molded over bar (middle); shaped projector over chip (bottom).

Data-Lit. Litronix, which likes to needle Monsanto (one of its ads listing MAN-type LEDs was headlined, "Bless you, Monsanto"), will introduce the Data-Lit 707 and Data-Lit 704 this month. They are 0.3-in. competitors for the MAN 1 and the common-cathode MAN 4. Besides being larger, they are cheaper at $3.25 (100 to 999).

The Super-Lits cost less than "MAN displays," says David Laws, marketing manager for industrial displays, because Litronix molds the diffusers around each chip instead of assembling them. The molded segments also have mitred corners, like picture frames, making the gaps between segments hardly noticeable. A third advantage claimed for the molded design is that the display is legible with a drive current of only 5 milliamperes rather than the usual 10 to 20 mA. The reason is that light transfers more efficiently from GaAsP to plastic than from GaAsP to air, so the diodes appear brighter with a low-current drive.

Laws checked out the prices of all the popular display devices and all the drive circuitry each requires. At distributor prices for 100 parts, the Super-Lit 1 costs a total of $5.85 a digit, versus $7.75 for planar displays and $5.70 for incandescent displays made in Japan.

Reinforcements. Texas Instruments and National Semiconductor both plan to introduce MAN 1 replacements this summer. While TI hasn't set the list price, Ian S. McCrae, optoelectronics marketing manager at the Dallas headquarters, says that the new part will sell for $1 a digit in high volume by the end of the year.

Paul Pagnini, his counterpart at National in Santa Clara, Calif., intends to list the NSN-4 at $3.60 in 1,000-unit lots. National plans to use multidiode bars at first, rather than chips, because it feels it can "squeeze out" costs from the basic MAN design.

Opcoa Inc., of Edison, N.J., hasn't changed its designs—it pioneered small-chip construction several years ago because it uses the very expensive gallium phosphide. However, Sanford Sussman, vice president, promises price cuts for green-emitting displays. Green digits will drop to $2 or less in high volume this year, he says.

Opcoa's standard digits are ⅓-in. high. The larger size and the better legibility of green will make them a better buy, he argues. At present, Opcoa lists red digits at $5.15, green at $8 and yellow at $8 to $9.50, but Sussman says the prices will be adjusted to meet competition.

Counterattack. Panaplex II, a fluorescent panel display that Burroughs Corp. makes in Plainfield, N.J., by thick-film printing methods, is said by most LED manufacturers to be the toughest competitor in the desk-calculator market. It sells for $1 to $1.10 a digit in high volume, but requires high-voltage drivers [*Electronics*, March 1, p. 97].

John Pittman, Burroughs marketing manager, seems unconcerned in the face of the LED onslaught. He likens the competition between LEDs and panels to the trench warfare between semiconductor and core memories. Each time semiconductors have seemed to be gaining ground, cores have regained the price edge, the Burroughs executive points out.

The next move by panels will probably be to enter the fast-growing digital-clock market, which will not pay more than around 50 cents a digit. "We think we can upgrade our technology to produce four-digit units at $2, but thank God we don't have to do that at the moment," Pittman remarks. He also thinks that comparisons between support circuitry costs are more confusing than illuminating. While panel voltage is high, currents are low and the power tradeoff can favor panels.

Pittman won't concede even the pocket-calculator field to LEDs. He points out that Burkey Photo Inc. of Clifton, N.J., chose 1/5-in. displays for its Keystone line of pocket calculators.

The Keystone models don't need rechargeable batteries—they run about 20 hours on four penlight cells, which cuts their power costs considerably. □

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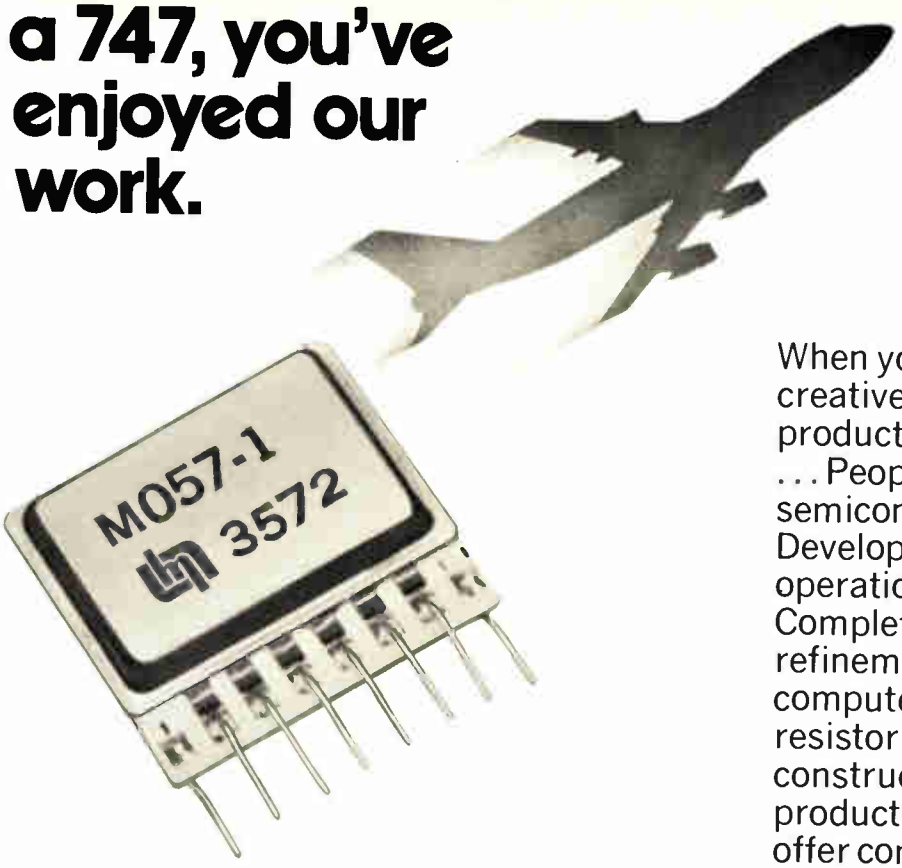

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Military electronics

Shore-integrated systems a Navy first

Electronics for the DD-963 class of destroyers are being integrated, tested in land mock-up, where they also serve as software development lab

by Paul Franson, Los Angeles bureau manager

First build the ship, then put together the electronics aboard—that's the traditional way of doing things. However, for its new Spruance destroyers, the DD-963 class, the Navy has not only borrowed the aerospace system concept for design and construction, but it is following the aerospace industry's practice of integrating and testing hardware before it's put on board.

The 30 ships are being procured under a complete package contract from Litton Industries' Ship Systems division, which designed them. Litton is also handling program management for all systems (except some weapons), is building the craft, and is responsible for their performance. Construction at Litton's Ingalls shipyard in Pascagoula, Miss., is still in its early stages, but the extensive electronics complement is already being tested while serving as a laboratory for software at a shore station near Los Angeles.

This must comfort the Navy, for two reasons. First, electronics accounts for 45% of the $2.8 billion to be spent for the ships. Second, ship construction itself, using modules in a production line technique new to the Navy, is causing some nervousness at the Pentagon and in the Congress. The same concept is also being used for five landing helicopter assault (LHA) ships, also being built by Litton with modular techniques, and that program is beset by deadline and cost overrun problems.

Electronics for the DD-963 through DD-992 should be less controversial. Prime electronics contractor to Litton ship systems is Litton Industries' Data Systems division, Van Nuys, Calif. In the words of D.G. Somerville, who, as manager of systems integration and analysis for ship electronics systems, works at the shore station in Culver City, about 70% of the electronics systems are off the shelf.

"They're existing products with known general characteristics, but they haven't ever worked together," he says. "We have to check them out, make interfaces, and then develop the software." Alluding to the old practice of doing the work aboard ship, Somerville points out that the Navy "hasn't ever had production at this high level—expected eventually to reach one ship on the ways per month. For this reason, and because of the complexity of the integrated systems, we had to do it differently."

Mockups. As for the shore station where the testing is going on, it includes all the hardware, with two critical areas mocked up to duplicate the arrangements aboard. Somerville says that in those two, the combat information center (CIC) and the communications center, man is the constraint, and the exact models permit the engineers to check human factors and repair capability. The two are accurate even to ceiling height and spacings, and old Navy hands would be surprised at both replicas. The communications center, for example, includes sophisticated message processing and distribution that screens incoming messages, displaying only those addressed to the ship in question. This eliminates large masses of paperwork and reduces the exposure of classified material. And the roomy CIC area, says Somerville, is the largest the Navy has ever seen. Much of the room is ticketed for growth, not just crew convenience and comfort.

Part of the highly integrated ship tactical data system will be the system-monitoring equipment that diagnoses faults in the CIC, inter-

Driver's seat. Exact model of DD-963's combat information center helps study of human factors, repair capability.

ference friend or foe (IFF) equipment, and a quality monitoring and control system for the communications center.

Litton's models are of the electronics inside the ship, but Somerville says that topside design is a major effort as well: "This is the first time that ship design has taken electromagnetic interference into account." The radio environment on a ship is staggering: "There are upwards of 60 transmitters, and 40 to 50 receivers on the ship—all with antennas, and they can interfere in many ways and modes. In the past, the Navy has simply accepted that such and such a channel was unusable with another transmitter operating. Now we're attempting to place the antennas to minimize interference and desensitization. We use computer software simulation. It's a bear of a job; you couldn't do it manually."

Related to the direct interference problems was the even more elusive rusty bolt. Rusty bolts—hardly uncommon on seagoing ships—can form diodes that mix and emit all sorts of signals when subjected to strong transmitted signals. "The Naval Electronics Lab is trying to eliminate this problem on existing ships, but we're trying to design it out."

One reason for the shore station is, of course, to make sure the ships work as a whole. "The error penalty is quite prohibitive," says Somerville. "We have to test and validate as much of the total sensor weapon chain as possible in the shore station."

An important question for an installation of this magnitude is whether it's worthwhile. Somerville points out, "If it catches even one problem that could hold up production for even a few weeks it could pay for itself. This is a true production line, and one ship can't proceed until the first moves on. There's no question that we've found problems and eliminated them." □

At Pascagoula . . .

Compared to the flap between the Navy and Litton Industries over how much the Naval Ships Systems Command should pay Litton's Ingalls Shipbuilding division for five Landing Helicopter Assault (LHA) ships, things are relatively better on the DD-963.

Litton says it will go to court, if necessary, to get another $100 million-plus it says "represents the cost of work and schedule delays caused by actions of the Navy" on the LHA program. The Litton challenge came after the Navy set a $946 million price on the program, including a $795.3 million ceiling for the ships and approximately $151 million to cover the impact of inflation. Litton says it made Navships a "final offer" of $1,056 million.

The DD-963 program, on the other hand, "is currently ahead of schedule and within contract cost projections," according to Litton. However, the General Accounting Office anticipates some slippage.

Government

Multinationals skimp on R&D

First analysis of their impact also blames Kennedy Administration for lower tariffs that led to consumer electronics "runaways"

by Ray Connolly, Washington bureau manager

The first major study of multinational corporations by a Federal agency says that electronics multinationals are reluctant to spend much on research and development. Yet these companies, with their operating bases in many countries, are a distinct asset to the American trade balance—as are the other multinationals that use high technology.

These are two of the more significant—and, to some, unexpected—conclusions by the U.S. Tariff Commission in its 930-page analysis, prepared for the subcommittee on international trade of the Senate Committee on Finance. The study, in a business area that is coming under increasing scrutiny by Congress, also contains the first official acknowledgement that the U.S. consumer-electronics manufacturing capability departed for offshore plants, not because of multinational activities, but because the Kennedy Administration negotiated lower tariffs on consumer products. This was accomplished despite warnings by domestic manufacturers that rising competition was coming in the 1960s, notably from Japan.

Offshore rush. "Prior to the Kennedy Round negotiations," reports the commission, "many electronics producers had insisted that rising imports represented a strong potential threat to their domestic operations. Significantly higher duties would have been necessary to blunt this threat, whereas the Kennedy Round ultimately lowered the relevant tariff rates. When imports began to soar by the mid-1960s, the affected U.S. companies began moving their electronic assembly plants to Mexico, Hong Kong, and Taiwan (or making arrangements with Japanese producers for domestic-label imports) and shipping the products back to the United States."

What neither the policy-makers nor their critics foresaw, says the study, was the extraordinary acceptance of foreign-made goods by U.S. consumers, the ability of some low-wage countries to absorb high rates of plant automation and rapidly increase productivity, and the extent to which some foreign Governments were willing to subsidize production for export by foreign investors. For the electronics industries, in particular, there was the lesson that "relatively unskilled labor can be combined with fairly sophisticated equipment." This, says the report, contradicts the stereotyped notion of "high technology as a process in which highly skilled labor must always be available."

The consequence of this "runaway" in consumer electronics, says the study, was that "by 1970, total imports would account for about 90% of all U.S. domestic sales of household radios, 40% of black-and-white TV sets, 15% of color-TV sets (whose imports only began around 1965), and 35% of phonographs—with U.S. production of all these items still trending strongly downward."

Broad view. After laying the blame for the loss of a domestic consumer-electronics manufacturing capability at the doorstep of the Kennedy Administration, the commission study lays out its numbers to make a strong case in favor multinational corporations, or MNCs.

- "The MNCs' direct impact on U.S. trade in high-technology goods has been strongly favorable and much superior to the performance of non-MNC firms in the high-technology industries"—such as electronics—"whether it involves computers, consumer goods, components, or commercial aerospace products."
- "The direct contribution of the MNC has been more favorable to U.S. trade performance in the high-technology sectors," such as elec-

That low R&D

Why do the electronics multinationals come in so low in R&D spending? The Tariff Commission report offers two answers:

"First, the electronics industry has an unusually low level of concentration; many small firms, rather than a few large and dominant ones, characterize its organization. Thus, much R&D in this industry is carried out by small firms which do not have significant foreign direct investment and hence are not MNCs.

"Second, the industry as a whole is characterized by extremely fast rates of diffusion of technology among competing firms. Proprietary control of a new bit of exclusive technology is an ephemeral thing in this industry. Hence, it is possible for firms—including the MNCs—to include newer technologies in their products without incurring the R&D costs of developing them. This factor is especially relevant in the case of consumer products, which often incorporate technologies originally developed for space, military, or industrial applications."

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tronics, "than in either the medium- or low-technology industries."

- "The indirect effects on U.S. trade produced by the MNCs' affiliates sales abroad probably were small, relative to the size of the affiliates' total new foreign sales."

Taking export and import figures during the five-year period from 1966 to 1970 for multinationals in 24 industries, the Tariff Commission concludes that the MNCs generated $3.4 billion more in exports than in imports for the period, plus another $415 million in indirect income through the sales of foreign affiliates, for a net U.S. trade gain of more than $3.8 billion. Four industrial categories containing large proportions of electronics operations were among the 16 that produced probable net gains for the nation's trade balances, while one—household appliances and miscellaneous electrical machinery—was among the group of eight industries that generated net losses over the five years. Such operations generated a net trade loss of $351 million, all but $5 million of it produced by imports from offshore facilities.

Topping the commission's list of 24 categories was "nonelectrical machinery, except farm machinery"—the listing under which the Government inexplicably continues to carry computer equipment. Multinationals in that category generated $1.4 billion in favorable trade balances during the five years, all but $26 million of it in a direct export surplus.

Instruments, a catch-all category for electronic and nonelectronic devices, ranked ninth with a net gain of $203 million. Electrical equipment and apparatus came in 13th with a net gain of $105 million as an export surplus of $303 million offset a $198 million negative balance of foreign affiliates in trade with the U.S. Furthermore, electronic components, radio, and TV ranked 14th with a net gain of $82 million after a $92 million export surplus offset a $10 million negative balance that was rung up in trade with foreign affiliates.

Reasons for the apparent parsimony of multinational electronics manufacturers surface in an extensive section of the study entitled, "Technology, R&D, and the Multinational Firm." In its look at multinationals' R&D, the study found that "nonmultinational firms hardly count." Though MNCs averaged only 52% in the study's tables on R&D investment, the report notes that it would be higher—about 80% if the average was not "pulled down by a few exceptionally low numbers in a few industries." Those industries are aerospace and electronics.

Transportation equipment, for example, is an area where MNCs had only a 37% share of the 1966 R&D outlay of $6.8 billion. "The aggregate figure for this industry," explains the study, "is heavily weighted by outlays in the aerospace industries, which have few multinational connections."

Electronics, however, is heavily multinational. Nevertheless, the study turns up "the exceptionally low (30%) share of total R&D spending accounted for by the MNCs in the electronics subsector of the electrical-machinery industry. It contrasts sharply with the 82% share of the MNCs in the rest of the industry."

Despite its effort of more than a year, the commission found its numbers fuzzier when it came to measuring "technological intensity"—the relationship of R&D to industry size and a set of numbers it believes is "essential for making inter-industry comparisons of R&D performance with other variables," such as trade or investment performance.

After measuring the MNCs' stocks of foreign and domestic capital against R&D outlays for different industries, the study concludes that "there is a feeble inverse relationship between the rankings in terms of technological intensity and their rankings as domestic investors. The higher-ranked industries in technological terms are the lower-ranked ones as domestic investors, and vice versa for the lower-ranked R&D spenders"—such as the electronics industries.

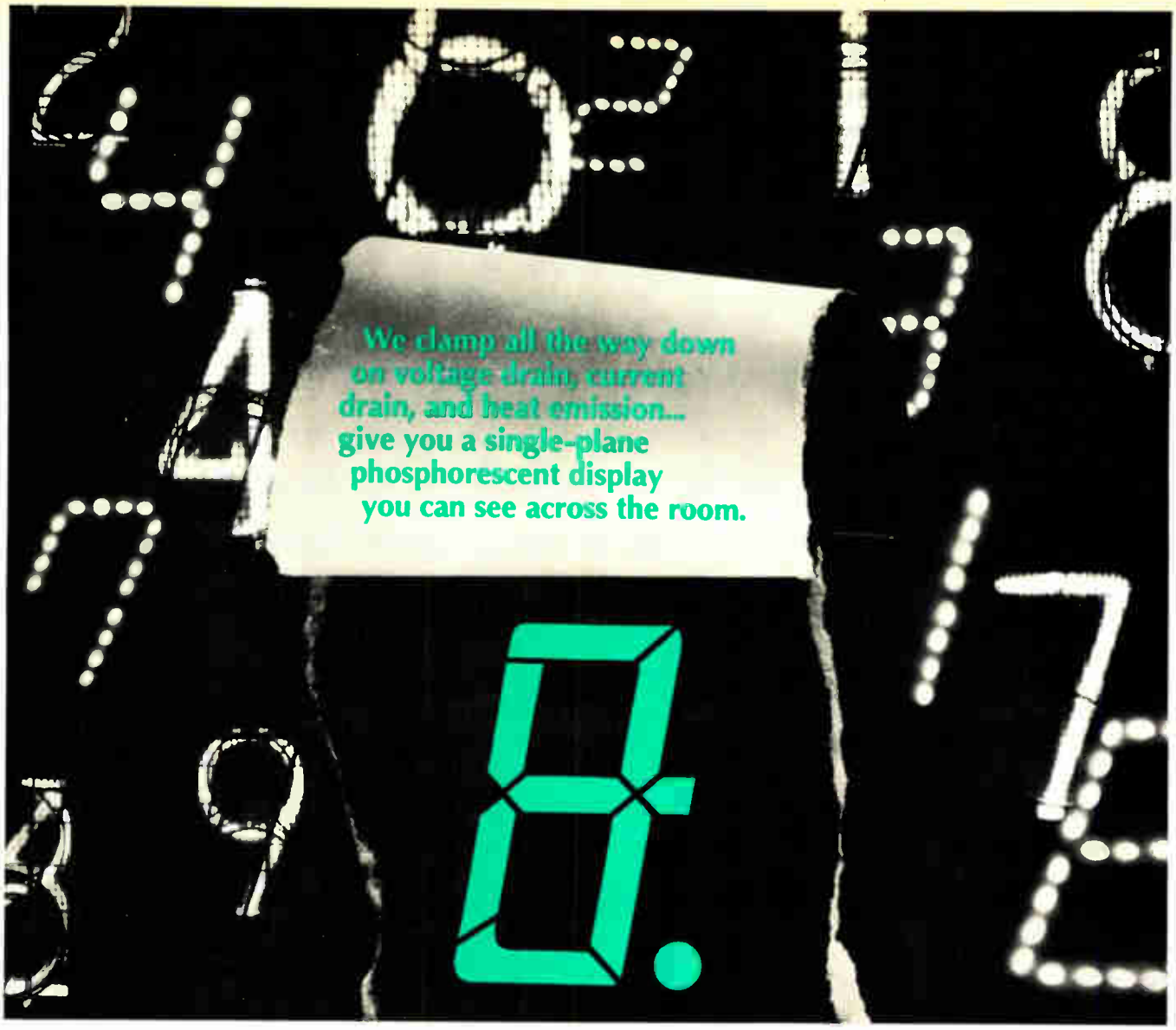
"Technological muscle and investment," the study therefore concludes, "do not necessarily go together as economic phenomena, and they may actually move in opposite directions. Moreover, some industries, such as electronics, get by on relatively little capital, while they depend heavily on technology."

The complete study is available from the Superintendent of Documents, U.S., Government Printing Office, Washington, D.C. 20402. The price is $9.25, postpaid. Dated February 1973 and bearing stock number 5270-01708, the report's full title is "Implications of Multinational Firms for World Trade and Investment and for U.S. Trade and Labor—a Report to the Committee on Finance of the U.S. Senate and Its Subcommittee on International Trade." □

Not much transfer?

One aspect of electronics—the transfer of technology overseas—puzzled the Tariff Commission. Its report observes that American manufacturers either are not transferring much or not getting paid much for it, since electronics "ranks much lower as royalty and fee recipients than as R&D spenders" in comparison with other American multinational operations, such as food corporations.

The anomaly suggests to the tariff group that "(1) the data on international payments for technology are but an imprecise measure of the actual amounts of technology that have flowed abroad in the past; or (2) to the extent that the figures do accurately measure past flows of technology, some of the important high-technology industries appear to have transferred less technology abroad than is commonly supposed. Certainly, if such high-technology as electronics had transferred significant amounts of technology abroad before 1966, the royalty figures for that year indicate rather small payments for it, whereas the food processors seemed to be profiting rather handsomely for teaching affiliated or nonaffiliated foreigners how to accomplish the technological marvels of putting soup in a can, spicy rice in a box, or vegetables in a frozen package."



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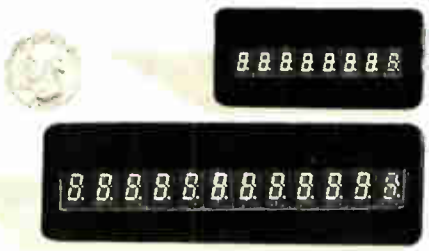

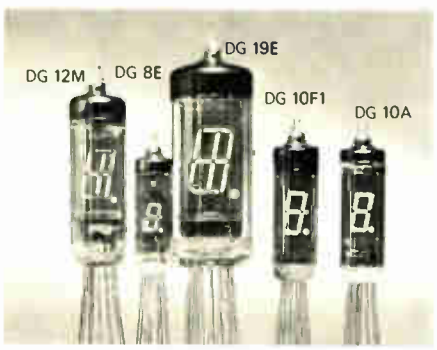

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Electronics abroad

Selling to Peking is a challenge

First American executives to do business in China find their opposite numbers are knowledgeable and cost-conscious

by Alfred Rosenblatt, New York bureau manager

American makers of aerospace equipment and electronics are learning that potential customers in the People's Republic of China are anything but easy marks. That's the opinion of American executives who have had a taste of doing business in the most populous nation in the world since U.S.-Chinese relations have eased.

The first reports are that, for all their seeming inexperience with high-technology equipment, the Chinese are far from uninformed. Rather, the consensus among the American engineers and executives who have trekked to China to prepare for President Nixon's visit last year and those who have followed is that their Chinese counterparts are hard-driving bargainers who are extremely knowledgeable about the equipment they're out to buy.

"As businessmen, the Chinese are damned good in every sense of the word," declares Robert J. Angliss, an executive vice president of RCA Global Communications Inc., New York. "They know their subject and are quite capable of discussing the technology and making the choices between different types of equipment. And they look at both their long- and short-range needs."

Angliss was part of the RCA Globcom team that sold the Chinese two satellite-communications earth stations last year. The first was a $2.9 million transportable station with a 33-foot antenna dish. It was set

up in Shanghai in February 1972 to provide live television transmission via the Intelsat IV satellite over the Pacific during President Nixon's visit to China, as well as to provide telephone and telegraphic services. Then last August, Globcom signed an additional $5.7 million contract to change to a 98-ft dish at Shanghai, and to install a new earth station with a 98-ft antenna at Peking, the capital.

Western Union International is also supplying a satellite ground station to the Chinese. This New York-based company has a $4-million-plus contract for a 98-ft station in Peking, to be subcontracted by GTE International, that will operate westward toward the Near East and Europe via the Intelsat IV satellite over the Indian Ocean. WUI won the contract because of the success of its 33-ft transportable ground station, using Hughes Aircraft Co. equipment, that was set up temporarily in Peking for President Nixon's visit.

These have been the major electronics sales to China, but more are expected. For instance, the Boeing Co. is negotiating for the sale of 10 B-707 jet liners, valued with spare parts and a complement of avionics at around $150 million.

The Hewlett-Packard Co. has been there also. "We wrote and asked them if we could come," says a spokesman for the Palo Alto, Calif., corporation, "and they invited us." No sales have resulted, although negotiations have not been concluded yet, says international vice president William Doolittle, one of two H-P executives who made the trip to China last fall.

On the wall. Hewlett-Packard's William P. Doolittle poses with Chinese guides on the Great Wall of China

In China, the American firms dealt with the China National Machinery Import and Export Corp., which is a trading organization that serves as an intermediary between Chinese user groups and outside suppliers. Under its purview are not only telecommunications gear, but such items as tractors

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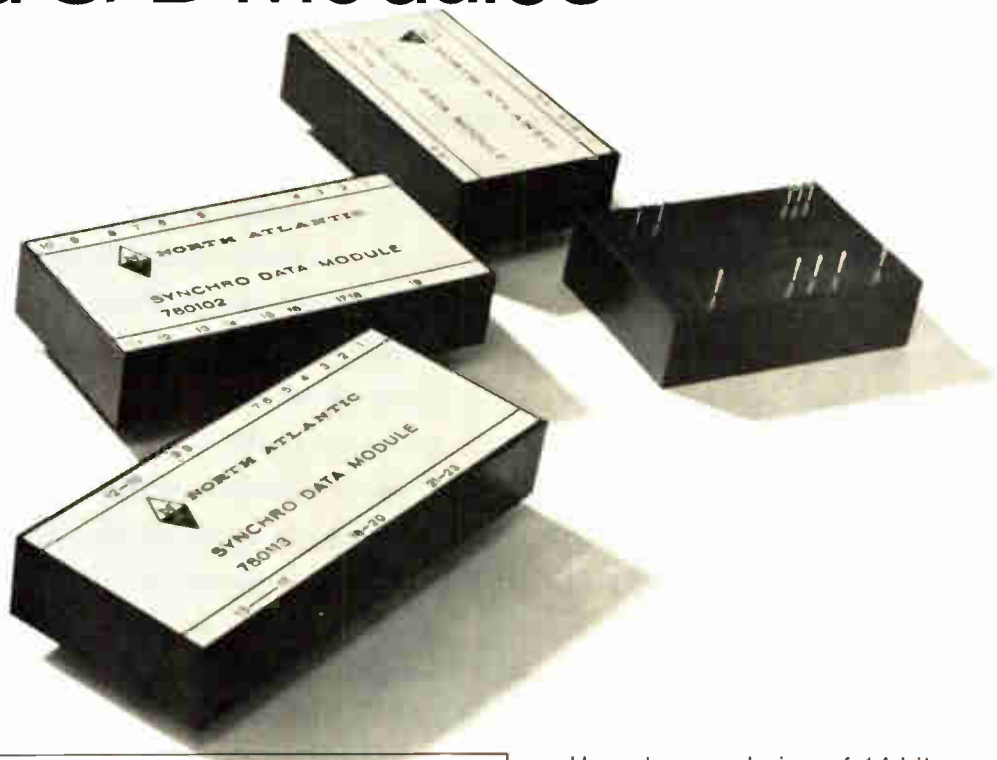

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and electric-power generators. China has at least half a dozen other major trading corporations dealing in such other major commodities as foodstuffs, metals and minerals, and pharmaceuticals.

Knocked down. For the earth stations, China preferred joint construction with the Americans, rather than turnkey systems. Western Union International, for example, sends the engineering drawings for the antenna dish and buildings, and the Chinese handle the construction. The antennas themselves are put together in the U.S., then are disassembled and shipped. Says RCA Globcom's Angliss, "I'm just as happy to supply the station this way; local talent is cheaper."

Apparently the Chinese had offers for earth stations from many countries, according to the American suppliers, who saw proposals from Japan, the United Kingdom, West Germany, France, Italy, and Canada. With all that material to study, it's not surprising that the Chinese not only seemed to know exactly what they wanted, but had firm ideas about what it should cost. "They knew almost to a penny where the break-even point goes," reports WUI's Thomas S. Greenish, executive vice president. Are the Chinese good bargainers? RCA Globcom's Angliss replies by rolling his eyes skyward and repeating the question sotto voce. "They certainly are," he concludes.

Hughes Aircraft Co. representatives are similarly in awe of the bargaining capability of the Chinese. The Chinese counter-offer to Hughes' initial price was 50% of what Hughes asked, says Louis A. Greenbaum, manager of satellite ground systems at Hughes Aircraft's Commercial Satellite division, El Segundo, Calif.

Must have minimum. Greenbaum says that no one leaves China feeling he got the deal he wanted. "Any negotiator must know in his head his absolute rock-bottom price; otherwise he may find himself going back home for more instructions."

What are the Chinese engineers like? Uniformly, the Americans who have been there report them to be very sharp. They may lack practical experience, says Robert TinWin, satellite systems manager for RCA Globcom, but they have read an enormous amount and were very knowledgeable.

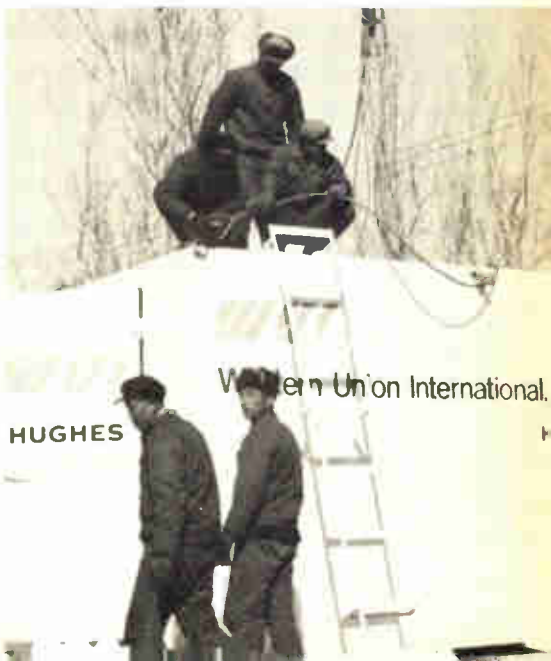
"Better make sure you're well prepared when you make a presentation," TinWin cautions. "They'll pop questions at you about virtually everything." He praises the ability of the Chinese technicians, as well. Wiring in the equipment he saw was "beautiful," and although the workmen are not up-to-date in technology, the telecommunications equipment they use is operated and maintained very well. The Chinese have been operating the earth station in Shanghai since March 1972, and they're doing an extremely competent job, he states.

"And when repairs must be made, the Chinese try to replace the component instead of the module or circuit board, which we would try to replace here," TinWin continues. "They're asking for spare components—transistors and resistors—rather than for modules. They want both to save money and to find out as much as they can about the equipment."

What's the best way to begin dealing with the Chinese? It will not come "automatically or by happenstance," says RCA Globcom's chairman Howard R. Hawkins. The traditional hard-sell or attempt to make a quick and sharp deal will not work.

Contracts tend to be short, which pleases engineers more than con-

Putting it up. Chinese workmen assemble WUI-Hughes earth station.



tract writers, a Hughes man points out. RCA's contract for the first Shanghai station covered only one-and-a-half pages, says TinWin, "We shook hands and agreed to do our best," he recalls. "Any disputes were to be settled by a friendly negotiation between the parties."

Take cash. As for traveling in China, Greenbaum advises anyone going there to take "a big bag of cash or traveler's checks." Credit cards seem to be out. And be prepared for elaborate doses of cordiality and friendship, the American visitors agree. The Chinese seem to show much greater hospitality than the Americans have experienced elsewhere in the Communist bloc of countries. Food is good, and living accommodations are inexpensive and excellent—$4 or $5 for a single room in a fine hotel.

But there are some words of caution regarding the seemingly boundless vista of the Chinese market. The U.S. State Department, for one, is not at all clear yet about what American electronic gear to allow into China nor are the Commerce and Defense Departments. Thus, the problem is that Washington tells the hopeful exporter to submit a list of what he has in mind and wait for a ruling—but the Chinese want a list of what they are permitted to buy. And the only guideline vaguely bans strategic materials or anything that has potentially strategic value. In any event, get in touch with Rauer Meyer at the Office of Export Control, Bureau of East-West Trade, Department of Commerce.

More to come. As for the Chinese themselves, they appear to have set top priorities to upgrading only their telecommunications and transportation facilities. There is, for instance, no instrument-navigation equipment on planes or in airports; bad weather keeps aircraft on the ground. Although these could be sizable markets, China is limited in her foreign-exchange resources, points out Hewlett-Packard's Doolittle, who predicts that China will develop into an "interesting market" for the U.S. electronics industries—"not overnight, but over a long period of time." □

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"6,000 man-hours convinced us."

Ben Franklin, Manager, Equipment Product Engineering,
Systems Operations Division, The Foxboro Company

Ben Franklin

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74S05	Hex-Inverter (Open Collector)
74S10	Triple 3-Input NAND Gate
74S11	Triple 3-Input Positive AND Gate
74S15	Triple 3-Input Positive AND Gate (Open Collector)
74S20	Dual 4-Input NAND Gate
74S64	4-2-3-2-Input AND/OR/INVERT Gate
74S65	4-2-3-2-Input AND/OR/INVERT Gate
74S74	Dual D-Type Edge-Triggered Flip-Flop
74S112	Dual J-K Edge-Triggered Flip-Flop
74S113	Dual J-K Edge-Triggered Flip-Flop
74S114	Dual J-K Edge-Triggered Flip-Flop
74S40	Dual 4-Input NAND Buffer
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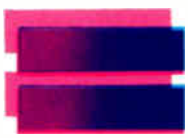
You can make the same call encompass MSI too. Signetics 74S MSI circuits offer the same volume availability as SSI, as well as the same total TTL compatibility—pin-for-pin fits with standard TTL and low-power Schottky. Ten MSI devices in stock now, with more to be announced in the next few months.



MSI SCHOTTKY 74S TTL	
74S151	8-Input Data Selector/Multiplexer
74S153	Dual 4-Input-to-1-Line Selector/Multiplexer
74S157	Quad 2-Line-to-1-Line Data Selector/Multiplexer
74S158	Quad 2-Line-to-1-Line Selector/Multiplexer (Inverting)
74S174	Hex D-Type Flip-Flop w/Clear
74S175	Quad D-Type Flip-Flop w/Clear
*74S181	Arithmetic Logic
*74S194	4-Bit Bidirectional Shift Register
*74S195	4-Bit Parallel Access Shift Register
74S251	8-Input Data Selector/Multiplexer w/tri-state
74S253	Dual 4-Input-to-1-Line Selector/Multiplexer w/tri-state
74S257	Quad 2-Line-to-1-Line Data Selector/Multiplexer w/tri-state outputs
74S258	Quad 2-Line-to-1-Line Selector/Multiplexer (Inverting) w/tri-state

*January-February announcement

Complementing 74S, Signetics 82S series MSI circuits offer significant advantages in sophisticated Schottky systems designs. The conventional TTL input circuit found in all Schottky logic, other than Signetics 82S, suffers from low input impedance.

Signetics advanced PNP structure produces significantly higher input impedance. You can drive far more devices from one output since input current is one-fifth that of standard Schottky inputs. With Signetics 82S MSI you need not worry about noise when driving long lines since, in addition to 10 PNP loads, a termination resistor can be accommodated when needed without fan-out reduction.

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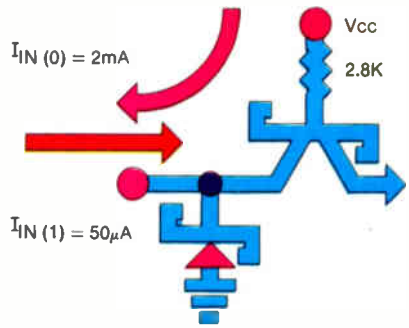
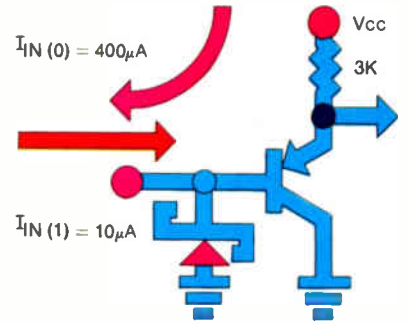
CONVENTIONAL 74S INPUT



ADVANCED SIGNETICS 82S INPUT



The growing line of 82S includes ultra high speed pin-for-pin replacements for the popular 8200 series MSI. In addition, the 82S90/91 100 MHz counter will replace the 74196/197, and the 82S70/71 70 MHz shift register will replace the 74178/179 in systems requiring improved speed performance.

The BCD arithmetic unit 82S82 replaces at least six MSI packages previously needed for the same function while at the same time operating speed is improved by a factor of 3. For BCD applications that only require addition, the 82S83 adder will replace three MSI circuits, and double operating speed. The 82S62 parity generator/checker is unsurpassed in speed.

Of course the 82S MSI line interfaces with 74S logic directly, operating in the same design environment as all 7400 circuitry but with the added advantage of direct replacement without violating fan-out rules.

