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Robert A. Pease, Sr. Engineer

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Electronics

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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
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Porcelain

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Posts

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Electronics

Publisher's letter

With the first quarter of 1974 almost behind us, it looks like some of the uncertainties that accompanied the start of the new year are definitely behind us.

On page 65, you'll find a report on how healthy the electronics industries are—despite fuel and material shortages, talk of recession, and all the other worries the general economy faces. Right after that, on page 68, is a report on the remarkable optimism among Europe's electronics leaders as they prepare for next month's bellwether Paris Components Show. And, in an editorial on page 12, we point out that the long-term strengths of electronics technology far and away outbalance the short-term uncertainties—and that this is certainly not the time to cut back on expansion plans.

Significantly, more and more evidence is piling up that electronics is contracyclical—it does not plummet when the general economy does. Indeed, some experts think that electronics technology is now so basic, pervasive, and essential that it is immune from the extreme recessionary swings that may hit other industries. When you read our economic reports, you'll see some of that evidence for yourself.

Despite the enormous economic uncertainties facing Western Europe because of the energy crisis and near-runaway inflation, our field editors there found a near-unanimous feeling that 1974 will be a good year. Even in Great Britain, the country where things could go most wrong, components companies are surprisingly optimistic. After checking out the technology leaders in France, West Germany, Great Britain, and Italy, our reporters stationed in Europe concluded that evolution in technology, rather than revolutionary new products, would set the tenor at the Paris Salon International des Composants Electroniques.

As part of his contribution to our story on the market outlook just before salon time, our Paris-based Managing Editor-International, Art Erikson, talked with the heads of France's two largest components companies.

"It would be hard to imagine two more different locales for interviews," says Erikson. "Thomson-CSF is in the midst of converting an old factory in a western Paris suburb to modern headquarters for its components operations. It was there that I saw Philippe Giscard d'Estaing, who heads them. A few days later, I went with a trainload of French business journalists to the Chateau d'Artigny near Tours, where RTC-La Radiotechnique-Compelec's director-general Jacques Bouyer reported on the outlook for his company in the domed ballroom of the chateau.

"Whether the surroundings were functional or gilded, the message was the same. Based on last year's surge and what they've seen so far this year, both men figure to log strong growth this year."

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40 years ago

From the pages of Electronics, March, 1934

Science makes jobs

Every reader of *Electronics* has been asked: "But don't these new electronic inventions put men out of work, and so aggravate the world's troubles of unemployment?"

The answer, definitely to the effect that science and electronic inventions *build new industries and so create jobs*, rather than destroy employment, was made by a group of outstanding American scientists whose names are also synonymous with electronic discovery and application, during a joint meeting of the New York Electrical Society and the American Institute of Physics in the Engineering Auditorium, New York City, Feb. 22, at which the editor of Electronics presided, as head of the Electrical Society.

Following are pointed paragraphs from the discussions:

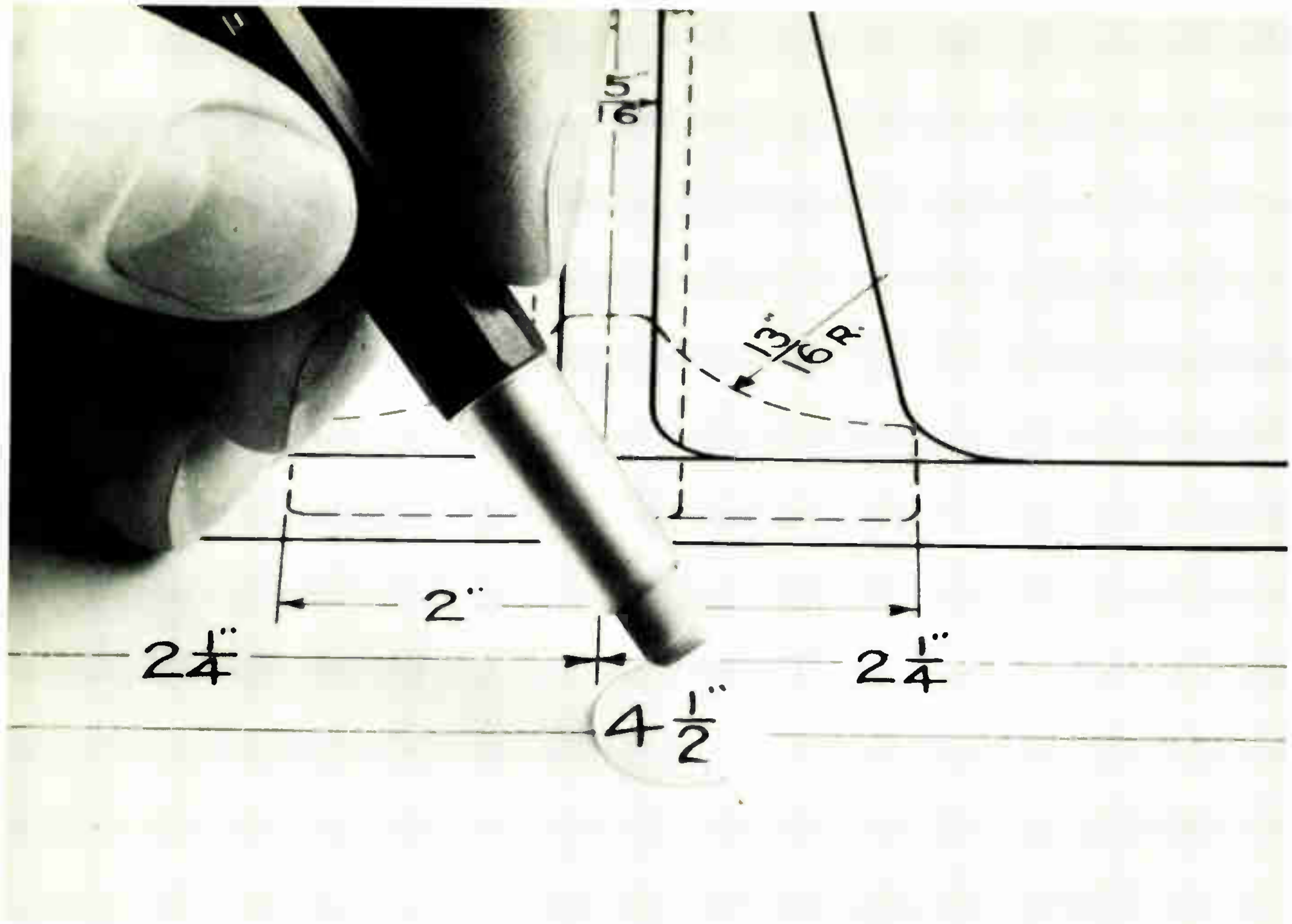
Dr. Karl T. Compton, *Chairman, U.S. Science Advisory Board, President*, MIT

• The idea that science takes away jobs, or in general is at the root of our economic and social ills, is contrary to fact, is based on ignorance or misconception, is vicious in its possible social consequences, and yet has taken insidious hold on many minds.

The spread of this idea is threatening to reduce public support of scientific work, and in particular, through certain codes of the NRA, to stifle further technical improvements in our manufacturing processes. Either of these results would be nothing short of a national calamity,—barring us from an advanced state of knowledge and standard of living.

Dr. Robert A. Millikan, *Director California Institute of Technology*

• Every labor-saving device creates in general as many,—oftentimes more,—jobs than it destroys. And the new jobs are in general better for the individual affected, and much better for society as a whole, than the old ones. The world's drudgery that used to be done by human slaves, is now done by soulless, feelingless iron slaves.



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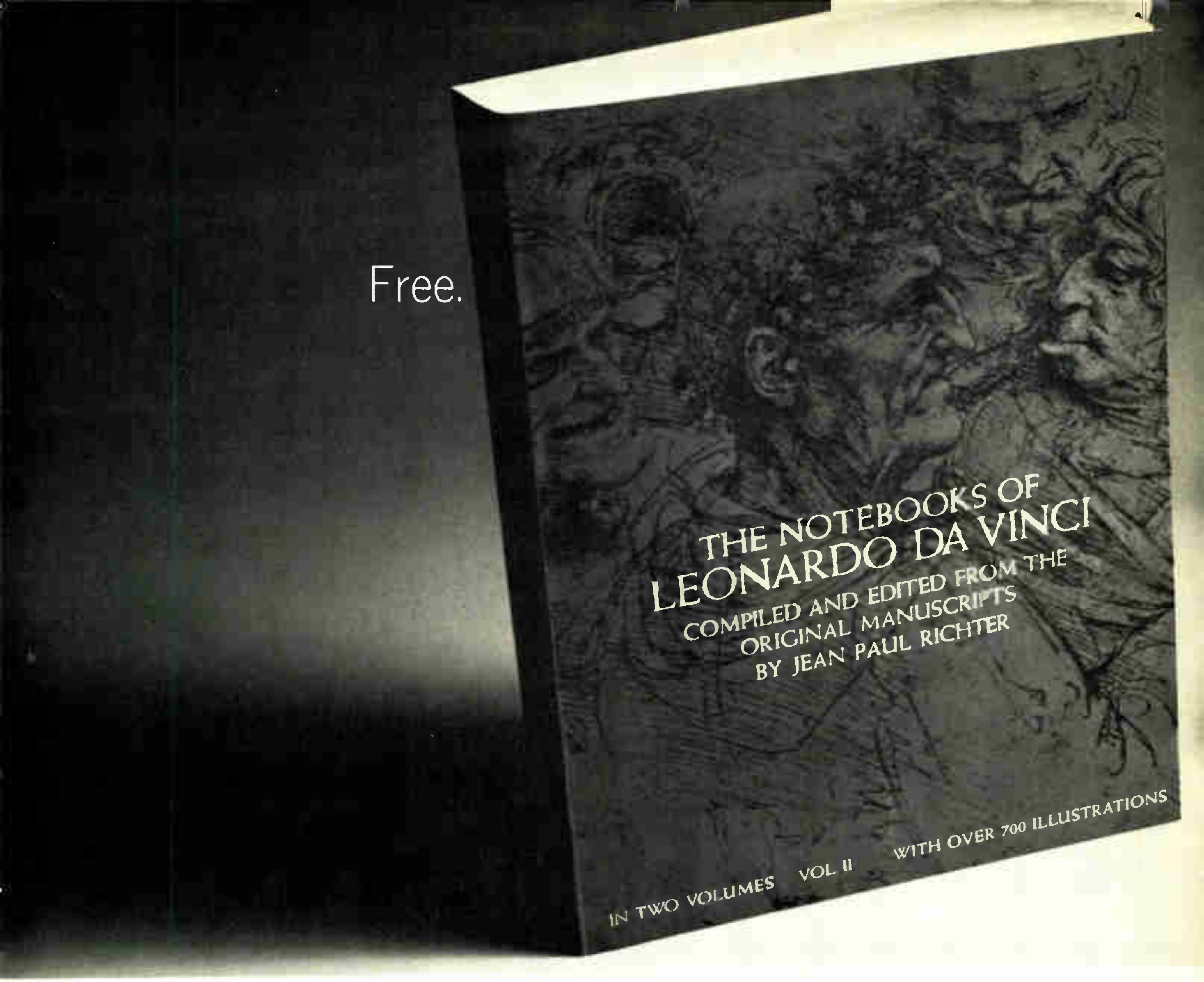

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Editorial

The challenge of expansion

It's a puzzling year for electronics firms. On the one side, there's bad news, with some economists persisting in their forecast of recession. But a hard look at the electronics industries shows that in most segments—especially in semiconductors — business isn't just good, it's terrific.

Many companies echo the comments of Morris Chang, group vice president of Texas Instruments Semiconductor Group: "Demand shows no sign of slackening. We are still very much production limited and expect to be for quite a while." And Patrick D. Lynch, Motorola vice president, sees semiconductors growing 20–25% this year, with his company due to match that growth.

Other cheery predictions come from spokesmen in the communications, computer, and components industries. Neal W. Welch, board chairman at Sprague, points to an open order backlog in excess of $100 million at the start of the year. He sees "a continued healthy demand for our products in virtually all of the markets we serve." And the word from minicomputer makers is even more upbeat, with many companies talking of the strong contracyclical nature of their product. "The minis have always come through the swings okay," says one company official.

Further, a recent report on capital spending by the economics department of McGraw-Hill Publications shows that corporate expansion plans have been expanded themselves. Overall, companies plan an 18% increase in capital expenditures. Manufacturing companies plan a whopping 31% increase. In fact, since a preliminary survey in October, manufacturing companies have added about $3 billion to their expansion plans.

Yet in spite of this outlook, many executives are scanning all reports looking for the trouble they've been told is coming. This isn't bad in itself—if they remain prepared to act. However, if they turn cautious and hold off—or cut back—on expansion plans, it could hurt.

There's no denying that the country and electronics industries face a set of problems that have left executives edgy, to say the least. Prices continue to climb, especially for energy—not only gasoline but for natural gas and electricity. Unemployment, swelled by the drop in auto sales, may have levelled off at 5.2% of the labor force. And shortages still plague the industry. All of these, plus the crisis in confidence in Government summed up by the word Watergate as well as the uncertain state of the stock market, have created an atmosphere in which it's tough to make aggressive decisions.

But there's still plenty of unfulfilled demand, which strengthens the prospects for growth. Companies see no chance of cutting down leadtimes that, in some cases, are too long to be healthy. For instance, TI's Chang sees the delivery situtation in TTL logic improving some, but doesn't think it will reach eight weeks this year. It's now at 24 weeks.

Capacity, therefore, still is the problem, and many instrument and semiconductor firms have aggressive programs for increasing capacity. Indeed, executives in rapidly expanding areas such as semiconductors and instruments have tough decisions to make. Do they pay attention to those financial analysts and economists who see rougher times ahead and either scale down or slow down efforts to bring new capacity on line? Or do they believe their own order books?

Our vote is on the side of the order books. Those that don't expand are likely to find themselves well back in the race. The worst fear is that they will let the uncertainties outweigh the strengths—and talk themselves into limiting their own growth.

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CELANESE ENGINEERING RESINS

People

Ben Grossman steers into capacitor sales

Buyer. Ben Grossman heads IEC which recently bought Electro Motive Corp.

International Electronics Corp., a $3 million company in Melville, N.Y., has a sophisticated technology-oriented sales and marketing organization, but it lacked its own factories and technology know-how. So it bought the much larger Electro Motive Corp. Electro Motive, which had experience and production capability but lacked a dynamic marketing effort, produces the El Menco line of capacitors, with plants in Willimantic, Mass., Florence, S. C., and Kingston, Jamaica. It was a merger of capabilities.

The man negotiating the deal was Ben Grossman, then president of IEC and now president and chairman of the board of both companies. Last August, after the sale was completed, there were some serious problems, says Grossman: "Electro Motive was booking orders like mad, but lead time was 20 to 30 weeks. Customers were screaming and beginning to blame us for what wasn't delivered. We had to clear up the clogged pipelines." On top of this, IEC had to negotiate a union contract at Electro Motive's, Florence, S.C. plant about the same time. But the result appears to have been worth the trouble.

"When we took over Electro Motive," says Grossman, "it had $18 million in sales as of their year-end, May 1973. Since the changeover, it is operating at a $30 million annual rate. Production has increased to the point where we have shortened lead times to 14 weeks with the same backlog as before."

Why should a successful capacitor company sell out to a smaller firm, especially when the long-range prospects look so good? "People make the most money," says Grossman, "by selling in a rising market." And he adds, "The original founders of the company were getting older and were not ready to start rejuvenating an industry."

For Ben Grossman, the climb to his present position began when he was 12 years old: "I used El Menco capacitors in making my own radios." In the 1930s, he tested tubes at his father's distributing operation, and "at age 16, I was a components supplier to the back-room radio manufacturers."

Grossman got much of his technical training in the Signal Corps during World War 2 and afterwards decided to make his own radio set. "But we couldn't get components. Rather than go bankrupt, we decided to sell the components we had, basically for export."

From England's Mullard Co., Grossman imported a better quality of tube, one with less hum than then U.S-made tubes, and this was the start of IEC—a company that has grown to more than three times its size in less than nine months.

Ottobrini sees ceramic boom

Harold Ottobrini, the founder of Metalized Ceramics Corp. (MetCeram), is pleased: sales of ceramic packages in 1973 soared nearly

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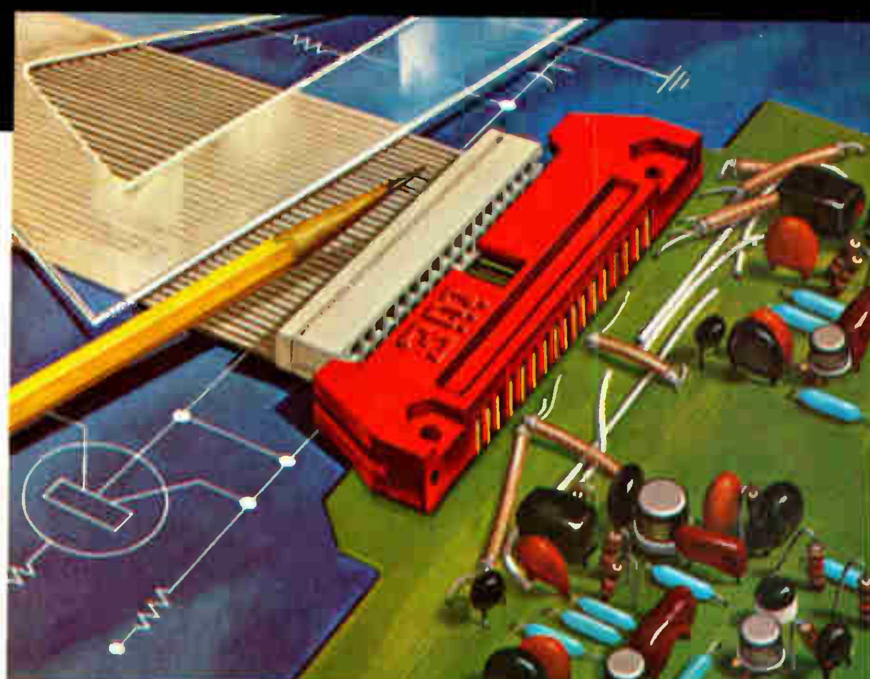

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For full information on the "Scotchflex" systems approach to circuitry, write to Dept. EAH-1, 3M Center, St. Paul, Minn. 55101.

3M COMPANY

Circle 15 on reader service card

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Barber-Colman Co., Loomis & River Sts., Rockford, Ill.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa. (See page 10.)
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill. (See page 13.)
H-B Electric Co., 2518 N. Broad St., Philadelphia, Pa.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Philadelphia Thermometer Co., 917 Filbert St., Philadelphia, Pa.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Ward-Leonard Electric Co., 31 South St., Mount Vernon, N. Y. (See page 34.)
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

POLARIZED RELAYS

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Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa. (See page 10.)
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
L A B Corp., Summit, N. J.
Miller Co., Bertrand F., Trenton, N. J.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

SENSITIVE CONTROL RELAYS

Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
Allied Control Co., 227 Fulton St., New York, N. Y. (See page 164.)
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa. (See page 10.)
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill. (See page 149.)
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill. (See p. 13.)
Kurman Electric Co., 241 Lafayette St., New York, N. Y. (See page 104.)
Potter & Brumfield Mfg. Co., Princeton, Ind.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Sigma Instruments, Inc., 78 Freeport St., Boston, Mass. (See page 151.)
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

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Roller-Smith Co., Bethlehem, Pa.

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Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
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Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Cal.

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American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn. (See page 169.)
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
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Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
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Friez & Son, Julien P., 4 N. Central Ave., Baltimore, Md.
General Electric Co., Schenectady, N. Y.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
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Photobell Corp., 116 Nassau St., New York, N. Y.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
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Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Spencer Thermostat Co., 1404 Forest St., Attleboro, Mass. (See page 111.)
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.
White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo.
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General Radio Co., 30 State St., Cambridge, Mass.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill. (See page 39.)
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa. (See page 6.)
Supreme Instruments Corp., 414 Howard St., Greenwood, Miss.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

DUMMY ANTENNA RESISTORS

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Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
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Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis. (See page 8.)
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y. (See page 136.)
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Joseph, Monmouth St., Jersey City, N. J.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
Electro-Motive Mfg. Co., Willimantic, Conn.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa. (See page 45.)
Euclid Electric & Mfg. Co., Chardon Rd., Euclid, Ohio
General Electric Co., Schenectady, N. Y.
Globar Div. Carborundum Co., Buffalo Ave., Niagara Falls, N. Y. (See p. 33.)
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J. (See page 20.)
Instrument Resistors Co., Little Falls, N. J. (See page 14.)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa. (See page 93.)
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill. (See page 39.)
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Speer Resistor Corp., St. Marys, Pa. (See page 113.)
Sprague Specialties Co., North Adams, Mass. (See page 135.)
Square D Co., 6060 Rivard St., Detroit, Mich.
Stackpole Carbon Co., Tannery St., St. Marys, Pa. (See page 48.)
States Co., 3 New Park Ave., Hartford, Conn.
Tuttle & Co., H. W., 261 W. Maumee St., Adrian, Mich.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y. (See page 34.)
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
White Dental Mfg. Co., S. S. (Industrial Div.), 10 E. 40th St., New York, N. Y. (See page 170.)
Wirt Co., 5221 Greene St. (Germantown), Philadelphia, Pa.

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Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
General Radio Co., 30 State St., Cambridge, Mass.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J. (See page 20)
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J. (See page 14.)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa. (See page 93.)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill. (See page 39.)
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa. (See page 6.)
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y. (See page 34.)

100% over 1972's sales and reached $10.8 million at the Providence, R.I., firm. Also, Ottobrini was just elected president and chief operating officer of MetCeram, although he downplays the promotion as more of a change of title. As senior vice president, he and former president John A. Long, now chairman of the board and chief executive officer, have functioned interchangeably for the last five years.

For Ottobrini, the future is also pleasing. He expects the boom in ceramic packaging to continue for the next few years because its end users are in the fast-growing markets for semiconductor memory and MOS digital logic devices. "The onslaught of semiconductor memory devices," he says, "has made a tremendous difference in the company's success and is the main reason we predict such a large growth for the next few years." Ottobrini says that MetCeram is the first company to ship ceramic IC packages in volume to semiconductor manufacturers.

Room for growth. He rejects the idea that plastics may be hurting the ceramics market. "The requirements of all technologies have grown, and there is plenty of room for plastics and ceramics," says Ottobrini. He points out that certain products lend themselves to the encapsulation in plastic, while others require ceramic packaging. "But we're not in competition with plastics in the sense that we talk to a guy and try to convince him to use ceramic packaging rather than plastic."

Also, the introduction last July of a selective gold-plating process has brought a lot of business to the company. The process slices as much as 35% from the prices of some packages and provides ceramics with another plus over plastics.

Taking his cue from the semiconductor industry, Ottobrini says that MetCeram plans to set up manufacturing plants in areas like the Orient and Mexico to utilize low-cost labor. In another effort to reduce costs, MetCeram finds itself in the middle of a program to upgrade labor standards and manufacturing methods with, among other things, a worker-incentive program.

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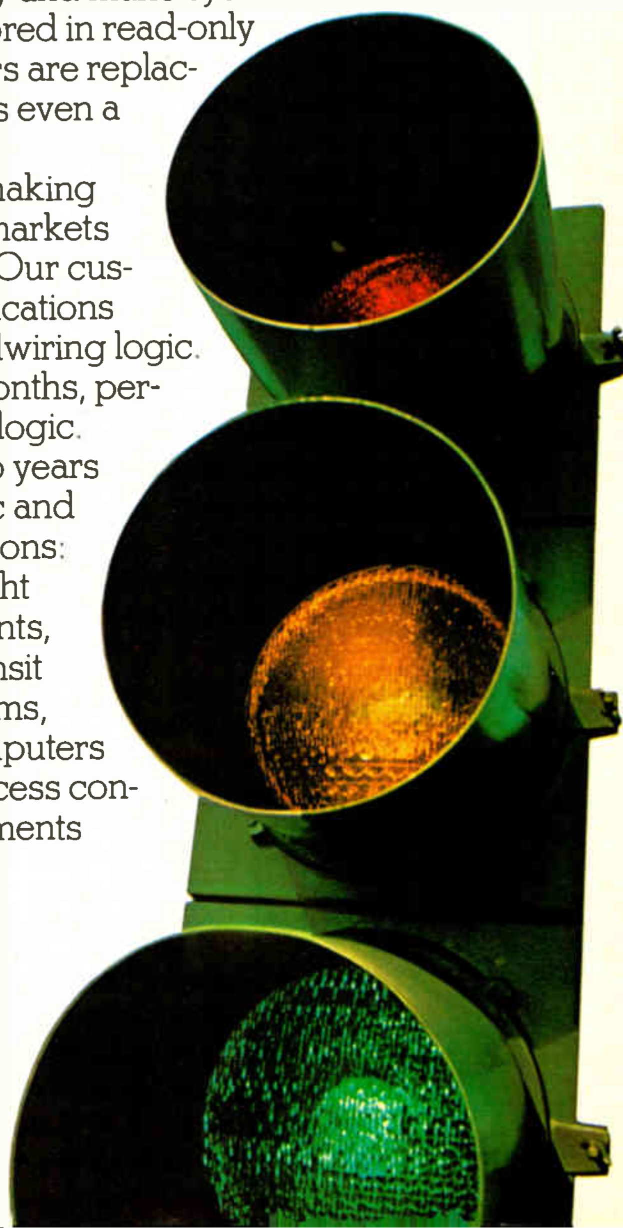

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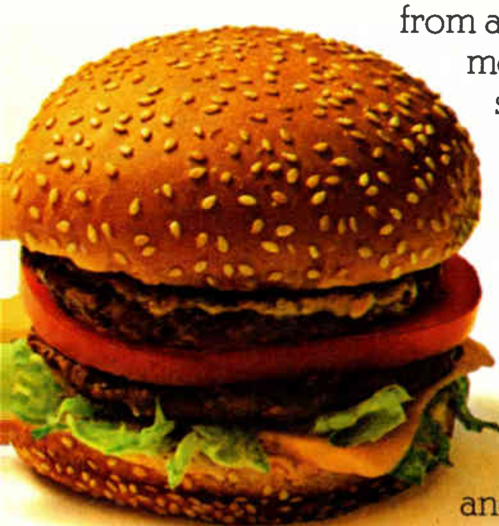

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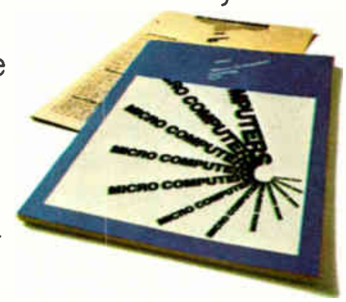

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Salon des Composants Electroniques: SDSA, Porte de Versailles, Paris, France, April 1-6.

