March 7, 1974

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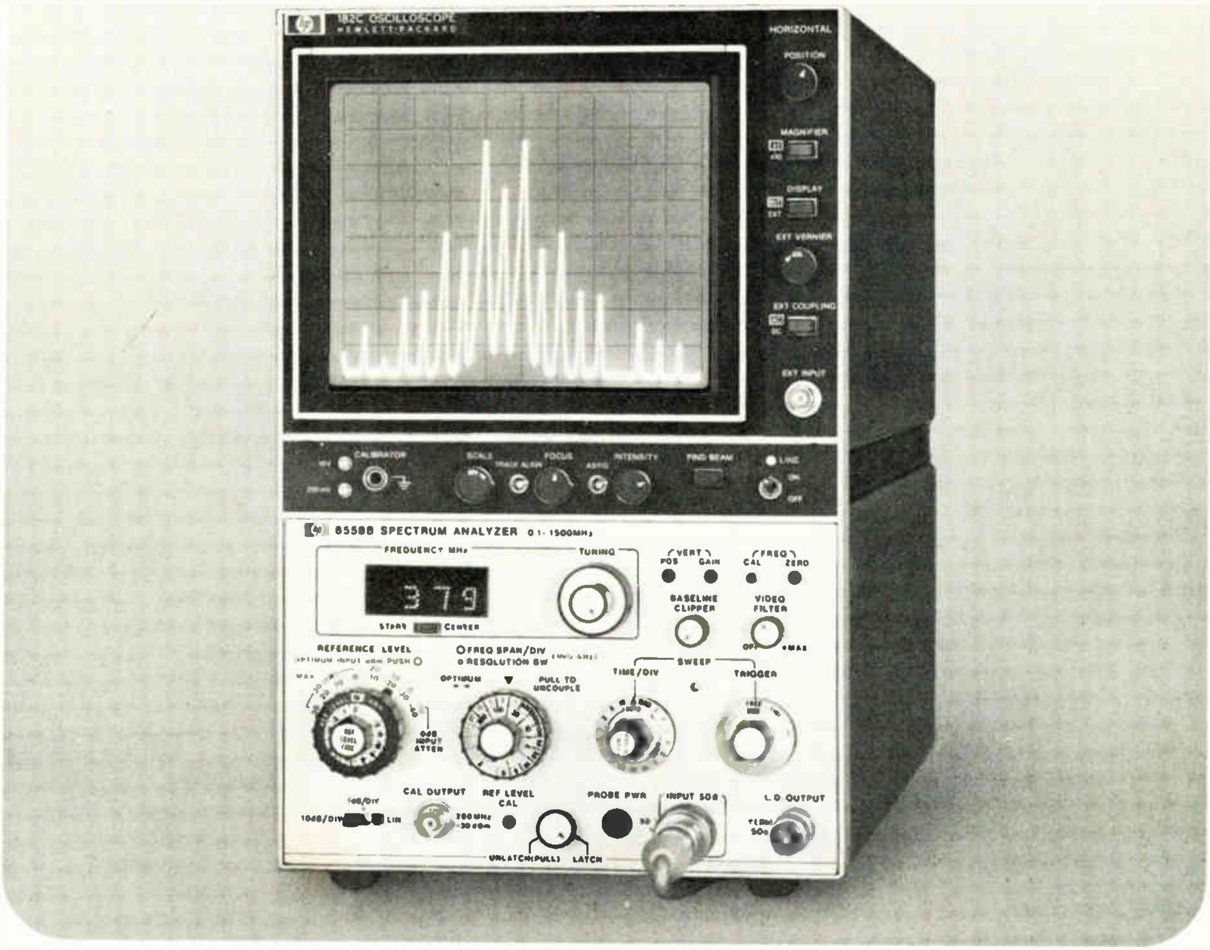

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Electronics

The International Magazine of Electronics Technology

Vol. 47, No. 5 • March 7, 1974

Highlights

The cover: Analog display takes on new glow, 89
Bar graphs driven by digital circuitry are the latest development in the fast-moving field of gas-discharge technology. Having no moving parts, a Burroughs panel is a strong challenger to existing electromechanical indicators.

Car makers need perfect devices for pennies, 74
Semiconductor manufacturers have yet to learn that automobile economics demands higher levels of quality control and reliability than even aerospace programs. This was the message from automotive company representatives at an ISSCC discussion and a panel sponsored by *Electronics*' magazine.

How companies evaluate EE performance, 107
Today's more thorough and more objective evaluations are improving communications between managers and EEs and often help the individual engineer plan his career more effectively. This Special Report surveys systems in use at firms across the country, and a questionnaire invites *Electronics*' readers to tell how they react to being evaluated.

Simpler n-channel process increases yields, 117
Higher yields mean lower costs, yet the resulting ion-implanted metal-gate MOS devices perform as well as silicon-gate LSI. They also operate off +5 volts and are fully TTL-compatible.

And in the next issue . . .
Optical waveguide moves into systems . . . a 12-bit microcomputer . . . designing with computer-generated Smith charts.

Electronics

Publisher's letter

As **evaluation** of an engineer's job performance has become more sophisticated, the process of evaluation itself is having increasingly more impact on the career of every engineer. What's more, evaluation has become an increasingly effective tool in helping supervisory personnel do their job.

Since evaluation used to be thought of as just a necessary chore, we were surprised at some of the changes in attitude that we found when we conducted a survey for our report on the dimensions of engineering evaluation today (see p. 99). For one, an unexpectedly large number of EEs not only approve of the concept, but, in fact, desire to be evaluated—and then informed of the results. Indeed, more and more companies are encouraging the engineer to comment on his rating by providing space for that purpose on the evaluation forms.

The most important byproduct of evaluation procedures is an increased communication between supervisor and engineer, which leads to higher productivity and greatly helps in career planning.

Our survey's cross-section, while representative, was necessarily a small one. So, to get a better handle on the pros and cons of evaluation—and find out how you readers react to your company's evaluation procedures—we've included two questionnaires in this issue (see p. 103 and p. 104). We urge you to take the time to fill one out. In an upcoming issue, we'll publish the results, as well as the most illuminating comments that we receive.

The **automobile** represents a relatively new and potentially lucrative market for electronic products. But there's a long journey between seeing the possibilities of the market and successfully entering it. In our Probing the News section this issue, we have two stories—both about automotive electronics—illustrating that long trip.

The first, by our Washington bureau chief, Ray Connolly, rounds up the current status of electric-vehicle research in the U.S., Europe, and Japan (see p. 70). The conclusion: there should be a strong market there for electronic controls. But there's still a lot of work to be done—on both cost and performance—and it's still at least three years before electric vehicles—most likely buses—come on strong.

Connolly, in reporting on the Third International Electric Vehicle Symposium, points out that "solid-state technology is still a newcomer in the EV marketplace." It's the potential of that technology that makes the market attractive and only time will tell if the potential can be realized.

In a way, the electric-vehicle market holds out the same kind of promise that Detroit did several years ago. On page 74, our Managing Editor-News, Larry Curran, has put together a report card on the first mass installations of electronic seat-belt interlock systems, electronic ignition, and electronic fuel injection. The score given by auto makers to electronics: A for effort. But as you'll see when you read the article, the reliability vs. cost problem, the key to the future of electronics in cars, is still a big question mark.

March 7, 1974 Volume 47, Number 5
93,157 copies of this issue printed

Published every other Thursday by McGraw-Hill, Inc. Founder: James H. McGraw 1860-1948. Publication office 1221 Avenue of the Americas, N.Y., N.Y. 10020, second class postage paid at New York, N.Y. and additional mailing offices.

Executive, editorial, circulation and advertising addresses: Electronics, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 997-1221. Teletype TWX N.Y. 710-581-5234. Cable address: M C G R A W H I L L N. Y.

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Readers comment

Date-coding ICs

To the Editor: This is to supplement Fred U. Rosenberger's letter on the problems of date-coding ICs [*Electronics*, Dec. 20, 1973, p.6]. The confusion that Mr. Rosenberger mentions is, in fact, already with us because several manufacturers use a three-digit code. They must eliminate the initial seven, banking on the likelihood that the user won't mix parts made recently with parts made a decade ago or a decade hence. Thus it was that I was asked to determine if an op amp marked 316 was, in fact, LM316. It was not, but it certainly was date-coded for the 16th week of 1973.

I suggest that if manufacturers who use the four-digit code would substitute the letter D for the seven, and if manufacturers who use the three-digit code would prefix their codes with the letter D, it would cause less confusion.

Lawrence W. Johnson
Hewlett-Packard Laboratories
Palo Alto, Calif.

HP-35 statistical analysis

To the Editor: In "doing statistical analysis with a single data entry," [*Electronics*, Nov. 8, 1973, p.121], Walter Manka suggests a 10-step method for finding standard deviations. Here's a key sequence that eliminates one of the steps: DATA, ENTER, ENTER, ×, RCL, +, STO, ROLL DOWN, +. If you have a large number of data inputs, saving that single step can save a lot of time.

It is also possible to use the HP-35 calculator as a counter, taking advantage of the behavior noted by J. Snaper in another Engineer's Notebook, "Storing two constants instead of just one," [Nov. 8, 1973, p. 121]. Just load the increment, push ENTER three times, and you are ready to count. To set the display to zero, push CLX, and each press of the + key will then change the display by the desired increment.

The Rev. Walter L. Pragnell
Grace Church
Everett, Mass.

To the Editor: The Engineer's Notebook, "Doing statistical analysis with a single data entry," shows an equation that is not the generally accepted one for relatively small sample sizes, where N is less than or equal to 30. The correct equation is:

$$S.D. = [[\Sigma(D_i)^2/N-1] - [(\Sigma D_i)^2/N(N-1)]]^{1/2}$$

With this equation, the mean, variance, and standard deviation can still be determined with a single data entry on the HP-35 calculator.

Paul Wahlstrom
Reserve Mining Co.
Silver Bay, Minn.

■ *The author replies: Where a rigorous analysis is required, your equation should be used. By increasing N, the two equations approach equality. The differences between the two equations with N = 5 is about 12%, with N = 10, it is about 5%, and with N = 30, it is about 1.7%. These differences usually are not large, compared with the indeterminate errors present. Therefore, it becomes a matter of convenience which equation to use.*

For example, with N = 31, there is still a difference of 1.02%. In some situations, this may still be significant, requiring that your equation be used with sample sizes greater than 30. The accuracy desired depends on the situation. The important point is that statistical analysis can be done on the HP-35 with a single data entry.

Cutting keystrokes

To the Editor: Some keystrokes can be trimmed from the method suggested by Philip Geffe in "Evaluating polynomials and finding their roots by means of the HP-35 [*Electronics*, Engineer's Notebook, Nov. 8, 1973, p.120].

The polynomial can be written as:

$$P(x) = a_n x^n + a_{n-1}x^{n-1} + \ldots + a_1 x + a_0$$

For evaluating $P(x_0)$, the key sequence becomes:

x_0, ROLL UP, ROLL UP, ROLL UP, a_n, ×, a_{n-1}, +, ×, a_{n-2}, +, ×, . . . , a_1, +, ×, a_0, +

The longer the polynomial is, the more keystrokes can be saved with this method.

John A. Ball
Harvard College Observatory
Harvard, Mass.

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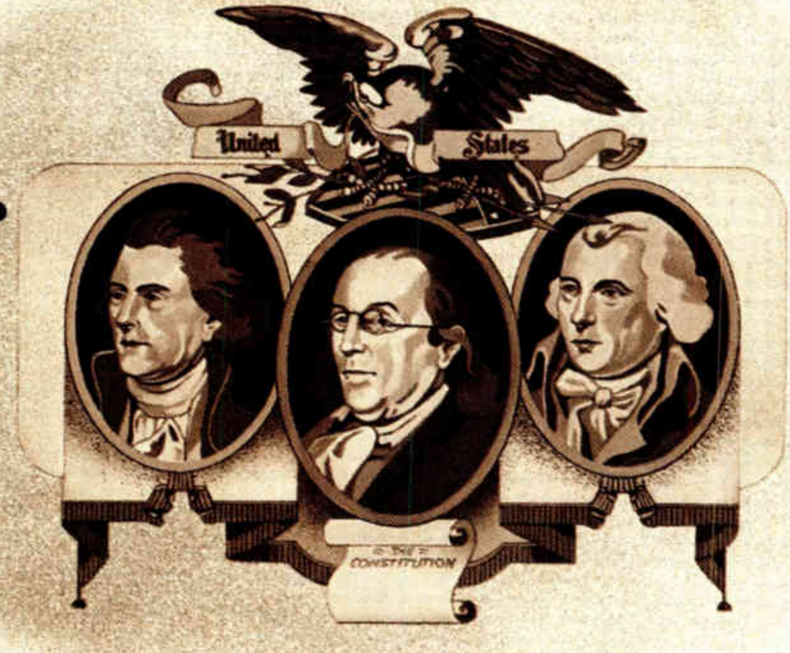

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40 years ago

From the pages of Electronics, March, 1934

Radio and the FCC

President Roosevelt has asked that a new Federal Communications Commission be set up to take over the functions of the Federal Radio Commission and the communication responsibilities of the Interstate Commerce Commission. Two bills accordingly have been introduced in Congress: Representative Rayburn's bill which would create the new Communications administration and set it in operation with the existing radio laws; and Senator Dill's bill which would repeal all present radio legislation and enact a wholly new law in its place.

The Federal Radio Commission has been purely a traffic-regulating body. The new Commission of seven will handle ether traffic and in addition take over rate-fixing and the supervision of all charges made for interstate and international communication. Excepted from this, however, will be broadcasting advertising rates—broadcasting being clearly defined by all parties as not a common carrier. Supervision of operating conditions by broadcasters will be continued by the new Communications Commission.

While there is always the hazard that a new group of seven political appointees will find work to keep themselves apparently busy and to build a vast bureaucracy as in the cases of other Washington commissions, it begins to be apparent that the force of the new communications administration will fall chiefly on the wire services where the vast bulk of the dollar volume lies. There is as yet little continental radio communicating service . . . When the new FCC comes to fixing upon international radio rates, the dilemma is presented as to how the American commission can fix rates, when it has no authority over the various foreign governments which cooperate in the interchange of radio messages! On the other hand the FCC can play a great future part in coordinating American communication services and putting the Government firmly behind American operating companies . . .

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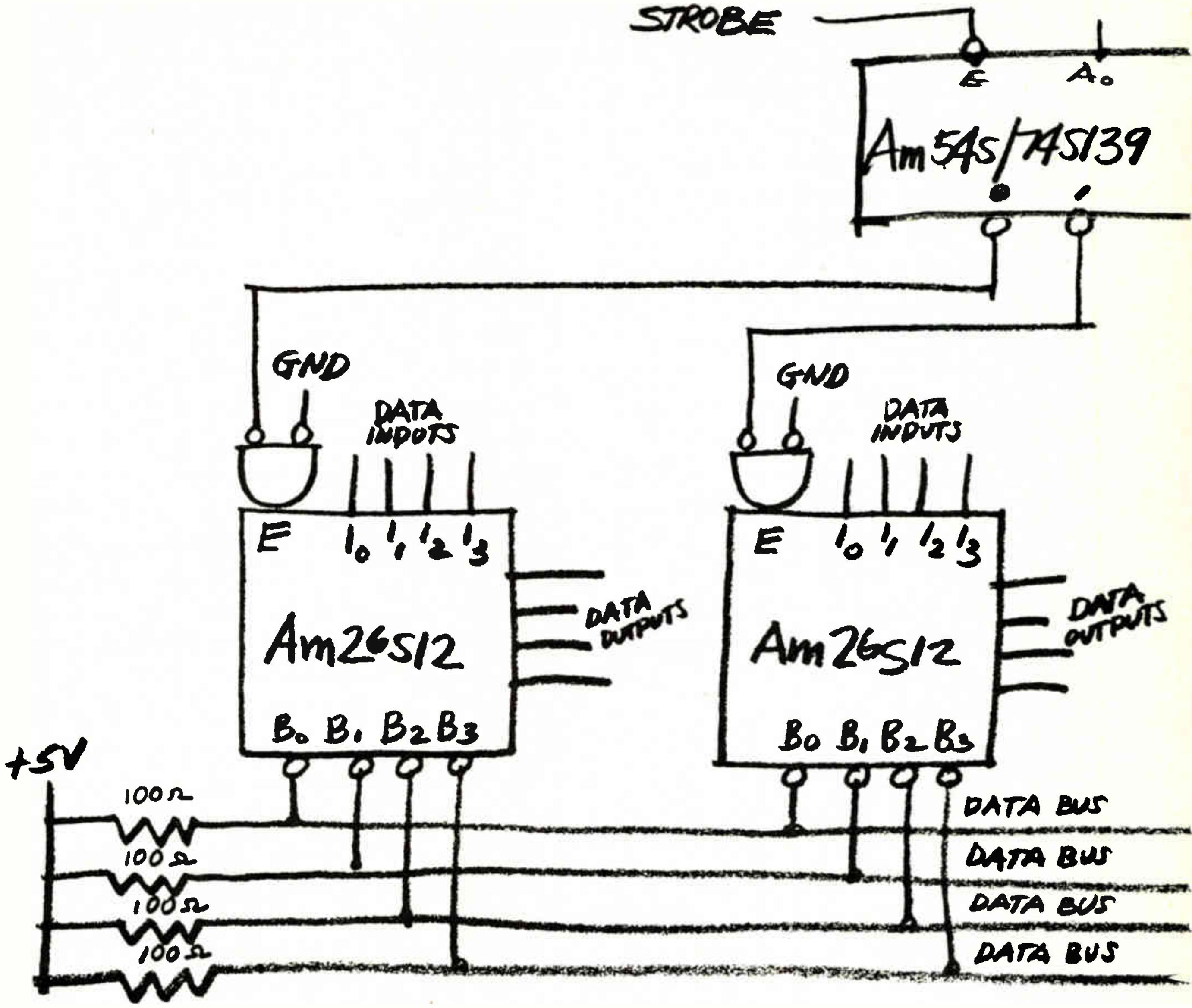
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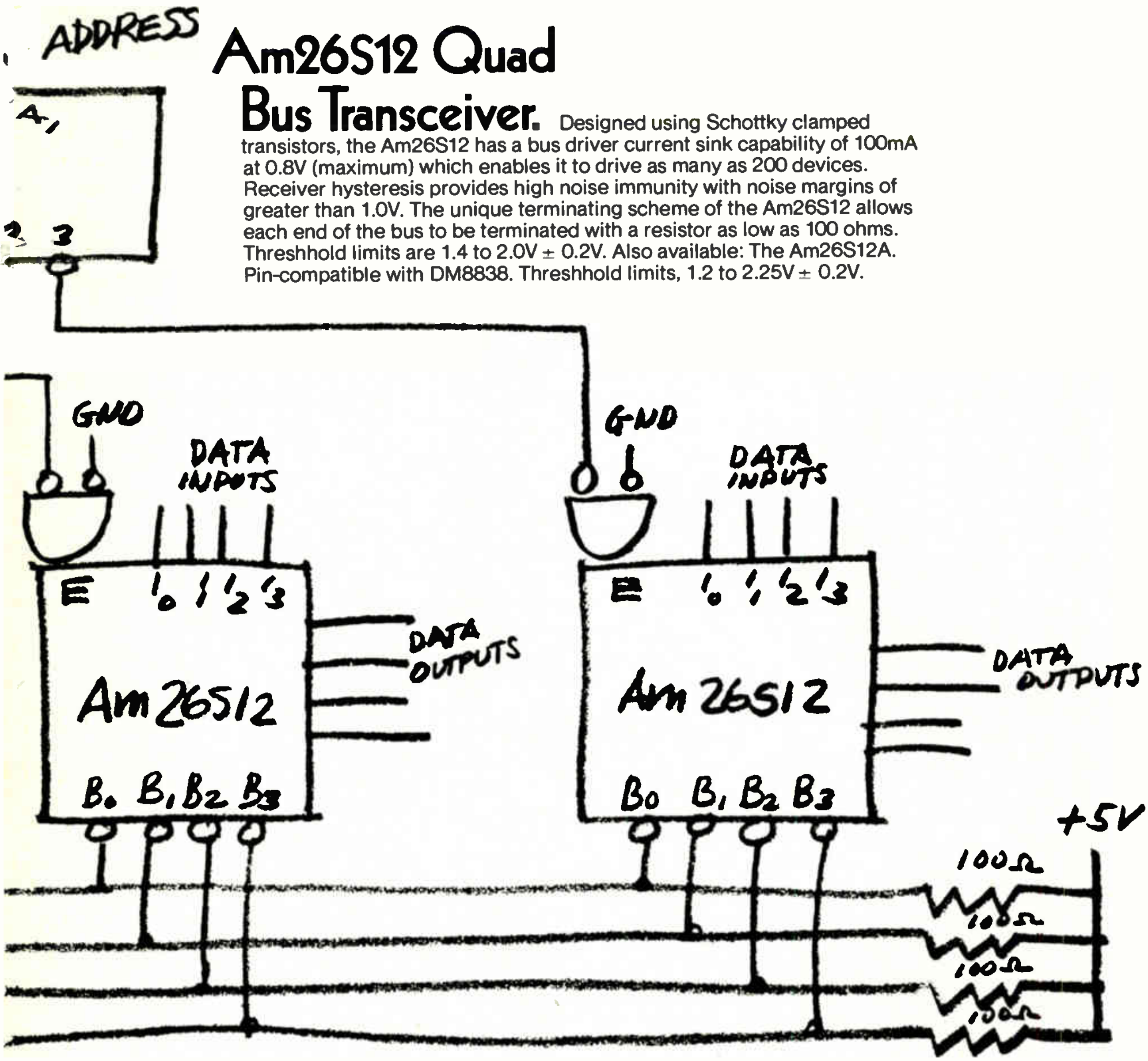
DATA BUS

Am26S12 Quad Bus Transceiver.

Designed using Schottky clamped transistors, the Am26S12 has a bus driver current sink capability of 100mA at 0.8V (maximum) which enables it to drive as many as 200 devices. Receiver hysteresis provides high noise immunity with noise margins of greater than 1.0V. The unique terminating scheme of the Am26S12 allows each end of the bus to be terminated with a resistor as low as 100 ohms. Threshhold limits are 1.4 to 2.0V ± 0.2V. Also available: The Am26S12A. Pin-compatible with DM8838. Threshhold limits, 1.2 to 2.25V ± 0.2V.



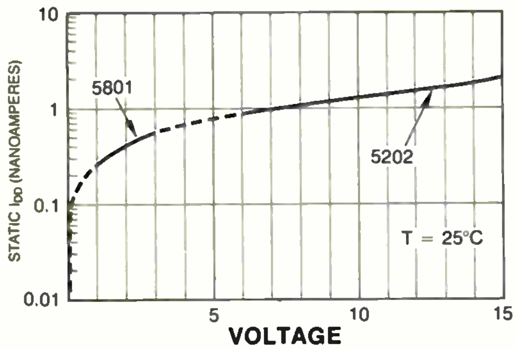
It's a bus driver with the world's highest drive capability and a bus receiver with unbelievably high noise immunity together in a single package.

It's the speedy new Am26S12 Quad Bus Transceiver. Yet another step forward in our relentless effort to become the sixth largest maker of integrated circuits in the country by 1975.

Advanced Micro Devices Inc.

(We're going to be #6.)

Intel to talk CMOS.



Intel's watch circuits exploit this technology to limit the power dissipation of a two-chip watch system to 15 microwatts, while driving a liquid crystal display directly at high voltage and maintaining an accuracy better than 1 minute per year.

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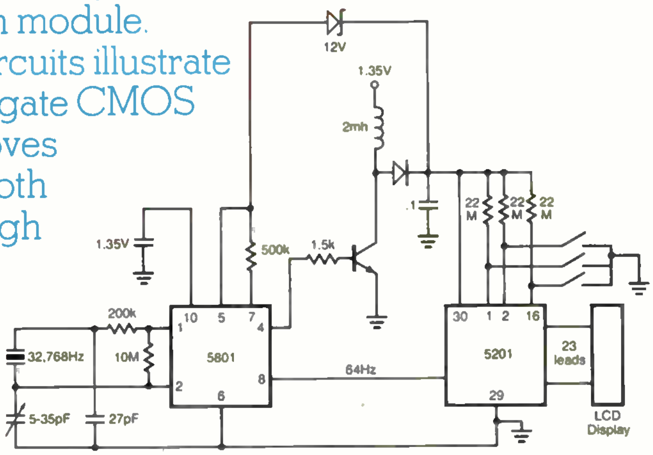
The watch circuits illustrate how Intel's silicon gate CMOS technology improves performance in both low voltage and high voltage operating ranges. They're a small sample of the exciting CMOS designs you'll be talking about with Intel. Don't wait—write now for more information on silicon gate CMOS. Intel Corporation, 3065 Bowers Avenue, Santa Clara, California 95051 (408) 246-7501.



TYPICAL LCD WATCH DIAGRAM.

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People

CCD inventors win Liebmann award

With the charge-coupled device rapidly finding its way into practical applications, its co-inventors—Willard S. Boyle and George E. Smith—have been honored by the IEEE with the Morris N. Liebman memorial award. Citing the two Bell Telephone Laboratories engineers for leadership in the field of MOS-device physics, the award was presented at the recent International Solid State Circuits Conference in Philadelphia.

The acceptance of CCDs was not unexpected by the two Bell Labs men. Both envisioned from the outset the three principal applications areas that are emerging: imaging, memories, and analog delay lines. For his part, though, Boyle has been mildly surprised at how fast imaging applications are moving. "We're now talking about some large arrays that work," he points out, such as the 256-by-220-bit one in Bell's experimental video camera [*Electronics*, Feb 21, p. 29]. (Smith and Boyle are shown on a video monitor through the lens of the experimental Bell Labs' camera.)

Boyle who is now executive director of Bell's Allentown and Reading, Pa. labs, believes that imaging has probably come on first because "there just wasn't anything that did the solid-state imaging job very well. It filled a vacuum."

Smith, a department head in the Unipolar Integrated Circuit Laboratory, remarked how easy it was to get good transfer efficiency into the devices: "That was our first bugaboo," he says, but it was quickly overcome.

As for memory applications, Smith notes that several companies are making CCD memories at the 4,096-bit and 8,192-bit levels and "it's not going to stop there. I think they'll start to trickle into systems, and then it will be like RAMS vs core. The important thing is that those companies making RAMS can use the same production lines to make CCDs," he says.

Boyle foresees use of future CCD imaging in a variety of consumer products, but he also looks for incorporation of CCDs into instrumentation. "If you have a good linear device with good resolution," he observes, "it should get into spectroscopy, for example, and maybe even astronomy."

Smith thinks astronomy is probably a rather esoteric field for CCDs, although he won't rule it out. However he expects "more mundane" uses to be found for the devices. "A big use," he says, "could be in machine-positioning functions, such as mechanical-assembly machines, because you'd get good positive feedback."

Heath makes assembled instruments, kits compatible

Deciding to home in on the industrial assembled-instrument market, the Heath Co. has started to phase out its more exotic scientific instruments, such as the spectrophotometer. The principal architect of the change for the Benton Har-

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United Cinephone Corp., Torrington, Conn.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Warner Products Corp., 1019 W. Lake St., Chicago, Ill.

PHOTOTUBE RELAYS

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Products Co., St. Charles, Ill.
General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Schools

RADIO and TELEVISION TRAINING SCHOOLS

American School, Drexel Ave., at 58th St., Chicago, Ill.
Capitol Radio Engineering Institute, Inc., 3224 16th St., N. W., Washington, D. C.
Dodge Telegraph & Radio Institute, 405 Monroe St., Valparaiso, Ind.
Massachusetts Radio School, 18 Boylston St., Boston, Mass.
Midland Radio & Television Schools, Inc., Power & Light Bldg., Kansas City, Mo.
National Schools, 4000 Figueroa St., Los Angeles, Cal.
National Radio Institute, 16th & U Sts., Washington, D. C.
Pacific Radio Institute, 1355 Market St., San Francisco, Cal.
Radio Institute of Cal., 1117 Venice Blvd., Los Angeles, Cal.
Radio Television Institute, Inc., 480 Lexington Ave., New York, N. Y.
Radio Training Association of America, 1559 Devon Ave., Chicago, Ill.
RCA Institute, Inc., 75 Varick St., New York, N. Y.
Sprayberry Academy of Radio, 2548 University Pl., N. W., Washington, D. C.

Sound

COMPLETE SOUND SYSTEMS

Altec Lansing Corp., 6900 McKinley Ave., Los Angeles, Cal.
American Communications Corp., 306 Broadway, New York, N. Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Atlas Sound Corp., 1442 39th St., Brooklyn, N. Y.
Audiograph Sound Systems, 1313 W. Randolph St., Chicago, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bogen Co., David, 663 Broadway, New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Chicago Sound System Co., 2124 S. Michigan Blvd., Chicago, Ill.
Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati, Ohio
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.

Dilks Acoustic Co., S. Norwalk, Conn. **(See page 155.)**
Electronic Laboratories, Inc., 122 W. New York St., Indianapolis, Ind.
Empire Radio Mfg. Co., 114 E. 47th St., New York, N. Y.
Gates Companies, Quincy, Ill.
General Communication Products Co., Lexington Ave. at Vine, Hollywood, Cal.
Gibbs & Co., 900 W. Lake St., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Jack Mfg. Corp., Charles, 420 Lehigh St., Allentown, Pa.
Laurehk Radio Mfg. Co., 3918 Monroe Ave., Wayne, Mich.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Labs., 1617 N. Damen Ave., Chicago, Ill.
Morlen Electric Co., 60 W. 15th St., New York, N. Y.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Cal.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radiad Service, 720 W. Schubert Ave., Chicago, Ill.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
Ray-Lab, Inc., 211 Railroad Ave., Elmira, N. Y.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17 St., New York, N. Y.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Simpson Mfg. Co., Mark, 188 W. Fourth St., New York, N. Y.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sound Scriber Corp., 82 Audubon St., New Haven, Conn. **(See page 162.)**
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Triumph Mfg. Co., 4016 W. Lake St., Chicago, Ill.
United Sound Engrg. Co., 6642 Santa Monica Blvd., Hollywood, Cal.
Webster Electric Co., Clark & DeKoven Aves., Racine, Wis.
Western Electric Co.—see Graybar Electric Co.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.