MSI SCHOTTKY 82S TTL		
		SPEED
82S30/31/32	8-Input Digital Multiplexer	15 ns
82S33/34	2-Input, 4-Bit Digital Multiplexer	15 ns
82S41/42	Quad Exclusive-OR/Quad Exclusive-NOR	5 ns
82S50/52	Binary-to-Octal/BCD-to-Decimal Decoder	12 ns
82S62	9-Bit Parity Generator/Checker	17 ns
82S66/67	2-Input, 4-Bit Digital Multiplexer	15 ns
82S70/71	4-Bit Shift Register	70 MHz
82S82	BCD Arithmetic Unit	20 ns
82S83	BCD Adder	20 ns
82S90/91	Presettable Decade/Binary Counter	100 MHz

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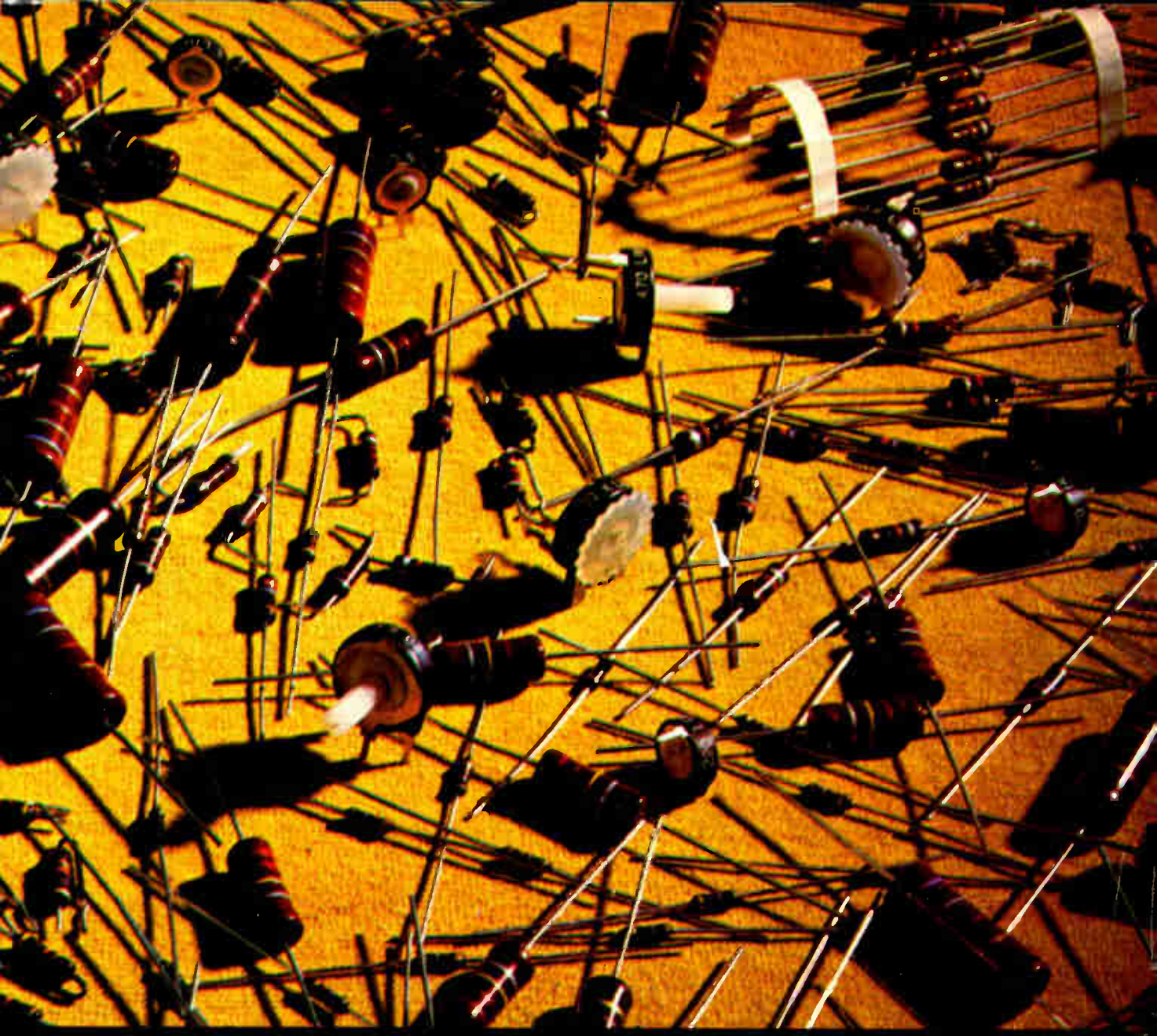

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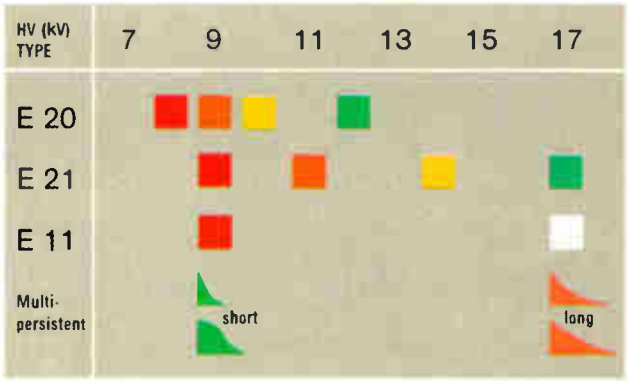

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1706

INTERCON 73 SPECIAL

What concerns these EEs

A panel of eight front line EEs spent a day discussing their lives in engineering and the impact of technology changes, industry changes, and the IEEE

Continued on next page

Representing what may be the first generation of EEs to analyze 'what it's all about,' eight engineers tell Electronics editors how their world has changed

The roundtable discussion was moderated by Electronics *executive editor Samuel Weber, who was assisted by Lawrence Curran, managing editor for news. This report was prepared by associate editor Gerald M. Walker. All photos at the meeting were taken by Dan Baliotti, a freelance photographer.*

☐ Midway through a recent meeting in which eight electrical engineers were discussing their careers, someone remarked that he hadn't realized how self-analytical EEs have become. "It used to be, when you became an engineer, you just went out and did it. Now everyone's thinking about what he's doing," he commented. All agreed that the phenomenon of the introspective engineer has indeed arrived.

Members of this group aptly portrayed all the nuances of this change. Participants in the conference, arranged by *Electronics* in anticipation of this year's IEEE Intercon, were EEs who represent a variety of electronics companies and a Government agency, all from the East Coast. (See "Who's who on the roundtable," p. 89.)

This group represents perhaps the first generation of EEs to have not only ridden the employment roller coaster through booms and busts, but to analyze the meaning of it all. Seven members of the panel have had direct experience with the uncertainties of defense/aerospace contractors. Reflecting the changing emphasis of the industry, five of the seven have chosen to move to industrial/consumer-oriented jobs.

On the whole, much of what this group concluded about the engineering career is rather gloomy, yet all are committed to making the EE career better, rather than getting out. One point now clearer to all is that electrical engineering is essentially a young man's game. This is mainly because older EEs get higher salaries than younger men, and managers tend to prefer the lower salary over the greater experience. Also, some managers do not like to have older subordinates.

For better or worse, the older an EE gets, the more likely he is to be scrapped unless he can move to the management ladder, or else become self-employed. And many don't want to be managers. Panelists agreed that industry tends to make a specialist of the EE, but overspecialization is self-defeating. However, they were unable to prescribe exactly how the engineer can diversify under these circumstances.

Impact of ICs

Prompted by the IEEE theme, "Solid State Shapes the Future" and recurring observances of the transistor's 25th anniversary, the main subject discussed at the roundtable was the impact of solid state—specifically, the integrated circuit—on front-line EEs. As it turned out, changing technology, changing career status, and the changing attitude toward the engineering establishment have become intertwined—evidenced by the fact that it was impossible to discuss solid-state technology without touching on education and, in turn, the uncertainties in earning an engineering livelihood. Furthermore, it was impossible to talk about engineering careers without bringing in the IEEE.

After a day of free-wheeling discussion, marked by a few disagreements, striking similarities in outlook, and a touch of insiders' humor, these points emerged:

- Application of ICs has simultaneously provided more freedom to the engineer and made the job of keeping up-to-date with technology more difficult than ever.
- While the principles of problem-solving may have remained much the same, the ground rules are different because much of the circuit-design work formerly done by individual engineering departments is now done by IC houses. The integrated-circuit user has relinquished the basic design procedure to the semiconductor-supplier, but not his need to keep up with IC technology.
- Uneasiness continues over the split personality of the engineer—bearing the responsibility of a professional, yet troubled by chronic job insecurity.
- As sometimes happens in just about every walk of life, the engineer may encounter a "mid-career crisis" and think about getting out. In order to progress financially, EEs frequently are forced to leave engineering work and move to management positions for which they may not be suited. Educational obsolescence with age, unique in engineering, makes this crisis more severe.
- The IEEE's move toward career-oriented activities is a good thing—if the institute pursues its mandate aggressively.
- Intercon has not been as interesting to these representative engineers in recent years as specialized group symposia and exhibits.

Changes caused by ICs

The discussion of solid state's impact on engineering quickly focused on integrated circuits. ICs have caused a fundamental change in design effort and have created new problems.

One of the disagreements concerned the effect of ICs on system costs. On the one hand, James Loy, lead engineer for Fisher Radio, Long Island City, N.Y., wondered if consumers are satisfied with integrated circuits because higher-priced service has come with increased complexity. On the other hand, Edward Keplinger, development engineer for Graphic Sciences Inc., Danbury, Conn., argued that the use of ICs has made his company's facsimile machines easier to maintain, and thus more profitable because they are usually leased to customers.

Peter Martin, senior engineer for Digital Equipment Corp., Maynard, Mass., also contended that ICs contribute to being competitive, adding that the minicomputer business is now in the middle of a price war just as

fierce as the competitive battles in consumer products. In this sense, the long-time distinction between the consumer and commercial cost approach has become blurred, he pointed out.

The panel members' disagreement stemmed from the feeling by each participant that his own need to cut costs was more vital to success than that of the others. In short, each roundtable spokesman projected a more-cost-conscious-than-thou attitude.

Among the changes brought about by ICs has been the deemphasis of basic circuit design that in the past has been the task of a majority of electronic engineers. Now this work is done by smaller cadres inside the semiconductor houses.

"There are people who still do basic design," commented Hugo Ritucci, Grumman Aerospace Corp., Bethpage, N.Y. "The people in the back room of a semiconductor company still have to put together resistors and capacitors, working out resistive and capacitive values for a particular function. These people are doing the basic design that we used to do with discrete components just a few years ago."

Peter Lowitt, PRD Electronics, Westbury, N.Y., concurred. "I think you're finding specialized circuit designers going more and more to the IC houses—a smaller group of people to do the basic design work. And the results are taken by the rest of the industry, rather than reinventing the wheel over and over in each and every engineering activity. In the manufacturing enterprises, the results of this work are taken by a different level of

Who's who on the roundtable

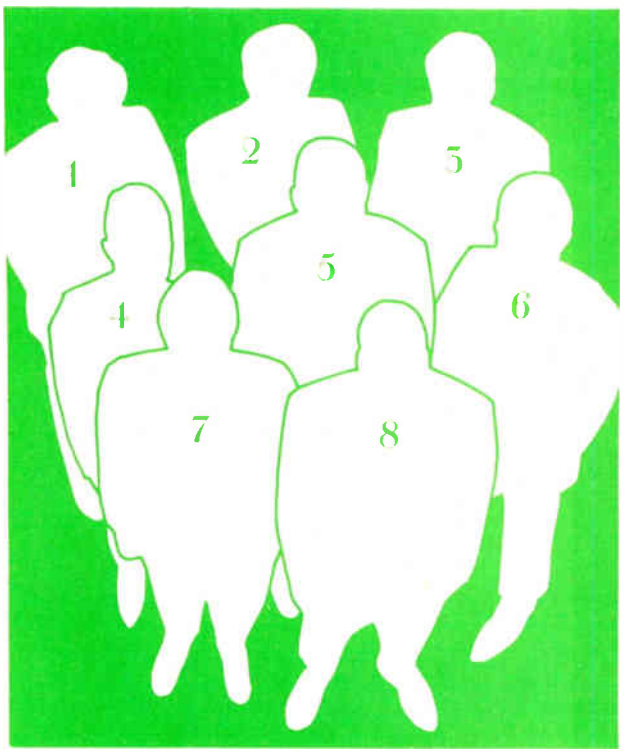
The eight electrical engineers who participated in the *Electronics* roundtable discussion all work on the East Coast. They were invited to attend and express their views strictly as individuals, and not as representatives of their companies. The group's experience represented a variety of disciplines from a cross-section of manufacturers and a Government agency.

All the panelists are experienced front-line engineers who have worked for more than one company or agency. The informal discussion was designed to allow maximum interaction of observations and philosophies and thereby to get a personal view of what engineers are thinking.

Roundtable members were:

- Gene Chao, who is head of the Microwave Acoustics section in the Electronics division of the Naval Research Laboratory, Washington, D.C. He has a Ph.D. from Stanford University, a master's degree from San Jose State, and a BS from the University of California. Before going to the Naval Research Lab in 1961, he worked on radar development in the San Francisco Bay area.
- Vernon Hills, who is manager of COS/MOS IC system applications for RCA Solid State division, Somerville, N.J., also began in defense-industry engineering. He has worked for the RCA Defense Electronic Products division, and four years ago, he moved to the semiconductor arm of the company.
- Edward Keplinger is a development engineer for Graphic Sciences Inc., Danbury, Conn., a facsimile-equipment manufacturer. He has worked for a telemetry-systems company in the aerospace industry and for two defense contractors. Keplinger has been studying for his EE degree at night school since 1964.
- Peter Lowitt is a project engineer for PRD Electronics, Westbury, N.Y., a test-equipment firm. He has worked in precision tracking radar and servo control for Sperry Gyroscope. Lowitt has a master's degree from New York University and a BS from City College of New York.
- James Loy is a lead engineer for Fisher Radio, Long Island City, N.Y. After being graduated from Brooklyn Polytechnic seven years ago, he worked for ITT, then switched to designing audio products for a company in New Jersey. When that company went out of the hi-fi business, he joined Fisher in the R&D activity.
- Peter Martin is senior engineer, Computer Logic Products, for Digital Equipment Corp., Maynard, Mass. He started as a research engineer for Veterans Administration hospitals after graduation from the University of Utah. While with the VA, he became interested in DEC minicomputers, and he applied for a job as a design engineer. He is now involved in remote-terminal design.
- Peter Pleshko, manager for IBM display systems in Yorktown Heights, N.Y., worked for defense-industry contractors from the time he was graduated from City College of New York in 1956 until he joined IBM. He received his master's degree in 1958, his Ph.D. in 1961, and is studying for a degree in business administration.
- Hugo Ritucci heads a "quick-react" design group for Grumman Aerospace Corp., Bethpage, N.Y. But before that, he organized his own company with a group of other engineers to produce microwave swept-signal sources and related products. The company went into Chapter XI reorganization in 1965, and he joined Grumman.

Outlined in the silhouette below are (1) Loy, (2) Chao, (3) Ritucci, (4) Martin, (5) Hills, (6) Keplinger, (7) Lowitt, and (8) Pleshko.



Peter Pleshko: "If you allow yourself the freedom of choosing a technology or changing a technology, it means you have to be familiar with that technology. It means you have to reeducate yourself. The user cannot afford to be unfamiliar with IC design."

engineers and used to design the end-product."

But the rapidity of these IC developments, while freeing the engineer from the nitty gritty of spinning out a circuit design composed of discrete components, has created a limitation of flexibility. As Martin explained:

"There's a problem in many large companies that find it very expensive to bring in any new family of ICs. There are instances where we would like to use C-MOS technology, but to tool up and set up inspection procedures and testing for C-MOS or for ECL, or for any new type of IC, is a limitation to the designer.

"The designer cannot have a free choice of ICs because the turnaround time for a design is anywhere from nine months to a year-and-a-half to get it out on the market. By that time, sometimes a whole new technology has developed that fits the application that you have just designed—only with two or three ICs, where you've done it with a hundred.

"Your design may be taking 5 amps of power, whereas with the new technology, it'd be in microamps. It took us about two years at DEC to bring in the 7400 TTL series. We designed the PDP-9 with all discretes and then we designed the PDP-15, which was a complement to the PDP-9, with all ICs."

More ICs than EEs can swallow

"If you allow yourself the freedom of choosing a technology or changing a technology, it means you have to be familiar with various aspects of the technology," Peter Pleshko, IBM Corp. display-systems manager in Yorktown Heights, N.Y., pointed out. "You may have to worry about diffusion process, or about cycle times. It means that you have to reeducate yourself."

Pleshko identified two levels of design work—one at the semiconductor company and the other at the IC user's company. The semiconductor-company engineer worries about how to get a particular IC family to perform optimally, and the user worries about which IC family to employ. Both have to understand the technology involved—that is, the user cannot afford to be unfamiliar with IC design.

Part of the reeducation mentioned by Pleshko and the others involves simply keeping aware of all of the new ICs announced. As Ritucci pointed out, it's a tremendous cataloging job merely for the engineer to keep track of what ICs are available. On the nontechnical side, it is more difficult to break in a newly graduated engineer today than in the past because there are so few basic tasks to assign a beginner so that he can learn the ropes. From the beginning, he's thrown into what is, in effect, a system-design problem using ICs. This, said Martin, can be very confusing and frustrating because the new EE doesn't know where to begin.

As a result, beginning engineers must attend special courses on IC application, in the same way experienced EEs had to be reeducated. Once again, the universities have not caught up to the changes in the outside world.

Historically, when transistors began to replace tubes, it was a number of years before the engineering schools developed good courses on transistor applications. Now, with the growing impact of ICs, it will be some years before the universities have adequate courses to teach IC capabilities and applications.

In the meantime, quickie courses taught by semiconductor companies and on-the-job experience must suffice. Part of the problem is that, while engineering schools have begun emphasizing a general, broad education, which the panelists applauded, industry is demanding specialists.

Commenting on these points, Vernon Hills of RCA Solid State Division, Somerville, N.J., suggested that engineering students do not get exposure to using catalogs. He continued: "I can't recall an instance when I was in school where catalog use was taught. It turns out my interest in electrical engineering developed from an Allied Radio catalog my dad bought because he wanted to buy an amplifier. In other words, my first interest in electronics came from a catalog, and cataloging is still necessary today.

"But do the schools ever try out that methodology? You get a young guy in today, and give him an assignment. How often does he call up the vendor and ask if they've got a particular part? Experienced engineers do it. It's one of the first things they do. But the young guy probably goes back to the textbook."

Hills added that because of the wide application of ICs and the different levels of understanding among users, suppliers have the problem of learning how to communicate with this cross-section of customers. "At one company, they may say they want something that does this. You ask if they've got a spec and they say, 'no,—only what we've just told you.'

"You return home and build up a logic diagram and, if you send that to them, you might just as well send them a piece of wallpaper, for all the meaning it will have. Other customers know exactly what they want

and call out all the specs. So, learning to work with these various levels of understanding is a problem."

Analog world still discrete

Although ICs have preoccupied the digital-design world, the situation in linear applications is somewhat different, Loy interjected. "In the analog world, it's still discretes." He added: "There are no ICs that can give you noise performance, cross-modulation, etc., that a good discrete design can give you.

"In high-power design—power amps—discretes go up to a few hundred watts. There are no ICs that can do that. So the discrete designer is still around, and he's still doing what the old tube designers used to do—take a look at specs and find its safe area of operation, its thermal characteristics, its optimal point in terms of noise resistance, and biasing.

"It's true that the trend is going toward digital and that a lot of these functions will ultimately be digitalized. But when we talk about hi-fi—involving low distortion, power bandwidth, etc.—analog is here to stay for some time."

However, Loy pointed out, because of stiff competition from Japan in the consumer market, he must also stay abreast of the state of the art in ICs, which may help his products get an edge on the imports. Specifically, in audio, ICs are being used in the rf section.

Moreover, the panelists agreed that the key problems remaining for ICs are temperature, interfacing circuits, and connection to the outside world. Martin added that power has again become an important consideration, and he noted that in the days of tube design, engineers had to worry about high power consumption. "With the advent of transistors, we eliminated most of the high-power problems—high voltage and high current consumption. Then the IC came along, and we said, 'let's package as densely as we can on the pc board.' Lo and behold, the problem comes right back again."

Martin explained that power is critical, especially for small devices, because of the desire to get as many ICs as possible on circuit boards, which raises power consumption quickly. This is especially vexing in multilayer boards with high-density packaging.

"If you take a board that's 15 by 10 inches, you can fit 150 ICs on it. Each IC is a critical component in power consumption and temperature. So the advent of the IC really isn't the answer to high power consumption. It developed more power problems because of the packaging density. C-MOS has come along with low power, but it's going to take the industry a while to accept C-MOS as a replacement for 7400-series gates."

New rules for testing

Testing has also become critical for ICs. Lowitt reported that, in a unique way, the development of integrated circuits has made possible economical IC testing. He indicated that digital computers built with ICs have led to development of automated test equipment, also constructed around integrated circuits. With this equipment, vital 100% testing of other complex ICs is now feasible for users. More specialized testing is also available under computer control.

"Probably the greatest impact that ICs have made in the microwave end of the spectrum is in automatic testing," Gene Chao of the Naval Research Laboratory, Washington, D.C., suggested. "Actually, it's crept into the design. Many companies are now using automatic network analyzers, at whatever frequencies, to look at their devices. They write programs so that a network virtually can be designed by the analyzer around that particular device.

"This is particularly true where there is not so much control, as in the newer state-of-the-art devices, where the properties tend to vary from chip to chip. You can almost do real-time designing in this way. There's a philosophical question involved—that is, whether you are designing any more. Before, you picked up the textbook, and you knew what you wanted. You went about a synthesis procedure, which hopefully you understood, to get to the end. Now you know what you want, but that's about it. You give it to a computer and say 'go until you get close enough.' "

The panelists generally agreed that automated systems to do 100% testing were a vital development, mainly because IC field failures are so difficult and expensive to repair.

Keplinger commented, "We are now doing 100% checking of ICs coming in. We were buying 2% fallout, which ended up being four out of 100. If you've got 30 or 40 ICs on a board and six boards in a system, you just can't afford to have a field-service man running around checking them.

"It's just as likely when the boards come back to us, they check out OK, which means that the field-service man did something wrong. So we can't check it 100% after it's on the board. That's why we had to institute 100% test of incoming components and add four hours of burn-in per machine. We found it to be a significant

Peter Lowitt: "You're finding specialized circuit designers going more and more to the IC houses—a smaller group of people to do the basic design work. The results are taken by the rest of the industry, rather than reinventing the wheel in every engineering activity."

Gene Chao: "Probably the greatest impact ICs have made in the microwave end of the spectrum is in automated testing—it's crept into the design procedure, as well."

Hugo Ritucci: "We like to think of ourselves as professionals. We are—in our attitude toward work—but we are not always masters of our own fate."

James Loy: "For someone to stay in this field, he has to stay up-to-date. But what about the rest of his interests and his family? It's a big personal sacrifice."

factor in reducing field failures."

Ritucci added that the military has long required purchase of burned-in components and has routinely conducted 100% incoming inspection, but burned-in finished systems still cause problems. "It's incumbent on the part of the engineer to try to reduce the probability of field failures so that his product will survive. But all these test steps have to be taken, and it starts with the component manufacturer," he concluded.

In short, economics is the limiting factor in IC testing. Starting with the supplier, each competitor must find the happy medium between acceptable quality, ascertained through testing, and competitive prices. Suppliers are in jeopardy if they deviate from this fine balance—either on the side of too-low quality or too-expensive testing.

For the user, the economic trade-off is between the cost of 100% incoming inspection and the cost of field repairs. All agreed that there is no perfect match—defective parts will slip through even the finest nets.

EEs look at themselves

Lowitt thus summarized the tenor of the roundtable discussion of the engineering career: "This is a relatively new industry, and electronic engineering has only evolved since World War II. We're now finding out for the first time, as a result of our own experiences, engineering as it is. For the first time we are assessing it.

"When I went to school, there was no valid assessment of what it would mean in 20 years to be in engineering. Everything was always going to be on the rise. Everything was always going to expand. But the law of supply and demand holds. Demand changed, but the supply of engineers was there, and things changed in engineering."

Concurring that the electronics industries are young and immature, and therefore unstable, Hills remarked, "We like to do everything fast. But the price you pay for having a fast rise time is that your system is liable to go into oscillation."

"Electrical engineering has been a field in which the technology has expanded rapidly," Loy added. "For someone to stay in this field, he has to work vigorously to keep up-to-date. And this raises the question, 'what does a person want out of life?' Does he want to be successful in this field, or does he want a more complete life? If he is to be successful, the engineer has to study—a couple of nights a week in school. But what about the rest of his interests—his family, hobbies, etc.? Isn't that a big sacrifice?

"Also, if he goes into management to succeed, he has to develop other skills—managerial skills. To some, it's natural, but to others, it's not. Quite a few engineers are not the managerial type. They're the type who would rather sit down with equipment and develop the state of the art."

This conversation inevitably led to a discussion of professionalism. The group indicated that the EE has been subjected to a double standard by employers. On the one hand, companies bill the engineer as a professional in his job, willing to take his work home, put in long hours, take advanced degrees, and consume chunks of his time off reading engineering literature.

But on the other hand, company management also treats the engineer as an employee with less job security than the average blue-collar union member. In addition, the union worker may be making the same salary as the EE, but he does not have the headaches that go with being a professional. The panelists were perturbed about the unfairness to the EE, who must pursue an

education as long and as difficult as that of a lawyer and do work as mentally taxing as that of a physician, but in the end, he has much less to show for it.

Said Ritucci, "We like to think of ourselves as professionals. Professional, almost by definition, means you're in business for yourself—you control your own destiny. But realistically, that's not true of an engineer. He is an employee. He is guided and routed around by his management or by the customer his company is trying to supply. Should contracts be canceled, he will find himself out of a job—not through negligance or any malfunction on his part, but just because of other influences on his company. So, the engineer is not a true professional. He is, as far as his attitude toward his work and the way he conducts himself; but as far as his career and the way it is being shaped, he is not always the master of his own destiny."

The sacrifices required of an engineer, coupled with the lack of employment security, contribute to a so-called mid-career crisis that may be worse than what people in other vocations encounter. Most of the group made a distinction between engineering managers and the rest of the EE fraternity. And they attributed some of the inequities suffered by lower-level engineers to the behavior of engineers on the management ladder.

This attitude was particularly apparent concerning the question of why engineering is a young man's career and why younger EEs have for years squeezed out older, more-experienced engineers—why there are so few elder statesmen in the ranks of working engineers. In part, younger men have more enthusiasm and more vitality to throw into a project than older men. Yet the panelists agreed on the principle that the EE should be able to pursue a lifetime career—the individual should become more valuable as he gains age and experience—not become a liability.

Let's reform management

The fallacy, as Peter Pleshko sees it, is the assumption that a younger man is better than an older engineer. "If you talk about enthusiasm, inventiveness, keeping up with the technology—those are individual matters. You can find a guy who three years after he gets out of school is absolutely worthless because he's only been writing proposals for all of those three years.

"It boils down to the fact that perhaps management's attitude is wrong. Why is it that engineers who get into management have this outlook? We're killing ourselves," he complained. The panelists decried the lack of security meted out by a system in which young, low-salaried engineers are continuously pushing out older, higher-paid EEs.

Hill contrasted this rampant insecurity with engineers he has met in the automotive industry. "In Detroit, you get a completely different feeling. The engineer has worked there, and he expects to work there next year and the year after that. He comes to work with a different attitude than an engineer in an electronics company. You can sense a different atmosphere there that is somehow related to maturity of the industry. You find mature engineers there as well."

This contrast prompted Chao to wonder about the success, or lack of success, of the dual-ladder system of advancement and salary in the electronics industries. In this regard, he believes that a Government laboratory offers greater opportunities for an engineer to continue to work strictly as a designer, avoid management, and not get stuck on an income plateau.

Curiously, despite the views that the prospects for successful engineering careers are rather bleak, not one of the engineers on the panel recommended that the solution to job security is control of the supply of EEs. The consensus was that a quota system limiting the number of engineering students would be counter-productive. The panelists agreed that the normal flow of students responding to supply and demand is sufficient—if students get adequate information on which to base their decisions to enter the profession.

They agreed that a plan to screen students would not work, because grades and aptitude tests do not indicate accurately which graduates will be effective on the job.

"It's a totally different environment in industry—you have to perform under pressure, and you have to perform many, many duties that nobody ever told you about or that you knew existed," Martin explained. "There are many engineers who cannot make it, but you can't find that out until he's been there."

"I don't think you can have effective screening methods before college or during college. I don't think it is an effective means of rating performance. The only way you can rate performance is to put a man on a job and observe him," he added.

Students need realistic information

A way out, Chao suggested, is tn provide more and better information to students about the engineering career than has been available. "A lot of engineers will say that the reason they made the wrong decision about entering the career was not only change of heart on

Peter Martin: "It's a totally different environment in industry—you have to perform many duties that nobody ever told you about. There are many engineers who cannot make it, but you can't find that out until they've been under the pressure to perform."

Edward Keplinger: "If you've got 30 or 40 ICs on a board and six boards in a system, you just can't afford to have a field-service man checking them. That's why we had to institute 100% test of incoming components and add four hours burn-in per machine."

Vernon Hills: "In Detroit, an engineer comes to work with a different attitude than an engineer in an electronics company. You can sense a different atmosphere there that is related to maturity of the industry. You find mature engineers (in auto companies), as well."

their part, but the lack of information or wrong information when they were in high school." he stated. Thus, the supply of engineers would be self-limiting. But for this approach to work effectively without oscillations between good times and bad times, some organization should present the true picture of engineering—with its pitfalls and benefits—to those making the decision to become engineers.

The need for such a career spokesman pointed immediately to the IEEE and its newly mandated responsibilities. Within the last year, members have passed a constitutional amendment that changed the institute's basic objectives to include career-oriented programs. The roundtable panelists strongly favored this change, and perhaps they expect a heavier push in this direction than IEEE is prepared to make. For example, Martin suggested that one desirable role for the institute would be to act as an advocate for engineers to try to minimize layoffs during hard times.

Generally, the group agreed that, for now, at least, the IEEE is the best spokesman for EEs because it's the only group that's organized to support their profession. Keplinger cautioned, however, that many EEs at the grassroots level are rather lukewarm toward IEEE. Martin interjected that one reason IEEE has not been meaningful to the working EE is that it has been too academically oriented in its programs.

"Now it's time to change from being a link with academia to a useful, usable organization for engineers," he proposed. While Martin visualizes the IEEE as a good place to start with career activism, he's also concerned that individual engineers do not have enough say in institute policy because membership is so dispersed.

Chao countered, "In order to change, there has to be a two-way street. IEEE is starting to do things for career aids, such as the salary survey, but it's our obligation to participate in the effort."

IEEE—it's all we've got

Recalling President Harry Truman's remark that there may have been many Americans more qualified than he to be president, but he was it, Lowitt paraphrased the quote to the effect that other organizations may be better qualified to carry the ball for the engineer, but IEEE has the ball.

"We tend to look at IEEE as it has been, rather than what it hopes to be," Chao responded. "Those are two different things. You can't point to past IEEE performance, because the constitution has been revised. I don't think you can look at what's been in the past and say this is what the IEEE will be in the future."

Panelists were unenthusiastic about the IEEE Intercon show and technical sessions opening next week. Ritucci, for instance, said that he had attended the show religiously for years, but had stopped going about five years ago because he realized he can get the same information in publications. With deemphasis on the show by manufacturers, there has been less to see, he pointed out. Martin recalled that the last show he went to was in 1965, "and I was impressed—of course I was awfully new, and I was impressed with everything they had. As I learned more, it just lost its appeal."

Lowitt reminded the others of the years when companies in the New York area gave the entire engineering staff time off to go to Intercon. "Now if you send one man from a division, it's considered adequate. There's been a change in attitude in the companies about the show," he stated.

The roundtable panned the technical sessions they've attended at Intercon, but all strongly supported the quality of IEEE's special-group symposia. One advantage of the technical sessions, Chao pointed out, is that they provide an opportunity for those who have developed new technologies to explain them to the rest of the engineering community.

Despite what, at best, has been benign neglect of Intercon by the panelists, no one would argue that the day of the broad, industry-wide show is necessarily gone forever. The panelists recommended that the show should be changed, rather than eliminated.

"The show is a good central forum for many products," said Lowitt. "You can find out a lot about your products by displaying. It's harder to find out the strengths and weaknesses of your products in a typical one-to-one sales call."

"It could be more of a product forum and less of a technology forum," summarized Keplinger. "The special groups could handle the technology end." □

IEEE shifts its power behind career objectives of members

Electronics engineers should soon begin to detect improvements in their stodgy institute; at Intercon '73, they'll also find innovations in the exhibits and measures to increase the value of the technical sessions

by Gerald M. Walker, *Associate Editor*

☐ On this 25th anniversary of the transistor, engineers unhappy with IEEE in general, and with the Intercon show in particular, may be pleased by the changes that have been shaping up for the last couple of years. While not exactly in a revolution, the institute has taken initiatives to revamp this year's show, improve the technical sessions, and change the course of the IEEE itself.

The grass-roots membership may not have caught yet the returning sense of confidence emanating from the organization. But this year, the groundwork for change, which has been laboriously prepared over the last couple of years, should finally begin to show results. Many EEs will point out that the IEEE's career militancy has come too late, and others may wonder if the institute's role as their spokesman to the outside world will stick during good times.

However, the leadership has moved enough with the times to stave off mass defection of members. The new Intercon management has jazzed up the show enough to stem exhibitor decline. And the program committee has sweated over the technical sessions enough perhaps to lure more spectators to the discussions. These improvements haven't been easy.

As the year began, the biggest excitement around New York headquarters concerned the new constitution, overwhelmingly approved by members, that now permits IEEE to become active in career-oriented projects. To be sure, the institute will continue as an educational society—the new amendments have simply added the career responsibility to the old charter. Actually, IEEE had begun experimental career-related projects even before the consitutional amendments were adopted.

"Our toe has been in the water for some time," says IEEE President Harold Chestnut, systems-engineering consultant for General Electric Co. research and development. "We've learned the concept of experiment—institutional experimentation."

These "experiments," which have now been turned into programs, include a thorough survey of salaries and fringe benefits of members, which has been published to provide a benchmark for negotiating pay and benefits. A portable pension plan on after-tax savings is

The show goes on. This year's Intercon will borrow some ideas used elsewhere to jazz up the show and help exhibitors hold down costs.

being prepared as a membership option. Pointing out that pensions are as complex as electrical engineering, Chestnut reports that a consultant has been hired to prepare the plan.

Tell it to the world

Although it will have less immediate impact on EEs than the salary survey or the pension plan, probably the most important action has been establishment of an office in Washington, D.C. to provide a source of information to lawmakers and Government agencies on matters pertaining to electronics technology and engineering jobs. IEEE wants to be heard where possible on Government decisions affecting engineers. Asked if it may be possible to reach the White House, as well as Congress, Chestnut replied, "We can't pull off miracles, but our presence in Washington is better than nothing."

In addition to providing information to Government agencies, the institute plans to become an aggressive spokesman for engineers to industrial and educational leaders. This role falls into what Chestnut calls the "coherency factor"—bringing together information and supplying it to the sources that can benefit electrical-engineering careers.

As one example, by periodic surveys of the 167,000-plus members, the institute hopes to provide information to engineering schools on how many engineers are needed and in what specialties. General manager Donald Fink explains that he wants the industry to realize that IEEE is an information center about EEs, just as members now look upon the institute as an information center on technology. "We're tightly coupled with a great deal of society," says Fink. "We can now deal with the engineer as a whole person with interests in economics and technology."

Both Chestnut and Fink are quick to point out that as an information center for universities, IEEE will not attempt to limit or control the number of EEs entering the career. Fink states that everyone wants the right number, and IEEE intends to help find it, but the institute won't try to dictate what that number should be.

The same policy holds true for the salary survey. Fink feels that the results are equally helpful to employee and employer because they provide a profile of what the average member earns. It's a guide.

Overall, Chestnut's goal during his year in office is to implement the mandate of the constitutional amendment vote, and at the same time continue IEEE's strong suit of technical education. Because funds are tight, he also intends to tighten the money belt at headquarters. For the first time, a vice president will be responsible for operations inside IEEE to help streamline management of the organization.

Changes at the Coliseum too

As for the effectiveness of Intercon, March 27 to 30 at the New York Coliseum, the IEEE president concedes that the show has declined in numbers, but not necessarily in value to exhibitors and visitors. The show, he contends, reflects a changed industry, no longer carried by the big money of defense/aerospace. On the other hand, Chestnut believes that Intercon can be recast to reflect these changes and attract a new engineering core—EEs in consumer and commercial companies, as well as nonelectronics companies.

One of the first changes visitors at Intercon '73 will note is that it will occupy two floors of the Coliseum, rather than four. This change simply reflects the reality embarrassingly evident last year, that there are not enough exhibitors to fill the four floors. (Intercon had contracted to take all four floors last year and went ahead with the deal, even though it was clear then that two floors would have been enough.) This year, six weeks before show time, some 260 exhibitors had signed up for just over 400 booths, about even with 1972.

One of the problems that continues to irk exhibitors is the high cost of putting on a show in New York's Coliseum and the growing reluctance of companies to pay for expensive accommodations in Fun City. Donald Larson, the show manager, has faced the situation and applied a little incentive to labor. IEEE has considered moving the show to Boston on an alternating basis to alleviate costs. Larson says that he mentioned this possibility to the labor representatives and drew a promise of complete cooperation in helping exhibitors. "We want to see if we can make New York work, before definitely deciding on Boston," he comments.

This year's is the first show under the combined Intercon/Wescon management, headed by Larson. He has initiated three ideas in New York that have proved helpful in shows elsewhere. First, in order to save exhibitors considerable expense in paying exorbitant overtime labor rates, the opening day of the exhibits has been changed from Monday to Tuesday. This will allow Monday to set up booths rather than forcing the more-expensive set-up on Sunday. Intercon has also authorized guest cards for exhibitors to invite customers to the show. These cards cost exhibitors only $1 each.

The third idea, this one imported from Europe, is use of enclosed booth space for conference areas. To en-

Harold Chestnut, IEEE president: "We've learned the concept of experiment—institutional experimentation," concerning IEEE's plans to implement programs relating to engineers' careers. Among the first will be supplying information to engineering schools.

courage the idea, Larson is charging half the rate for the additional conference-room space. Earlier, the desirability of permitting selling transactions on the show floor had been discussed. The final policy is a compromise—Intercon officials will allow order-taking, but not delivery, of products from the show booths. The reason for this proviso, Larson explains, is to control security. He wants to avoid the headache of trying to police people who may be walking out of the Coliseum carrying stolen equipment and actual customers leaving with their purchases. This way, there will be no confusion between the two.

On the positive side, this year's Semiconductor Applications Center (SIAC), in honor of the 25th anniversary of the transistor, will feature a display and film presentation by Bell Telephone Laboratories and Western Electric that traces the history of the device. From the SIAC entrance, visitors will pass down a carpeted "shopping center" of semiconductor exhibits. Each booth will have half its space devoted to a conference room for more-concentrated discussions. Motorola Semiconductor is paying for a slide presentation on the present and future of the semiconductor industry. Each visitor will receive a special souvenir book, sponsored by Fairchild Semiconductor, that summarizes the slide show.

Applications will be featured on the printed-circuit-board production line that will be in operation on the main floor of the Coliseum. In order to provide a more hands-on feel for the demonstration, engineers will be able to set up and operate test equipment as part of the pc-production process.

But what about the future of Intercon? Like just about everyone connected with the show, Larson has thought hard about that. "To those who say that the days of the show are over, I have to say they are wrong," Larson states. "The importance for engineers to see a broad line of products will continue."

Last July, Larson and his staff met with a handful of important exhibitors in a no-holds-barred discussion of Intercon's future. "The consensus was that the direction we are taking is where they want to go. The show is needed, but it needs innovations," Larson reports.

Putting more pull in tech sessions

There will be some changes in the technical sessions too. The meeting rooms, which had been in the New York Hilton in the past, this year will be in the Americana Hotel, and the applications sessions, formerly held at the Coliseum, will also convene at the Americana.

Joining the two may help increase attendance this year, suggests J. A. A. Raper, General Electric Co., who heads the program committee. The committee has narrowed the range of subjects covered and arranged them in a sequence to permit registrants to attend each session on a particular subject in an orderly manner.

This year's program consists of 57 daytime sessions and two evening specials. The first evening session is "Energy Crisis," featuring Edward E. David Jr., former head of the Office of Science and Technology, who is expected to have some frank remarks to make about his experiences as an adviser to the President. The other night meeting is "Limits to Growth—Technology in the Social Frame," this one featuring Jay W. Forrester of Massachussetts Institute of Technology.

In keeping with the theme, "Solid State Shapes the Future," the session, "The Transistor, Yesterday, Today, and Tomorrow," will be an informal discussion featuring transistor co-inventors William Shockley, John Bardeen, and Walter H. Brattain. The programer titled "High-Packing-Density Bipolar Technology for LSI" will have a first—a report by Roy H. Mattson, University of Arizona, on "Soviet Integrated Circuits Technology." This session will also have a paper by Paul A. Gary, Bell Telephone Laboratories, titled "Gimic—A High-Yield, High-Performance Technology for LSI." The panel on MOS LSI circuits will have a paper from Motorola Semiconductor on n-channel MOS; from RCA on C-MOS/SOS; and from Fairchild Semiconductor on high-density LSI with isoplanar MOS.

A panel, called "Bus Organized Interconnection Techniques," will touch on a relatively new topic in computer communications. Speakers are Daniel Stiglian Jr., IBM; C. S. Kim, General Electric; and Ronald Etner, Naval Air Systems Command.