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 Instruments, Electronics, and Automation Exhibition, Olympia, London, U.K., May 13-17.

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

Society for Information Display International Symposium, Town and Country Hotel, San Diego, Calif., May 21–23.

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

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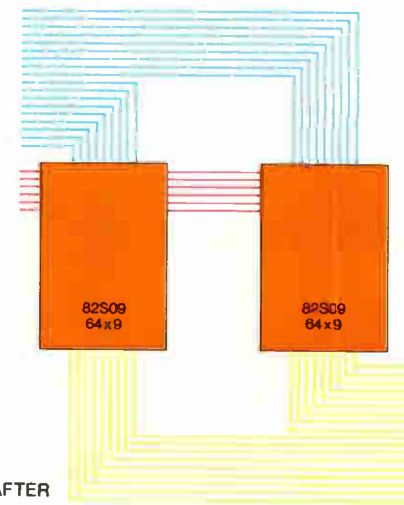
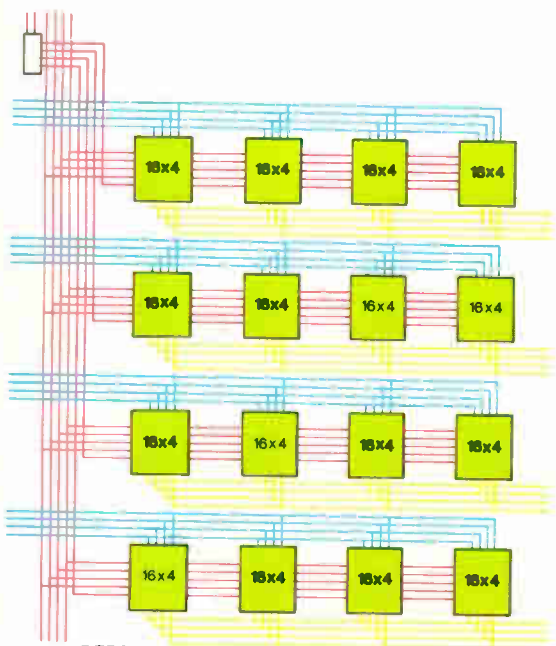


AFTER



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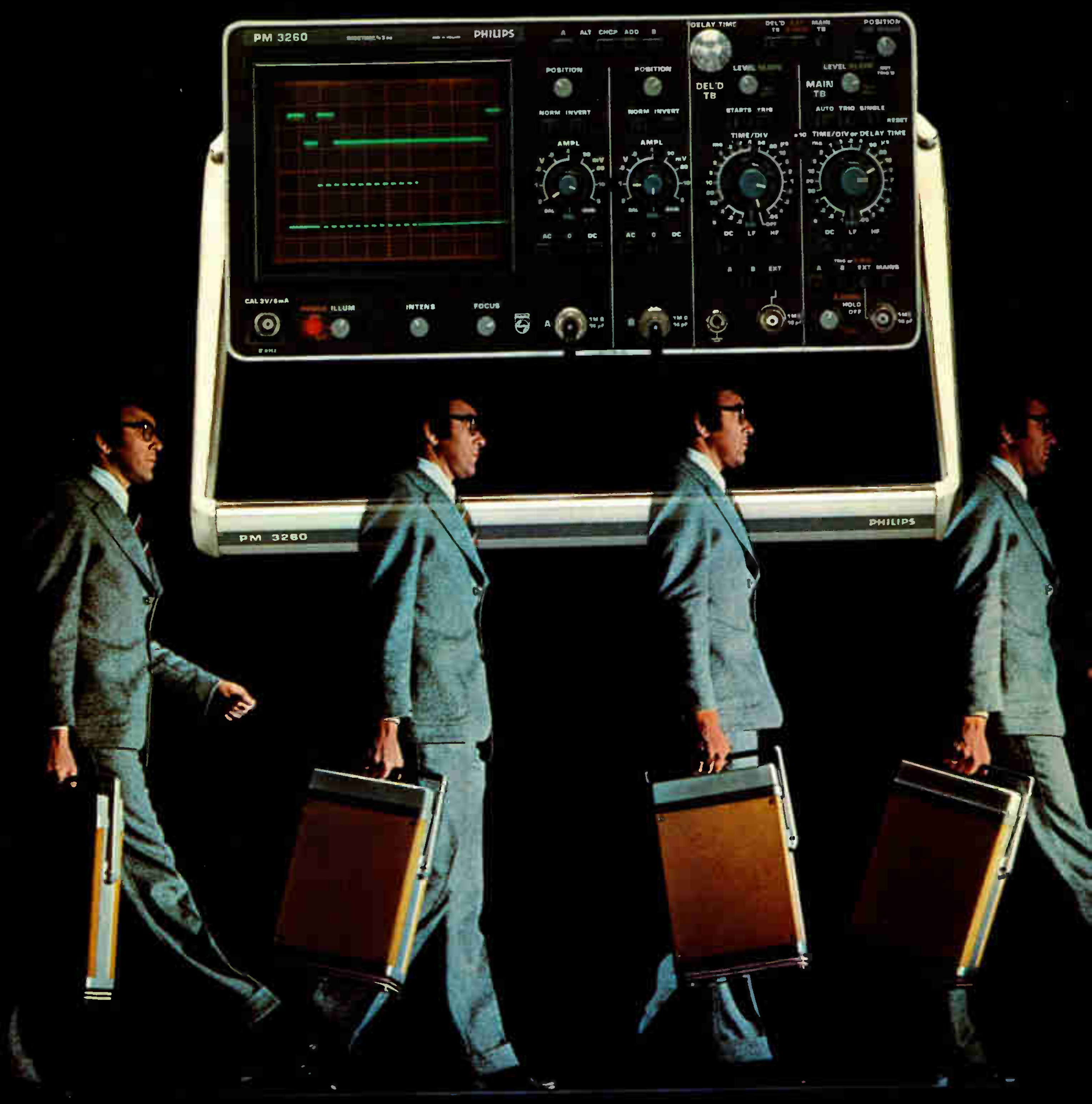

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For this you need a bandwidth of at least 100 MHz, therefore Philips supply 120 MHz in order to keep ahead of component developments like Schottky TTL.

A sensitivity of 5 mV is more than adequate, while a weight of only 20 lb comes as a pleasant surprise, (parking being what it is, every pound counts on a service call).

And a logical front panel layout is equally important since it lets you take measurement easier, quicker and with less possibility of error. (One example of our logic is the separation of main and delayed time base controls in order to avoid any ambiguity).

Even more

As well as these obvious benefits, the new PM 3260 has even more significant features like : the clean display, even at the highest writing speeds;

the wide use of thin film circuits that help the space and weight reduction and that increase overall reliability;

the specially-developed power supply that accepts any line voltage / frequency and DC and that dissipates only 45 W, thereby eliminating the need for a fan (and associated filters)

and finally, the modular construction that gives fast access to all boards, controls and components.

First in a family

The new PM 3260 is also the first in a new series of oscilloscopes that will soon include higher and lower bandwidth instruments – all with the same important benefits of high performance, light weight and excellent ergonomic design.

To find out more about the first in the family write to :

Test and Measuring Instruments Inc., 224 Duffy Avenue, Hicksville, L.I., N.Y. 11802

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PHILIPS

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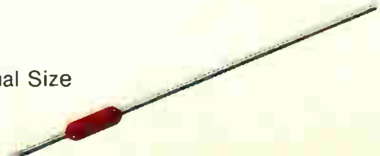
The result will change your thinking about film resistor suppliers.

Features? Capless design that does away with problems associated with end cap construction. And an alumina core with superior thermal characteristics and physical strength to resist fractures. Solderable/weldable leads. Even dual markings that are easy to read.



Actual Size

Now available in preferred number values from 10 ohms to 1 meg; 1% tolerance; ¼ watt at 70°C, ⅛ watt at 125°C; Size 0.250 L. by 0.090 D. Approved to MIL-R-10509 for style RN55, characteristic D. With tape reel packaging if you prefer.

For complete technical information on the Type CC cermet film fixed resistor, write Allen-Bradley Electronics Division, 1201 South Second St., Milwaukee, Wisconsin 53204.

There's more to resistors than resistance.

Circle 24 on reader service card

ALLEN-BRADLEY
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EC68

Mitre installs pilot solar-cell electricity system

Drawing a bead on the energy crisis and hoping to stimulate the hunt for means to alleviate it, Mitre Corp., McLean, Va., is ordering its own rooftop solar-cell power system for generating electricity directly from sunlight. The Mitre installation will generate 1 kilowatt of electric power, **making it the world's largest terrestrial photovoltaic installation put into place to date.**

Also included in the demonstration system, for which Mitre is spending $130,000 of its own money, is an electrolysis unit that **uses the electricity to convert water into hydrogen and oxygen.** Held in storage, the hydrogen will then be recombined with oxygen in a fuel cell so that the system will be able to generate electricity 24 hours a day. An inverter will change the dc output voltage to 110 volts ac for driving a demonstration load.

Mitre is buying all of the components off the shelf, and most of the solar panels—each generates 50 watts—come from Solarex Corp., Rockville, Md. The complete system could begin operating during the summer.

Brows raised by production of Intel bipolar RAM

In an industry where premature announcements are the rule, eyebrows have been raised by Intel's disclosure that its 1,048-bit bipolar RAM, unveiled last month at the International Solid State Circuits Conference, **has been in production for five months.** The new 60-nanosecond part, a simplified Schottky-TTL design that saves chip area with conventional processing [*Electronics*, Feb. 21, p. 114], is going exclusively to Intel's Memory Systems division for use in IBM 370/145 add-on memories. Although circuits are not yet for sale to outsiders and data sheets are unavailable, **the RAM may be put on the market as early as April or May.**

National schedules high-voltage interface-drivers

National Semiconductor will soon introduce high-voltage versions of the popular 75451 interface-driver circuit family. The 3611 through 3614 break down at 80 volts, compared to 30 or 40 V for the 7451 and 40 V for the 75461. Although the parts are pin-for-pin replacements and sink the same 300 milliamperes per side, **they switch in 120 nanoseconds, rather than the 20 ns of the devices they replace.** This is considered an advantage in many of the relay, solenoid, and hammer applications, where high speed of the devices complicates design.

Motorola's Texas facility plans shaping up

The emerging commitment to complementary and n-channel MOS at Motorola's Semiconductor Products division is underscored by initial plans for the division's new 300,000-square-foot facility in Austin, Texas. **The first plant section, which will go on-stream about midyear,** will be devoted to the line of 78 C-MOS products Motorola is now producing, and about 15 additional C-MOS parts will be introduced before year-end. The second step in Austin, planned for late this year or early 1975, will be to open a section devoted entirely to n-channel production.

No new p-channel MOS parts are being planned by Motorola. Offi-

HIGH VOLTAGE RESISTORS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Clarostat Mfg. Co., 285 N. Sixth St., Brooklyn, N. Y.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J. **(See page 20.)**
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa. **(See page 93.)**
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill. **(See page 39.)**
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa. **(See page 6.)**
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y. **(See page 34.)**

PRECISION RESISTORS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Cal.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64 W. Johnson St., (Germantown) Philadelphia, Pa.
Instrument Resistors Co., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa. **(See page 93.)**
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Meter Devices Co., 1001 Prospect Ave., S. W., Canton, Ohio
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa. **(See page 6.)**
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

WIRE WOUND RESISTORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Cal.
Clarostat Mfg. Co., 285 N. Sixth St., Brooklyn, N. Y. **(See page 136.)**
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64 W. Johnson St., (Germantown) Philadelphia, Pa.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J. **(See page 20.)**
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J. **(See page 14.)**
International Resistance Co., 401 N. Broad St., Philadelphia, Pa. **(See page 93.)**
Lectrohm, Inc., 5133 W. 25th Pl., (Cicero) Chicago, Ill. **(See page 181.)**
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill. **(See page 39.)**
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y. **(See page 34.)**
White Dental Mfg. Co., S. S., 10 E. 40th St., New York, N. Y. **(See page 170.)**
Wirt Co., 5221 Greene St., Philadelphia, Pa.

Rheostats

SLIDE WIRE RHEOSTATS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa. **(See page 165.)**
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y. **(See page 34.)**

VARIABLE RESISTORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Cal.
Clarostat Mfg. Co., 285 N. 6th St., Brooklyn, N. Y.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
DeJur Amsco Corp., 6 Bridge St., Shelton, Conn. **(See page 128.)**
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
Electro Motive Mfg. Co., Willimantic, Conn.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Gray Instrument Co., 64½ W. Johnson St., Philadelphia, Pa.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa. **(See page 93.)**
Le Carbone, Inc., Myrtle Ave., Boonton, N. J.
Lectrohm, Inc., 5133 W. 25th Pl. (Cicero) Chicago, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
National Carbon Co., 30 E. 42 St., New York, N. Y.
National Electric Controller Co., 5305 Ravenswood Ave., Chicago, Ill.
National Technical Laboratories, 820 Mission St., South Pasadena, Cal.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Mfg. Co, 4835 W. Flournoy St., Chicago, Ill. **(See page 39.)**
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Speer Carbon Co., St. Marys, Pa.
Stackpole Carbon Co., Tannery St., St. Marys, Pa.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

Rivets

American Brass Co., Waterbury, Conn.
Atlas Tack Corp., Pleasant St., Fairhaven, Mass.
Blake & Johnson Co., 1495 Thomaston Ave., Waterville, Conn.
Chicago Rivet & Machine Co., 1830 S. 54th Ave., (Cicero), Chicago, Ill.
Clark Bros. Bolt Co., Milldale, Conn.
Clendenin Bros., 108 South St., Baltimore, Md.
Cobb & Drew, Kingston St., Plymouth, Mass.
Harper Co., H. M., 2630 Fletcher St., Chicago, Ill.
Hassall, Inc., John, 402 Oakland St., Brooklyn, N. Y.
Industrial Screw & Supply Co., 711 W. Lake St., Chicago, Ill.
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
Manufacturer's Belt Hook Co., 1321 W. Congress St., Chicago, Ill.
Manufacturers Screw Products, 216 W. Hubbard St., Chicago, Ill.
Milton Mfg. Co., Milton, Pa.
New England Screw Co., 109 Emerald St., Keene, N. H.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Pittsburgh Screw & Bolt Corp., 2719 Preble Ave., N. S., Pittsburgh, Pa.
Plume & Atwood Mfg. Co., 470 Bank St., Waterbury, Conn.
Progressive Mfg. Co., 52 Norwood St., Torrington, Conn.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Rockford Bolt & Steel Co., 126 Mill St., Rockford, Ill.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Sterling Bolt Co., 707 W. Van Buren St., Chicago, Ill.
Stimpson Co., Edwin B., 74 Franklin Ave., Brooklyn, N. Y.
Tubular Rivet & Stud Co., Wollaston, Mass.

Scales

DIAL SCALES

see also Dials
also Escutcheons

American Emblem Co., Utica, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
The Emeloid Co., Inc., 287 Laurel Ave., Arlington, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Mallory & Co., P. R. 3029 E. Washington St., Indianapolis, Ind.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Parisian Novelty Co., Western Ave. at 35th St., Chicago, Ill.

Screws

MACHINE SCREWS

American Screw Co., 21 Stevens St., Providence, R. I.
Atlas Bolt & Screw Co., 1144 Ivanhoe Rd., Cleveland, Ohio
Blake & Johnson Co., 1495 Thomaston Ave., Waterville, Conn.
Central Screw Co., 3511 Shields Ave., Chicago, Ill.
Chandler Products Corp., 1475 Chardon Rd., Cleveland, Ohio
Clark Bros. Bolt Co., Milldale, Conn.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., High, Myrtle & Grove Sts., New Britain, Conn.
Eagle Lock Co., Terryville, Conn.
Economy Screw Corp., 2717 Greenview Ave., Chicago, Ill.
Elco Tool & Screw Corp., 1800 Broadway, Rockford, Ill.
Ferry Screw Products, Inc., E. W., 8219 Almira Ave., Cleveland, Ohio
Federal Screw Products Co., 26 S. Jefferson St., Chicago, Ill.

cials there believe the division is well positioned to cash in on C-MOS and n-channel MOS. They estimate that the two technologies will account for industry-wide sales of about $600 million and $800 million, respectively, by 1979.

Radiant's commercial electron-beam system sold

A dedicated commercial electron-beam micro-fabrication system reportedly has been sold by Radiant Energy Systems to Honeywell's corporate research group, but neither firm will confirm the sale. Radiant has been developing such systems under military contract, and has been shopping for customers in the commercial semiconductor business. Early versions of the machine incorporated a scanning electron microscope, **whose beam was directed by a minicomputer to "write" images on a wafer.**

The system sold to Honeywell, say industry sources, is apparently the model 600, an electron-beam pattern-generator with computer-aided design system for exposing sensitized substrates. It permits pattern editing as well as initial assembling. The system permits line width resolution as high as 0.2 micrometer. This is the major selling point for the electron-beam systems due to the extreme tolerance requirements of microwave and picosecond logic ICs, and surface-wave and integrated optical devices.

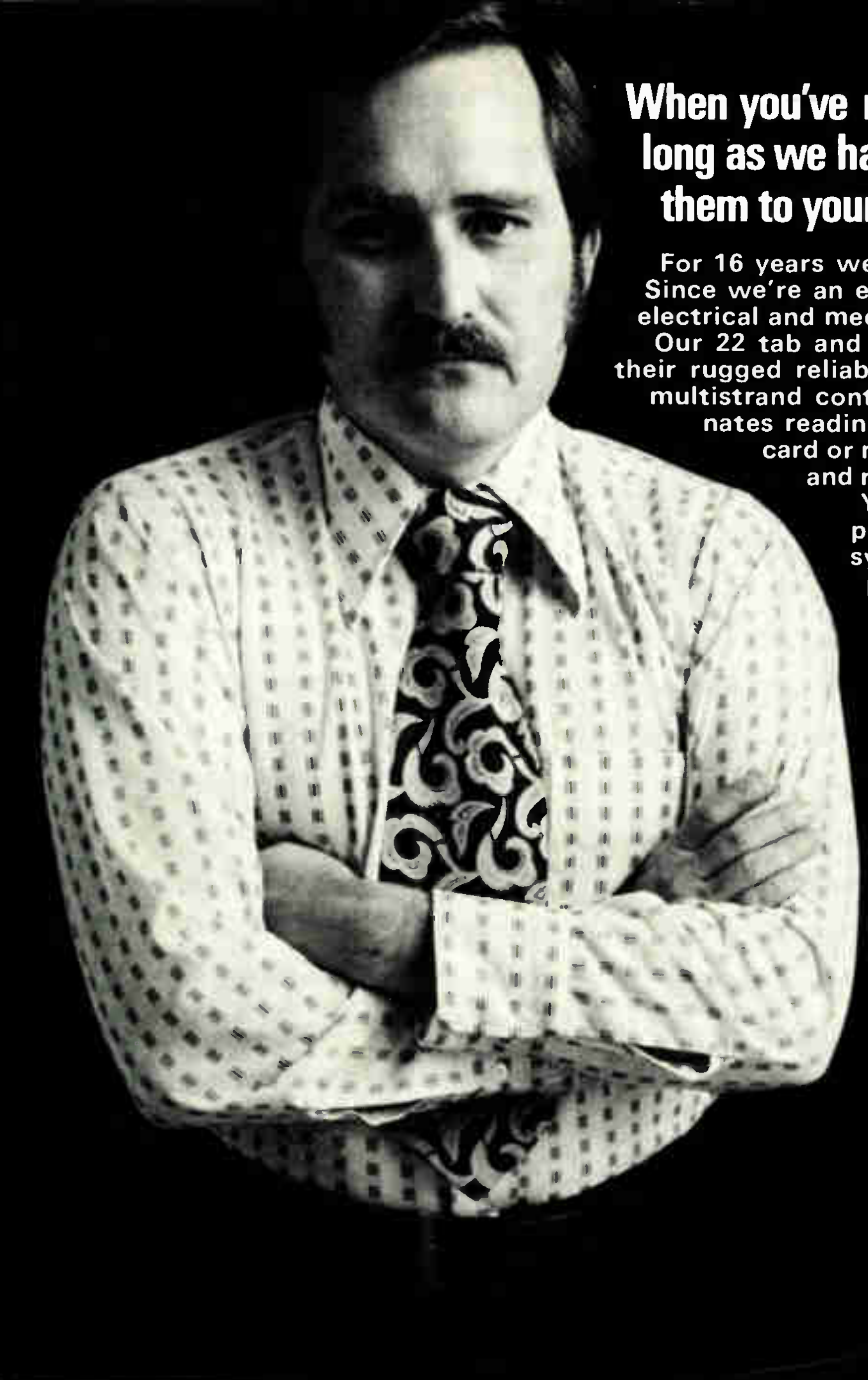
Russia to buy calculator chips

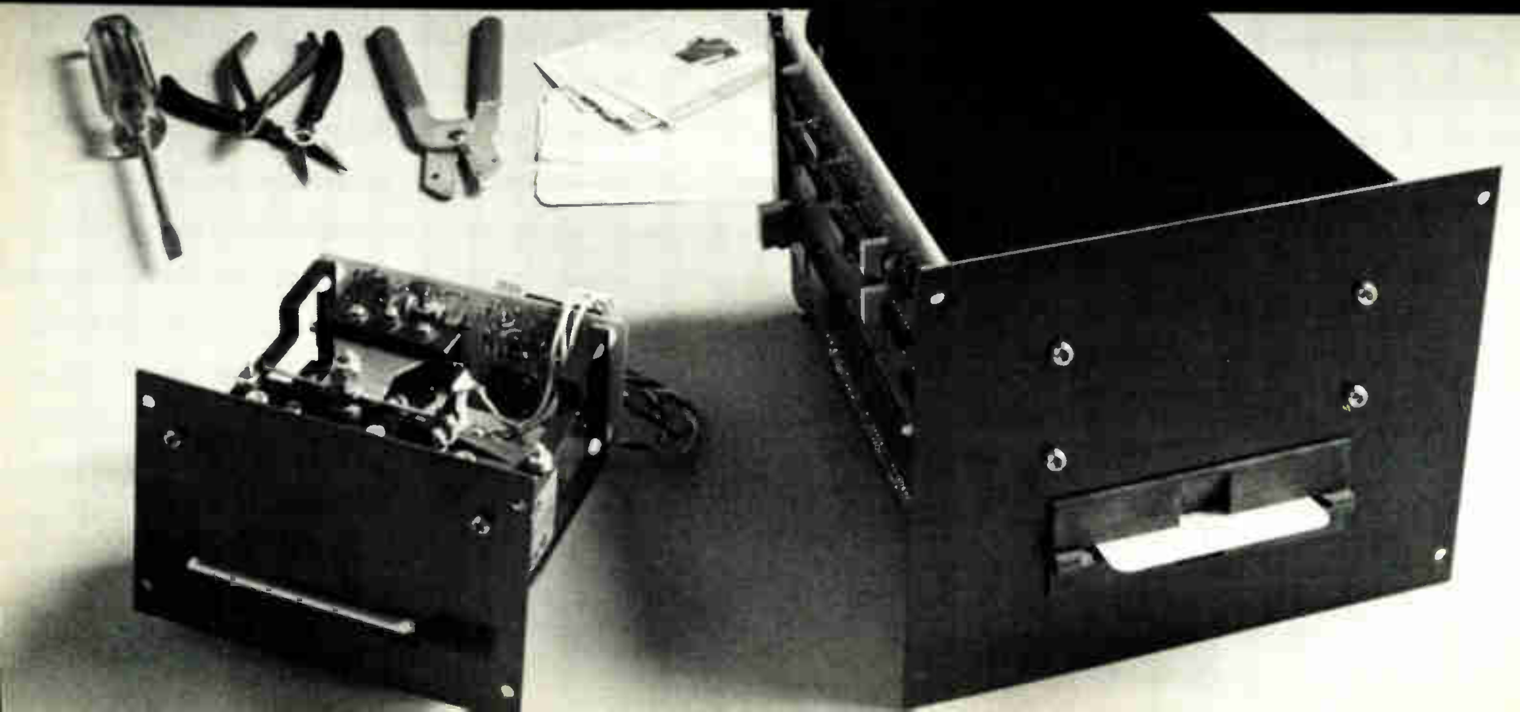
Electronic Arrays Inc. will market calculator chips to Russia and Eastern European countries through the California International Trade Corp., a specialist in trade with the Communist nations. Russian-born Rafael Gregorian, president of California Trade, says Soviet trade and technology officials have shown **more interest in calculator components than in complete machines.**

Mini controls Bay Bridge traffic lights

Traffic experts in metropolitan areas across the country are watching closely the new minicomputer-controlled traffic patterns on the Oakland-San Francisco Bay Bridge. The system went into operation this month. A Data General Nova 1210 minicomputer has been installed at the Bay Bridge toll plaza to meter the rate of traffic on the midsection of the bridge, **and to switch the traffic signals at the toll plaza at 4 to 10 seconds.** The computer, which has an 8,192-word memory, uses magnetometers in the middle of the bridge to record traffic volume, and employs wire loops at the stop signs that determine the rate at which cars should be released from the stop bars to allow optimum traffic flow.