Stroboscopes

Boulin Instrument Corp., 65 Madison Ave., New York, N. Y.
Commercial Engineering Laboratories, 4612 Woodward Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
L. A. B. Corp., Summit, N. J.
Pioneer Instrument Div. of Bendix Aviation, Bendix, N. J.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.

Testers

AUTOMOTIVE EQUIPMENT TESTERS

Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.
Bear Mfg. Co., Rock Island, Ill.
Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.

Engelhard, Inc., Charles, 90 Chestnut St., Newark, N. J.
Hays Corp., 925 Eighth Ave., Michigan City, Ind.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton Rogers Co.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

ELECTRICAL METER TESTERS

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Communication Measurements Laboratory, 136 Liberty St., New York, N. Y.
Deutschmann Corp., Tobe, Canton, Mass.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
Electrical Facilities, Inc., 4224 Holden St., Oakland, Pa.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
McFarlin Co., 29 W. Marion Ave., Youngstown, Ohio
Radio Design Co., 1353 Sterling Pl., Brooklyn, N. Y.
RCA Mfg. Co., Camden, N. J.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
States Co., 19 New Park Ave., Hartford, Conn.
Superior Instruments Co., 227 Fulton St., New York, N. Y.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

MAGNETIC TESTERS and TESTING MACHINES

Annis Co., R. B., 1101 N. Delaware St., Indianapolis, Ind.
Commercial Engineering Laboratories, 4612 Woodward Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Magnetic Analysis Corp., 42-44 12th St., Long Island City, N. Y.
Pioneer Instrument Div. of Bendix Aviation Corp., Bendix, N. J.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.

Timers

AUTOMATIC CYCLE TIMERS

American Gas Accumulator Co., 1029 Newark Ave., Elizabeth, N. J.
Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn.
Electric Switch Corp., 14th at Union St., Columbus, Ind.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Hanlon-Waters, Inc., Tulsa, Okla.
Industrial Instrument Co., 2249 14th St., S. W., Akron, Ohio
Industrial Timer Corp., 117 Edison Pl., Newark, N. J.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Penn Electric Switch Co., Goshen, Ind.
Sangamo Electric Co., Springfield, Ill.
Stromberg Electric Co., 233 W. Erie St., Chicago, Ill.
Tagliabue Mfg. Co., C. J. Park & Nostrand Aves., Brooklyn, N. Y.
Taylor Instrument Companies, 100 Ames St., Rochester, N. Y.

bor, Mich., firm, is Jimmy Lee, newly named engineering vice president. Lee, who has an MSEE from Georgia Tech, formerly was manager of the Heath/Schlumberger scientific instrument line.

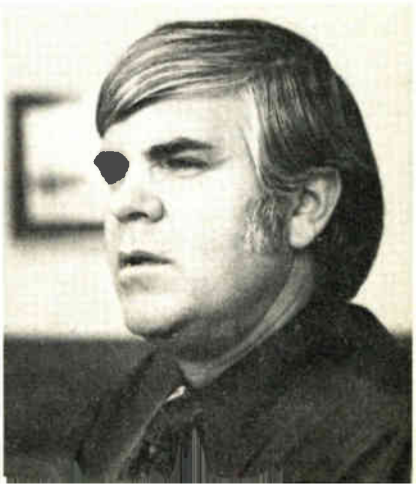
"We're concentrating on those instruments compatible with the rest of the Heath line—electronic test and measuring equipment and automotive-test equipment," he says. Besides consolidating Heath's two engineering staffs, the move will bring the marketing of the new line into closer compatibility with that of other Heath products. "A $6,000 instrument doesn't lend itself to mail-order," Lee comments.

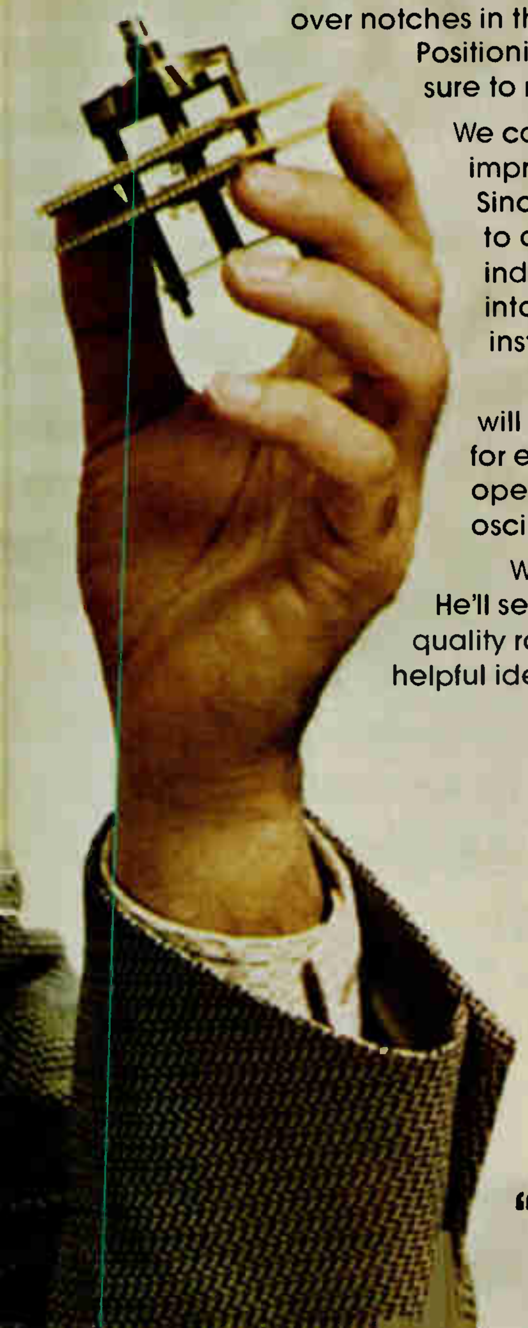
While the industrial and the hobbyist lines aim at the medium- to low-cost instrumentation market, there are differences: "Sometimes it's only a styling change; sometimes the instrument's design is involved." Differences are dictated by the differing needs of the customers, and by economies of production. "Take frequency counters, for example," Lee says. "We go up to 600 megahertz for our industrial counters, and the hobbyist doesn't need that sensitivity."

But the biggest factor is the more price-conscious kit builder. "The kit product may have a switch with wires to the pc board—we can save him some money," he points out. "But in the assembled product, we'll have a switch that plugs into the pc board. It's a more expensive part, but it saves labor."

The new line will be marketed through Heath's retail stores and by mail—a growing trend for medium-priced instrumentation sold to industry and consumers alike.

In phase. Jimmy Lee will phase out Heath's exotic instrument line.





Meetings

Aerospace and Electronics Systems Winter Convention (Wincon): IEEE, Marriott Hotel, Los Angeles, March 12–14.

Zurich Digital Communications International Seminar: IEEE, Swiss Federal Institute of Technology, Zurich, Switzerland, March 12–15.

International Convention (Intercon): IEEE, Coliseum and Statler Hilton Hotel, New York, March 26–29.

Salon des Composants Electroniques: SDSA, Porte de Versailles, Paris, France, April 1–6.

International Reliability Physics Symposium: IEEE, MGM Grand Hotel, Las Vegas, Nev., April 2–4.

International Optical Computing Conference. IEEE Computer Society, Zurich, Switzerland, April 9–11.

Optical and Acoustical Micro-Electronics: IEEE, Commodore Hotel, New York, N.Y., April 16–18.

Carnahan Conference on Electronic Crime Countermeasures: IEEE, University of Kentucky, Lexington, April 17–19.

International Circuits and Systems Symposium: IEEE, Sir Francis Drake Hotel, San Francisco, April 21–24.

Communications Satellite Systems Conference: IEEE, International Hotel, Los Angeles, Calif., April 22–24.

Pittsburgh Conference on Modeling and Simulation: ISA, University of Pittsburgh, Pa., April 24–26.

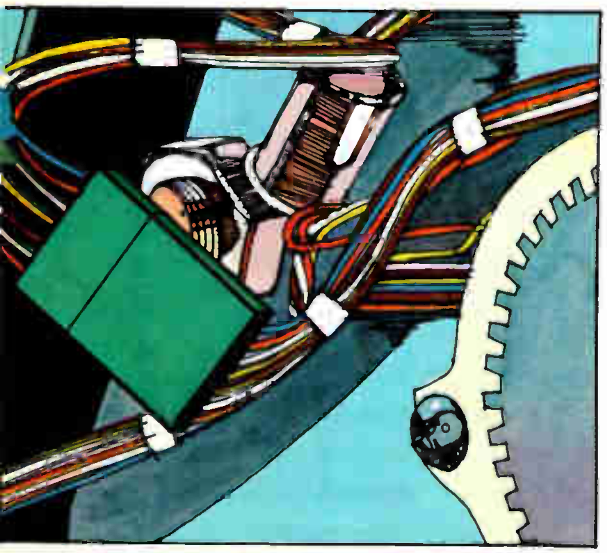
National Computer Conference, AFIPS/IEEE Computer Society, McCormick Place, Chicago, Ill., May 6–10.

International Magnetics Conference (Intermag) '74, IEEE, Four Seasons Sheraton Hotel, Toronto, Canada, May 14–17.

Semicon/West '74, SEMI, San Mateo Fairgrounds, San Mateo, Calif., May 21–23.

Growing with the

Amphenol connectors help assure correct weight in new automatic weighing system.



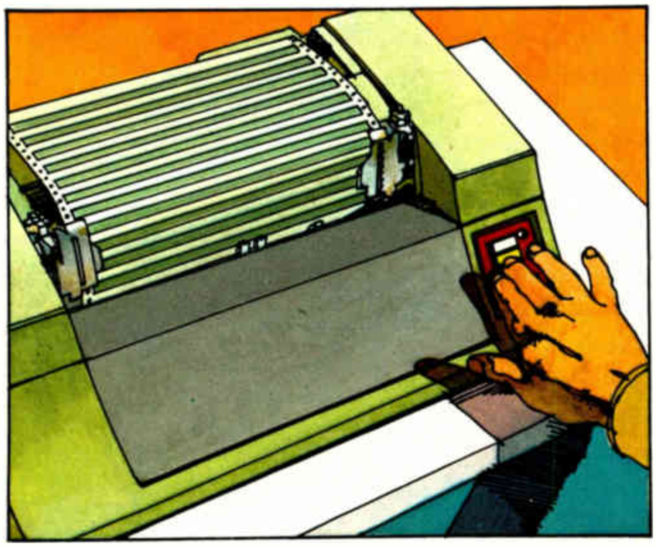
Meat merchandising has taken a big step forward with advanced solid state circuitry. The system includes a scale, mini-computer, and a printer in an integrated modular package that can weigh and price meat in seconds.

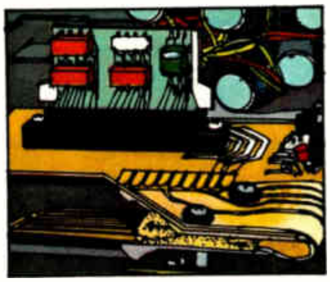
Amphenol 221 Series micro-miniature connectors share the responsibility for transmitting weight and price data to the mini-computer. Their low cost, sturdy design, and high-reliability contact configuration make them ideal for this application.

The 221 Series does the same kind of reliable work in a variety of equipment in the electronic data processing, telecommunications and home entertainment industries.

new electronics

Amphenol connectors help transmit computer data in new high speed printer.

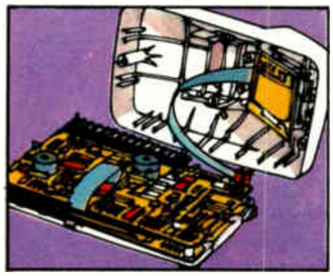




A unique modular matrix printer was recently developed to interface with mini-computers, medium-speed batch terminals, and other installations requiring high speed data output. Data is received at up to 75,000 characters per second. The data is then carried through PC cards to a printing head with an output of up to 165 characters per second.

Precise signal input and data output depend on consistent and accurate information flow. That's why this peripheral systems manufacturer specifies Amphenol 225 Series PC connectors and 6034 Series trimmers. They also rely on Amphenol connectors as an important link to the power supply portion of the printer.

Amphenol assembly services help produce new credit card verifier.



A major computer corporation recently developed a new computerized credit system. To eliminate a costly investment in production equipment and inventories, they turned to the Amphenol Cadre Division.

All assembly and material supply is now handled by Amphenol people including component preparation, stuffing and wave soldering of printed circuit boards, hand wiring, and mechanical assembly. In addition, unique quality control tests are carried out.

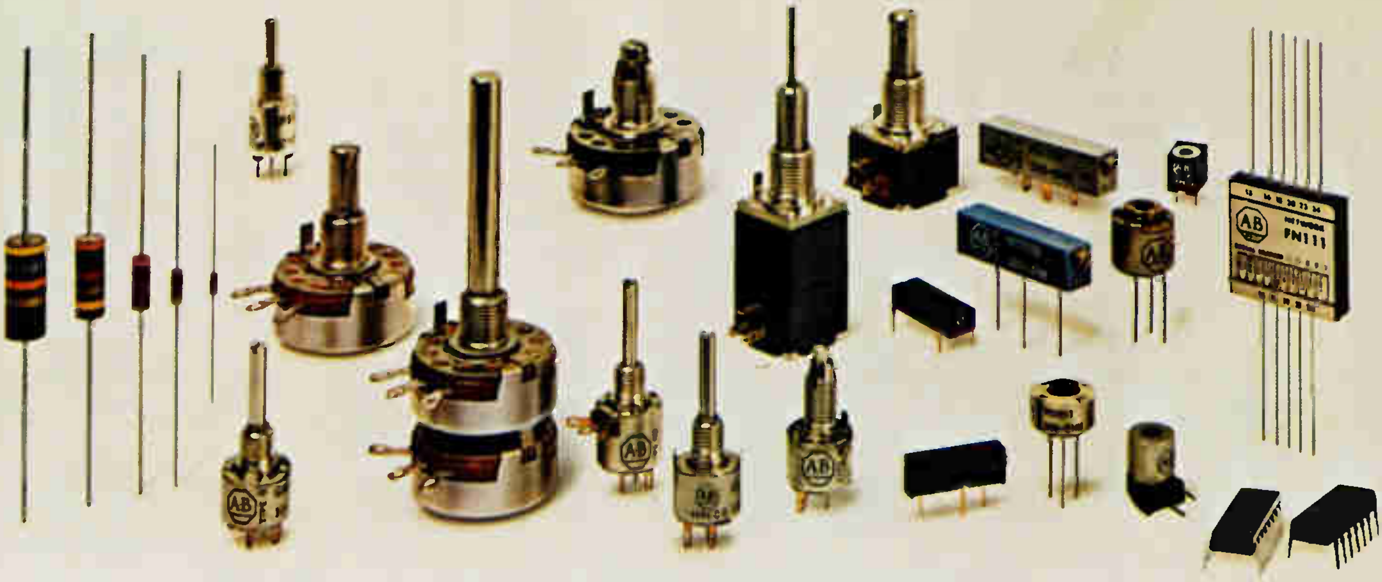
Over 500 units have already been produced with excellent turnaround time and high product quality. They are now in use by a nationwide resort and restaurant chain for added customer convenience and man-hour savings.

BUNKER RAMO AMPHENOL

For more information, contact these manufacturing/sales facilities. United States: Amphenol Components Group, 1830 S. 54th Av., Cicero, IL 60650 **Canada:** Amphenol Canada Ltd., 44 Metropolitan Rd., Scarborough, Ont. **Great Britain:** Amphenol Ltd., Thanet Way, Tankerton, Whitsable, Kent, England **West Germany:** Amphenol-Tuchel Electronics Gmbh, 8024 Deisenhofen bei Munchen, West Germany **France:** Usine Metallurgique Doloise, 92a98 Avenue de Gray, 39100—Dole, France **Australia:** Amphenol Tyree Pty. Ltd., 10-16 Charles St., Redfern, N.S.W. 2016, Australia **India:** Amphetronix Ltd., 105 Bhosari Industrial Area, Box 1, Poona 26, India **Japan:** Daiichi Denshi Kogyo K.K., 20, 3-Chome, Yoyogi, Shibuya-ku, Tokyo, Japan 151

Circle 23 on reader service card

There's more to resistors than resistance



If you're really serious about cost, be serious about quality.

If you think all resistive components are the same, listen to what these users have to say about Allen-Bradley fixed composition resistors:
Buyer—"A-B has shipped nearly four million parts without a single reject or problem. The quality is superb. I've spent 12 years in production control and purchasing. I've seen the amount of down-time, rework and field retrofit caused by others."
President—"We have used many millions of Allen-Bradley hot-molded resistors. The uniformity of quality from one shipment to the next is truly outstanding."
Engineer—"When we use A-B resistors instead of some other make, it's one less component we have to worry about."
"We learned the hard way. The subtle things make the difference. They all add up to the top quality we want in our products."
Purchasing Agent—"We wish we had more Allen-Bradleys."
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Circle 24 on reader service card

A-B QUALITY
Allen-Bradley
Milwaukee, Wisconsin 53204

TI's 4,096-bit RAM hit by yield problems

Texas Instruments is having yield problems with its much-heralded 4,096-bit RAM, the TMS4030. The result is that at least one customer is using an additional supplier while a second has contingency plans for a 1,024-bit part, **threatening TI's lead in the 4k memory market.** Hewlett-Packard, which has gone to Mostek to satisfy its needs, says that those TMS4030 memories it has on hand are "excellent," but that it isn't getting enough. And Datapoint, a San Antonio, Tex., terminal and peripheral maker, says it isn't alarmed because it can switch to a 1k memory.

Meanwhile, TI, which is working to increase yields and volume, says, **"We are convinced that the 4k RAM will be producible in large volumes this year"** but won't commit to definite delivery dates now.

United challenges instrument makers with test lines

United Systems Corp., Dayton, Ohio, is mounting a well-financed drive designed to take over a larger share of the test and measurement market. **The company has developed more than 20 new products for introduction during the first quarter of 1974** in a design effort that has cost more than half a million dollars thus far.

Included are new housings and proprietary circuitry, some of which is in the form of custom LSI chips. The objective is to make the company's new products more attractive, both physically and economically. **For example, United's 4½-digit panel meter sells for $219. The nearest competitor is priced at $250.**

The HT (for high-technology) series makes its formal debut at IEEE's Intercon 74 March 25 (see p. 147) where 22 members of the family are being shown.

Motorola invading data market

Motorola Semiconductor will soon launch a major invasion of the MOS data-communications market. Following the announcement of its 8-bit n-channel silicon-gate microprocessor chip set (see p. 29), **Motorola will introduce a number of MOS parts intended for data communications.** The microprocessor set itself includes a sophisticated asynchronous communications adapter that directly interfaces to a modem, and a synchronous adapter is to follow.

Some of the other new parts are designed for use with the microprocessor; others stand alone. All are n-channel or complementary-MOS. Next is a single-chip 300-bits-per-second modem designed to replace the Bell 103, to be followed by a 2,400 b/s, 201-type modem; a European CCITT modem; a bit-rate generator; a subscriber dialer; a first-in, first-out register for changing data rates; Touch Tone encoders and decoders, and a 1,200 b/s modem.

AMI, Standard develop 1-chip print calculators

Taking technology to its logical extreme, both American Microsystems Inc. and Standard Microsystems Inc. have developed single-chip printing calculators. The AMI device, developed with Sweden's Facit-Odhner, **is on a 214-by-218-mil chip, making the circuit one of the biggest ever developed at AMI.** It contains all the control logic, arithmetic unit, memory, timers, and clocks and hammer drivers, all running off the same +6 volt (operating mode) and −13 V (standby) supplies. The Facit calculator, a 10-digit machine called the 1145, sells for $349. It prints on the familiar roll of 2-inch paper tape and operates from house cur-

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see Timers

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Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass. (See page 181.)

rent or a 9 V battery. AMI plans more calculator circuits with built-in display functions—though not printers.

Standard has three printing calculator chips and three more to be in production late this year. They're for 12-digit machines, and have memories, floating-point, and several kinds of fixed-point arithmetic, and automatic accumulation. One of Standard's customers is Ataka of Japan.

Signetics to offer CCD shift register

Signetics will announce in the last quarter of this year a 16,384-bit CCD dynamic shift register, **becoming the first major American semiconductor maker to announce a CCD memory product.** The device is intended to replace disk and drum memories, and the company aims **to eliminate medium-size disks by 1975.** In addition to a cost of 0.1 cent a bit, the part runs at 20 megahertz, compared to the 3 to 5 MHz of today's MOS shift registers.

International Rectifier to offer LEDs

Power semiconductor specialist International Rectifier is about to enter the market for light-emitting diodes. First products will be discrete infrared LED's with wide frequency response and spectral response closely matched to fiber-optic transmission lines. **These products can transmit a TV signal and are also useful for high-voltage optical couplers,** which will be introduced later. The company does not plan to enter the visible LED arena.

CML Satellite faces shakeup

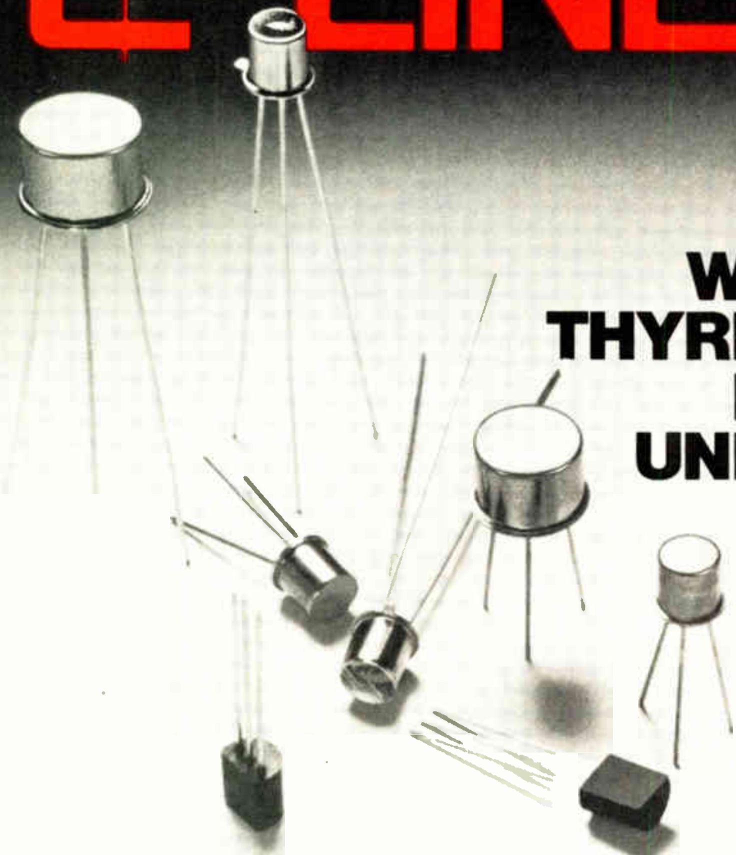
Industry sources see a shakeup brewing at CML Satellite Corp. among cash rich Comsat and its domsat partners, MCI and Lockheed. **The likely outcome will be one or more partners dropping its share of the operation.** A reason: Comsat, barred from dominating CML, is said to feel hamstrung by the company's financial pinch, especially since its partners came in with only $1 million each.

Fueling the rumors are serious talks between CML and American Satellite Corp. about some form of merger, a latchup both acknowledge they would like as they admit they're seeking partners. One official close to the discussions rates it "better than 50-50." CML, MCI, and Lockheed officially refuse any comment but a CML officer assures that the company will continue its newly planned program (see p. 42).

Ceramic package costs less and seals cooler

Diacon Inc. is marketing a new ceramic IC package **that not only seals at a lower temperature, but costs less than side-brazed or co-fired packages that typically seal at 310°C.** "MOS and linear devices with close-spaced metalizations, shallow-diffusion, and surface sensitivity suffer when subjected to high-temperature assembly," says Bryant (Buck) Rogers, president of the San Diego package company. "Consequently, lowering the sealing temperature to 265°C by using our lead-tin-indium seal should boost IC manufacturing yields." The package, a member of the cerdip family, is priced at 24 cents each in the 14- and 16-lead versions in million-lot quantities.

C-LINE SCRs



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See EBG Semiconductors Section for more complete product listing.

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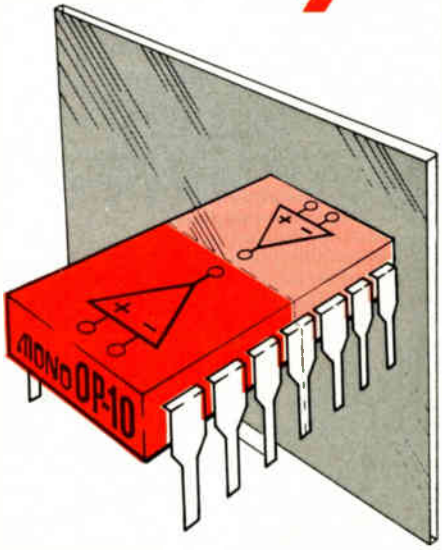

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Motorola joins microprocessor race with 8-bit entry

Motorola will supply all the 5-volt components for its microprocessor, assuring compatibility with TTL

The microprocessor race appears to be heating up with Motorola's development of its eight-bit, n-channel microprocessor family. The five-chip set, which includes a central processor, the 6800, along with random-access and read-only memories, and peripheral and communications interfaces, is expected to give Intel's n-channel, eight-bit systems, built around the new 8080 CPU, a run for their money.

Although all the details of the Intel chips have not yet been revealed, both microprocessors offer about the same number of instructions—78 for the 8080 and 72 for the 6800—with roughly comparable performance. The Motorola microprocessor, however, may result in system savings for certain applications by requiring fewer interface circuits and power supplies.

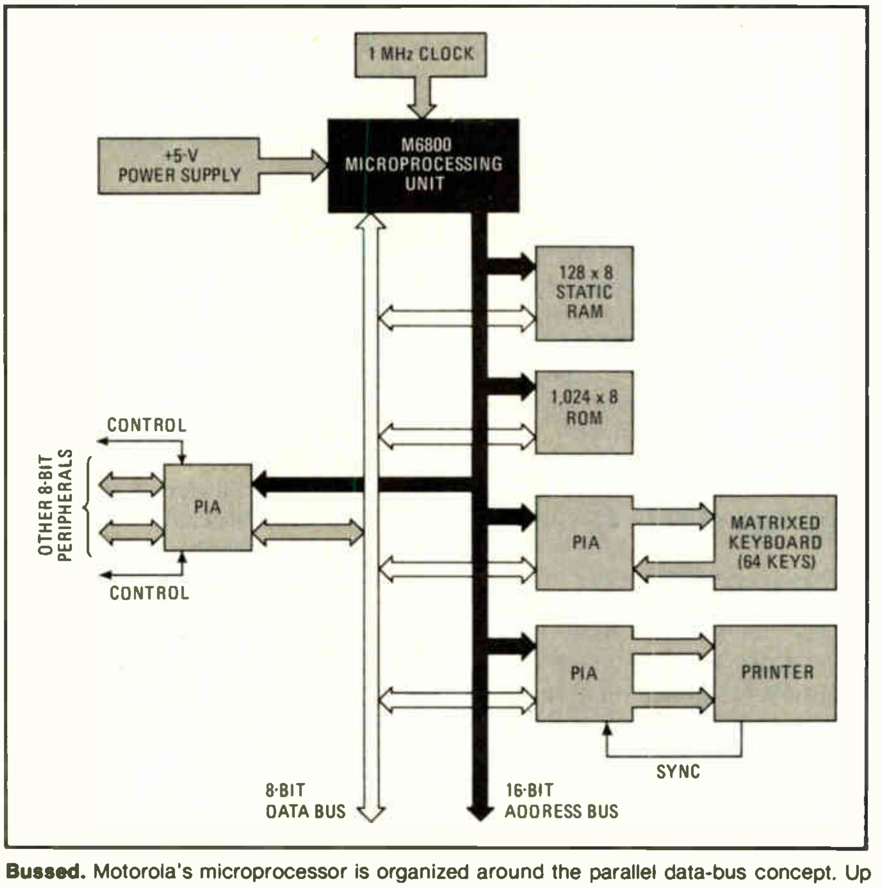
Significantly, the Motorola microprocessor set forms a complete microcomputer that needs only a single 5-volt supply and one external clock—no multiplex, multiple supplies, or interface packages are required. The chips, built with an ion-implanted n-channel silicon-gate process, will enter production in November.

Motorola's Semiconductor Products division has put extensive effort into developing the microprocessor because it feels this device is the key to getting the MOS business it hasn't enjoyed so far.

The single microprocessor chip (MC6800) is equivalent to about 120 MSI TTL packages. It has 72 self-contained basic instructions with decimal and binary arithmetic capability, variable-length instructions, double-byte operations, two accumulators, and seven addressing modes. The typical instruction time is under 5 microseconds, and since up to 64,000 bytes can be addressed in any combination of RAM, ROM, or peripheral registers, peripheral capacity is almost unlimited.

Another key component in the family is the MC6810, a static, 500-nanosecond 128-by-8-bit static RAM designed for use with the MPU, but other RAMs, including the 4,096-bit MCM6605, or other types and speeds of memory can be used. The MC6816 ROM is a static 1,024-by-8-bit memory for use with the system, but other ROMs are also usable.

The microprocessor set is organized around the popular parallel data-bus concept introduced by Digital Equipment Co., Maynard,



Bussed. Motorola's microprocessor is organized around the parallel data-bus concept. Up to 10 LSI chips can be directly attached to the bus—ROMs, RAMs, peripheral interface adapters (PIA), and communication interface adapters (CIA).

Electronics review

allow the signal to charge the bank of capacitors serially. When a start pulse loads the first bit of the register, the first switch closes and the first capacitor is charged. When the register shifts the bit to the next cell, the first switch opens, isolating the capacitor, and the next switch closes, charging the second capacitor. The start pulse thus has a maximum repetition rate of 1.8 times the clock frequency, where N equals the number of capacitors.

The output shift register reverses the process. The start pulse loads the register's first bit and connects the first capacitor to the output line, so that it discharges. As the bit travels down the register, it successively discharges each capacitor and reconstructs the waveform, with a new time base determined by the clock rate. A capacitor can take a new input signal as soon as it is discharged.