A good example of how the technical sessions will delve into topics from state of the art to applications is the panel titled "Information Theory After 25 Years." Speakers will review practical uses of information theory, covering recent developments in teleprocessing-system optimization, coding practices, and applying information theory to efficient image-transmission.

Summarizing the main thrust of the program committee, Raper observes, "We want the technical program to have a growing impact on Intercon, to get the same devotion to the technical sessions that, say, the Solid State Circuits Conference has in the semiconductor industry. We hope to get things going this year by attracting new blood to the rostrum and new blood to the audience. We want to build the image that engineers will learn something from the program." □

J.A.A. Raper, head of Intercon program committee: "We want the technical program to have a growing impact. We hope to get going by attracting new blood to the speaker's rostrum and new blood to the audience. We want to build a loyal following to the sessions."

Digital processing interface brings computer power to oscilloscope

Intelligent oscilloscope features simultaneous displays of time-domain waveforms and their frequency spectra, waveform averaging to extract clean signals from noise, and digital filtering of input signals

by Hiro Moriyasu, Bruce Hamilton, Luis Navarro, and Wayne Eshelman, *Tektronix Inc., Beaverton, Ore.*

☐ For the past two decades, oscilloscopes have been among the engineer's most versatile and widely used tools. And, as bandwidths, sensitivities, triggering circuitry, and storage capability have all improved over the years, the usefulness of this tool has increased.

At the same time, computers have made great strides—advancing to the point where a minicomputer is a common component in many systems today.

Now, for the first time as a product, these two technologies have been brought together in one instrument to create a new field of computer-aided oscillography. The result of this marriage of technologies is called the Digital Processing Oscilloscope.

Like a conventional instrument, the Digital Processing Oscilloscope contains a signal-acquisition unit and a display unit (Fig. 1a). In addition, the new scope contains a third section, called a processor, which has the ability to digitize an acquired waveform, provide an interface with a minicomputer, and to store digital data and convert it to analog form for display (Fig. 1b)

The applications of such an instrument, complete with minicomputer, are limited only by the imagination of the user. A few of the more obvious ones are:

- Signal averaging to extract signals from noise.
- Viewing of a signal after passing it through an arbitrarily constructed digital filter—one that may not even be realizable in conventional circuitry.
- Display of a signal in the frequency domain by calculating its Fourier transform.
- Correction of signal errors caused by such limitations in the measuring equipment as nonlinearity, small impedance mismatches, and the like.
- Automatic scaling of a displayed waveform to any convenient form—a logarithmic frequency scale, for example.

Processor architecture

The Digital Processing Oscilloscope's acquisition and display modules are identical to those of a conventional oscilloscope. Indeed, with the processor section removed, the Digital Processing Oscilloscope becomes a standard Tektronix 7704A oscilloscope.

The processor consists of two major parts: a signal interface, and an asynchronous bus (Fig. 2). The signal interface, which controls the display unit, receives its data from the acquisition unit and from a variety of functional devices plugged into the asynchronous bus.

The data bus allows the devices, all of which are built on 4½-by-11-inch etched-circuit boards, to work independently of each other. Six devices, which require a total of eight device positions, are shown in Fig. 2. The bus has 11 device positions available to allow for new devices being developed. Each device position consists of a single 72-pin edge connector, which provides parallel access to power supplies and address, data, and control lines.

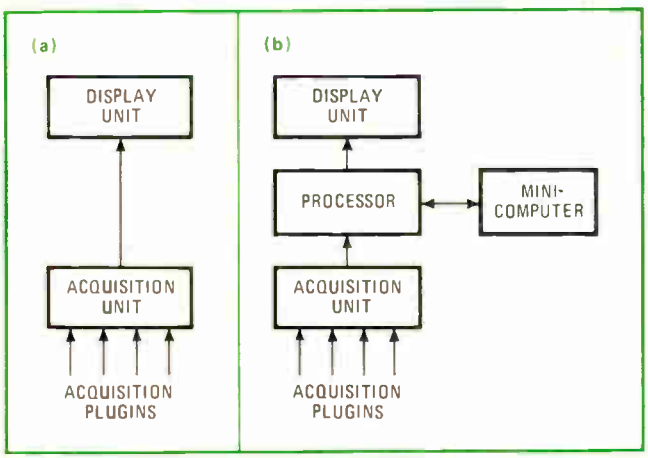
A serially connected line (daisy chain) in the bus establishes device priority in case two devices try to get control of the bus at the same time. Connections are available at each device location for input and output of signals. When wideband and low-noise paths are required, signals are routed directly from device to device via coaxial cables.

The heart of the processor

Probably the most important part of the processor is its three-axis asynchronous sampler and its associated analog to digital converter.

To store an acquired signal, the processor samples the

Closing the loop.
Readers who are interested in discussing this oscilloscope/minicomputer combination with the authors may call them on March 22 from 9 a.m. to 2 p.m. PST at (503) 644-0161. Ask for Hiro Moriyasu on Ext. 7047.



1. Adding an interface. Conventional oscilloscope (a) contains only acquisition and display units. Digital Processing Oscilloscope (b) also contains a processor for linking scope to a minicomputer.

scope's vertical axis every 6.5 microseconds. It samples the two other major axes (horizontal and blanking) 95 nanoseconds later. This allows time for the sweep-circuit start-up lag, which would otherwise prevent the storage of the leading edges of rapidly rising signals. A delay line in the display unit displaces the real-time vertical by the same amount, and thus coincidence of real time and stored signals is maintained when they are simultaneously displayed.

Significantly, the sampling rate imposes no limitation on the processor's frequency response because there is no need for all of the samples of a given waveform to be obtained on a single sweep. Of course, the faster the sweep speed needed to display a signal, the smaller the number of samples obtained per sweep, and the longer it will take to digitize the waveform. The sampler is nonsynchronous with the sweep to prevent the sampler from looking at the same points over and over again.

The vertical sample of the acquired waveform is converted by a 10-bit successive-approximation a-d converter to one of 1,024 possible levels, which correspond to 10 CRT divisions, eight of which are displayed.

The a-d converter then converts the horizontal sample to one of 512 horizontal memory positions that line up with the 10 horizontal divisions on the CRT faceplate. However, if the blanking sample indicates that the CRT was blanked—for retrace or channel switching, for example—when the vertical or horizontal sample was taken, the converted data is discarded. Conversely, if the CRT was unblanked, a memory address is generated and the vertical binary word is stored at that address in the processor memory.

An additional data acquisition mode is available. The computer may, at any time, obtain directly from the a-d converter the value of the last vertical sample, allowing inputs of unchanging data in a single operation or construction of arrays consisting of more than 512 elements of slowly varying data.

Perhaps the second most important device in the processor is its memory. This is a nonvolatile 4,000-byte-by 10-bit magnetic-core unit, which serves both to store data and act as a buffer for computer input/output functions. The memory stores acquired waveforms and scale factors for display and computer input, and stores computer output for display on the CRT. Data acquisition independent of I/O speed and flicker-free displays are results of this local memory.

The I/O device provides a bilateral processor/computer link: the computer has full access to the processor through the I/O device, and the processor in turn may interrupt the minicomputer at any time.

Controlling the display

Two devices in the processor are responsible for generating the data seen on the oscilloscope's screen: the display generator and the character-display control. The display generator creates waveforms from data stored in the processor memory or directly from computer output, while the character-display control generates characters from data stored for that purpose. The character-display control is also used in the opposite mode—to convert acquisition-unit readout information into ASCII format for storage in the processor memory.

The display generator can operate in two modes: Y versus time (y,t) and X versus Y (x,y). In the (y,t) mode, all specified memory locations (A,B,C,D) are examined sequentially and all non-zero points in the array are plotted. In the (x,y) mode, each point is plotted when directed by the computer, thus enabling the computer to generate a refreshed display of multivalued functions—spirals, for instance.

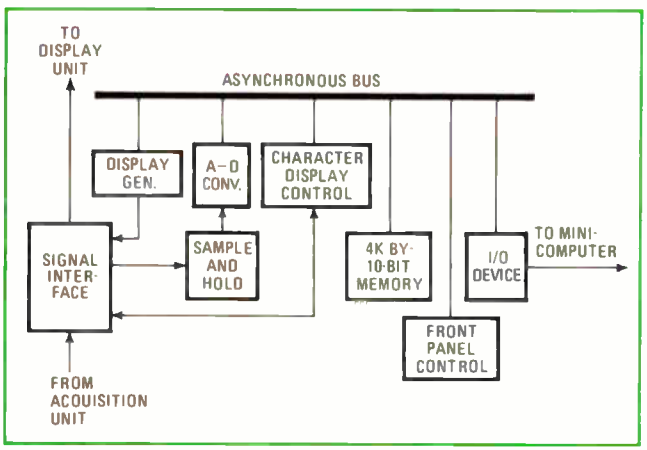
The fact that the (y,t) mode plots only non-zero points becomes significant in certain difficult measurement situations, such as measuring single-shot phenomena, where only a small number of points can be stored. The reason is that, in its normal mode of operation, the processor makes a linear interpolation between the plotted coordinates. Thus, if some points are missing, the display will ignore them, not return to zero, and then go back up to the next plotted point. If a point plot is desired, a strap option can be installed at pins provided on the display generator board.

The character display control device allows use of the full character set of the 7704A for both computer input and display on the CRT. In the STORE mode, the acquisition readout information is converted to ASCII and stored in the processor memory, providing a permanent record of waveform scale factors. Thus, whenever a stored waveform is displayed, so are its scale factors.

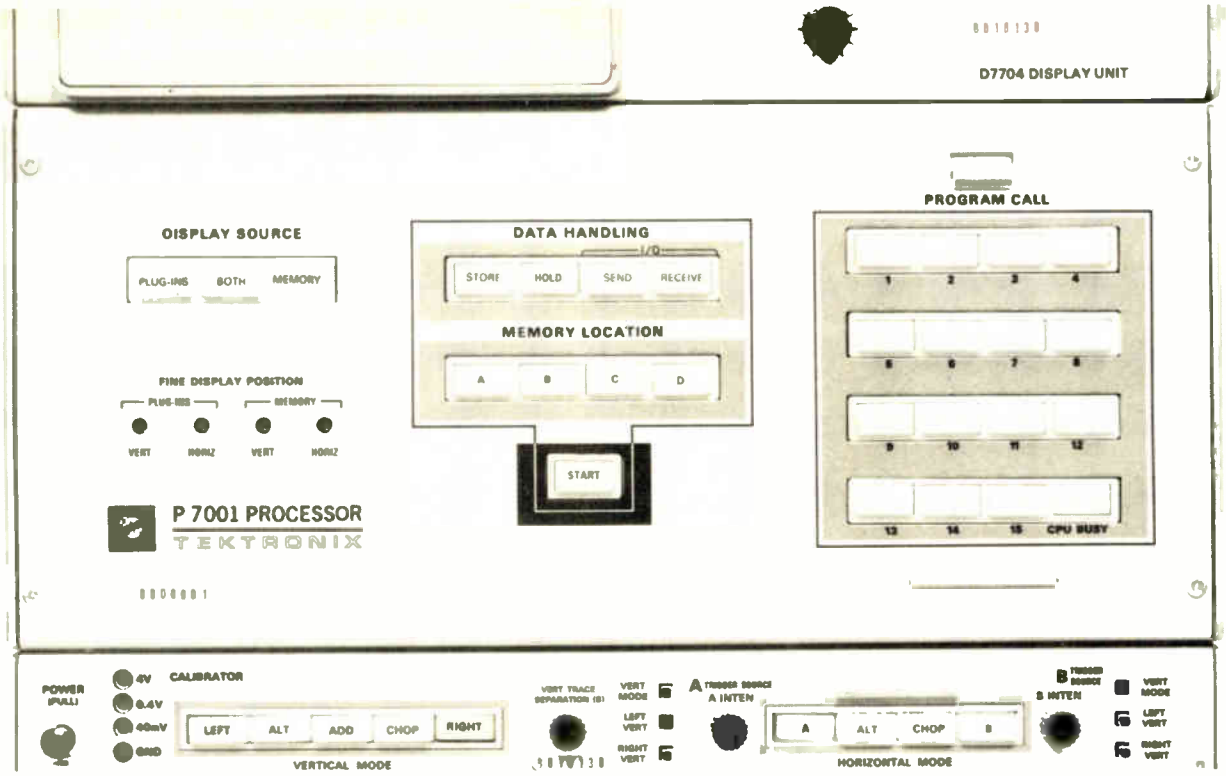
Sixteen 80-character messages may be stored in the processor memory. Four of these are allocated to the A, B, C, and D memory locations and are addressable from the front panel. Normally, these contain only scale factors. The remaining 12 messages may be used for computer-to-operator communication. These messages, once stored, may be displayed with one command.

Controlling the processor

Push buttons on the front panel provide access to logic circuits in the processor, allowing simple control of the Digital Processing Oscilloscope and its computer interface (Fig. 3). Each time a new mode is selected (STORE, START, etc.), the processor generates a computer interrupt, which allows complete operator-processor-computer interaction. The computer constantly monitors processor status, which is indicated by the lighted buttons. The buttons are also controlled by the



2. The processor. Signal interface allows display to be fed from acquisition units, or by processed signal, or both. Up to eight waveforms—four real-time, four processed—can be viewed at once.



3. Front-panel controls. Ten of these 28 buttons control the processor. The remainder are used to request computer action. The 16 program call buttons are used to direct the computer to execute user-definable programs and do not directly affect the processor unit itself.

I/O device to inform the operator of computer-initiated processor modes.

Ten of the 28 front-panel buttons directly control the processor. Two buttons set the status to STORE or HOLD, four buttons are used to designate the waveform memory locations, and three buttons set the CRT display source—PLUG-INS, BOTH, MEMORY.

The START button is used to initiate any processor or computer mode that will destroy previously stored waveform data (contents of A, B, C, or D), and thereby reduces the possibility of inadvertent destruction of stored data. The remaining 18 buttons are used to request computer action. The SEND and RECEIVE buttons direct the computer to input from the processor or to output desired waveforms. Each time SEND or RECEIVE is used, the processor is set into a HOLD mode, where acquired data is retained, and then a START command sends an interrupt to the I/O unit. The 16 program call buttons are used to direct the computer to execute user-definable programs and do not directly affect the processor.

The computer, through I/O control, can access any individual device in the processor and change any of its modes. This allows, under program control, operations such as simultaneous storage in and display from different memory locations. In addition, single-sweep reset and end-of-sweep interrupt are available to the computer, allowing further programing flexibility.

The software

The BASIC language was chosen as a starting point for the software because it is a simple, interactive language that is easy to use. An operator can write a program, run it, modify it, and run it again without reentering or recompiling the program. Some of the elements of BASIC were expanded to adapt the language to the needs of the Digital Processing Oscilloscope. New statements were added to improve waveform processing, and special features were added to support the oscilloscope hardware. Where possible, the software was designed to minimize waveform storage requirements and speed up waveform processing. The software is called APD BASIC, and it is written for the Digital Equipment Corp. PDP-11 series of minicomputers.

APD BASIC has four permanently defined arrays—that is, four portions of the core memory—for storing the waveforms from the processor. Four arrays are necessary for transferring waveforms with the SEND and RECEIVE buttons on the processor front panel. The floating-point format of the arrays gives the user access to waveforms for computation. Individual elements or the whole waveform can be examined or changed. A number of variables have been permanently defined to give the user access to waveform scale factors and units, as well as to scale factors from any of the acquisition unit's digital plug-ins, such as digital multimeters and counters.

One of the central features of APD BASIC is the LET statement, which has been greatly expanded from the LET in BASIC. In addition to the standard equivalence function, LET may be used to transfer waveforms and scale factors between any of the memory locations, either in the processor or the PDP-11 minicomputer. Typing the simple statement:

```
LET C = PA
```

will transfer a waveform and its scale factors from processor memory location A to APD BASIC array C.

The LET statement may also be used to perform sca-

lar-array operations, using any combination of the mathematical functions of BASIC. To generate a waveform that is the vector magnitude of two other waveforms, the simple statement:

```
LET PC = SQR(A*A + B*B)
```

results in each element of array A being squared and added to the corresponding element of array B squared. The square root of the sum is then stored in the corresponding element of processor memory location C.

The functions of the PRINT statement in BASIC have been expanded to form the DISPLAY statement, which may be used to display text, variables, and waveforms simultaneously on the scope's CRT. The statement

```
DISPLAY "THE PEAK VALUE IS", B(50), WB
```

displays the message "THE PEAK VALUE IS", the value of the 50th element of array B, and the waveform in processor memory location B simultaneously on the CRT. The DISPLAY statement is the key to programing interaction between the user and the program, and the previous program statement is a simple example of how this interaction might be programed.

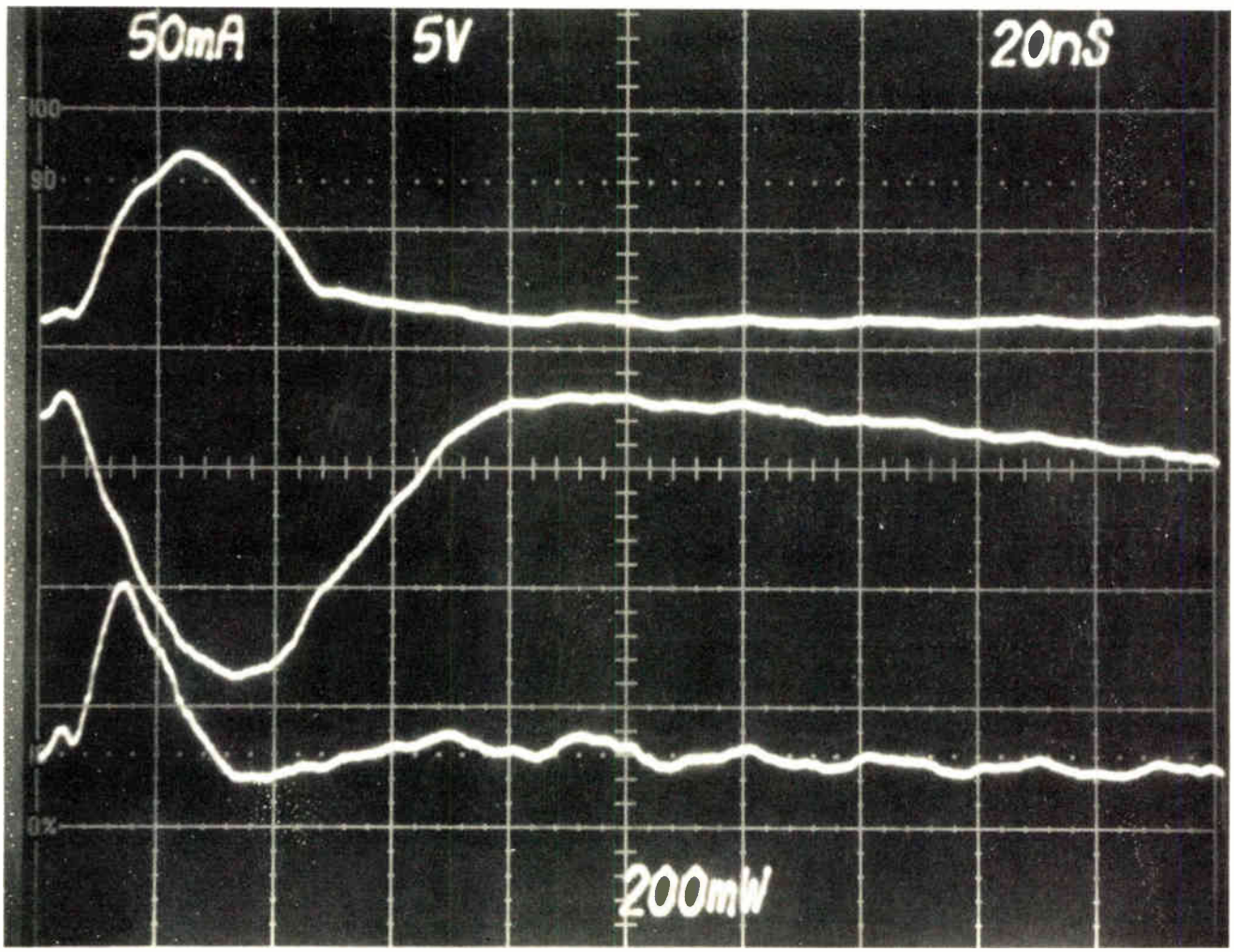
APD BASIC maintains correct waveform calibration at all times. When waveforms are transferred from the processor into an APD BASIC array, the vertical scale factor is combined with the waveform to give the actual values that came into the acquisition plug-in. Transfer of an APD BASIC array to a processor memory location results in the waveform being scaled to a standard oscilloscope scale factor, so that the waveform is completely visible on the CRT without interfering with the readout. This automatic scaling can be overridden by the user to position or scale the waveform on the display as desired.

Correct calibration of the units associated with scale factors is also maintained. For example, multiplying two voltage waveforms results in a waveform with units of "VV" (volts * volts).

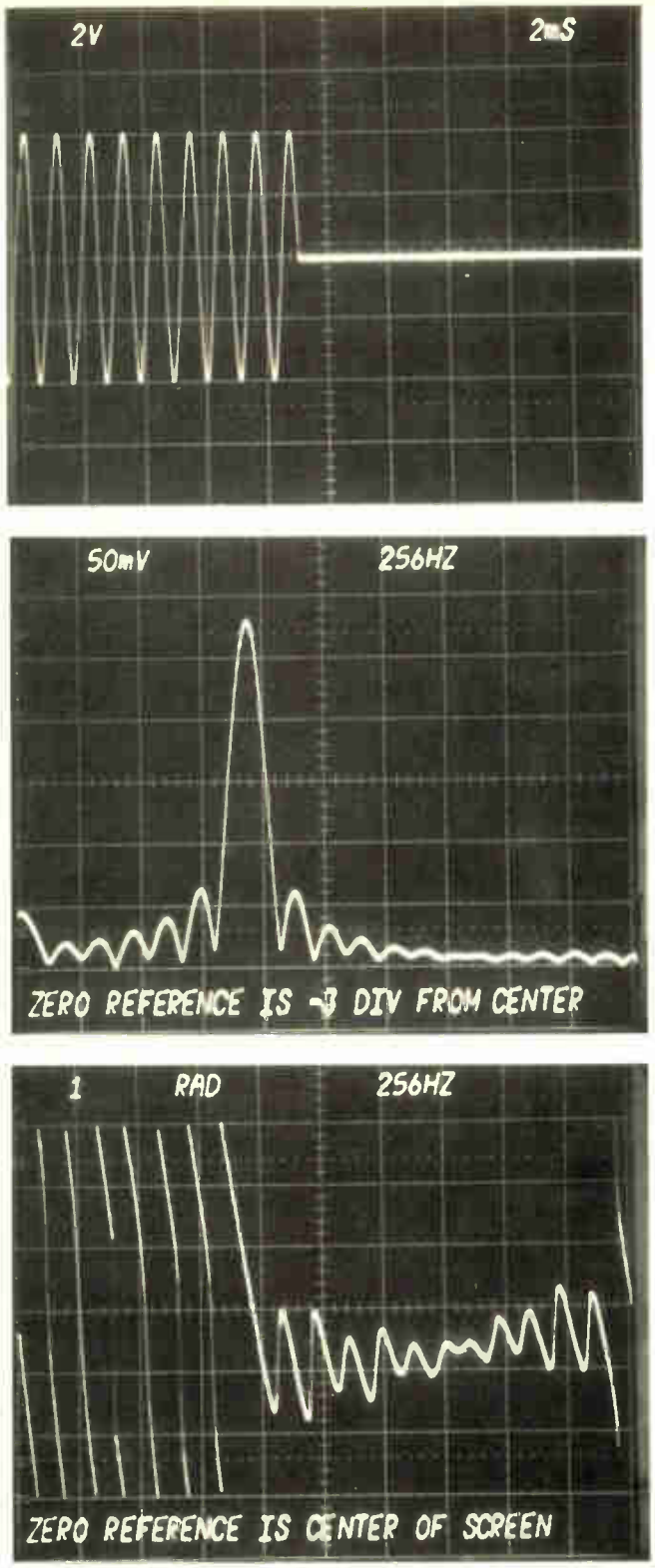
Special features have been added to APD BASIC to support the hardware functions of the scope. The interrupts sent to the computer from front-panel buttons are recognized by the software, which performs the action requested. The SEND and RECEIVE buttons transfer waveforms between APD BASIC arrays and the processor.

With the program call buttons on the front panel, the user may execute APD BASIC programs previously entered in the PDP-11. Button number 1 starts program execution at the lowest line number in the range 100 to 199, number 2 starts execution at the lowest line number in the range 200 to 299, and so on through button number 13. The user merely starts writing the program at the line number corresponding to the button he wants to execute the program.

Buttons 14, 15, and 16 are reserved for special pur-



4. Calculating power dissipation. Processor acquires collector current (top trace) and collector-to-emitter voltage (middle trace) waveforms from plug-in vertical amplifiers. Computer multiplies the two waveforms to get the instantaneous power displayed in the bottom trace.



5. Fourier transforms on display. A 9-millisecond burst of low-frequency sinusoid (top) is analyzed into its magnitude (middle) and phase spectra by a simple two-line program in APD BASIC.

poses. Number 14 is a CONTINUE control that allows the operator to interact with the computer in running a program. It is used, among other things, to provide the computer with a ground reference level—in the same manner that touching a probe to ground tells a human operator where ground is on a regular scope. Button 15, called RESET, is a sort of universal panic button. Pushing it stops the execution of any program and returns the software to its initial idle mode. Button 16 is simply a computer-busy indicator lamp.

A special statement has been added to set the status of any of the devices in the processor under program control. With this statement, operation of any of the front-panel push buttons can be duplicated, and the processor can be controlled in many ways that cannot be duplicated from the front panel. The X-Y display capability of the display generator in the processor is supported by the XYDISPLAY statement. Refreshed X-Y displays can be generated on the CRT from APD BASIC arrays.

Momentary power failures will not interfere with program execution even if the program is controlling the operation of the processor. APD BASIC is designed to recognize the power failure, then restore the status of the processor, and resume program execution after the power is restored.

APD BASIC contains a number of new statements to make waveform processing easier. The functions performed by any of these statements can be duplicated with an APD BASIC subroutine, but including them as a statement makes execution faster and programing easier. Some of these special functions are integration, differentiation, signal averaging, and fast Fourier transformations (FFTs).

For example, a fast Fourier transform written in APD BASIC requires about 20 minutes to transform 512 samples to magnitude and phase spectra. The same task requires less than 10 seconds using the FFT statement. Each of these statements may be used as a single command to be executed immediately or as part of a program. Correct calibration of the results including scale factors and units is always maintained.

Using the Digital Processing Oscilloscope

To display, say, the instantaneous power dissipated by a transistor as a function of time, a current-amplifier plug-in and a voltage-amplifier plug-in could be used to obtain traces of I_c and V_{ce} as shown in the top two traces of Fig. 4. Then, by using the short and simple program that follows, the power may be quickly computed and displayed along with an appropriate scale factor (bottom trace).

```
LIST
REMARK PDP-11 APD BASIC VERSION 001
  100 STATUS 250, 17
  110 FOR I = 1 TO 10:NEXT I
  120 LET PD = PA*PC
  130 DISPLAY WA, WC, WD, V1, V3," ",S1," ",V4
  140 FOR I = 1 TO 50:NEXT I
  150 GO TO 100
READY
*
```

Line 100 causes the scope to store the outputs of the current amplifier and the voltage amplifier in memory locations A and C, respectively. Line 110 is a wait loop that gives the processor enough time to store all of the points.

Line 120 multiplies the contents of A and C and places the result (power) in memory location D. Line

130 causes the oscilloscope to display the waveforms of I_c (waveform A), V_{ce} (C), and power (D) along with their scale factors in a specified format.

Line 140 allows time for viewing before allowing the program to proceed to line 150 which causes the whole process to begin again.

Since the program begins with line 100, pushing program call button number 1 causes the program to start. It will loop indefinitely until stopped by pressing button 15, the RESET button.

The fast and visible Fourier transform

One of the most attractive features of the Digital Processing Oscilloscope is its ability to calculate and display the Fourier transform of any acquired waveform. Figure 5a, for example, shows an expanded view of a burst of a low-frequency sine wave. The signal shown in the photograph was actually acquired and stored at a sweep speed of 20 milliseconds per division. It was then expanded to enable it to be shown in greater detail.

The following two-line program is all that is required to transform the signal into magnitude and phase components in the frequency domain.

```
100 FFT PA,B,C
110 POLAR B,C,PB,PC
```

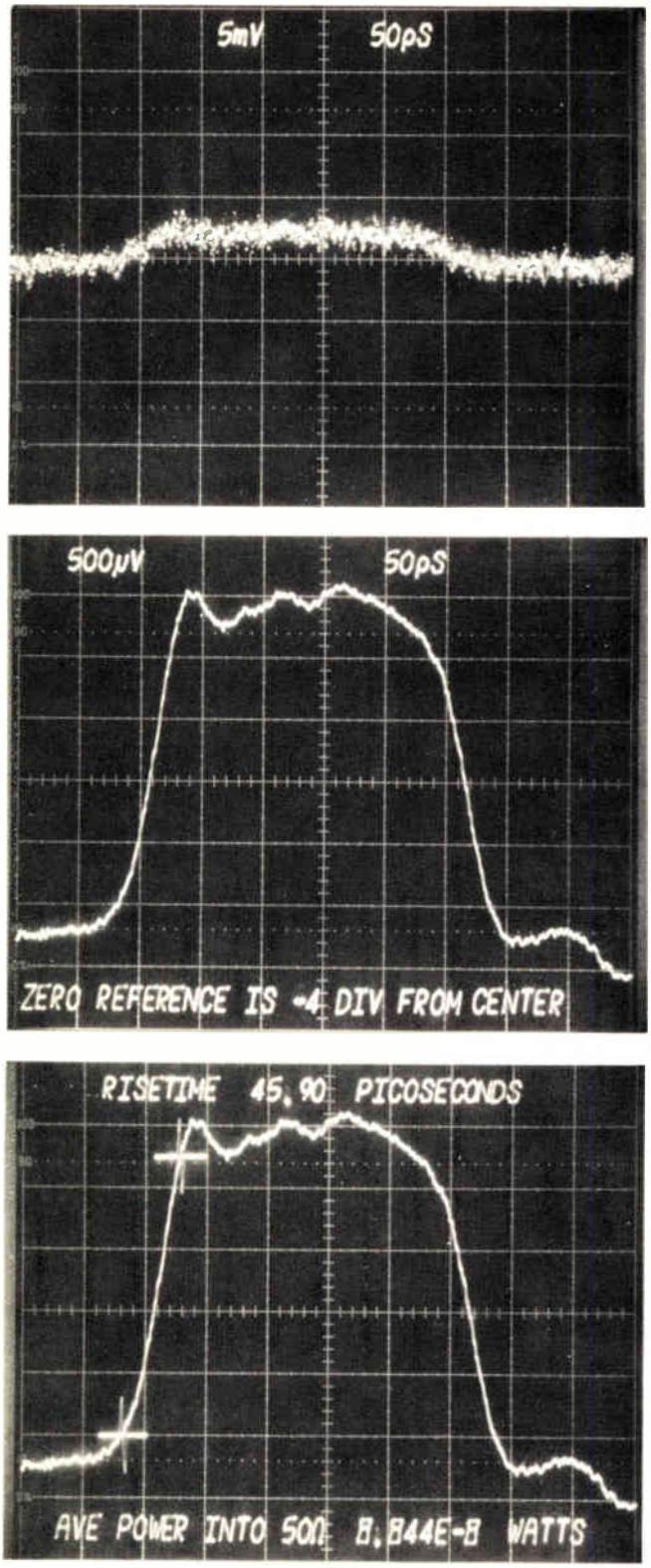
Line 100 causes the fast Fourier transform (FFT) algorithm to be applied to the signal stored in memory location A, resulting in 512 complex points which are separated into real and imaginary waveforms stored in arrays B and C, respectively. Line 110 converts the transform waveforms from rectangular coordinates to polar coordinates, and stores the magnitude and phase waveforms in memory locations B and C, respectively.

The displayed results (Figs. 5b and 5c) are as expected. The time-domain waveform is a 9-ms burst of a sinusoid of frequency slightly less than 1 kHz. It can be thought of as the product of a rectangular pulse and a continuous sine wave. Since multiplication in the time domain corresponds to convolution in the frequency domain, the transform is a (sin x)/x waveform convolved with an impulse at the sine wave frequency—that is, it is shifted so as to be centered at the frequency of the sine wave. The phase information is displayed modulo 2π; this is why discontinuities appear at points where the phase angle changes rapidly with frequency.

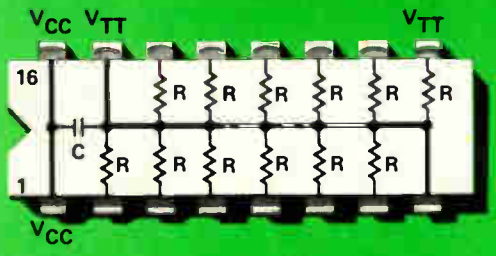
Computing through the noise

Pulling repetitive signals out of noisy backgrounds by averaging them is not a new technique. But it has probably never before been quite so easy to do as it is with the Digital Processing Oscilloscope, as shown in Fig. 6. Figure 6a shows a single trace, and the signal, a pulse, is barely visible in the noise. After averaging the pulse a thousand times, the greatly improved signal of Fig. 6b is obtained. Note the automatic scaling for best display resolution. Then, as shown in Fig. 6c, the oscilloscope has measured and displayed the rise time and average power into a 50-ohm load of the signal. The markers show the 10% and 90% points picked by the computer.

While a complete Digital Processing Oscilloscope, including a minicomputer, can cost anywhere from about $18,000 to about $29,000, without plug-ins, it is worth noting that the owner of a 7704A oscilloscope with an appropriate set of plug-ins and a PDP-11 minicomputer is well on his way to having an operating oscilloscope with brains. The Tektronix P7001 Processor unit costs $5,200, and the least expensive software package—APD BASIC I—costs an additional $650. Added to this is the cost of an I/O device like a teletypewriter. □



6. Signal averaging. Single pulse is barely visible in the noise (top). After averaging it 1,000 times, display is enhanced (middle). Rise time and power are calculated and displayed on CRT.



SERIES 898-41 −2.0 VOLT TERMINATORS contain eleven resistors for ECL line termination to a −2.0 volt bus. Each unit includes a 0.01 μF decoupling capacitor to bypass the −2.0 volt bus. Standard R values of 50, 75, and 100 ohms are available and are designated 898-41-R50, 898-41-R75, and 898-41-R100.
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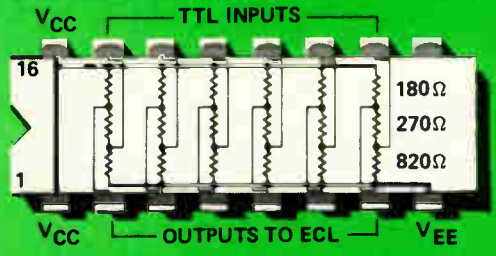

SERIES 898-45 TTL TO ECL TRANSLATOR contains six identical three-resistor sections for direct translation from TTL to ECL, both operating between a +5 volt supply and ground.
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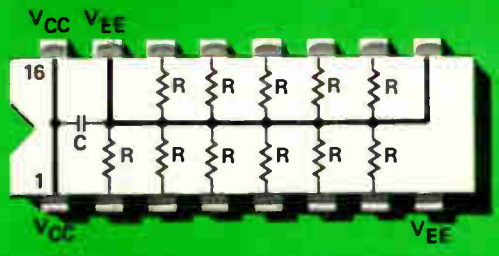

SERIES 898-42 −5.2 VOLT TERMINATORS contain twelve resistors for pull-down to the −5.2 volt bus. Each unit contains a 0.01 μF decoupling capacitor to bypass the −5.2 volt bus.
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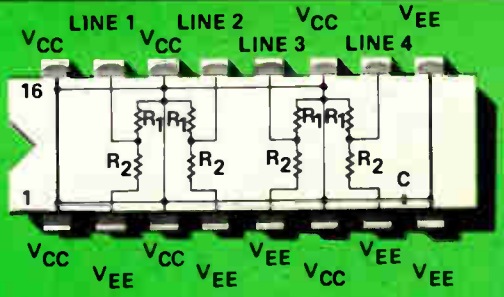
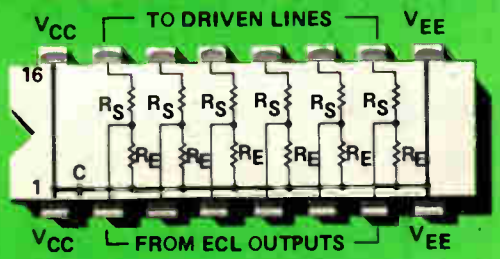


SERIES 898-43 THEVENIN EQUIVALENT TERMINATORS contain four Thevenin equivalent terminator sections. Each terminator section consists of two resistors connected as a divider from the ground bus to the −5.2 volt bus providing a Thevenin equivalent voltage of −2.0 volts. Each unit contains a 0.01 μF decoupling capacitor to bypass the −5.2 volt bus. Series 898-43 units are available with Thevenin equivalent impedances of 50, 75, and 100 ohms.

Series 898-43 R_1 and R_2 Values

Model	R_1	R_2
898-43-Z50	81Ω	130Ω
898-43-Z75	121Ω	195Ω
898-43-Z100	162Ω	260Ω

Price (1,000-4,999) $1.25



SERIES 898-44 SERIES LINE TERMINATORS contain six series terminator sections. Each section is designed for terminating a line at the driven end with a series resistor value equal to the line impedance minus the 7 ohm output impedance for 10,000 series ECL. The second resistor in each section is a pull-down resistor to the −5.2 volt bus. Each unit contains a 0.01 μF decoupling capacitor to bypass the −5.2 volt bus.

Series 898-44 R_S and R_E Values

Model	R_S	R_E
898-44-S43	43Ω	457Ω
898-44-S68	68Ω	682Ω
898-44-S93	93Ω	907Ω

Price (1,000-4,999) $1.25

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Functional redundancy assures greater system reliability

Two parallel electronic systems are more than twice as reliable as one alone: but even greater reliability can be achieved if the system is partitioned into functional blocks and those blocks are made redundant

by Roy J. Hughes Jr., *General Dynamics, Electronics Division, Orlando, Fla.*

☐ A popular technique for upgrading the reliability of an electronic system is simply to place two identical units in a parallel configuration, one operational and the other in standby. This redundancy gives the pair more than double the reliability of the single unit. However, failure in one of the two parallel units throws that entire unit out of action.

A more efficient solution is to partition the system into functional blocks and make each block parallel-redundant. This creates two parallel sets of functional blocks, the outputs of each pair of blocks being cross-strapped to the inputs of the succeeding pair. Reliability is increased because if one block in a set fails, the other blocks in that set can still be used.

Application

In a pulse-code-modulated (PCM) encoder proposed for the Air Force's Fleet Communications Satellite program, such functional partitioning reduces the probability of failure by a factor of three or four compared with conventional parallel standby redundancy designs, yet only 7.5% more components are required. Moreover, compared with a triple standby redundant version (one with two units in standby), the functionally redundant system requires much less circuitry, and even so it achieves greater reliability over the long term.

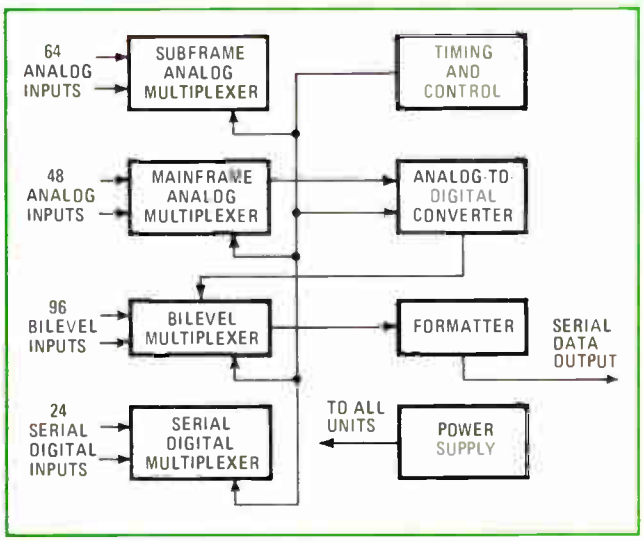
The PCM encoder is illustrated in Fig. 1. It samples both analog and digital information in real time with time-division multiplexers. The analog data is encoded to digital form and formatted with the digital data and synchronization information for data recovery.