The project, says Scott MacCalden, senior engineer of highway operations for the local district of the state Department of Transportation, will "allow a more efficient flow of traffic, and means safer merging" from the 15 lanes in front of the bridge entrance into the five lanes on the bridge. In addition, he says, emergency vehicles can be sped on their way by being routed through traffic if necessary. Total installation costs were $350,000.





CCD imager achieves full TV resolution for the first time

Once developmental work is done, RCA's CCD will be ready to take on new imaging roles

Another benchmark in solid-state imaging technology has been notched by the development of a charge-coupled-device imager capable of full 525-line TV resolution—the level considered critical if such devices are to penetrate into many commercial applications.

The achievement belongs to RCA's Electro-Products division in Lancaster, Pa. The CCD has four times the resolution of any previously disclosed CCD imager, including the 250-line device that Bell Laboratories, Holmdel, N.J., designed primarily for its Picturephone [*Electronics,* Feb. 21, p. 29].

The RCA division has built the new device into a black-and-white camera the size of a cigarette pack. So far, only the developmental stage has been reached, and no production plans have been formulated. The camera, which has a C-mount for lens interchangeability, has a bandwidth of 3 megahertz and a video data rate of 6 MHz. The video picture the camera produces on a standard TV monitor, says Robert L. Rodgers III, manager of the vidicon products group, is "for all practical purposes indistinguishable from one produced by a commercial vidicon tube."

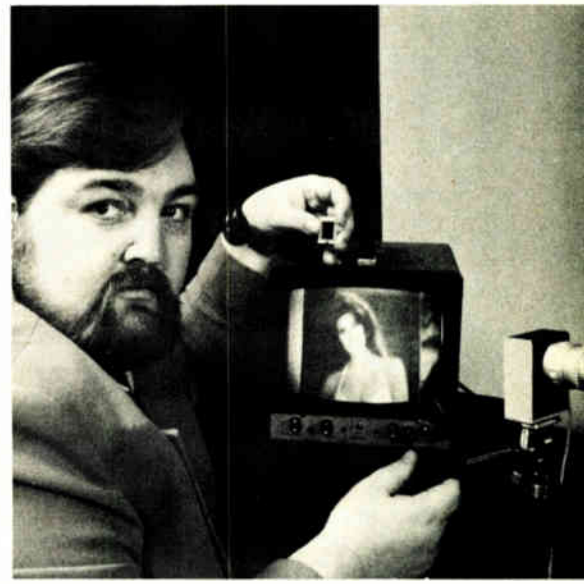
He adds that the camera can also generate the full resolution of broadcast color receivers and tape recorders. It is not suitable for studio-quality broadcasting, though, because even greater resolution is demanded there than can be displayed by commercial television sets.

However, its small size and low-power requirements make it an attractive alternative for many other types of 525-line TV applications—Rodgers suggests closed-circuit TV, some types of CATV programing, news and sports field cameras, industrial vidicons, medical and educational cameras, and military and surveillance systems.

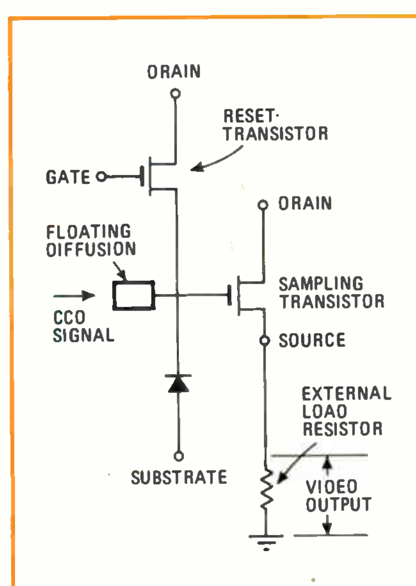
The 512-by-320 element area array, built with RCA's three-phase silicon-gate-type CCD imaging technology, is contained on a 500-by-750-mil superchip. It is laid out in the standard three-section format: a 256-by-320-element image area, a 256-by-320-element storage area, and a 320-stage output register, which shifts the video signals out at the 6-MHz rate. This register contains the clock inputs and preamplifier-output devices.

The image section is interlaced on alternate fields to generate the required 512-by-320 picture element per frame. In actual use, however, only 486 lines (243 per field) are displayed, leaving the extra elements for varying the system's blanking and timing to avoid nonuniformities at the picture edges.

Charge transfer. A unique feature of the RCA imager is its on-chip video-processing and detection scheme. As in all charge-coupled imaging devices, the charge signal is passed along without touching a diffusion on the chip until it is extracted at the output. In this setup, the charge detector is a diffusion with a floating potential, which is reset to a fixed potential once during



Vidicon replacement? Maybe. The image on the screen comes from a 525-line CCD camera. The diagram shows the detection scheme for RCA's CCD, featuring a floating diffusion detector, which senses voltage changes at corresponding nodes.



each clock period by a reset transistor.

Each charge packet, on reaching the floating diffusion, changes the voltage on the node's capacity. This voltage is then sampled by a transistor operating as a source follower. The very low node capacity of the floating diffusion results in a big improvement in signal-to-noise ratio over conventional silicon vidicons operating at the same light level—at normal signal levels, no noise at all is visible in a picture generated by the imager. □

Consumer electronics

Interactive TV can teach and play

As the price of gasoline rises, many a motorist may soon prefer to do his Sunday driving on his television screen, using an interactive terminal and programs from Telattach Corp. It's one of two interactive terminals coming from the two-year-old firm in Chevy Chase, Md.

But it looks as though the racing toy will be the first product off the starting line. The TelaRacing terminal consists of a wheel and dashboard connected by cable to a toy racing car mounted on a frame that is attached by suction cups to a TV screen. The programs, now being promoted among cable-TV operators, consist of 20 half-hour shows on race-driving, complete with sound effects.

The viewer attempts to steer around the course appearing on the screen, but if the toy car passes over an obstacle, a sensor under the car sets off a buzzer, and a skill recorder reduces the driver's score kept on a tally wheel to the right of the "dashboard." This racer set will sell for $24.95 when in full production.

Blinking. The firm's other interactive terminal will cost $375 and can be used by one student or a group. Each terminal has a 64-square board with a light under each square. A photocell, stuck by a suction cup to a corner of the TV screen, reads coded blinks coming from a video program, which may be either taped or live. Inside the terminal a simple digital hybrid assembly decodes the on-off time of the blinks.

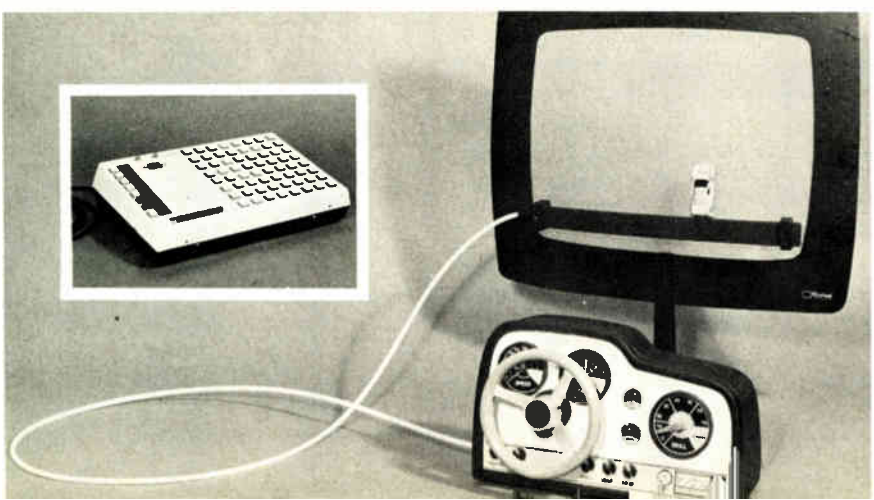
The teacher viewed on the screen may turn on any of the squares of light under the student's panel, and the student responds to a question by pressing a square. If the square lights up, the answer is correct. Templates of different shapes may be laid over the light panel of the terminal to aid in teaching various courses, ranging from pre-school recognition of shapes to electronics technology.

According to John Robinson, president of Telattach, the design objectives of the system were ease of programing and compatibility with any television receiver. He chose the 64-square light panel to make it possible to teach chess, but less expensive terminals using fewer lights and switches will be available.

To program the video portion, the firm had to develop a code generator to insert the light spot on the TV screen. Essentially, the generator supplies the on-off intervals used by the digital decoder to turn the panel lights on and off. In an audio version of the terminal, the code generator is used to program one channel of stereo tape with 400-hertz tones that trigger the lights. The Air Force is presently evaluating the audio training system, and other military agencies are trying out the video terminals.

Schools, hospitals, and industrial manufacturers are also looking over the Telattach terminals. □

Take a drive. The TelaRacing terminal is readily adapted to any television monitor.



Ohio gets big, cheap 2-way CATV system

Although experimental installations have proven that two-way TV is technically feasible, perhaps the stumbling block to its development has been the high cost of workable home terminals. But now Coaxial Communications Inc., Sarasota, Fla., which has the franchise to install CATV lines to some 60,000 homes in Columbus, Ohio, is planning to wire the first 10,000 to 15,000 subscriber sets on a completely bidirectional hookup using only slightly modified standard CATV converters.

The modified converters turn TV receivers into two-way terminals, sensing if the set is on, what channel is tuned, if a pay TV security key is activated, and if the converter is operating properly. It also communicates this information to a minicomputer used to poll the status of home TV sets.

These units will be a quarter the price of home terminals presently designed for two-way cable. The cost savings result from Coaxial Communications' system, which groups 100 to 200 homes on a time- and frequency-division-multiplexed network. In previous bidirectional layouts, each home terminal required a signal-processing module and transmitter. Coaxial Communications will use the system for pay-TV, but other uses include teaching, meter reading, polling, security alarms, and supplying special information on demand.

A minicomputer at the operator's central station (head end) polls terminal amplifiers controlling the groups of homes, rather than individual TV receivers. This arrangement also makes it possible to "open" only a small percentage of the return lines at any one time, limiting the amount of interference and noise that can penetrate the net.

The company has been conducting experimental pay-TV services with over 900 subscribers to test the hardware and get customers' reactions. In the present setup, a modified General Automation minicomputer polls the group terminal amplifiers every three to five minutes. It records what channel is being watched and, if it is the pay-TV channel, bills the subscriber $1.50 to $2.50 per movie.

Polling and paying. The set-top converters—Oak Industries Inc.'s Gamut-26 units—are ordered with modest additions: a digital encoder chip, which encodes the channel position of the tuner shaft, and an extra power supply. To this, Coaxial Communications adds an assembly of four ICs and about 20 discrete components. The total cost of the home unit is about $60.

Before being given the pay-TV service, subscribers sign agreements allowing the operator to monitor their viewing habits for billing purposes. The cable operator agrees not to reveal to any outside party the viewing records of the subscribers by name. Since the pay-TV plan only uses about half of the bit capacity of the $60 modified terminal, the CATV firm intends to offer other two-way services in partnership with other software companies. □

Clothes dryer uses MOS control chip

An MOS control chip has been designed into a second major household appliance. Sears' new Lady Kenmore model, which is made by Whirlpool, is the first automatic clothes dryer to use an MOS chip for timing and logic control. That chip and a solid-state moisture sensor for controlling the drying cycle are made by American Microsystems Inc., Santa Clara, Calif.—the company that had earlier developed the MOS chip for Frigidaire's sophisticated touch-control range [*Electronics*, Feb. 1, 1973 p. 44].

AMI's solid-state controls not only offer additional features, but are also expected to be more reliable and will be comparable in cost to the complex electromechanical controls needed for expensive appliances. The latter point is a pivotal one for consumer-product manufacturers, most of whom are reluctant to pay much more for an electronic part than for the electro mechanical unit it replaces.

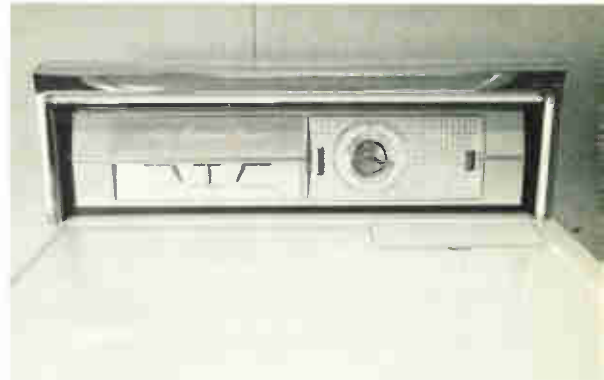
Wet feet. While Sears is a pioneer in incorporating microelectronic controls into appliances, according to Jim Meyer, manager of custom product marketing at AMI, there is a lot of interest at other companies, as well. "They all want to get their feet wet, but they don't want to drown," says Meyer.

The Sears/Whirlpool dryer uses a relatively conventional high-threshold metal-gate p-MOS part that measures less than 120 mils on a side. The drying cycle is relatively complex. It includes a drying period, the length of which depends on the moisture sensor. There is also a panel control for different types of clothes—to allow for drying the thick seams in jeans, for example, which otherwise might remain wet even when the surface is dry.

The electronically controlled dryer also has a cool-down cycle, and the popular anti-wrinkle feature. For this, a buzzer sounds and the drum tumbles occasionally if the clothes aren't removed. This alarm will continue for up to 2½ hours.

The circuit operates from a zener-regulated 27-volt, 30-milliampere supply. The 60-hertz clock is derived directly from the power line through a very large resistor, and is protected against transient peaks to 1,000 V. Extensive signal conditioning is required because of the electrically noisy environment.

The MOS chip operates relays that drive the heating coils and the motors for the drum and fan. Transistor buffers actually drive the relays. The chip is housed in 16-pin ceramic packages, but AMI expects plastic to be used eventually and is testing plastic-encapsulated units.



MOS pervades appliances. Beneath that dryer lies it MOS controls from AMI.

AMI credits Whirlpool for an excellent job of defining the logic required. Says Meyer: "In a custom job like this one, the better prepared the customer is, the smoother the development." □

Navigation

Two-system plan charts new market

The Coast Guard and the White House Office of Telecommunications policy have at last agreed on two navigation systems to cover U.S. coastal waters. These will be loran C for coastal and river coverage and Omega for ocean navigation [*Electronics*, April 26, 1973, p. 49]. The systems would supplant loran A for coastal regions, and prevent further proliferation of competing systems.

The Government has, in effect, pledged support for operation of loran C and Omega for at least 10 years until commercial satellite-based systems come into being. The result is that the plan:

- Solidifies new navigation-equipment markets as maritime users install necessary gear to use the services.
- Becomes the first phase of an impending national navigation plan

for land, sea, and air users, for which the White House Office of Telecommunications Policy is expected to issue the first Government-coordinated outline this fall.

- Signals the start of a $115 million effort by the Coast Guard to build new loran-C chains of transmitting stations and upgrade existing ones, if Congress approves.
- Sets up possible future confrontations among competing interests over whether the airlines' system and foreign-flagship owners might be required to add loran-C equipment before they may enter U.S. ports. Both now use loran A.
- Augurs eventual establishment of a civil maritime communications service, like the Federal Aviation Administration, and most likely operated by the Coast Guard.

The last point is a touchy issue because it raises the specter of user charges to support such an agency. But Government officials point out that existing maritime systems were set up for Government use and question whether or not the Government should be operating commercial systems.

DOT, mainly the Coast Guard, wanted loran-C for coastal coverage [*Electronics,* Dec. 18, 1972, p. 36], and the Office of Telecommunication Policy, working through the White House office of Management and Budget, had shown preference for Omega, while pushing for only two systems to cut down proliferation. The Department of Transportation apparently asserted itself, however. In the agreement, the Coast Guard got loran C, but it had to give up a third system to cover navigable rivers and harbors. Thus, the development contracts for the Rivers and Harbors Navigation System will be terminated with RCA and Tracor, a Coast Guard official says. Loran C serves this need.

Phase in and out. Once Congress approves the budget, loran-A users would be given five years to phase out, in addition to a two-year overlap before having to use loran C. This mostly would affect about 54,000 commercial vessels of more than five tons, of which 19,350 are fishing craft. Typical prices for loran-C and Omega receivers run about $3,000 each, although dual receivers are being developed. The Coast Guard plans to spend $17 million in fiscal 1975 to start building a new loran-C chain of five stations on the West Coast, followed by new chains in the Gulf Coast and the Gulf of Alaska in fiscal 1976.

The national plan identifies those systems that the U.S. is prepared to support, says Charles Joyce, assistant director of the Office of Telecommunication Policy. Users buy other systems at their own risk, he says. □

Components

Analog switch makes a telephone connection

A new analog switch from Siliconix Inc. could be an ideal solid-state switch for telephone systems. The monolithic array of four double-pole, single-throw switches, consisting of logic, four C-MOS drivers, and eight n-channel junction field-effect transistors, is expected by the company to replace the silicon-controlled rectifier even before the SCR has replaced the mechanical crossbar switch in phone matrixes.

The SCR has a number of drawbacks as a solid-state switch: it needs several milliamperes of holding current to stay on; being bandwidth-limited, it can't be used for multiplexing voice transmissions or sending digital data at high rates; and its high capacitance makes it susceptible to "feedthrough"—those other voices, 60 decibels down, that filter through "off" switches and onto the phone line.

The JFET, however, being a bulk, rather than a surface device, has high carrier mobility and low capacitance, low feedthrough, and low on-resistance per unit area.

The Santa Clara, Calif., firm has made JFET switches, with a variety of drivers, since its beginnings in the early 1960s. Later it began adding logic and drivers to the FETs and selling hybrid analog switches driven by bipolar and p-channel MOS transistors. In this array, the C-MOS driver, according to Lorimer Hill, who headed the Siliconix design team, eliminates the power drainage that characterized earlier drive circuits.

Connects. The FET needs a connection between gate and source to stay on, and a connection between gate and negative supply to stay off. Resistors, though the simplest way to connect gate and source, will pull current in either state and, in addition, load the analog voltage. Bipolar transistors require base current, unlike MOS devices. In the Siliconix array, therefore, a p-channel MOS transistor connects gate and source, and an n-channel transistor connects gate and negative supply.

With these C-MOS drivers, the switch has high off impedance (isolation, which depends on the size of the switch, is typically 60 to 80 dB at a video-signal frequency). There is no need for standby power and no loading of the analog signal. With leakage of 1 microampere, power loss is 15 microwatts, and typically, according to Siliconix, the drainage is two orders of magnitude less, on the order of nanowatts.

With 5 volts peak-to-peak signal-handling capability, the new switch will draw a few microamperes for the most negative analog voltage, and 10 to 20 μA for the most positive voltage. The actual power dissipation depends on how fast the device is switched between the most positive and negative voltages. Thus, dissipation depends on the rise and fall times of the system logic.

On same chip. Building the JFETs and MOS transistors on the same chip was chiefly a matter of working out the right temperatures, times, and procedures to control diffusion depths. The p-diffusion depth is critical in the JFET, while gate surface

1000 cm/µsec stored writing speed, four storage modes, and more.

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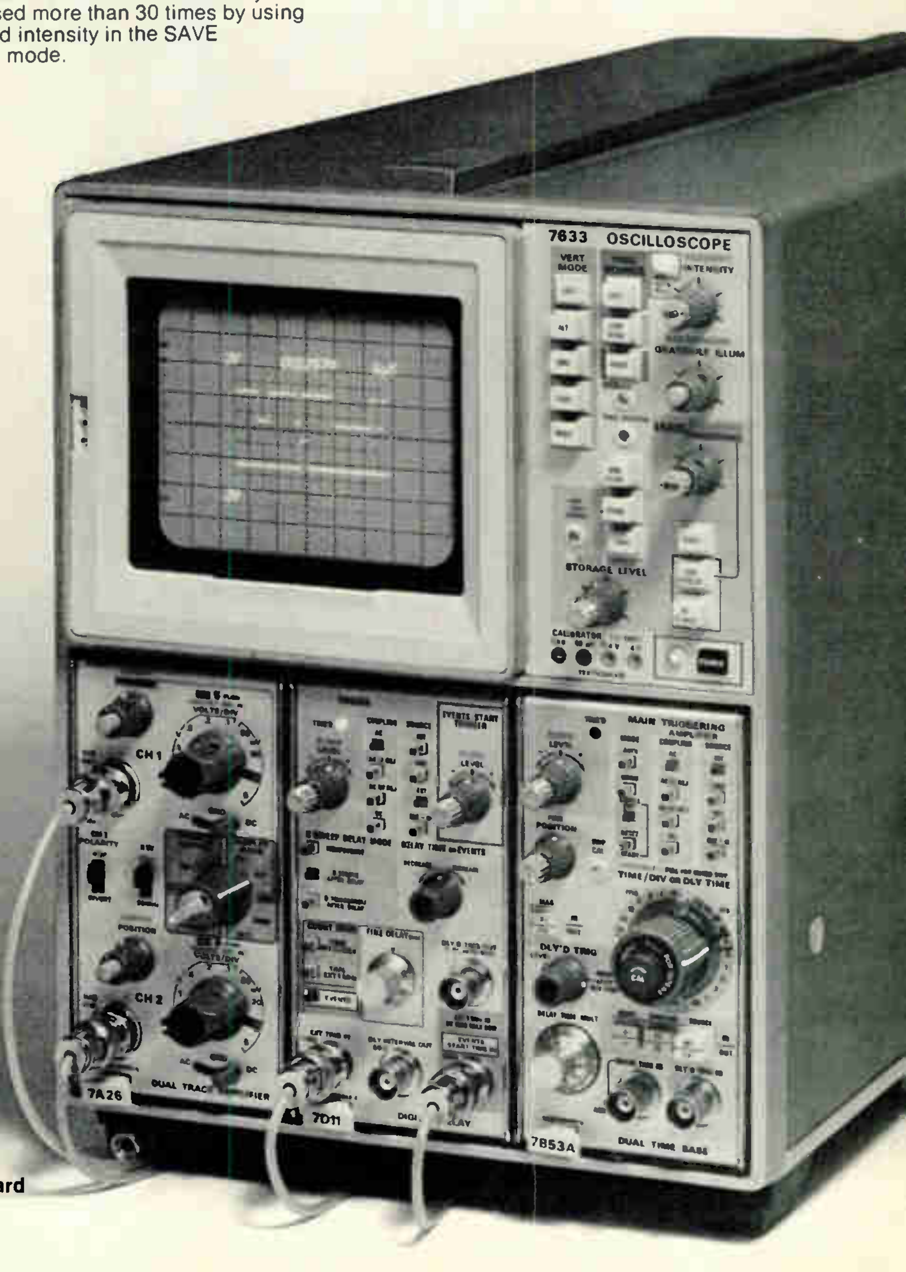


Circle 33 on reader service card
For a demonstration circle 32 on reader service card

concentrations are critical to fabricating the C-MOS devices. "It's not perfectly obvious how to do it right the first time," Lorimer observes.

Siliconix spent a year developing the process, and now feels it has got it down pat. The company is now in a "preproduction" phase for a military customer and plans to have samples available for civilian users by summer. Jerry Parker, analog-switch product manager, expects the array to find favor first with makers of PBX equipment, but hopes to sell to many of the telephone companies as well. □

Fiber optics

Low-loss coupler feeds 20 terminals

Before multi-terminal optical-data systems can become practical (see pp. 89–96), a standardized method of efficiently distributing a single light signal among many terminals is essential. Such a device has recently been developed by Corning Research Labs., Corning, N.Y.

The device, called a Star Coupler, consists of an aligned group of reflectively coupled fiber bundles that are inserted into a cavity with a mirrored end face. When light from a single fiber strikes the mirror, the light is distributed evenly to each of as many as 20 optical fibers, which, in turn, may be connected to various types of terminals.

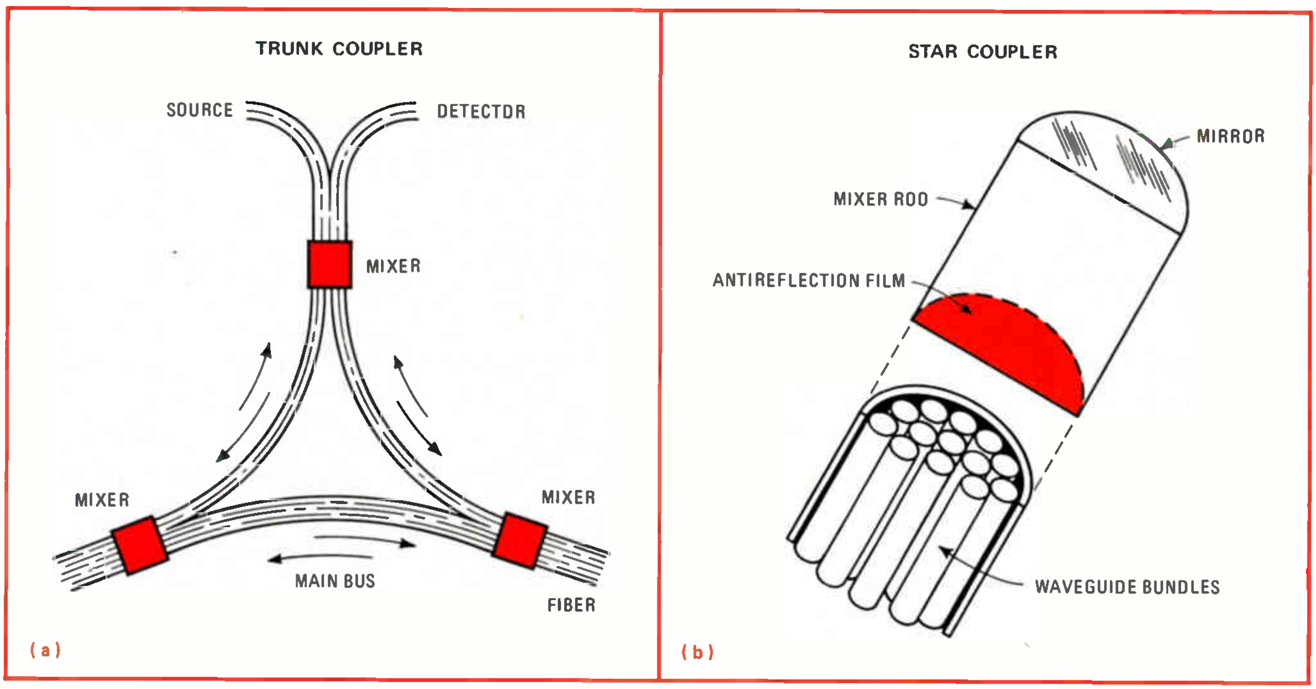
With the device, the mixing and interconnection signal losses increase only logarithmically with the number of terminals, rather than linearly, as is the case with a tapped data trunk. Moreover, because 20 ports can be tapped, only one Star Coupler is likely to be needed for a given system.