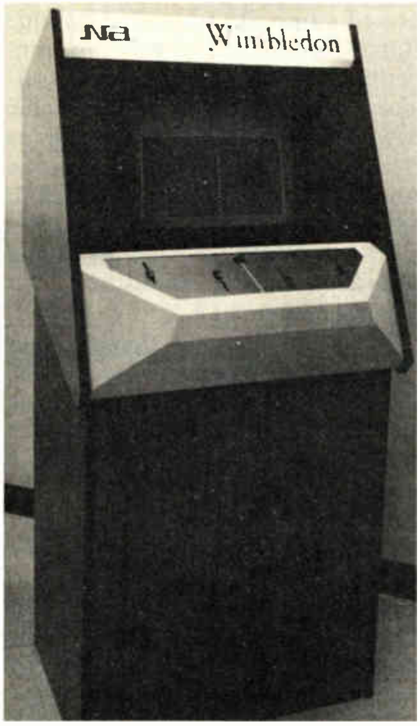
All of the circuitry for the SAM is fabricated on Intel's standard 67-by-300-mil silicon-gate MOS chip. To build it, Reticon uses the process and production facilities of the Intel Corp., its part owner, which are right across the street from its plant. Reticon has provided sample circuits to several manufacturers, and the SAM has already been installed in equipment.

John J. Rado, Reticon's president, says the circuit is also suitable for digital filtering, including fast-fourier transforms, time and frequency expansion and compression, pattern recognition, bandwidth compression for multichannel transmission, and other applications. □

Anyone for tennis —via color TV?

The contenders may not be Billy Jean King or Bobby Riggs, and the site of the match may not be the Astrodome, but the basic game is tennis—now in a coin-operated color-video version.

Called "Wimbledon," the new game uses a TTL processor and a television set to simulate a tennis match—complete with the sounds of



Love it. Wimbledon is new coin-operated tennis game played on color-TV set.

play, a grass-green field, white border lines, white ball, tennis rackets in four different colors, and scores displayed on a bright yellow background. The first coin-operated color game, it is being marketed by Nutting Associates, Inc., Mountain View, Calif., which was among the originators of black-and-white video games two years ago.

Color, says William G. Nutting, president of the firm, is an important advance because black-and-white games are rather dull in appearance. He expects Wimbledon to recapture the market in "sophisticated locations, whose clientele won't tolerate the clanging of pinball machines." The generic name "pong" refers to the sounds of play the video games produce. In the past two years, some 22 game manufacturers have come out with black-and-white pong games, Nutting says.

The TTL processor, reports Miel Domis, Nutting's project engineer, controls the three guns of the color tube to simulate the motion of the rackets and ball on the colored field. The image of the field is generated by a solid-state memory, while the processor itself produces the other movements by generating digital vectors.

The players move sliding resistance controls, one for each racket. Control positions are stored in registers while the controls change the trigger settings of timing circuits, Domis explains. The timing changes vary the rate at which the electron guns are gated by the data words representing the rackets and ball, making them appear to move as the guns sweep across the field. If the ball hits the racket, a rebound vector is started by a flip-flop output. If not, or if the ball goes out of bounds, a point is scored and displayed.

No endless volleys. A 14.318-megahertz crystal output is counted down to time the motions and generate the TV gating, synchronization signals, and also the sounds of play for Wimbledon. The composite signals are fed to the set's antenna terminals. And there is another new feature for those who have learned to lock a pong game into a stable state where the paddles or rackets are placed so that the ball oscillates endlessly back and forth. Now, after eight volleys, a counter triggers a change in the ball's vector.

Having created color control, Domis is now considering other games, such as billiards or pool, where color would create a more realistic game. □

Solid state

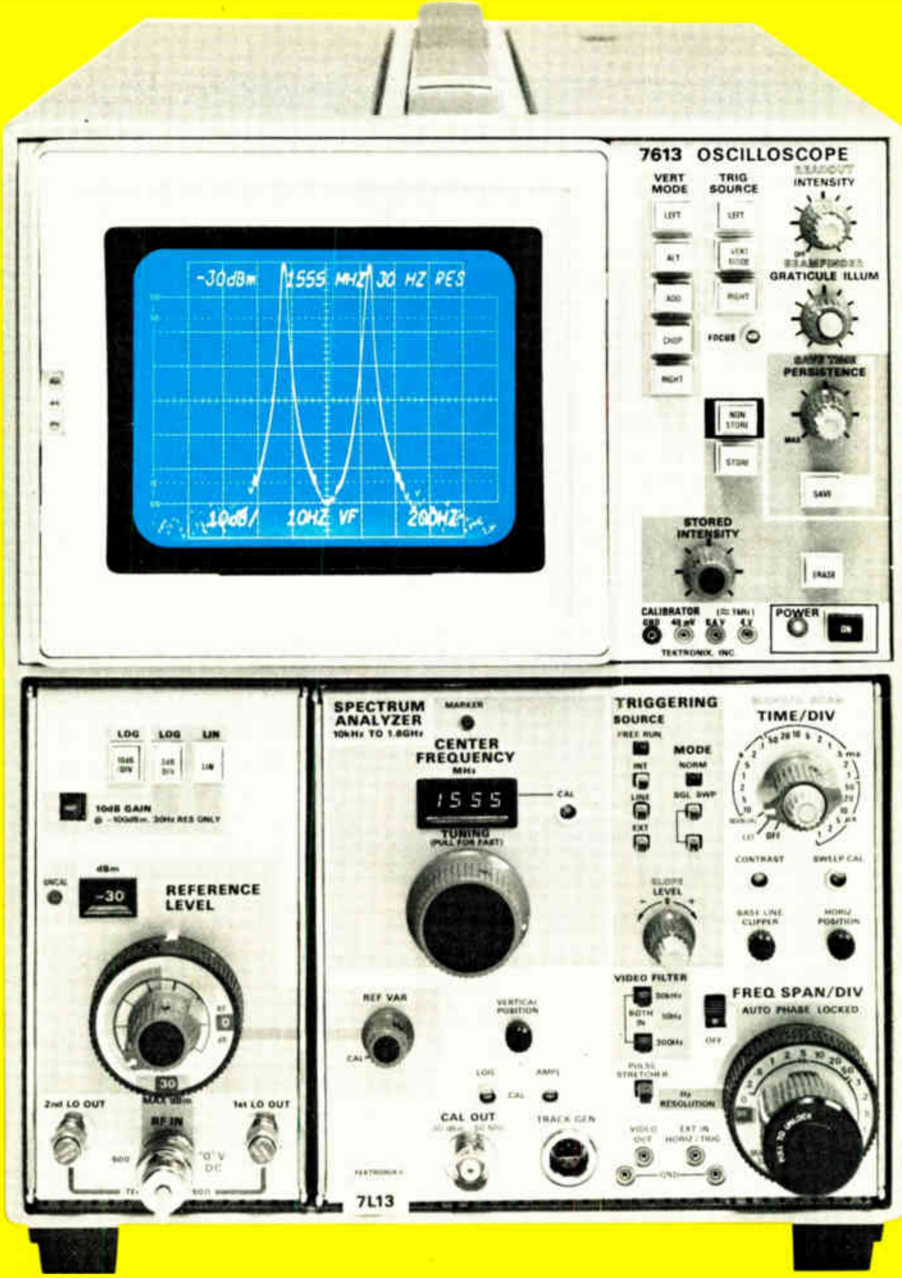
Low-power Schottky gets second sources

Texas Instruments will shortly get its first competition in low-power Schottky TTL. Both Signetics and Fairchild will begin introducing the hard-to-make devices, which so far offer the best performance/power tradeoffs to military OEMs.

Signetics is entering the 54LS market with a few simple circuits—the 54/74LS/0 and 05 hex inverters in March, and some dual JK flip-flops—the 54/74LS 112, 113, and

the 30Hz Resolution Revolution

Spectrum Analysis in the 0-to-1800 MHz region



The TEKTRONIX 7L13 adds revolutionary measurement power to spectrum analysis: 30 Hertz Resolution that is useful all the way to 1800 MHz.

There is no smearing from drift or FM in this 200 Hz/div display, even though the total sweep time is 20 seconds. Signals are resolved to 70 dB down even though they are only 500 Hz apart. Center frequency is 1555 MHz.

It is generally understood that High resolution means the ability to distinguish between signals differing little in frequency. Actually, the design that makes 30 Hz resolution possible results in more than just the ability to distinguish between close together signals. The design of the 7L13 means better sensitivity, −128 dBm; less drift, under 2kHz per hour; less FM, under 10 Hz phase locked; it means less noise . . . it means the revolutionary analyzer performance that is available from Tektronix, Inc. in the 7L13.

Because of the resolution revolution, the performance of your edge-of-the-art circuitry and devices can now be quantified, not guessed at. A discussion or demonstration of TEKTRONIX Spectrum Analyzer performance can be arranged by any Tektronix Field Engineer. Call him or use one of the two reader service numbers below.

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Circle 33 on reader service card

114—in May and June. Product manager Stan Bruederle says the company will introduce 20 products this year, including the 54/74LS 181, a 4-bit arithmetic unit, and some other medium-scale-integration items.

Fairchild's first low-power Schottky parts, to be available in late March, will be small-scale-integration products. According to Rob Walker, product planning manager in the Digital Products division, "they are specified at twice the speed of the TI devices—5 nanoseconds typical and 10 ns maximum. Walker expects the Fairchild products, catalogued the 9LS, to serve "as a replacement to all H series and a lot of S circuits, as well as standard TTL."

TI presently offers about 60 circuits in the 54LS family. Signetics does not expect to compete across the board for some time, and is introducing the line now in the expectation of participating in some projects later this year. Low-power Schottky devices are presently going into avionics and ground transportable equipment operating at over 5 megahertz.

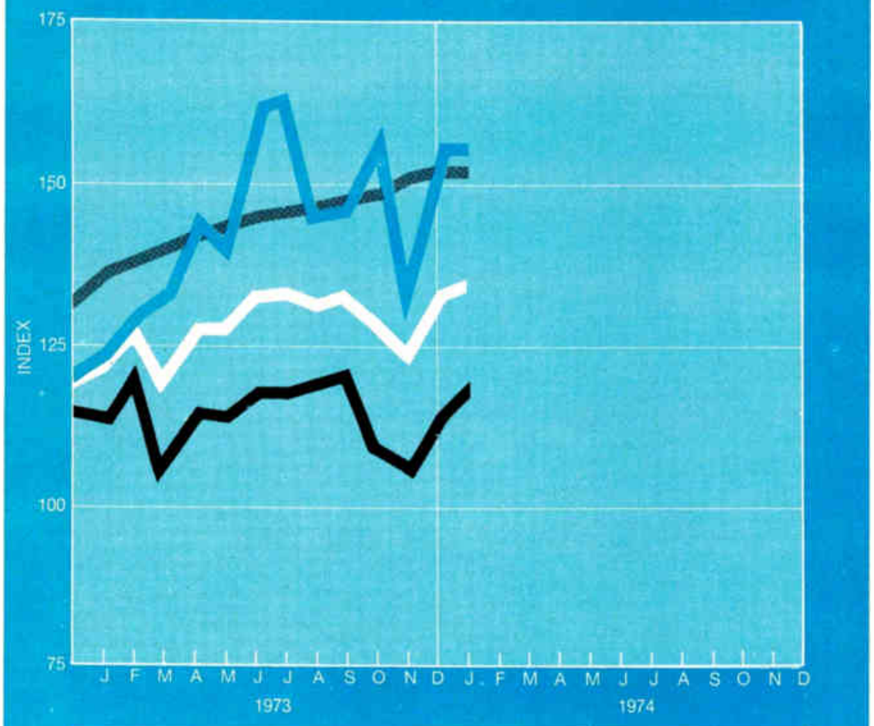
Low-power Schottky offers typical power dissipation of 2 milliwatts per gate while operating at 10 ns gate delay and 35 MHz flip-flop toggle rate. The regular 54/74 series has five times the power dissipation at comparable performance. The low-power series 54L, which dissipates only 1 mW/gate, operates at 33-ns gate delay and a 10-MHz flip-flop rate.

The C-MOS circuits match low-power Schottky at low frequencies, but C-MOS power dissipation goes up exponentially and crosses that of low-power Schottky at around 2 MHz. Low power dissipation is a must for military suppliers, and avionics contracts conventionally specify bonuses for undercutting power requirements and penalties for exceeding them. Signetics believes that low-power Schottky capability is essential for companies that wish to continue to supply the military. Within five years, Bruederle says, 54LS will be the standard military-design tool.

Military pressure for a second-source to TI induced Signetics to spend the money raised during last fall's $20 million stock sale for the ion-implantation and thin-film equipment necessary to build 54/74L. Signetics already uses ion implantation in every product line and has a thin-film process comparable to Fairchild's Isoplanar.

The first key to building the 54LS line is a technique, derived from LSI processing, for fabricating resistors no bigger than conventional Schottky resistors. □

Electronics Index of Activity



Segment of Industry	Jan. '74	Dec. '73*	Jan. '73
Industrial-commercial electronics	156.3	156.5	142.3
Consumer electronics	119.7	114.9	114.5
Defense electronics	152.5	152.5	137.8
Total industry	135.8	133.3	126.3

The index rose for the second straight month, reaching a level that is the highest since October 1969, and 7.5% above last year's level. The defense sector was the largest gainer, rising 4.2% above the previous month. The only drop occured in consumer electronics, which fell 0.1% from December's figure.

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

Thermoplastic used between IC layers

Multichip LSIs with thermoplastic insulation between the layers of wiring interconnecting the chips has been developed in a joint Japanese-U.S. research program. Tokyo Shibaura Electric Co.'s Research and Development Center and the General Electric Co.'s Electronics Labo-

an unbeatable combination... 350 MHz and 1ns/div in a portable!

Dual trace, 350 MHz bandpass, high writing speed, 5 mV/div to full bandwidth and 1 ns/div sweep together with many operator conveniences assure fast accurate high-speed oscilloscope measurements. This combination is now available in a portable—the 485 from Tektronix. It weighs just 24 pounds, allowing you to move it in the lab and shop, or you easily take it with you on installation and repair jobs.

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485 Oscilloscope $4200

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Circle 35 on reader service card

ratory, Syracuse, N.Y., have conducted the engineering research.

The advantages of the process, called semiconductor thermoplastic dielectric by GE, include reduction in circuit size and weight, elimination of labor-intensive processes, including wire bonding, and improved heat-sinking and reliability. A variation of the approach has been developed for microwave applications.

In the basic process, standard IC chips with conventional aluminum bonding pads are positioned precisely on an aluminum substrate, covered with a sheet of FEP, a fluorocarbon plastic, and then subjected to heat and pressure. The chips are pressed slightly into the substrate. The plastic at the top of the chip is extruded to produce a thin plastic layer covering the chips and a thicker plastic layer filling in spaces between the chips.

Holes are etched in the plastic layer for interconnections, which are copper, with a titanium barrier layer between copper and aluminum pads to prevent undesirable solid alloys. The insulation for the second and subsequent interconnection layers is also plastic, but the companies won't disclose its composition.

How big? An experimental circuit includes 11 TTL chips on a 25-millimeter square, 2-mm-thick, substrate. The two layers of wiring form 312 interconnections. The power dissipation is 2 watts, and temperature rise is 25°C. Thus, the completed product functionally replaces an equivalent number of integrated circuits mounted on a multilayer printed circuit. What's more, the unit insulated with thermoplastic is smaller and can be fabricated by batch processes that yield improved performance and reliability.

Microwave integrated circuits are built on a beryllia substrate with deposited connections to the reverse side of the chips, but the insulation system is similar. An experimental circuit on a 7-mm-square substrate has a power output of 14 W at 1.5 gigahertz and a bandwidth of 250 megahertz. Multichip circuits, therefore, have been shown to be suitable for micropower to high-power devices from dc to microwave frequencies. GE managed the design and evaluation, and Toshiba has handled the fabrication. □

Consumer electronics

Depthmeter's sonar put on a chip

With ICs turning up in more and more products, it's not surprising to find one in a product for the angler or yachtsman. Now, National Semiconductor Corp., Santa Clara, Calif., is producing a single-chip sonar system for an under-$100 fishfinder/depthmeter.

The bipolar integrated circuit, which measures only about 80 by 90 mils, includes a complete 12-watt transmitter—perhaps the first practical monolithic transmitter—and a receiver that drives a neon bulb with 10 W of power. The part was developed as a custom product for a large depthmeter manufacturer by National development engineers Thomas A. Frederiksen and William M. Howard.

Echoes. The system consists of a piezoelectric transducer mounted on the hull under the water, the receiver and transmitter, the IC, and a rotating-disk display. The transmitter feeds 12 W at 200 kilohertz to the transducer for approximately 800 microseconds. The transducer both converts this signal to a sonic wave, which is sent toward the bottom, and picks up echoes from fish or the bottom.

If the received signal is large enough to trigger a threshold detector and get through a special impulse-noise limiter, a neon bulb mounted on a rotating disk flashes. The angle at which the bulb flashes indicates the depth. Multiple flashes can occur—showing, for example, both a school of fish and the bottom. The system timing is derived from the rotating disk, which is driven by a small battery-operated motor.

Benefits offered. A single inductor is used to set both receive and transmit frequencies, eliminating the need for tuning the system in production, as is necessary with discrete units. What's more, frequency drift does not affect operation. And, in contrast to current gear, any transducer can be used. Present depthmeters require that the equipment be tuned to the transducer, a problem when a transducer or finder must be replaced.

No external transistors are required because the 18-pin package contains all semiconductors other than a swamping diode on an output transformer. But the transducer and the neon bulb require voltage transformation, since the transducer impedance is a high 600 ohms. And triggering the neon bulb requires substantially more than the 12-volt operating supply. Large Darlington power transistors on the chip drive the bulb and transducer, a piezoelectric crystal. □

Communications

Optical waveguide has own modulator

Electro-optical modulators built right into tiny monolithic waveguides for laser light are the latest links in the chain of development leading toward practical fiber-optic communication systems [*Electronics*, May 24, 1973, p. 33].

RCA's David Sarnoff Research Center, Princeton, N.J., and Bell Laboratories, Holmdel, N.J., have

Eyeing an electro-optic modulator. RCA's device is built into a light waveguide.

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Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Link, Fred M., 125 W. 17th St., New York, N. Y.
National Co., 61 Sherman St., Malden, Mass.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Spokane Radio Co., 611 First Ave., Spokane, Wash.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Western Electric Co.—see Graybar Electric Co.

MOBILE TRANSMITTERS

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Bassett, Inc., Rex, Municipal Airport, Fort Lauderdale, Fla.
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Gates Companies, 200 Block Hampshire St., Quincy, Ill.
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Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass. (See page 181.)
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
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Majestic Radio & Television Corp., 2600 W. 50th St., Chicago, Ill.
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Radio Transceiver Laboratories, 120-03 Jamaica Ave., Richmond Hill, N. Y.
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Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
RCA Mfg. Co., Camden, N. J.

TELEVISION TRANSMITTERS

Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J. (See p. 118.)
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
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Winders

COIL WINDERS—see Machines

HOW TO USE THIS BUYERS GUIDE

IN THIS DIRECTORY of suppliers, products are alphabetically listed in three separate sections:

1—PARTS, ACCESSORIES, MATERIALS

Basic commodities used in the fabrication, assembly and maintenance of electronic devices

2—ELECTRICAL INSTRUMENTS

Test and measurement items used in the design, production and adjustment of electronic devices

3—ELECTRONIC EQUIPMENT

Devices having electronic operating principles, used by other fields as well as by the electronic industry itself

In each of these three sections products are listed under the noun or principal word. Certain products, not readily classified, have been arbitrarily included in the third section. The index on pages D-2 and D-3 serves as a general key to all three sections.

fabricated low-loss optical waveguides and used them to modulate light at rates that could exceed 1 gigahertz. Once developed, such devices could be used to modulate signals for thousands of telephone channels in one waveguide.

The RCA modulator is made by depositing a film of niobium on a crystal of lithium tantalate, which is then placed in a furnace. Niobium atoms diffuse in to replace the tantalum and form a tiny waveguide of lithium-niobate tantalate. Because that compound has a higher refractive index than lithium tantalate, light coupled into the guide remains inside.

In a typical layer, about 30% of the tantalum in the substrate is replaced by niobium near the surface. This fraction falls to zero at a depth of about 2 micrometers. One device fabricated in a single-mode guide required 6.5 volts for 80% modulation at a wavelength of 6,328 angstroms and 3.5 v at 4,495 angstroms.

Modulation is performed by varying the voltage applied to the waveguide. As the electric field varies, the crystal's refractive index changes, and this change is used to produce amplitude modulation or beam diffraction.

The RCA device will operate—at 0.1 mw per megahertz—"as fast as it can be driven," according to Brown F. Williams, head of quantum electronic research at the center. The limit on frequency is the capacitance of the electrodes connected to the waveguide. Single-mode losses are of the order of 1 decibel per centimeter. The device has an active volume of 0.12 by 0.02 by 0.02 inches.

The Bell single-mode waveguide modulator is fabricated using an out-diffusion technique in which lithium atoms are removed from a lithium niobate crystal. What's left is a lithium-deficient waveguide at the surface of the crystal. Power requirements for the unit—0.4 milliwatt per megahertz—are somewhat more than for the RCA device. Thus, at 0.4 w, the modulator will operate at 1 GHz. The active region of the modulator measures 0.24 by 0.002 by 0.002 in.

The RCA unit is an amplitude modulator, whereas the Bell Labs device modulates phase. Both modulators operate at wavelengths from the visible to the near-infrared. □

Energy

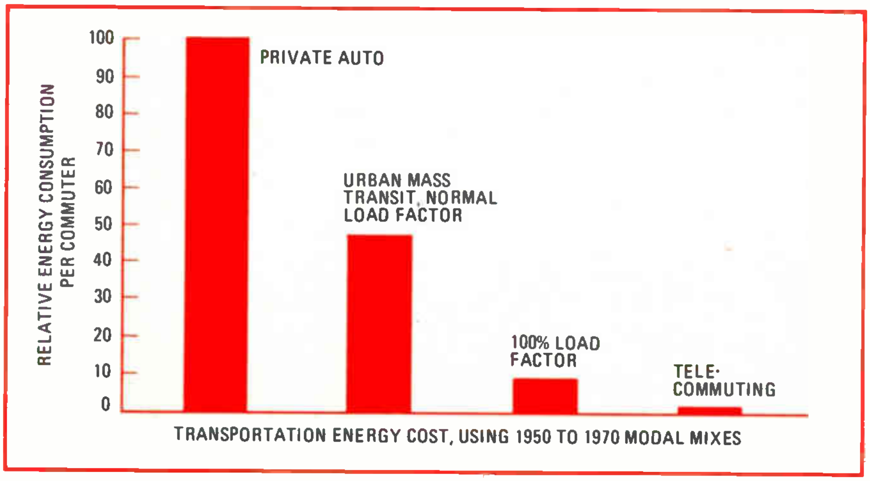
Communicating may replace commuting

The energy crisis may well accelerate the adoption of a far-reaching change in life style: communicating instead of commuting to work. The change has long been touted by futurologists, but research in computer and telecommunications technology indicates that it may be economically practical, even now—at least for some businesses. The University of Southern California, working under a grant from the National Science Foundation, is studying the subject, which could be a vital one for car-oriented Los Angeles, where USC is located.

The study, being coordinated by Jack M. Nilles, director of interdisciplinary program development, is concentrating on near-term practical results. A major part of the study is investigating those companies that Nilles classifies as "people huddled around a computer"—banks and insurance companies, for example.

Nilles points out that the workers in such companies could be dispersed to work centers near their homes. The additional costs involved would be for terminals plus communication lines to the central organization. These costs would be about the same as the present costs of commuting, he adds, suggesting that employees would walk or bicycle, rather than drive, to work centers near their homes, and they would pay at least part of the terminal costs in lieu of commuting expenses. The estimated energy consumption for a car in a typical Los Angeles round-trip commute of 22 miles is 50 kilowatt-hours, compared to only 2 kilowatt-hours for computer and telephone lines.

Among the technical problems being investigated is the man-machine interface. Nilles suggests that the traditional typewriter keyboard plus CRT terminals may not be optimum. Serious investigation must also be devoted to the communications lines. Present 3-kilohertz telephone lines could become inadequate if many companies adopt remote operations, and coaxial-cable or even fiber-optic communications lines might be needed □



Microwaves

Baritt diodes find new applications

Barrier injection transit-time diodes—Baritts, for short—have been little more than laboratory curiosities. But their status may be

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Compare the Hughes 1024's price and performance with the General Radio 1792, Teradyne 115, and other higher-priced systems. Three Teradyne 115s, for example, can easily set you back $210,000. Get the new Hughes 1024 system with three independent work stations instead, and you invest only $118,000.

We can charge less because we've built in more flexibility and economy. The 1024's disk-based system uses a common mini-computer and disk mass storage to drive up to three work stations. You can start with the basic control unit and one work station (256 two-way lines) for as little as $68,000, and readily add two more stations for $25,000 each.

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changing as the Baritt finds applications in self-mixed doppler radars, X-band microwave generators in intruder-alarm doppler radars and in anti-skid braking systems.

Baritts have two serious disadvantages. They require 60 to 100 volts bias—while Gunn diodes use 6 or 12 V. What's more, their power output has been limited to about 10 milliwatts at 11 gigahertz—at least an order of magnitude less than Gunn devices.

However, a Swedish company, IMA Microwave Products, believes that the Baritt has enough going for it to give it the edge in certain applications. IMA has developed a complete intruder-alarm doppler-radar module using a Baritt, and is offering Baritt samples rated at 30 mW cw at 7 GHz, 20 mW at 9 GHz and 10 mW at 10 GHz. The worldwide doppler-alarm industry, which uses thousands of Gunn diodes every week, is the market IMA is aiming at.

IMA, a joint venture between the Microwave Institute in Stockholm, a government-sponsored research establishment, which does the R&D; ASEA, an electrical equipment manufacturer, which makes most of the semiconductor products; and Incentive AB, which provides financial backing.

Pros. Peter Weissglas, a professor at the Microwave Institute and consultant to IMA, lists the pros of Baritts in doppler alarms:

- The 10-GHz radar has an output of 5 mW, the same as many similar Gunn radars.
- The IMA module has a much longer effective range than Gunn modules because Baritt module noise is some 20 to 30 decibels better than Gunn module noise. That means fewer Baritt radars are needed to protect the same area.
- The Baritt is easier to set up in an alarm, because it is made of silicon, and so is more frequency stable with temperature changes than a gallium-arsenide Gunn unit.
- Accidental surges that will destroy a Gunn device don't affect a Baritt, so fewer should be wasted during installation.
- In the long run, the Baritt should be cheaper to manufacture, because

News briefs

IBM and Owens-Illinois agree on cross-license

IBM and Owens-Illinois have hammered out a non-exclusive cross-license for the manufacture of plasma-panel products. IBM has paid an initial $2 million to use the Owens-Illinois Digivue panel display. A non-refundable $1 million is earmarked for future royalties and the rest covers royalties and payments for IBM's past use of the technology in data-processing terminals for banks. Industry experts say that the panels may turn up next in IBM terminals for airline scheduling and stock-quotation systems.

Solarex to buy Centralab's solar-cell operation

In a move that would markedly expand its fledgling photovoltaic cell business, tiny Solarex Corp., Rockville, Md., has agreed in principle to buy the solar-cell operation of Globe-Union's Centralab division, El Monte, Calif. Price and details of the final agreement, which hinges on Solarex's ability to raise the capital, are expected in a few weeks. Committed to terrestrial uses, Solarex [*Electronics*, Feb. 21, p. 32] would acquire Centralab's photovoltaic-production line in space leased from Globe-Union and gain such customers as TRW and Lockheed.

Computer to ease Bay Bridge traffic

A minicomputer that is programed to ease traffic congestion is going into operation this month on the San Francisco-Oakland Bay Bridge. Part of a Department of Transportation project, the $350,000 installation consists of a Data General Corp. Nova 1210 with 8,000 words of memory at the bridge's plaza and magnometers at the bridge's midsection to record traffic volume. Cars will be sent from the toll booth at intervals of 4 to 10 seconds.

Western Union starts service center

Service support for their more than 13,000 leased terminals is being offered by Western Union Data Services Co., Mahwah, N.J., through Termicare, an automated computer center for diagnosis, documentation, and service dispatch. Users calling the center will receive preliminary assistance from a service analyst who can call up each malfunctioning terminal's service history on a CRT. If a field engineer is dispatched, data on the service call is recorded in the file for further updating.

Japan opens exhibit to foreigners

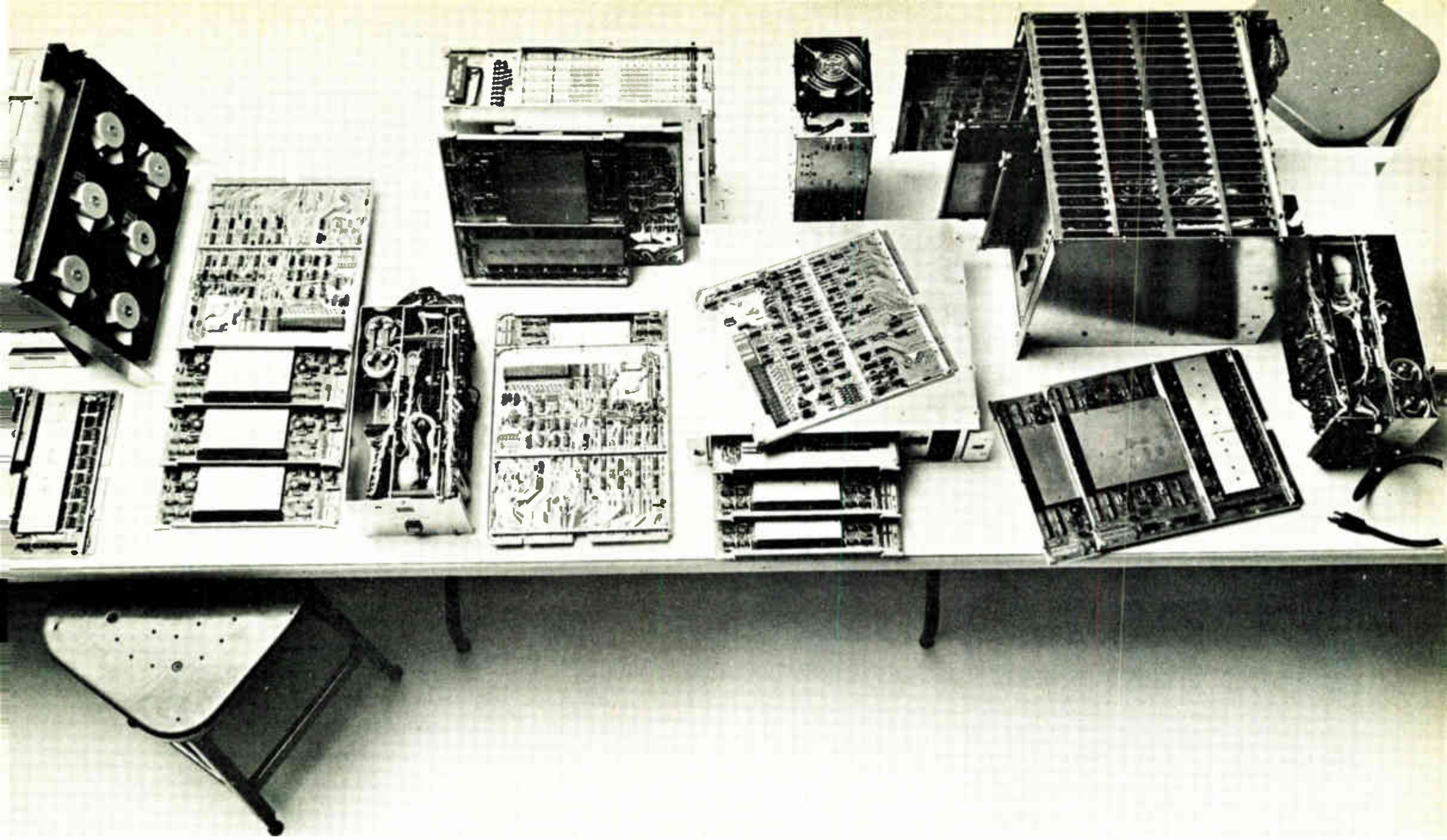
Japan's Printed Circuit Association show (June 1-4) will be open to non-Japanese exhibitors for the first time this year, providing an entree for American electronics firms. The Tokyo show includes exhibits of materials, production machinery, and components, as well as seminars, and demonstrations of printed-circuit techniques and labor saving technology.