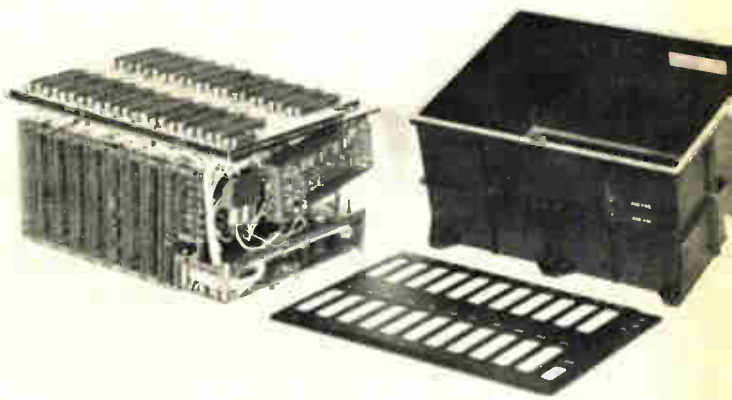
A reliability model of the encoder with each of the main functional areas and its failure rate is shown in Fig. 2. Failure rates are calculated by conventional methods for each function. Total encoder failure rate is simply the sum of the failure rates of each functional block.

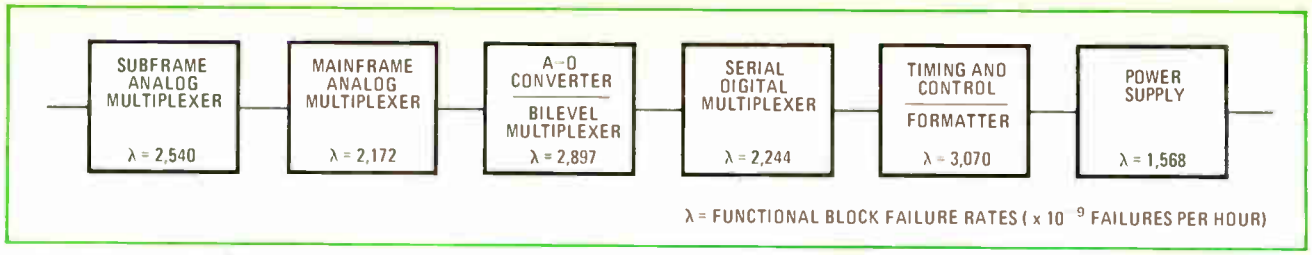
Numerous tradeoffs determine the number of functions to be isolated. However, as will be seen later in partitioning for functional redundancy, it is generally desirable to structure the model so that the reliability of each functional block is approximately the same. Otherwise, one particularly unreliable functional block has a dominant effect on the total system reliability, and the capability of switching between parallel redundant functions elsewhere in the system becomes relatively meaningless.

For this reason, the more reliable analog-to-digital converter and the bilevel multiplexer have been lumped together so that they form a single function. So also do

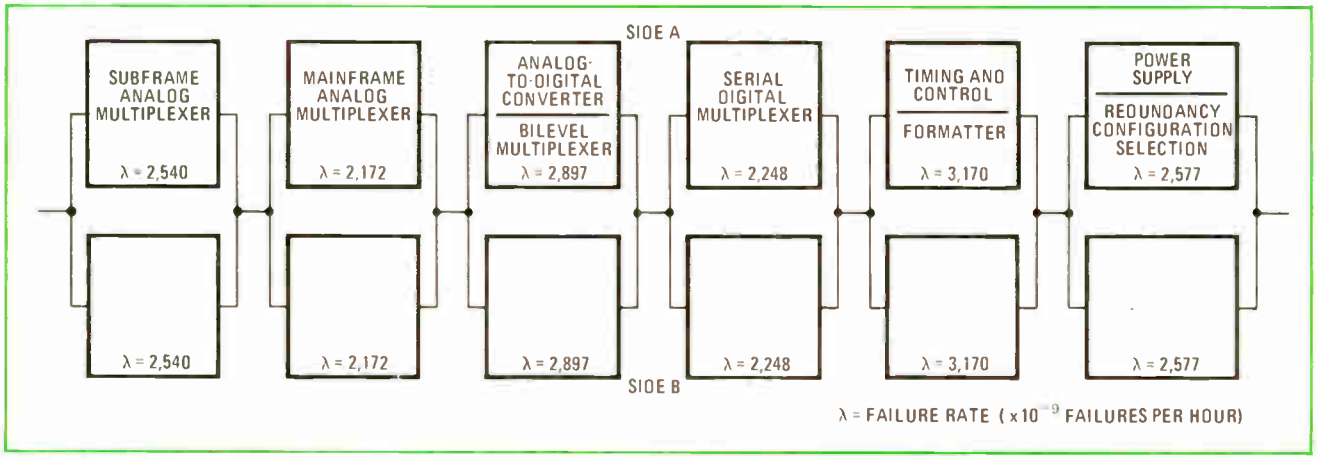
1. Typical subsystem. A PCM encoder is a good example of an electronic subsystem that can be readily partitioned into redundant functional blocks for enhanced reliability. Photo shows hardware required for the parallel-redundant encoder now used.







2. Nonredundant model. Reliability model for the nonredundant encoder shows its vulnerability to failure. Total failure rate (which in this case is 14,491 × 10^{-9} failures per hour) is the sum of the rates for each functional block.



3. Functional redundancy. Reliability model for the functionally partitioned encoder cross-straps outputs of one stage to inputs of subsequent stages. Additional circuitry is needed to control the redundancy configuration through appropriate command switching. This added circuitry increases failure rates in some functional blocks over those in the model of Fig. 2.

the formatter and the timing and control circuitry.

Consider first the case of a nonredundant configuration. The total failure rate of the operating encoder is the sum of the individual component failure rates. In this case, the rate is 14,491 × 10^{-9} failures per hour.

Reliability analysis

System reliability, or probability of the encoder's survival at some time in a given mission, is calculated from:

$$R_S = e^{-\lambda t} \quad (1)$$

where λ = the failure rate in failures per hour, and t = mission operation time, in hours.

The typical power-on operational time of the encoder is 5% of the total mission time. Inactive component failure rates (for components in a power-off or standby state) are estimated at 10% to 50% of the active failure rate. For the present example, a 50% figure will be assumed.

Thus, with an operational duty cycle of 5%, the failure rate becomes:

$$\lambda = (\lambda_{on}t_{on} + \lambda_{off}t_{off})/t$$
$$= [\lambda_{on}(0.05t) + 0.5\lambda_{on}(0.95t)]/t = 0.525\lambda_{on} \quad (2)$$

where λ_{on} = failure rate of components in powered state
$\lambda_{off} = 0.5\lambda_{on}$
t_{on} = 5% of mission time t
t_{off} = 95% of mission time t

Substituting equation 2 in equation 1, we get:

$$R_S = e^{-0.525\lambda_{on}t} \quad (3)$$

Now consider two encoders in parallel standby redundancy. The operating unit has a compound failure rate of λ_1, while the standby unit has a failure rate of λ_2 after it begins to operate, but otherwise has a failure rate of λ_3. The reliability of such a configuration is: [1]

$$R_P = e^{-\lambda_1 t} + [\lambda_1/(\lambda_1 + \lambda_3 - \lambda_2)][e^{-\lambda_2 t}e^{-(\lambda_1+\lambda_3)t}] \quad (4)$$

where R_P = probability of survival of the two units in parallel
$\lambda_1 = \lambda_2$, since both units are identical
$\lambda_3 = 0.5\lambda_1$

The parallel standby redundant configuration, however, is inefficient since the operational circuitry that is not affected by a failure may no longer be used. It is more efficient to partition the system circuitry functionally into smaller blocks of circuitry that can be activated on command, and so make the encoder redundant at this functional-block level. The reliability model of an encoder that has been partitioned in this way is shown in Fig. 3.

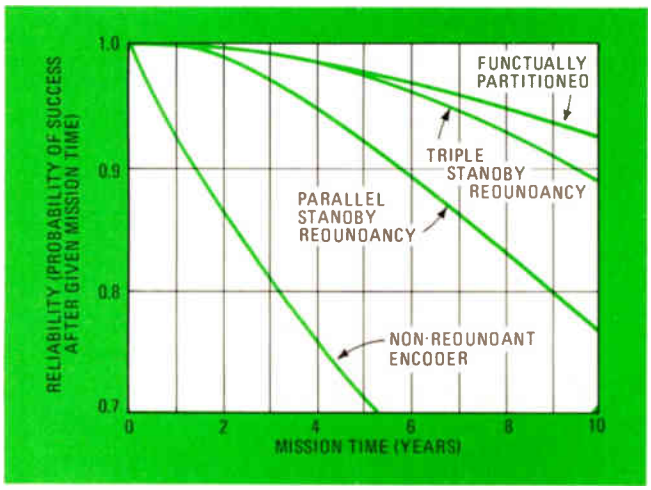
With the encoder partitioned into six parallel-redundant functional blocks, it can now be configured into 2^6, or 64 possible combinations of functions to circumvent failures should they occur. Functional sections are activated by power switching. The reliability for each parallel stage is calculated using equation 4. The total system reliability is the product of the reliabilities of each of the six stages.

Note that in Fig. 3 the failure rates in some functional blocks have increased over those in the model of Fig. 2. These increases are due to the additional circuitry required to process the redundancy configuration command word, to switch power to activate functional blocks, and to provide fail-safe cross-strapping of signals between blocks. Overall, a 7.5% increase in components is required in this case.

The reliability for the functionally partitioned enco-

der is compared with the parallel redundancy configuration in Fig. 4 for mission times of up to ten years. As the graph indicates, functional partitioning achieves a very significant improvement.

The reliability of a triple redundant configuration (three units in parallel) is also plotted. Here, a marked improvement over parallel redundant configurations is also achieved, but the hardware, weight, and cost are increased approximately 50%. And for durations that are greater than about five years, triple standby redundancy is still noticeably less reliable than functional partitioning.



4. Reliability comparisons. By functionally partitioning an encoder into six parallel stages, it's possible to increase its reliability even beyond that achieved by placing three encoders in standby redundancy. At the end of a ten-year mission, the probability of success of such a functionally partitioned encoder is 0.9265.

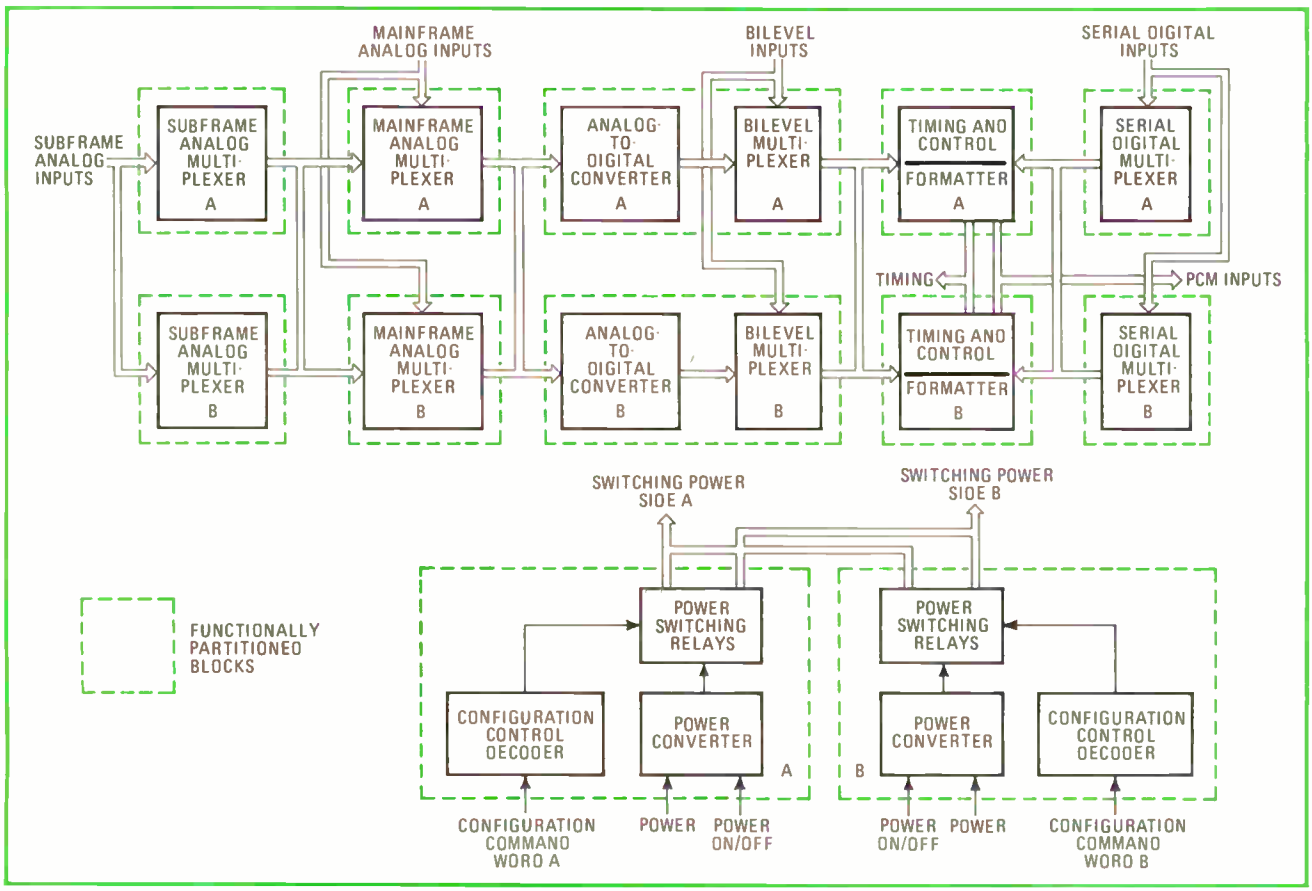
System features

The organization of a functionally partitioned encoder is shown in Fig. 5. Redundancy is controlled by a serial digital command word from a satellite command decoder.

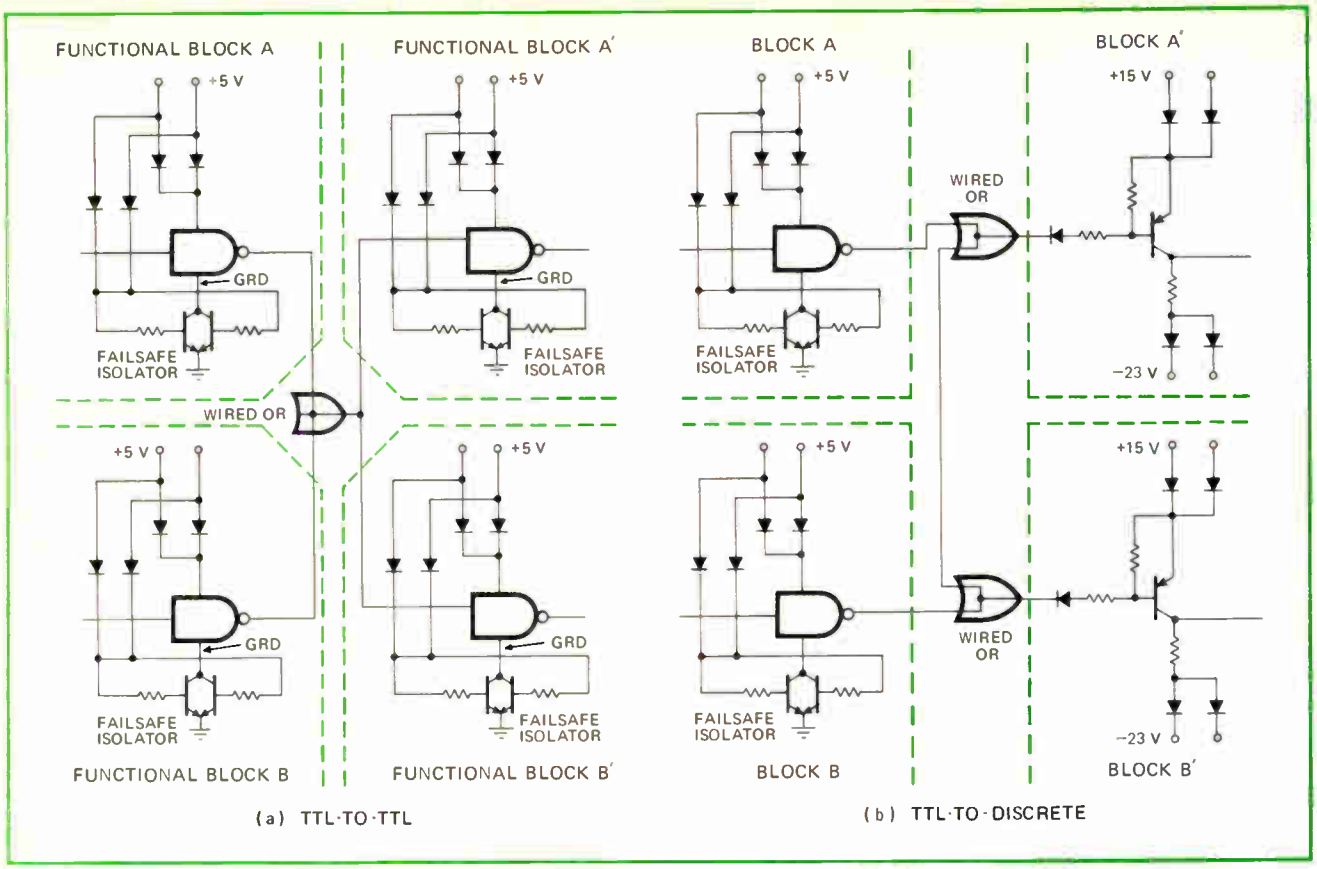
A command word initiates operation of electromechanical latching relays, which then switch power to the functional section to be activated. Such relays have the advantage over solid-state power switching, in that they maintain a given redundancy configuration even after a power on-off-on sequence. Because the relays are in a normally inactive state, their reliability is approximately equal to that of solid-state switches.

The state of each latch relay is sampled by the bilevel multiplexer and inserted in the data as a redundancy identification word for ground verification.

For increased reliability, the lines that cross-strap signals between the two sets of functional blocks must be protected against failures in one block that could affect the operation of its parallel-redundant block. A typical cross-strapping arrangement (Fig. 6a) connects TTL output gates in functional blocks A and B to TTL input gates in subsequent blocks A′ and B′. To prevent failures due to internal shorting to ground at the TTL input or output, ground isolator circuits are provided to place



5. Signal flow. Redundant configuration is controlled by added decoding circuitry. Electomechanical latching relays select one of 64 possible combinations of operating blocks simply by applying or removing input power to the desired circuit function.



6. Fail-safe cross-straps. In the TTL-to-TTL interfaces generally used between functional blocks, (a), ground isolating circuits prevent a short-circuited input (or output) stage from grounding the signal line and so making the corresponding redundant block inoperable. Similarly, discrete circuits at the input to a functional block (b) can be isolated by input diodes.

a high impedance to ground when bias power is removed. Each ground-isolator transistor-pair is capable of isolating eight output (or input) signal gates from ground.

The diodes in the bias leads isolate the unused power supply. Similarly, Fig. 8 illustrates cross-strapping between TTL gates and discrete circuitry. Here, diodes are used to isolate inputs to the discrete-circuit gates.

Controlling the blocks

In the redundancy control scheme, a six-bit word—one bit for each functional block pair—selects the desired redundancy configuration. Bits of synchronization and parity information can be added to the word to reduce the possibility of executing a word containing errors. In addition, the command word may be accompanied by an enable gate that envelops the command word. Then the command is executed on the enable gate's trailing edge.

Where it is not desired to have a serial command capability, a counter or stepping switch can be used which steps through each possible redundancy configuration. The counter or stepping switch is advanced by a transmitted tone burst. Variations of these techniques which allow any desired level of error control can, of course, be employed.

Conventional guidelines for packaging of high-reliability systems should not be overlooked. Of course, the fact that all the circuitry of the functionally redundant encoder is packaged in a single housing, in addition to decreasing weight and size, also reduces the requirement for relatively unreliable interface connections.

In many cases, the circuitry allocated to a printed-circuit board is limited by the number of functions to be carried on and off the board through a single edge-board connector. Hard wiring of input and output signals circumvents this problem and at the same time increases reliability. Therefore, in high-reliability systems like the encoder, hard wiring of interfaces is preferred to the use of edge-board connectors.

The encoder described has been proposed for FLTSATCOM, the Air Force's next communications satellite program. A similar system has been proposed for the NATO-3 communications satellite, which will also be administered by the U.S. Air Force. And the use of functional redundancy partitioning seems certain in future satellite programs, both military and NASA, especially with a trend toward longer missions with higher investment stakes.

Reliable equipment making use of functional redundancy partitioning could also be incorporated into a number of terrestrial military communications systems, where a combat mission's success depends on uninterrupted communications links. Even in industrial electronic systems, a successful effort in reliability engineering can pay off handsomely in terms of lower maintenance costs and downtime. □

REFERENCE

1. Igor Bazorsky, "Reliability Theory Practice," p. 118, Prentice-Hall Space Technology Series, 1961.

Selecting the optimum circuit-board package

Faced with the alternatives of using wire-wrapped or printed-circuit panels, the packaging engineer's choice can significantly lower costs of engineering design, plant production, and field maintenance

by Max Peel, *Texas Instruments Connector Products, Attleboro, Mass*

☐ Somewhere in the design phase of an electronic product, the packaging engineer enters the picture and begins to develop the assembly drawings, the parts lists, and the detailed parts drawings that will specify the final assembled package.

Before he began his effort, things were simpler. The circuit designer had been penciling his changes on a schematic. There was no formal or detailed documentation that required changes.

The entry of the packaging engineer into the design phase is the first step in expanding the documentation, and as a result, making any change becomes more expensive. Circuit and package changes begin to affect each other, and each change may mean revising many drawings and parts lists. In short, dollars are spent that had not been budgeted.

But frequently these expenses can be mimimized by designing around wire-wrap modular packaging panels that can withstand many circuit modifications with only slight impact on design and tooling costs. Often one such panel can serve as a common foundation for many deliverable products. One version is the pin-in-board panel (Fig. 1) and another is the socket-in-board panel (Fig. 2). These panels frequently prove more economical than printed-circuit boards.

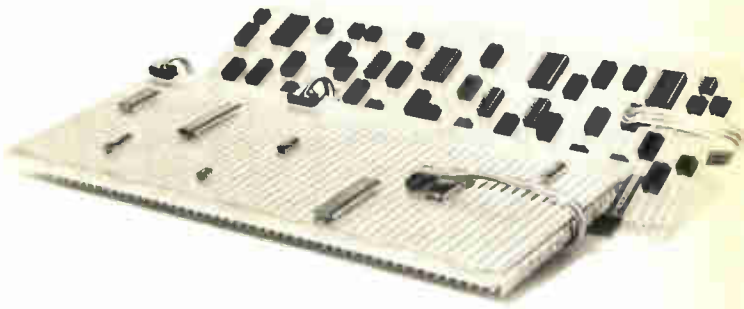
Both the pin-in-board and socket-in-board packaging techniques are highly versatile for several reasons: the component side of the panel will accept a variety of pluggable devices such as dual in-line integrated circuits, IC sockets, and component-mounting platforms. These platforms (Fig. 3) permit such discrete components as resistors, capacitors, and diodes to be plugged into the board.

On the back of both pin-in-board and socket-in-board panels are mounted conventional 0.025-inch-square wire-wrapped pins. The user can interconnect them to establish the circuits he desires. And often inventory can be sharply reduced by stocking several of these standard panels.

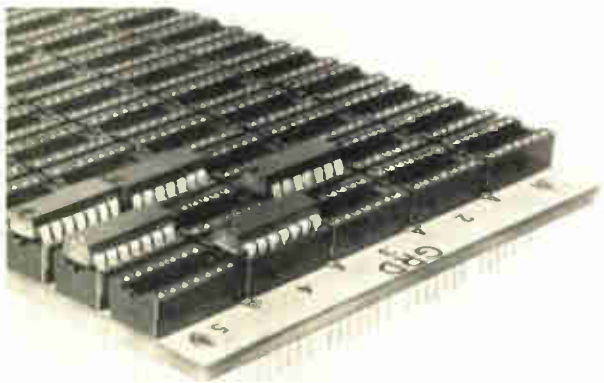
For example, one designer developed 25 deliverable items from only one board-and-socket arrangement. When needed, the board is withdrawn from inventory and wired according to the appropriate wire-wrap program to become one of the 25 systems. Then the desired ICs and other discrete components are plugged into the appropriate sockets.

If printed-circuit boards were stocked instead, it is probable that each board would become only one product. Therefore, if a manufacturer designed 25 systems around printed-circuit boards, he would probably require a unique board for each product.

Is it economically desirable to employ wire-wrap systems, or will it be better to turn to pc boards? A number of variables must be considered in making the decision. Part of the choice concerns whether or not the ICs should be plugged into sockets or should be soldered in place. If the decision is to go pluggable, then the de-



1. Pin-in-board. For dual in-line-device mounting, low-profile board (0.060 inch maximum above panel) may be wired on the back for varying circuit applications. Board is priced between 85 cents and $1.50 per device, based on two devices per square inch.



2. Socket-in-board. More economical than the pin-in-board—60 cents to $1.25 per device, based on two devices per square inch—this cost advantage can be realized at a sacrifice of profile (0.285 inch maximum above the board).

TABLE 1.
IC DEVICE PLUGGABILITY VERSUS REPAIR FREQUENCY

ICs per board	Frequency of IC replacement		
	High	Moderate	Low
Up to 25	Yes	Maybe	No
25 to 100	Yes	Yes	Maybe
Over 200	Yes	Yes	Yes

signer can next examine the options of the wire-wrap board versus the printed-circuit board. If soldered-down devices are selected, the printed-circuit board is the only way to go.

How many devices?

As a starting point, the number of ICs required per board can determine the advisability of field-replacement of IC devices, hence, whether or not pluggable component design is warranted. For a board containing 25 or fewer ICs, and where anticipated frequency of repair is low, pluggable devices are not warranted (table 1). It is cheaper to throw away a faulty board than to repair it.

On the other hand, pluggable devices begin to make economic sense for 200 devices or more, even if frequency of repair is low. The reason is that if repair on a board containing a large number of soldered devices fails, the entire board, which is probably expensive, may have to be scrapped.

There is a gray area for panels containing 25 to 200 devices, so the designer must turn to other factors to reach his decision.

Customers are paying closer attention to repair costs, which are growing because of increases in circuit complexity and rising labor costs. Here is an expression that will determine field repair costs for competing packaging techniques:

$$\frac{(A+B+C+D)}{\text{Yield}} + (E+F+G) = \text{Unit repair cost}$$

when:

A = the cost of access to the device for removal from the equipment
B = the diagnostic cost
C = cost of devices replaced
D = cost of labor for the replacement
Yield = percentage of successful repairs
E = a prorated cost of service-inflicted damage
F = inventory costs
G = obsolescence costs

The term yield indicates the percentage of successful field replacements of the devices. Less than a 100% yield can result from inadvertently installing defective devices or from service-inflicted damage. This yield term does not include losses due to soldering—these costs appear as factor E. Pluggable-system repair yield is about 99.9% for standard small-scale ICs and about 95% for medium-scale integrated devices.

Factor E is the prorated cost attributable to solder damage, like ruining plated-through holes; such dam-

TABLE 2.
SAMPLE UNIT REPAIR COST CALCULATIONS FOR PLUGGABLE AND NONPLUGGABLE SYSTEMS

Factor	Nonpluggable	Pluggable	Remarks
A. Cost to gain access to defective IC.	$100	$100	
B. Cost to diagnose and localize malfunction at a repair station @ $25 an hour plus $15 setup and breakdown cost.	$15 + $40 = $55	$15 + $20 = $35	Pluggable systems average less time to repair because IC devices can be easily substituted.
C. Cost of devices replaced: 12 @ 17 cents each.	$2.04	$2.04	
D. Cost of labor to remove and replace ICs.	$5.00	$1.67	Pluggable devices require no soldering, which speeds device replacement.
Yield. Effectiveness of repair (losses reflect damages and malfunctions other than soldering damages to board, covered by factor E).	90%	99%	Nonpluggable-device repair yields are lower because of component damage during soldering.
E. Damage factor – boards that require scrapping due to solder damage during field repair. (Assume 1 in 10 is destroyed, and boards cost $250 each).	$25	Zero	The 90% repair yield factor due to solder damage is a cost assigned to each nonpluggable field repair.
F. Inventory costs – assume $10 average unit inventory cost. Assume replacement spares of 5% (40 units) for nonpluggable and 3% (24 units) for pluggable, built for an 800-unit marketable run. Assume 30 and 20, respectively, field requests for parts before obsolescence.	$\frac{40 (\$250 + \$10)}{30}$ = $346.67	$\frac{24 (\$250 + \$10)}{20}$ = $312.00	Since damage factor is zero for pluggable systems, fewer spares need be built.
G. Obsolescence cost – parts stocked, but not shipped as spares, are chargeable to the shipped spares. Assume $15 unit inventory cost until units are declared obsolete and scrapped.	$\frac{10 (\$250 + \$15)}{30}$ = $88.33	$\frac{4 (\$250 + \$15)}{20}$ = $53.00	

FOR A NONPLUGGABLE SYSTEM

$$\text{Unit repair cost} = \frac{(A+B+C+D)}{\text{yield}} + (E+F+G)$$

$$= \frac{(\$100 + \$55 + \$2.04 + \$5.00)}{0.90} + (\$25 + \$346.67 + \$88.33)$$

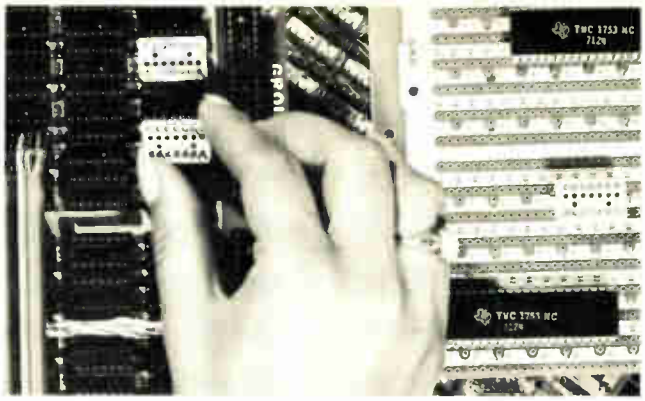
$$= \$640.04$$

FOR PLUGGABLE SYSTEM

$$\text{Unit repair cost} = \frac{(A+B+C+D)}{\text{yield}} + (E+F+G)$$

$$= \frac{(\$100 + \$35 + \$2.04 + \$1.67)}{0.99} + (\$0 + \$312.00 + \$53.00)$$

$$= \$505.11$$



3. **For discretes.** Component-mounting platforms, shown plugged into both socket-in-board and pin-in-board panels, facilitate mounting capacitors, resistors, and other leaded devices.

age renders the entire board useless. This factor is, of course, zero for pluggable systems.

Factor G is a cost assigned to obsolescence, which comes about from time to time as a result of design changes that require scrapping of spare boards in inventory. Some typical calculations of unit repair cost, with numbers assigned to all of the factors, appear in table 2.

Downtime

Since downtime is crucial in most systems, it is important to examine the impact of pluggable components on how long the equipment can be expected to be out of service. It turns out that pluggable systems enable both faster fault diagnosis and repair than do nonpluggable systems. Some calculations provide numerical values for comparing the two types of systems.

For pluggable systems, downtime = $K_1 + (C \times D)$, where K_1 is the time required for the equipment to be shut down while making diagnostic tests, replacing components, and starting up; C is the time required to remove and replace faulty ICs; and D is the number of devices handled.

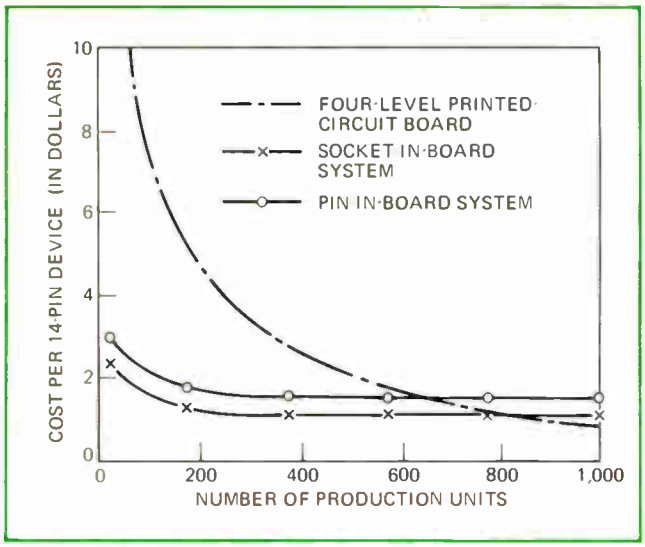
For soldered-device systems, downtime = $K_2 + (A+B+C) \times D$, where A is the time required to unsolder devices and B is time required to solder replacements.

K_1 will be smaller than K_2 because frequently the serviceman can localize the malfunction in a pluggable board by simple device substitution. In fact, it may be economically desirable to replace all ICs on boards containing only a few pluggable devices.

However, in nonpluggable systems, the dangers that accompany unsoldering a multiple-lead device discourage removal of a suspected faulty IC until the serviceman is reasonably sure that it is indeed the culprit. The values of K_1 and K_2 will also be influenced by the size of the board, and particularly by the number of ICs on the board.

Which board?

If the designer chooses a pluggable system, the next question to be resolved is whether to choose a wire-wrapped or a printed-circuit board. As a starting point, the designer should consider the quantity of systems planned for production. This determines the unit device cost. Figure 4 presents costs for three packaging approaches—the two wire-wrap techniques and solder-mounting devices on a pc board.



4. **Tooling impact.** Steep descent of multilevel printed-circuit board cost curve indicates the heavy tooling-cost impact on the first 800 units. In contrast, tooling costs for pin-in-board and socket-in-board systems heavily load only the first 200 units.

These assumptions were made in generating the curves:

- Multilayer boards have four conducting layers.
- Cost is based on 100 ICs per board.
- Tooling costs are included.
- Wire-wrap connections on socket-in-board and pin-in-board assemblies average seven wraps per device.

The slope of each curve in Fig. 4 reflects the impact of tooling costs on the wire-wrap boards and the multilayer boards. Since tooling costs are virtually independent of production volume, this fixed cost is spread over an increasing number of devices as volume increases. For higher-volume production levels, the tooling cost becomes a proportionally smaller fraction of the unit device cost.

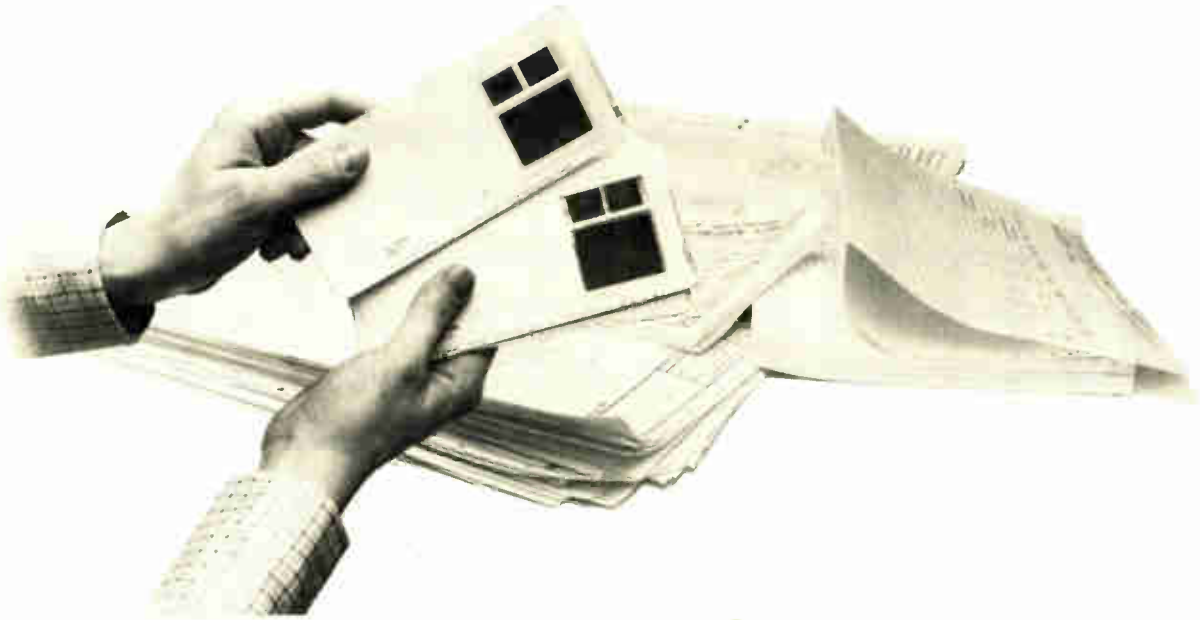
Because tooling costs are virtually amortized at about 200 units in the pin-and-socket systems, these two curves nearly level out after that point. On the other hand, tooling costs for multilayer boards impact unit costs heavily through the first 800 devices; then the curve begins to level out, and at 800 it crosses the curve that represents the socket-in-board systems.

Unit costs are high for devices in multilayer pc boards for less than 800 units because the original artwork and subsequent artwork changes, which continue until the system is debugged, are costly. In contrast, debugging changes in wire-wrap systems are usually confined to modifying the wire-wrapping program, and these alterations are less costly than artwork changes.

Above 800 units, the cost per device diminishes only slightly for all three approaches, and devices used in multilayer boards become about 10 to 40 cents a unit cheaper than the pin-in-board and socket-in-board packaging techniques.

Should the designer consider using multilayer printed-circuit boards with sockets soldered in place, he must add 14 to 25 cents a unit above the multilayer curve shown in Fig. 4 for the multilayer board. □

How to get it all under control.



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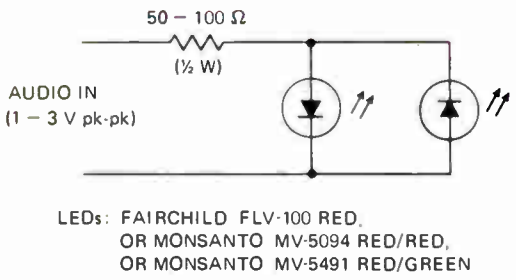
Visual zero-beat indicator uses reverse-polarity LEDs

by Calvin R. Graf
Kelly Air Force Base, San Antonio, Texas

Two light-emitting diodes connected in parallel, but with opposing polarities, make an inexpensive display for indicating zero-beat frequency (the frequency at which a receiver is exactly tuned to the signal being transmitted). The display can be driven by an audio-frequency voltage from a single-sideband receiver or by the signal for an rf signal-generator headset. A current-limiting resistor protects both the LEDs from overload.

When the input frequency is more than 1 kilohertz away from the zero-beat frequency, both LEDs appear to be on all the time. Each one is correctly biased for half a cycle of the input and shut off for the other half. As the input frequency comes within about 20 hertz of zero beat, the LEDs will flicker until zero beat is reached. Both LEDs then go out and remain out over the width of the zero-beat-frequency notch, which is about ±5 Hz.

While the display is being tuned, LED intensity varies, since it depends on the low-frequency response of the audio amplifier being used. If the amplifier can go down to dc, the circuit can be used to detect the direction of current flow—each LED can indicate a different direction for current flow. If red and green LEDs are used, the direction of current flow can be color-coded. □



Zero-beat display. Light-emitting diodes connected with reverse polarity provide visual indication of zero-beat frequency. Each LED is on for only half a cycle of the input. Both LEDs glow or flicker until zero beat is reached, when they go out. The zero-beat notch is ±5 hertz.