The prototypes that have been constructed so far link seven ports although they contain enough optical fibers to link 20. Insertion losses are expected to be as low as 4 decibels, according to Frank Theil, supervisor of applied electrophysics at Corning. By contrast, a T-coupler for data trunks, recently developed by the Naval Electronics Laboratory Center [*Electronics*, Dec. 20, 1973, p. 30] has 3-dB mixing/interconnection loss for a single terminal coupling. Critical to the coupler's successful operation are rigidity in its packaging, to prevent misalignment under shock and vibration, and a very flat mirror—to a fraction of a wavelength.

The Star Coupler uses the optical nature of the signals in a waveguide to perform all the mixing and signal division at a single point in the optical system. Central to its functioning is the spreading of light from a given multimode fiber at an angle that is a characteristic of the fiber. A fiber bundle from each terminal is brought into the coupler, and either a central processor or a single terminal acts as a signal source. The light strikes the mirror and is instantly coupled to the terminals of the system. The light simply spreads out, covers the mirror, and irradiates all the fibers uniformly. Moreover, all terminals receive an equal fraction of the input signal.

In contrast, in the tapped trunk, if each terminal received the same fraction of the main trunk signal, then terminals further down the trunk would be receiving less optical energy than those nearer the signal source. The problem is that the trunk is configured analogously to an electronic data bus, but lacks an

Contrast in techniques. Data trunk (a) requires a mixer for each tap off the main bus. The Star Coupler (b) simultaneously couples all terminals to the source. And adding more terminals extracts only minimum source power.



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MIL-M-38510/05003	CD4023A	Triple 3-Input NAND Gate
MIL-M-38510/05101	CD4013A	Dual "D" Flip-Flop
MIL-M-38510/05102	CD4027A	Dual J-K Flip-Flop
MIL-M-38510/05301	CD4007A	Dual Complementary Pair Plus Inverter
MIL-M-38510/05302	CD4019A	Quad AND-OR Select Gate
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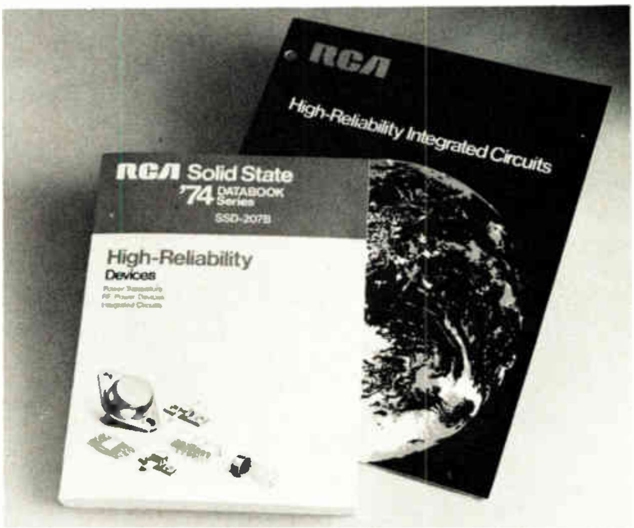

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optical analog of a high-impedance amplifier, which removes only negligible amounts of energy from the signal.

Government electronics

Automated weather stations planned

A national network of automated weather-monitoring stations is being planned by the Federal Aviation Administration and the National Weather Service. About June 1, requests for proposals will be issued for the development of a prototype station to tabulate and track a host of weather parameters. Eventually, as many as 155 automated stations may be installed.

The three-year development plan for what the FAA calls an aviation automated weather-observation system (AV-AWOS) includes phases for completing the prototype and the developmental model, and the installation, evaluation and testing of the final product. Development of the prototype is expected to cost over $1 million, even though contractors will be asked to keep the design as simple as possible.

Under the joint program, the FAA is funding the project, but the Weather Service is issuing the RFPs. Who pays for the proposed operational network has yet to be decided. The funding in subsequent years will determine the number of stations ultimately installed. Nor have the over-all costs yet been estimated, since some of the sensing technology needs further development.

The stations will multiplex, process, and store data collected by a variety of sensors, automatically maintaining a weather record plotted over 24 hours. This will include such parameters as temperature of land and water, wind velocity and direction, and a count of pollutants. This information will be available from each station's minicomputers, which will be linked to central computers. Each input/output and communications terminal will include a Teletype interface, independent processing system interface, local and remote displays, a manual input/output device and a local data recorder.

Options. In selecting sensors, contractors will have the option of using either those already developed by the Weather Service or commercial versions with the same performance specifications. Where the Weather Service doesn't have adequate sensors, designs will be selected and evaluated for the developmental model and later for the prototype.

The FAA says that the automated network will fit into its program for automating flight-service stations and will augment its string of Limited Aviation-Weather Reporting Stations. □

Trade

U.S. forecasts 1974 decline in imports

A net decrease in 1974 U.S. imports of home-entertainment electronics, as well as a shift in the relative markets shares of Japan, Taiwan, and Korea, has been forecast by the U.S.

News briefs

National sets up Memory Systems group
National Semiconductor Corp., Santa Clara, Calif., has formed a Memory Systems group charged with designing, building and testing custom semiconductor-memory systems. The new group, says National president Charles Sporck, will provide customers with a cost-effective method to implement semiconductor memories in end-user data-processing systems, while at the same time attempting to minimize the financial and scheduling risks often encountered by companies using semiconductor-memory technology for the first time. David Martin, a former vice president of marketing for Advanced Memory Systems, who recently joined National, will be general manager.

Copyright ruling cheers CATV industry
A 10-year legal dispute between broadcasters and the cable-television industry ended when the U.S. Supreme Court ruled 6-3 that cable operators may import distant signals and rebroadcast them locally without paying copyright fees. The decision, in a case between the Columbia Broadcasting System and TelePrompTer Corp., was hailed as a victory by the National Cable Television Association.

General Automation acquires typesetting firm
General Automation Inc., the Anaheim, Calif., maker of minicomputers and minicomputer-based automation systems, has acquired Tal-Star Computer Systems Inc. for an undisclosed amount of cash and stock. Tal-Star sells computer-automated typesetting, printing and other systems to newspapers. General Automation has been supplying Tal-Star with computers, while the latter provides the operating systems required to automate the typesetting, printing, and distribution of a large number of U.S. dailies.

Opel named president of IBM
John R. Opel has moved into the presidency of International Business Machines Corp., replacing Frank T. Cary. Cary continues to wear his other two hats, those of chairman and chief executive officer. The change makes Opel the third man in the corporate office, which runs the company day-to-day, along with Cary and Gilbert E. Jones, chairman of the IBM World Trade Corp. Until the end of January, Cary and Jones had shared the corporate office with Thomas J. Watson Jr., who retired upon reaching the age of 60. Opel was promoted from senior vice president.

U.S. IMPORTS OF CONSUMER AUDIO AND VIDEO PRODUCTS BY COUNTRY OF ORIGIN
(BY THOUSANDS OF DOLLARS)

	1972	Percent of Total	1973	Percent of Total
Japan	$1,175,201	68.8	$1,182,118	61.7
Taiwan	233,534	13.7	329,469	17.2
Hong Kong	99,566	5.8	117,666	6.1
U.K.	73,587	4.3	75,965	4.0
Korea	16,492	1.0	58,560	3.1
Singapore	25,335	1.5	31,298	1.6
Canada	26,553	1.6	30,932	1.6
Germany	16,022	0.9	21,072	1.1
Mexico	25,388	1.5	20,790	1.1
Brazil	825	0.1	15,801	0.9
Other	14,996	0.8	30,837	1.6
Total	$1,707,499		$1,914,508	

Source: Bureau of Census

Department of Commerce. The estimate came with the Government's disclosure in mid-March that 1973 imports of home-entertainment products that totaled $1.9 billion reflect a slowdown in the rate of growth.

Total imports of audio and video consumer products last year rose 12% from the 1972 level of $1.7 billion, according to the Census Bureau. This increase compares with a 31% increase between 1971 and 1972.

Decline? In its look ahead at imports for this year, the department said a net decrease in imports from the 1973 level could result from "slackening U.S. demand, as well as production adjustments in Japan." Japan continued to supply the lion's share of U.S. audio and video imports last year—nearly $1.2 billion for 61.7% of the total—but its share of the import market continued to slip.

Coupled to the "strong possibility of a substantial decline in U.S. imports from Japan," the Government forecasts continuing strong gains in Taiwan's second-place share of the U.S. imports market, as well as a growing surge from Korea to make it "the fastest-growing supplier" to the U.S. consumer market.

How much this expected redistribution of U.S. import-market shares will really affect Japanese interests is uncertain, however. Indeed, much of it may come as a result of direct Japanese action, suggests the Commerce Department study. For example, the 1974 growth of Korea's role as a supplier to the U.S. will be a product "almost exclusively of joint Korean-Japanese ventures" generating "the highest-value percentage gains of any other foreign supplier." Korea is now in various stages of joint ventures with such major Japanese manufacturers of home-entertainment electronics as Matsushita, Toshiba, Sanyo, and Crown. As a nation that had less than 0.5% of the U.S. import market in 1971, Korea supplied 3.1% of the imports last year, rising to fifth place.

Declining share. Japan's share of U.S. imports has been declining for multiple reasons: the change in international monetary relationships; the beginning of color-TV assembly by Sony in San Diego; opening of a Matsushita plant in Puerto Rico; and increased shipments to the U.S. from American and Japanese subsidiaries and other producers in Asian countries.

Faced in 1974 with continuing rises in wage and material prices at home, costly pollution-control directives, and quantitative voluntary export controls on TV receivers, plus a check-price system on tape recorders shipped to Europe, in the U.S. view, Japan will "concentrate on production of market-tested, premium-type, high-profit items."

Japan's Ministry of International Trade and Industry (MITI) says the U.S. report has already predicted 1974 production declines of 29% in monochrome-TV sets, 15% in radios, and 5% in color-TV receivers. However, the same MITI forecast notes that Japan's exports of resistors, tubes, and diodes should rise by 39%, 25%, and 15%, respectively. These gains, the U.S. study says, "reflects the expansion in production capacity of overseas Japanese subsidiaries assembling audio and video products."

In breaking out 1973 consumer product imports, the Commerce Department analyzed the changes this way:

- Color TV: Imports of 1.46 million units rose by only 140,000 sets from 1972, while domestic production of 8.7 million units reflected a sharp increase of 1.7 million sets in the year. As a result, the import share of color-TV sets slipped to 13% from the 18.6% peak of 1971.
- Monochrome TV: The nearly 5 million units imported ran about 60,000 below the 1972 total. However, the drop in domestic output "exceeded by far the import decrease," plummeting 34% from 1972 to last year's estimated output of 2.1 million sets. In the comparable period, unit imports rose from 62% to 70% of domestic consumption.
- Tape recorders/players: This leading consumer-import category reflected only a nominal unit import gain of 2.6% to 22 million sets from 1972. However, price increases by all foreign suppliers produced the largest dollar gain for any category. Of the $657 million import total, up $76 million from 1972, Japan captured 87% of the market.
- Home radios: Hong Kong remained the leading unit supplier with 48.2% of total imports, numbering nearly 41 million sets. The import market increased a nominal 1.9% in quantity and 11% in value from 1972.
- Radio/phonograph combinations: Unit imports dropped 8% to 2 million from the 2.2 million posted in 1972. Japan's share declined in both units and dollars as Taiwan's share increased.
- Auto radios: Imports of 4.5 mil-

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lion units, valued at $91 million, registered the largest gains of any import category in 1973, jumping 53% and 71% in quantity and value, respectively. Japan and Canada remain the two major suppliers with 44% and 37% shares of the total units imported. □

Commercial electronics

Matsushita-Motorola deal presages more

Last week's announcement that Matsushita Electric Industrial Co. of Japan had agreed to buy the home TV-receiver product line of Motorola Inc. may just represent the tip of the iceberg as Matsushita steers itself more squarely into the U.S. market.

"This is the first step in the medium-term objective of vertical integration in mainland U.S.," says Nat Gilbert, vice president and treasurer of Matsushita Electric Co. of America, headquartered in New York City. Matsushita's long-range goal, says Gilbert is full vertical integration in the U.S. And this could mean start-ups as well as acquisitions. "Up to now, we were simply a distributor" of the Panasonic product line made by Matsushita, Gilbert notes. "Now we're going to be a manufacturer as well."

He says that the company is looking at a number of other acquisition possibilities, even though Matsushita "has not actively sought any company. Motorola came to us." Other companies have, too—although Gilbert refuses to name them or what market areas they're in. He does stress, however, that it's not Matsushita's intention to gobble up U.S. businesses.

The Motorola transaction is expected to be consummated next month, assuming that the boards of both firms and the Japanese government approve it. Matsushita plans to retain the Motorola Quasar tradename on its TV sets. In fact, a new company, Quasar Electronics Corp., will result from the transaction. Gilbert says that the Quasar and Panasonic TV-set lines will be fully competitive with each other, and that "very little will change except the name on the sets," in the Quasar line. Nor does Matsushita plan any management changes in Motorola operation.

Rumors that Motorola wanted out of the home TV-set business preceded the announcement. Motorola officials declined to say whether the business was profitable last year, but did admit that its TV business "hasn't achieved appropriate profit objectives in recent years." Industry sources peg Motorola's share of the TV-set market at between 6% and 7%, and suggest that level would account for some $244 million in the firm's 1973 sales of $1.43 billion.

The sale will encompass present Motorola production facilities in three Illinois cities: Franklin Park, Quincy, and Pontiac. The Matsushita subsidiary also will assume the lease for an assembly plant in Markham, Ontario. The deal also includes appropriate U.S. and Canadian inventories for the sets. □

AT&T and MCI lock horns

The counteroffensive launched by AT&T to quell competition fostered by the Federal Communications Commission and pursued by the specialized common carriers has run into more legal and regulatory crossfire [*Electronics*, Oct. 25, 1973, p. 40]. MCI Communications Corp. has filed suit in U.S. District Court in Chicago, charging AT&T with violating the Sherman Antitrust Act.

MCI seeks treble damages in a four-count complaint charging AT&T with attempting to monopolize the $1.1 billion business and data-communications market. The main charge is that AT&T has delayed in providing local telephone lines that would permit MCI customers to reach MCI's long-haul relay equipment.

An AT&T spokesman responded unusually sharply to MCI's suit, expressing amazement that "MCI thinks there are any antitrust violations. We have cooperated with MCI, enabling them to provide end-to-end private-line service to their customers." Frankly, he says, "the complaint is ridiculous."

Trouble. MCI's suit promises some trouble for AT&T, but how much remains to be seen. For one thing, the Justice Department reportedly is investigating AT&T's conduct in the private-line communications market and has asked the company for pertinent documents.

And, MCI's new suit seeks to open the wedge it won in a Philadelphia Federal Court in February. There, it got an injunction, now on appeal, ordering AT&T to provide MCI the same kinds of circuits the same way it provides them to AT&T subsidiaries.

Earlier before the FCC, the two sides argued during a full day's hearing whether or not AT&T was required to provide the specialized common carriers with foreign and common control switching arrangements.

AT&T's Richard R. Hough, Long Lines department president, contended that AT&T is not required to provide such service under the FCC order establishing the specialized common carriers. To do so, he said, would fragment the network, degrade service, and increase cost to the public. MCI and other specialized common carriers argued otherwise, saying that denial undermined them competitively with AT&T.

And, Kelly E. Griffith, deputy chief of the FCC's Common Carrier Bureau, stated that the specialized common carriers are permitted to provide those services, and that they can do it without harm to the network. This left the decision to the FCC, which gave no indication when it might decide the thorny issue.

In previous arguments before the FCC, MCI and other specialized common carriers, aided by the FCC's Common Carrier Bureau, tried to gun down AT&T's policies on interconnecting its facilities with the carrier's services, alleging that AT&T intentionally moved slowly to try muzzle the new companies. □

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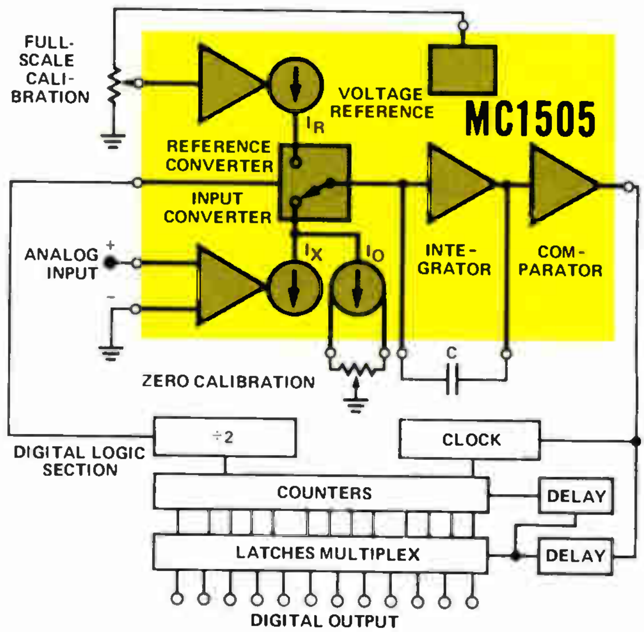

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Accuracy. Outstanding accuracy. With the digital system of your choosing; counters, a clock, and some gates, you can show off an A/D converter of either 3½ or 4½ BCD bits or up to 13 bits in the binary code.

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Try it in a 3½ or 4½ digit A/D converter — combined with either CMOS or bipolar logic for the complete A/D converter function. Particulars can be found in the detailed 14-page data sheet. The data sheet can be found at P. O. Box 20912, Phoenix, Arizona 85036, or circle the reader service number below.

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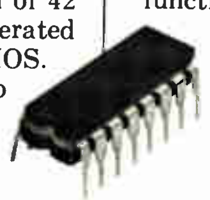

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Hegeler Zinc Co., Danville, Ill.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Paul & Beekman, 4250 Wissahickon Ave., Philadelphia, Pa.

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Lenz Electric Co., 1751 No. Western Ave., Chicago, Ill.

TUBE SOCKETS

Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago, Ill.
Alden Products Co., 715 Center St., Brockton, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cinch Mfg. Co., 2335 W. Van Buren St., Chicago, Ill.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Eby, Inc., H. H., 4700 Stenton Ave., Philadelphia, Pa.
Federal Screw Products Co., 26 S. Jefferson St., Chicago, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y. (See page 98.)
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill. (See page 151.)
Micarta Fabricators, Inc., 4619 Ravenswood Ave., Chicago, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Remler Co., 2101 Bryant St., San Francisco, Cal.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.

Solder

Allen Co., L. B., 6730 Bryn Mawr Ave., Chicago, Ill.
Alpha Metal & Rolling Mills, Inc., 363 Hudson Ave., Brooklyn, N. Y.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Division Lead Co., 836 W. Kinzie St., Chicago, Ill.
Dunton Co., M. W., 670 Eddy St., Providence, R. I.
Gardiner Metal Co., 4820 S. Campbell Ave., Chicago, Ill.
Glaser Lead Co., 31 Wycoff Ave., Brooklyn, N. Y.
Heck Metal Co., 318 N. Holliday St., Baltimore, Md.
Kester Solder Co., 4212 Wrightwood Ave., Chicago, Ill.
Lenk Mfg. Co., Newton Lower Falls, Mass.
National Lead Co., 111 Broadway, New York, N. Y.
New York Solder Co., 15 Crosby St., New York, N. Y.
Ruby Chemical Co., 68 McDowell St., Columbus, Ohio

Soundproofing

Celotex Corp., 919 N. Michigan Ave., Chicago, Ill.
Insulite Co., Builders Exchange Bldg., Minneapolis, Minn.
Johns-Manville, 22 E. 40th St., New York, N. Y.
Masonite Corp., Cellufoam Products Div. 6565 S. Lavergne Ave., Chicago, Ill.
United States Gypsum Co., 300 W. Adams St., Chicago, Ill.

Speakers

see Loudspeakers

Springs

Accurate Spring Mfg. Co., 3817 W. Lake St., Chicago, Ill.
American Coil Spring Co., 2034 Keating Ave., Muskegon, Mich.
American Spiral Spring & Mfg. Co., 5528 Harrison St., Pittsburgh, Pa.
American Spring & Wire Specialty Co., 816 N. Spaulding St., Chicago, Ill.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Barnes Co., Wallace, Div. of Associated Spring Corp., Bristol, Conn.
Barnes-Gibson-Raymond Div. of Associated Spring Corp., 6400 Miller Ave., Detroit, Mich.
Cary Spring Works, Inc., 240 W. 29th St., New York, N. Y.
Cleveland Wire Spring Co., Cuyahoga Heights, Cleveland, Ohio
Cuyahoga Spring Co., 10272 Berea Rd., Cleveland, Ohio
Dunbar Bros. Co., Div. of Associated Spring Corp., 76 South St., Bristol, Conn.
Fischer Spring Co., Chas., 260 Kent Ave., Brooklyn, N. Y.
Gardner Wire Co., 5045 W. Lake St., Chicago, Ill.
Gibson Co., Wm. D., Div. of Associated Spring Corp., 1800 Clybourn Ave., Chicago, Ill.
Hubbard Spring Co., M. D., 672 Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa. (See page 43.)
Instrument Specialties Co., 246 Bergen Blvd., Little Falls, N. J. (See page 152.)
Jones Spring Co., W. B., 124 E. Seventh St., Cincinnati, Ohio
Lee Spring Co., 30 Main St., Brooklyn, N. Y.
Manross & Sons, F. N., Div. of Associated Spring Corp., Forestville, Conn.
Mid-West Spring Mfg. Co., 4634 S. Western Ave., Chicago, Ill.
New Britain Spring Co., New Britain, Conn.
Muehlhausen Spring Corp., E. Ottowa Ave., Logansport, Ind.
Peck Spring Co., Plainville, Conn.
Phoenix Hardware Mfg. Co., 49 Illinois St., Buffalo, N. Y.
Precision Products Co., Waltham, Mass.
Raymond Mfg. Co., Div. of Associated Spring Corp., 226 S. Center St., Corry, Pa.
Reliance Spring & Mfg. Co., 238 40th St., Brooklyn, N. Y.
Reynolds Spring Co., 955 Water St., Jackson, Mich.
Steel Co., Herman D., Lafayette Bldg., Philadelphia, Pa.
Tuck Mfg. Co., Brockton, Mass.
Union Spring & Mfg. Co., New Kensington, Pa.
Wickwire Spencer Steel Co., 500 Fifth Ave., New York, N. Y.
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Stabilizers