Buckbee-Mears expands metal-plating line

Buckbee-Mears, St. Paul, Minn., a major supplier of etched lead frames for ICs, has completed a $200,000 expansion of its precious-metal-plating line. Vice president Lee Barton says this will "more than double the company's capacity to supply over-all silver-plated and spot-gold-plated lead frames" at a time when IC makers, demanding more product output, are also worrying about material shortages.

Addenda

A new high temperature for superconductivity of −418°F has been recorded at Bell Laboratories. The superconducting material was a niobium germanium alloy. . . . The initial phase of a $17 million contract to provide 27 large-diameter antennas for a radio-telescope system has been awarded to E-Systems Inc. by Associated Universities Inc. . . . Hughes Aircraft Co. subsidiaries have signed an $18.4 million contract with Greece to strengthen NATO's air-defense coverage in the Eastern Mediterranean . . . Scientists at Westinghouse Research Laboratories are developing a lock that opens by voice command to sell for less than $100.



Lockheed Introduces 192 New Memory Products.

Lockheed Electronics SENTINEL Memory System makes it all possible. With SENTINEL you have the advantage of buying a customized memory, while paying only a standardized price.

SENTINEL consists of standard modular memory boards, power supplies and chassis. These can be combined in 192 ways to satisfy almost any customer's specific need.

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One of the beauties of the SENTINEL Memory is that you don't have to buy the entire system to get exactly what you need. SENTINEL flexible combinations include assemblies from 4K by 18 up to 128K by 36 or any combination in between in modular increments of 4K, 8K or 16K words . . . all at submicrosecond speeds.

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Circle 41 on reader service card

it is well within established silicon technology.

Weissglas admits that a dc up-converter is needed to get 60 v from the standard 12-v standby batteries. Yet, he says, the extra cost is cancelled "because you can cut out the Schottky-diode detector from the receiver system." The Baritt diode used as transmitter has sufficiently low noise to serve as detector as well, he says, whereas a Gunn radar needs a Schottky detector because the Gunn is too noisy for detection. In support of this, Prof. of electrical engineering, George I. Hadad, of the University of Michigan, Ann Arbor, who has extensively studied microwave devices, says that the low conversion loss and low noise of Baritts will offset their disadvantages in doppler-radar applications where self-mixing is impossible.

Not all agree. Jim Charters, engineering manager of Microwave and Electronic Systems Ltd. Newbridge, Midlothian, Scotland, one of the biggest makers of doppler intruder alarms, thinks the 60-v requirement is a serious drawback. Any up-converter, he says, will need to be very stable to avoid fluctuations at 12 v being multiplied and causing frequency changes.

Charters says the frequency stability and reliability of Gunn devices are not problems. And the longer life of Baritt diodes remains to be proved. In practice, higher sensitivity is not useful, according to Charters, because if the range is extended to take advantage of it, the sensitivity becomes too great close in. Furthermore, insects, such as moths, near the antenna can set off the alarm. Nonetheless, he acknowledges that an alarm maker not committed to Gunns might find Baritts attractive.

Despite the controversy in the area of doppler alarms, the Lucas Electrical Co. of Birmingham, England, is investigating the possibility of using a Baritt-powered radar as part of a vehicle anti-skid system. The company hopes that the radar will be able to pick out consistently the instant before the wheel locks, and trigger release of the brakes. Mechanical sensors aren't accurate enough, and a Gunn radar can't remain stable and sensitive enough through the wide temperature range involved.

IMA's samples use a simple pnp structure made with standard varactor technology. A p^+ substrate holds an epitaxial n layer into which is diffused a shallow p^+ top contact. The only critical factors are the n-layer thickness, which is 6 to 7 micrometers for X band, and its doping level, which is 2×10^{15}. This structure is mesa etched to make devices about 8 mils in diameter.

The power density is low, and junction temperature is not more than 100°C. Samples are scheduled for year-end distribution. Weissglas says they will make good low-noise local oscillators in full-size radars and communication systems. □

Satellites

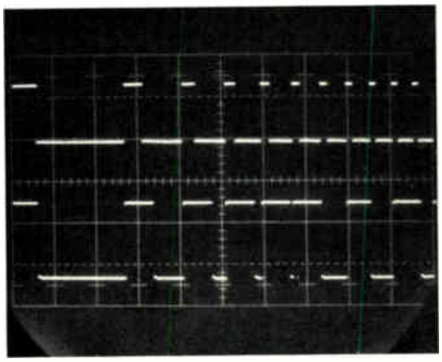
ASC, CML revise domsat plans

When Western Union launches its own Westar satellite this spring, it likely will be launching several competitors' systems as well. This may happen because building expensive technological systems in an uncertain market is causing several companies to change their plans.

American Satellite Corp. (ASC) has drastically revised its plans and will now start its system by using Westar. CML Satellite Corp. plans to lease this fall one or two transponders on Westar for test and sales purposes over two years. Moreover, Western Union and RCA Globecom are talking about a possible link-up. And, Western Union is said to be talking with AT&T and Southern Pacific, among others, in an effort to fill its spacecraft.

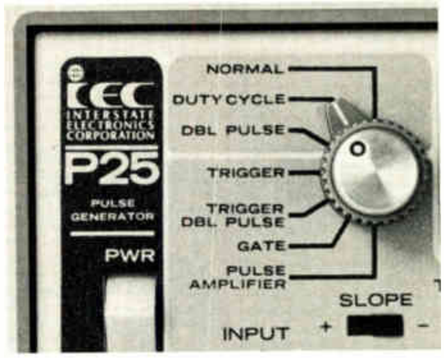
Although the companies' actions may dampen a spacecraft market, it will allow them to go into operation earlier and cheaper without the high hardware costs of their own initial systems. It also will give them time to test out techniques and better gauge the market before they send

yes, yes, no, yes, no.



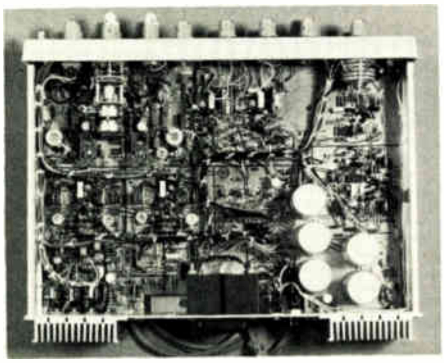
Upper trace: Constant Duty Cycle pulses over a 10:1 frequency range.
Lower trace: Normal pulses over same range.

"Standard pulses with predetermined width are fine for most requirements, but when I'm changing repetition rates I have to fiddle with the width control to make sure that I don't lose the pulse. Does your 'Constant Duty Cycle' mode let me set width as a percent of pulse period so I can change rep rates *without* tweaking the other controls?" (YES)



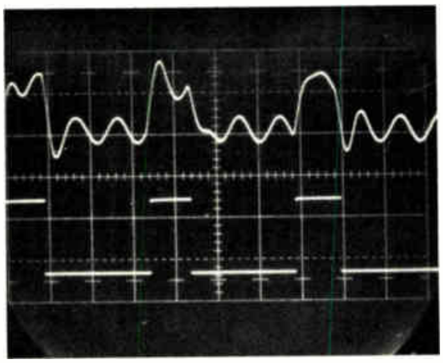
A single control selects all 7 modes.

"That Duty Cycle mode could come in handy, but I also want the regular pulses that I'm used to, and double pulses, and 50% squarewaves to 50 MHz. How about trigger, gate, triggered double pulse, and pulse shaping? (And all of these modes better be easy to set!)" (YES)



All components are fully accessible.

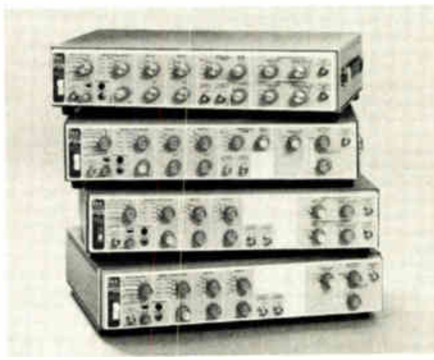
"Reliability and maintainability count, too. I want a generator that works! But in case it needs service I'd like to specify plug-in sockets for dual in-line IC's, and a parts list minus factory widgets. If I put my money on your model, will my QC man hate me?" (NO)



Upper trace: distorted, noisy input.

Lower trace: pulse generator output (Pulse Amplifier Mode).

"My application calls for pure pulses with a bare minimum of overshoot and squiggles. And I need to clean up distorted signals — you know, send in a crummy pulse train and get out a nice squared-up pulse with the offset, amplitude, and rise/fall times I've set up on the generator. Can do?" (YES)



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ASC originally was going to start with Canada's Anik 2 domsat and then buy three satellites from Hughes for a $25 million second phase while developing a "permanent" third-phase system under the over-all $100 million program. Instead, beginning this summer, the company will lease three transponders from Western Union's Hughes-built Westar series for $4.8 million a year, drop the use of Anik 2, and cancel the Hughes contract, for which it already has made $5 million in progress payments. The company still plans to launch a three-axis-stabilized spacecraft by 1977, according to John G. Puente, vice president, technical.

"By this move, we save up-front money," Puente says, including $30 million in launch costs and $90,000 per year for each transponder, as Westar is cheaper than Anik. The Western Union contract is extendable beyond 1976, and the company has Anik as a possible backup. The new system will cost an estimated $70 million, including launch costs, Puente estimates.

The revised plans will allow both ASC and CML to further develop newer 12- and 14-gigahertz transmission techniques for direct rooftop communications. ASC's second phase will be a mixture of communications at 4 and 6 GHz and 12 and 14 GHz. CML's satellite will use only 12 and 14 GHz. In June, CML expects to go out for bids for a subcontract to develop the higher-frequency technology and within a year after that it plans to award the prime contract to build three spacecraft.

These satellites will be built while it leases Westar. The company basically is looking at spin-stabilized 1,500-pound spacecraft for its $130 million system. Getting partners Comsat, MCI, and Lockheed to agree has also helped delay plans that originally called for bids to go out last fall [*Electronics*, June 21, 1973, p. 72). □

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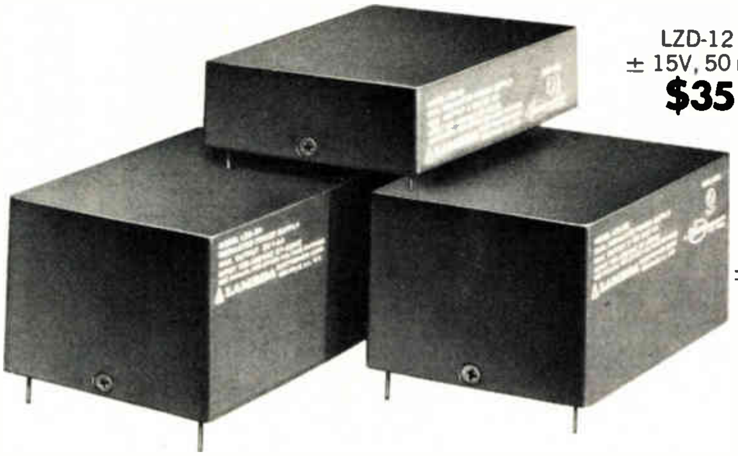

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2½" x 3½" x ⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-10	3	317	$35
LZS-10	4	384	35
LZS-10	5	450	35
LZS-11	10	225	35
LZS-11	12	195	35
LZS-11	15	150	35

LZ-10 SERIES DUAL TRACKING OUTPUT

2½" x 3½" x ⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-12	±15V	50	$35

LZ-20 SERIES SINGLE OUTPUT

2½" x 3½" x 1¼"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-20	10	247	$55
LZS-20	12	268	55
LZS-20	15	300	55
*LZD-22	24	73	40
*LZD-23	24	129	55
*LZD-22	28	84	40
*LZD-23	28	143	55

*Single output ratings for dual output models connected in series

LZ-20 SERIES DUAL TRACKING OUTPUT

2½" x 3½" x 1¼"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-21	± 3	217	$55
LZD-21	± 4	258	55
LZD-21	± 5	300	55
LZD-22	±10	61	40
LZD-23	±10	114	55
LZD-22	±12	73	40
LZD-23	±12	129	55
LZD-22	±15	90	40
LZD-23	±15	150	55

LZ-30 SERIES SINGLE OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZS-30	3	633	$65
LZS-30	4	767	65
LZS-30	5	900	65
LZS-33	10	293	65
LZS-33	12	336	65
LZS-33	15	400	65
LZS-34	3	950	95
LZS-34	4	1180	95
LZS-34	5	1400	95
*LZD-32	24	186	65
*LZD-32	28	208	65
*LZD-35	24	240	95
*LZD-35	28	280	95

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LZ-30 SERIES DUAL TRACKING OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZD-31	± 3	333	$65
LZD-31	± 4	417	65
LZD-31	± 5	500	65
LZD-32	±10	163	65
LZD-32	±12	186	65
LZD-32	±15	220	65
LZD-35	±10	200	95
LZD-35	±12	240	95
LZD-35	±15	300	95

LZ-30 SERIES TRIPLE OUTPUT

2½" x 3½" x 1⅞"

MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZT-36	5	500	$70
	±15	50	

NOTES: (1) LZ models are adjustable between the following limits: LZS-10 2.5 to 6V LZS-11 8 to 15V LZS-20 8 to 15V LZS-30 2.5 to 6V LZS-33 8 to 15V LZS-34 2.5 to 6V LZD-12 ± 14.5 to ± 15.5V LZD-21 ± 2.5 to ± 6V LZD-22 ± 8 to ± 15V LZD-23 ± 8 to ± 15V LZD-31 ± 2.5 to ± 6V LZD-32 ± 8 to ± 15V LZD-35 ± 8 to ± 15V LZT-36 2.5V-6V for + 5V output only, ± 14.5 to ± 15.5 for ± 15V output only. Contact factory for current ratings at voltage settings not indicated in the tables. (2) All prices and specifications are subject to change without notice.

SPECIFICATIONS FOR LZ SERIES

Regulation

0.15%—line or load; models LZS-10, LZS-30, LZS-34, LZD-21 and LZD-31 have load regulation of 0.15% + 5mV; model LZD-12 has line or load regulation of 0.25%; LZT-36 line regulation 0.15% (±5V) 0.25% (±15V); load regulation 0.15% + 10mV (+5V), 0.25% (±15V).

Ripple and noise

1.5mV RMS, 5mV, pk-pk

Temperature coefficient

0.03%/°C

Overshoot

no overshoot on turn-on, turn-off, or power failure

Tracking accuracy

2% absolute voltage difference for dual output models only and only for the ±15V output in LZT-36; 0.2% change for all conditions of line, load and temperature

Ambient operating temperature range

continuous duty from 0°C to + 50°C

Wide AC input voltage range

105 to 132 Vac, 57-63 Hz

Storage temperature range

−25°C to +85°C

Overload protection

fixed automatic electronic current limiting circuit

Input & output connections

printed circuit solder pins on lower surface of unit. For model LZT-36 the ± 15V outputs are independent from the 5V output.

Controls

screwdriver voltage adjustment over entire voltage range.

Mounting

tapped holes on lower surface

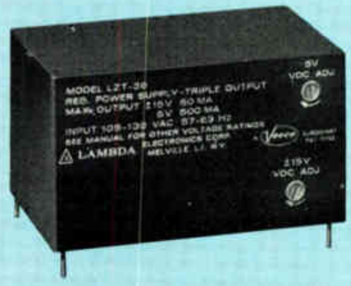
Physical data

Size	Weight
see tables	LZ-10 series 10 oz. net 18 oz. ship.
	LZ-20 series 17 oz. net 25 oz. ship.
	LZ-30 series 24 oz. net 32 oz. ship.

60-day guarantee

60-day guarantee includes labor as well as parts

LZ SERIES NOW AVAILABLE IN NEW TRIPLE OUTPUT MODEL



MODEL	VOLTAGE(1) VDC	CURRENT mA	PRICE(2)
LZT-36	5V	500	$70
	±15V	50	

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Circle 47 on reader service card

Alphabetical Index to Advertisers

SEARCHLIGHT SECTION

(Classified Advertising)

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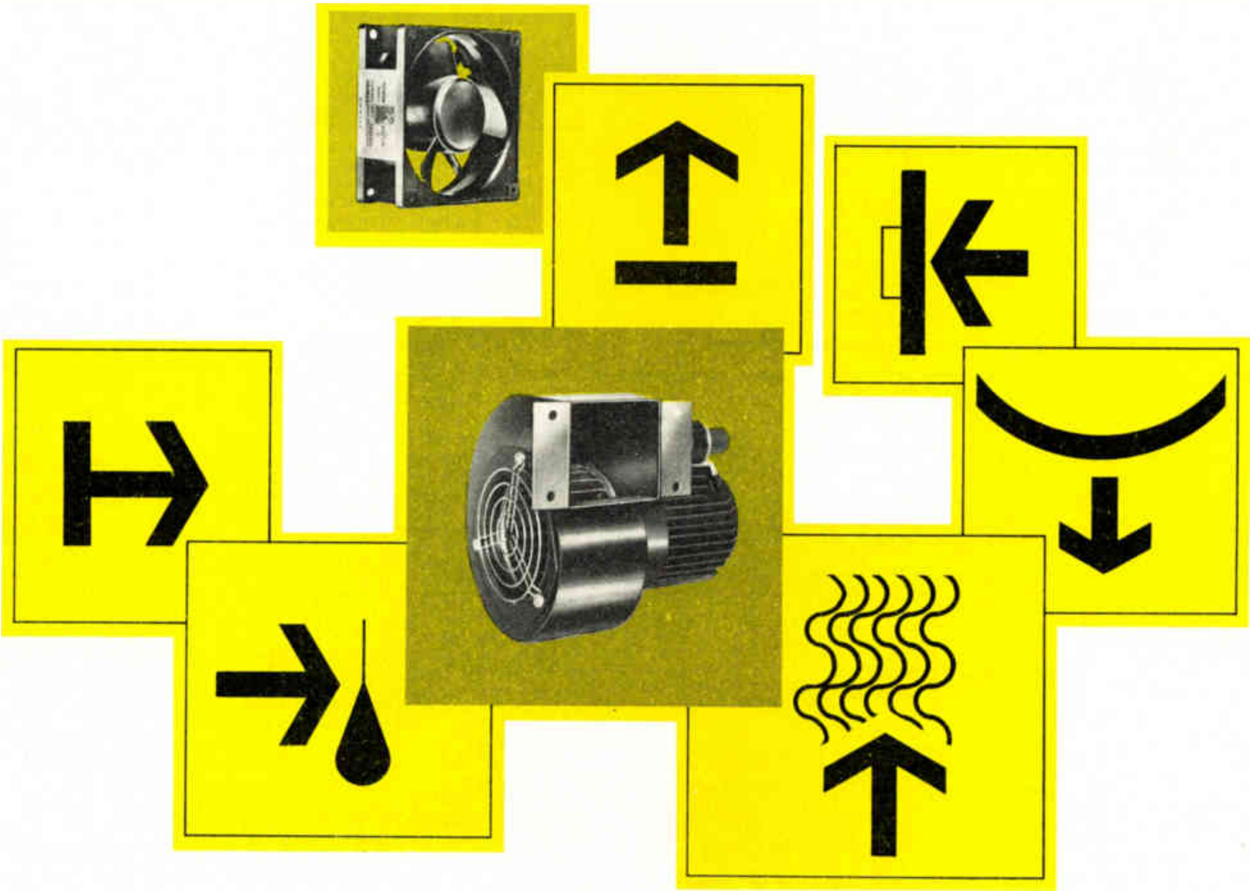

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New engineers quit DOD over salaries, promotions

Engineering salaries in the Pentagon's in-house laboratory system have failed to keep pace with those of private industry, unlike most Federal pay scales for most administrative and other specialties. So says the Directorate of Defense Research and Engineering, which complains that **the starting Federal salary for a new BS in engineering in the spring of 1973 is about $1,500 a year less than that of private industry** because of the latter's increased demand for engineers and physical scientists. Because, too, **controls on the number of Federal jobs have slowed down Civil Service promotions,** DDR&E says "many of the bright, young people we were able to attract two or three years ago are leaving."

OMB chokes plan for emergency medical services

Despite congressional, departmental, and medical support, the powerful **White House Office of Management and Budget is strangling a program to fund local emergency medical services,** confide officials at the Department of Health, Education, and Welfare. **Congress has authorized $185 million over three years to pump life into local emergency communications networks** [*Electronics*, Jan. 10, p. 80], **but OMB has cut the fiscal 1974 funding from $45 million to $27 million.** Moreover, the regulations on how to grant the money are coming out so late that the fiscal year could end before all the money is spent.

Will Congress notice? "Congress has so many things to be upset about right now that it might not do anything," one official worries. Another official offers **a possible solution: get funds committed for as many networks as possible and hope for more money in fiscal 1975.**

Navy researchers develop high-power satcom test facility

Details of **a new Naval Research Laboratory installation for high-power testing of communication satellite components and materials** are to be disclosed at the March 26-28 millimeter-wave-technique conference in San Diego, Calif., at the Naval Electronics Laboratory Center.

The installation at the Microwave Space Research Facility, Waldorf, Md., has a 1-kW K_a-band power capability in the 36-38-GH2 band. As a result, says NRL's R.E. Cushing, principal investigator for the project, **system designers can now obtain complete high-power testing of system components during development of a satcom terminal,** saving time and money and preventing component failure in future satcom system use. A small interior radiation chamber is for antenna and materials evaluation at high rf flux densities and power levels to 1 kW cw for long intervals of time. **Direct-reading digital calorimetric water loads have been developed for waveguide and radiation sources.**

Secure voice unit formed for military communications

A Secure Voice Consortium made up of representatives of all defense communications users has been **established by the Directorate of Defense Research and Engineering to eliminate duplication and coordinate military programs on secure communications.** The SVC will oversee implementation of the interim system, Autosevocom Phase 2, as well as **development of narrow-band 2–8-kilobit/second voice-processing equipment** for use where wide-band digital transmission will not be available. **Large-scale integrated circuits, are "the key to the economic implementation of the relatively complicated voice-processing algorithms needed,"** says DDR&E director Malcolm Currie.

The domsat shakeout

When the Federal Communications Commission gave its long-delayed blessing two years ago to the competitive development of domestic satellite systems, there was much speculation about whether the marketplace could support the six systems proposed. It was then that Dean Burch—who is now leaving the commission to join the White House staff—displayed the characteristic common sense that was to mark much of his rule as FCC chairman.

Burch's law was simply "let the marketplace decide." In judging petitioners' applications to launch satellites for domestic service, he said, the FCC would base its decisions on technical considerations only.

The wisdom of that judgment is borne out by the news that American Satellite Corp., CML Satellite Corp., and possibly RCA Globcom and AT&T, will now buy transponder space on Western Union's Westar satellite—the first domsat scheduled for operation and to be launched in April (see p. 42). The shakeout in domestic satellites clearly is well under way.

The shakeout also demonstrates the wisdom of Western Union's gamble in placing its order for satellites before it received FCC approval of its plan. By getting its order for satellites and NASA launch rockets in first, WU achieved a significant leg up on the competition.

Financing their respective entries into the new and undeveloped communications satellite market proved the principal problem for most of the companies. Fairchild Industries, which now has total control of American Satellite after a two-step acquisition of Western Union International's 50% interest, has had difficulties as well. Predominantly known as a military aircraft maker, Fairchild's push to get public investment for its infant American Satellite flopped last year. CML Satellite, with holdings equally divided among Comsat Corp., MCI Communications Corp. and Lockheed, has also had fiscal problems. Comsat, it seems, is the only one with money to spare, yet is precluded from bankrolling its partners by FCC's restrictions on investment in and control of CML.

However, AT&T, RCA Globcom, and Hughes-GTE have sufficient resources to leverage their way into the domsat market later, should it prove lucrative for Western Union. Fortunately for Western Union, it managed to find the funds to make its commitment first. As one company official now says of Westar, "my guess is that we'll go to launch sold out."

Problems of innovation

Starting a totally new industry in 20th century America is more than difficult. It is almost impossible—particularly if your resources are limited and the new business threatens to disrupt the existing marketplace. This is the hard lesson being learned by Richard Ahern, the young entrepreneur promoting the concept of electronic shopping in the home by means of an AT&T Touch Tone telephone linked to a computer catalog with voice answer-back.

Ahern's Computer Shopping Inc. is hardly an industrial giant. And in an industrial society where oligopoly is the rule rather than the exception, Computer Shopping's limited resources are a large part of its problem. The other part is a very human fear of the unknown, from which no corporate leader is immune. It is a fear that can destroy the innovator seeking to alter the *status quo*.

Since Ahern unveiled his computer shopping system last year—one he contends can save the U.S. "a minimum of 600,000 barrels of gasoline a day" by eliminating unneeded supermarket shopping trips—the new company has struck out in its efforts to get a major food retailer to participate in a demonstration prototype system. Ahern says the food retailers fear that such a system could severely reduce purchases of their highest-profit items customarily bought on impulse—fresh produce, meats, and such unnecessaries as costly frozen chocolate cakes, pies, or cocktail glasses. Moreover, says Ahern, large food chains with an estimated $100,000 invested per store balk at a concept that might make such outlays unprofitable.

Unfortunately, Computer Shopping is unable to afford the high cost of a demonstration prototype system—something that most of the conservative industries he expects to service want to see first. Working hardware is virtually essential to any high-capital-risk venture.

Now, however, Computer Shopping believes it can get a $100,000 commitment from the Federal Energy Office for a demonstration system, provided it can find a customer to make a comparable investment. At the very least, this is what computer shopping needs. If it does not get it, another innovative concept may fail—and with it will go a significant potential market for electronics technology. **—Ray Connolly**

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Thomson-CSF readies a translucent video disk

Thomson-CSF intends to unveil a video disk player within the next four or five months. Company officials now say their research group has been getting **very good color images with a player that pairs a soft translucent plastic disk and a laser-based readout system.** The bandwidth of the encoded video signal is 4.5 megahertz, the disk spins at 1,500 revolutions per minute, and it carries up to 40 minutes of program.

Robert Pontillon, who directs Thomson-CSF's audio-visual activities, says that **the French company is pushing hard for an agreement on a single standard for video disk players.** The other European contenders are Philips Gloeilampenfabrieken, and the Telefunken-Decca venture, Teldec. Like Thomson-CSF's, Philips' player uses optical readout, but the Dutch company opted for a rigid, reflecting disk. Thomson-CSF, therefore, can't make its player compatible with Philips', but Pontillon maintains that the French playback system could be made compatible with Teldec disks, which have a pressure-sensitive readout.

German company to mass produce electronic speedometer

VDO Adolf Schindling, a leading European automobile-instruments maker, is about to begin production of electronic speedometers on a large-volume basis, making it the first company to have readied such speedometers for mass production. **The units will go into passenger cars that will come off the assembly lines of a German automobile producer starting this spring.**

The new VDO speedometers offer several advantages over conventional mechanical systems, the prime one being that the vehicle no longer needs a flexible shaft. Instead, a wire—one that can easily be run in the car's cable harness—is used for sending the speed and distance pulses from the transducer to the speedometer and its mileage indicator. The key component is an integrated circuit developed by Intermetall GmbH, an affiliate of the ITT Semiconductor group. **The price of the electronic speedometer, VDO says, will be about the same as a conventional one plus its flexible shaft.**

Electric bus to use sophisticated electronic controls

Chloride Technical Ltd., part of the British Chloride Group—whose activities include automobile batteries—**has developed an electrically powered 50-seat single-deck city bus that makes considerable use of electronic controls.** It will go into trial service in Manchester in a few months. Maximum speed is said to be 40 miles per hour and range 40 miles on a single charge of the 330-volt lead-acid battery. Normal battery recharge time is not more than 5½ hours, so that it can be recharged between morning and evening peak use times.

The bus uses a series-wound dc main-drive motor controlled by a 1,000-ampere thyristor chopper-controller, which incorporates a regeneration system that recharges the batteries during deceleration and braking. The controller has been developed by Sevcon Engineering Ltd. of Gateshead, a subsidiary of Technical Operations Inc., Burlington, Mass. It includes logic on the speed/time relationship, which keeps down acceleration and deceleration to comfortable levels. A pulse regeneration technique is used: current builds up in the armature and contacts until at a pre-set level it transfers through a diode to the battery.