Computer plots curves on standard printer

by David Klein
Automation Industries Inc., Vitro Labs Division, Silver Spring, Md.

Although most computer facilities contain digital plotters, curves are frequently plotted by hand because using a digital plotter requires additional programing and turnaround time. A Fortran subroutine, however, enables a standard printer to plot curves directly.

The Fortran subroutine of Fig. 1 can print any number of curves simultaneously, although only 12 different symbols (one is a blank) are provided in this instance.

ARGUMENT DEFINITIONS		PRINTOUT SYMBOL	INTEGER DESIGNATION
ARG1:	Name of array under which curve data is stored	0	1
ARG2:	M dimension of array	*	2
ARG3:	Number of curves to be plotted (N dimension of array)	X	3
ARG4:	Starting point of X axis	+	4
ARG5:	Amount X should be incremented	·	5
ARG6:	Final value of X (end of X axis)	A	6
ARG7:	Name of array in which symbol data is stored	D	7
ARG8:	Integer indicator – logic 0 tells subroutine to generate its own linear X axis, logic 1 tells subroutine that user is generating X axis	4	8
ARG9:	Name of array in which user's X axis is stored (Use logic 0 if ARG8 is logic 0)	Q	9
ARG10:	Value to which ARG9 is dimensioned (Use logic 1 if ARG8 is logic 0)	#	10
ARG11:	Number of data points to be plotted if ARG8 is logic 1, otherwise logic 0	S	11
ARG12:	Increment in which X-axis values are to be printed	Blank	12

1. Software plotter. Subroutine written in Fortran permits computer printer to plot directly up to 12 curves at the same time. Since one of the printout symbols is a blank, one of the curves can be made invisible. The X axis can be scaled in a number of ways, even with a special function, such as a logarithmic curve. Points of intersection between two curves are noted by the $ printout symbol.

The X axis can be started or stopped at any value and incremented by any amount. In addition, the user can specify at what increment the X-axis values are to be printed out.

Also, an option is included that allows the user to select any function he wishes to scale the X axis—for example, a logarithmic function. When this option is used, the fifth argument of the call statement positions the Y axis within a window around zero that is within 25% of the X increment. The other argument definitions and the 12 printout symbols are listed in the table.

X-axis scaling is determined by the maximum and minimum data values of the first curve to be plotted. When these data points are all positive or all negative, the program will position the X axis at the top or bottom of the printout page. When the data values are both positive and negative, the X axis is printed in the center of the printer field allocated for the graph.

The user can scale the Y axis to a value larger than the maximum value of the desired function by filling the plotting-data array for the first curve with a function that will be scaled by the program according to the desired maximum and minimum values. Since this function is not the desired curve, it can be printed with the blank printout symbol so that it will be invisible. But whenever it crosses either the X or Y axis, it will blank out the printout symbol for that axis.

If the X and Y values of any two curves are the same, the $ symbol is printed, unless one of the curves is invisible. The invisible curve, then, can also be used to blank selected portions of a function.

The user's main program must include:

- A call statement, for example, CALL PLOT (ARG1, ARG2, ..., ARG12).
- An INTEGER array dimensioned to 12.
- A REAL*4 array dimensioned N, M, where N is the number of curves to be plotted, and M is greater than or equal to the number of data points.

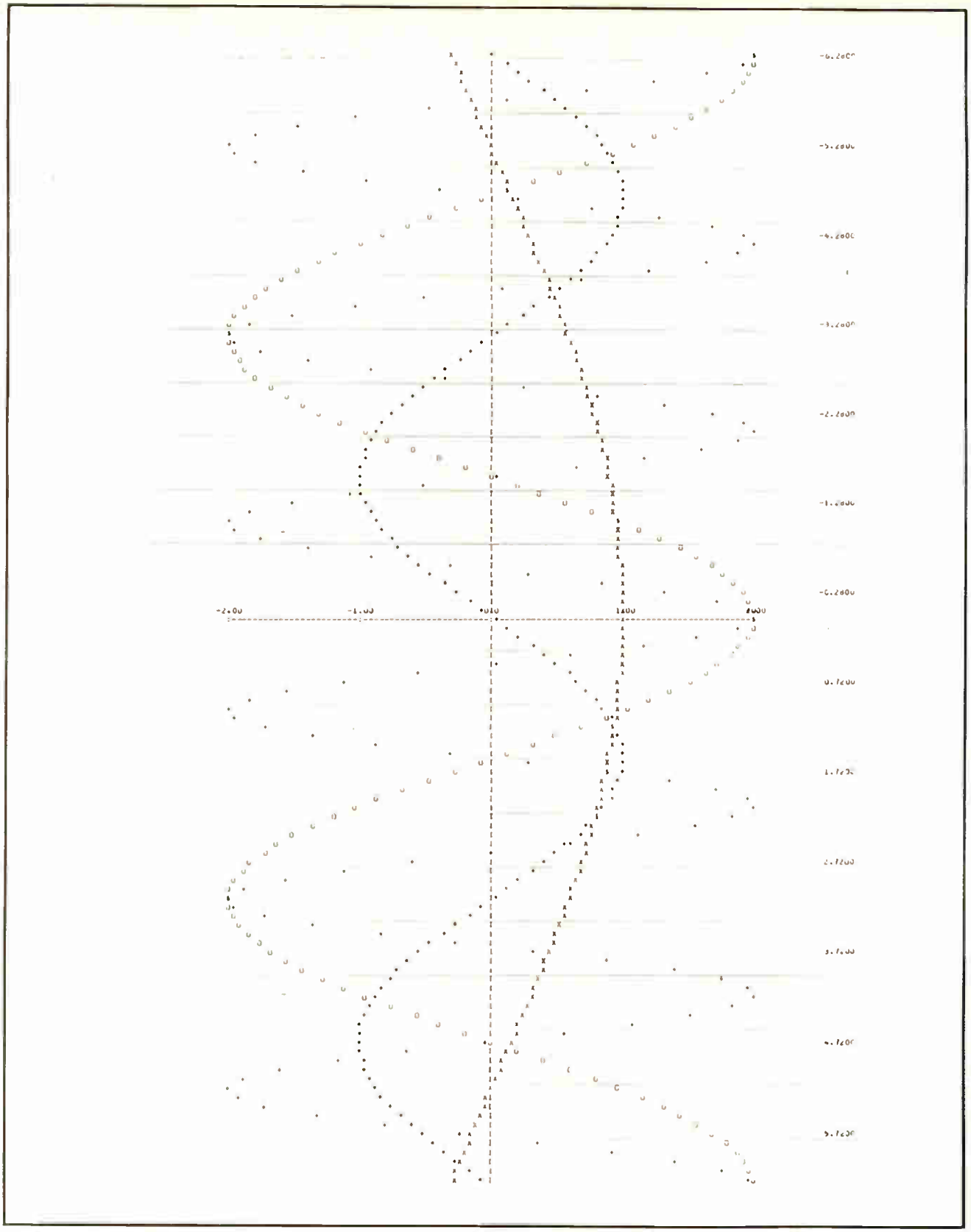
A symbol to plot each curve is designated by an integer stored in array ARG7. The table shows each printout symbol and its associated integer callout. If the array is called NSYM and two curves are to be plotted with NYSM(1) = 12 and NYSM(2) = 3, then the first curve will be invisible, and the second will be indicated by X.

Figure 2 contains a sample of a main program calling in subroutine PLOT to graph four curves simultaneously. The resulting printout of three cosine functions (printout symbols 0, X, and +) and a single sine function (printout symbol *) is also shown. When any of the curves intersect, the $ symbol is printed.

It is best to retrieve the data generated for subroutine PLOT on a high-speed printer that has a 132-character

```
      DIMENSION  A(4,200),NSYM(12),R(2,100),XRAY(100)
      SAX=6.28
      START=-6.28
      DO 200  M=1,130
      A(1,M)=COS(START)*2.0
      A(2,M)=SIN(START)
      A(3,M)=COS(START*0.3)
      A(4,M)=COS(START*3.07)*2.0
      START=START+0.1
200   CONTINUE
      DO 250 N=1,4
250   NSYM(N)=N
      CALL PLOT(A,200,4-6.28,0.1,SAX,NSYM,0,0,1,0,10)
      X=1.0
      HRADR=50.0
      SQRH=SQRT(HRADR)
      DO 300 N=1,100
      XRAY(N)=10.0**X
      R(1,N)=300.0
      R(2,N)=1.23*(SQRH+SQRT(XRAY(N)))
      X=X+0.05
300   CONTINUE
      NSYM(1)=12
      NSYM(2)=7
      CALL PLOT(R,100,2,0.0,40.0,100000.0,NSYM,XRAY,100,76,2)
      STOP
      END
```

2. Calling in the subroutine. Sample program shows how subroutine PLOT can be used to obtain graph of four curves simultaneously. There are three cosine functions (represented by symbols 0, X, and +) and a sine function (represented by the * symbol).



field. If the field is smaller, the format statements can be appropriately modified. A teleprinter terminal can be used for data retrieval, but the subroutine uses a carriage typeover control to which this type of terminal does not respond. As a result, a teleprinter leaves a one-space break in the plot where the Y-axis values are printed out. If the plot begins with the Y axis (the first curve being plotted has an initial X value of zero), then this limitation does not apply. □

Engineer's notebook is a regular feature in Electronics. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

Engineer's newsletter

1-k RAMs nudge shift register in display refresh

Now that 1,024-bit random-access memories **have come down in price to the $3 or $4 level in big buys,** designers of terminals should check out the idea of using them for display refresh. Shift registers are the usual way to do the job, but RAMs are faster and more flexible. For example, **a 1-kilobit RAM whose address is counter-cycled makes a dandy variable-length shift register,** just right for a display-refresh application.

Technician supply drying up?

Circuit designers had better get their soldering irons ready because soon they may be building their prototypes as well as designing them. Fewer technicians will be coming down the pipeline, according to a recent survey conducted by the Engineering Manpower Commission of Engineers Joint Council. The Commission estimates that, overall, first-year tech enrollments were down by 2% and second-year enrollments down by 6% last year. **Some schools have even dropped their technology programs.**

Need a third eye? Use a LED

Here's a cute idea from NASA that's so simple it hurts. When you really must know the instant a warning light on a bench prototype goes on, **tape a phototransistor or photodiode to the light and hook it up to a bell** or, better yet, a relay off-switch.

Quick switch

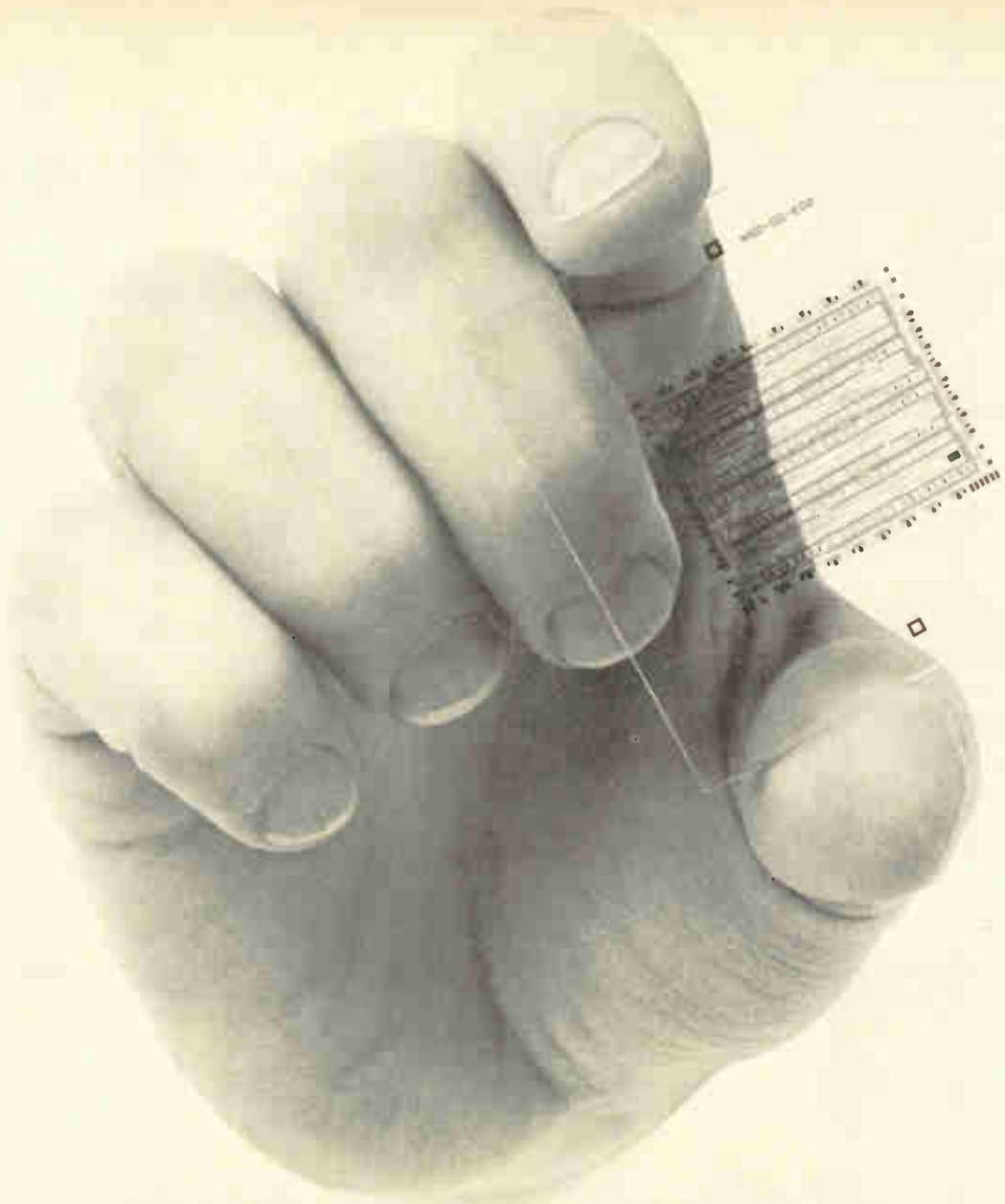
Those of you who design a system first and fish around for the right switch at the last minute should **hang a new designer's prototype kit on the bench.** Offered for $17 by Cherry Electrical Products Corp., Waukegan, Ill., the kit features 32 popular switches worth $69, including snap-action, thumbwheel/leverwheel, keyboard, and crosspoint switches. What's more, the firm will replace items used off the board this year without charge.

Manual helps keep track of software

Starting in April is **a new reference service for data-processing managers,** who surely can use all the help they can get keeping the software flowing. Monthly portfolios, called Data Processing Manual for Computer Operations and Management, will cover six subjects: general management; administration; system development; standards, practices and documentation; operations, and technology. Annual price for portfolios and desk-size binder: $125 before March 31, $150 after. Write to Auerback Publishers Inc., Dept. 10503, 121 North Broad St., Philadelphia, Penn. 19107.

How to attack the TTL-ECL interface

If you've been itching to upgrade a TTL system with some fast ECL circuits but have hesitated for lack of decent buffers, you can take heart. Semiconductor manufacturers are busy tooling **ECL-to-TTL interface circuits that will give peripheral TTL data entry to ECL processors,** and vice versa. For example, Motorola's new 10124 and 10125 quad translators (±5-volts power supply) will interface data and control signals between ECL and the saturated logic sections of a digital system and do it **with an insertion delay of only 5 nanoseconds.** Quad translators 1067 and 1068 will move it the other way.



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Circle 126 on reader service card

Instrument innovations to be spotlighted at Intercon 73

Storage unit adjusts for analyzer error

Network analyzers are supposed to give accurate measurements of magnitude, phase, group delay, and other parameters, but like most other instruments, their measurements are imperfect. A television manufacturer may not require more accuracy than the analyzer can give him, but in some applications, such as communications-relay stations, the inherent error of a measuring system may be important. To improve accuracy by offsetting the effect of these errors, General Radio Co. will introduce at IEEE Intercon 73 the model 1716 reference-storage unit as an accessory to the company's model 1710 rf-network analyzer.

Basically, the 1716 consists of a semiconductor memory with 256 8-bit words, an analog-to-digital converter, and a simple arithmetic unit. The errors inherent in the analyzer are determined by hooking up the 1710 to a dead short and seeing how much the frequency response varies from a straight line. This error, as a function of frequency, is stored in the RSU's memory. The arithmetic unit subtracts these systematic errors before the output is displayed.

While GR sees the 1716's main use as error correction, the instrument can also compare measurements or do limit-testing—the limits or comparisons are simply stored in memory—and do go/no-go testing. It can also digitize analog measurements and can be used as an a-d converter if the user wishes.

At $1,600, the 1716 is considerably less expensive than computer-operated units that can cost from $22,000 to more than $100,000, including analyzer. GR claims it is also cheaper than competing units that are not computer-oriented, which start at about $2,000.

The unit accepts an input range of 1 to 4 volts from any source, and it takes both sweep inputs from 10 milliseconds to 10 seconds and signal inputs of ±0.5 v, as well as digital input. Up to 256 sample points can be taken, which the a-d converter breaks down into digital numbers representing, for instance, amplitude. Output resolution is 0.25% of full scale; for example, a frequency-response flatness of 0.025 decibel can be achieved over the full 500-megahertz operating band of the 1710. That accuracy is roughly 100 times better than the 1710 achieves when operating alone.

The 1716 is designed to be used with GR's own network analyzer, but the company says it can also be used with those made by other companies, as well as with multimeters, bridges, and other instruments. "It can be used with anybody's equipment, regardless of what it is measuring," says a spokesman, "as long

as it is given the right signal."

However, GR expects the bulk of the sales will be for use with the 1710. Anyone looking at higher frequencies will be interested in the unit, GR thinks, including manufacturers of communications equipment and crystals.

Price of the 1716 is $1,600. Delivery, from stock, is to start in April.

General Radio Co., 300 Baker Ave., West Concord, Mass. 01781 [364]

5½-digit panel meters to bow

A unique line of 5½-digit panel meters will be unveiled at IEEE Intercon 73 by Data Precision Corp. Called the series 3,000, the DPM is essentially a lower-cost, stripped-down version of the company's series 2,000 digital multimeter. The new meter comes in five standard models with full-scale voltages ranging from ±100 millivolts to ±1,000 volts. Pricing is $645 each for all the meters, except the 100-mV unit, which goes for $695.

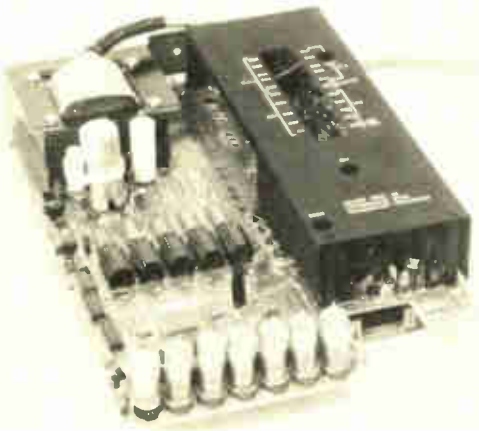
Built around the company's Triphasic a-d converter, the series 3,000 meters all have automatic zero-setting, which not only eliminates offset errors, but reduces drift, as well.

The Maximum error for all of the meters except the 100-mV unit is ±(0.007% of reading + 0.001% of full scale + 1 least significant digit). For the 100-mV meter, the figures are ±(0.008% of reading + 0.004% of full scale + 1 digit). All of these figures are specified by Data Precision for six months at a temperature of 23° ±5° C.

To make sure that all of this accuracy is not wasted, the DPM has a true-differential, floating, guarded, bipolar input section, completly isolated from the power supply and digital circuitry. Although the meter can handle bipolar signals and indicate polarity automatically, it does not suffer from tracking errors in polarity reversals because it uses only one zener reference element, regardless of the polarity of the voltage that is being measured.

Input impedance is greater than 1,000 MΩ on the three lowest ranges, and is equal to 10 MΩ on the two top ranges.

Data Precision Corp., Audubon Road, Wakefield, Mass. 01880 [365]



Under-$3,000 generator has digital display

Digital frequency readout in an am/fm signal generator priced below $3,000 is offered by Boonton Electronics Corp., Parsippany, N.J. in the just-into-production model 102A. In its design, Boonton was out to "capture a fair share of the fm market, but not in an $8,000-to-$10,000 generator," says staff engineer Ray Polen. The company is counting on the price level (under $3,000) plus some attractive design features. The generator has a true-peak-reading modulation meter, an fm generator that provides at least 1 megahertz of deviation at the low end of the frequency band, and a variable-inductance tuned oscillator.

Applications include measurements for mobile-radio, entertainment, navigational aids, telemetry systems, and communications equipment.

The model 102A has a five-step frequency range of 4.3 to 520 MHz, displayed to 100-Hz resolution on a six-digit light-emitting-diode display. Stability is specified 10 parts per million per 10 minutes after a two-hour warm-up time, which is fairly typical of such units. But Polen claims that the 102A's stability has been found to reach this figure typically after only 15 minutes of warm-up, and the specification may soon be changed. Making this quick readiness possible is a variable-inductance oscillator, rather than the cavity generator used in more-expensive units, Polen explains. With a much lower mass than a cavity generator, the Boonton oscillator reaches its stable temperature point much faster than comparable units, he points out.

Output of the generator is +13 to −130 dBm, and worst-case accuracy is within ±2.0 dB, leveling to ±0.5 dB. For fm operation, the unit is calibrated from 0 to 300 kilohertz at all carrier frequencies, and it is true-

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The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

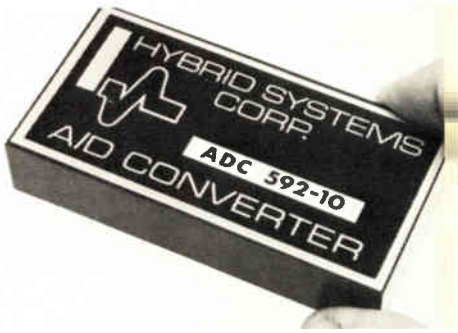
Circle 129 on reader service card

ter. The model 395 d-a converter lends itself well to use in the a-d converter, and dense packing further cuts down on size. The 395 is plugged into a digital card, and all logic is of the high-speed Schottky type—"We used the fastest stuff we could get our hands on," says the spokesman. The 395 has a fast settling time of 50 ns, which, in conjunction with a proprietary variation of successive-approximation logic, allows the logic to operate at its highest rate, the company says.

The unit uses a clock that automatically varies in accordance with the bit position. For operation, only ±15 V, ±5 V, is necessary, and no trimming or external components are required. The 592-10 will operate over a temperature range of 0 to 70°C with a temperature coefficient of 50 ppm/°C. Selection of input signal is through a simple pin interconnection. Coding is binary and fully TTL/DTL-compatible. Dual in-line pin spacing lets the unit plug into a standard IC socket.

Price of the ADC592-10 is $895.

Hybrid Systems Corp., 87 Second Ave., Northwest Park, Burlington, Mass. 01803 [367]



Digital synthesizer has 8 ranges

One significant factor in the increasing popularity of frequency synthesizers is the steady reduction in prices for these stable signal sources [*Electronics*, April 24, 1972, p. 78]. A new model at Intercon 73 sells for $800.

The SI-80 digital synthesizer from Syntronics Inc. offers BCD programability and five-digit frequency selection in eight ranges from 0.1000 to 9.999 megahertz.

The solid-state instrument puts out a continuously variable 0-3-volt TTL-compatible square-wave signal having frequency accuracy and stability to within ±10 parts per million from 0°C to 50°C. Nonharmonic spurious output is 70 dB below full output from 1 hertz to 100 kilohertz and 60 dB below full output from 100 kHz to 10 MHz. Phase noise is 60 dB below 1 radian from 0.1 Hz to 100 kHz, 40 dB below 1 radian from 100 kHz to 1 MHz, and 30 dB below 1 radian in the range from 1 MHz to 10 MHz.

Settling time of 100 milliseconds for a 10% frequency step is typical with the SI-800.

An additional provision is made to accommodate an external 1-MHz standard input. Options include extended output range to .001 Hz and 16 MHz, external dc power input, and ±1 ppm stability from 0°C to 15°C.

Price is less than $800 in single quantities.

Syntronics Inc., Marlboro, Mass. [362]

Meter provides 5 functions

A full-function digital multimeter that sells for under $1,000 will be introduced at Intercon 73 by Systron-Donner's Instruments division. It provides five full functions for measuring ac, dc, volts, amperes, and ohms. Features include lead compensation for resistance measurements, ac voltage response to 1 megahertz, an in-line Sperry display that provides positive indication of overrange, and 10 ranges of built-in dc and ac.

The five-function, 26-range model 7205 offers five ranges of dc voltage to a maximum of ±1-microvolt reso-

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Circle 133 on reader service card

lution with 1,000-volt protection on all ranges, five ranges of ac voltage measurement with 500-volt protection and 1-megahertz response, six ranges of resistance with a maximum resolution of 1 milliohm featuring advantages of four-wire resistance without the complexity of four leads, and 10 ranges of built-in dc and ac to 1.3 amperes.

Overrange is 30% on the large in-line, in-plane ½-inch display. Input impedance is greater than 1,000 megohms on the three lower dc voltage ranges. Common-mode and normal-mode noise rejection is greater than 140 dB and 60 dB, respectively, with 500 volts common-mode voltage capability.

The price is $995.

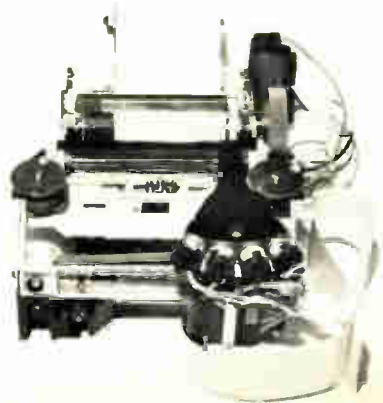
Concord Instruments Division, Systron-Donner Corp., 10 Systron Dr., Concord, Calif. 94518 [369]

Flexible printer

A serial impact-type dot matrix output printer will be introduced at Intercon 73 by Victor Comptometer Corp.'s Business Products group, Chicago. Developed for use in future Victor electronic calculators, it can also be used for point-of-sale systems, instrumentation, data logging, and business machines.

The IPM 130 is fully alphanumeric and prints 110 characters per second with a capacity of 34 characters per line, six lines per inch. It can be used for 5-by-7 or 9-by-7 character fonts, and will accommodate adding-machine roll paper from 2 9/32 through 3¾ inches wide. The mechanism measures 9¼ by 9½ by 5½ inches, and weighs 5½ pounds.

Victor Comptometer Corp., Business Products Group, 3900 N. Rockwell St., Chicago, Ill. 60618 [370]



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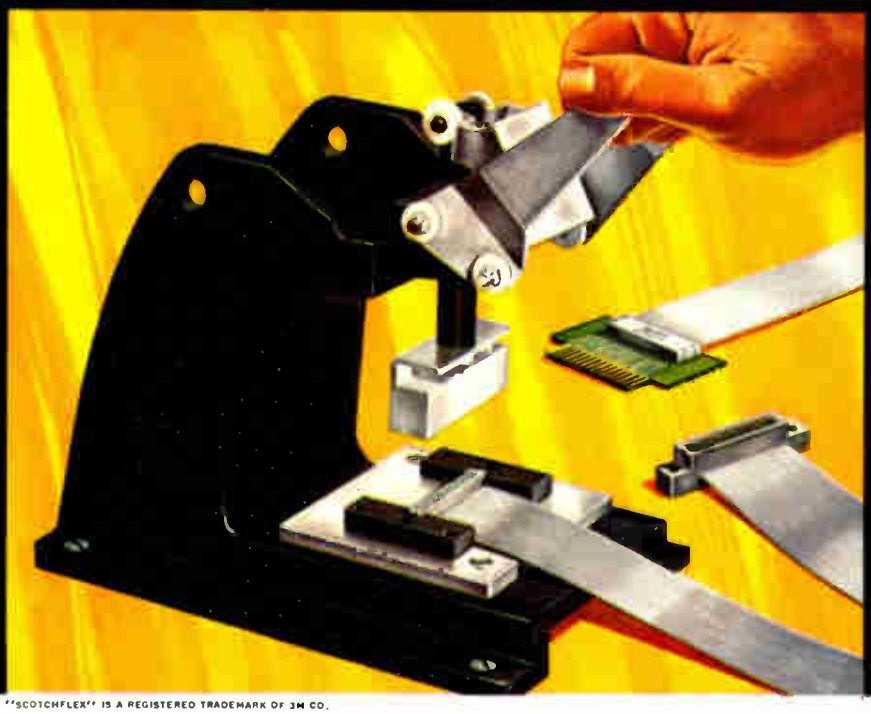

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Switching capabilities range from 1.7 to 20 A rms, 60 Hz depending upon type of package and mounting method. All have a 1 Form A (SPST-NO) "contact" as well as an internal RC network that provides dv/dt suppression. All feature the inherent long life and the ability to switch high inrush loads that characterize thyristors.

ECT Series. Steady-state rms current ratings (at 25°C) range from 2 to 20 amperes depending upon the method of mounting. Coil voltages are from 5 to 48V DC. Power requirements are 290 mW for 120V, 60 Hz operation and 450 mW for 240V, 60 Hz. .250″ quick-connect terminals are standard with .187″ and .205″ also available.

EBT Series. The solid-state "contact" is designed to carry a maximum load current of 7A rms, 60 Hz at 25°C ambient. This series provides the convenience of octal plug-in terminals and may be mounted in a socket having screw terminals.

JDB Series. This fully-encapsulated, low-profile (.350″ height) hybrid will switch 1.7A AC loads. It is being used in modern machine tool controls, food packaging equipment and similar applications requiring DC input and AC out-put switching.

EKU Series. Rated at 7 amperes, 60 Hz at 25°C, the EKU is housed in the versatile KU-style case and has .187″ quick-connect terminals. It may be mounted direct to a chassis or in a socket having screw, solder or printed-circuit terminals. A wide variety of P&B relays and solid state time delays are housed in this same case.

For complete information, call your local P&B representative or Potter & Brumfield Division AMF Incorporated, Princeton, Indiana 47670. 812 385 5251

**Like to try your hand at solving the puzzle shown above? Ask your P&B representative for one.*

Solving switching problems is what we're all about.

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†"Madagascar Madness". Copyright Behavioral Sciences, Inc.

Circle 136 on reader service card

Subassemblies

Active filter goes to 200 kHz

User-programable modules, based on state-variable principle, sell as low as $16

The latest wide-use analog module to appear on the market, the universal active filter, is now caught up in the kind of race that also overtook operational amplifiers, digital-to-analog converters, and analog-to-digital converters. The most recent entry is the Burr-Brown UAF series, with frequency response from dc up to 200 kilohertz, dual in-line pin configuration, and price as low as $16 in quantity. Burr-Brown expects that applications will include communications, test equipment, servo systems, process control equipment and sonar.

Active filters in general are smaller than their discrete counterparts, particularly at low frequencies, and also exhibit gain instead of loss. But user programability is what's expected to make the UAF a favorite. The user can stock the basic building blocks in quantity, then adjust the frequency response, gain and Q-factor as needed with four external resistors. (Many presently available active filters are pretuned by the manufacturer.)

The basic circuitry of the Burr-Brown modules utilizes the state-variable principle, in which three filter responses are simultaneously available as outputs from a single two-pole filter element. The three are low pass, high pass and band pass; band rejection is also available by the summing of appropriate low- and high-pass outputs. The units can be cascaded to form complex filter functions with two to eight poles in such forms as Bessel, Butterworth, Cauer, Chebyshev, and elliptic.

Several varieties of filter are available. One major series (UAF-10) has a full power bandwidth of 10 kilohertz at the low-pass output for ±10-volt signal ranges and is usable up to 100 kHz for a ±1-v range. The UAF-20 series can be used to 1 megahertz for a 1-v swing, or 100 kHz for 10. Full programing instructions, including a Basic computer program, are detailed in a comprehensive data sheet.

Both series offer a choice of 1% or 5% frequency accuracy (with 0.1% external resistors) and ±50 ppm/°C frequency stability. The Q range of each series is 0.5 to 500 with stabilities of 0.01% to 0.1%/°C, depending on the frequency-Q product. Gain is adjustable from 1 to 100. Output impedance is 2 ohms for the UAF-10 series and 10 ohms for the UAF-20.

Input bias current is 15 nanoamperes for the UAF-20, 100 nA for the UAF 10, with input voltage limited to ±10 v. Input resistance is 100 kilohms. The units require ± v at 9 milliamperes. The minimum supply voltage is at 5 v.

Two types of packaging are available, epoxy and hermetic. Both have DIP pin spacing. The epoxy module is rated at -25° to +85°C and is 0.76 inch long by 0.18 in. high by 0.44 in. wide. The hermetic version, rated at -55° to +125°C, is slightly larger, and Burr-Brown says that it will meet the environmental tests of MIL STD 883.

Delivery is from stock, with the least expensive 5%, 20-kHz, epoxy module $16 in OEM quantity. The 200-kHz equivalent is $34.

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz., 85706 [381]

Dc servo amplifier puts out 1,000 watts

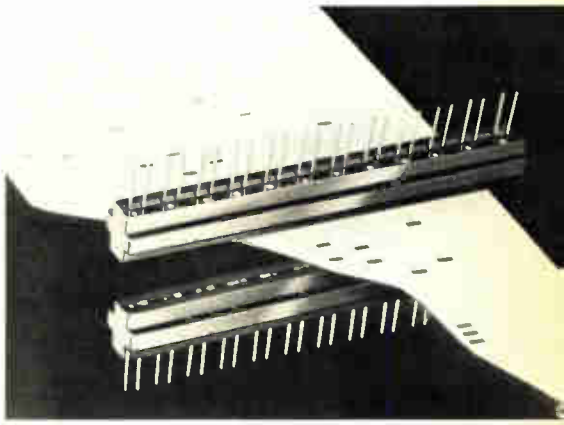
A linear dc power amplifier for servo applications requiring a dc motor drive of up to 1,000 watts is designated the DCA 1000. The amplifier will output ±65 volts dc at 15 amperes peak current. The wide-bandwidth unit has voltage or current feedback and a self-contained cooling fan.

The DCA 1000 is capable of 1,000-w continuous dissipation at 25° ambient temperature with no external heat-sinking. Output-current-limiting is continuously adjustable in the range of 10% to 100% of rated load. The unit will withstand a sustained short circuit on output at rated current.

Bulova Watch Co. Inc., Electronics Division, 61-20 Woodside Ave., Woodside, N.Y. 11377 [385]

Source-sensor arrays drive logic ICs without amplification

A family of 9-, 10-, and 12-position matched-pair infrared source-and-sensor arrays is designed for mounting and handling in all types of optoelectronic recognition equipment. The arrays can be used to sense reflected as well as incident light through punched holes. Designated the ST/A series, the units are ideal for computer peripherals or data-collection systems, and they drive logic ICs without requiring amplification.



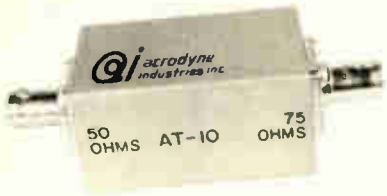
Sensor Technology Inc., 21012 Lassen St., Chatsworth, Calif. 91311 [386]

Transformers handle 10 W between 40 and 250 MHz

With a total volume of under 4 cubic inches, the AT-10 series of high-power rf transformers has applications that include matching antennas to transmission lines or rf generators to transmission-line un-

New products

balanced impedances. The transformers, with an impedance transformation of 50 ohms to 75 ohms reversable, will handle 10 watts of



average power between 40 megahertz and 250 MHz. VSWRs in and out are typically 1.2:0 and 1.5:1 maximum. Price in small quantities is $39.95 each.

Acrodyne Industries Inc., 21 Commerce Dr., Montgomeryville, Pa. 18936 [387]

Filter line offers narrow bandwidth

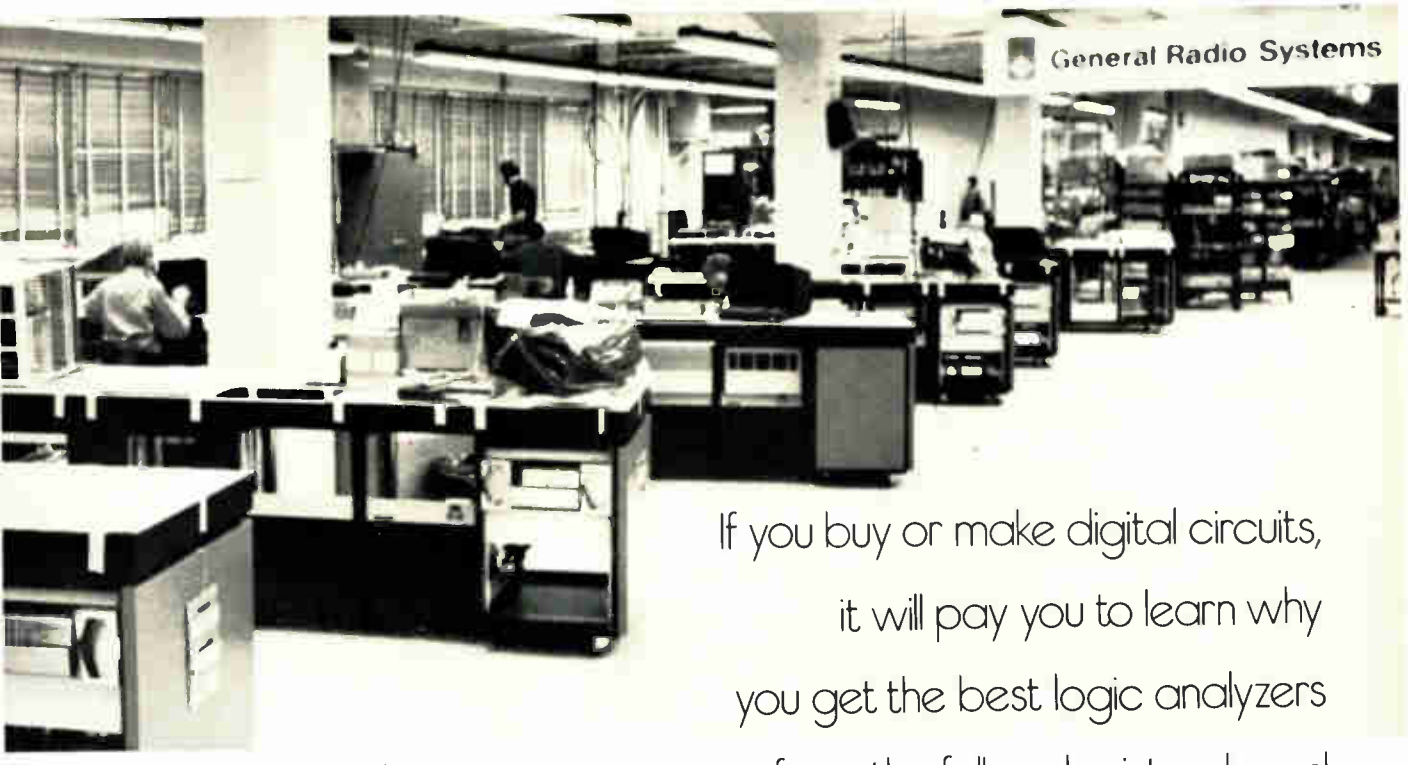
A narrow-bandwidth filter, model K12, has a 3-dB bandwidth of ±1% of center frequency. The bandpass device offers 30-dB minimum attenuation at 0.94 center frequency

and 1.06 center frequency. The unit is available for any center frequency from 500 Hz to 100 MHz and for any impedance from 50 ohms to 500 kilohms, depending upon the center frequency specified. Price is $65.