VOLTAGE STABILIZERS—see Regulators

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Ainsworth Mfg. Co., 2200 Franklin St., Detroit, Mich.
Akron-Selle Co., Chestnut St., Akron, Ohio
Allegheny-Ludlum Steel Corp., Oliver Bldg., Pittsburgh, Pa.
Aluminum Goods Mfg. Co., 15th & Franklin Sts., Manitowoc, Wis.
American Brass Co., Waterbury, Conn.
American Emblem Co., Utica, N. Y.
American Pulley Co., 4260 Wissahickon Ave., Philadelphia, Pa.
American Stamping Co., 1000 E. 64th St., Cleveland, Ohio
Ansonia Mfg. Co., Ansonia, Conn.
Auburn Mfg. Co., 5 Stack St., Middletown, Conn.
Barnes Co., Div. of Associated Spring Corp., Wallace, Bristol, Conn.
Barnes-Gibson-Raymond Div. of Associated Spring Corp., 6400 Miller Ave., Detroit, Mich.
Bay State Stamping Co., 380 Chandler St., Worcester, Mass.
Berger Mfg. Co., Canton, Ohio
Bettcher Mfg. Co., 3106 W. 61st St., Cleveland, Ohio
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Bowen Products Corp., Auburn, N. Y.
Brewer-Tichner Corp., Cortland, N. Y.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
Briggs Mfg. Co., 11631 Mack Ave., Detroit, Mich.
Budd Mfg. Co., Edward G., 25th & Hunting Park Ave., Philadelphia, Pa.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Continental Machines, Inc., 1308 South Washington Ave., Minneapolis, Minn.
Crosby Co., 183 Pratt St., Buffalo, N. Y.
Dahlstrom Metallic Door Co., Buffalo St., Jamestown, N. Y.
Defiance Pressed Steel Co., Defiance, Ohio
Detroit Stamping Co., 3461 W. Fort St., Detroit, Mich.
Dickey-Grabler Co., 10302 Madison Ave., Cleveland, Ohio
Dunbar Bros. Co., 76 South St., Bristol, Conn.
Edwards Mfg. Co., 529 Eggleston Ave., Cincinnati, Ohio
Erie Art Metal Co., 1602 E. 18th St., Erie, Pa.
Erie Can Co., 816 W. Erie St., Chicago, Ill.
Faries Mfg. Co., 1036 E. Grand Ave., Decatur, Ill.
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
Forsyth Metal Goods Co., Aurora, Ill.
Fostoria Pressed Steel Co., Fostoria, Ohio
Franklin Fibre-Lamitex Corp., Wilmington, Del.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y. (See page 98.)
Fulton Sylphon Co., 2300 Cumberland Ave., Knoxville, Tenn.
General Industries Co., Cleveland and Olive Sts., Elyria, Ohio
General Metal Products Co., 3879 Delor St., St. Louis, Mo.
Geometric Stamping Co., 1111 E. 200th St., Cleveland, Ohio
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Glenvale Products Corp., 9316 French Rd., Detroit, Mich.
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Goetze Gasket & Packing Co., New Brunswick, N. J.
Grabler Mfg. Co., 6565 Broadway, S.E., Cleveland, Ohio
Grammes & Sons, L. F., 344 Union St., Allentown, Pa.
Gregory Mfg. Co., (Mt. Carmel) New Haven, Conn.
Greist Mfg. Co., 501 Blake St., New Haven, Conn.
Hoosier Lamp & Stamping Corp., Evansville, Ind.
Hubbard Spring Co., M. D., 672 Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Insuline Corp. of America, 30-34 Long Island City, N. Y. (See page 163.)
International Insulating Div., General Industries Co., Cleveland and Olive Sts., Elyria, Ohio
King Laboratories, Inc., 205 Oneida St., Syracuse, N. Y.
Lansing Stamping Co., 1159 Pennsylvania Ave., Lansing, Mich.
Manganese Steel Forge Co., Allen St. and Castor Ave., Philadelphia, Pa.
Master Products Co., 6414 Park Ave., Cleveland, Ohio
McCord Radiator & Mfg. Co., 2587 E. Grand Ave., Detroit, Mich.
Melrath Supply & Gasket Co., Tioga & Memphis Sts., Philadelphia, Pa.
Mico Instrument Co., 10 Arrow St., Cambridge, Mass. (See page 162.)
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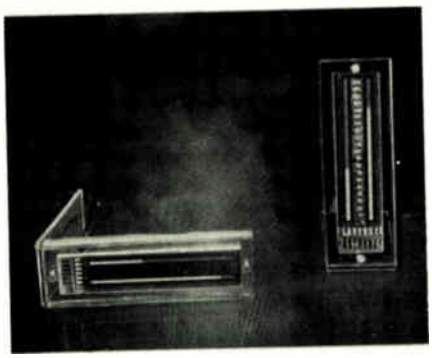

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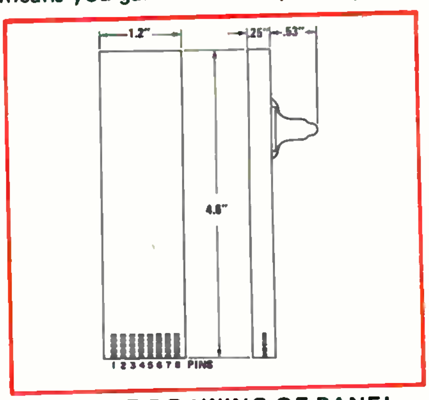

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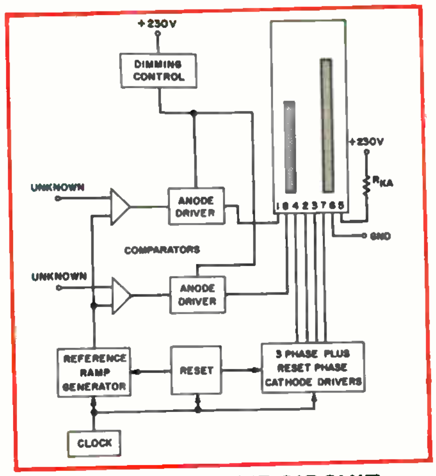

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The best part is the price.
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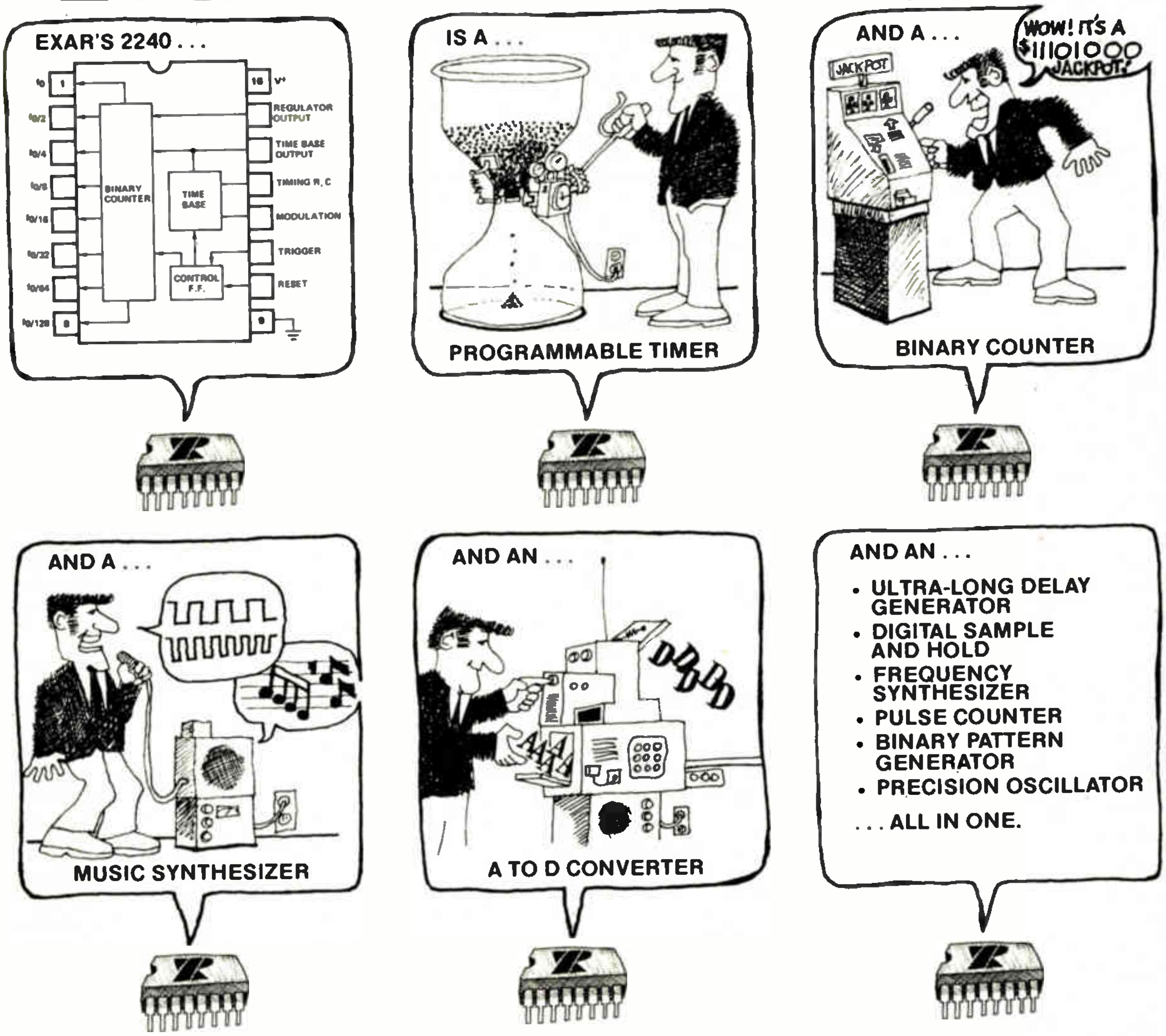
THE FIRST OF THE BIG COUNT TIMERS



Exar's new XR-2240 counter/programmable timer solves so many tough problems that designers will unanimously agree that it's really the universal timer.

With its unique combination of analog and digital timing methods, you can now replace inadequate and complex assemblages of monolithic and electromechanical timers with the much simpler XR-2240. As a bonus, you get greater flexibility, precision operation, and a reduction in components and costs for most applications.

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The XR-2240 operates over a 4V to 15V supply range with an accuracy of 0.5% and a 50 ppm/°C temperature stability. It's available in either a 16-pin ceramic or plastic dual-in-line package for military or commercial applications. Prices start at $3.00 in 100 piece quantities.

For the more conventional timing applications, look to our other timers: the XR-220/230 timing circuit and the XR-2556 dual timers. Call or write Exar, the timer leader, for complete information.

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Washington newsletter

FCC vacancies may not deter Wiley from 900-MHz action

Federal Communications Commission chairman Richard E. Wiley is sufficiently anxious to get a decision on Docket 18262 which will **open and apportion spectrum space in the 900-megahertz region** [*Electronics*, May 10, 1973, p. 29] that he may push for a decision despite the three vacancies on the seven-member commission. Wiley, who calls the proceeding **"one of the most significant decisions which the FCC will make during my tenure, and perhaps during the commission's lifetime,"** indicated at the Electronic Industries Association's spring conference that he may go "with the four horsemen, as we are now being called." **Such a decision would require a unanimous 4-0 vote to preclude petitions for reconsideration later** after any White House nominees are approved by the Senate. But **"all the evidence is in and the staff work is essentially completed"** on the docket, Wiley noted, saying, "it is my profound intention to bring it home just as soon as humanly possible."

Coast Guard seeks systems to monitor ocean dumping

The U.S. Coast Guard is asking for industry responses by March 31 to its question whether ocean-dumping surveillance systems can be made from off-the-shelf equipment. **Charged by the Environmental Protection Agency with enforcing the ocean-dumping laws, the service wants the systems for policing when and where barges discharge their loads.** "It's amazing what and how much is dumped" in the way of sewage, chemicals and dredge soil, declares one officer. **A typical system would combine a Loran C receiver with an events recorder and a draft sensor and could cost from $10,000 to $60,000, depending on the shore-based equipment.** Japan's Furuno Electric Co. makes the only known complete system, and Environmental Quality Systems Inc., Rockville, Md., is reportedly talking about its U.S. licensing. **If no off-the-shelf unit emerges, the Coast Guard will consider issuing a request for proposal for a developmental model.** Who will pay for the units—the service or the dumpers—is as yet undecided.

NASA seeks high-efficiency solar cells

Looking to standardize solar-cell arrays for future spacecraft, the National Aeronautics and Space Administration is issuing requests for proposals for **1,000 cells of greater than 13% efficiency and 2 to 8 mils thick** for a year's testing. Most cells are about 10% efficient and 12 to 14 mils thick. Heliotek, which is developing a new cell, and Centralab, which has had the license for Comsat's "violet cell", seem favored, but a NASA source says **the agency wants several firms capable of making a standard array.** The first big buy of the arrays might be in late 1975 for the international sun-earth explorer.

Bureau of Mines aims to automate mining

In the push to double coal production by 1980, the Bureau of Mines wants to develop **automated mining machines that will use sensing and guidance systems to find and extract rich veins.** The agency is asking companies to submit ideas for advanced systems by May and could fund development of several promising concepts. Also, **the bureau's R&D budget, which in fiscal 1975 has jumped to $50 million from $7 million, includes congressionally approved funding for automated continuous and long-haul mining machines with onboard minicomputers,** and requests for proposals for these should go out in fiscal 1975.

Washington commentary

The EE and the new social perspective

Ignorance of the law has long been held no excuse for its violation. Yet many electronics engineers and manufacturers remain ignorant of how their products can be held in violation of the regulations of such agencies as the Occupational Safety and Health Administration and the Environmental Protection Administration. And that ignorance is not confined to industry. Within Federal agencies that the electronics industries number among their biggest customers, there are project offices proceeding unaware that they may have failed to comply with some safety or environmental regulation already written into Federal or state law.

The Electronic Industries Association now says it is time to change all that. It wants to pull together representatives of all levels of government—Federal through municipal—to meet with the industries' engineering leadership for the first of what the association hopes will be a continuing series of information exchanges. Thus far, EIA's reach appears to have exceeded its grasp, for its three-day design-effectiveness workshop is still something less than sold out, little more than a month before it opens on April 30 at San Diego.

Sponsored by EIA's Government Products division, the conference no doubt has suffered somewhat from its nondescript title: "New Perspectives—Product Effectiveness." But, led by representatives from military and nonmilitary government users, industry, and the academic and consulting communities, the seven scheduled sessions could mark the beginning of an end to ignorance about new Federal requirements concerning product and worker safety, electromagnetic compatibility with other spectrum users, reliability, maintainability, and so on.

Philco's dilemma

Philco-Ford Co.'s Curtis Cunningham, vice chairman of the workshop, is convinced that the sessions will be unique. Among other things, he sees them as one way of obviating the kinds of costs that Philco-Ford and the Government will be required to incur to make a new, multimillion-dollar military antenna comply with OSHA regulations. Both contractor and customer were unaware of these at the time the installation was designed and built.

Teledyne Ryan Aeronautical's Keith Sargent, another conference planner, sees the sessions as providing more than just another opportunity for the personal contact and experience exchange with Government agency specialists that most meetings offer. As leader of the session on product warranty and contractor liability, Sargent is anxious to examine the impact of standards set by agencies other than the customer on the future engineering environment in industry.

EIA's contention is that "this is the first time the producers have invited the users from all levels of government to a mutual working conference." Though that is not in dispute, one official of an EIA member company on the eastern seaboard remains unconvinced of the need to send his engineers off to San Diego. "Why did they pick San Diego?" he asks. For IBM's D. R. Fox, another of the workshop planners, the answer seems obvious: "More and more Federal money is being spent by the states and cities, and California is spending more of it than anyone else."

The combination of money, along with California's legislative leadership in promulgating local environmental and safety controls, makes the Golden State a microcosm of what contractors may expect to encounter elsewhere in the nation, in the view of Fox and his colleagues.

Who stands to lose

Ironically, it may be the smaller electronics manufacturers—those who stand to benefit most from such a workshop series—that choose not to go. Yet the companies that cannot afford heavy staffs of Washington representatives, much less large in-house legal departments equipped to do battle in court with agencies such as OSHA, are among the most vulnerable to the changes now going on in government contracting at the Federal, state and county levels.

For example, says Teledyne's Sargent, "if OSHA says 'stop,' that is exactly what they mean. They can stop work, and they can stop payments" if a contract is believed to be in violation of the Occupational Safety and Health Act. "How many companies," Sargent asks, "can afford to lose their cash flow for a month or more" on a major contract? The unspoken response is obvious.

Such OSHA rulings and the economic chaos they can generate have been the exception rather than the rule thus far. But OSHA and other agencies not directly tied to the contracting process are getting larger and more powerful. Now engineering managers in the electronics industries have an opportunity to learn of contract requirements that, though outside their own disciplines, are certain to have an increasing impact on their jobs and how they must do them. **—Ray Connolly**

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Circle 51 on reader service card

Japanese camera goes heavy on electronic controls

An electronic shutter with continuously variable speeds and an LED digital readout to display those speeds are among the features of one of Japan's smallest professional 35-mm single-lens-reflex cameras, the 901, just announced by Fuji Photo Film Co. These functions are implemented by some of the most sophisticated electronics ever squeezed into a camera, including a multidigit monolithic light-emitting diode, a silicon solar-cell photosensor, and three integrated circuits, one a 1,000-transistor C-MOS chip.

Display. Fuji replaces the venerable d'Arsonval meter by an apparent four-digit monolithic LED display, cleverly designed to get by with only 11 bonded leads. The first digit, a standard seven-segment design that is 0.8 mm high but magnified about five times by the viewfinder lens, has seven leads. The other three digits are small zeroes half the size of the first digit, and the 11th lead goes to a bar over the second zero.

The display shows the shutter speeds, measured in fractions of a second, 1,000, 500, 200, 100, 50, 30, 10, 5, 2, and 1. Slower shutter speeds of 2, 5, 10, and 20 seconds are distinguished from the fractions by the fact that the bar over the second zero turns on. Actual variation of shutter speed is continuous.

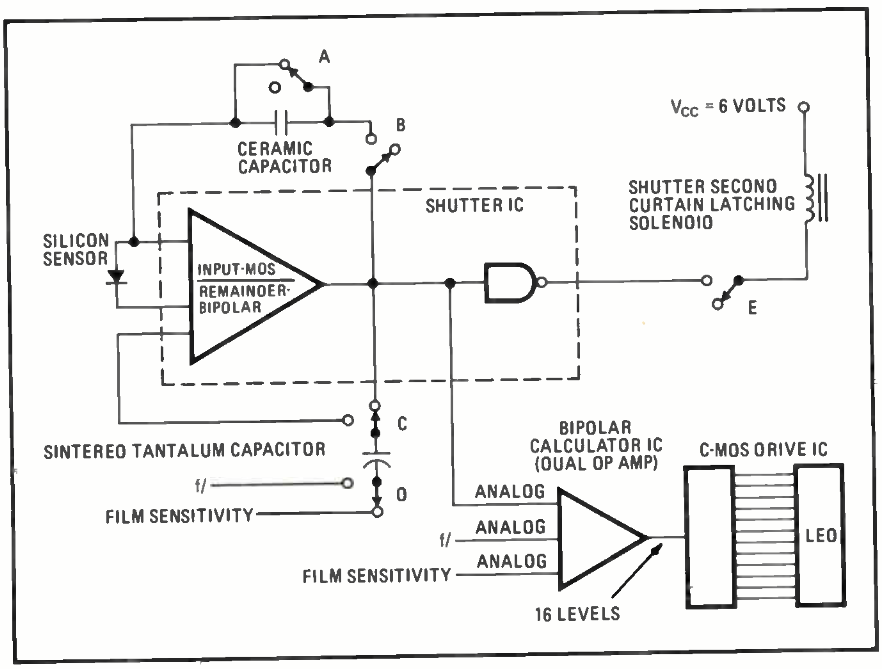
The bar over the second zero has another function as well. The combination of the first zero and the bar indicates overexposure. It is used where exposures shorter than 0.001 second would be required.

The driver for this LED display is the C-MOS LSI chip with the 1,000 or so transistors. Both the LSI and the display chip are made by Oki Electric Industry Co. Ltd. Input to the LSI unit is a 1-4-volt analog signal from the calculator IC. Sixteen comparators convert it to a 16-level signal corresponding to overexposure, the 14 speed indications, and underexposure—indicated merely by the 20-second display.

In addition to decoding and driving the proper digits, the driver LSI also varies the intensity of the display, over a range of about 16 to 1, as it changes indicated shutter speed. The third function of the driver LSI is to call attention to need to change the 6-V silver oxide battery. It does this by causing the display to blink.

The same advanced engineering that goes into the display is incorporated in the measurement and shutter control circuits. The sensor device is a fast-response blue-cell silicon solar battery type of device, operated with reverse bias. It features a dark current in the order of 10^{-13} amperes and an operating current that varies linearly with brightness over more than a seven orders of magnitude range. These characteristics eliminate the need to compensate for nonlinearity in subsequent circuits and cannot be matched by the commonly used cadmium sulfide photoresistor.

Innards. Integrated circuits control the continuously variable shutter and drive a monolithic LED display in $300 camera.



Shutter. The shutter IC includes an operational amplifier whose MOSFET input stage has the low input current needed to match the silicon sensor and whose comparator-output stage can handle the approximately 5 milliamperes at 6 V, for up to 20 seconds, needed to actuate the shutter solenoid. Fuji will not reveal the manufacturer of this IC, but does add that the op amp has a sintered tantalum capacitor load, with a capacitance of several tens of microfarads, which acts as shutter memory while the exposure is being made. A memory is necessary because during exposure the camera's mirror is raised and no light reaches the sensor.

When the shutter button is depressed, the ground side of the capacitor is connected by switch D to a bias voltage dependent on lens aperture (see figure). This voltage is added algebraically to the voltage stored in the capacitor. Before blackout of the image in the viewfinder causes the shutter IC amp output to change, though, switch C connects the other terminal of the capacitor to the amp input as memory input. At the same time, switch B converts the op amp to an integrator by connecting the ceramic feedback capacitor between input and output terminals. This feedback capacitor cannot charge, though, because it is shorted by switch A.

Another switch, E, closes the circuit to the solenoid that latches the second of two curtains in the focal-plane shutter. The exposure period is the difference between the time the trailing edge of the first curtain passes and opens the shutter, and the time the leading edge on the second curtain passes and closes it.

Switch A, shorting the integrating capacitor, is opened just as leading edge of first curtain starts to move. The voltage of the integrator starts to rise at a rate proportional to the algebraic sum of the voltage initially stored on the integrating capacitor and the two bias voltages. When the integrator output voltages reaches a preset level, the comparator operates and the current through the solenoid is interrupted. The second curtain is released and closes.

The calculator IC, made by Toshiba, incorporates two op amps. It monitors shutter IC output voltage before the shutter is actuated. It combines this voltage with biases representing film sensitivity and lens aperture to give analog voltage proportional to shutter speed. □

Around the world

Nuernberg installs two-way cable TV

In medieval Nuernberg, town criers spread the news, but now the city is turning to a more sophisticated method—two-way cable TV. Not only does the CATV system transmit television and radio programs into homes, it can also be used for return transmissions from certain terminals back to the broadcast center for distribution to network subscribers. With two-way communications capability, the system's designers say, the Nuernberg cable network goes a step beyond those now proliferating all over Europe.

A project of the communications firm Felten and Guilleaume Fernmeldeanlagen GmbH and supported by $400,000 from the German Post Office, the network constitutes what the company terms "the first step toward a truly broad-band communications system." In addition to handling a maximum of 12 television programs and the same number of radio programs, the system could eventually be used to monitor children's playgrounds, to send data from bank branches to a main office, and to transmit readings from gas, electricity, and water meters to an accounting center. What's more, the system also allows within-city video-telephone communications.

Military LED arrays use TV, mirrors

British military authorities are experimenting with various ways of using light-emitting diodes to create displays in infrared night viewing systems. For one such system Plessey Co. has supplied strips of 30 yellow LEDs to Hawker Siddeley Dynamics Ltd., which is building a battlefield imager around them. [*Electronics*, p. 55, March 15, 1973]. Sequential mechanical scanning by multiple prisms turns a single diode strip into a rectangular display and the image is formed in a binocular lens.

Another system, being developed by the Ministry of Defence, uses a strip of 192 red gallium-arsenide-phosphide LEDs made by Standard Telecommunication Laboratories Ltd., ITT's British research laboratory. The STL array will have television presentation. The scene is scanned by a strip of cadmium-mercury-telluride infrared detectors, each one of which feeds a LED through an amplifier. As the detectors scan across the scene, the LED brightness varies according to the highlights and shadows in the scene. Then, a scanning mirror will transfer the 192 simultaneously varying light levels to the face of a vidicon tube as 192 parallel lines.

That means the image of the LEDs in the mirror must be reflected back past the LEDs to the face of the vidicon, which is mounted behind the array. The array strip is half an inch long—each diode is 50 micrometers square, and the spacing between diodes is 12.5 μm. The strip is mounted on a copper heat sink attached to the "hub" point of a three-spoke "wheel" 5 inches or so in diameter.

The Netherlands

Magnetism drives Philips recorders

A problem that has plagued makers of cassette recorders has finally been solved: how to design a simple mechanism for driving the take-up reel at constant torque. The solution comes from Philips Gloeilampenfabrieken's Electro-Acoustics division in Eindhoven, the Netherlands. It is simply application of magnetism to replace the mechanical slip-friction coupling. The new magnetic-friction system makes possible close tolerances in recorder manufacture and retention of excellent friction properties during the lifetime of the recorder. As in any recorder, the prime requirement for proper playback and recording is uniform winding of the tape. To achieve this, the speed at which the reel rotates must be constantly adapted to the changing diameter of the tape on the reel. However, unevenly acting slip friction can cause more or less tight windings, and this sometimes leads to tape blocking—a problem even in special and carefully constructed cassettes. The magnetic approach virtually eliminates this problem.