Siemens turns to MOS ICs for remote TV control

Watch for West Germany's Siemens AG to offer an all-MOS set of integrated circuits for remote control of color-television receivers. The complete set, to hit the market during the second half of this year, will consist of three standardized MOS circuits—one each for the control system's transmitter, receiver, and memory. **It will sell for about $15, roughly equal to the price of all other integrated circuits—between eight and 10—used in German-built color-TV receivers today.**

Desk-calculator makers in Japan set quality standards

In the near future, desk calculator purchasers may look for a new mark—a stylized B and M—that goes with the quality standard to be introduced on March 1 by the Japan Business Machine Makers Association. **The association hopes the standard will help to maintain product quality despite the current high level of competition.** Eligibility for the mark includes registration of the model, inspection of the company's plant and after-sales service setup, and inspection of the quality of calculators. **The quality test will include repeated computation, to assure that there are no errors, and a vibration test.**

The association now has 14 manufacturers who produce calculators. Estimates of the number of "outsiders" that produce calculators range up to 50 companies. Most of the outsiders' calculators are exported.

SAAB-Scania takes over Facit's computer systems

Sweden's SAAB-Scania has taken over development and marketing of complete computer systems developed by office-machine maker, Facit. Now, SAAB, which has concentrated in large computers and large-computer bank-terminal systems, will be able to move into the lower level of computer applications. The Facit systems include an electronic invoicing system, multi-access office computer system, and a program-control system using magnetic tapes and alphanumeric CRT display screen.

At the same time, the take-over will also enable SAAB to use the well-developed world-wide Facit marketing organization. SAAB has concentrated its computer sales in Scandinavia and some East European markets, although last year it established a U.S. subsidiary, Data-SAAB Systems Inc. SAAB has one bank-terminal system in operation in the U.S., at New York City's Central Savings Bank.

Facit will retain development and marketing of its computer peripheral equipment, including tape punches and readers, which it sells to a number of computer makers. **Facit will also continue to handle production of the computer systems that SAAB is acquiring.**

Cables and Wireless picks Italian group for earth-station gear

Cable and Wireless Ltd., operators of seven satellite communications earth stations around the world—all built for it by Marconi Co. Ltd.—is moving to the Italian consortium Consorzio per Sistemi di Telecommunicazioni via Satelliti SpA. (STS) for its next two stations. These stations will be in Fiji and in Dubai in the Persian Gulf. **STS has a contract worth some $5 million for the antenna structures and some other equipment,** possibly including much of the transmit and receive gear. Marconi has to be content with an $800,000 order for some receiver subsystems and modulators. Other UK companies have taken smaller orders for ancilliary equipment.

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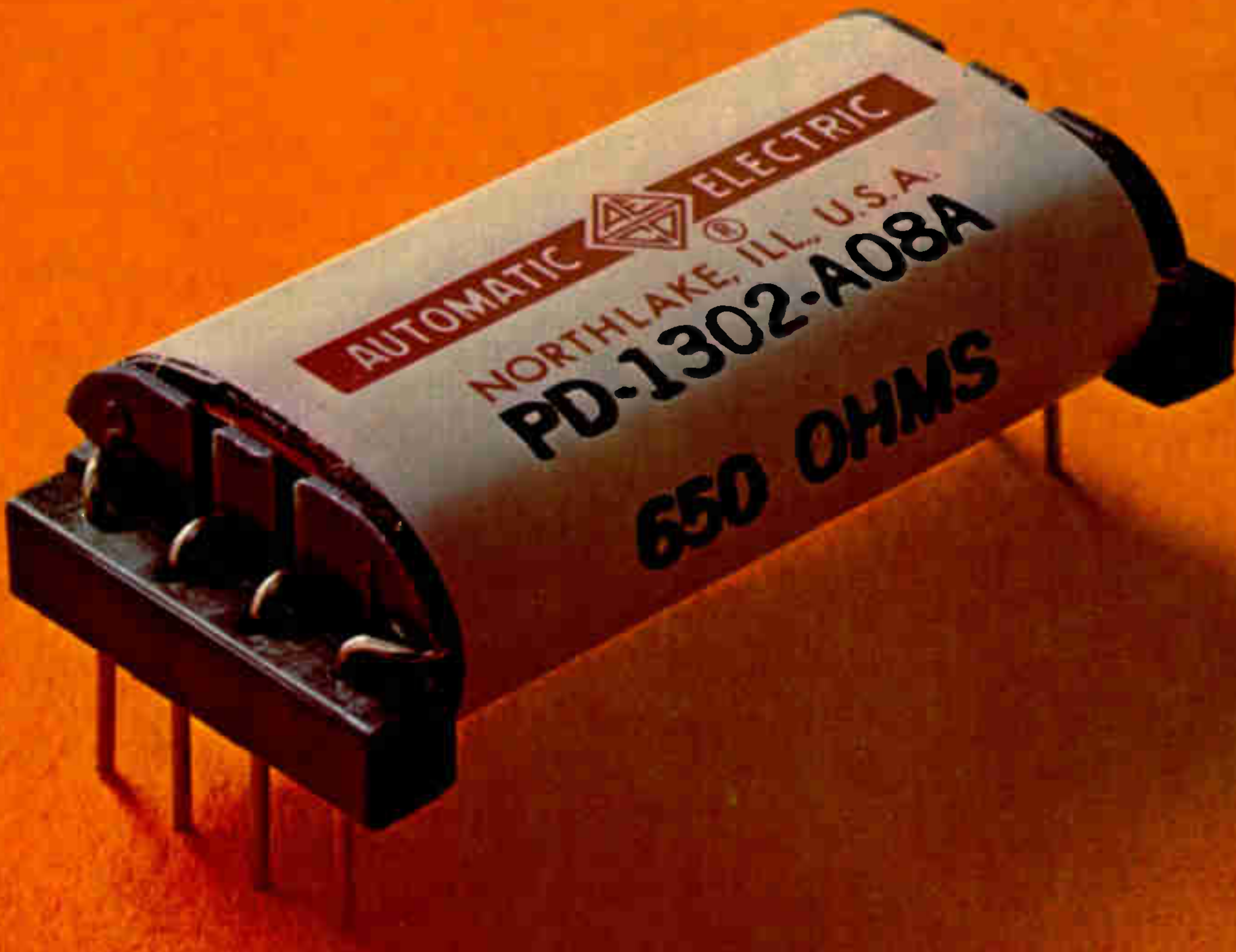
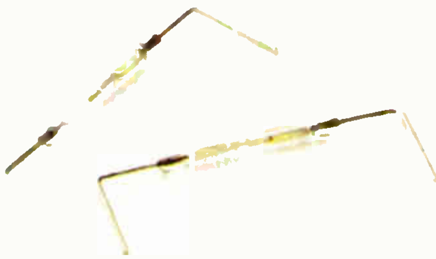


here's the way it looks.



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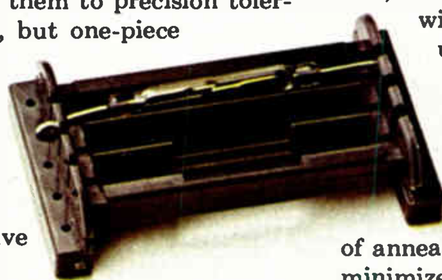

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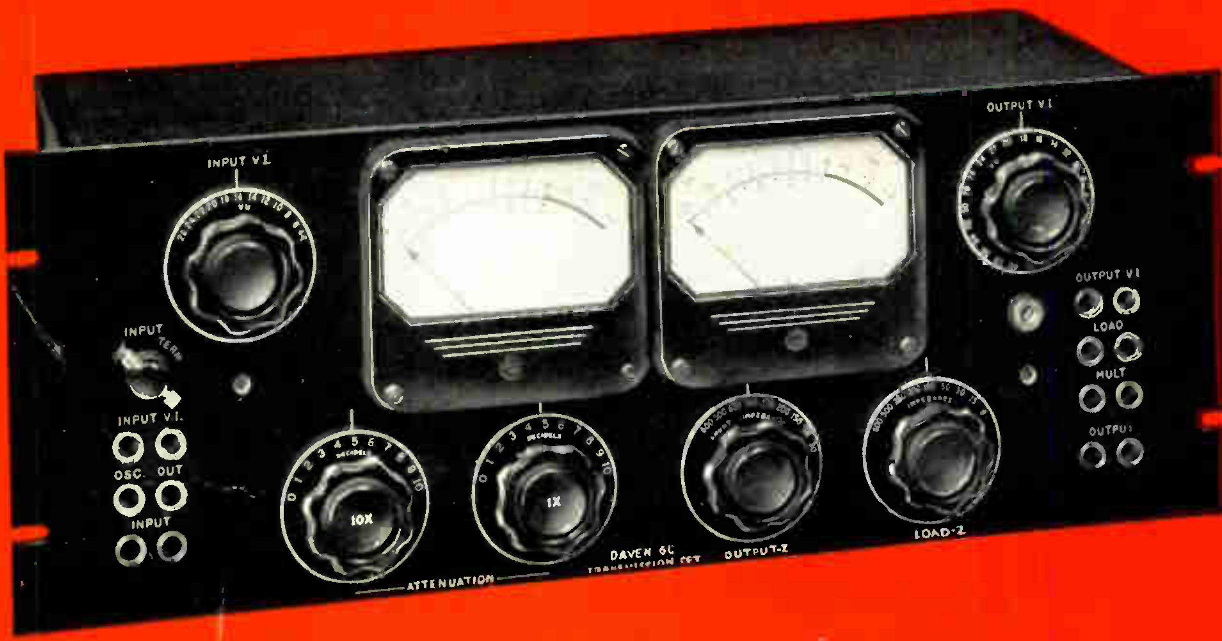

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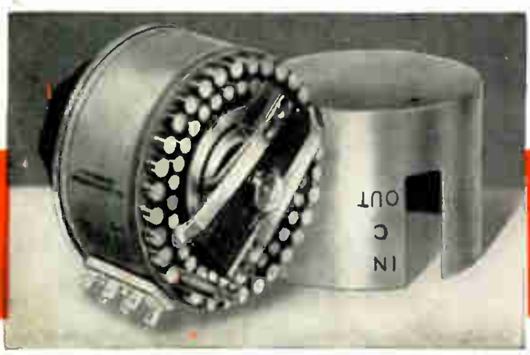

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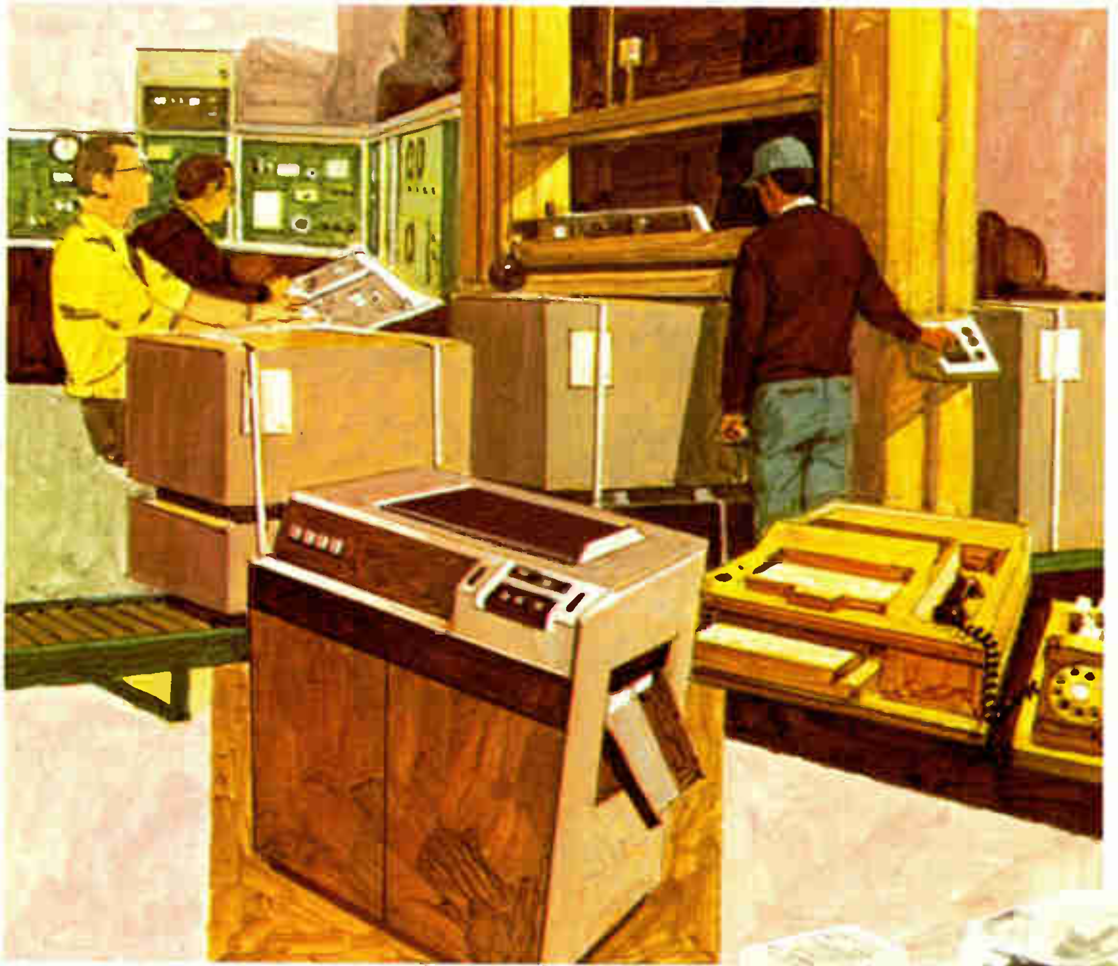

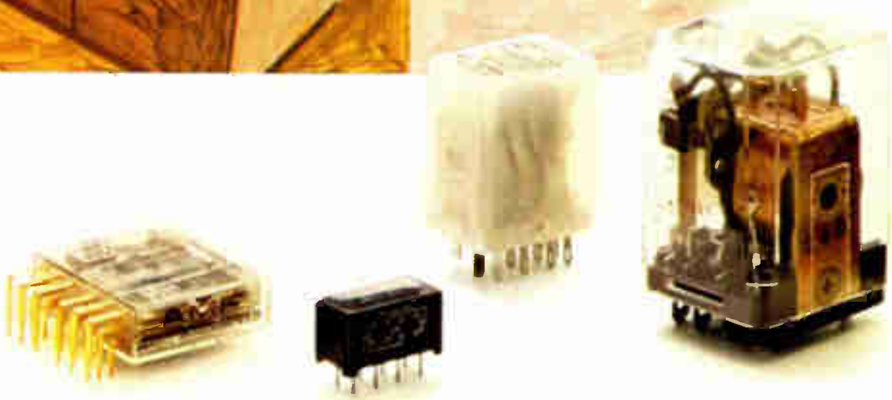

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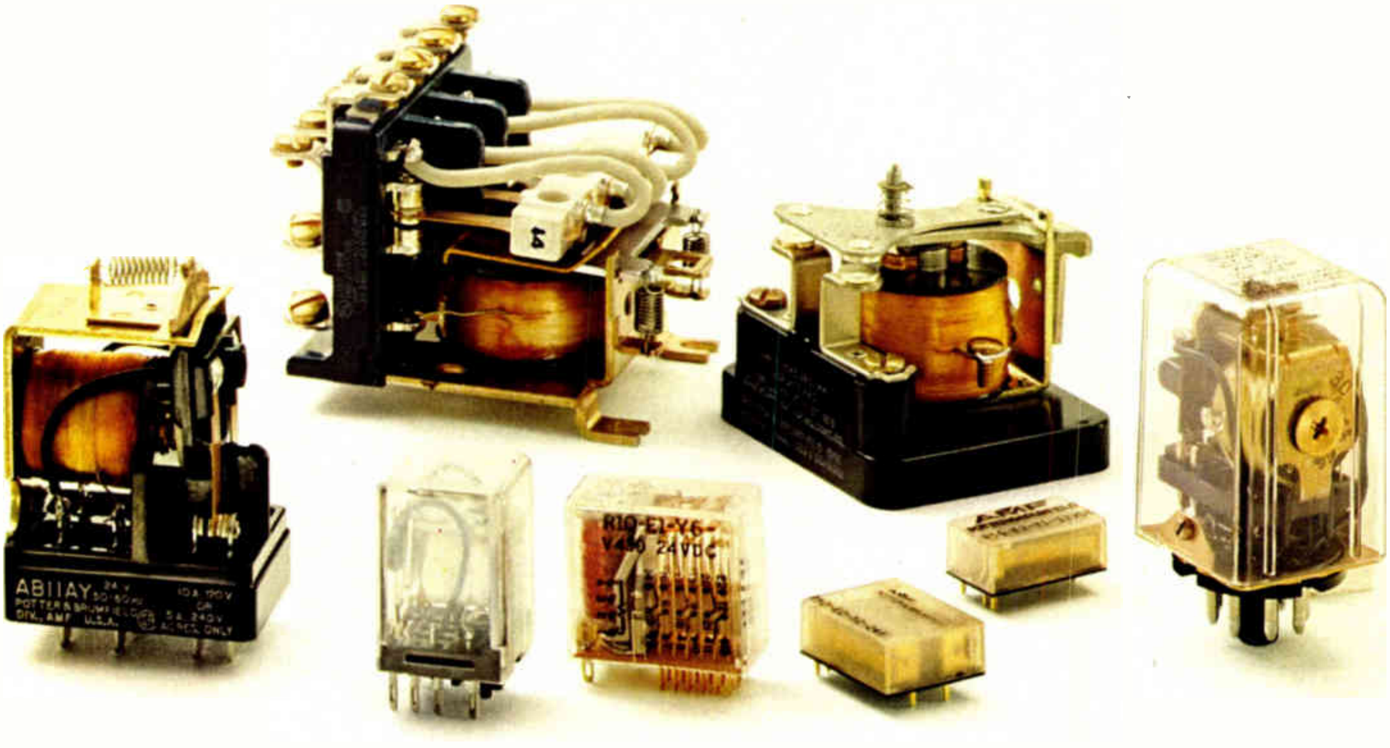

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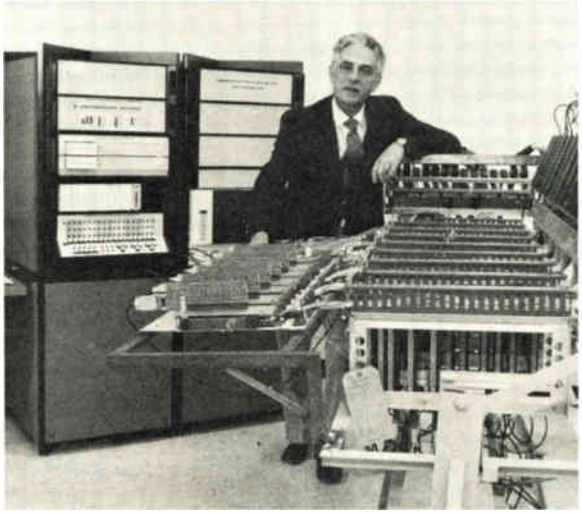

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Solid-state imagers halfway there

Industrial-quality CCD, injection, and MOS versions are available, but broadcast-type equipment is still several years away

by Laurence Altman, Solid State Editor

Solid-state imaging devices, hailed as the new generation of camera technology as early as 1970, are still not commercially available for high-density facsimile and video-camera applications. And while it is becoming clear that cameras that can meet the tough demands of manufacturers of broadcast and consumer equipment are still at least two or three years away, a wide variety of industrial equipment has become available. These products include lower-resolution linear and area imagers (charge-coupled, injection, and MOS devices) for such applications as slow-scan optical character recognition and basic-recognition intrusion systems.

Consider the developments of the last month:

- Bell Laboratories has built a CCD vidicon capable of full Picturephone resolution (250 by 225 lines) for data-transmission systems, and, in the process, designed a high-yield device structure that greatly reduces the manufacturing tolerances.
- An injection-type MOS camera has just been introduced by General Electric. While capable of only 100-line video resolution, it's so sensitive that it can detect images illuminated by nothing more than the light from a candle. Signal-to-noise ratio is 1,200 to 1, and peak sensitivity is about 300 milliamperes per watt. This camera joins the 100-by-100-element CCD imager from Fairchild Camera & Instrument.
- A new MOS photodiode readout structure from Stanford University reduces the noise of MOS self-scanning arrays. The structure will add to the applications of the industrial-type self-scanners available from Reticon Inc. and Photomatrix Ltd.
- Finally, and perhaps most significant in foretelling developments, workers at RCA Lancaster are operating a CCD video camera that's capable of the full 525-line video resolution. This 512-by-320-element array is technically capable of performing in today's TV systems.

But it should be pointed out that available camera components fall short of the resolution and picture quality required for most video applications; standard industrial-quality data-transmission, video, and facsimile equipment; and toughest of all, low-cost consumer cameras capable of displaying good pictures on home TV monitors at a price less than $200.

Indeed, some observers have begun to question whether solid-state techniques will ever be capable of producing imaging devices comparable in quality and cost to today's vidicon tubes—a standard 525-line black-and-white video camera from Japan can be bought for less than $200.

These new developments indicate that solid-state imagers are clearly

Soft light. GE's injection-type MOS camera is so sensitive that it can detect objects illuminated only by candlelight.

ready to penetrate many industrial markets. One user, Richard Van Thyne of Recognition Equipment Co., Dallas, states that "all three types of solid-state imagers—CCD, injection, and self-scan—are being evaluated for both simple character-recognition systems, like card and postal readers, and the tougher-to-implement point-of-sale applications. "For the OCR systems," says Van Thyne, "a linear scanner is sufficient because the material has to move past the image head anyway. And the available CCD and MOS scanners can already do the job. The problem is cost—we'd buy all we could at $5 apiece, and the vendors would supply all we wanted at $100 apiece. It's mostly a question of getting the economics together."

But Van Thyne indicates that it's not just the cost of the image component that must be considered—the total system saving can be considerable with solid-state imaging devices because they are smaller, use less power, and are generally more reliable. "You'll pay more for a device you know is reliable" and can operate at a fraction of the power dissipation and light levels that generally are available from tube imagers, he points out.

Whether industrial users know it or not, device manufacturers see them as providing a foot in the door for many special-purpose imaging applications. According to Gilbert Ameleo, in charge of CCD device work at Fairchild, "The industrial market provides a proving ground where many of the advantages of solid-state imaging can be tested." Even the early low-resolution image devices, like the 100-line camera, are already in demand for fly-by surveillance and monitoring applications because they are lightweight and rugged. But Ameleo cautions that penetration into industrial, let alone the broadcast or consumer markets, rests with the ability of solid-state-imager manufacturers to increase device density to the standard 525-line TV level. At this level, the solid-state device would begin to penetrate such fields as facsimile and page-reader equipment, to name two.

The density gap is quickly being filled by devices such as Bell Labs' 250-line and the RCA's 525-line imagers. The Bell device is promising because it greatly relaxes the manufacturing tolerances required in dense image arrays. Michael Tompsett, supervisor of the Bell CCD group, points out that the structure "considerably relaxes demands in mask making and photolithography because no narrow gaps have to be etched." The smallest device feature is the electrode itself—in this case, it measures larger than 15 micrometers.

This means that yields on CCD imaging chips can be quite high, even though the chips themselves are very large—500 mils and larger on a side—pointing to much lower manufacturing costs than might be expected for jumbo chips, "In fact," says Tompsett, "the problem with the commercial production of CCD imaging chips from the supplier's viewpoint may be that the price may fall too fast." And although most device manufacturers say they will supply both chips and complete camera systems, low prices on chips would stimulate more interest in supplying complete camera and monitoring systems.

RCA, which has been a major supplier of video-camera tubes, is clearly aiming at the systems market—a realization that may not be too far away, to judge from its 525-line CCD camera. According to Robert Rodgers, manager of the Lancaster camera group, the device, although still developmental, is technically capable of competing with many vidicons. "We have it hooked up to a standard TV monitor, and it's hard to tell it from a standard TV image. The CCD-camera cost, however, would be high, and because of this penetration into the general vidicon market, is still some years away."

This goes for both the broadcast camera market and the consumer home-video market. "For the broadcast market," says Rodgers, "even a 512-by-320-element camera is not good enough because sponsor pressure requires that the image quality must be higher than that shown on a home-TV monitor." And for the home-video market, the $200 vidicon presents a formidable competitor.

But as a special purpose camera, such as for low-light-level news and sports applications, teaching aids, and medical applications, the solid-state video camera may soon be in the picture. □

Bell ringer. This CCD vidicon built by Bell Labs can produce Picturephone resolution (250 by 225 lines). Researchers there also managed to reduce manufacturing tolerances.

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Automotive electronics

Electric vehicles draw interest

Electronic control systems are part of struggle to overcome cost, performance limitations in transit efforts

by Ray Connolly, Washington bureau manager

Consumers of the Western world waiting for an electric vehicle to rescue them from their dependence on gasoline pumps still have several years to wait. And when the first EVs arrive in quantity, they will most likely be in the shape of buses, rather than passenger cars. Moreover, those buses with their electronic control systems probably will have been made in Europe or perhaps Japan, rather than in the United States.

Surprisingly, those conclusions drawn from the Third International Electric Vehicle Symposium in Washington didn't discourage the electronics engineers at the three-day meeting near the end of February. "That may be discouraging for car drivers, but it is good news to us," contended one Westinghouse Electric Co. engineer, who noted that solid-state technology is still a newcomer to the EV marketplace. "There is still a chance."

How chancy is the potential for electronics as the principal control system for electric over-the-road vehicles? Most Americans acknowledge that they do not yet know, because the domestic market has not yet been tapped as it is beginning to be in Western Europe, where vehicle development is further along. There, the emphasis is on city buses and delivery vans with the capacity to carry the large, heavy battery packs now required by EVs. But the potential for electronic control systems unquestionably exists, if they can be proved economically competitive with older, established mechanical contactor systems and torque converters.

"It is still feasible to consider the mechanical contactor systems, for these have been greatly reduced in size and relative cost from the early days of streetcars and electric cars," says Ford Motor Co.'s Lewis E. Unnewehr. "However, many investigators feel that solid-state devices and circuits hold the most promise, and there is no doubt that such systems can give a smoother, more sophisticated type of control and would be much smaller in size."

Conflict. However, some European EV specialists have different views of the economics and performance of electronic control systems. On the cost side, David Gurwitz, managing director of Britain's Sevcon Ltd., says that electronic controls as they now exist are too expensive. To move a small, in-plant personnel carrier, for example, a minimum solid-state system could cost $200. For a large vehicle capable of accelerations to a top speed of 60 miles per hour with the torque equivalent of 200 horsepower, a control system could cost as much as $1,000 each in quantity. "These costs are not competitive," says Gurwitz.

Gurwitz' frustration with solid-state control costs was matched by one French engineering executive's concern with the performance of present controls. General manager Pierre Margrain of Establissements E. Ragonot, an affiliate of the Thomson Lucas Group, called for

Is there a consumer market?

In 1972, the New York-based Electric Vehicle Council commissioned a market study that determined there were about 55 million Americans who would be interested in a plug-in automobile for urban use if it could deliver a top speed of 40 miles per hour, would travel 150 miles without recharging, and could be bought for less than $2,000. Both that range and price are still beyond the state of the EV art—now limited to about 50 miles and a price tag closer to $4,000—but much has changed in America in the past two years.

Chief among these are the attitudes of the consumer, lately discontented with seemingly unending waits to buy limited quantities of gasoline. If there is an indication in the number of consumers who called the Third International EV Symposium anxious to see the exhibits—and in some cases, "place my order for an electric car"—then the principal obstacle to developing the consumer market would seem to be only the absence of a proven consumer product.

Offsetting the EV's high first cost and range limitations are its distinct advantages in the area of low fuel costs—about one-half cent per mile—as well as its low pollution level and relatively simple maintenance compared to conventional vehicles.

Of the 42% of U.S. consumers who expressed an interest in an electric vehicle, more interest was shown by women then men (43% vs 41%), by younger people than older (half of those in the 18 to 29 age bracket), and by big-city dwellers (48%) than those in rural or other urban areas. Said one analyst of the data, "in developing the market, it seems that college students and liberated women should come first."

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Why R&D's stalled in America

There seemed a common sense of frustration among the more than 1,000 entrepreneurs, economists, and electronics engineers at the Third International Electric Vehicle Symposium. But the origins of the concern were different for the Americans than they were for the more experienced EV specialists from Britain, France, and West Germany, who dominated the meeting. While the Europeans pondered the need for new electronic controls and power sources, the Americans griped at the slower pace of their own programs.

"Various European cities have found the electric bus an efficient and economical answer to mass transportation, but here in the United States, the Urban Mass Transportation Administration has announced grants of funds in the millions of dollars for internal-combustion buses, and not a dollar for the electric type," complained Sen. James A. McClure (R., Idaho). Asked later to respond to the criticism, Undersecretary of Transportation John W. Barnum could do no more than confirm the accuracy of McClure's assertion.

Japan, meanwhile, is well on its way to spending a $13.89 million government grant for R&D on electric vehicles, following the development of 320 prototype vehicles to transport visitors around the grounds of the Tokyo World's Fair.

Why has the U. S. experienced such problems with innovation? Many EV buffs are convinced that the shadow cast on their progress is one made by "the oil companies—a lobby for which there is no counterpart in Europe and Japan."

development of high-power transistors with collector currents as high as 500 amperes so that the company's urban-vehicle controller can achieve economies as high as 80% in labor costs by replacing 33 components with no more than four or five that could cost 20% less. Margrain says he believes such components will be developed for use as choppers in EV speed-drive systems. Ragonot's prototype urban-vehicle controller has 11 independent power blocks, each consisting of three parallel transistors, driven in a Darlington assembly by a fourth. The problem, says Margrain, is the cost and complexity of the circuitry, as well as the associated problems of getting so many transistors to work in parallel.

Systems. Though most Americans concede that EV applications are more advanced in Europe and Japan—where gasoline prices have always been higher and the distances between cities comparatively shorter than in the U.S.—the belief that the higher level of American systems-engineering expertise may prove an advantage in the long run.

While all participants acknowledged that the limitations of battery technology are still the biggest handicap facing EV programs, Edward E. David Jr., Gould Inc.'s executive vice president for R&D, condemned the lack of system design. The former Science Adviser to the President said: "On-road truck and passenger vehicles are not realities today [because] too little effort has been spent optimizing electric vehicles from a total systems standpoint. Until recently, most electric vehicles were developed by removing an internal-combustion engine from an existing vehicle and adding standard batteries, motors, and controls. That is not adequate, and we now see that for a lead-acid battery to support broader vehicle applications, we must optimize all portions of the vehicle" before it can be economically marketed and manufactured.