TT Electronics Inc., 2214 Barry Ave., Los Angeles, Calif. 90064 [388]

Triple-output power supply has overvoltage protection

A triple-output modular power supply, model Z15AT100TL, features ±15 volts at 100 milliamperes of output and 5 V at 300 mA with no current derating over the operating



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Circle 139 on reader service card

temperature range of −25°C to +71°C. Line and load regulation for the 15-v outputs is to 0.2%. The 5-v output is electrically floating, enabling the user to ground either output terminal to obtain a positive or negative 5 v. The 5-v output also

has crowbar overvoltage protection. If a line overvoltage or transient causes the pass transistor to fail, the crowbar circuit pulls the output voltage down, ensuring that the modules under power will not be damaged. Price in small quantities is $49 each.

Zeltex Inc., 1000 Chalamar Rd., Concord, Calif. 94520 [389]

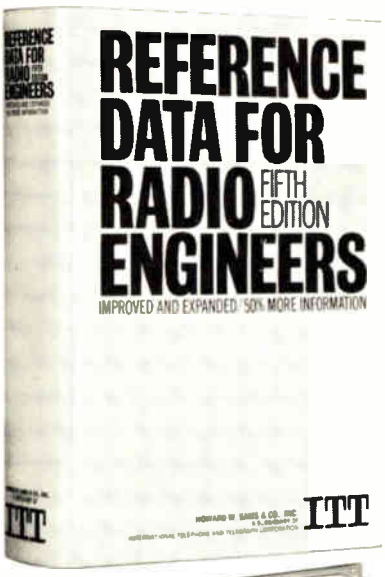
Dc power supplies provide 16-binary-digit programing

Computer-compatible dc power supplies for automatic control from computers or other high-speed controllers feature programing of 16 binary digits or 17 binary-coded-decimal digits for bipolar outputs up to 100 volts. Ac input to dc-output isolation is rated at 10,000 megohms

and 10 picofarads. Output resolutions as fine as 500 microvolts are available, and any range of full-scale and step voltages is also available, including nonlinear step functions. Price is $1,495.

Moxon Inc., SCR Division, 2222 Michelson Dr., Irvine, Calif. 92664 [390]

The Essential Three



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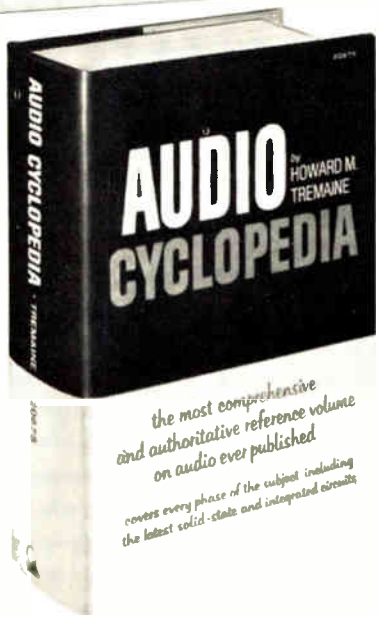

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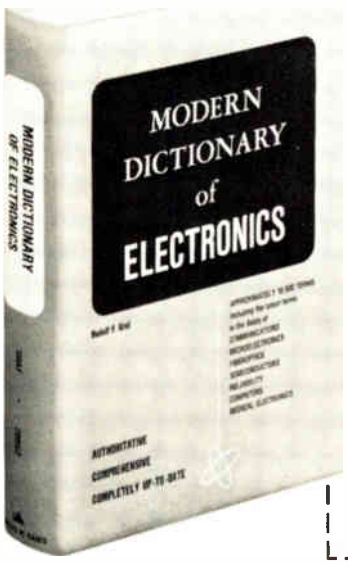

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It works like this:

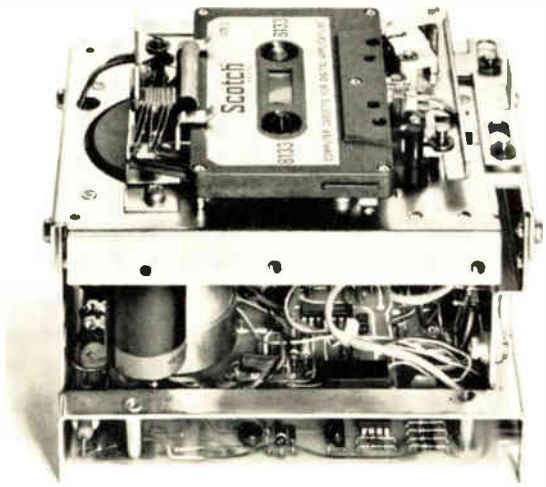
First you place an order with us for some of our DPC-202 digital cassette drives. Then we start delivering large volumes of one of the lowest priced, most reliable Philips-type cassette drives made, while you start making more money.

Simple?

Sure, but that's only because the DPC-202 is unique.

It's built around a patented drive mechanism that needs only a single dc motor for FORWARD and REWIND operation, doing away with at least one motor and the usual gears, links and levers.

It could eliminate some of your customer call-backs and service costs. (The drive requires fewer parts and much less mechanical cycling for operation, a full-size capstan reduces wear and skew, and the EOT/BOT lamp is positioned away from the tape, where its heat can't do any damage.)



And it's less than $200 in OEM quantities, complete with servo and read/write amplifiers.

We've been cranking out DPC-202's for CRT terminals, remote and point-of-sale data capture systems, word processors and calculators. Over 5000 of them sold. With one or two data channels. At 4, 6, 8 or 12 ips. In face or edge-loading configurations.

So the sooner you contact us for the whole story, the sooner we can start cranking them out for you. And you know how much that can mean to you.

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Instruments

System modules are programable

Tester organized around data bus can be manually or computer-controlled

The modern computer-controlled test system grew out of bench-top and rack-mounted individual instruments, and it looks—and costs—it. Large cabinets, extensive knobs and displays, plus unneeded capability, can add unnecessarily to the cost of its development, assembly, service and use. But with a new system of programable modules and accessories from Xincom Corp., the user buys only the parts of instruments he needs and can assemble them quickly to obtain a programable test system usable with computer, manual or other control. In fact, Xincom president Brian E. Sear thinks that this approach could eventually take over half the present bench-instrument market.

The Xincom system is based on plug-in programable instrument "Pinto" modules organized around a data bus much like the one in the DEC PDP-11 computer. Any module can be addressed by the control system, which can be a minicomputer, front-panel switches, remote computer, or microprogramed read-only memory as in present programable bench instruments. The modules now include pulse generators, level switches, a crystal-controlled clock, power amplifiers, a 1-nanosecond 10-millivolt dual comparator, a voltage/current force amplifier for parametric testing, digital-to-analog and analog-to-digital converters, and sample-and-hold amplifiers. Modules for signal conditioning, signal measurement, computation and display are planned.

The modules plug into Pintocards, each of which accepts up to three modules and contains addressable decoding. All data connections (16-bit data, 6-bit address) plug into the rear data bus, as do power and other relatively low-frequency signals (up to 20 kilohertz typical). The front panels of the small cards contain miniature coaxial connectors for high-frequency signals; the system is useful for 1-ns signals. Universal wire-wrap IC cards are also available.

The cards with modules plug into the Pintofile cabinet. It will accept up to 22 cards, and any card can go in any slot. The cabinet also contains the bus structure, a miniature panel display showing the state of each data line, and a one- or two-way controller. A front panel much like those used with minicomputers can be used for manual address, but most users will undoubtedly be interested in automatic control. When an RS-232 interface is connected to the Pintofile controller, the whole instrument assembly looks to the phone lines like any computer terminal. For higher-speed operation, direct interfaces are available, including ones that make possible multiplexing a number of Pintofile "instrument terminals" to one minicomputer.

For service, all elements plug in, and extender cards permit easy access to circuitry. The modules have long, double-ended wire-wrapped terminals so that they are available from both sides. High-frequency connections are on 20-inch coaxial cables, so they need not be changed for service or development of systems.

The cabinets cost $595, cards $100 (without modules), and modules $48 to $980 (for the current/voltage force amplifier with a voltage range of 1 millivolt to 80 volts and current range of 10 nanoamperes to 500 milliamperes).

Xincom Corp., Box 648, Chatsworth, Calif. 91311 [351]

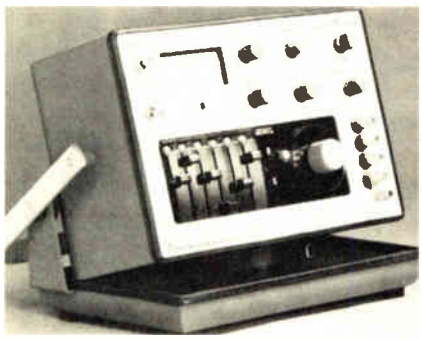
Portable digital multimeter uses triple-slope conversion

The model 4444 digital multimeter is an instant autoranging four-digit portable unit designed with the following automatic features: setting of the decimal point, polarity sign, proper units annunciator, overranging, blanking of redundant zeros, and overload protection. The instant autoranging is made possible by triple-slope integration techniques. Any input from 10 μV to 1 kV can be applied without damaging the unit. Common-mode rejection is over 130 dB for dc voltage measurements and greater than 70 dB for ac measurements at 50/60 hertz ±1%. The 4½-digit LED display is formed on a single chip. Price is $575.

Weston Instruments Inc., 614 Frelinghuysen Ave., Newark, N.J. [356]

Precision resistance bridge has ultra-wide range

A wide-range precision dc resistance bridge includes four ±0.02% bridge circuits and six-digit resolution, to provide a total measurement range of from 1 microhm to 1 teraohm. Measuring accuracy is to within 1%. Designated the model 1666, the unit handles both open and closed resist-



ance of relays and switches, in addition to forward and reverse diode resistances, transformer-winding resistance and insulation conductance, resistance thermometers, and dielectrics. Price is $950.

General Radio, 300 Baker Ave., Concord, Mass. 01742 [354]

Digital panel meter has 50,000 count

A self-contained digital panel meter with a resolution of 1/50,000 and an accuracy to within ±0.003% offers a

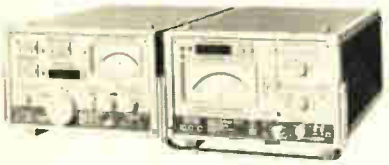
single-plane, segmented Sperry display that can be viewed at angles up to 130°. The model 386 is designed for applications where extended resolution is required, such as digital

phase indication and temperature measurement. The unit contains its own power supply and operates on 115/230 V ac. Also offered are TTL-level BCD outputs. Price is $260.

Electro-Numerics Corp., 2961 Corvin Dr., Santa Clara, Calif. 95051 [355]

Measuring set built for group delay, attenuation

The model LD-3 is a measuring set for group delay and attenuation. It is especially useful when long-distance telephone circuits are employed for high-speed data transmission, where frequency-



dependent group delay and attenuation frequency distortions must be observed at the pertinent frequency range. The unit covers the range of from 200 Hz to 20 kHz and is capable of wide-range send and receive from −50 to +10 dBm. Price is $6,580.

W. & G. Instruments Inc., 6 Great Meadow Lane, East Hanover, N.J. 07936 [358]

Function generator provides wide frequency range

Providing sine, square and triangle waveforms over a frequency range of from 0.002 Hz to 2 MHz, the

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New Selectashaft Rotary Switch program corrects industry shortcoming.

Users of custom rotary switches can now get delivery within days, thanks to this new field assembly program offered by participating Centralab Distributors.

If it's taking you several weeks or even months to get delivery of custom rotary switches, you'll want to look into a new field assembly program pioneered by Centralab and available from their Selectashaft™ Distributors.

The thrust of the program is to ship orders of custom rotary switches within hours of their receipt. Eliminated are lengthy factory delays and special factory set-up charges.

Customers are finding the scope of Selectashaft switches indeed awesome. More than 100,000 combinations of miniature and subminiature switches are available, filling 95% of user needs.

Custom switch assemblies with more than 100,000 combinations are available in days from Centralab Selectashaft Distributors.

The program enables you to select the exact length front shaft, exact shaft end details, and the exact shaft flat angles required. You can choose from 92 types of rotary switches for field assembly by the Distributor to your choice of three .250 inch diameter shaft styles: plain round, .218 inch flat, or .156 flat configurations. The shafts themselves are offered in 24 sizes from .687 inch to 2.375 inches long from the mounting surface. Shaft flat angles can be specified in increments of 15°.

The Selectashaft Distributor program has been underway barely a year, and both Distributors and customers agree it meets a definite shortcoming that previously existed. In that short span, the number of participating distributors has grown to make the benefits of Selectashaft rotary switches available nationwide —on a local basis.

For complete product and price information, contact the Centralab Selectashaft Distributor nearest you. Or write Centralab Distributor Products, Dept. SAS-2.

Circle 213 on reader service card

MIL spec pots. A few words about a big bargain. What more can be said about a line of hot molded potentiometers that meets MIL-R-94C requirements—and can be purchased for as little as 92¢ each, in quantities of 251-500? How about the fact that the pots are shelf items and available immediately. And that they're made by Centralab, whose quality control sets the standard for the industry. Why not write for the catalog which gives a few more reasons to try them before buying them. Ask for Catalog 34-I supplement.

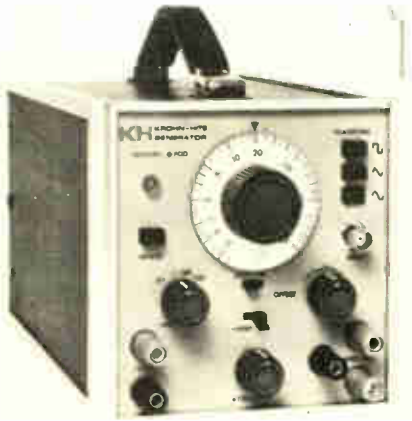
Circle 212 on reader service card

New 100 VDC transistor circuit caps. Low voltage rating of 100 VDC is combined with high capacitance of .005 mf to .1 mf in these new ceramic disc capacitors from Centralab. Their miniature size is specially designed for transistor circuits, where tighter tolerances are essential. Write for Bulletin 42D562.

Circle 214 on reader service card

New products

model 5700 function generator has an error of ±5% of reading for the entire 1,000:1 tuning range of the dial. Output is controlled by a two-position dB step attenuator and amplitude vernier offering both a 50-ohm single-end and a 600-ohm bal-

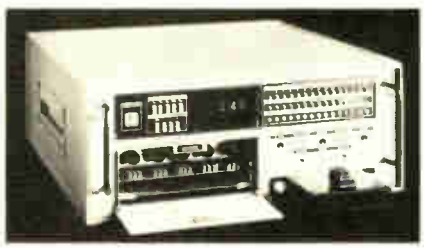


anced output. The outputs provide 15 V peak-to-peak and 30 V peak-to-peak respectively. A 1-V auxiliary output is also supplied. Price is as low as $295.

Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass. 02139 [359]

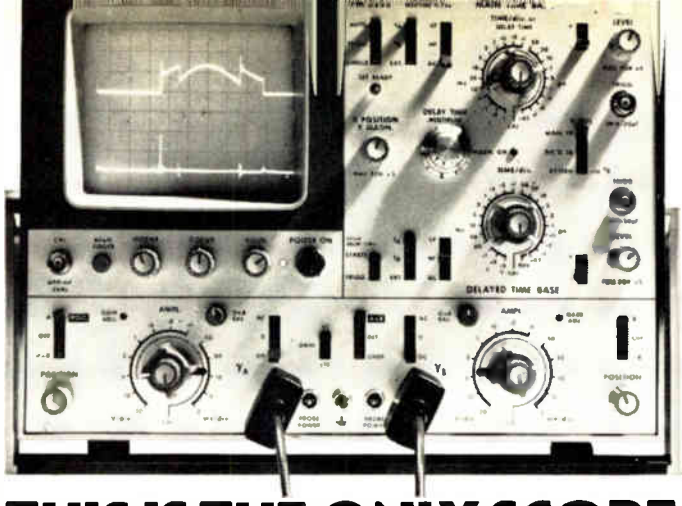
Automatic circuit tester verifies truth table

An automatic digital-circuit tester designated the model 721A offers verification of truth-table and dc parameteric specifications of digital circuits having up to 16 pins. An operator simply inserts a device pro-



gram card in the tester and selects the appropriate limits for the family being tested. The unit may be used as a classification tool, incoming inspection tool, high-speed wafer test tool, or automatic digital test tool in conjunction with a circuit handler. Price is $4,950.

Computest Corp., 3 Computer Dr., Cherry Hill, N.J. 08002 [360]



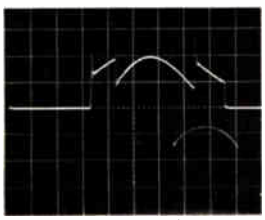
THIS IS THE ONLY SCOPE

THE NEW PHILIPS PM3252

THAT CAN DISPLAY

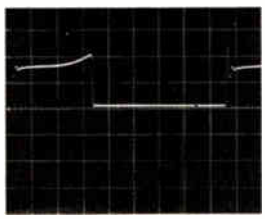
A x B

A



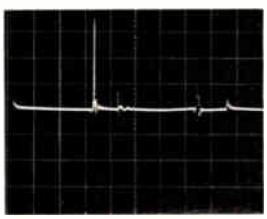
Collector voltage of the power transistor in a DC-DC converter is displayed on channel A of the PM3252. (200 V/div. 0.5 μsec/div.)

B



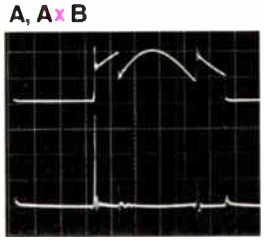
Collector current displayed on channel B (0.1 A/div)

A x B



Flicking the mode selector switch to A x B now displays instantaneous collector dissipation with vertical calibration of 20 W/div. (200 V/div. x 0.1A/div. = 20W/div.) A x B display reveals sharp power transient (70 W) not directly detectable on conventional scopes.

A, A x B



Simultaneous, two - channel display (A and A x B) reveals that the 70 watts is dissipated when transistor switches from current to voltage mode.

Displaying the product of two signals up to now has required an expensive, complex bench-test setup...and even then you were limited to less than 5 MHz working bandwidth.

Not any more!

Now, with the Philips PM3252—a 60 MHz high-performance general-purpose dual trace scope—you can display the product of two signals as easily as their sum or difference, and you can do it at 30 MHz bandwidth. With the PM3252 you can easily switch back and forth among A x B, A - B, and A + B...and you can display a second channel along with any of them.

- The PM3252 allows you to display instantaneous power. And its analog output converts an ordinary DC voltmeter into a wattmeter.
- It allows you to make precise phase adjustments...for example, in aligning heads on a multi-channel recorder.
- Its 30 MHz multiplication bandwidth allows you to make precise dynamic measurements of phase variations caused by wow and flutter.
- In physical investigations, the PM3252 can display the instantaneous product of two rapidly changing transduced properties such as force and displacement or torque and angular rate.

In addition to its unique capability for multiplication, the PM3252 which sells for $1995 offers top performance as a conventional dual trace scope. It has sensitivity of 2 mV/div at 60 MHz (or 200 μV at 5 MHz). DC drift is a negligible 1 div/week. Triggering for the main and delayed time bases is completely independent...and automated for simple operation. The vertical channel delay is 65 nsec, 30 nsec of which is visible so that leading edges can be fully investigated.

If your application involves single-shot or fast rise time events, a sister-instrument, PM3253, offers identical multiplication performance and adds variable-persistence and storage capability.

The PM3252 will be demonstrated for you at our Booth, number 2110, at the IEEE Show. If you're working or expect to be working on cybernetics, DC to DC converters, pulse and switching circuits, audio and video output stages, switching regulators, logic and integrated circuits, power control circuits, SCR's, or transient studies...you won't want to miss this comprehensive demonstration of the world's first multiplier scope. For more information or personal demonstration, write: Test & Measuring Instruments Inc., 224 Duffy Avenue, Hicksville, New York 11802. Telephone: 516-433-8800.

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Circle 147 on reader service card

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Semiconductors

Films put on multiplier chip

Laser-trimmable resistors give on-chip compensation for multiplier/divider

Internal compensation of linear integrated circuits has never succeeded as a cure-all. Although the 741-type, for example, is internally compensated to help control undesirable characteristics, a more accurate job of compensation can be done with the 709 through component selection and matching; therefore, many engineers still use 709s. The weak spot is the 741's diffused resistors because they have broad tolerances and can be produced only with more sacrifice of accuracy than other resistors. Now, Analog Devices has announced what it calls a "totally self-contained monolothic multiplier/divider" that has a new compensation approach.

The AD532K, a high-performance device, is guaranteed to have a maximum multiplying error of less than 1% and an output swing of ±10 volts without need for such outboarded components as trimmer resistors and output-boosting operational amplifiers.

The prime feature of the new circuit is its set of laser-trimmable thin-film-type resistors — deposited directly on the chip itself—almost as an extension of masking. Previously, Analog spokesmen say in-package trimmers could have been outboarded to a small ceramic substrate, which would then have been wired to the chip and placed in the same package. Alternately, films could have been placed atop the passivation layer and sandblasted or cut by laser to a desired resistance, but the process risks heat-shock to the IC and also of splatter—redeposition of vaporized resistor material—usually in the wrong place, possibly short-circuiting conductors.

With the 532, the film resistors can be laser-trimmed through the passivation layer without much danger of heat shock or splatter. The 532, brother to Analog's 530 and 531, is plug-for-plug compatible with the 530; the user merely removes the old external trim components. The AD530 requires four external adjustments.

The 532 multiplies in four quadrants with a 10 Z/X transfer function, and it performs square-root calculations in one quadrant with a transfer function of minus the square root of 10 Z. Analog calls it a computation circuit, rather than merely a multiplier.

Among applications, the firm lists rms computation, phase-detection, programable gain-instrumentation amplification, power measurements through derived voltages, function generation, signal correlation, peak detection, automatic gain control, frequency discrimination, modulation, and demodulation.

On-chip trimming eliminates the need for an extra substrate and its expense, as well as possible assembly flaws and their added cost. The technique may increase yields by allowing IC engineers more design latitude, enabling them to tighten specs through laser trimming. But this represents a change in IC-design philosophy, and the technique probably will be seen far more in future circuits than in the 532.

On-chip trimming frees bonding pads that would otherwise have been needed for outboarding, thus the AD532 can provide differential X and Y inputs because the -X and -Y inputs aren't needed for trimming. Power dissipation is lowered, and thermal effects on the chip can

be optimized. Since on-chip trimming allows the designer to vary resistor values in the low-current portions of a circuit, there is only a limited penalty for having the resistors inside the package. The power dissipation of the AD532 is 4.5 milliamperes—the same as the AD530's—but when the recommended trim pots are added to the 530, power dissipation doubles to 9 milliamperes.

Moreover, because the entire chip cools as a unit, temperature tracking of the on-chip resistors is better than it would be if they were located on hybrid substrates and much better than that of outboarded resistors, the company says.

In lots of one to 24, the AD532K sells for $36. The unit is available in the -J configuration at $26, with slightly higher transfer-function error and output-offset voltage. On the other hand, a $49 series -L is offered with higher specs than those of the 532K. A MIL-STD-883 version also is available at $60. Deliveries are from stock for units in the TO-100 can, two to three weeks if ordered in the TO-116 dual in-line package, and as long as six weeks on MIL-STD-883 versions.

Analog Devices Inc., Rte. 1 Industrial Park, Box 280, Norwood, Mass. 02062 [411]

Monolithic quad power strobe aims at ROM systems

A quad power strobe in a monolithic design promises to reduce system standby power by as much as an order of magnitude because it can route power to selected components. Labeled the HD-6600 by its developer, Harris Semiconductor of Melbourne, Fla., the strobe is aimed mainly at read-only memories, both mask-type and field-programable.

Access time from the HD-6600 input to 1,024-bit PROM output is typically 100 nanoseconds, but that can be reduced to as little as 50 ns by powering the memory circuit before the read operation. This means, says Harris, that systems can be designed with power efficiencies near those of MOS counterparts, but faster.

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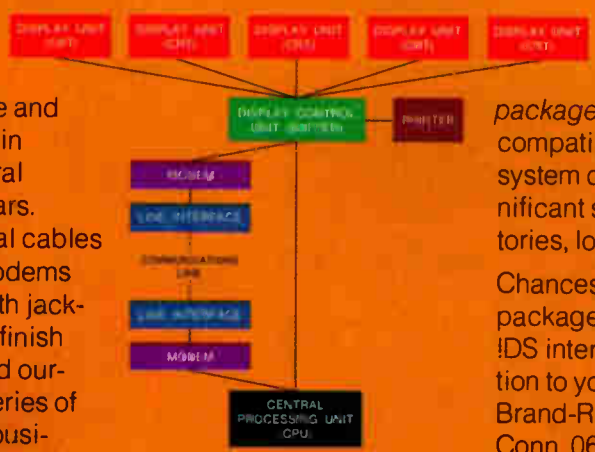

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Circle 151 on reader service card

New products

Inputs to the strobe are TTL-compatible. Each of the four outputs can deliver up to 150 milliamperes typical; there is a maximum drop of 250 millivolts from the power supply to the power-strobe output. However, if larger voltage drops are acceptable, an output of 200 mA or more is possible.

Logic for the HD-6600 is a TTL-inverting buffer with power gain. With input in the high state, input voltage equal to or greater than 2.4 V dc, output is clamped at V_{out} low, which is equal to or less than 1 V dc. In the low state, input voltage less than or equal to 0.8 V, output is held to V_{out} high, which is equal to or greater than the V_{CC3} power supply, minus 250 mV.

Harris Semiconductor, a Division of Harris Intertype Corp., Melbourne, Fla. 32901 [412]

MOS LSI digital-clock circuit offers 4- or 6-digit display

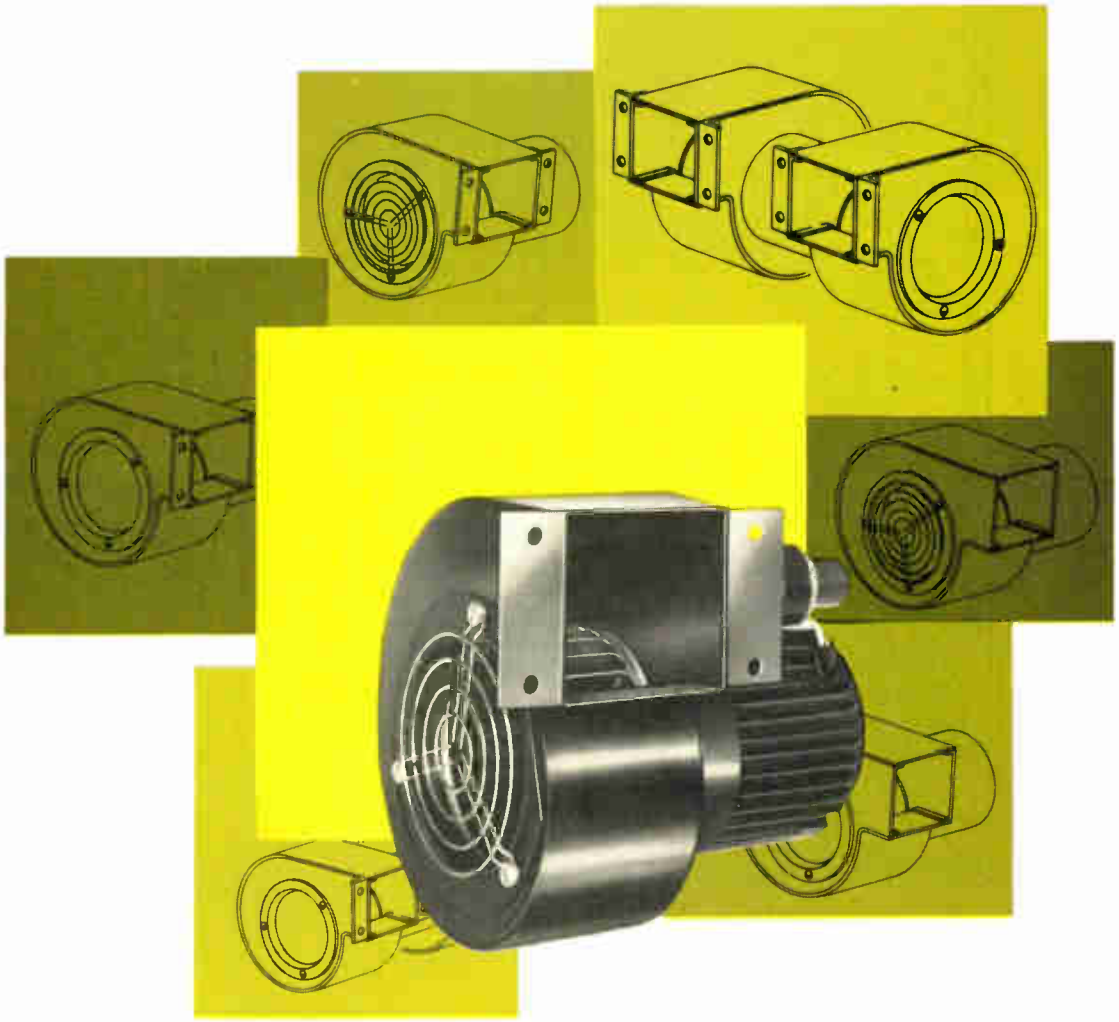
An MOS LSI circuit for digital clocks, the MC-1001, can display hours and minutes or hours, minutes, and seconds in a 12- or 24-hour format. The unit also offers a 4- or 6-digit display, 50- or 60-Hz timing, multiplexed outputs for both segments and digits, operation from a single 11- to 17-V dc power supply, hold-control, and an output strobe control that blanks the display for low-power applications. Price is $11.50 in 100-lots.

Antex Industries Inc., 1059 E. Meadow Circle, Palo Alto, Calif. 94303 [414]

Opto-isolator built for driving TTL

The model IL-74 logic drive opto-isolator, designed to interface directly into and out of TTL, has a 1,500-V breakdown voltage and 35% typical dc transfer ratio, 12.5% minimum. Another device, the model IL-5 high-efficiency photo-transistor opto-isolator, has a 2,500-V breakdown voltage and 50% minimum current transfer ratio, 70% typical.

Rotron?
In commercial blowers?



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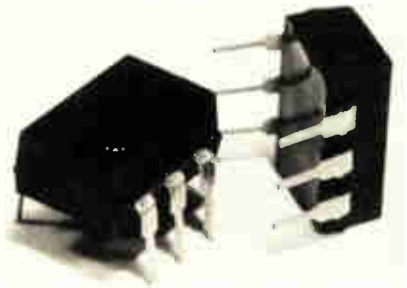
Circle 153 on reader service card 153

New products



Price of the IL-4 in 1,000-lots is $1.29, and the IL-5 is $1.75 in the same quantity.
Litronix, 19000 Homestead Rd., Cupertino, Calif. 95014 [415]

MOS shift register has 10-MHz rate

Designed to provide a 10-MHz shifting rate, a 2,048-bit multiplexed dynamic shift register operates over the temperature range of −55°C to +125°C. Designated the HDSR 2048, the circuit is structured as a dual 1,024-bit register, and is also available as a single 1,024-bit unit, a dual 512-bit unit, and a quad 256-bit unit. Inputs can be directly driven by MOS, TTL, or DTL integrated circuits, and bipolar and MOS circuits can be driven by the output stages. Price is $36 each in quantities of 100.
Hughes Aircraft Co., P.O. Box 90515, Los Angeles, Calif. 90009 [416]

Transistor rated at 2,200 volts, 2 amperes

A power transistor rated at peak collector-emitter voltage of 2,200 v is designated the BUY71. It is designed primarily for the horizontal-deflection circuits in black-and-white television. Other features are

New products

a continuous collector current of 2 A and a switching time of 0.7 μs at 1.5 A. Total power dissipation at a collector-emitter voltage of 100 V and at 80°C case temperature is 10 W. Total dissipation at 25°C is 40 W. Price in 100-lots is $12.35.

Texas Instruments Incorporated, P.O. Box 5012, M.S. 308, Dallas, Texas 75222 [418]

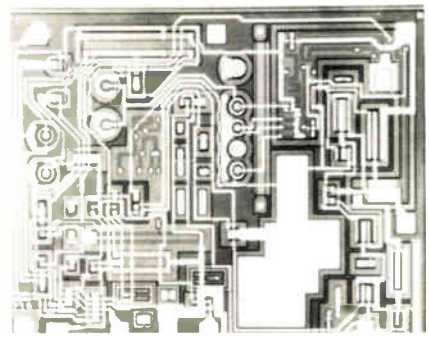
Hybrid lamp driver includes six units in one flatpack

A hybrid display panel-lamp driver, the LD401 series, has six 60-mA drivers in one flatpack measuring ⅜ by ⅜ by 0.075 inch. The unit can drive a variety of lamps with different lamp voltages to 20 V dc. Principal applications of the flexible circuit, other than lamp-driving, include relay-driving, power-driving, and hex inverters. Input is TTL- and DTL-compatible.

ILC Data Devices Corp., 100 Tec St., Hicksville, N.Y. 11801 [417]

Operational amplifier has fast slew rate

Input offset current of 2 nA and bias current of 15 nA are features of the model SG1556 operational amplifier. Slew rate is typically 2.5 V/μs, and offset voltage is 4 mV. Power consumption is 45 mW maximum. In addition, two commercial grades



are offered with a temperature range of from 0°C to 70°C. The SG1456 has a 10-mV offset voltage, and the SG1456CT, 12 mV. A typical price in 100-lots is $2.25.

Silicon General Inc., 7382 Bolsa Ave., Westminster, Calif. 92683 [419]

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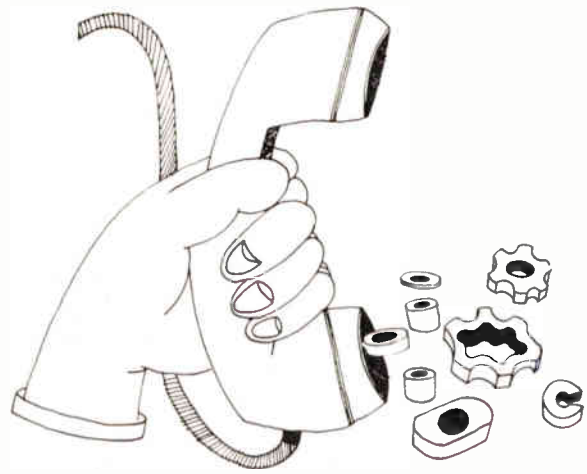

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YCM-8D (ALNICO-8)	7,500- 8,300	1,700-1,850	5.5- 6.5
YCM-8E (ALNICO-8)	7,500- 8,500	2,000-2,150	5.5- 7.0
YCM-9B (ALNICO-9)	10,000-11,000	1,350-1,500	9.0-11.0
HICOREX ($SmCo_5$)	7,700- 9,200	7,700-9,000	15.0-21.0

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Circle 157 on reader service card

Packaging & production

Analog tests are automated

Computer-controlled system for production line checks components and modules

Parlaying its "laboratory-measurements forte into a complete test system," the Automation Products division of Boonton Electronics Corp., Parsippany, N.J., is moving into the production-line test field with a computer-directed test and measurement unit for analog components and modules. At the core of Boonton's new System 70 tester is a Digital Equipment Corp. PDP-8E minicomputer that will use one or more 25-channel scanners, with four wires per channel, to control as many as eight separate measurement modules.

Boonton has five modules ready initially, each based on one of its own laboratory-instrument designs. These will measure resistance and continuity, capacitance and dissipation factor, rf voltage, dc voltage, and dc current, according to vice president of engineering Ben Chun. Modules for leakage, audio-frequency voltage and rf power are still being developed.

"We've always sold measurement modules to end users who've lashed systems together themselves," Chun says. "Now we find many of our customers want us to do it for them."

And although the parameters of the modules represent "no earth-shaking news," the availability of laboratory-grade modules in an automated tester is a great convenience, he continues. Applications include evaluation of resistor and capacitor networks, testing and data logging of high-reliability components, temperature-coefficient and delta testing, strain-gage and thermocouple data logging, active-filter manufacture and test, trim-anodize processing, and trimming of components with abrasives or lasers.

The parameters of the individual modules are numerous. The three-terminal capacitance measuring bridge, for example, is a unit that's not generally controlled by a computer, Chun points out, and can produce a measurement in 100 milliseconds. The direct-reading bridge has a range of 0.1 picofarad to 100 microfarads and a basic accuracy of ±0.1%. The resistance module, which makes four-wire measurements of open, closed and buried resistors, has a ±0.01% accuracy, a 0-to-100 megohm range, and a 10-ms measurement time. Dc voltage range is 0-to-100 volts, with ±0.1% resolution of full scale and a 500-microsecond test time; dc current range is 1 microampere to 1 ampere, ±0.1% full scale resolution, 500-μs test time. Both dc voltage and dc currents are resolved to 12 bits.

No programing knowledge is required of the user, according to Boonton, which supplies interface, diagnostic, and operating routines. Price of a system, which includes a PDP-8E with 4 kilobits of core memory, scanner, ASR-33 Teletype, and the resistance measurement module is $24,500. Delivery is in 120 days. A multiple test station can also be supplied, Chun points out. And the system can be interfaced to a broad range of computer peripherals such as disk memory, tape cassetes and reel-to-reel tape drives, IBM card punches and readers, CRT display/keyboard, paper-tape punch/reader, and high-speed line printer. Minicomputers other than the PDP-8 can also be supplied.

Automation Products Division, Boonton Electronics Corp., 1279 U.S. Rte. 46, Parsippany, N.J. 07054 [391]

Handler permits testing 4,000 naked DIPs an hour

Most equipment for environmental testing of dual in-line semiconductor packages requires that the DIPs first be mounted in carriers. This represents a substantial investment in labor and parts for incoming inspection at user facilities, and many users would prefer to work with naked DIPs, says Ray Twigg, manager of equipment at Diacon, San Diego, Calif.

Diacon has developed a naked-DIP environmental handler, the model 7194, which is a complete assembly, including oven.

Parts are fed from two plastic tubes of the type commonly used by manufacturers for shipping. Since one tube is active at a time, an operator can replace empty tubes without interruption of tests. As an option, parts can be bowl-fed. The system sorts into one of five tubes, or it can be set up for bulk-sort.

Twigg says that a test rate of 3,000 to 4,000 units per hour is typical. The chamber is set up with short leads, for high-frequency tests, and he says the equipment can be used with any IC tester. The modular drive mechanism of the 7194 permits quick changing from one type of device to another, at a cost of about $1,500 per module.

The tester weighs about 180 pounds. Price is $6,000.

Diacon, 4812 Kearny Mesa Rd., San Diego, Calif. 92111 [392]

Matrix board programer has 100 cross-points

Rear-mounted slip-on terminals, already drilled and plated for solder connections, permit flexible installation in test equipment and hard-wired OEM units for three-deck-matrix-board programers. The 10-by-10 matrix provides 100 cross-points on 0.50-inch centers. Thirty terminals connect to the bussed contact strips, which have individually flexing solder-plated beryllium copper contacts.

Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543 [394]

Soldering system permits spot repair of hybrids

The model CM-2 micro-reflow-soldering system permits high-temperature spot removal or attach-

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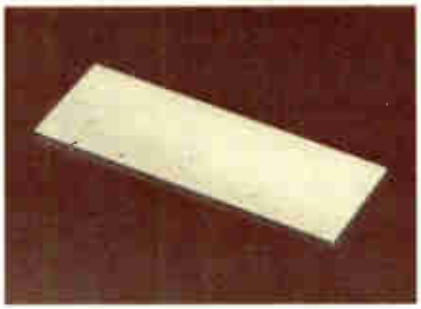

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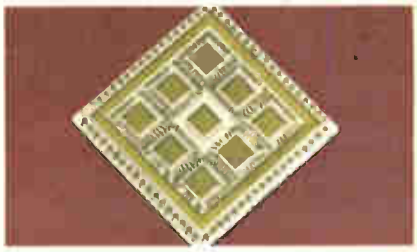

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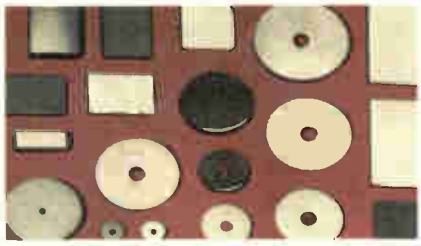

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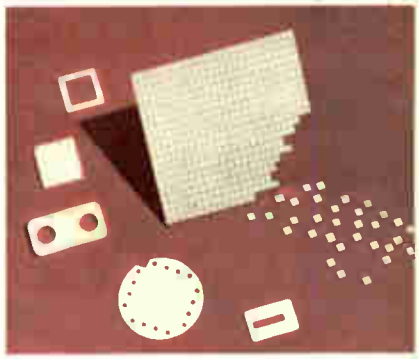

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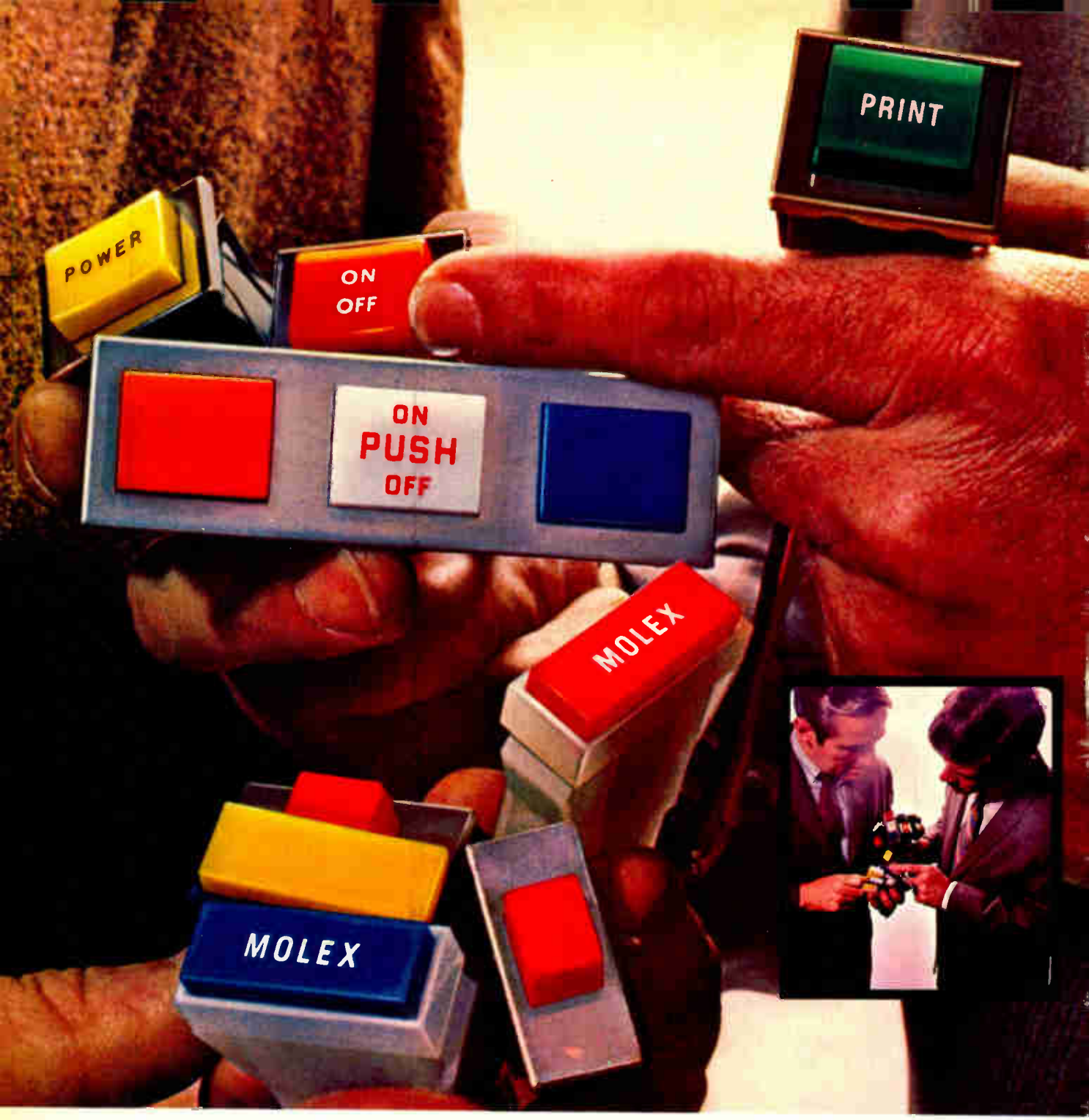

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Or phone (312) 969-4550.

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molex

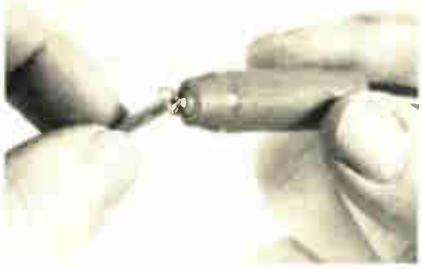
M159A Circle 160 on reader service card

ment of semiconductor dice and chip components on hybrid substrates and headers. The unit uses a pulse-ignited hydrogen microjet with a foot-controlled automatic cycle, and it generates localized bonding temperatures in excess of 1,000°C in less than a second. The system can operate within confined packages and on large heat-sinked devices through a preheater stage. Price is $1,550.

Browne Corp., 212 East Gutierrez St., Santa Barbara, Calif. 93101 [395]

Single-tip probe measures coating thicknesses

Accurately measuring coating thickness on magnetic substrates having small or irregular surfaces, such as a fastener or screwhead, is difficult, but the Permascope, with a single-tip probe, measures coatings to within 30 millionths of an inch. This is made possible by the new probe design and special circuitry. The probe is available in two different models: a standard handheld type,



model E2.5; and a constant-pressure version, model V-6-E2.5

Twin City Testing Corp., Box 248, N. Tonawanda, N.Y. 14150 [396]

Circuit-board ejector fastens without riveting

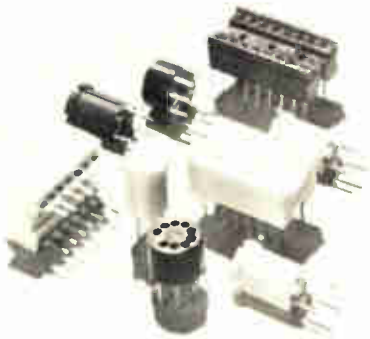
The all-nylon series CBE circuit-board ejector eliminates riveting the ejector to the board. The unit is 1.12 inches long and fits any board thickness up to 1/16 in. by snapping into a 0.100-in.-diameter hole. A 45° pull of the ejector asserts a lever action against the guide, rack, or chassis to

eject the card from the pc board.

Richo Plastic Co., 5825 N. Tripp Ave., Chicago, Ill. 60646 [397]

Self-extinguishing material used in transistor, IC sockets

Additions to the dual in-line series of integrated-circuit and transistor sockets include those rated SE-0, which have thermoplastic molded bodies. The sockets are rated at 750 v dielectric strength, and temperature rating is 230°F continuous. Products available in the series are



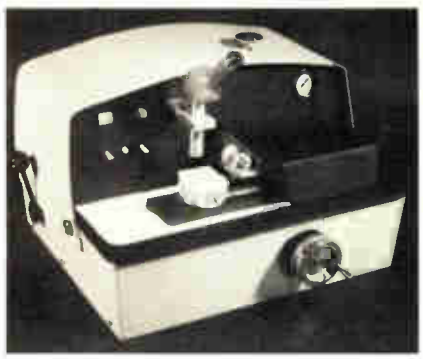
14-pin and 16-pin dual in-line IC sockets, three-lead transistor sockets, and 10-pin transistor sockets. The units are also available in materials rated SE-1. Price ranges from 5 to 30 cents each.

Methode Manufacturing Corp., 1700 Hicks Rd., Rolling Meadows, Ill. 60008 [398]

Dicing saw offers blade speed up to 45,000 rpm

Designed to cut ceramic substrates and other thin materials requiring a high-speed diamond wheel, an automatic dicing saw provides variable depth of cut, feed rate and blade speed up to 45,000 rpm. Kerf width is 0.010 inch and the unit can handle material as large as 3.0 by 3.0 in. The saw automatically continues dicing to any preset measurement with a stepping increment to 0.0005 in. Hybrid-circuit manufac-

New products



turers can use the saw to separate multiple circuits on ceramic substrates, cut odd-size substrates, or notch substrates to be snapped apart later. Prices of the model CD-35 saw, with manual indexing is $4,200, and an automatic-indexing option is $2,000.

Motion Dynamics Research Inc., Box 221, Spotswood, N.J. 08884 [399]

Flatpack test contactor designed to prevent damage

A contactor for test, burn-in, and aging of flatpack integrated circuits when housed in standard carriers is part of the Welcon series for flatpack, TO-5 and DIP devices. The contactor is designed to preclude overstressing of contacts during insertion of the carrier, presenting a smooth, radiused surface to the lead device, optimized for contact force. The contactors are available in 14- and 16-pin versions in a range of contact and body materials for use over temperatures of 150°C, 250°C, and 300°C. Price ranges from $1 to $3.

Wells Electronics Inc., 1701 S. Main St., S. Bend, Ind. [400]

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What you may not have known, is that they are available, off-the-shelf, in substantial quantities, with identical performance characteristics to the prototype units you may have purchased for design development. Making quality coils available in quantity is the CAMBION Double "Q" approach.

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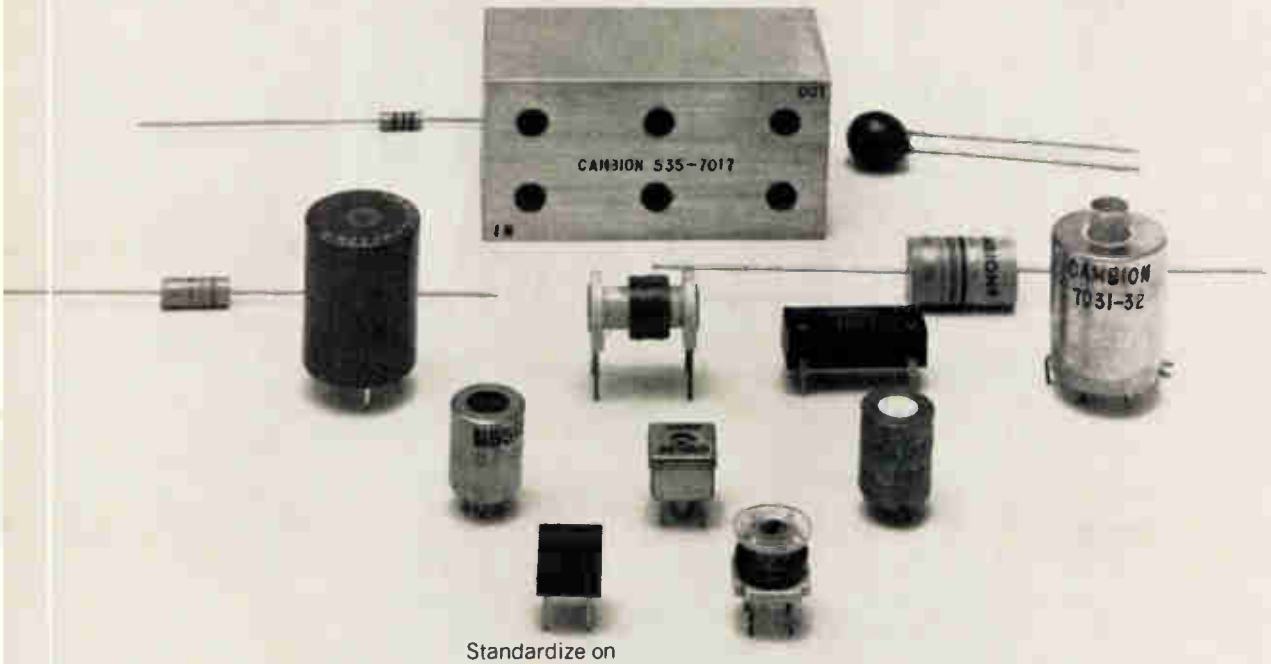
At Cambion, coils have a Double "QQ"



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In the short time since introduction, our new 8000A LSI multimeter with 26 ranges and five functions has become the standard of excellence in the low cost field. Thousands of satisfied users all over the world are using the 8000A daily to diagnose service problems and analyze design of electrical and electronic circuits.

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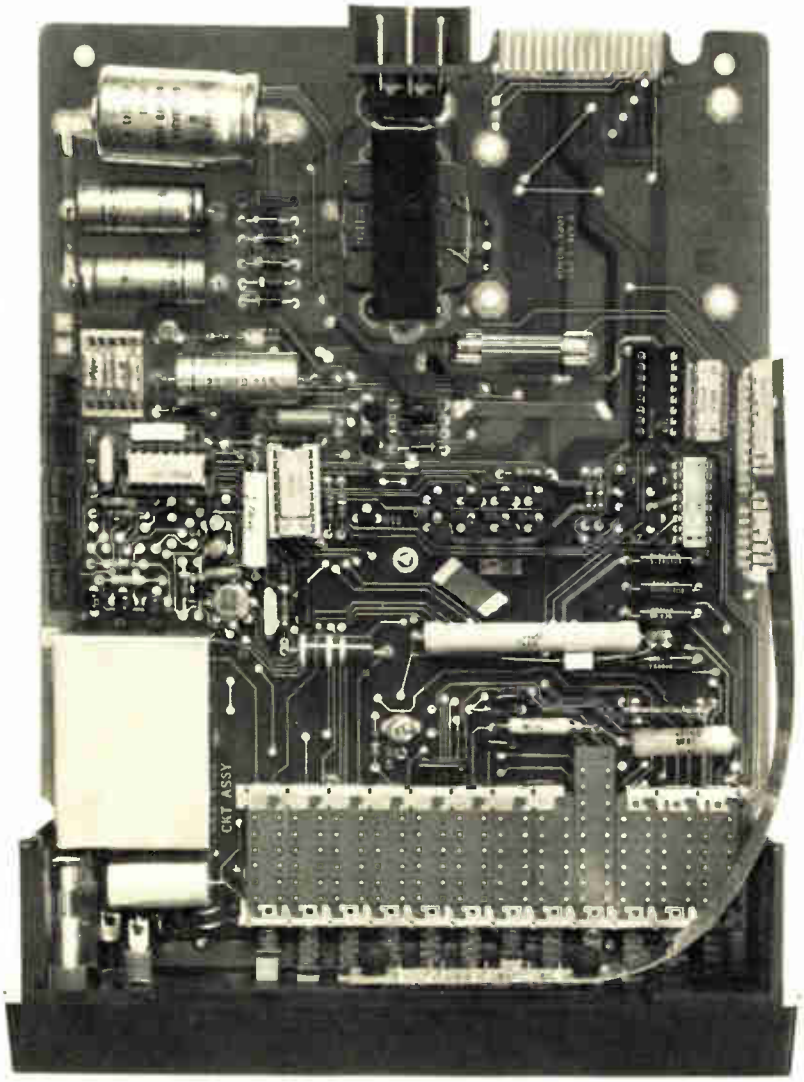
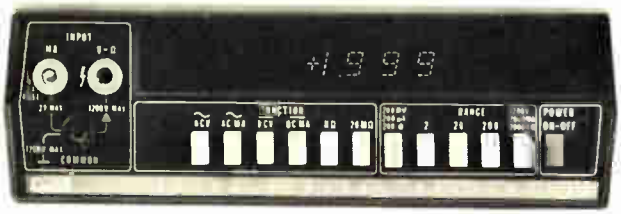


but quality.



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Components

Terminators fill ECL bill

Beckman's 898 series has low inductance to meet high-speed needs

With the increasing popularity of the 10K series of emitter-coupled logic introduced by Motorola as MECL and now made by other suppliers, other companies are designing components and hardware to complement the 10K ICs. The latest is a line of dual in-line multiple ECL terminators from Beckman Instruments' Helipot division.

Lyle F. Pittroff, linear-products sales supervisor, says the parts are designed to meet the requirements outlined in Motorola's comprehensive MECL systems-design handbook. The parts can also be used with 10K ECL from other suppliers, and with Fairchild Semiconductor's 95K line.

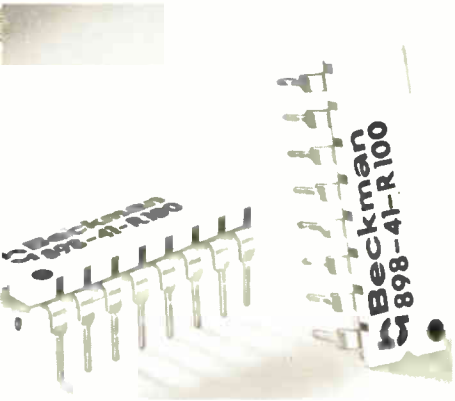
Each member in the 898-41 series, for example, includes 11 resistors for ECL termination to a -2.0-volt bus, with 50-, 75-, and 100-ohm versions available. A second variety, 989-42, contains 12 510-ohm resistors for pulldown to the -5.2-v bus. The 898-43 units contain four Thevenin-equivalent terminator sections, each consisting of two resistors connected as a divider from the ground bus to the -5.2-v bus and providing a Thevenin-equivalent voltage of -2.0 v at the proper impedance (50, 75 or 100 ohms). And each unit in the fourth terminator series, 898-44, contains six sections, each designed for terminating a line at the driven end with a series resistance equal to the line impedance minus the 7-ohm output impedance for the 10K logic. Again, versions are made for the popular 50-, 75-, and 100-ohm applications.

All the terminators consist of thick-film networks with layouts designed for low inductance to meet the high-speed characteristics of ECL. They also include low-impedance 0.01-microfarad decoupling capacitors; each capacitor consists of two metal plates and a single-layer dielectric, selected for high capacitance at high frequency. The capacitor is fabricated on the side of the substrate opposite to the resistor network. Another series, the 898-45, provides TTL-to-ECL translation. It does not include the bypass capacitor.

Resistor tolerances in the networks are ±2% for values over 100 ohms, and ±2 ohms for values under 100 ohms. Resistance-temperature coefficient is ±100 ppm/°C. Capacitor tolerance is +40% -20%, and its voltage rating is 25 v.

Pittroff says that power dissipation of the networks has been considered to make the unit capable of operating with ECL voltage levels at 85°C in still air without heat-sinking. All are in 16-pin ceramic packages, and are priced at $1.25 each in 1,000 to 4,999 quantities, which Pittroff says makes the parts competitive on a system level with discrete terminators.

Beckman Instruments, Helipot Division, Fullerton, Calif. 92634 [341]



Transducers sense low pressure, give high output

A high-output pressure transducer for precision measurements at low pressure has been developed by Setra Systems Inc. The full-scale range of the model 236 is from 0.1 pound per square inch to 20 psi, differential and absolute, and full-scale accuracy is to within ±0.1%. Com-

New products

plete signal conditioning with an internally regulated power supply is included; full input voltage is regulated from 16 to 28 v dc. Remote control of zero and sensitivity, as well as a zero-offset calibration signal, are also provided.

Setra Systems Inc., 12 Huron Dr., Natick, Mass. 01760 [342]

Wirewound resistors sense temperature at 7,000 ppm/°C

A line of temperature-sensitive wirewound resistors is designed for use as resistance thermometers and compensators. Rated for continuous operation through 583°C, the resistors can be furnished with any temperature coefficient from −100 ppm/°C to +7000 ppm/°C. Ohmic values range from 0.1 ohm to 25 kilohms, and resistance value tolerances from 0.1% to 10%. The resistors are available with axial or radial leads, or with leads out one end; leads are available in a variety of sizes from 0.1- to 0.25-inch in diameter and from 0.25 to 0.75 in. long. Unit price ranges from 29 cents to $2; delivery time is from three to four weeks.

Arcidy Associates, 370 Commercial St., Manchester, N.H. 03101 [475]

Reed switch acts as proximity sensor

A form C single-pole double-throw miniature reed switch is an addition to a proximity-sensor line that is en-

$395

Model 5112-1 single pen recorder with 1, 2, 5, 10 in/min. chart speeds and 10 mv fixed input spans.

$445

Model 5110-2 single pen recorder with 2.2, 5, 10, 20 cm/min. chart speeds and 5 input spans of 10 mv up.

$595

Model 5212-1 two pen recorder with 1, 2, 5, 10 in/min. chart speeds and 10 mv fixed input spans.

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presents

Model 5212-2 two pen recorder with 1, 2, 5, 10 in/min. chart speeds and 5 input spans of 10 mv up.

$690

OmniScribe$_{TM}$ Strip Chart Recorders

Here are five versions of the ***OmniScribe***$_{TM}$ 10" Strip Chart recorder. They're just a sample of the more than a score of possible combinations of speeds, spans, accessories and other goodies designed into this beautiful little unit.

And features? Just the lowest cost on the market. About half price. And a perfected positive feed sprocketless paper drive. Plus a unique operating feature in the non-contact re-balance element. And the multi-speed chart drive with English/Metric option. More for your money with ***OmniScribe***$_{TM}$

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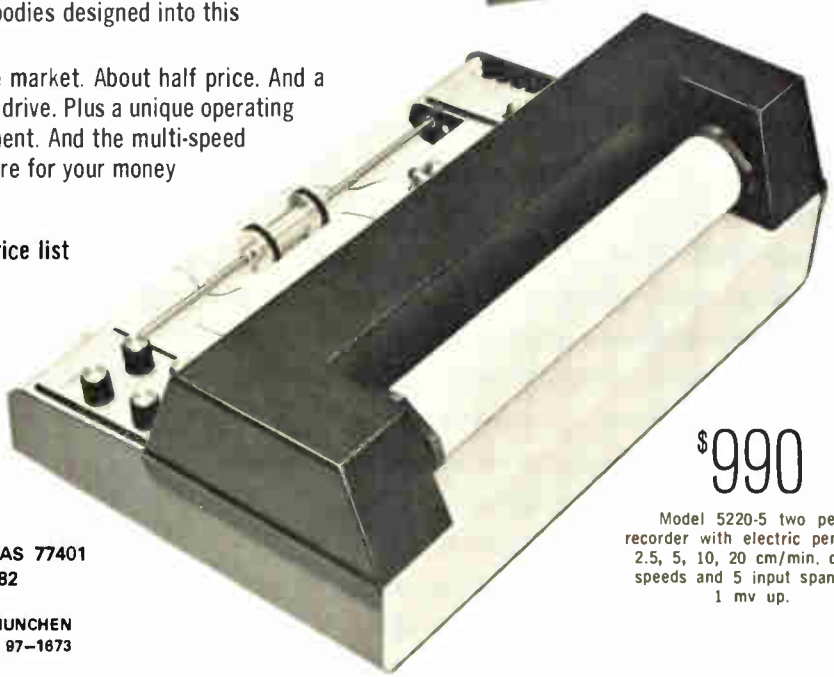

$990

Model 5220-5 two pen recorder with electric pen lift, 2.5, 5, 10, 20 cm/min. chart speeds and 5 input spans of 1 mv up.

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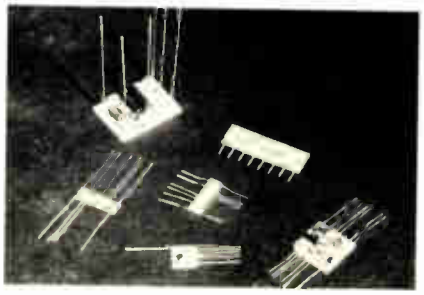
capsulated in one-piece molded packages. The mode of operation can be head-on, varied, slide, rotary motion, or shunting. No auxiliary source of amplification is needed. The packaging seals the switches and leads, providing protection from hostile environments. Contact and current ratings are 3 W and 0.250 A, respectively. Maximum switching voltage is 28 V dc. Price in lots of 1,000 is $4.70.

Hamlin Inc., Lake Mills, Wisconsin [343]

Thick-film resistor circuits dissipate power to 5 W

A line of thick-film resistor circuits for high- and low- voltage applications are packaged in single DIPs that offer low-tolerance precision networks. Designated the AF 4000 series, the resistors have power dissipation to 5 W, a range from 3 ohms

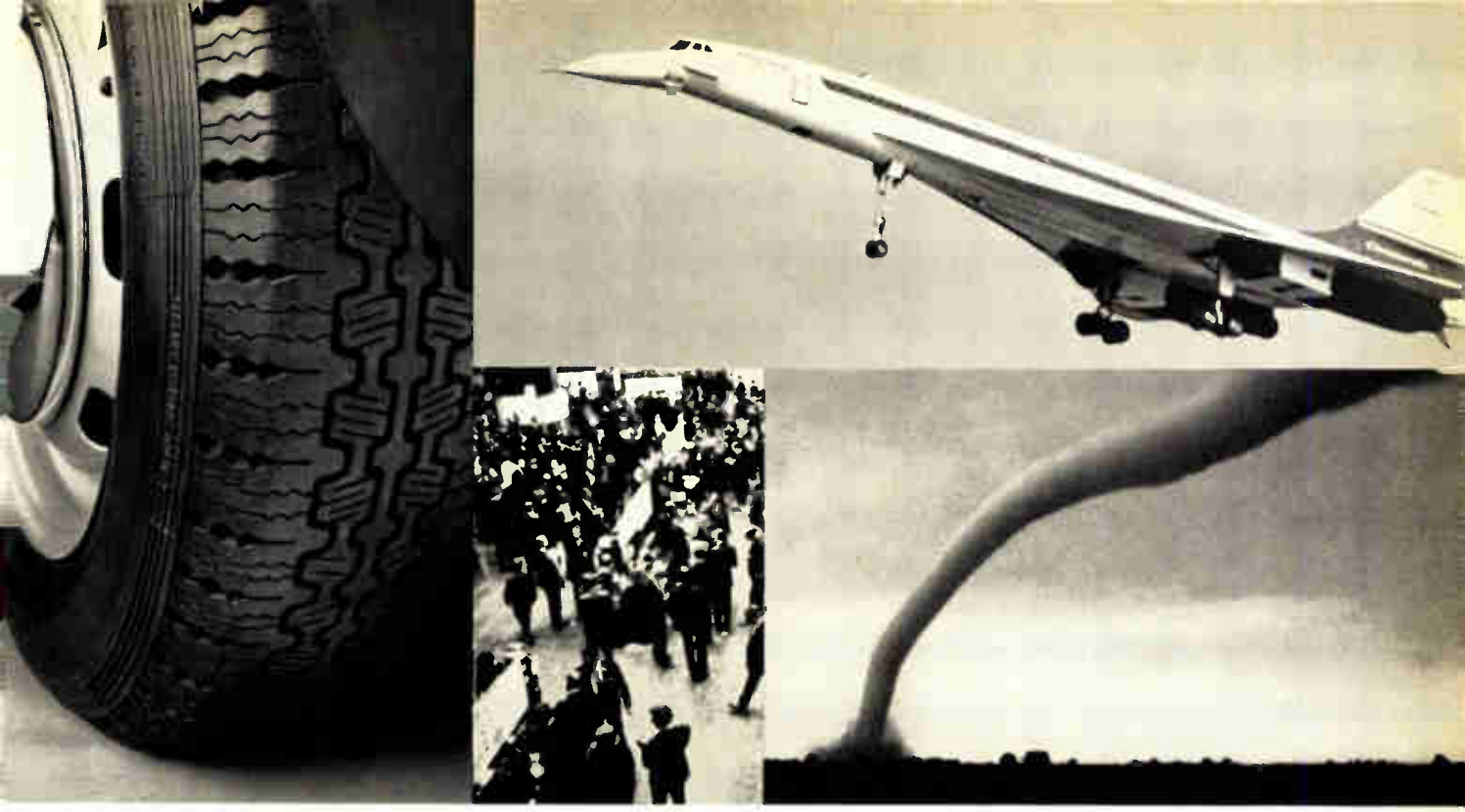


to 10^8 ohms, operating voltage to 50 kV, and noise levels from −3dB at low resistivities to +15 dB at high sensitivities.

AFI Industries, 400 Warburton Place, Long Branch, N.J. 07740 [344]

Triaxial accelerometer weighs 850 milligrams

Weighing 850 milligrams and measuring 0.3 by 0.25 by 0.20 inch in size, the Picotriax model 23, a vibration-measurement sensor, provides a flat frequency response up to 10 kHz in three axes. The triaxial piezoelectric accelerometer is designed so that all cables exit from the same face, which simplifies mounting and cable connection. The cable measures 0.17 in. in diameter. Weight of the sensor with



The plot changes. The story stays the same.

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At the same time, Hoare & Company, stock brokers of London, begin their week with trend analysis graphs plotted for their customers on CalComp drum plotters.

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The plot changes. But our reputation for innovation and our concern for excellence —those stay the same.

For information on plotters, call your local CalComp office, or contact California Computer Products, Inc., EM-M4-73, 2411 West La Palma Avenue, Anaheim, California 92801. (714) 821-2011.

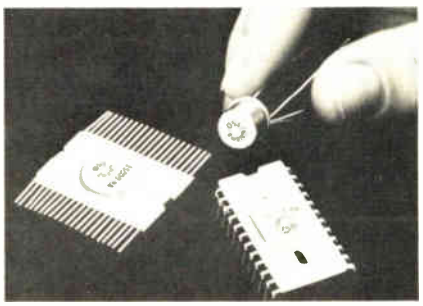
CALCOMP

New products

cables is 940 milligrams.
Endevco Dynamic Instrument Division, 801 S. Arroyo Parkway, Pasadena, Calif. 91109 [345]

Temperature recorder is accurate to within 1%

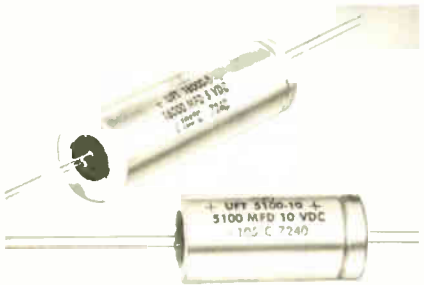
The Hot Spot temperature recorder is a tiny single-increment heat sensor that is accurate to within 1%.



Units are available to cover the range between 100° and 350°F in 10°F steps. The window, 1/16 inch in diameter, turns irreversibly black from a silver color when exposed to its rated temperature value. Over-all diameter is 3/16 inch. Price is 65 cents each in 500 pieces.
Telatemp Corp., Box 5160, Fullerton, Calif. 92535 [346]

Electrolytic capacitor has four-terminal construction

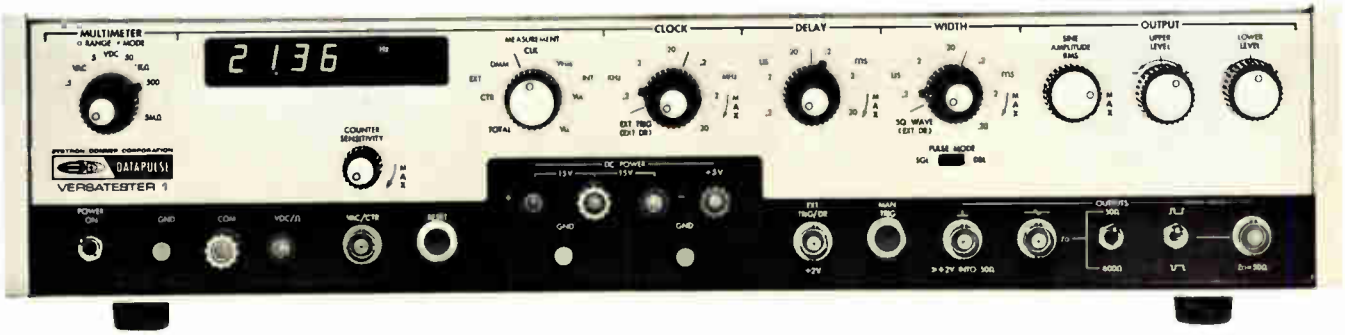
An aluminum electrolytic capacitor, type UFT, has an impedance that decreases at frequencies above 1,000



Hz, accomplished by four-terminal construction. Either end may be used as the input stage with the opposite end as the output stage. This allows short lead lengths for terminations, since all the connections

What's wrong with this picture

Recognize the unnecessary, out-of-date clutter, confusion, complexity and cost all these separate test instruments represent? One (1) Systron-Donner VERSATESTER 1™ replaces the lot with laboratory accuracy at home workshop cost.



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  (1) Pulses
  (2) Sine waves
  (3) Square waves

(c) Digitally measures and displays to four digits
  (1) Frequency, auto ranging 20 Hz to 20 MHz
  (2) dc volts, 0 - 500 v in 4 ranges
  (3) ac volts, 0 - 500 v in 4 ranges
  (4) dc ohms, 0 - 5 MΩ in 5 ranges

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Circle 168 on reader service card

New products

can be made directly and not to a common tie point. It also eliminates any possible inductance that the wire itself might contribute. Capacitance is varied over a wide range.

Cornell Dubilier Electronics, 150 Ave. L, Newark, N.J. 07101 [347]

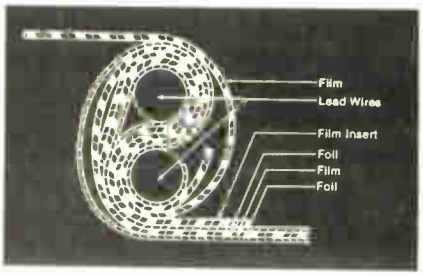
Tantalum capacitors have range from 0.0047 to 330 μF

Kemet miniature and subminiature metal-case epoxy end-filled solid tantalum capacitors are designated the T314 and T324 series. Available in eight case sizes, they range in value from 0.0047 to 330 μF in ±5, ±10, and ±20% capacitance tolerance, 6 to 50 volts. Operating temperature range is −55 to +85°C and to +125°C with derated voltage. The capacitors are designed for bypassing filters and coupling applications in industrial and commercial-grade circuits.

Union Carbide Corp., Components Dept., Box 5928, Greenville, S.C. 29606 [348]

Polypropylene film capacitors range from 100 pF to 0.15μF

A capacitor with a 25-guage polypropylene dielectric, designated Micromatic, offers a total range of 100 pF to 0.15 μF, ±1 to ±20% at 200 or 400 v. The leads on the units serve as winding mandrels in their manufacture. Electrode foils and lead wires are separated by three layers of dielectric, and no dielectric is in direct contact with either lead wire in the electrical field. This insures against voltage breakdown in the area of lead-wire penetration.



Paktron Division, Illinois Tool Works Inc., 1321 Leslie Ave., Alexandria, Va. [349]

When a bump costs $50.

It's time to take a look at Sanders Flexprint® Circuits — the rugged, reliable, flexible circuitry that withstands the bumps and shakes of handling in transit — and saves you the cost of finding and repairing a broken connection.

A manufacturer of electronic systems for home entertainment turned to Flexprint Circuits for just that reason. Every time one of his products was mishandled in transit, it could cost him as much as $50 to find the loose wiring connection.

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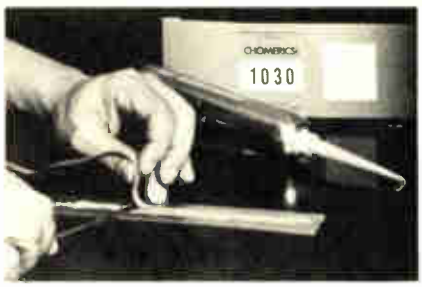
New products/materials



An electrically conductive one-component silicone-based adhesive sealant, called Cho-Bond 1030, can be extruded from a tube and spread with a spatula. It bonds conductive silicone EMI gaskets to metal substrates. The material contains no acetic acid or other corrosive curing agents and cures when exposed to atmospheric moisture. It remains resilient and flexible and has a peel strength of typically 3.0 lb/in. width. A set is obtained in 24 hours, and full cure in 48 hours.

Chomerics Inc., 77 Dragon Ct., Woburn, Mass. 01801 [476]

An epoxy casting compound exhibits low shrinkage and exotherm upon curing. Designated XCA, the material has a relatively low viscosity, and this allows easy pouring. Pot life is about 1 hour, and the material cures at room temperature in 18 to 24 hours. XCA is available in quart and gallon containers.

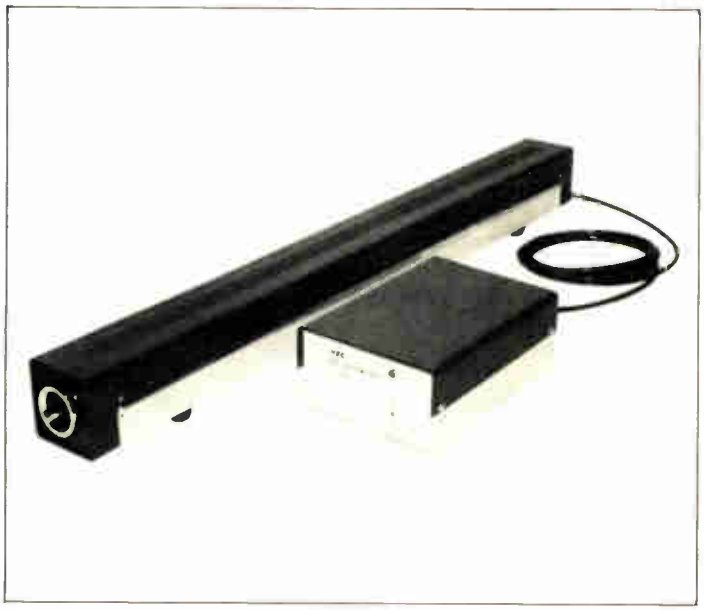
Electro-Kinetic Systems Inc., 2500 E. Ridley Ave., Chester, Pa. 19013 [477]

Hot pressing dies, for the fabrication of electro-optic, piezoelectric, ferroelectric and ferrite materials, uses hot-pressed silicon carbide. The oxidation-resistant dies offer good strength, and can operate in air, oxygen, nitrogen, inert, vacuum, or reducing atmospheres to temperatures in excess of 1,400 C.

Ceradyne Inc., 8948 Fulbright Ave., Chatsworth, Calif. 91311 [478]

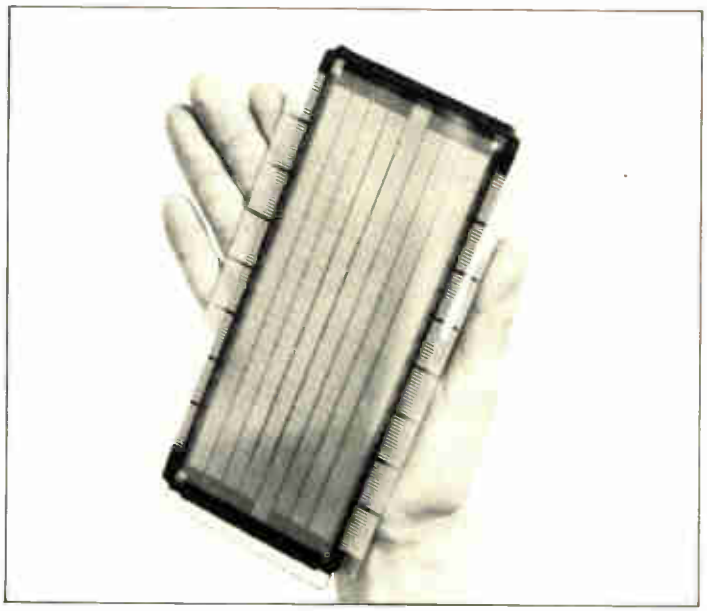
A dip for solder plate on etched printed-circuit boards is called Kenvert 78 and is designed to prevent immersion tin deposition on bare copper or gold areas of pc boards. Thus, if the boards are not completely etched during one cycle and then receive an immersion tin deposit during post-etch treatment,

New Directions in Gas Laser and Plasma Display Panel-By NEC



15 mW He-Ne Gas Laser GLG 2040

NEC's new 15 mW He-Ne Gas Laser offers two distinct improvements from conventional ones—greater stability and extra-long operating and shelf life, with no heat run necessary during storage. Output power, for example, is remarkably stable within ±2%/hour after a 30-minute warm-up. Cavity spacers are made of ultra-low-expansion "Neoceram" glass rods. Moreover, the brewster windows are sealed with glass rather than adhesives. That's why NEC guarantees it for the first full year following delivery.