The drive system for new Philips tape recorders consists of a flywheel that is a rotating permanent magnet with its circumference surrounded by an independently mounted concentric steel strip, called a hysteresis strip, bonded to a plastic cover. A belt from the recorder motor turns the external plastic-and-steel concentric, and the resulting rotation of the magnet turns a shaft and pulley that presses against the recorder's take-up disk to drive it smoothly. When the motor is stopped, force of the magnetic coupling stops the tape smoothly. The plastic shell, which covers the entire drive mechanism, prevents loss of magnetism and protects the system from moisture. □

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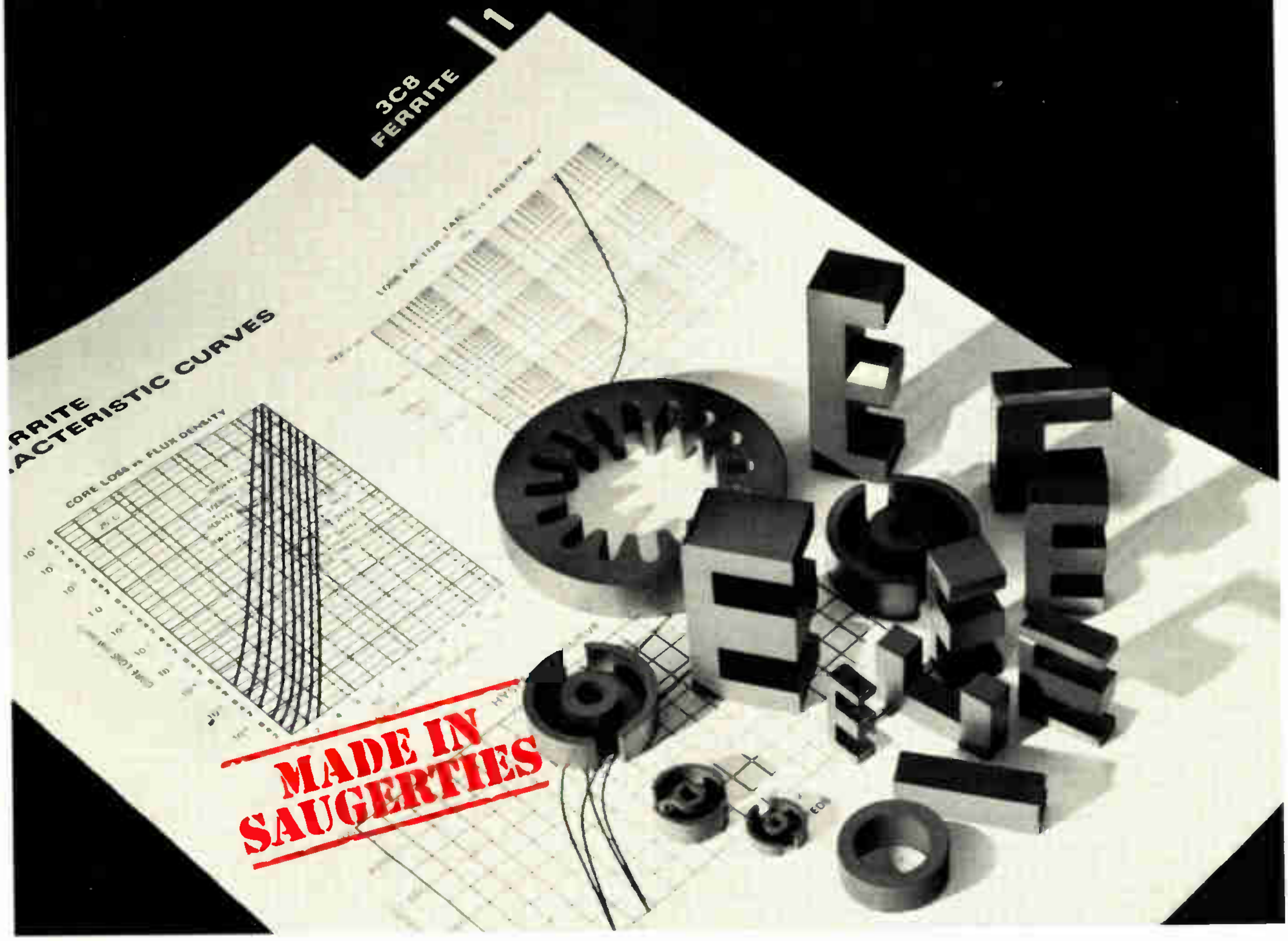

The market is ripe for product breakthroughs. Just look, for example, at the growth of such items as the hand-held calculator, small camera flashguns, ultra-mini portable radios and recorders. The key to these tremendous sales successes is high frequency power conversion circuits.

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16404

French TV sets will have new picture tubes

Color-TV sets with a new generation of picture tubes will hit the French market next year. Both RTC-La Radiotechnique-Compelec and Videocolor SA plan to be in production by then with tubes that have in-line electron guns, vertical-line screens, and slit-aperture shadow masks. RTC, a Philips subsidiary, will use a thick-neck 110° tube and offer screen sizes of 18, 22, and 26 inches. Videocolor, a joint venture of Thomson-Brandt and RCA, will use a 90° thin-neck tube and initially offer only a 21-inch size. Both tubes will come with factory-aligned deflection systems, since there is no need for dynamic convergence circuits with either one.

Plessey lands Japanese order for core memories

Plessey Co. has contracted to supply core-memory modules worth more than $2.5 million during the next 12 months to the Japanese minicomputer maker Oki Electric Industry Co. for use in the company's Okitat 4300 machine. **This contract marks Plessey's first big memory sale in Japan.** The module will have 8,192 18-bit words and 650-nanoseconds cycle time. It's a single board, measuring 17 by 12 inches. Plessey says that this is smaller than similar modules offered by Japanese memory makers—and was an important reason why Plessey got the order.

CIT-Alcatel, Plessey to develop PCM phone system

CIT-Alcatel of France and Plessey Telecommunications Ltd. of Britain plan to develop a large-scale, fully digital PCM telephone-switching system using CIT's digital switching know-how and Plessey's expertise in computer control of communications systems. **The starting points are CIT's type E-10 PCM switching module designed to handle up to 10,000 or 15,000 lines and Plessey's System 250 multiprocessor communications controller,** introduced nearly two years ago [*Electronics,* Electronics International, July 3 1972]. So far, Plessey has one large order from the British Army for System 250 and several small orders. Combining the technologies and developing out of them larger local and trunk exchange systems will probably take two or three years and cost up to $20 million.

The E-10 is an all-electronic time-division system controlled by small computers that can be linked in series to form larger capacity transit-type exchanges. For large exchanges, the French government telecommunications development agency, CNET, is currently working on a similar system, code-named E-12, controlled by a single large computer and capable of handling up to 50,000 lines. In fact, CIT's rival, ITT subsidiary Compagnie Générale de Constructions Téléphoniques, already has a working prototype in operation and is hoping to beat CIT-Alcatel for French orders.

Right now the E-10 unit uses hard-wired-logic control, but new software for the System 250 will replace this and timed storage may replace the present bipolar gates as the time-switching method. And, to make the overall system acceptable for many export markets, a new analog-switching, small local exchange capable of PCM input and output to the large unit has to be developed. **Plessey, however, is going into the project aware that its not likely to make any money out of sales**

National Stamping Co., 630 St. Jean St., Detroit, Mich.
O'Neil-Irwin Mfg. Co., 316 8th Ave., S, Minneapolis, Minn. (See page 170.)
Parish Pressed Steel Co., Robinson & Neiser Sts., Reading, Pa.
Parisian Novelty Co., Western Ave. at 35th St., Chicago, Ill.
Patton-Mac Guyer Co., Baker St. & Virginia Ave., Providence, R. I.
Peck Spring Co., Plainville, Conn.
Permoflux Corp., 4916 W. Grand Ave., Chicago, Ill.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Plume & Atwood Mfg. Co., 470 Bank St., Waterbury, Conn.
Powell Pressed Steel Co., Hubbard, Ohio
Prentice Mfg. Co., G. E., New Britain Ave., New Britain, Conn.
Pressed Steel Co., Wilkes-Barre, Pa.
Raymond Mfg. Co., Div. of Associated Spring Corp., 226 S. Center St., Corry, Pa.
Reliable Spring Co., 3167 Fulton Rd., Cleveland, Ohio
Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.
Rockwood Sprinkler Co., 50 Harlow St., Worcester, Mass.
Saginaw Stamping & Tool Co., Saginaw, Mich.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Sessions & Sons, J. H., Bristol, Conn.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y. (See page 150.)
Standard Pressed Steel Co., Jenkintown, Pa.
Stanley Works, New Britain, Conn.
Steel & Tubes, Inc., 250 E. 131st St., Cleveland, Ohio
Stimpson Co., Edwin B., 74 Franklin Ave., Brooklyn, N. Y.
Swanson Machine Co., Jamestown, N. Y.
Thomas & Skinner Steel Products Co., 1120 E. 23d St., Indianapolis, Ind.
Titchener & Co., E. H., Walnut St., & Erie R. R., Binghamton, N. Y.
Transue & Williams Steel Forging Corp., 562 W. Ely St., Alliance, Ohio
Truscon Steel Co., Pressed Steel Div. 6100 Truscon Ave., Cleveland, Ohio
Union Spring & Mfg. Co., New Kensington, Pa.
United Carr Fastener Corp., Cambridge, Mass.
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.
U. S. Indestructible Gasket Co., 829 E. 15 St., Brooklyn, N. Y.
Veeder-Root, Inc., 63 Sargeant St., Hartford, Conn.
Victor Mfg. & Gasket Co., 5750 W. Roosevelt Rd., Chicago, Ill.
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Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.
Western Cartridge Co., East Alton, Ill.
Whitehead Stamping Co., 1661 W. Lafayette Blvd., Detroit, Mich.
Wilcox, Crittenden & Co., Middletown, Conn.
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Stands

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Amperite Co., 561 Broadway, New York, N. Y.
Art Specialty Co., 3245 Lake St., Chicago, Ill.
Astatic Corp., 830 Market St., Youngstown, Ohio
Atlas Sound Corp., 1442 39th St., Brooklyn, N. Y.
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Eastern Mike-Stand Co., 56 Christopher Ave., Brooklyn, N. Y.
Electrical Sound Engineering Co., 5303 Kenilworth Ave., Baltimore, Md.
Electro-Voice Mfg. Co., 1239 South Bend Ave., South Bend, Ind.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Lifetime Corp., 1101 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
National-Dobro Corp., 400 S. Peoria St., Chicago, Ill.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Cal.
Operadio Mfg. Co., 13th and Indiana Sts., St. Charles, Ill.
RCA Mfg. Co., Camden, N. J.
Simpson Mfg. Co., Mark, 188 W. Fourth St., New York, N. Y.
Turner Co., Cedar Rapids, Iowa
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SPEAKER STANDS

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Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Lifetime Corp., 1101 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.

Steel

ELECTRICAL STEEL—see Metals

Strips

TERMINAL STRIPS—see Posts

Switches

LIMIT SWITCHES

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.

ROTARY and BAND CHANGE SWITCHES

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Daven Co., 158 Summit St., Newark, N. J.
General Electric Co., Appliance and Merchindise Dept., Bridgeport, Conn.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
JBL Instrument Co., Darby, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind. (See page 50.)
Meissner Mfg. Co, Mt. Carmel, Ill.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill. (See page 39.)
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Tagliabue Mfg. Co., C. J., Park & Nostrand Ave., Brooklyn, N. Y.
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General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind. (See page 50.)
McDonnell & Miller, Wrigley Bldg., Chicago, Ill.
Micro Switch Corp., Freeport, Ill.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Mu-Switch Corp., 38 Pequit St., Canton, Mass.
Stackpole Carbon Co., Tannery St., St. Marys, Pa.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

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Anderson Mfg. Co., Albert & J. M., 305 A St., Boston, Mass.
Automatic Electric Mfg. Co., 729 S. Front St., Mankato, Minn.
Bacon Electric Timer Corp., 4513 Brooklyn Ave., Cleveland, Ohio
Cleveland Time Clock & Service Co., Superior Ave. at E. 27th St., Cleveland, Ohio
Cramer Co., R. W., Centerbrook, Conn. (See page 169.)
Eagle Signal Corp., Moline, Ill.
Electric Controls Corp., 68 Murray St., New York, N. Y.
Fernwall, Inc., Ashland, Mass.
Frober-Faybor Co., Chagrin Falls, Ohio
General Electric Co., Schenectady, N. Y.
Industrial Engineering Corp., Evansville, Ind.
Industrial Instrument Co., 2249 14th St., S.W., Akron, Ohio
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
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Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Penn Electric Switch Co., Goshen, Ind.
Reliance Automatic Lighting Co., 1931 Mead St., Racine, Wis.
Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford, Conn.
Sangamo Electric Co., Springfield, Ill.
South Bend Current Controller Co., 2038 River Pk., South Bend, Ind.
States Co., 19 New Park Ave., Hartford, Conn. (See page 165.)
Swartzbaugh Mfg. Co., 1336 W. Bancroft St., Toledo, Ohio
Thomas Clock Co., Seth, Main & Trott Sts., Thomaston, Conn.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Tork Clock Co., 31 South St., Mount Vernon, N. Y.
Wadsworth Electric Mfg. Co., 20 W. 11th St., Covington, Ky.
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General Electric Co., Schenectady, N. Y.
Hope Webbing Co., Providence, R. I.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Krout & Fite Mfg. Co., Allegheny Ave. & Emerald St., Philadelphia, Pa.
Lambeth Pope Corp., New Bedford, Mass.
Linton & Bro., Horace, 3081 Ruth St., Philadelphia, Pa.
Mica Insulator Co., 200 Varick St., New York, N. Y. (See page 100.)
Priscilla Braid Co., 1309 Broad St., Central Falls, R. I.
Sidebotham, Inc., John, 4317 Griscom St., (Frankford) Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

VARNISHED TAPE

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.

in its domestic market. That's because Plessey's chance of profit depends on use of System 250, and the British Post Office has selected a rival GEC processor for future stored-program exchange control. So far, the most BPO has offered is to consider the switch module—when it's ready for possible use with the GEC processor.

Paris' new airport is site of air-traffic squabble

The swankiest new airport in Europe is undoubtedly Roissy/Charles de Gaulle, just north of Paris. **But air-traffic controllers for the Paris region are deeply concerned over the new ATC plan** that went into effect when the new airport went into service in mid-March. The controllers say that the new plan cuts safety margins to the bone. Although they don't fault the Thomson-CSF radar equipment itself at Roissy, the controllers claim that it was too hastily installed and still needs much adjustment to cut out blind spots and fixed echos. The pilots, too, are worried, and their union is clamoring for a new traffic plan—fast.

Milan anti-tank missile heads toward mass production

The first electronic weapons system in a series of joint German-French missile development projects is now entering the mass production stage. The system, called Milan, is an anti-tank missile for infantry use, 10,000 of which will be made by France's Aerospatiale and West Germany's Messerschmitt-Boelkow-Blohm, the two Milan developers. Also part of the government contract are 200 launchers and associated training equipment. **The 25-pound Milan system is a second-generation anti-tank missile with manual aiming but with fully automatic guidance to the target.** Its maximum range is about 2,000 yards. Other joint MBB-Aerospatiale missile systems, which are now being troop-tested, are the Hot anti-tank missile for firing from vehicles and helicopters, and Roland, a missile against low-flying aircraft.

Another U.S. company bought by Siemens

Taking advantage of what the firm calls "an interesting dollar-mark exchange parity", **West Germany's Siemens AG is strengthening its toehold in the U.S. electronics market by acquiring companies.** Following last year's purchase of the New Jersey-based test equipment maker Computest Corp. is this month's acquisition of the Dickson Electronics Corp., a 1,300-man components company in Scottsdale, Ariz., for which Siemans paid $8.7 million.

Philips tests video telephone net

Culminating several years of development work at Philips Gloeilampenfabrieken is a video telephone network **linking some 65 subscribers in the Netherlands.** The trial network, which extends over more than 200 miles, is to be used for studying methods of transmission, design of exchanges and the potential of the video telephone as a new means of communications. **In the 325-line, 1-megahertz system all signals except the video pulses are transmitted in digital form within the blanking periods.** In contrast to the six- and eight-wire Picturephone system in the U.S., the Dutch network uses only four wires. Other advantages, a Philips researcher says, are the system's high audio quality and the greater flexibility that digital transmission affords.

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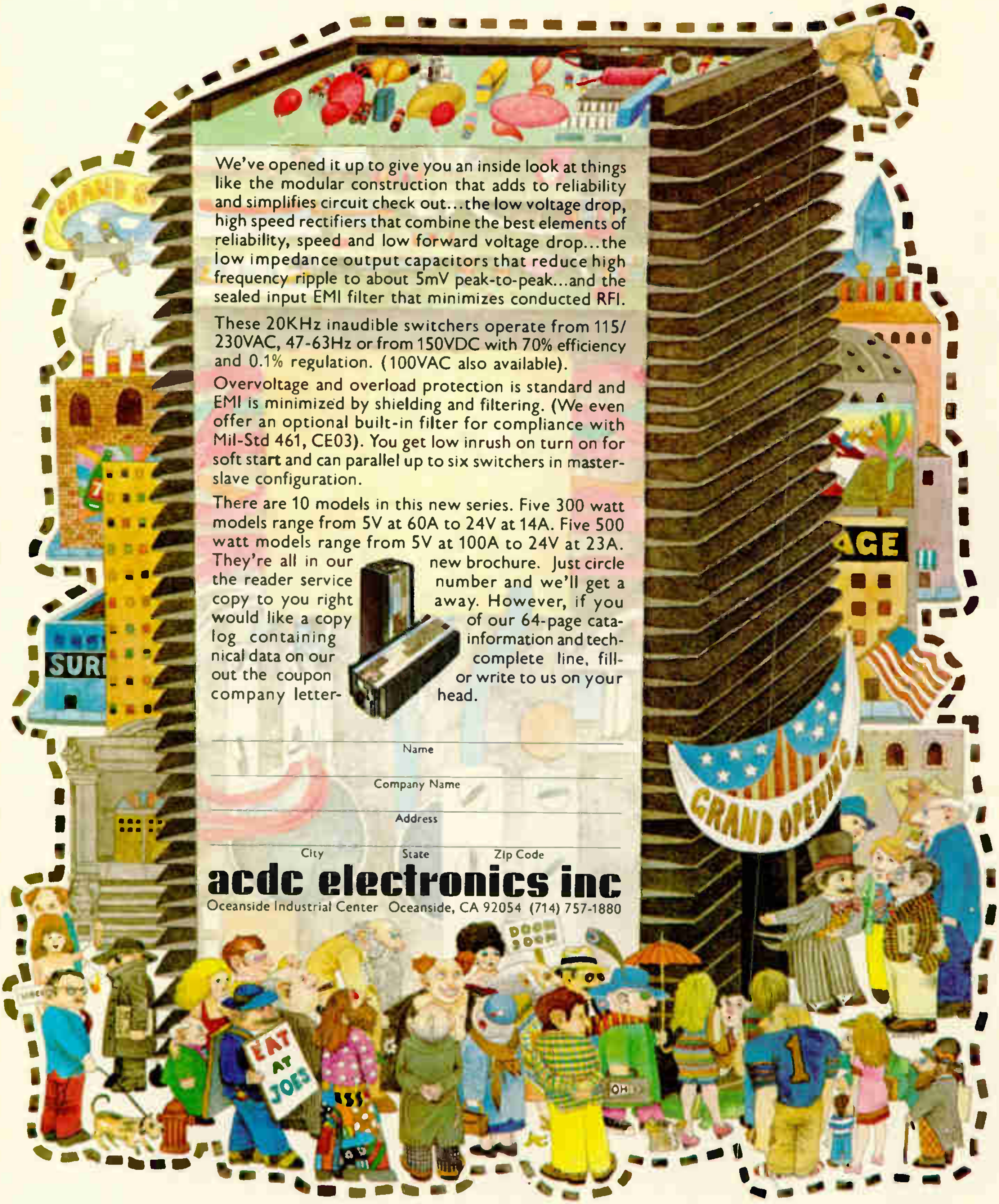

We've opened it up to give you an inside look at things like the modular construction that adds to reliability and simplifies circuit check out...the low voltage drop, high speed rectifiers that combine the best elements of reliability, speed and low forward voltage drop...the low impedance output capacitors that reduce high frequency ripple to about 5mV peak-to-peak...and the sealed input EMI filter that minimizes conducted RFI.

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There are 10 models in this new series. Five 300 watt models range from 5V at 60A to 24V at 14A. Five 500 watt models range from 5V at 100A to 24V at 23A. They're all in our new brochure. Just circle the reader service number and we'll get a copy to you right away. However, if you would like a copy of our 64-page catalog containing information and technical data on our complete line, fill-out the coupon or write to us on your company letterhead.

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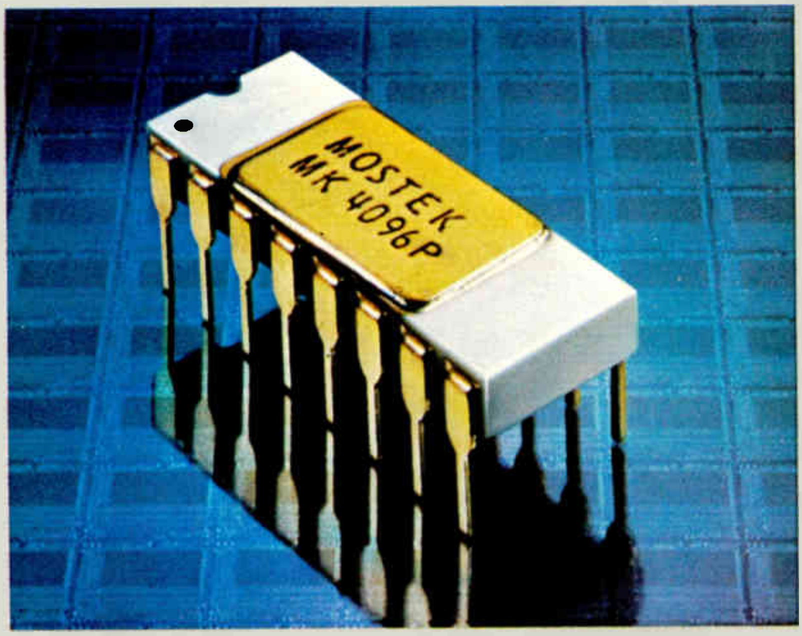
MOS breakthrough...from MOSTEK

the 4K RAM in a 16-pin package!



MOSTEK's 4K RAM is No. 1 in ease of use, performance, and volume availability

MOSTEK's top design and process engineers worked nearly three years to produce a 4096-bit RAM with the optimum combination of ease of use, performance, and volume availability. The MK4096P is the result.

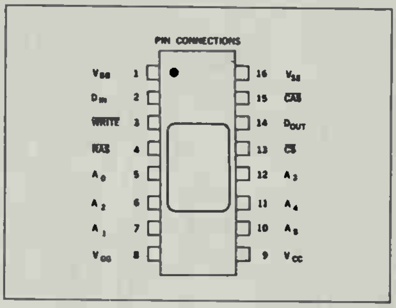
Easy to use. Most important, the MK4096P was designed to a 16-pin dual in-line configuration, enabling memory engineers to achieve the greatest possible memory storage in the smallest area. For example, using conservative PCB layout rules, the 16-pin package can provide 56% more memory storage per unit area than the alternate 22-pin package; 83% more using more dense PCB layouts.

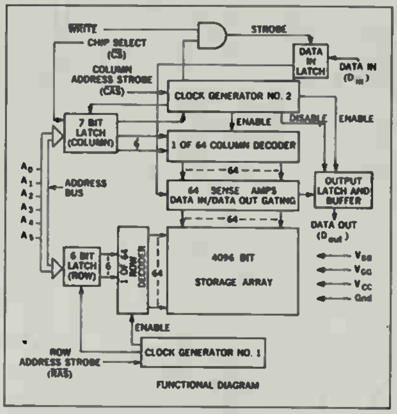
Other design advantages include:

- readily available automatic insertion equipment can be used in board assembly
- voltage pins are located on the corners to simplify PCB layout
- all inputs including clocks are directly TTL compatible with low capacitance of 8 picofarads
- outputs are TTL compatible, three state
- the circuit is extremely tolerant of noisy system environments

Performance. MOSTEK's MK4096P features an access time of 350 nsecs and read or write cycle times of 500 nsecs. Active power is under 100 μW/bit. Refresh time for each of the 64 row addresses is 2 milliseconds. All specifications are guaranteed over a temperature range of 0° to +70°C.

Volume availability. A major MOSTEK design goal was to make the MK4096P a high-yield, mass-producible MOS circuit. To accomplish this, a special N-channel self-aligned gate, polysilicon-interconnect process was developed to eliminate all contacts from the storage matrix. Also, the single transistor cell design markedly reduces chip size. Design layout rules were intentionally conservative to allow for further manufacturing efficiencies.





MOSTEK's capability in volume RAM production is proven by past production experience. MOSTEK is now one of the largest producers of MOS RAMs, having delivered a total of over 2 billion bits. The present RAM production level is over 250 million bits per month.

Want to know more? Then call your local MOSTEK distributor or representative or contact MOSTEK, 1215 West Crosby Road, Carrollton, Texas 75006, (214) 242-0444.