That view was echoed by Siemens AG's Rudolf Wagner, who observed that "we EEs are technically inferior to machinery designers" in the automotive industry when it comes to determining with precision the long-range production costs of a mass-produced vehicle. But, Wagner added, "we accept the challenge."

Before an EV can be successfully marketed, much needs to be done to determine accurately the product's reliability and performance data in order "to make decisions on mass production, requiring a very high capital investment." By Wagner's estimate, "at least 10,000 cars will have to be built so that all technical data will be solidly grounded." Moreover, he urged the infant industry to move quickly to develop technical standards, especially in such areas as battery chargers, "so that the electromotive engine does not fail at the start."

Postal program. Some symposium registrants saw a certain irony in that the biggest EV effort in America is being sponsored by the U.S. Postal Service, an agency not ordinarily associated with innovative technology. Of the USPS program to move from 30 prototypes to 300 operational electrically powered postal vans in one bound, one Briton said, "a very, very brave jump indeed." Building even 100 vehicles "is enough to drive anybody mad," he argued, warning that "problems are going to exist" in the program because "none of the companies operating in the U.S. could expect to build even 10 vehicles at anything resembling real cost."

Westinghouse Electric Corp.'s Pittsburgh R&D Center identified some of the EV postal-route requirements in that city, reported a team of its specialists at the meeting. On three routes, mileage requirements varied from 12.3 to 28. Stops and starts totaled 375 on the longest run and 477 on the shortest. Kilowatt hours per mission ranged from 8.75 to 15.1, according to the study.

Are these and other proposed electric vehicles efficient? For the long term, the answer is a definite "yes," according to analyses by Westinghouse and others. In a study by Westinghouse's A. H. Long and three of his colleagues, the comparative costs per mile for an EV in 1973 were already competitive with conventional cars. They are 18.7 and 18.5 cents, respectively, on the basis of combined fixed and variable costs. And, as U.S. gasoline costs rise and emission-control systems continue to reduce the mileage per gallon, the Westinghouse study estimates that internal-combustion vehicle costs will nearly double by 1983 to 33.3 cents per mile. □

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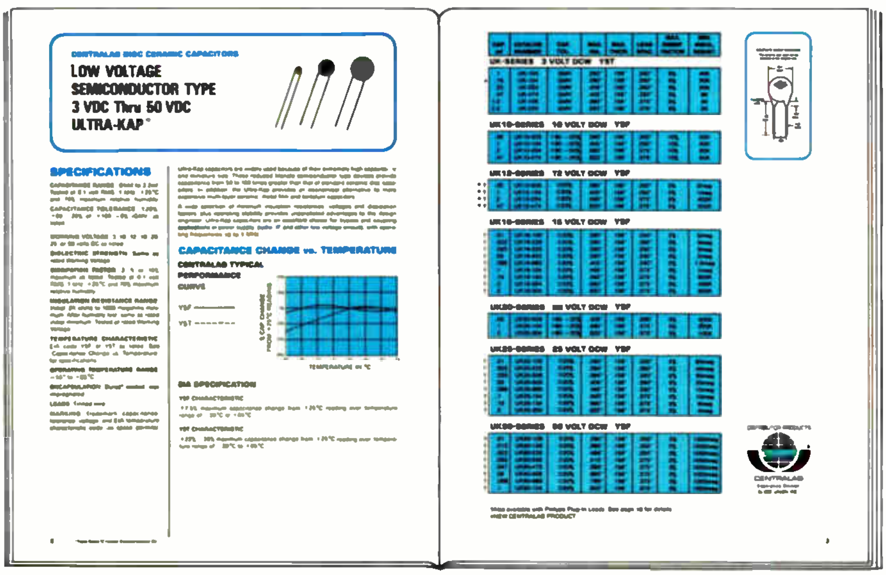

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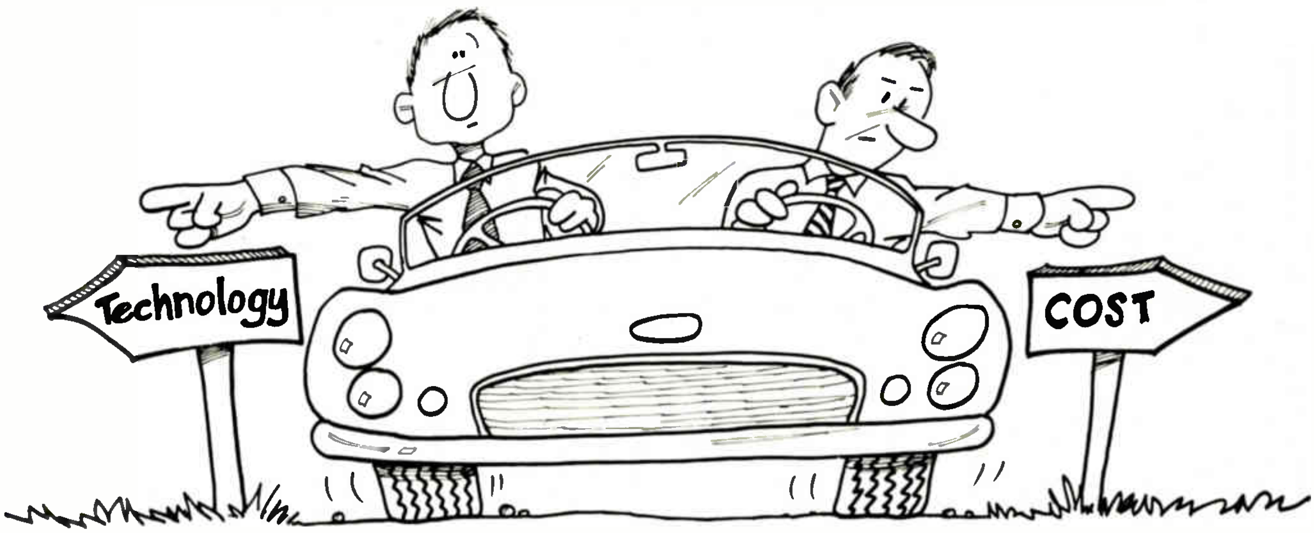

Automotive electronics

Is electronics heading wrong way?

Auto makers complain that semiconductor devices for cars need to be more cost-effective and more reliable

by Lawrence Curran, Managing Editor, News

In the eyes of the automobile industry, semiconductor manufacturers still have a long way to go both in understanding the penny-watching economics of the auto makers and in demonstrating that semiconductor devices are reliable enough for automotive use. Those were two of the salient points made at a panel entitled "Automotive Electronics Revisited," during the International Solid State Circuits Conference last month in Philadelphia, and at a follow-up discussion there with *Electronics* editors.

Auto company representatives stressed, too, that reliability and economics are tightly intertwined in their industry—the auto manufacturer has to pay not only for the electronic systems but also for their service during that part of a car's life that's under warranty.

Regarding reliability, the auto spokesmen said flatly that they don't want to pay for any bad semiconductor devices. Their reliability requirements are often more stringent than those in the aerospace industry, they maintain, where semiconductor suppliers have become accustomed to talking with their customers about "lot tolerance percent defective" levels— the acceptable percentage of defective parts in a lot. Automotive manufacturers have no such tolerance. John Webster, manager of electronic-product development at Chrysler's Huntsville, Ala., division, perhaps best crystallizes his industry's view when he says that semiconductor manufacturers have to learn to subscribe to the "childish simplification" embodied in a grocery-store analogy.

Economics. Says Webster, "If you buy a 50-pound bag of potatoes and you get three bad potatoes, you can take them back, and that groceryman will give you three new ones. He'll do it happily because he wants you to come back again." By the same token, Webster says, if a semiconductor supplier "is shipping us half of 1% bad parts and we're buying 20 million of them, he can forget about doing business with us the next time around."

Frank E. Jaumot Jr., director of research and engineering at the Delco Electronics division of General Motors Corp., Kokomo, Ind., also hammered at economics to his ISSCC panel audience when he said that automotive manufacturers still aren't necessarily enamored of electronic systems. If the choice is between an electronic solution to a problem and a cheaper mechanical or electromechanical solution, the auto maker will pick the cheaper unit.

Jaumot, though, made the point that electronic systems are beginning to prove their value in systems where considerable experience has been gained. For example, Jaumot says, electronic ignition systems have 1% of the failures of their mechanical predecessors. "The problem with the electronic-ignition system," Jaumot says, "is that the failure is usually catastrophic; it's a tow-in job 40% of the time," whereas the mechanical system degrades slowly.

Chrysler's Webster agrees that switching to electronics for the ignition system, which Chrysler pioneered and now is installing in all its autos, has cut the failure rate in that system. At Chrysler, there have been about 20% fewer electronic failures than the mechanical systems had, although the age-old problem of semiconductor "infant mortality" still haunts users (see "Electronic ignition: the first 100 miles").

At West Germany's Volkswagenwerk AG in Wolfsburg, the use of electronic fuel-injection systems gives fewer failures—70% fewer—than the old carburetor, says Klaus Stamm, of Volkswagen's research-and-development staff. Stamm says, though, that failures in the electronic-injection system are 2.3 times more costly to repair.

Unfulfilled promise. Further, says Stamm, the advance billing of greater reliability for integrated circuits promised by their manufacturers hasn't proved out. Some 25% of the failures in Volkswagen flashing warning lights have been traced to faulty integrated circuits. Nevertheless, Volkswagenwerk is going to an injection system that is more fully integrated than the original. The new version, made by Robert Bosch GmbH, uses three ICs and a total of 80 electronic components, compared with 300 discrete components in the original.

The toughest lesson for the semiconductor industry in dealing with Detroit, Chrysler's Webster believes, is to learn that automotive manufacturers aren't going to change their way of operating to accommodate the semiconductor manufacturer; the reverse will have to happen.

Regarding Detroit, Webster says "They've been building cars for lots of years, and they really know what they're talking about. They're almost unbelievable in their demands from the economic standpoint." With a car that contains all kinds of combinations of options—a lot of them involving electronics—coming off production lines each minute, the auto makers have to make sure that parts are available at the lowest possible price. "The rest of us have to do it their way, and that's true of electronics, as well," Webster emphasizes.

For ICs, Chrysler's Huntsville division has worked out a sampling plan that applies an acceptable quality limit (AQL) of 0.15 until experience is gained with a given semiconductor maker. Then if he's found to be delivering good parts, the AQL level is cut back so that fewer of those parts are tested. An AQL level of 0.15 means one bad device in 315, "and that's pretty mean," Webster admits.

The AQL challenge. For their part, panelists representing the semiconductor industry aren't wild about working under the shadow of such stringent demands as that AQL level or the need to supply huge volumes on a fast-turnaround basis (which happened with seat-belt-interlock systems for 1974 models).

Will Steffe, analog design manager at Fairchild Semiconductor, observed, "We may argue about whether we'd want to sign a contract with that AQL number in hard, black writing." William Davis, who is responsible for design engineering for consumer, linear, and non-entertainment products at Motorola's Semiconductor Products division, argues for more understanding of semiconductor cycle times on the part of automotive manufacturers, just as semiconductor makers must realize that Detroit won't stop production lines because promised devices aren't there.

We have a problem with cycle times, too," Davis says. "It takes a certain amount of development time, mask time, and production time to get the material through and get it out. We don't feel they really understand that."

Robert Hood, Fairchild's manager of automotive systems engineering, says the problem in the auto industry "is that the underlying concept is, 'All right. Today, let's shoot the designer and go into production,' and that's not the best thing to do—either from a cost or reliability standpoint. How we all learn to grapple with that over the coming years is going to be interesting." □

Electronic ignition: the first 100 miles

Chrysler statistics show that the first 100 miles are the riskiest for electronic-ignition systems. In fact, during the first 10 miles, there is a substantial semiconductor "infant-mortality" rate. For more than 6,000 failed systems from a total of about 2 million produced for a given model year, 24% of them failed in the first 100 miles, and 15% of those failures happened in the first 10 miles of driving.

Interestingly, almost half the units that came back to the dealer as faulty turned out to be functioning properly, but, of the true failures, 78% resulted from component failures, "most of which were semiconductor failures," says John Webster, manager of electronic-product development at Chrysler's Huntsville, Ala., division.

'Self-repairing' seat-belt systems

Little statistical data has been gathered by automotive companies on seat-belt interlocks because the systems still haven't been in the field long enough. Delco's Frank Jaumot Jr. says Delco itself had to supply far more semiconductor devices than it had expected because outside suppliers were late with deliveries. But now that large quantities are coming from the semiconductor industry, he's pleased that the solid-state industry "really turned to on seat-belt systems and really put the relay people down." GM had designed a backup relay system for use if semiconductor suppliers dropped the ball, but it wasn't needed.

One reason, though, that few statistics are available on seat-belt-system failures, says Chrysler's John Webster, is that if the system fails, yet the car still runs, "we'll never hear about it. Out numbers are unbelievable at this point. Our digital clocks weren't that good, and they use the same C-MOS technology." Besides he says, "the seat belt is a self-repairing system." By that, Webster means that consumers are finding ways to disable what many regard as a nuisance, even though the system is a federally mandated safety feature.

Computers

Unidata starts long climb upward

European computer combine must deal with problems of nationalism as it prepares to do battle with the dominant IBM

by James Smith, McGraw-Hill World News

On Jan. 15 the nameplate came down on the headquarters of Siemens Data SpA at Via Fabio Filzi 25A, Milan, and a new sign went up announcing Unidata—the tripartite company formed by Philips, Siemens, and CII to cut into IBM's domination of Europe. The event, repeated in Spain, Belgium, the Netherlands, Austria, and elsewhere, coincided with introduction of the 7720, the first computer in Unidata's new line of five or six machines.

Six months after its formation, Unidata seemed on the right track: A troika of managers from the parent firms was presiding over working sales offices in seven countries, a second machine was scheduled to appear in a few months, and the group was working on an advanced second-generation lineup. But as good as this record is, setting up a transnational European rival to IBM and other American firms isn't easy. Competitors are predicting Unidata will have to do a lot more before its success is certain. For example, a squabble over French contributions, only just settled, threatened to break up Unidata at the start.

So far, the organization is not much more than a sales operation directly headed by a three-member board of management consisting of the president of CII (Compagnie Internationale pour l'Informatique) and the heads of the Philips and Siemens data divisions. Many of the sales operations are still not formally incorporated, and some consist mainly of changes of the name on the door.

Accommodating various market shares is probably the least of Unidata's worries. Any real merger of sales operations involves tremendous fiscal, managerial, and psychological problems. In addition, Unidata must step into a maze of contracts and offers made by the original sales organizations and persuade customers to accept Unidata.

With such complications on the marketing side, it is not surprising that Unidata has scarcely broached the possibility of eventual fusion of production facilities—the area in which Common Market Commission experts estimate that real operating efficiencies lie. While Unidata's management board has direct control over selling operations, it has merely coordinating control over supply centers, which in the foreseeable future will remain in the hands of the partner companies.

Research and development, plus investment in production, is apparently left largely to each individual partner. Unidata's role is to coordinate development of software and hardware and to negotiate production contracts for specific machines.

Moreover, while the partners may effect some economies by phasing out overlapping machines in their existing lines, little production rationalization is probable on the present generation of machines, the technologies of which are essentially different. The Unidata 7720, for example, is basically the P2000, designed by Philips.

Subsidies. In addition, government subsidies to the various national partners present another obstacle to merger that the complicated Unidata formula does not seem likely to overcome. French partner CII, expected to build two of the eventual five or six Unidata units, will get the bulk of the funds for its Unidata R&D commitments this year from the French government's Délégation à l'Informatique

Split. In Germany, to protect Philips' share of office-computer market, there will be two companies. One will be 80% owned by Philips with the rest in the hands of a planned holding company. The second, for medium and large units, will be controlled by Siemens. In the French setup, to be in existence by the end of this year or early '75, CII will have the 80%.

WHO OWNS UNIDATA?
(BY %)

	Philips	Siemens	CII	Holding
West Germany	80	–	–	20
West Germany	–	80	–	20
France	–	–	80	20
France	80	–	–	20
Holland	67	13	–	20
Spain	20	40	40	–

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as part of the Plan Calcul. Says a Siemens man, "Care must be taken to see that these funds don't wind up with German and Dutch partners."

On the other hand, such financial backing cuts both ways. Most governments subsidize the local computer industry in some fashion. In Belgium, for example, the government takes 50% of its hardware needs from Philips and Siemens, in return for which both firms operate manufacturing facilities in the country. French public authorities have earmarked $160 million from 1971 through 1975 for hardware under the Plan Calcul. And Germany will spend more than $200 million in the same period. Taken together, such funds would make a tidy subsidy if they are directed mainly toward Unidata efforts.

What's more, the French government has favored CII extensively through its buying policy. Early last year, CII equipment amounted to 26% of the hardware installed in government administrations, compared to 16% the year before. At the same time, shares of Honeywell-Bull and IBM went down slightly. In Italy, the government tie-in, which accounts for nearly half of all investment spending, is not expected to hurt Unidata in the least. Aldo Carlevaro, one of the three sales managers of Unidata SpA, estimates the group will get 30% of its future sales from government and public administration uses, and another 20% on the local level.

The blandishments of government assistance are not lost on Unidata's U.S. competitors. Honeywell-Bull's French president Jean-Pierre Brulé and Univac's top executives have clearly stated they would like to do business in Europe under Unidata's colors. As John C. Butler, head of Univac's European operations, puts it, "We are aware that in the future we will find ourselves between the hammer [IBM] and the anvil [Unidata], since Europe will certainly become more and more nationalistic. Thus, it is our intention to seek a solution through assisting a European company to combat IBM's dominant position."

U.S. out. So far, any participation by U.S. firms has been vetoed by the French government. As the French partners in Unidata see it, every effort has to be made to get Britain's ICL (International Computers Ltd.) into the combine.

"It will take five years to build such a European company," says a senior French-government source, "and only when it exists will we discuss anything with possible international partners. Any talks before

The British are coming

All concerned agree that Unidata would be playing a much stronger hand if it could add a fourth to the three computer makers that have combined to form the new super-company. The fourth they have in mind is Great Britain's International Computers Ltd.

Although the president of Compagnie Internationale pour l'Informatique, Michel Barré, says that discussions with ICL are under way, what is happening seems to be a replay of French and British failure to reach agreement two years ago. As Common Market Commission sources note, ICL's line is not compatible with those of the three partners, and ICL is interested in keeping things that way to protect its 35% share of the British market.

Joining Unidata, whose machines are compatible with IBM hardware, would simply expose it to the U.S. giant. What's more, the British, fresh from success in East European markets, are now preparing an attack on West Europe. "ICL's machines are competitive with Siemens' upper line, and as far as use is concerned, they can substitute for the IRIS, CII's line," says a Brussels consultant.

Some industry experts think the British company can easily get 10% of the existing European market share in France and Germany in the next five years—the time in which Unidata is expected to take to develop its second-generation line. A Philips Electrologica spokesman declines to call the contacts with ICL "negotiations." "There is no base for negotiations," he says flatly. "And the British market is heavily protected."

that stage with non-European companies would mean the failure of the all-European effort. We do not want such a solution."

The question of American participation may be the first ripple of a major disagreement between Unidata's partners. Though Unidata's sales figures—about $700 million by the three partners—and number of installed computers—17,000 machines—look good on paper, the fact is the combine, with 8% of European sales compared to 13% for Honeywell-Bull and 60% for IBM, is just on the borderline of what experts consider economically sound.

"We would favor contact with anyone, including the Americans, provided they have a similar base," says a spokesman for Philips Electrologica, the Dutch giant's computer arm. Even CII's big private shareholder, Compagnie Générale d'Electricité, wants a U.S. link to promote the viability of the group before investing the additional funds needed to meet CII's Unidata research commitments. The furor over CGE's reluctance to put up its share of the needed investment money threatened to break up Unidata before it got off the ground, and was settled only the last week in February by the French government's willingness to increase to $52 million the amount required to carry CII through this year.

Unconcerned. Officially at least, CII's partners do not seem bothered by the French firm's problems. "No company can pull out," explains a Siemens official, "because they would be left with a torso—one or two machines—without a complete line. The longer Unidata lasts, the greater the momentum built up."

Even if Unidata gets the size it needs and manages to rationalize its production, other problems may still exist. Computer experts say Siemens, which relied heavily on its old license ties with RCA to beef up its research and development, may gradually move out of the mainframe business and broaden its telecommunications activities.

CII, anchored to large machines, might stand to broaden its market penetration outside France, where it has practically no presence. But the main partner to benefit from Unidata, according to this argument, would be Philips. The giant would gain the market needed to develop its general-purpose computer line—which thus far seems to be losing about $70 million a year.

Not everyone agrees. One of Unidata's Italian competitors sees the 7720 as a further design of the Siemens 4004—a point which Unidata hotly disputes—and he thinks Siemens may come out ahead.

In either case, the French firm, which is by far the smallest of the triumvirate, when measured in total sales, appears likely to be on the short end. That prospect may already be troubling some of CII's non-government shareholders. If and when the Dutch or Germans start getting most of the benefits, what will happen to French-government participation? □

Circle 79 on reader service card

Production

Changing MOS wafers in 36 hours

Western Digital uses special equipment and facilities to cut time from the usual weeks or, in—some cases—months

by Paul Franson, Los Angeles bureau manager

Making changes in MOS masks can delay production for weeks or even months. That's what motivated a three-year-old MOS firm in Newport Beach, Calif., using some ingenuity and modifications of tools that are readily available, to cut that time down to 36 hours and sometimes even less.

The company, Western Digital Corp., uses a combination of tailored equipment, in-house facilities, and carefully thought-out procedures to effect the dramatic saving in time. William Roberts, vice president for R&D, says that, while several factors enable Western Digital to respond so quickly, the most important is its use of a photoplotter, rather than rubylith masks. Other important contributors are a much-modified Applicon design system and the fact that the company has its own mask shop.

Perhaps the most interesting aspect of Western Digital's system isn't so much that it is unique, but rather that the company has attacked the time problem and licked it to the extent that president Alvin B. Phillips can declare flatly, "We have the world's fastest system."

The photoplotter is perhaps the key to the process. The company uses an inexpensive ($38,000 original price) machine from the Gyrex Corp. rather than the more common $300,000 David Mann photomask maker. Roberts points out that the Gyrex machine wasn't designed for LSI work—it was originally intended for circuit boards—and doesn't have anywhere near the resolution of the Mann machine. But "it turns out that we don't need it," says Roberts. "The mask aligners can't align accurately enough to take advantage of the Mann's capability."

Western Digital has modified the Gyrex machine substantially. It is controlled by cassettes generated by a Digital Equipment Corp. PDP-11, rather than the paper tape originally used. Richard Perrin, manager of product design engineering, says: "We took the Gyrex controller out of the loop. We use ramping techniques that give a 3-to-1 improvement in speed over the paper tape, and, in the process, eliminated many errors that resulted from use of the paper."

Along with the photoplotter comes another practice that is unusual for Western Digital, a small semiconductor firm: The company

The shrewd timing of Western Digital

Western Digital started in business at what is considered a terrible time by most standards—April 22, 1970, in the midst of the worst slump ever to hit the semiconductor business. However, the company's progress since then has been most impressive. The latest figures show $3.5 million in sales and 25% pretax profits in the quarter ended Dec. 31. This is almost three times the sales of the corresponding 1972 quarter. Nevertheless, the chairman and president, Al Phillips (left) gets annoyed when people seem surprised. "It's all according to the plan I established over three years ago," he points out.

Phillips says that the bad times when he started didn't cause problems. It even might have been an advantage. "My business plan said I would lose money for two years, and its realism probably helped me get capital." Emerson Electric made an initial investment of $1.5 million in the company. And the St. Louis parent is happy about the relationship. Says a spokesman: "They're doing very well—in fact, we just added to our equity."

Phillips, who likes to call his own shots, had previously set up and managed the Rockwell Microelectronics facility, and before that, Sylvania's integrated-circuit operation. There he watched the company pioneer in SUHL TTL, then lose its lead to the Texas Instruments 54/7400 series—because, says Phillips, of overly cautious and conservative higher management. He has also worked at Motorola and General Electric.

To get his infant company started,

makes all its own masks from bare glass. This obviously helps turnaround in the present tight market, and Phillips says it gives far better quality and lower cost. The company has even applied for a patent on its techniques.

Cassette control. The Gyrex machine is run from a cassette generated by the Applicon design system. The firm feels that this is also vital—but not for initial layouts. "The aid for us in this computer-aided-design system is in making changes quickly and accurately," says Perrin. He points out that in designing a chip with 100,000 components, it's difficult to avoid a few mistakes, but he feels that the system corrects them fast. The Applicon setup could be used on-line with the Gyrex plotter, but Roberts says that would sacrifice much flexibility just to save some hardware, and it would be especially unfortunate if the system were to break down during mask making.

Western Digital uses manual layout and design initially, since the company feels that the Applicon is "a very expensive drafting machine," says Perrin, adding that people seem to be much better at layout than machines. But the Applicon is used for rote work, such as the repetitive cells in circuits, and to prepare completed segments of the circuits. "The designer thinks; we draw." Input to the Applicon is through an Autotrol digitizer. The company doesn't use standard cells, usually considered a time-saver. "We've gotten away from them," says Perrin. "They work, but they're not dense enough for the high-volume parts we're making."

The initial logic simulation is done by a program Western Digital developed. The Applicon itself operates from a PDP-11, and is one of the first Applicon design systems to use a minicomputer, rather than a large computer. The present system has about 20,000 words of core memory, which will soon be increased to about 28,000, plus a 500-million-word disk memory. This is to be increased to 10 million words, which will permit all current design efforts to be stored and eliminate the need for loading from cassettes each time. A multicolor California Computer Products model 936 high-speed drum plotter is used to generate artwork copies.

Interactive editing. The Applicon CRT interactive terminal is used in the actual editing; Perrin says it's very fast and effective for editing designs. The company also has programs to check design-rule violations, many developed in-house.

Comparing his computer-aided-design process with that of larger firms, Roberts points out that it is a small, dedicated system ready for use. "The bigger a CAD system is, the more cumbersome it is to use. And when we get a tape off the Applicon, we don't worry about it. We know it's good."

Though almost all semiconductor companies talk about fast turnaround, few in practice aspire to times like those of Western Digital. Fast turnaround at most is four to six weeks, and the average may run into months; some can do the job in a week under crisis conditions. Smaller firms generally have to wait in line for outside maskmaking and other services, and at the large companies there is fierce competition for in-house services. And some experts maintain they could do the job faster, but see no real reason for it.

Roberts says that the CAD system will be even more valuable when the company gets into the read-only-memory business; Western Digital will announce shortly an 8,192-bit silicon-gate n-channel ROM. "We expect to be able to go from customer tapes to mask in 12 hours or so," says Roberts. "We will be able to directly generate the cassette for the Gyrex, plus a test program for our Spartan tester. I can't imagine why anyone would get involved with rubies for ROMs, but I know many companies are trying to do it that way. The result is weeks or months of delay. We'll have parts in a few days." □

Phillips picked a new technology. He settled on silicon-gate technology, even though it is a more difficult process than the more popular aluminum-gate technology. He concentrated on that one process: "Companies that try to do too much get poor yields." The process has been p-channel, but a compatible n-channel variation will shortly be added for 4,096-bit random-access memory and microprocessor chips.

Initially, the company concentrated on calculator chips with a contract from Ise Electronics of Japan to get things under way. Now, Phillips is looking for 25% of the U.S. personal-calculator-chip market this year with its "chipstick" eight-digit, floating-decimal-point circuit with memory. This part is being sold in large quantity to Bowmar and Commodore, two of the three largest calculator companies (the other is TI), and others. This would rank Western Digital among the top chip suppliers, with TI, Rockwell, and MOS Technology Inc. But unlike the first two, Phillips has no plans to go into the end-user-equipment business—except to market his Spartan LSI test system, originally developed for in-house use. What is unusual for a small semiconductor company, Western Digital also makes its own masks and molds its own plastic cavity packages. The company also makes custom chips, including units for the 40,000 credit verifiers installed by TRW Data Systems, but its moving away from custom chips to standards. And Western Digital's data communications parts go to more than 600 customers.

For now, Phillips is forecasting sales of $18 million and profits 20% higher than this year; the current order backlog tops $30 million. And the company's first plant expansion is in progress; when Western Digital moved into its present facility three years ago, the building was almost empty, but it's full now and being expanded by one half, to 40,000 square feet. The company is also adding 12,000 square feet in Malaysia.

Phillips is especially happy with his location near Los Angeles and far from Silicon Valley: "Am I glad we're not there! Labor is scarce up there, and there are no secrets and no discipline among workers. Here it's warm, it's close to Newport Beach, where I keep my Islander 29 sailboat, and there's plenty of labor around."

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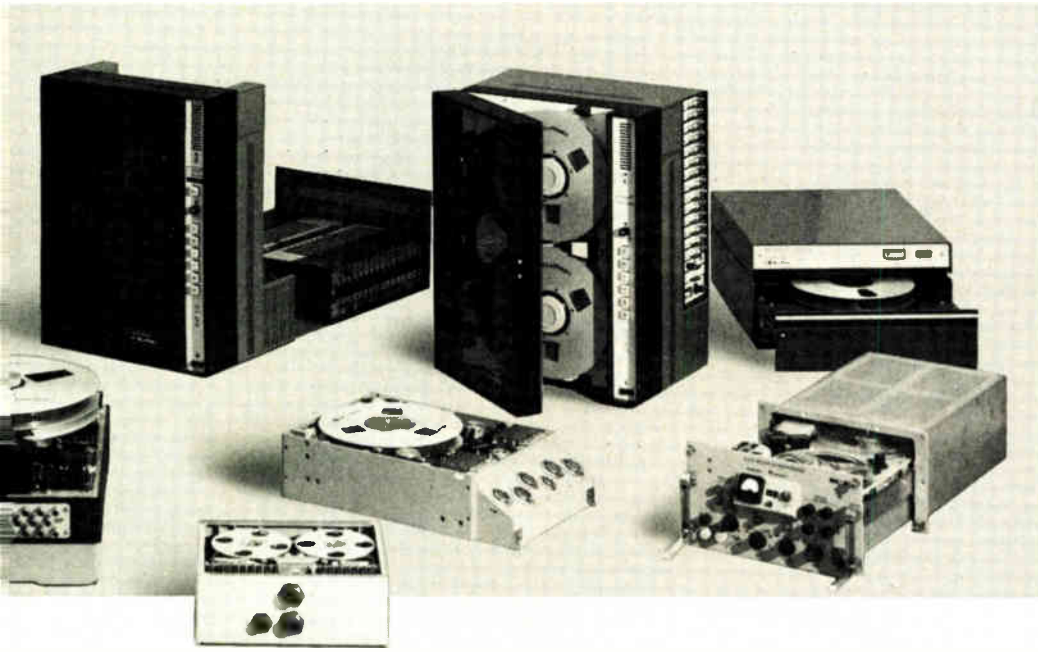
Our CPR-4010 and 4040 bring the lab into the field.