New Type "UTOVUE" Dotmatrix type Plasma Display Panel

Capable of reproducing any letter in the alphabet or any number. The display panel is equipped with a transparent electrode to ensure unusual brightness. It is a decided improvement over conventional types. Featuring a refresh-type operation, this versatile panel can be applied for all kinds of terminal equipment such as computer, data transmission electronic calculators and instrumentation and industrial machines. Sample will be available this fall.

Make it a point to stop by the NEC booth at New York Coliseum IEEE Show, March 27—30. NEC is eagerly looking forward to the opportunity of showing you its new UTOVUE units, new Gas Laser and many more of its electronic products. You'll find them all at Booth 1702-4.

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NEC
Nippon Electric Co., Ltd.
Tokyo, Japan

New products/materials

they cannot be run through another etching cycle to complete the etch, and they become rejects. By preventing deposition on copper and gold, Kenvert 78 reduces rejects. The material is supplied as a powder, which is mixed with water and supplemented 2% by volume with Kenvert-L liquid additive.

Conversion Chemical Corp., 210 E. Main St., Rockville, Conn 06066 [480]

The Orotemp 20 series is a 99.999% pure neutral gold solution designed especially for ultra-high-speed spot and strip gold plating. The material is capable of plating 50 to 60 millionths of an inch in 1½ to 2½ seconds and produces a deposit that is stress-free, ductile, and heat-resistant. Deposits die-bond, resistance-weld, and then solder with no discoloration. Orotemp 20 solution is stable at operating current densities up to 1,800 ASF. The material contains no brighteners, organic or inorganic, and no free cyanide.

Technic Inc., Box 1965, Providence, R.I. 02901 [371]

Pure-A-Loy is a line of contamination-free solders produced in bar, ingot, and anode form, and can be used with all types of automatic soldering machines. Sulphur content is guaranteed less than 5 parts per million, and oxides and other nonmetallic inclusions not in excess of 10 ppm. Features of the material include good wetting action, low initial dross, shallow fillets for lower dielectric resistance, brighter solder joints, and reduction of hand-touchup time. The material is available in any tin-lead alloy or in special formulations of other alloys.

Gardiner Solder Co., 4820 S. Campbell Ave., Chicago, Ill. 60632 [372]

A paste solder for automatic soldering machines is a tin-lead alloy, combined with a noncorrosive flux. Available alloys include 50/50, 60/40, and 95/5 configurations. The amount of flux residue that remains after soldering is minimal, noncorrosive, and nonconductive.

Force Chemicals Division, American Solder and Flux Co. Inc., Industrial Blvd., Paoli, Pa. 19301 [410]

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1. TEMPILABELS°: self-adhesive temperature monitors consisting of one or more heat-sensitive indicators sealed under transparent, heat resistant windows. The centers of the indicator circles turn from white to black irreversibly at the temperature ratings shown on the label. Tempilabels° are available in several sizes, and in single or multiple temperature ratings from 100° to 500°F. Accuracy is within ±1% of the stated rating. They are particularly useful for monitoring operating temperatures of equipment or processes; obtaining temperature data of components as a guide to design and material selection; safeguarding temperature-sensitive materials in storage or transit. To serve as a permanent record, Tempilabels° can be removed from the surface and attached to a report.

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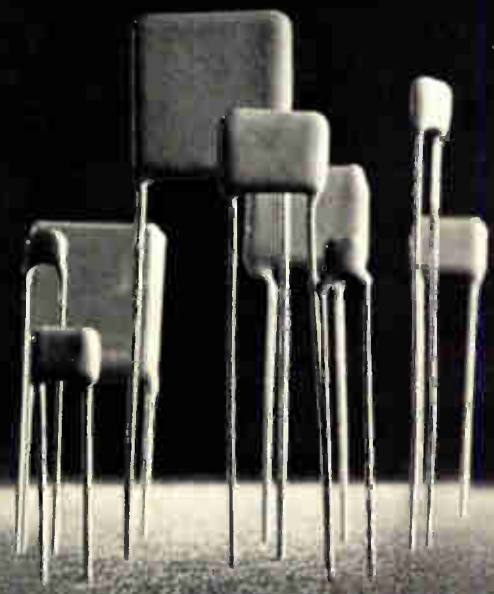

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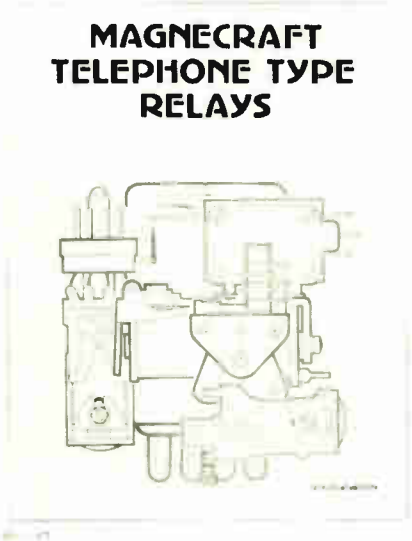
Circle 221 on reader service card

New literature

Measuring instruments. Fogg System Co. Inc., 1380 S. Dahlia St., Denver, Colo. A short-form catalog describes portable measuring instruments, including transducer simulators, bridge amplifiers, and millivolt sources. Circle 421 on reader service card.

Telephone relays. Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. 60630, has published a 60-



page catalog containing more than 35 types of telephone relays. These include miniature, subminiature, small, and medium-sized units. Also contained in the catalog are specifications and line drawings. [422]

Contamination problems. Millipore Corp., Bedford, Mass. 01730. A 45-page manual offers solutions to the particulate contamination problems encountered most frequently in photomask and wafer production. [379]

Force transducers. Quartz piezoelectric force transducers with built-in integrated-circuit amplifiers are described in summary data sheet 200872, available from PCB Piezoelectronics Inc., Box 33, Buffalo, N.Y. 14225. [423]

Floppy disk. Innovex Corp., 4 Alfred Circle, Bedford, Mass., is offering a six-page foldout product brochure on the company's Diskette floppy-disk system. Price, performance

Dialight sees a need:

(**Need:** A space-saving thumbwheel switch)

See Dialight.

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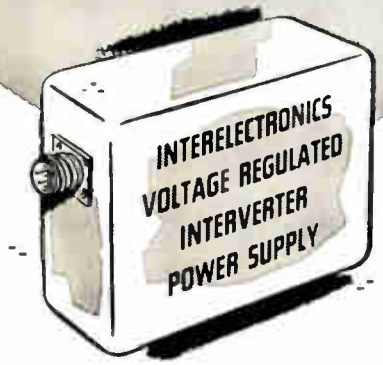

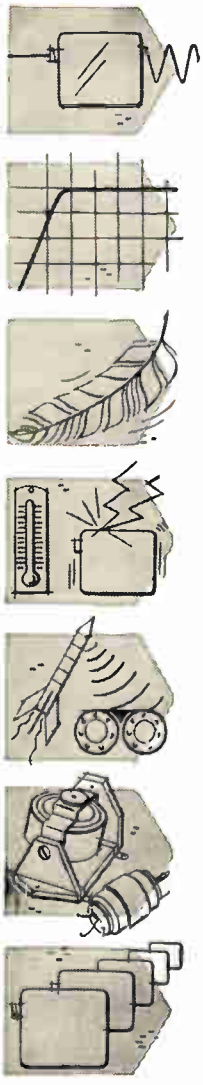

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INTERELECTRONICS CORP.

700 U. S. Route 303 Congers, New York 10920

Circle 179 on reader service card

New literature

characteristics, and technical specifications are discussed. [424]

Dictionary. A German-English electronics dictionary contains more than 78,000 terms and abbreviations in 700 pages. The dictionary sells for $12 in Germany and is available from Verlag H. Wernicke, 8024 Deisenhofen, Box 165, West Germany.

Connectors. Continental Connector Corp., 34-63 56th St., Woodside, N.Y. 11377, has issued an 88-page printed-circuit connector catalog covering printed-card and flexible-cable applications. [425]

Capacitors. Series M high-energy-density pulse discharge capacitors are featured in Bulletin 401R from Maxwell Laboratories Inc., 9244 Balboa Ave., San Diego, Calif. 92123. [426]

Waveform generator. The model F280A programable waveform generator is described in a four-page bulletin available from Ailtech, a Cutler Hammer Co., 19535 E. Walnut Dr., City of Industry, Calif. Included is data for interfacing with contact closure or DTL and TTL levels. [338]

Linear ICs. RCA Corp., Solid State Division, Rte. 202, Somerville, N.J. 08876. A 48-page product guide provides reference information on linear ICs for instrumentation, computer, and other applications. [339]

Measuring indicators. Howell Instruments Inc., 3479 W. Vickery Blvd., Fort Worth, Texas, is offering a catalog describing 16 multipoint measuring indicator panels. [340]

Information handling. The application of MOS LSI technology to information-handling systems is the subject of a brochure from Hycom, 1641 McGaw, Santa Ana, Calif. 92705. [427]

Sensors. Product bulletin FS-1 from Thermometrics Inc., 15 Jean Pl., Edison, N.J. 08817, describes Thermoflake sensors that consist of a flake thermistor mounted at the top

New literature

surface of a glass-to-metal feedthrough header. [429]

Sensing relay. A data sheet describing the model SR510 resistance-sensing relay for rugged industrial environments is available from Regent Controls Inc., Harvard Ave., Stamford, Conn. 06902. [430]

Circuit faults. SofTech Inc., 391 Totten Pond Rd., Waltham, Mass. 02154. An application note discusses the use of the Aedcap circuit simulation system for analyzing faults in electronic circuits. [431]

Function generator. An application note from Wavetek, Box 651, San Diego, Calif., provides information on a function generator. [432]

Instruments. A 16-page catalog from Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill., features its line of instruments, including digital voltmeters, strip chart recorders, and multimeters. [433]

Pilot lights. A 24-page guide to the selection of pilot lights, available from Industrial Devices Inc., Edgewater, N.J., reviews the specifications of a variety of custom and stock lights in neon, incandescent and solid-state fabrications. [434]

Data transfer system. Nuclear Enterprises Ltd., Sighthill, Edinburgh, Scotland. A catalog on a modular

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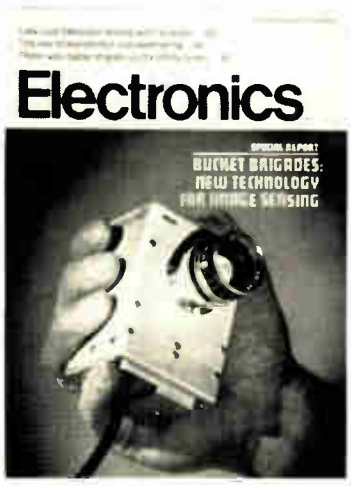

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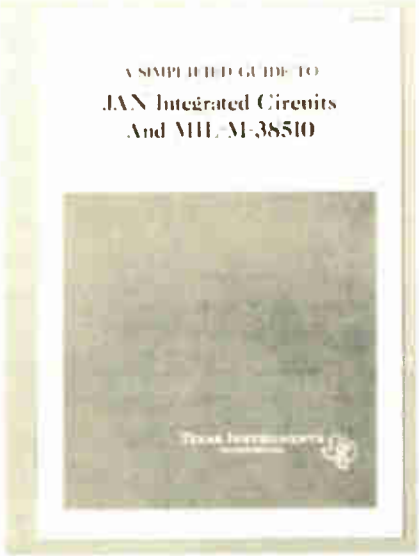
New literature

data-transfer system includes specifications and applications in 128 pages. [436]

Instruments. A 20-page catalog describes instruments such as temperature probes and precision thermistors available from Yellow Spring Instrument Co., Box 279, Yellow Spring, Ohio 45387. [437]

Photomultipliers. A data sheet from Gencom Division, Emitonics Inc., 80 Express St., Plainview, N.Y., provides details on 2-inch and extended S-20 photomultipliers. [438]

JAN ICs. A simplified guide to specifying JAN integrated circuits is available from Texas Instruments Incorporated, Box 5012, M/S 308,



Dallas, Texas. Booklet CB-151 answers questions and clarifies misunderstandings that have arisen because of the complexity of qualification specifications and procedures. [380]

FETs. Siliconix Inc., 2201 Laurlewood Rd., Santa Clara, Calif. 95054. An application note describes the characteristics of field-effect transistors when used as analog switches. The paper deals with the behavior of junction FET, p-MOS FET, and C-MOS FET switches and associated driver circuits. [378]

Materials handling. Aerojet Industrial Systems, Aerojet-General

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Offering many of the same features, our compact Model SD555 is a rotating, 4-compartment, thermal shock chamber that fits a floor space only 2 feet square.

And for *high-volume* testing, there's our SD678 – the big one.

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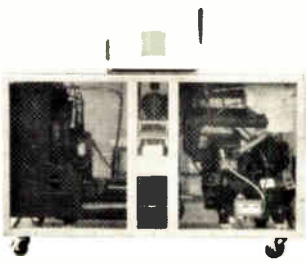
Statham Instruments, Inc., Industrial Division, 2230 Statham Blvd., Oxnard, CA 93030. (805) 487-8511.



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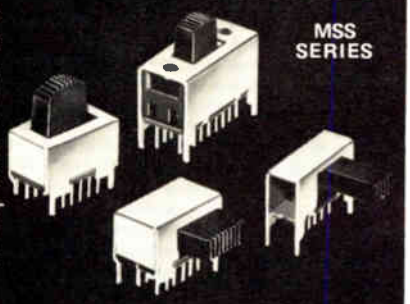

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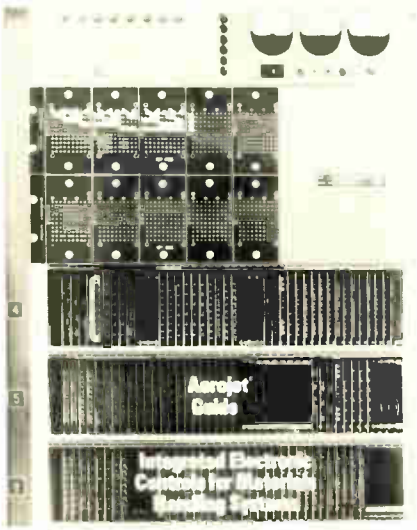
New literature

Corp., Box 460, Frederick, Md., has published a guide to integrated electronics controls for materials handling systems, and describes how



controls may be adapted to new or existing handling systems to increase inputs and provide greater reliability. [377]

Tape transport interfacing. A 90-page users manual from Pertec Corp., 10880 Wilshire Blvd., Los Angeles, Calif., provides the system designer with a description of designing an interface for any of the synchronous digital magnetic tape transports manufactured by the company. [376]

Thermistors. Fenwal Electronics, 63 Fountain St., Framingham, Mass. 01701, is offering a short-form catalog, number L-4A, providing thermistor users with an introduction to the range of sensors and sensor assemblies manufactured by the company. [375]

Antennas. A catalog from Phelps Dodge Communications Co., Rte. 79, Marlboro, N.J., covers the company's line of land-mobile-communications antenna systems. [374]

Accessory equipment. A 60-page catalog of accessory equipment for data, telegraph and associated transmission systems is available from GTE Lenkurt Inc., Dept. C720, 1101 County Rd., San Carlos, Calif. 94070 [373]

New books

Engineering Tables and Data, A.M. Howatson, P.G. Lund, and J.D. Todd, Halsted Press, a division of John Wiley & Sons Inc., 168 pp., $6.50 (paper).

This is a handy book, even though it's intended mainly for the student. It summarizes, in reference form, basic information for three of major engineering disciplines—electronic, mechanical, and civil. In addition to sections on thermodynamics, fluid mechanics, and structural analysis, the authors cover the properties of matter, including semiconductors and ferromagnetic materials.

There are also many tables of "everyday" mathematical functions like base-10 logarithms, trigonometric functions, and the exponential function, as well as listings of specialized functions like Fourier transforms, Laplace transforms, and frequently used differential equations.

The portion of the book devoted to electronics broadly outlines the theory of electromagnetism, linear active circuits, and electrical machines. Transistor equivalent circuits are also presented along the theory of linear passive circuits. This last section includes a usable Smith chart. Although the working engineer would probably prefer a data book that specializes in his specific job needs, this book would be a good reference source for his shelf.

Recently published

Semiconductor Device Modeling for Computer-Aided Design, Gerald J. Herskowitz and Ronald B. Schilling, McGraw-Hill Book Co., 360 pp., $16.50

Computer-Aided Analysis of Electrical Networks, Thomas W. Davis and Ray W. Palmer, Charles E. Merrill Publishing Co., 438 pp., $15.95.

The Art of Computer Programming, Vol. 3: Sorting and Searching, Donald E. Knuth, Addison-Wesley Publishing Co., 722 pp., $19.50.

Electronic Engineering Mathematics, D. E. Taylor, John Wiley & Sons Inc., 228 pp., $12.50.

"Let's kill all the lawyers!"

"The first thing we do, let's kill all the lawyers!"
—Henry VI, Part II, Act III

Jack Cade, in Shakespeare's play, was leading a rebellion and looking for a scapegoat.

He hit upon a somewhat bloodthirsty, but extremely popular, idea.

There is a new and different kind of rebellion in America today. An angry revolt against the pollution and despoilment of our environment.

And some people, again seeking a scapegoat, have also hit upon a popular idea.

Put the blame, and the burden, on business.

Indict U.S. industry as "The perpetrator of an irresponsible assault on the environment."

Demand that industry immediately stop all pollution, end all depletion, and forthwith "restore our natural heritage."

And enforce these demands with new, harsh and punitive, laws and regulations. Impose criminal penalties on the owners and officers of offending companies. Launch an onslaught of "Citizens' and workers' suits for environmental damages." Attack, harass, threaten, punish and compel.

The idea has its appeal. It focuses on a convenient, conspicuous and vulnerable target. It offers immediate action and immediate release for accumulated frustration and anger. Most temptingly, it promises a quick, easy and painless solution to the whole environmental problem.

Against this attack, and in the face of this appeal, industry is at a crippling disadvantage. It has, to put it bluntly, been hit with charges that cannot be denied—demands that cannot be satisfied. And, backed into its corner, it is in an awkward position.

A position in which anything it says is likely to be taken as defensive or evasive, anything it does is questioned in advance as inadequate.

Nevertheless, some things *need* to be said.

First, that industry *is* guilty of an assault upon the environment, and *is* responsible for the consequences.

But, second, that the guilt has long since been acknowledged, the responsibility long since accepted. Today, however belatedly, U.S. industry stands firmly and fully committed to the environmental cause.

The commitment is sincere. It is also specific and binding. The U.S. Commission on Environmental Quality has designed a massive pro-

gram to cleanse and restore the American environment in the 1970's, at a total cost of $287-billion. Industry's share of this cost is set at $195-billion.

Clearly, this assigned task and this imposed burden will strain the financial, and test the technical and managerial, capacities of U.S. industry to the utmost. It adds an enormous responsibility and a formidable challenge to all of the other responsibilities and challenges that industry must continue to confront in a competitive and demanding world.

The responsibility has been accepted, the job will be done. But beyond this assigned task, beyond this designated goal, beyond these outer limits of the possible, industry probably cannot go. It is not a question of will, but of capacity. The issue is not what industry *ought* to do, but what industry *can* do.

To the extremists' premise that industry can be threatened, harassed and driven to exceed its utmost capacities—that it can somehow be *made* to do what it manifestly cannot do—a frank and unequivocal response must be made.

Industry cannot immediately stop all pollution, end all depletion, and overnight restore our natural heritage. It is impossible. It is financially impossible, technically impossible, economically impossible, morally impossible, and physically impossible.

It is financially impossible for industry to immediately allocate and spend $195-billion. There is not that much money to be had, from any source, by any means, using any device.

It is technically impossible, at any price, to totally eliminate all forms of pollution.

It is economically impossible to bring all of U.S. industry to a complete halt while pollution control is given absolute priority over production.

It is morally impossible to close every offending plant, shut down every faulty operation, and throw thousands of people out of jobs, whole communities into bankruptcy.

And it is physically impossible, even if everything else could be done, to compress the work of a decade into a day, a month, or a year.

To these obvious impossibilities, one more must be added. It is impossible to separate industry from the society to which it belongs —and which it serves and reflects.

The environmental crisis is not an isolated, but a total, national crisis. The result of universal neglect and unanimous irresponsibility. And of a prolonged, overwhelming, devastating *mass* assault on the environment, made by millions of American citizens and consumers, in ignorance or blithe disregard of the consequences.

We are no longer ignorant. We are no longer quite so blithe. But the assault continues. Because the insistent, unrelenting pressure of consumer needs, wants, desires and demands continues.

And this, ultimately, is the problem. Not for industry alone, but for the whole of a truly interdependent society. Any major solution to the environmental crisis requires a profound change in the personal expectations, habits, attitudes and actions of millions of individual Americans.

But the point, with regard to industry's responsibility, is simple. Industry cannot dictate change. It can control its own actions and reform its own habits. But it cannot refuse to meet needs, ignore wants, desires and demands, and reform the habits, attitudes and actions of 200-million Americans.

Killing lawyers does not further the cause of justice. Persecuting and punishing industry will not advance the cause of a better environment. The sacrifice of a scapegoat solves nothing and gets us nowhere.

Except off the track. A common, national problem demands a common, united, national effort. The job belongs to us all.

It is time to forget the diversion and get on, *together*, with the job.

We at McGraw-Hill believe in the interdependence of American society. We believe that, particularly among the major groups—business, professions, labor and government—there is too little recognition of our mutual dependence, and of our respective contributions. And we believe that it is the responsibility of the media to improve this recognition.

This is the sixth of a series of editorial messages on a variety of significant subjects that we hope will contribute to a broader understanding.

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John R Emery

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■ American Lava Corporation Sub. of Minnesota Mining & Mfg. Co. 159
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• American Microsystems, Inc. 24E-25E
Wilton Coombs & Colnett Inc

AMF/Potter & Brumfield Division 136
Fuller & Smith & Ross Inc.

• AMP Italia 9E
Studio Dolci

• Anritsu Electric Co. Ltd. 22E
Diamond Agency Co Ltd

Applicon Incorporated 123
Johnson Raffin & Lingard, Incorporated

■ Augat 80-81
Creamer, Trowbridge, Case & Basford Inc

■‡ Beckman Instruments, Inc., Helipot Div. 104-105
N W Ayer/Jorgensen/MacDonald, Inc

■ Bendix Corporation, Electrical Components Div. 129
D'Arcy-MacManus-Intermarco, Inc.

•‡ Bourns, Inc. 18-19
Marlborough Assoc., Inc

Brand-Rex 151
Creamer, Trowbridge, Case & Basford, Inc.

■• Burndy 17E
Intermarco Publicem

Business Week 174

California Computer Products 169
Dailey & Associates Advertising

■ Cambridge Thermionic Corporation 163
Chirurg & Cairns, Inc.

■ CELCO 181
Stano Advertising

Centralab, Electronics Div. of Globe Union, Inc. 145
The Brady Co

• CIT Alcatel 26E
Promotion Industrielle

■ Clairex Corporation 4th Cover
Black-Russell-Morris

Colorado, State of Commerce & Development Division 180
Frye-Sills, Inc

Computer Automation 15
Cochrane Chase & Company, Inc

• Computer Components, Inc. 32E

■ Constantine Engineering Laboratory Co. 181
Stano Advertising

CTS Corporation 133
Reincke Meyer & Finn, Inc

■ Curtis Instruments, Inc. 132
Marc Dorian, Inc

Datacraft Corporation 60-61
The Communicator

Data Test 48
DTC Advertising Agency

Datatron, Inc. 20
Larry Courtney Company

■ Datel Systems, Inc. 27
John Dolan Advertising

Delco Electronics Division, General Motors Corp. 58-59
Campbell-Ewald Company

■ Dialight Corporation 179
Michel-Cather, Inc

• The Digitran Company 29E
Jansson Advertising, Inc

Diva, Inc. 110
Halloff & Caine

Eastern Air Devices 185
Weston Associates, Inc

■ Eastman Chemical Products, Inc., Industrial Chemicals 178
J Walter Thompson Company

Eastman Kodak Company, Business Systems Markets Div. 118
J Walter Thompson Company

Edo Western Corporation 182
Technical Services for Industry

Energy Conversion Devices, Inc. 156
Watkins Rogers Inc

Esterline Angus, A Unit of Esterline Corporation 181
Odiorne Industrial Advertising Inc

Fairchild Semiconductor, Inc. 46-47
Carson/Roberts, Inc Adv Division of Ogilvy & Mather, Inc

Fluke Manufacturing Co., John 164
Bonfield Associates

General Automation 62-63
Chiat Day Inc Advertising

■ General Electric Electronic Components 28
Robert S Cragin Inc

General Magnetics 2nd Cover
McCarthy Scelba DeBiasi Adv Agcy Inc

• General Radio 5E
Grad Associates

■ General Radio Co. 139
Grad Associates

Georgia Department of Industry & Trade 166
Cargill Wilson & Acree, Inc Adv

■ Gould, Inc./Instrument Systems Div. 43
Carr Liggett Adv Inc

■ Gralex Industries Division of General Microwave Corp. 168
Industrial Marketing Associates

■ Grayhill, Incorporated 157
Carr Liggett Advertising, Inc.

‡ Guardian Electric Mfg. Co. 22-23
Kolb Tookey and Associates Inc

Hamilton Digital Controls, Inc. 165
Graystone and Ramsey Inc

Hermes Electronics Ltd. 79
Public & Industrial Relations Limited

■ Hewlett Packard 76-77
Richardson Seigle, Rolfs & McCoy Inc

■ Hewlett-Packard 21
Richardson Seigle, Rolfs & McCoy, Inc

■ Hewlett-Packard 10-11
Tallant Yates Advertising, Inc

■ Hewlett-Packard 12 125
Tallant Yates Advertising, Inc

■ Hewlett-Packard 2
Richardson, Seigle, Rolfs & McCoy, Inc.

■ Hewlett-Packard 1
McCarthy, Scelba, and DeBiasi Adv Agcy, Inc

Hitachi Metals, Ltd. 157
Asia Adv Agcy, Inc

Houston Instrument 167
Ray Cooley and Associates, Inc

Hughes Aircraft Company 148
Foote, Cone & Belding

Hutson Industries 184
Warren-Guild

Hybrid Systems Corp. 144
Susan E Schur

Industrial Electronics Engineers, Inc. 170
S Michelson Advertising

Innovex Corporation 39
Weber Donohue Cooper, Inc

Inselek 71
Insel Advertising Agency

Integrated Microsystems, Inc. 67
Paul Pease Advertising Inc

■ Interelectronics Inc. 179
Samuel H Meyer Advertising

Intersil 12-13
Herrick Associates, Inc

• Invest Export-Import
Interwerbung

Iowa Development Commission 186
Creswell, Munsell, Schubert & Zirbel, Inc.

IseElectronics Corp. 73
Shinwa International, Inc.

ITT Semiconductors 19&54
Hall & McKenzie Advertising

■ Johnson Company, E.F. 138
Martin Williams Advertising

Keithley Instruments, Inc. 140
Chagrin Valley Marketing Associates

■ Kepco Incorporated 5
Weiss Advertising

■ Lambda Electronics Corporation 3rd Cover
Michel Cather, Inc

McGraw-Hill Magazines 188-189

Marco-Oak 155
Jansen Associates, Inc.

Micro Consultants Ltd. 183
Geoffrey Dadd Ltd.

Micro Power Systems 72
Associated Adventures

Microsystems International Ltd. 40-41
Media Advertising Ltd

■ 3M Electro Products Division 135
Batten, Barton, Durstine & Osborn, Inc.

■ 3M Company - Mincom Division 142-162
D'Arcy-MacManus-&Masius, Inc

• Molex Incorporated 160-161
Total Communications Service

■ Nippon Electric Co., Ltd. 175
Hakuhodo Inc

• Nippon Kogaku K.K. 18
K & L Advertising Agency

North Atlantic Industries, Inc. 75
Diversified Corporate Services, Inc

• Oscilloquartz SA, Neuchetel 28E
M R Hofer Werbeagentur BSR/EAAA Bern

Pace, Inc. 152
Communications Unlimited, Inc

■ Permag Corporation 187
Schneider, Allen, Walsh, Inc

• Philips N.V. Pit/T & M Division 54
Marsteller International S.A.

■ Piezo Technology, Inc. 149
Shattuck/Roether Advertising, Inc.

Piher International 84-85
Scott MacTaggart Advertising

Plastics Engineering Company 146
Kuttner & Kuttner, Inc.

PROCOND S.p.A. 182
QUADRAGONO

• RCA Ltd. 10E-11E
Marsteller Ltd

■ RCL Electronics, Inc. 14
Morvay Advertising Agency

■ Rental Electronics, Inc. 150
Communications Unlimited, Inc.

‡ Rohde & Schwarz, Inc. 57
R + S Sales Company

• Rohde & Schwarz 1E

Rotek Instrument Corp. 180
Buck Associates

Rotron, Incorporated 153
Black-Russell-Morris

Howard W. Sams & Co. 141
Aitkin-Kynett Co., Inc.

Sanders Associates, Inc. 173
Harold Cabot & Co., Inc.

Schauer Manufacturing Corp. 178
Nolan, Keelor & Stites

Scientific-Atlanta, Inc. 187
NOW Advertising

• S.E. Laboratories Ltd. 12E-13E
Graphic Publicity Ltd.

• Sescosem 6E
Perez Publicite

• Siemens Aktiengesellschaft 52
Linder Presse Union GmbH

■ Signal Transformer 172
Russell Technical Services, Inc

Signetics Corp., Sub. of Corning Glass Works 82-83
Hall Butler Blatherwick, Inc

Siliconix 109
Robertson West, Inc.

■ **Solitron Devices, Inc., Transistor Division** 131
Haselmire Pearson Advertising, Inc

■ **Sprague Electric Company** 154
Harry P. Bridge Company

Statham Instruments, Inc., Industrial Div. 185
Artistic Advertising

■ **Systron Donner Concord Instruments** 51
Bonfield Associates

■ **Systron Donner Corp. - Datapulse Div.** 171
Bonfield Associates

Taiyo Denki Co., Ltd. 174
Daiyusha Inc

* **Takeda Riken** 17

* **Tandbergs Radiofabrikk A/S** 21E
Holter, Young & Rubicam AS

■ **T-Bar, Incorporated** 8
The Robert A. Paul Advertising Agency, Inc.

* **TEAC Corp.** 22
Dentsu Advertising Ltd.

TEC, Inc. 157
TEC-AD

Tektronix, Inc. 33,35,37,44-45
Dawson, Inc

■* **Teledyne Philbrick** 104
Ingalls Associates, Inc., Advertising

Teledyne Relays 27E
S. Michelson Advertising

Teledyne Systems Company 64
Kelly/McDonough Advertising

Templl Ind., Div. of Big Three Ind. 177
Black-Russell-Morris

Test & Measuring Instruments, Inc. 147
Sam Groden, Incorporated

Thermalloy 191
Warren-Guild

‡ **Thomas & Betts Company** 17
McCarthy, Sceiba, DeBiasi Advertising Agency, Inc.

■ **Thomson CSF** 86
Bazaine Publicite

Toko, Inc. 172
Hakuhodo, Inc.

■ **TRW Electronics, Semiconductor Division** 7
The Bowes Company

Trygon Electronic Subsidiary of Systron Donner Corporation 42
RAMA Advertising

Tung Sol Division, Wagner Electric Corp. 186
Winius Brandon Company

U.S. Capacitor Corp. 177
S. Michelson Advertising

■ **VARO SEMICONDUCTOR, INC.** 170
Warren-Guild

Vector Electronic Company, Inc. 176
Communications Management Company

Victoreen Instrument Division 78
Dix & Eaton, Inc.

■ **Vishay Resistor Products** 183
The Larwin Agency

■ **Wavetek** 126
Chapman Michetti Advertising

* **Wayne Kerr Co., Ltd.** 19E
Dennis & Garland Ltd

Weston Instruments, Inc. 16A-16B
APCL&K, Inc.

Wima, Westermann 16

* **Yokogawa Electric Works Ltd.** 105
General Advertising Agency, Inc.

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EQUIPMENT (Used or Surplus New) For Sale

Employment 184
Radio Research Instrument Co. 184
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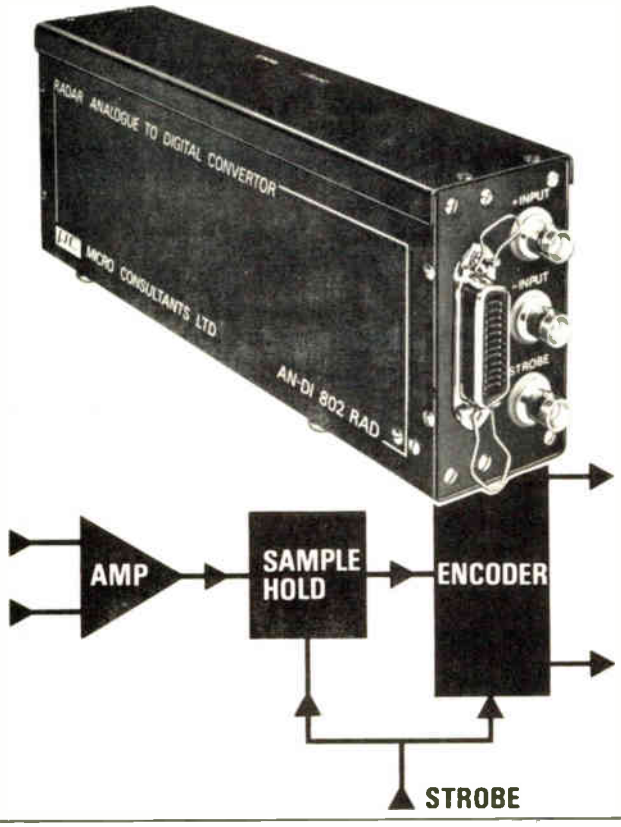

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Resolution	8 bits
Throughput	15 MHz
Input	± 1 volt 50Ω or 75Ω diff
Sample Aperture	100 picoseconds
Output	Parallel MECL balanced line drivers
Size	3·6 × 2·0 × 9·5 inches

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Resolution	10 bits
Throughput	4 MHz
Input	± 1 volt 50Ω or KΩ diff
Sample Aperture	20 nanoseconds
Output	74 TTL
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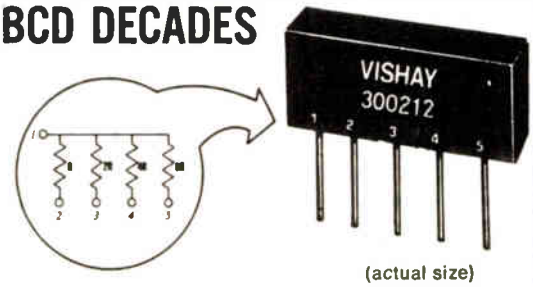

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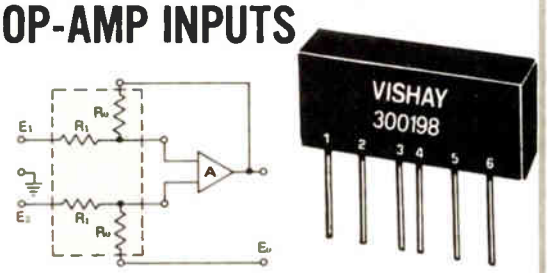

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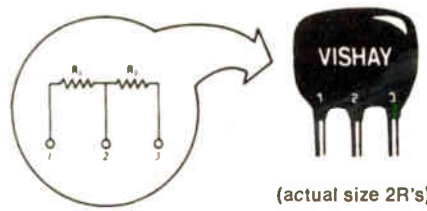

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2, 3, or 4 resistor voltage dividers

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- **each resistor 100Ω to 75K ohms**
- **absolute tolerance each resistor to ±0.005%**
- **absolute TC each resistor 5ppm/°C (−55°C to +125°C)**
- **ratio tolerance to 0.005%**
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- **Rise time to 1 nanosec (each resistor)**

other networks available to 16 bits

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A DIVISION OF VISHAY INTERTECHNOLOGY, INC.
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1	21	41	61	81	101	121	141	161	181	201	221	241	261	343	363	383	403	423	443	463	483	503	713
2	22	42	62	82	102	122	142	162	182	202	222	242	262	344	364	384	404	424	444	464	484	504	714
3	23	43	63	83	103	123	143	163	183	203	223	243	263	345	365	385	405	425	445	465	485	505	715
4	24	44	64	84	104	124	144	164	184	204	224	244	264	346	366	386	406	426	446	466	486	506	716
5	25	45	65	85	105	125	145	165	185	205	225	245	265	347	367	387	407	427	447	467	487	507	717
6	26	46	66	86	106	126	146	166	186	206	226	246	266	348	368	388	408	428	448	468	488	508	718
7	27	47	67	87	107	127	147	167	187	207	227	247	267	349	369	389	409	429	449	469	489	509	719
8	28	48	68	88	108	128	148	168	188	208	228	248	268	350	370	390	410	430	450	470	490	510	720
9	29	49	69	89	109	129	149	169	189	209	229	249	269	351	371	391	411	431	451	471	491	701	900
10	30	50	70	90	110	130	150	170	190	210	230	250	270	352	372	392	412	432	452	472	492	702	901
11	31	51	71	91	111	131	151	171	191	211	231	251	271	353	373	393	413	433	453	473	493	703	902
12	32	52	72	92	112	132	152	172	192	212	232	252	272	354	374	394	414	434	454	474	494	704	951
13	33	53	73	93	113	133	153	173	193	213	233	253	273	355	375	395	415	435	455	475	495	705	952
14	34	54	74	94	114	134	154	174	194	214	234	254	274	356	376	396	416	436	456	476	496	706	953
15	35	55	75	95	115	135	155	175	195	215	235	255	275	357	377	397	417	437	457	477	497	707	954
16	36	56	76	96	116	136	156	176	196	216	236	256	338	358	378	398	418	438	458	478	498	708	956
17	37	57	77	97	117	137	157	177	197	217	237	257	339	359	379	399	419	439	459	479	499	709	957
18	38	58	78	98	118	138	158	178	198	218	238	258	340	360	380	400	420	440	460	480	500	710	958
19	39	59	79	99	119	139	159	179	199	219	239	259	341	361	381	401	421	441	461	481	501	711	959
20	40	60	80	100	120	140	160	180	200	220	240	260	342	362	382	402	422	442	462	482	502	712	960

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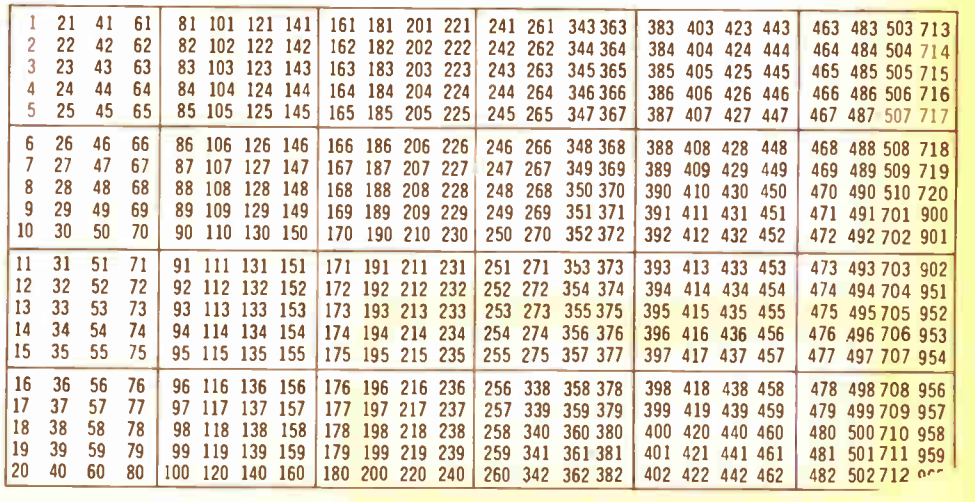

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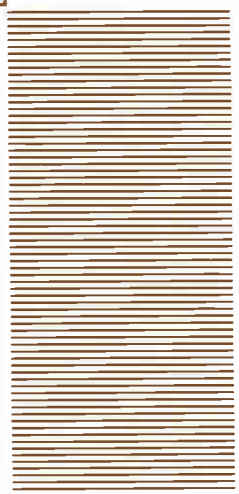

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