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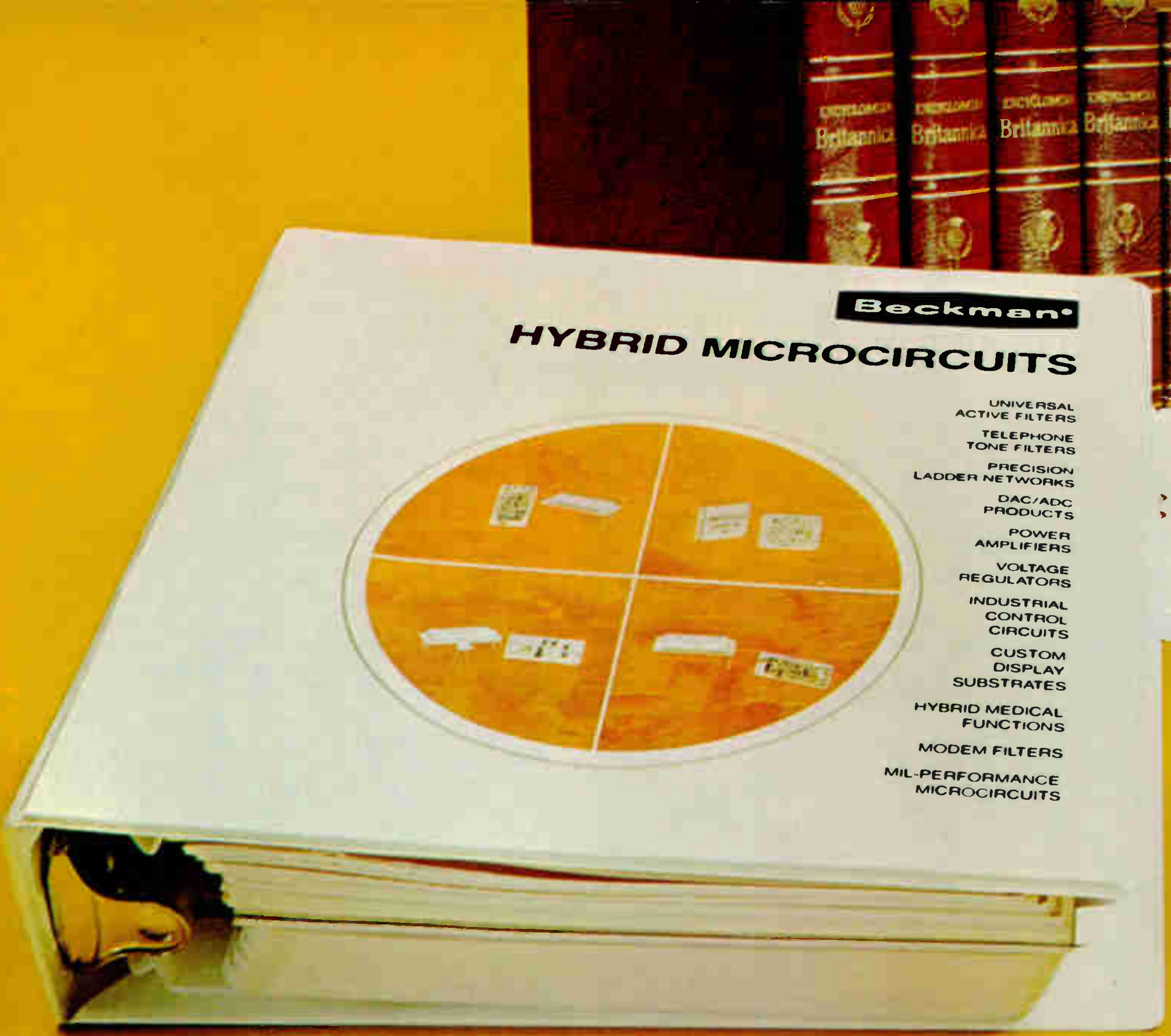

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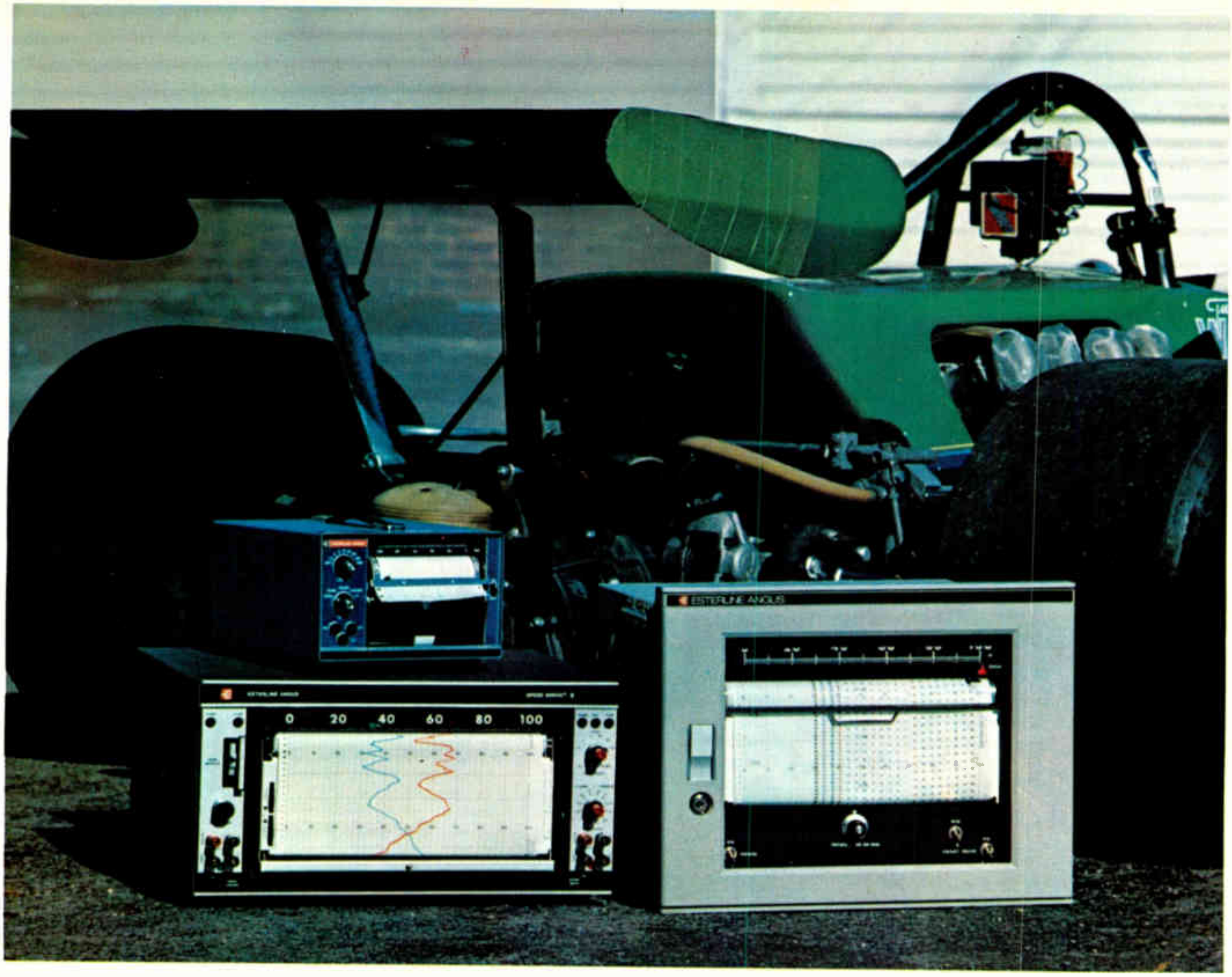

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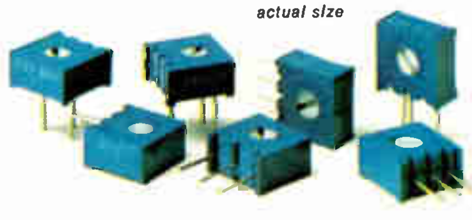

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Recession? Not for U.S. electronics firms

From coast to coast, billings and bookings are up as companies carry out expansion plans

"Everyone seems to be waiting for the other shoe to drop, and it isn't dropping." The other shoe in this case is the much-forecast, much-talked-about recession. That observation by John Buchholz, senior vice president at Bunker-Ramo Corp., sums up neatly the feelings of officials of the electronics industries as they navigate boldly through an unsettled economy.

Buchholz sees "no reason at this point in time for any pessimism," a view that is subscribed to from coast to coast. Comments about business so far this year range from National Semiconductor's "absolutely unbelievable" to Hewlett-Packard's "very good." And even where a late-year decline in the growth rate is predicted, many company planners tend to exclude themselves.

Fueling the optimism is the healthy state of bookings and billings. For example, Buchholz says that Amphenol Connector divisions' booking-billing ratio, compared to the first quarter of 1973, is 10% to 15% stronger. "In the Amphenol divisions, everything in the United States is going according to our plans of last fall. Business is very solid," he says. This far into the year, domestic connector business for Amphenol is 5% to 10% better, Buchholz notes, "and business in Europe is running better than we had expected."

On the West Coast, National Semiconductor's vice president of finance, John Hughes, says the company is "booked heavily into 1975." The firm had third-quarter sales of $66 million, up from $22 million the previous quarter, and, says Hughes, "We'll more than double that figure" in the fourth quarter.

With experts predicting a boom in the test and measurement industry, Tektronix Inc. reports a 28% increase in the order rate for the first two quarters (through April) of this fiscal year over that of the first two quarters of last year. The sales figure is up 41%, while backlog has leaped 70%.

This whole year, says Richard Reisinger, development manager, "is going to be as good or better than" last. He admits that "for some time, our corporate management expected a slowdown in the economy, and we are seeing it. But we expected it to have more of an impact on Tektronix. It hasn't. And we're reasonably optimistic" that Tek will grow.

Richard J. Osborne, executive vice president, finance and business development, at Fairchild Camera & Instrument Corp., echoes the views of his industry peers. "We continue to book more than we are shipping," he says, although he offers no figures. "In spite of the general economy," he adds, "we expect this to be a good year."

No worry. At Allen-Bradley Co., the booking/billing ratio is down from the first quarter of 1973. "This is of no great concern, however," notes Stanley J. Kukawka, vice president and general manager of the firm's Electronics division. "There is more caution today on long-term commitments and inventory bills, and we have more capacity on stream, and so can ship bookings faster than a year ago," he says. Allen-Bradley plans for a 10% increase in shipments over the level in 1973, and so far is doing that.

In the Boston area, the planners at Data General Corp. like to quote

Looking up. Sprague's Welch, top, and Allen-Bradley's Kukawaka both expect business to increase during 1974.

Edson DeCastro, president, who says that there are so many economists saying so many different things that you can always find someone to say something that you want to hear. So neither they nor their counterparts at Digital Equipment Corp. nor Sprague Electric Co. profess to pay much attention to dire warnings.

The figures back them up. Sales and bookings for each have increased from those of last year. A Data General spokesman says bookings are up significantly, with increases spread across all applications and geographic areas. The minicomputer market, says the spokesman, will counter cyclical swings in the general economy. "It has always come through the swings OK," he says.

Neal W. Welch, chairman and chief executive officer at Sprague, says that the outlook for both domestic and overseas operations in 1974 continues to be strong. "We have an open-order backlog at year-end in excess of $100 million. Evidence is toward a continued healthy demand for our product in virtually

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Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y. (See page 164.)
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
New York Transformer Co., 51 W. 3rd St., New York, N. Y.
Norwalk Transformer Corp., South Norwalk, Conn.
Oxford Tartak Radio Corp., 915 W. Van Buren St., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill. (See page 7.)
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill. (See page 145.)
Superior Electric Co., 32 Harrison St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill. (See p. 130.)
United Transformer Co., 150 Varick St., New York, N. Y. (See page 2.)
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Cal.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

INSTRUMENT TRANSFORMERS

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Transformer Co., 178 Emmet St., Newark, N. J. (See page 36.)
Condit Works, Allis-Chalmers Mfg. Co., Hyde Park Station, Boston, Mass.
Duncan Electric Co., 244 S. Third St., Lafayette, Ind.
Electrical Facilities, Inc., 4224 Holden St., Oakland, Cal.
Erie Electric Co., 124 Church St., Buffalo, N. Y.
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Cal.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
New York Transformer Co., 51 W. 3rd St., New York, N. Y. (See page 123.)
Niagara Electric Improvement Corp., 122 E. 42d St., New York, N. Y.
Roller-Smith Co., Bethlehem, Pa.
Sangamo Electric Co., Springfield, Ill.
Sparkes Mfg. Co., 318 Jefferson St., Newark, N. J.
Standard Transformer Co., 140 Dana St., N.E., Warren, Ohio. (See page 145.)
States Co., 3 New Park Ave., Hartford, Conn.
Surges Electric Co., 101 E. Seeboth St., Milwaukee, Wis.
Uptegraff Mfg. Co., R. E., Scottdale, Pa.
Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

I. F. TRANSFORMERS

Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J. (See page 36.)
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Automatic Windings Co., 900 Passaic Ave., East Passaic, N. J. (See p. 9.)
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
General Winding Co., 254 W. 31st St., New York, N. Y.
Guthman & Co., E. I., 400 S. Peoria St., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Meissner Mfg. Co., Mount Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Sickles Co., F. W., Springfield, Mass.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.

RECEIVER AUDIO & POWER TRANSFORMERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, N. Y.
American Transformer Co., 178 Emmet St., Newark, N. J. (See page 36.)
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Arlavox Mfg. Co., 430 S. Green St., Chicago, Ill.
Audio Development Co., 123 Bryant Ave., N., Minneapolis, Minn.
Cinaudagraph Speakers, Inc., 3929 S. Michigan Ave., Chicago, Ill.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Dinion Coil Co., 1 North St., Caledonia, N. Y.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
Electronic Transformer Co., 515 W. 29th St., New York, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y. (See p. 173.)
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill. (See page 23.)
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Cal.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y. (See page 164.)
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
New York Transformer Co., 51 W. Third St., New York, N. Y. (See page 123.)
Norwalk Transformer Corp., South Norwalk, Conn.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass. (See page 150.)
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Standard Transformer Corp., 1500 N Halsted St., Chicago, Ill. (See page 145.)
Superior Electric Co., 32 Harrison St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill. (See p. 130.)
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

TRANSMITTER TRANSFORMERS

American Transformer Co., 178 Emmet St., Newark, N. J. (See page 36.)
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
Ferranti Electric, Inc., RCA Building, New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Jefferson Electric Co., Belllwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y. (See page 164.)
New York Transformer Co., 51 W. 3rd St., New York, N. Y. (See page 123.)
Norwalk Transformer Corp., South Norwalk, Conn.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill. (See p. 145.)
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill. (See p. 130.)
United Transformer Co., 150 Varick St., New York, N. Y. (See page 2.)
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

VOLTAGE REGULATING TRANSFORMERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, N. Y.
American Transformer Co., 178 Emmet St., Newark, N. J. (See page 36.)
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Audio Development Co., 123 Bryant Ave., N., Minneapolis, Minn.
Boonton Radio Corp., Boonton, N. J.
Clark Controller Co., 1146 E. 152d St., Cleveland, Ohio
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill. (See page 23.)
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
International Transformer Co., 17 W. 20th St., New York, N. Y.
New York Transformer Co., 51 W. 3rd St., New York, N. Y. (See page 123.)
Norwalk Transformer Corp., South Norwalk, Conn.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass. (See page 150.)
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill. (See page 7.)
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill. (See p. 145.)
Superior Electric Co., 32 Harrison St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill. (See p. 130.)
United Transformer Co., 150 Varick St., New York, N. Y. (See page 2.)

all of the markets we serve," he says.

But West Coast distributor Liberty Electronics, a division of Wyle Laboratories, warns that bookings in the components business can be "a bit of a confusion factor to people." Sid Spiegel, Liberty's president, says, "I think that last year, with all the publicity concerning the energy shortage, people did even more extra buying."

Lending added strength to the general feeling of prosperity are the plans of many electronics firms to carry out expansion plans. Some, in fact, have decided to broaden or accelerate those plans. One of these is Bunker-Ramo.

Vice president Buchholz says that the Amphenol divisions have increased capital-expansion plans, both for acquisition and growth.

More growth. Hewlett-Packard Co., where Ed van Bronkhorst, vice president and treasurer, expects the growth trend to continue, will spend $100 million in fiscal 1974 on capital investment. Last year's figure was $81 million. The main expenditure will be for six new plants both in the U.S. and overseas. And at Digital Equipment Corp., the emphasis on expansion of the past few years will continue. The company is thinking about building a plant in Korea for the fabrication of core memories. Minicomputer rival Data General, too, is thinking of a new plant.

National Semiconductor is also gearing up for increased semiconductor demand by increasing its capital spending from the $13 million of last year, to more than $16 million for fiscal 1974. A portion of that budget will be spent on a new wafer-fabrication plant. Financial vice president Hughes believes this increased capital spending on the part of National and other companies illustrates the industry's immunity to recession. "We don't believe a recession will affect National or the industry," he says. And while semiconductor content of TV sets is climbing "see panel", Zenith expects to have at least as good a year as 1973, which set records for dollars and units. So far, first-quarter sales are ahead of last year's quarter. □

'Everybody's popping circuits'

Texas Instruments has earned a reputation in the semiconductor industry for its on-target economic forecasts. In the following interview with Larry Armstrong, Midwest bureau manager of Electronics, *Charles Clough, vice president for semiconductor marketing, tells why TI is optimistic.*

"Demand is still exceptionally high for semiconductor products," says Charles Clough, Texas Instruments' vice president for semiconductor marketing. The domestic market for semiconductors should grow about 18%, he says, to $2.18 billion in 1974.

"The semiconductor market's strong for simple, basic reasons," he points out, "reasons apart from the governmental and Watergate climate we read about in the newspapers. And the overriding reason for the continued demand is a tremendous proliferation of customers using semiconductors," he says.

"Semiconductors are like vitamin pills today—everybody's popping 74N circuits." Last year, 1,450 customers comprised 85% of TI's business, he says. In 1969, 80% of its business came from 19 customers. "The standard logic block, the 7400, makes it very easy for small companies to get into electronics assembly," he says, and estimates that the average home now has 3,000 transistor functions.

"Backlogs are excellent; we've never been in a position with backlogs such as we are today," he says. But Clough sees a little double ordering today where he saw none six months ago. "Conservatively, I'd guess that this is about 3% or 4% of our backlog. And it's something very secretive," he says. "When this happened three or four years ago, the approach that the buyer used was 'Be careful—if you don't ship the stuff, Fairchild will.' The guy doesn't tell you that today," Clough explains. "Our response would be: 'That's good news; let me apply the capacity somewhere else.' " Lead times, he says, won't get back to normal until simetime in 1975, however. "We define normal as the basic ability to ship 70% of a customer's requirements over a three-month period. And the industry won't get there in 1974."

Pacing the growth of the industry will be the consumer segment, led by color TV despite the general nervousness about the economy. "In color television, I think you'll see about a 20% increase, 1974 over 1973," he forecasts. "If you talk to color TV manufacturers, every one will tell you the end-equipment market will drop from 3% to 5%, but if you add up the individual production plans of each, it will tell you that the end-equipment market will increase by 5% to 8%," he says. His 20% prediction assumes the slight decrease, however. The offset is in the increasing semiconductor content, pegged by TI at $12 per set in 1974, up from $9 in 1973.

Even the embryonic automotive market for semiconductors will show an increase, despite the gloomy outlook for Detroit. Clough expects a growth to $76 million to $80 million, up from about $62 million in 1973, principally because 1974 will be the first full production year for seat-belt interlocks.

Price controls, or lack of controls, do not affect the learning curve pricing structure that TI diligently adheres to for large volume products. "As volumes increase, prices drop, and it's our intention to price aggressively to gain volume," Clough says. The most dramatic drops will be seen for the increasingly accepted complex functions: "We brought them down in 1973 and we'll do it again in 1974," he adds.

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Electronics abroad

In Europe, things are good—for now

Component and instrument makers head for Paris show in optimistic mood, but economic and political problems could mean trouble on horizon

by the European editors of Electronics

Throughout Western Europe, national economies are seething with troubles that nobody seems able to do much about. Inflation threatens to hit runaway levels, yet there's no obvious way to hold down prices while energy and raw-materials costs zoom. And while foreign trade long has been a mainstay for European business, doing business abroad has become harrowing because of the erratic world monetary system. What's worse, at a time when strong governments are needed to keep economics growing rationally, many governments are shakier than any these countries have had for a long time.

All told, it looks as if 1974 could mark the start of a painful transition from an economy of affluence toward an economy of scarcity. But for the 1,000-odd producers of components and instruments who will have their wares on display at the big annual Salon International des Composants Electroniques in Paris in early April, affluence still persists. Most companies went into 1974 with bulging order backlogs and plenty of momentum.

Reflecting the tone of cautious optimism that prevails among European electronics executives now, Thomson-CSF's Philippe Giscard d'Estaing says, "There are uncertainties, but there's no inquietude."

A look at the giant French company's components divisions, which Giscard d'Estaing heads, shows why there's no inordinate uneasiness yet about his operation. Thomson-CSF's components sales shot up by more than one third last year to edge past $200 million. This year, Thomson-CSF has budgeted the same kind of growth. "Last November and December," says Giscard, "we were afraid our budget was too high. Now we see our year-end pessimism wasn't right. So far this year, we've not dropped below budget, either for orders or production."

Optimism shared. And Thomson-CSF is not the only French heavyweight with strong 1974 expansion in sight. RTC–La Radiotechnique Compelec–the components company of the Philips group in France, saw its sales shoot up 22% last year to top the $200 million mark. Jacques Bouyer, RTC's director-general, is thinking of something like 15% for this year's growth. But he warns that the figure could go as high as 30% or as low as 5%. Uncertainties or no, RTC will invest heavily in new capacity for the second year in a row. Smaller companies, too, are doing well. "We had an explosion in orders for hybrid circuits last year," enthuses Alain Gayet, commercial director of the Microcircuits division of Sintra. "Our backlog is up to 10 million francs (roughly $2 million), and we'll have another 30% to 35% jump in sales this year."

It's not hard to see why French component makers feel sure their domestic market will ring solidly this year. Set makers gobble up some 40% of the components used in France, and they now are projecting a strong, but not booming, 1974. Color-TV sales, the kingpin item here, ran about 600,000 units last year. Paul-Roger Sallebert, general director of the Fédération Nationale des Industries Electroniques (FNIE), reports that his trade group expects this year's sales to run about 790,000 sets. "Before the crisis," he adds, "we were predicting something like 825,000." Other market watchers, despite a setback in sales last month, see a chance of a rise to above 850,000 units.

No matter who is right, it will be a good year for entertainment elec-

tronics. Even better, the instrument and communications markets look particularly solid. The French Posts and Telecommunications Ministry has vowed to double the number of telephone lines in service during the next five years, and this year alone, it will commit some $1.5 billion for improvements to its telecommunications network. The computer makers, after a slow 1974 start, now "expect a normal level of activity," reports Maxime Bonnet, marketing director for Honeywell-Bull. As a result, mainframe and peripherals makers should be good customers.

Energy market. Noting that the domestic outlook isn't at all bad, FNIE's Sallebert points out that producers of telecommunications, military, and industrial equipment should pick up some extra business because of the deals the French government has been working on with oil-producing countries. For the long term, there'll be other added energy business.

The government, for example, has launched a massive project to get nuclear-power plants on line and plans to commit some $1.2 billion yearly for them over the next seven years. And, although higher gasoline prices and possible shortages may one day impact consumer electronics as the woes of auto makers work back through the economy, this may be more than offset by nonconsumer gains.

"The more expensive transportation becomes, the more people will be forced to depend on telecommunications," says Louis Brousse, commercial director for Schlumberger instruments and systems.

German optimism. West German component makers who turn up at the Paris show will add a further note of optimism. Their 1974 sales prospects range from "not bad" to "as good as last year," despite a turndown in growth that's predicted for the West German economy as a whole. For the electrical-electronics sector, the rise is pegged at between 5% and 10%.

Semiconductor makers will do much better than this. They are looking forward to gains of 15% to 20%. Much of the increase will come from continuing high demand from German set makers, who account for more than half the country's semiconductor consumption. "We are not disquieted by the shorter work weeks at some radio and TV producers," says Erich Gelder, marketing manager for ICs at Siemens AG. "That's only a temporary thing," he adds.

There's growth also from "new" semiconductor markets. Gerhard Liebscher, director of marketing services for ITT affiliate Intermetall GmbH, says semiconductor sales to watch and clock companies will be on the rise, even if their growth slows. Components sales to the auto industry, too, should stay at about 1973 levels, even though a lot fewer cars will come off the lines this year.

As for ICs, Gelder foresees a rise in industry-wide sales of some 17% in Germany. For discretes, he predicts that the increase will be 12%. Siemens, largely because of its strength in circuits for touch tuners, foresees a spurt of 70% this year for its IC sales.

Italian effervescence. The transalpine contingent from Italy will also come to Paris in an effervescent mood. There's no doubt that order books are bulging for equipment makers and components makers. But some market watchers say the components orders are mostly attempts to counter inflation.

Not so, says Ernesto Bartolozzi, marketing director for SGS-Ates, Italy's largest semiconductor maker. He says that his customers are not stockpiling components, but are using them now to meet their own orders for consumer electronics, communications equipment, and calculators. "We see an expanding market," he says, "and see no need to modify expansion plans."

British worry. The cross-channel contingent from Great Britain will come to the Paris salon with nagging worries. No one yet can guess how effective the new government will be at unsnarling the economy. And, until something like normal times return, no one can guess what will happen to color TV, the top income producer.

Set makers are the biggest buyers of components in Britain, and last year their output soared to 2.5 million sets. This year, sales at the retail level have slumped between 20% and 25%, largely because of government curbs on consumer credit. Set output now outstrips demand, but, so far, that's not been too troubling; set inventories were abnormally low before the government slapped on its curbs. By midsummer, though, set makers may have to cut way back on production, and that will hurt components suppliers badly.

For the moment, though, component makers can sell almost everything they can make. Power rationing has kept them working short-time, but their equipment-making customers have had to do the same, and so the shortfalls roughly cancel each other. Delivery delays for new customers, thus, still run as long as 12 months for items made from scarce raw materials—polyester capacitors, for instance.

In most cases, components companies are rushing ahead with expansion plans made last year before crisis was in the wind. Semiconductor makers are working on the assumption that demand will expand continuously across the board for ICs. In particular, MOS LSI deliveries are expected to increase fast as several development projects turn into production orders. Joe Hurley, general manager of ITT Semiconductors Ltd., estimates that UK MOS sales will be up 40% this year, compared with a general UK semiconductor growth rate of about 17%. □

Looking optimistic. Manufacturers are heading for Paris components show with smiles on their faces, despite economic uncertainty. Scenes are of last year's show.

Memories

Customers sweat out 4,096-bit RAMs

Computer and peripherals makers are eager to use the big memories as soon as they reach acceptable yield and performance levels

by Howard Wolff, Associate Editor

Potential users of the new 4,096-bit MOS random-access memories are waiting warily and anxiously as manufacturers of the devices work to iron out production problems. At stake for the users are design decisions involving planned and projected product lines, ranging from peripherals to computer mainframes. Dangling before the eyes of the makers are chunks of a market that could reach $60 million to $75 million next year.

But the 4-k memory is an elusive, as well as tantalizing, target—elusive because it involves manufacturing a high-density device with the advanced and sophisticated n-channel silicon-gate technique; tantalizing because it is the first semiconductor to outdo core-memory systems in both performance and price. That's why manufacturers consider 4-k worth working for, and users generally think it's worth waiting for.