The rough and ready



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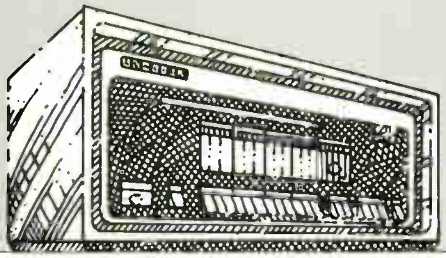

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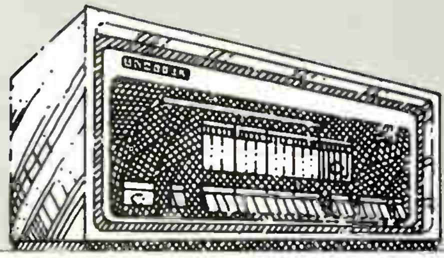

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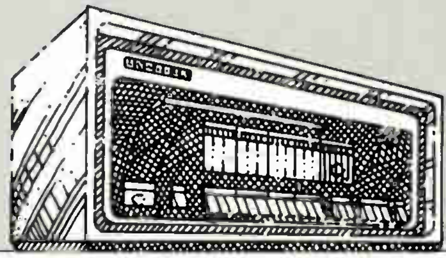

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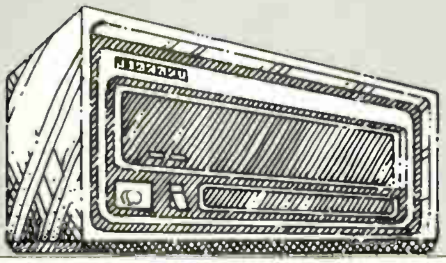

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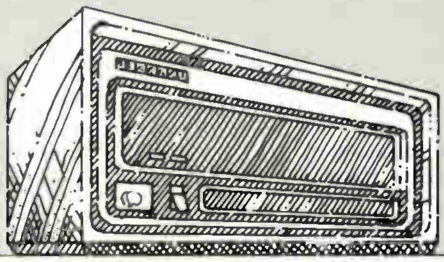

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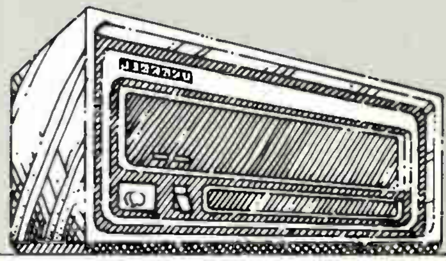

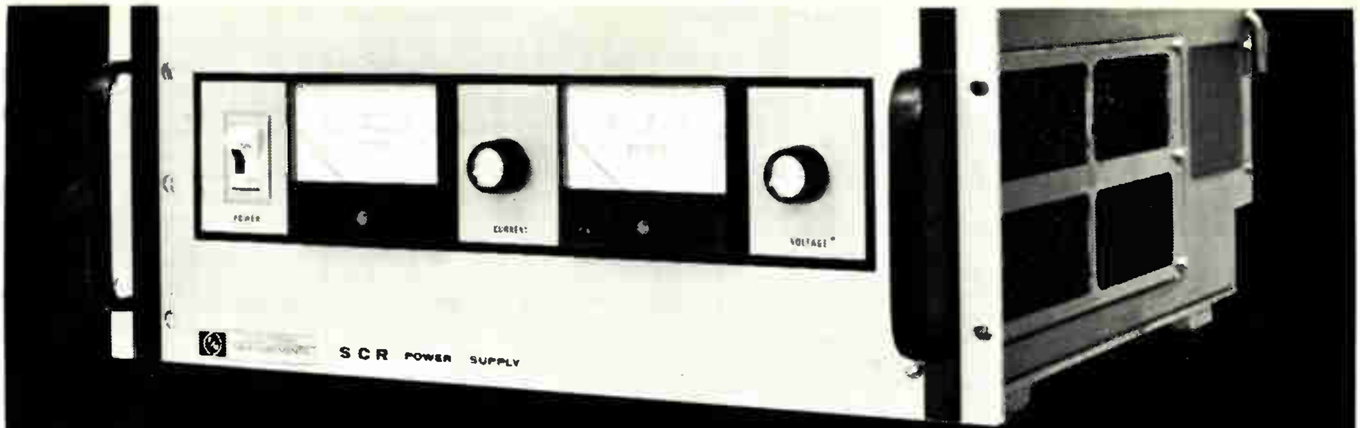

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20V-250A	1,500	1,800
20V-500A	2,300	2,700
30V-100A	1,100	1,300
30V-200A	1,500	1,800
40V-60A	1,100	1,300

	Price	
Rating	EM	SCR
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40V-250A	2,100	2,500
50V-200A	2,300	2,700
80V-30A	1,100	1,300
80V-60A	1,400	1,700
100-100A	2,300	2,700
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160V-60A	2,100	2,500
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Plasma's progress: gas-discharge technology moves into analog realm

Screen-printing and internal-address techniques used in digital displays are combined to form a digitally addressed analog bar graph with no moving parts; 200-segment bars yield a resolution of 0.5%

by Richard Saxon, *Burroughs Corp., Electronic Components Division, Plainfield, N. J.*

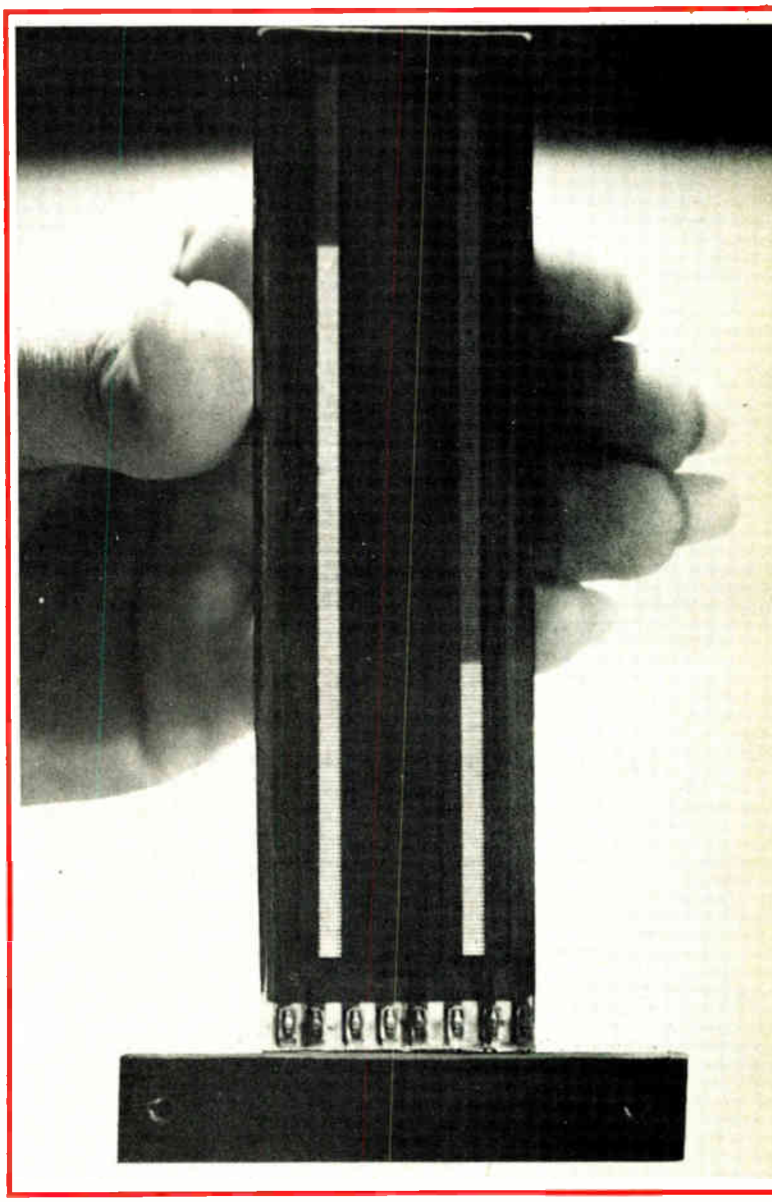
☐ Despite all the brouhaha reverberating through industry about the relative merits of light-emitting diodes, liquid crystals, electrochromics, and other exotic display technologies, many of the most successful displays in use today are of the gas-discharge variety. Not only is this technology doing well commercially, it is also advancing at an unprecedented rate on a technological level. In fact, more progress has been made in developing new gas-discharge products and processes during the past two years than had been made in the preceding 10. Large message-display panels have become a reality, multicolored displays are just coming out of the laboratory into limited production, and compatibility with MOS drivers has been achieved.

One of the most exciting new developments in this area is a digitally addressed Self-Scan (a registered trade mark of Burroughs Corp.) analog bar-graph display (Fig. 1). Unlike the electromechanical indicating devices it is designed to replace, the new display has no moving parts. A combination of the screen-printing technique used in the manufacture of Panaplex (a trademark of Burroughs Corp.) II display panels, and the simplicity of the internal-address drive circuitry in the Self-Scan panels has made possible an extensive family of extremely rugged, low-cost, linear indicating devices.

The first in the series of new displays is a flat panel containing two separate bar graphs. Each bar is composed of 200 closely spaced segments so that, at normal viewing distances, the glowing segments blend into a continuous, but precisely controlled, bar length.

The display is designed to be used in a scan mode, with a cathode-drive circuit common to both channels. Corresponding segments of both bars are bused together in a three-phase configuration with two independent anodes and separate reset cathodes (Fig. 2). These techniques enable only six active drivers to operate both channels. If more than two channels are needed, it is a simple matter to add additional panels. The cathodes of the new panel or panels are simply connected in parallel with the old ones, and a new driver is provided for each new anode.

Since each element represents a discrete, reproducible display step, each segment of the display is directly



1. Glowing. Digitally addressed analog bar-graph display has no moving parts. Each bar contains 200 segments, providing 0.5% resolution. Only six transistors are needed to drive the device.

The many faces of gas discharge

Burroughs' new bar-graph display is only one manifestation of recent progress in gas-discharge readouts. Large panels having as many as 250,000 display cells have been developed, as have devices capable of producing a full spectrum of colors. Some displays, such as the Digivue panel made by Owens-Illinois, even have an inherent storage capability that eliminates the need for a refresh memory, while others allow the production of precisely controlled gray scales.

Gas-discharge panels are particularly well suited for large displays with variable brightness because of the ease with which large numbers of cells can be matched for both optical and electrical parameters. Unlike light-emitting diodes, which must be individually selected for brightness matching and which may match at one drive current and not at another, the cells in a gas-discharge panel are inherently well matched. In a typical device, the cells are all enclosed in a common envelope with a common fill gas. When the panel is operated so that each cell is turned on for a length of time that is long, compared with its ionization time, the slight variations in ionization time caused by minor geometrical variations are not important, and all of the cells in a panel can be regarded as identical. The result is that brightness can easily be controlled by varying either the duty cycle or the cell current, with no visible cell-to-cell variation.

Gas-discharge displays have traditionally offered the user a choice of about three colors: neon orange, plus the red and amber hues that can be filtered from it. Now, two techniques for the generation of other colors have been proven feasible.

The first method uses the ultraviolet component of the gas discharge to excite a phosphor coating within the panel to produce visible light. Different colors can be obtained by using different phosphors or by filtering the output of a phosphor that produces white light.

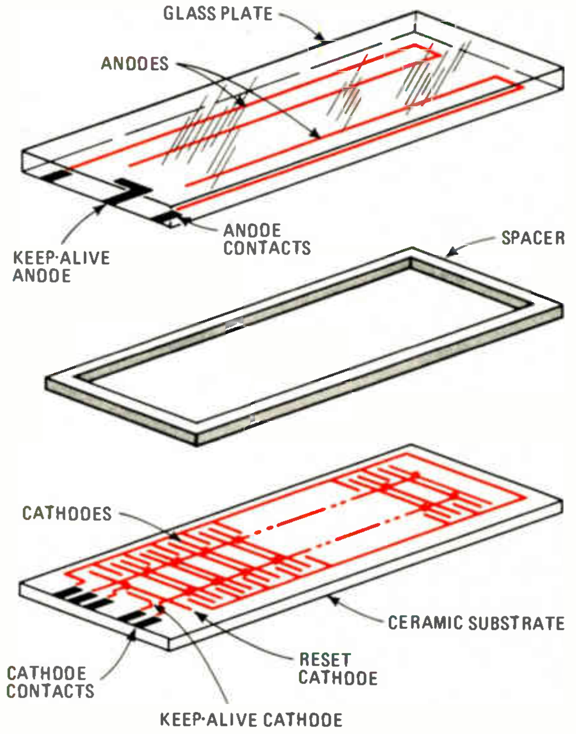
The second method is more versatile and permits color to be changed electronically. With this method, both the ultraviolet and visible outputs of the gas discharge are exploited. At low drive-current levels, very little visible light is produced, but enough ultraviolet is generated to saturate a zinc orthosilicate phosphor, producing a green glow. As the drive current is increased, the visible neon orange emission becomes stronger, changing the display output to red.

Other color combinations beside red-green can be obtained by selecting different phosphor coatings. These can be expected to lead to inexpensive multicolor graphic displays in the not-too-distant future.

relatable to a digital number. For instance, on the 200-segment bar, a digital count of 127 will result in a bar with 127 elements illuminated.

Sandwiching the panel

As shown in Fig. 2, the display consists of a rear ceramic substrate, a spacer, and a glass front plate. The segment-metalization pattern is screened onto the ceramic substrate, as is a black dielectric material that surrounds the metalization. The black material creates a light-absorbent background that enhances the display's contrast ratio. Two transparent conductive anodes are



2. Sandwich. Cathodes comprising bar segment pattern are screened onto ceramic substrate, while transparent anodes are deposited on inside of glass front plate.

applied to the glass front plate, and the rear substrate, spacer, and front plate are then sealed together in a sandwich-like construction. The display is evacuated through a small hole in the back substrate and is then filled with a neon-gas mixture.

In almost every respect, except the shape of the metalization pattern screened onto the substrate, the construction of the display is the same as the construction of the Panaplex II digital display [*Electronics*, April 12, 1973, p. 92].

At first, it may seem impossible to generate 400 discrete bar lengths (2 bars × 200 segments per bar) in a device that has only seven input lines. The trick is to exploit the glow-transfer principle in which the glow is first established at the reset cathode, and then, by using a repetitive scan, the glow is transferred sequentially up to the desired segment height.

When the panel is energized, the current flow between the keep-alive anode and cathode establishes a glow discharge at the keep-alive cathode (Fig. 3). In the vicinity of this glow discharge, there is a heavy concentration of electrons, ions, and metastables*. The area around the keep-alive cathode is open so as to allow the metastables and charged particles to diffuse into the region of the reset cathode.

A three-phase clock with a fourth reset phase controls the transfer of glow along the panel. To initiate a scan, the reset input to the J-K flip-flops is brought to ground potential, which sets both Q outputs of the J-K flip-flops to the logic 1 state and turns off reset transistor Q_1, grounding the reset cathode. The anodes are connected through limiting resistors to the +250-volt power source. When the reset cathode is grounded, the gas is ionized above this single cathode. The glow occurs within a fraction of the 60-μs clock interval because of the presence of the metastables that have diffused into the region from the keep-alive cell.

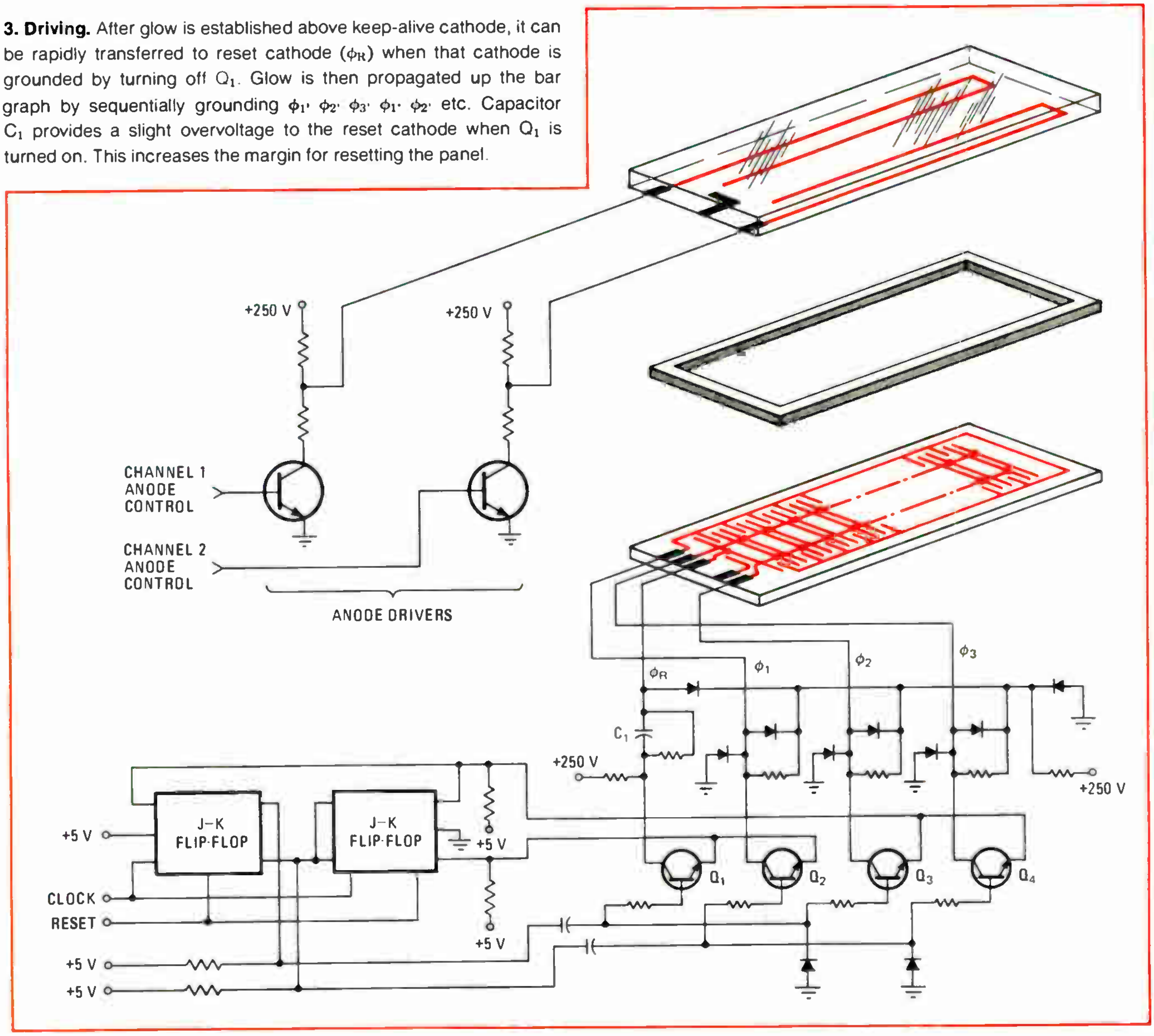
After the gas around the reset cathode is ionized, and the reset pulse is returned to the logic 1 state, the first negative transition of the system clock advances the counter (which is made up of the two J-K flip-flops). The relationship between the reset pulse and the three clock pulses is shown in Fig. 4.

When the counter advances, reset transistor Q_1 is turned off, and transistor Q_2 is turned on. Transistor Q_2, coupled to the phase 1 bus, grounds every third cathode, while the reset cathode is returned to off-bias potential. While the reset cathode is grounded, ionizing particles diffuse along the anode cavity to the adjacent (No. 1) cathode. When the phase 1 cathode is brought to ground, the gas near cathode 1 ionizes very rapidly, while ionization is no longer supported at the reset cathode, since this electrode has been returned to off-bias potential. The rapid transfer of the ionization glow from the reset cathode to cathode 1 is attributable to the high concentration of priming particles near cathode 1.

As soon as a glow is established near cathode 1, the flow of current through the anode-current-limiting resistor reduces the anode voltage to a level that is sufficient to maintain the glow at cathode 1 but too low to cause ionization at any other grounded cathode. In other words, although every third cathode is grounded at the same time, ionization takes place much more rapidly at the primed cathode than at any of the others (Fig. 5). And once it takes place, the anode voltage drops so low that none of the others can ionize at all.

The next clock pulse turns off transistor Q_2 and turns on Q_3. This grounds the phase 2 cathode and returns the phase 1 cathode to the off-bias condition. While ionization was present at the ϕ_1 cathode, the concentration of charged particles was heaviest around the adjacent cathodes (ϕ_R and ϕ_2). When the counter advanced, the ϕ_1 cathode was reset to off-bias potential and the ϕ_2 cathode was grounded. Since the ϕ_R cathode was still at off-bias potential, ionization could not form on the reset

3. Driving. After glow is established above keep-alive cathode, it can be rapidly transferred to reset cathode (ϕ_R) when that cathode is grounded by turning off Q_1. Glow is then propagated up the bar graph by sequentially grounding ϕ_1, ϕ_2, ϕ_3, ϕ_1, ϕ_2, etc. Capacitor C_1 provides a slight overvoltage to the reset cathode when Q_1 is turned on. This increases the margin for resetting the panel.



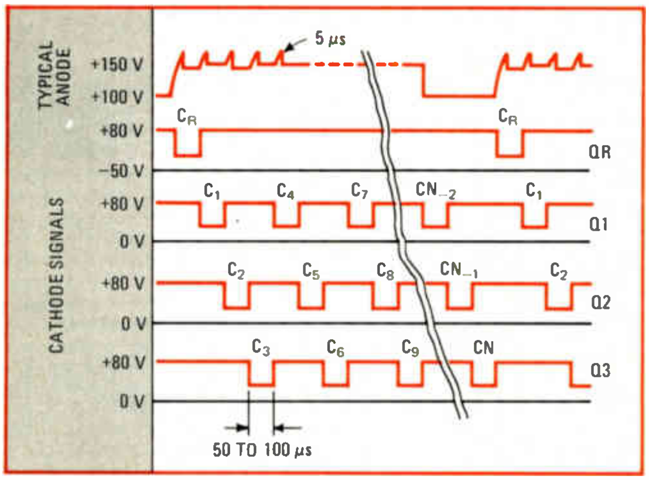
cathode, so the glow is formed on (or transferred to) the ϕ_2 cathode. The next clock pulse turns off transistor Q_3 and turns on transistor Q_4, so that cathode ϕ_2 is returned to off-bias potential and ionization transfers to the preionized, and now grounded, ϕ_3 cathode.

As the counter advances, the cathode buses are sequentially grounded, causing the glow to transfer down the panel. After the glow is transferred to the last cathode in the display, the reset pulse again grounds the ϕ_R cathode, and the scan cycle begins again.

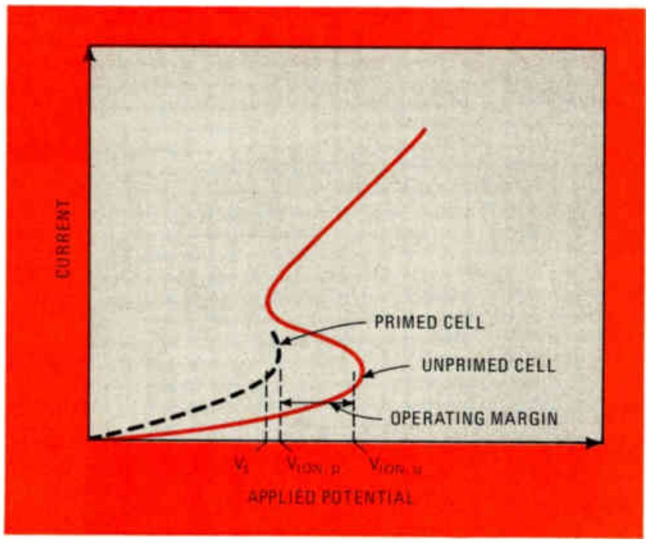
Selecting the scan rate

To eliminate perceptible flicker, the scan rate must exceed approximately 60 Hz. A 60-Hz scan rate requires 16.6 milliseconds per scan; thus, for a 200-element bar graph, each element is turned on for a maximum of approximately 83 μs.

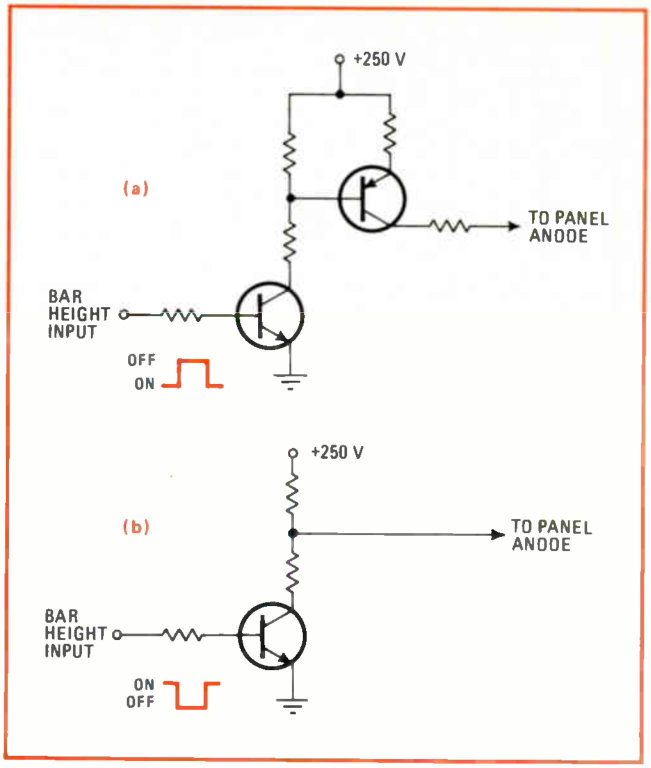
To ascertain if these numbers are reasonable, one must ask what determines the maximum scanning rate of the display. The limiting factor turns out to be the requirement that any cathode that has been ionized and then turned off must remain off long enough to allow the ionization to decay below the level at which it could prime that cathode into firing when it is next turned on. With the three-phase-clock system used in the bar-graph display, each element is on for one clock period and off for two.



4. Timing. Although all cathodes bused to a common driver are activated at the same time, glow only transfers to the one that has been primed by ionizing particles from adjacent glowing segment.



5. Priming. Presence of priming particles not only reduces ionization time, it also cuts ionization voltage from high value of unprimed cell ($V_{ion,u}$) to a value ($V_{ion,p}$) close to the cell sustaining voltage (V_s).



6. Anode drivers. Power-conserving anode driver (a) needs two transistors to control 250-V potential with 5-V logic swing. One-transistor circuit (b) is cheaper, but dissipates power when anode is off.

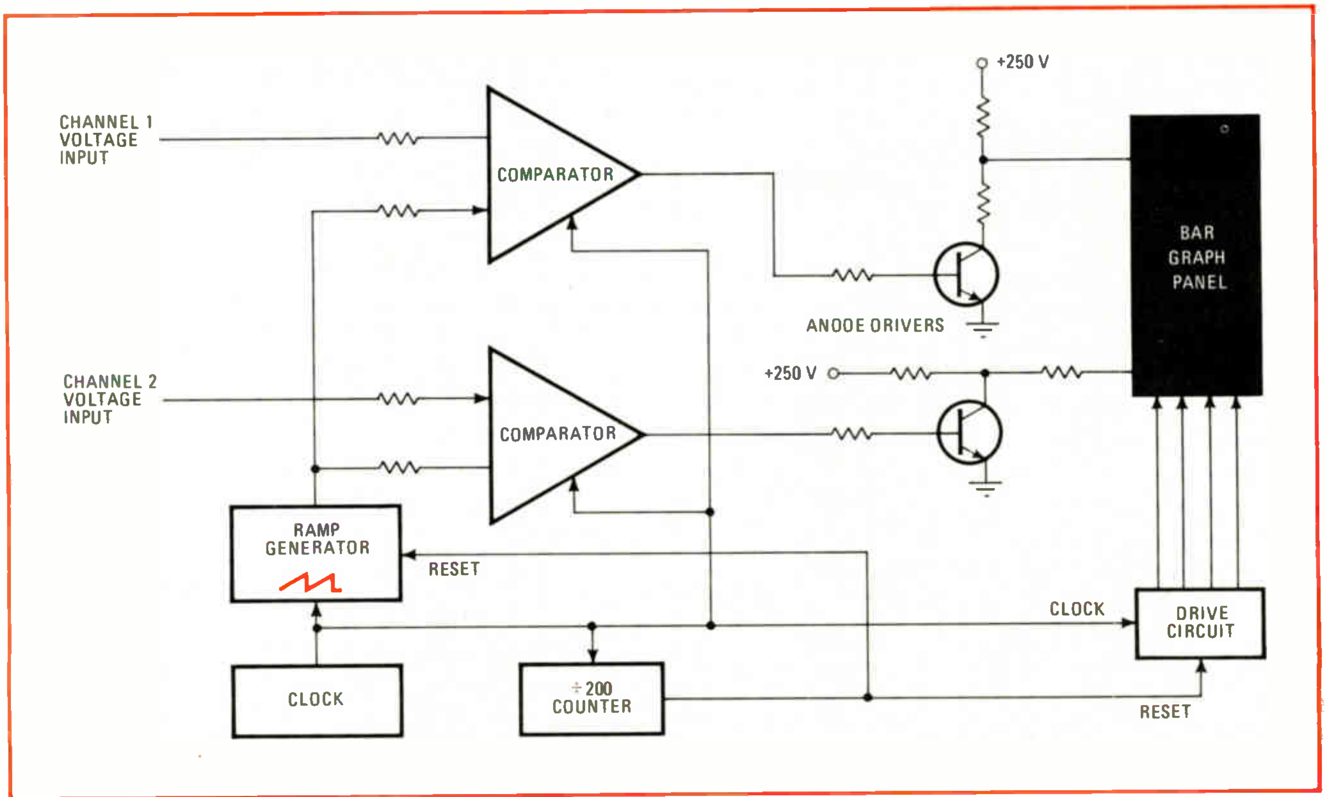
The minimum length of time for which a cathode must remain off is about 80 μs. Since a 60-Hz scan rate implies that each element is on for a maximum of 83 μs and off for 166 μs, there is no problem in making a flicker-free display. In point of fact, the usual scan rate used with the bar-graph display is between 70 Hz and 100 Hz.

The 83-μs figure is a maximum for a full 200-element scan at a 60-Hz rate. This cathode dwell time could be increased for greater brightness when fewer than 200 elements are energized, but the result would be uneven aging of the display. Also, the display brightness would then vary with bar length. For uniform aging and maximum display life, the cathode-dwell time should not exceed the figure determined for a full 200-element scan at the lowest possible rate consistent with a flicker-free display.

Controlling the bar height

As described thus far, the bar graph will always show a full-scale indication. How then does one vary the length of the bar? The answer is to let the cathode drive circuitry continuously scan the entire array of 200 segments and simply turn the anode voltage off when the bar has reached the desired length.

With this approach, a common drive circuit can be used for the cathodes of both bars in the display, al-



7. Comparator display. Typical application of bar-graph display is to compare two or more voltages. Simple setup shown here provides excellent results, since both comparators are driven by same ramp generator. Scheme is easily extended to handle more than two inputs.

though each anode must, of course, be driven separately. On each scan, the anodes are both turned on at the beginning of the rest period, and they are turned off independently when the desired bar heights are reached.

One design for the anode drive circuit makes use of a series pass transistor, either as a saturating switch with an appropriate anode current limiting resistor or, preferably, as a switched-current source. This technique conserves power, but requires either a capacitive or an active level-translator to control the +250 V with the normal logic-voltage swings. An alternative approach utilizes an npn transistor to turn the panel anode off by clamping it to a voltage lower than its sustaining voltage. This latter technique wastes power when the anode is off, but it saves a level-translation stage. Both configurations are illustrated in Fig. 6.

One advantage of this method of determining bar height is that the brightness of the bar does not vary with its length. No matter how long or short the bar is, each segment that is to be turned on at all is turned on for the same length of time as every other energized segment—83 μs for a 60-Hz scan.

Bar graphs are practical

When one considers that the indicator of the familiar analog panel meter moves in a circular arc because it's easier to build that way, not because the world wanted it to have that configuration, one realizes just how attractive a truly linear display can be. For a marine depth sounder, for example, downward is clearly the direction for the bar length to go as the depth increases.

Two applications that are made to order for the bar graph are matching and comparison. If an operator must adjust some controls until two (or more) voltages (flow rates, pressures, or other measurements) are matched, there is probably no simpler way than to adjust them until two adjacent bars are the same length.

Similarly, if a pilot wants to find out at a glance if all four engines of an airplane are equally loaded, what could be easier than a look at an array of four bars? If it is necessary to read off a number to several decimal places, a digital meter is required; but for many applications, the bar graph fills the bill.

A nearly universal comparison setup is shown in Fig. 7. Voltage inputs are shown, but any other quantities could be displayed by putting suitable signal-conditioning circuitry in front of the voltage inputs.

A 50-μs clock controls the three-phase drive circuit and a divide-by-200 counter. When the counter reaches 200, a reset signal energizes the reset cathode on the panel and initiates the ramp generator. The ramp generator starts at zero and is at maximum at a count of 200.

This ramp signal is routed to two comparators whose outputs are connected to the anode drivers. The other comparator inputs are the signals to be monitored. The comparators hold the anode transistors off (the segments glow) until the internally generated ramp voltage reaches the level of the externally applied voltage, when the anode turnoff transistor quenches the glow. □

*Metastables are gas atoms that have been raised to an intermediate energy level from which they cannot return to the ground state without interacting with other particles or the walls of the chamber. If this interaction takes place with an atom of lower ionization energy, then the metastable causes this other atom to ionize. In the panel, the metastables of the neon ionize the atoms of an additive gas upon collision.

T3L achieves C-MOS noise immunity while retaining TTL speed

Inserting a third transistor in a TTL circuit makes the threshold voltage about half the logic swing, or nearly the optimum for noise immunity; drawback of lower density is offset by ease of mixing TTL with T3L

by Werner Fleishhammer, Günter Schneider, and Gerd Koppe, *Siemens AG, Munich, West Germany*

☐ The best things in digital circuits do not come free. For instance, part of the payment Schottky transistor-transistor logic makes for being faster than unclamped TTL is a heightened susceptibility to noise, so that it also requires tighter wiring rules and more attention to grounding and transmission-line problems.

Optimum noise immunity is obtained by digital circuits in which the threshold is in the middle of the logic swing. Complementary metal-oxide-semiconductor (CMOS) logic satisfies this requirement, but the faster, noisier TTL circuits do not. Typically, a TTL threshold voltage of 1.4 volts is only about 37% of the 3.5 V (0.1 to 3.6 V) logic swing, and noise immunity is both asymmetrical and around 1V at a low level, which is only 28% of the logic swing. The percentages are even worse with low-level logic and Schottky-clamped TTL.

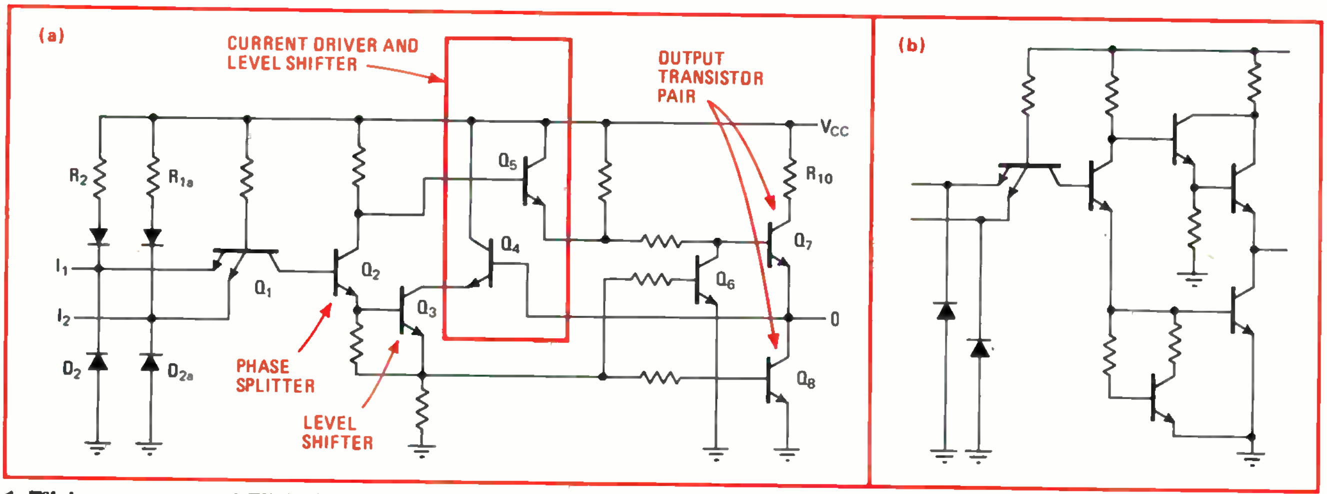
Therefore, a logic family combining C-MOS noise immunity with TTL speed would fill a gap in existing logic families. The lead came from noting that one diode voltage drop of 0.7 V will shift threshold voltage and the logic swing to 2.1 V and 4.2 V (0.1 to 4.3 V), respectively, making the threshold voltage near the optimum 50% of the logic swing. The shift also provides a symmetrical noise immunity range of about 1.7 V, or about 40% of the logic swing. Similar improvements are achieved with Schottky TTL.

Circuits that feature this extra diode drop have been named T^3L here because the input threshold voltage is determined by three base-emitter voltage drops. They were initially developed a few years ago by RCA in the U.S. and later by Siemens AG in Germany.

T^3L circuits feature increased noise immunity, possibly complementary outputs, and slightly higher speed than conventional T^2L. However, these good things also come at a price, both literally—the circuits cost more—and in terms of space—since no T^3L MSI is available at the present time. Consequently, when maximum density and minimum cost are at a premium, T^2L will probably prevail. But, since T^3L can readily be interfaced with T^2L, mixed systems can be designed that exploit the advantages of each family.

How it's done, what it does

Figure 1 shows a T^3L NAND gate alongside a typical T^2L NAND gate. At inputs I_1 and I_2, resistor R_1 and R_2 are provided with clamping diodes D_1 and D_2, allowing unused inputs to be left floating because they are tied internally to V_{cc} through resistors R_1 and R_2. The shifts in threshold level to three base-emitter drops, or 2.1 V, is accomplished by the insertion of transistor Q_3 between the phase-splitting transistor Q_2 and the output transistors. This insertion, coupled with the need for an output voltage of 4.3 V in the high state, required the upper output stage to be modified from the standard



1. T²L to a new power. A T^3L NAND gate and its T^2L counterpart demonstrate the essential differences between the two families. Transistors Q_3, Q_4 and Q_5 provide an extra pn junction drop that improves noise immunity by increasing the gate threshold for the same supply voltage, and also improves switching speed and driving capability. The amount of cell area is only slightly increased.

T^2L configuration. The upper output transistor Q_7 is turned off by Q_6 whenever Q_8 is on.

Two other modifications of the T^2L gate in Fig. 1b should also be noted. They are provided by transistors Q_4 and Q_5, which improve the switching speed and the dynamic current drive capability without increasing static power dissipation. If the output switches from a high to a low level, Q_4 turns on and provides extra current to the base of the lower output transistor Q_8. During switching from a low to a high level, Q_5 turns on and delivers additional base current to the upper output transistor Q_7. The increases in threshold and output voltage is illustrated in the voltage transfer characteristic curve shown in Fig. 2.

The output was designed to deliver full line current while maintaining logic voltage levels in both the low and high states and for 100-ohm lines. At low levels, this is done by having transistor Q_4 turn on transistor Q_8 when the output voltage exceeds 1.6 V. The small resistance of R_{10} allows high-level currents of 33 milliamperes at 2.6 V.

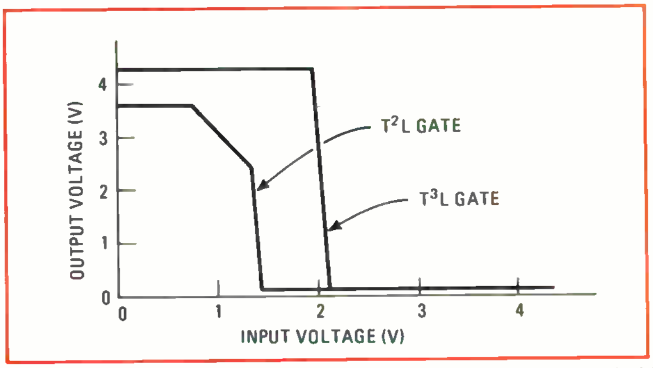
Typical input and output characteristics are shown in Fig. 3. In the low condition (dotted line), the input current is 2.5 mA. One output can typically drive eight T^3L inputs, which compares favorably with the fanout of 10 featured in most T^2L families. The output drive in the low state (dashed line) and in the high condition (solid line) demonstrate its high current drive capabilities. Despite the good drive capabilities and complexity, average power dissipation is only 28 milliwatts per gate, higher than standard T^2L. The typical gate delay time, however, is shorter. For a 50-picofarad load, T^3L has a 14-nanosecond maximum gate delay (10 ns typical) as against the 22 ns of T^2L. The speed-power product of T^3L, however, is about twice as high.

Where it's useful

The ease with which T^3L circuits can be interfaced with the T^2L logic family is illustrated by the hookup schemes in Fig. 4. To drive T^3L by T^2L, all that is necessary is to insert a resistance of 2.2 kilohms to V_{cc} between them. The reverse is even less trouble—T^3L logic needs no extra circuitry to drive T^2L. This makes it easy for a designer to combine in a single system the noise immunity, complementary output and drive capabilities of T^3L with low-cost and high density advantages of standard T^2L.

But the main usefulness of the new logic family lies in the area of design automation. T^3L's higher noise immunity in the low state and its smaller output resistance in the high state allow for simplified techniques of system wiring and the connection of two or more back planes, into each of which many printed-circuit boards may be plugged. Standard T^2L, and especially Schottky T^2L, requires good rf wiring practice utilizing ground planes, power supply decoupling and thorough consideration of line-to-line crosstalk—considerations that are difficult to include in design automation programs. At Siemens, the programs used in developing new systems around T^3L need few electrical restrictions.

To illustrate, within one backplane in a T^3L system, serially wired networks up to 7 feet long can readily be driven. Between different backplanes in a system, flat

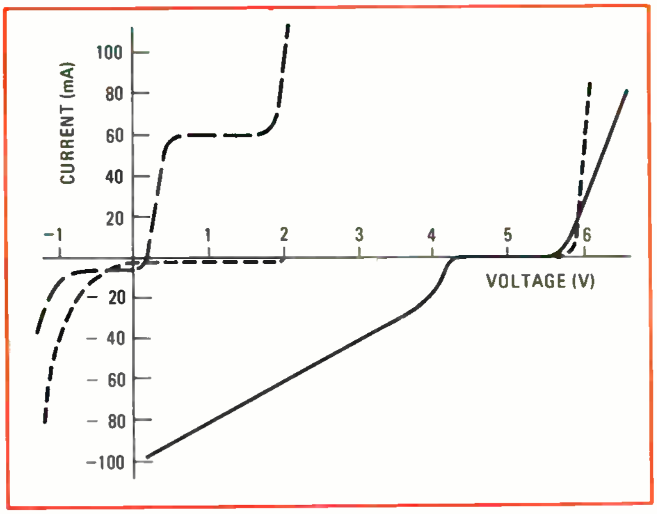


2. An ideal change. For T^3L, both the output voltage and threshold voltage increase by 0.7 V, leading to a threshold voltage that is 48% of the logic swing—almost the optimum for noise immumity.

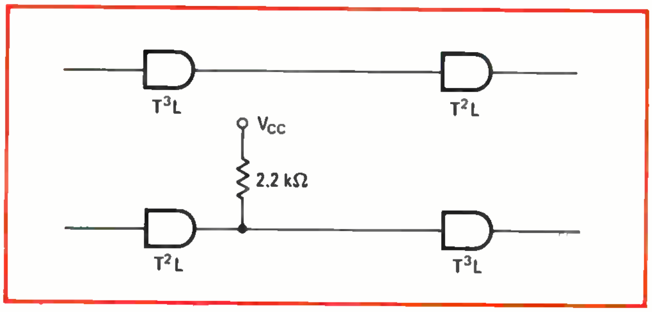
cables with an 100-ohm characteristic impedance can have lengths up to 34 feet without needing the special driving and receiving gates and line terminations that T^2L circuits would require.

At high speeds and for longer-line lengths, however, careful consideration of noise margins becomes critical. Three factors cause a device in the low state to suffer more from noise than when in the high state. First, ground noise is larger. Second, distortion due to reflection is also larger, since the voltage swing of the propagating signal wave is higher for the falling than for the rising edge. Third, the signal level of the falling edge deteriorates along the line because of the resistive component of the input impedance of the load gate circuitry.

Unlike T^2L, which has a lower noise margin at the low level than at the high level, T^3L has a higher noise margin in the low state. T^3L's low output resistance in the high state eliminates pedestal problems with the signals pulse's leading edge causing spurious triggering. When a long line is driven by one T^3L circuit, the signal swing is large enough for all gates on the line to be switched by the initially propagating signal. Thus a satisfactory noise margin is provided at every point of the line. Voltage induced by one line connecting logic circuits in an-



3. Current-voltage characteristics. Input current versus voltage (dotted line) is about 2.5 mA in the low state. Output low voltage (dashed line) and high voltage (solid line) versus current demonstrate drive capability of T^3L.



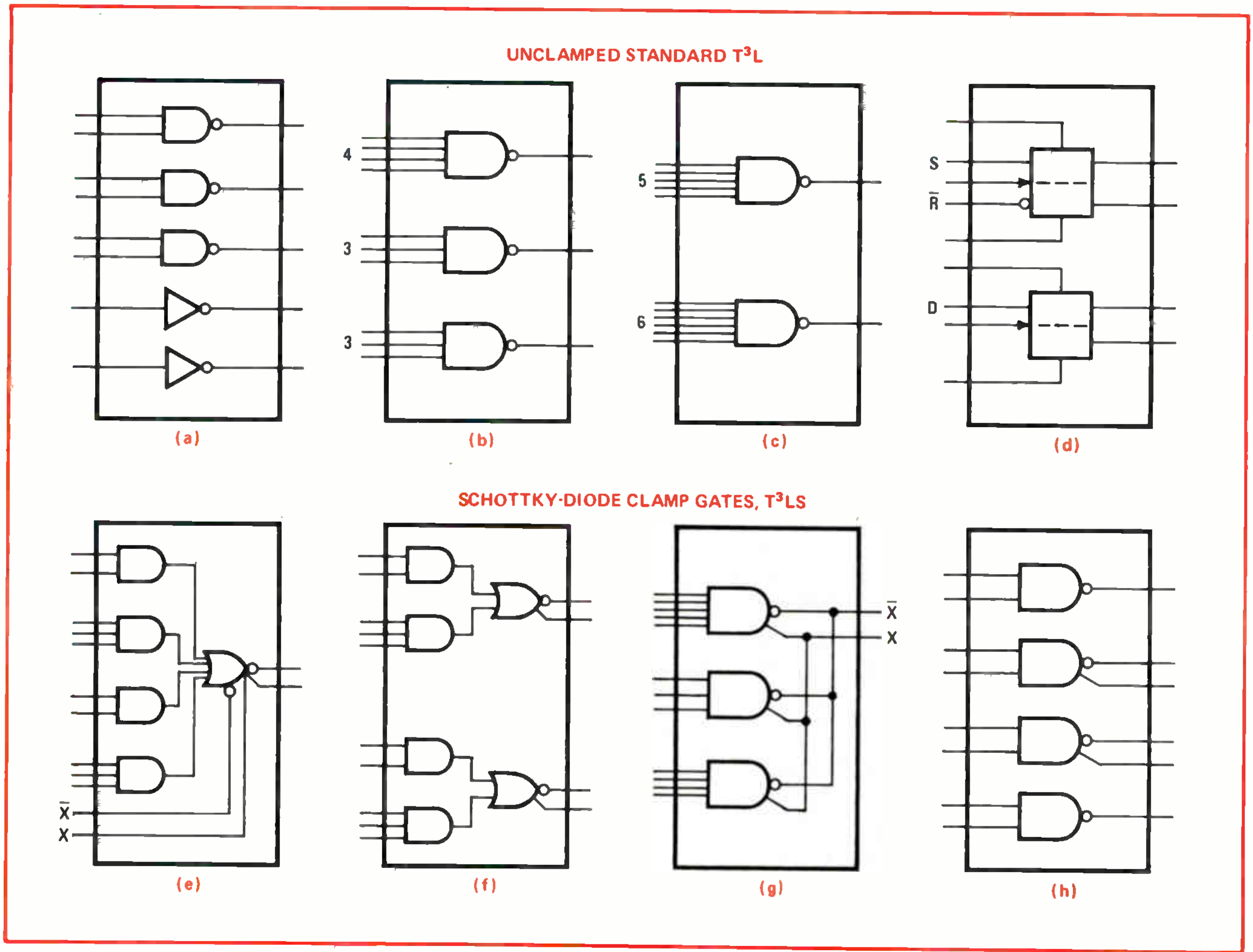
4. Saving interface. T³L can drive T²L directly (above) and can readily be driven by T²L (below), so that it can be used for special applications without complex interfacing and logic level shifting.

other line running parallel to it and connecting other networks are a critical factor in determing whether undisturbed signal transmission is possible. These induced crosstalk voltages are larger in T³L than in T²L, because of larger voltages on the signal lines. However, they are more than offset by T³L's better noise immunity so that the permissible coupling length for T³L logic is approximately 60% higher than that of T²L.

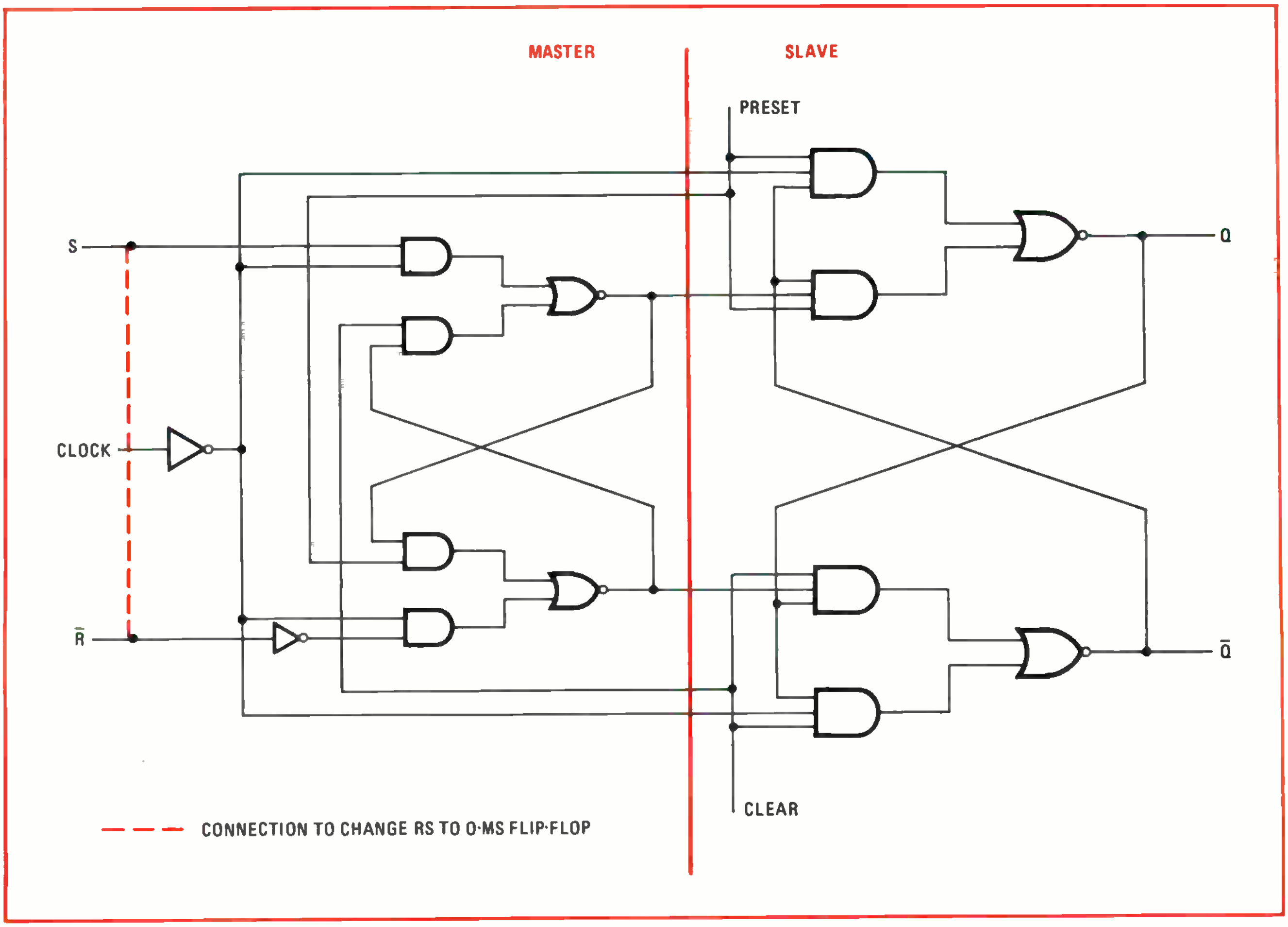
The initial development effort at RCA and then at Siemens AG led to the family of eight circuits shown in Fig. 4. Both Schottky-diode-clamped and standard unclamped circuits are available. They are being used to a large extent in medium-sized basic processor units, along with T²L MSI circuits. Other semiconductor companies, like Motorola, Signetics, and Transitron, are building these circuits under subcontracts from Siemens AG.

The T³L family consists of NAND gates with two, three, four, five or six inputs, inverters, and two master-slave flip-flops. These circuits are available in four different 16-pin dual-in-line packages. These are shown in the upper row of Fig. 5. The two master-slave flip-flops have the same noise-immunity and line-drive characteristics as the gates. Both flip-flops have the same internal structure except that the logic input can be altered to make one an RS-master-slave flip-flop, and the other a D-master-slave flip-flop (Fig. 6). They have independent preset, clear and clock inputs. Information from the logic inputs enters the master with the falling edge of the clock pulse and is transferred to the outputs with the rising edge. On the D-type flip-flop, information may change while the clock is low. The RS flip-flop can also be used as a D-type flip-flop by connecting together S and $\bar{R}$ inputs.

A family of similar circuits with Schottky diodes has also been developed. It consists of the four different packages shown in the lower row of Fig. 5. To make use of the higher speed of internal gates, most of the circuits



5. Family portrait. Various T³L gate combinations are available in four types of standard 16-pin DIP packages. Although not as fast as the fastest Schottky T²L, T³L is faster than available C-MOS, and provides comparable dc noise immunity.



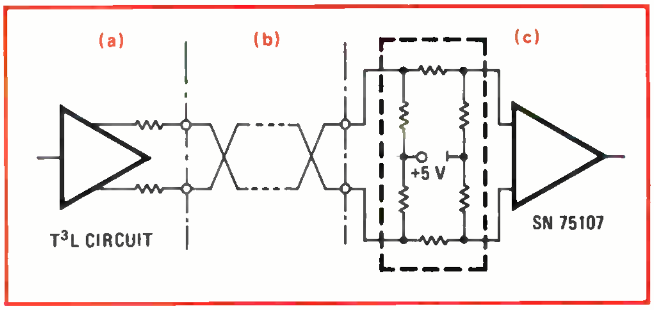
6. Dependency relation. An expanded diagram of Fig. 5d demonstrates how, by changing logic inputs, the same internal structure can be used to realize both an R-S- and a D-type master-slave flip-flop. Information enters on the falling edge of the clock pulse and is transferred to the output on the rising edge, but on the D-type flip-flop information may change while the clock is low.

have two-stage logic and complementary outputs. There are expandable AND-OR/NOR gates, an expander, AND/NAND gates, and NAND gates. The gates have the same characteristics and loading rules as the T^3L gates, except that threshold and output levels are slightly different because of the Schottky diodes and both speed and power dissipation have increased. The typical delay time for both outputs of an AND-OR/NOR gate loaded with 50 pF is 8 ns (11 ns maximum).

Typical applications

A signal-transmission circuit which combines the noise immunity and complementary outputs of Schottky T^3L is diagramed in Fig. 7. The circuits with inverting and noninverting outputs are used as a differential line transmitter. This, when coupled with a differential receiver such as Texas Instruments' SN 75107, realizes a transmission system for devices separated by as much as 200 feet. The system is operable even when a dc noise voltage of up to 19 V is applied between the grounds of both devices. Neglecting cable delay, the propagation delay over the differential transmitter and receiver is typically as low as 24 ns.

T^3L gates are also useful where high noise immunity is not a necessity but where the logical structure of these Schottky-diode circuits simplifies the design concept and improves circuit speed. For example, a very fast



7. It goes a long way. A T^3L circuit with both inverting and noninverting output (A) can successfully transmit over 200 feet of cable (B) to a receiver with a terminating network (C). Such a scheme would be impossible with T^2L but high drive capability makes it feasible with T^3L. in the presence of high common mode noise.

and simple RS flip-flop can be realized with only one AND-OR/NOR gate if the gate's noninverting output is fed back to one of its inputs.

This logic family is still at a small-scale integration level. Future developments will include MSI development and mixing T^3L and T^2L in medium-sized basic processor units and peripherals, as well as and in input-output controllers. The use of T^2L wherever possible will optimize the systems' logic power and cost, while T^3L will be mixed in wherever noise immunity and complementary outputs are called for. □

Formalizing of evaluations helps EEs climb career ladder

Engineers and managers agree that regular performance rating improves communications, enhances job output, and aids in career planning; most companies have dual track for promoting specialists and managers

by Gerald M. Walker, *Associate Editor*

☐ Methods of evaluating job performance of engineers appear to have passed through two or three cycles during the last couple of decades. Although different companies may be at different points on the trend line, depending on size of department and management's current bent, the approach to rating EEs has swung from bland informality to strictly check-list formality.

Today, performance evaluation has stabilized at a point somewhere between these two extremes, combining the use of written forms with personal contact between the supervisor or manager and the working engineer. What's more, it also appears that today's engineer expects—in fact, desires— to be evaluated and then told about his rating.

These conclusions were gleaned from a sampling of a cross section of electronics companies throughout the country to find out how engineering departments evaluate job performance. In general, here's what *Electronics* reporters found out in this roundup:

- Most written evaluation forms are a combination of one-word ratings—excellent, good, fair, poor—and narrative description.
- Practically every department performs evaluation annually, but most stress that keeping tabs on how EEs are doing is an ongoing process throughout the year—usually on an informal basis.
- Some companies include space on their forms for the evaluated engineer to comment on his rating, and others also make room for a projection of goals for the coming year.
- Evaluation forms are generally designed by personnel departments, rather than the engineering departments. However, forms for EEs have different formats from those for hourly blue-collar employees.
- Although criteria may vary from company to company, engineering managers have clearcut ideas of what they are looking for in their men and stick to them.
- Every company reports the existence of a dual-ladder promotion system.
- Working-level EEs generally approve of the evaluation systems. Complaints center around failure of supervisors to be objective.
- Supervisors generally approve of the systems too. Their complaints: Engineering project schedules don't coincide with required evaluation dates, making it difficult to complete thorough ratings.

Times are changing, but why?

While there are variations from these generalizations, both the supervisors and the working EEs agree that thorough performance evaluations are more important today than in the past. The reasons for this attitude are not completely clear. To get a bench mark on this point, engineering managers were asked if they evaluate EEs any differently from how they had been evaluated as beginners. The responses were equivocal.

Many say that, as designers, they did not get the same amount of attention from their supervisors that they now give their people. Others recall that, in the past, evaluations were much too subjective. If they didn't make any waves, their ratings were high. In some cases, evaluation had been so distasteful to supervisors that they let each EE fill out his own check sheet. Still others