Hewlett-Packard Co. seems to think so. The Palo Alto, Calif., instrument and computer maker designed the Texas Instruments TMS4030 into its new minicomputer line, only to be stymied by yield problems at TI's Houston MOS-production line [*Electronics*, March 7, p. 25]. H-P has had to go to Mostek Corp. to fill its demands, a solution that creates a design problem in itself because the TI and Mostek parts are not pin-compatible (see chart). Datapoint of San Antonio, Texas, another TI customer, also was caught short.

That hole in the 4-k picture needs patching, most users agree. As Brian Croxon of Honeywell Information Systems puts it: "There's a lack of maturity. By that, I mean that a high-volume user likes to see second-sourcing pretty early." Croxon,

4,096-BIT RAMs

PARAMETER	MOTOROLA 6605	AMI 6605	MIL MF 7112	INTEL 2107A	AMS 6004	TI TMS 4030	MOSTEK MK4096P
Cell chip size	3TC 179/197	3TC 168/195	3TC 149/166	3TC 137/167	3TC 190/220	1TC 159/181	1TC 157/185
Type	N-MOS	N-MOS	N-MOS	N-MOS	P-MOS	N-MOS	N-MOS
Access (ns)	<300	<300	400	300	460	300	350
Read cycle (ns)	450	450	445	500	695	470	500
Power active/stand by	350/5	<100/0.5	287/49	350/39	130/55	400/2	<400/<12
Power supplies	+5 +12 −5	±5 +12 −3	+12 −2	+12 +5 −5	+5 +3 −15	+5 +12 −3	+12 +5 −9
Inputs	T^2L	T^2L	T^2L	T^2L	D^2L	T^2L	T^2L
Output	T^2L/ECL	T^2L/ECL	Low-power T^2L	T^2L	N/A	T^2L	T^2L
Refresh rate (ms) cycles	2 32	2 32	2 16	1 <100	2 32	2 64	2 60
Samples	Now	Now	Now	Now	Now	Now	Now
Production	Now 74	2nd qtr. 74	3rd qtr. 74	Now			Now
Pin compatible to	AMI	Motorola	None	TI, MIL	None	INTEL 2107A	None
No. of pins	22	22	22	22	22	22	16
No clocks	1	1	3	1	3	1	2
Voltage swings	All T^2L except clock	All T^2L except clock		All T^2L		All T^2L except 12 V clock	All T^2L

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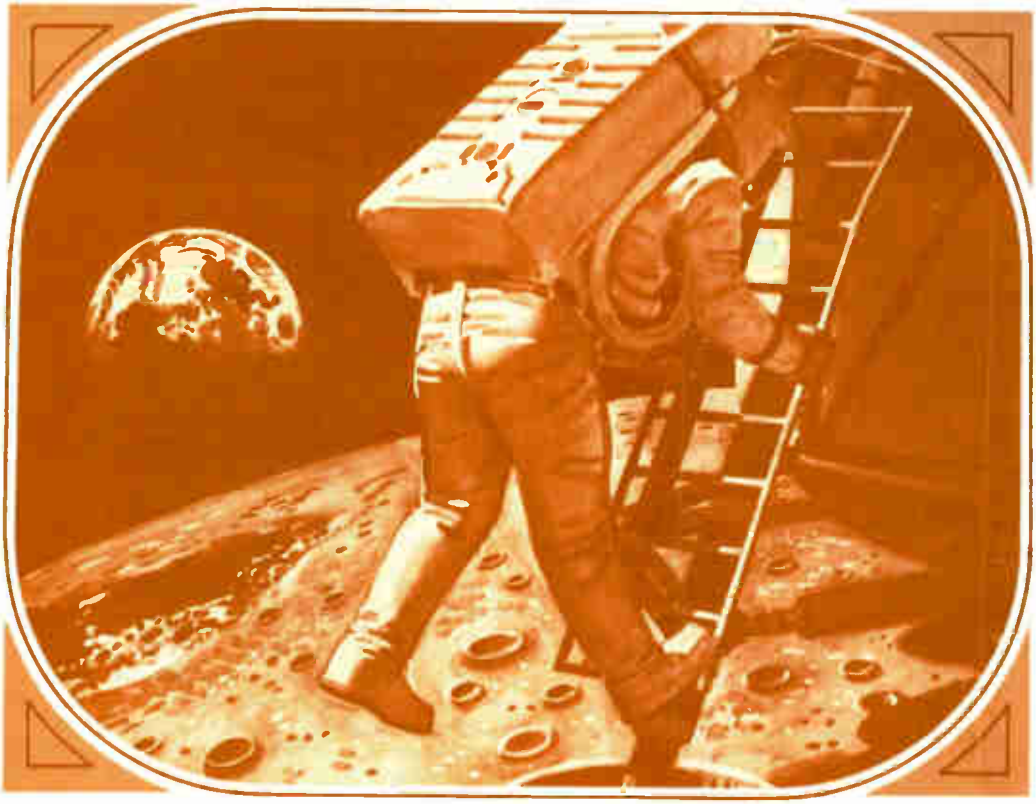

On July 20, 1969, at 10:56 p.m., E.D.T., Neil Armstrong made the first personal contact with the surface of the moon. His famous words, "That's one small step for a man, one giant leap for mankind," will live in history! Edwin Aldrin followed him onto the moon, while Michael Collins controlled the Apollo 11 spacecraft in orbit. The two men spent a total of 2 hours, 31 minutes exploring the moon's surface.

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Probing the news

a section head in the HIS Billerica, Mass., memory department, says that 4-k yield problems follow the classic pattern of semiconductor memories. "We went through about the same thing with the early 1-k ones," he points out.

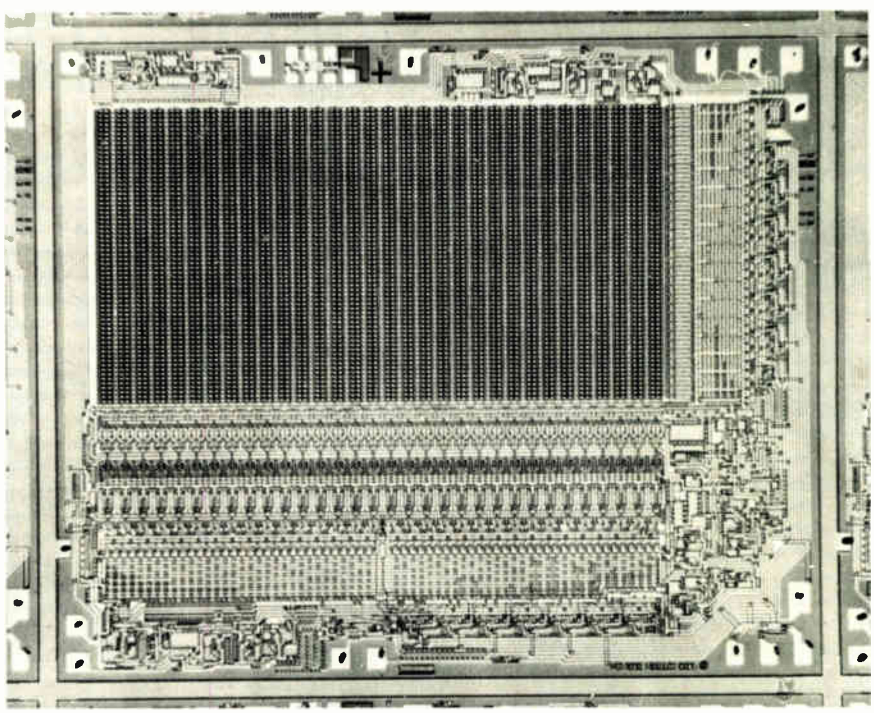
Croxon says that Honeywell is getting samples from "everyone who makes one" for use in designing prototype memory systems. "But we can't even get enough parts for that prototype work," he adds. Croxon characterizes the parts he has been getting as of generally good quality. "Overall, they've been clean, with reasonably wide operating margins. However, a lot were initially 50 to 100 nanoseconds slower than specified." Croxon is one of those users who advocates patience. "I don't think 4-k parts are here yet for the big systems makers," he says.

DEC shops. Another computer maker, Digital Equipment Corp., says that, since TI is having production problems, it will probably order from such other makers as Mostek and its second source, Fairchild Semiconductor, American Microsystems Inc., Motorola Semiconductor, and Western Digital Corp. If that fails, says a spokesman, DEC will return to core. The Maynard, Mass., manufacturer has 4-k memories ticketed for its PDP-8 and PDP-11 lines for now, and later for its DECSystem-10 line. The spokesman says that performance of 4-k RAMs received thus far—from TI—is "not sparkling." He adds that large memories usually need logic-correction modules to guard against so-called soft errors.

Other computer makers agree with Honeywell and DEC. For example, Control Data Corp. reports ordering 100 units from each of three or four vendors; so far, it has received less than 50. One user's spokesman says he won't schedule production of any machine until he knows that 4-k RAMs are available in quantity from multiple sources.

TI was first out of the gate with a large-volume order (from Hewlett-Packard) and is paying the price: its yield problems are visible to everyone. But TI says it has no intention of changing its one-transistor-cell design and that "an intensive effort is being applied to the buildup of a production line and to increase yields while at the same time increasing the volume." A spokesman insists, "We are convinced that the

Mostek's entry. This is the Mostek 4,096-bit MOS RAM, a 16-pin model offering 350 nanosecond access time. White marks around periphery were left by test probes.



It's nice to know that there's a super source for large quantities of 12 and 50 Volt ceramic capacitors. Nichicon can meet your immediate needs, or help you plan for long range requirements. When 30 weeks lead time seems to be a stock answer from almost every capacitor manufacturer, it's nice to know you can count on Nichicon for fast delivery. And when we make a delivery promise, we deliver as promised.

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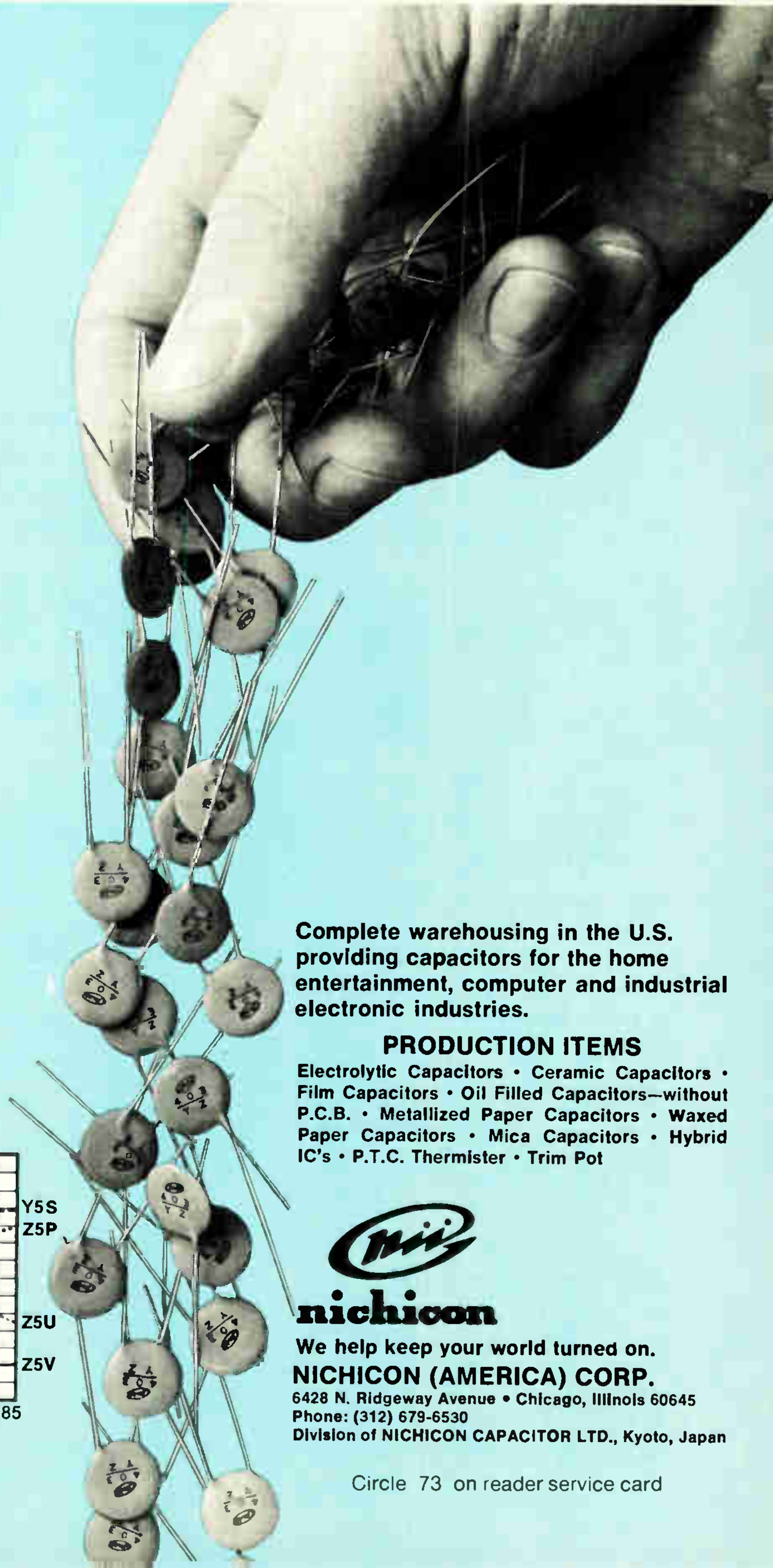
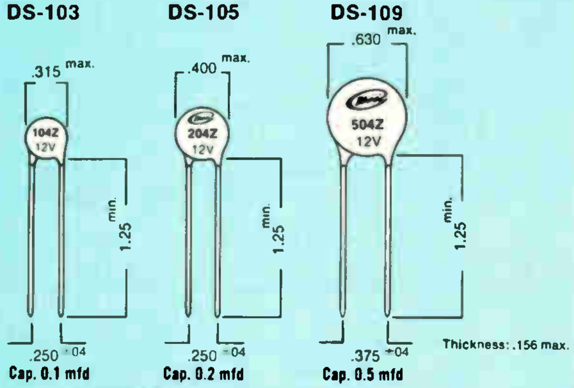


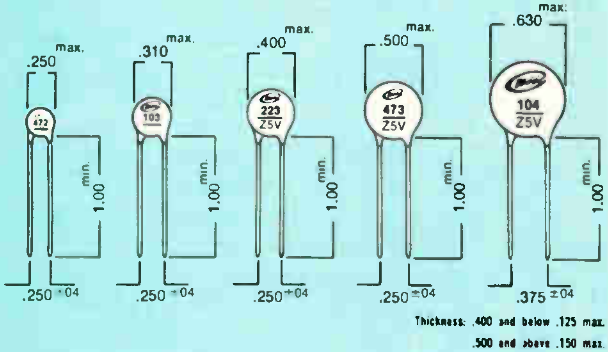
12V.DC Disc Capacitors—Y5S



SPECIFICATIONS

Temperature Characteristics:	Y5S
Operating Temperature Range:	−30°C to + 85°C
Lead Wire:	#22
Applications:	By-pass and audio couplings in transistorized circuits.
Equivalent to:	Centralab's "Ultra-Kap" UK series, and RMC's "Magna-Cap" M-12 series.

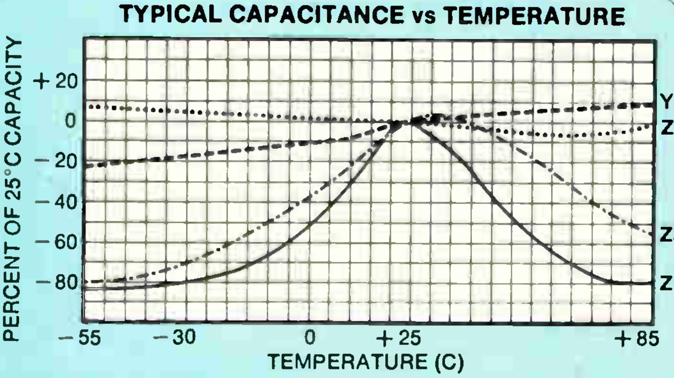
50V.DC Disc Capacitors—Z5P, Z5U and Z5V



SPECIFICATIONS

	Capacitance Range	Capacitance Tolerance
Z5P	180 pF thru 10,000 pF	±10% or ±20%
Z5U	1,000 pF thru 22,000 pF	±20%
Z5V	1,000 pF thru 100,000 pF	+80% −20%

TYPICAL CAPACITANCE vs TEMPERATURE



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Circle 73 on reader service card

Probing the news

4-k RAM will be producible in large volume during 1974." While TI is "very cautious at this time in committing to definite schedules," industry sources predict that TI will be in production during the fourth quarter of the year.

Mostek benefits. Mostek Corp., which has benefited from TI's problems, now has another advantage: a second source. Fairchild Semiconductor, initially using dice from Mostek, will start next month to ship its pin-for-pin replacement in a 16-pin dual in-line package, called the 4096 DC. At the same time, Fairchild will develop a wafer-fabrication capability, based on its own Isoplanar-N (for n-channel) process, and officials plan to be in full production by 1975's first quarter.

As for Mostek itself, Berry Cash, executive vice president, says the company is turning out its MK 4096 "in the range of thousands per week." Cash adds, "The yields are still low, compared to where we'd like them to go, but they're high enough to make a lot of them without losing any money."

Mostek is building its part under the supervision of engineers who train the production people, Cash says. Now that the company has snagged the H-P order, as well as others, Mostek is "trying to figure out how we can crank out a lot of them this year" after initial plans called for production of fewer than 100,000 parts in 1974.

Second phase. The first semiconductor house to announce a 4-k RAM, Microsystems International Ltd. of Ottawa, Canada, says its early troubles with yield are over, and the second planned phase of the MF 7112 has begun. This, says Peter Loconto, MOS marketing manager, involves reducing the die size to 149 by 166 mils (from 168 by 204) and increasing production from the present 250 parts a week, to 500 in May, 1,000 in June, and doubling monthly until volume production is finally reached in the last quarter. Loconto says MIL will sell 40,000 pieces this year, and the biggest order in the house calls for 10,000.

Motorola's Semiconductor Products division is in "initial production" of the 6605 4-k RAM, says Durrell Hillis, MOS microprocessor and memory-products marketing manager. He says the device is working in one customer's system, and that the division has been shipping early production quantities to meet orders from 20 major customers. Motorola is banking heavily on the 6605 as a pivotal part that can bring significant MOS business to the division after a couple of false starts with earlier memory products.

Because of the joint development program with AMI for the 6605, Motorola and its California "partner" are assured of at least one second source initially—an important consideration for users. And Hillis says Motorola is negotiating with two other second-source possibilities that could have the product in production six to nine months after being selected. □

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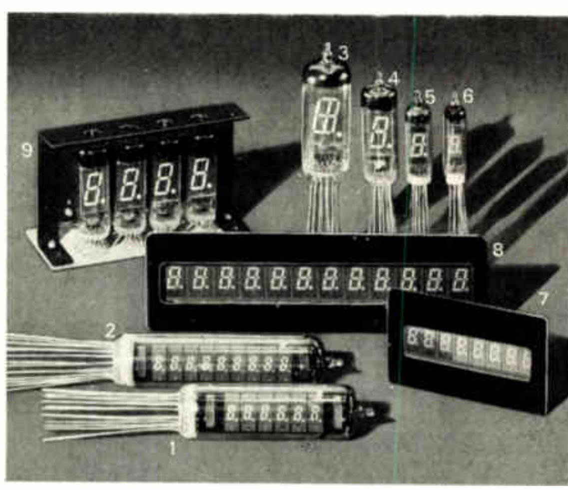

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Tubes

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American Television Corp., 130 W. 56th St., New York, N. Y.
DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J. (See page 118.)
Farnsworth Television & Radio Corp., 3700 Pontiac St., Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y. (See page 79.)
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass. (See page 12.)
National Union Radio Corp., 15 Washington St., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Western Electric Co.—see Graybar Electric Co.

CURRENT REGULATING TUBES (Ballast)

Amperite Co., 561 Broadway, New York, N. Y.
Art Radio Corp., 115 Liberty St., New York, N. Y.
Champion Radio Works, Div. of Consolidated Electric Lamp Co., Danvers, Mass.
Hytron Corp. & Hytronic Laboratories, 76 Lafayette St., Salem, Mass.
RCA Mfg. Co., Camden, N. J.

HEARING AID TUBES

Hytron Corp., & Hytronic Laboratories, 76 Lafayette St., Salem, Mass. (See page 95.)
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Raytheon Production Corp., 420 Lexington Ave., New York, N. Y.
RCA Mfg. Co., Camden, N. J.

INDUSTRIAL TUBES

Amperex Electronic Products, 79 Washington St., Brooklyn, N. Y. (See inside front cover.)
Continental Electric Co., Geneva, Ill.
Electrons, Inc., 127 Sussex Ave., Newark, N. J.
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
General Electric Co., Schenectady, N. Y. (See page 79.)
Heintz & Kaufman, Ltd., South San Francisco, Cal.
Hytron Corp. & Hytronic Laboratories, 76 Lafayette St., Salem, Mass. (See page 95.)
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Raytheon Production Corp., 420 Lexington Ave., New York, N. Y.
RCA Mfg. Co., Camden, N. J. (See page 87.)
Taylor Tubes, Inc., 2341 Wabansia Ave., Chicago, Ill.
United Electronics Co., 42 Spring St., Newark, N. J.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.

PHOTOTUBES

Bradley Laboratories, 82 Meadow St., New Haven, Conn. (See page 161.)
Continental Electric Co., Geneva, Ill. (See page 148.)
De Jur-Amsco Corp., 6 Bridge St., Shelton, Conn.
De Vry, Herman A., 1111 W. Center St., Chicago, Ill.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Emby Products Co., 1800 W. Pico Blvd., Los Angeles, Cal.
General Electric Co., Schenectady, N. Y. (See page 79.)
General Scientific Corp., 4829 S. Kedzie Ave., Chicago, Ill.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Photobell Corp., 123 Liberty St., New York, N. Y.
RCA Mfg. Co., Camden, N. J. (See back cover.)
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Rhamstine, J. Thos., 301 Beaubien St., Detroit, Mich.
Western Electric Co.—see Graybar Electric Co.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

RECEIVING TUBES

Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y. (See page 79.)
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass. (See page 12.)
Hytron Corp. & Hytronic Laboratories, 76 Lafayette St., Salem, Mass. (See page 95.)
Ken-Rad Tube & Lamp Corp., 227 E. Ninth St., Owensboro, Ky.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Raytheon Production Corp., 420 Lexington Ave., New York, N. Y.
RCA Mfg. Co., Camden, N. J. (See page 87.)
Tung-Sol Lamp Works Inc., 95 Eighth Ave., Newark, N. J.
Western Electric Co.—see Graybar Electric Co.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

TRANSMITTING TUBES

Amperex Electronic Products, 79 Washington St., Brooklyn, N. Y. (See inside front cover.)
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Eitel-McCullough, Inc., San Bruno, Cal. (See page 115.)
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
General Electric Co., Schenectady, N. Y. (See page 79.)
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Heintz & Kaufman, Ltd., South San Francisco, Cal. (See page 30.)
Hytron Corp. & Hytronic Laboratories, 76 Lafayette St., Salem, Mass. (See page 95.)
National Union Radio Corp., 15 Washington St., Newark, N. J.
Radio Specialties Co., 1956 Figueroa St., San Francisco, Cal.
Raytheon Production Corp., 420 Lexington Ave., New York, N. Y.
RCA Mfg. Co., Camden, N. J. (See back cover.)
Taylor Tubes, Inc., 2341 Wabansia Ave., Chicago, Ill.
Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.
United Electronics Co., 42 Spring St., Newark, N. J.
Western Electric Co.—see Graybar Electric Co.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.

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Amperite Co., 561 Broadway, New York, N. Y.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass. (See page 12.)
Hytron Corp., & Hytronic Laboratories, 76 Lafayette St., Salem, Mass.
RCA Mfg. Co., Camden, N. J.

X-RAY TUBES

Adlanco X-Ray Corp., 54 Lafayette St., New York, N. Y.
Fischer & Co., H. G., 2323 Wabansia Ave., Chicago, Ill.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Machlett Laboratories, Springdale, Conn.
Philips Metalix Corp., 419 Fourth Ave., New York, N. Y.
Standard X-Ray Co., 1930 N. Burling St., Chicago, Ill.
Westinghouse X-Ray Co., 21-16 43d Ave., Long Island City, N. Y.

Tubing

BRASS and COPPER TUBES and TUBING

American Brass Co., Waterbury, Conn.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Mueller Brass Co., 1925 Lapeer Ave., Port Huron, Mich.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Universal Brass Works, Howard & Lehigh Ave., Philadelphia, Pa.
Wolverine Tube Co., 1411 Central Ave., Detroit, Mich.

CERAMIC TUBING—see Insulation
FIBRE TUBING—see Insulation

FABRIC TUBES and TUBING

Anchor Webbing Co., 1005 Main St., Pawtucket, R. I.
B & C Insulation Products, Inc., 22 W. 21st St., New York, N. Y. (See page 160.)
Bentley, Harris Mfg. Co., Hector & Lime Sts., Conshohocken, Pa. (See page 154.)
Brand & Co., William, 276 Fourth Ave., New York, N. Y. (See page 15.)
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Insulation Products, Inc., 22 W. 21st St., New York, N. Y.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Pearce Co., R. T., 235 Scott Blvd., Covington, Ky.
Surprenant Electrical Insulation Co., 84 Purchase St., Boston, Mass.
Varflex Corp., Cor. Ford & Floral Sts., Rome, N. Y. (See page 172.)

GLASS TUBES and TUBING

Bentley, Harris Mfg. Co., Hector & Lime Sts., Conshohocken, Pa. (See page 154.)
Corning Glass Works, Corning, N. Y.
Duro-Test Corp., North Bergen, N. J.
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Luminous Laboratories, Inc., 6 E. Lake St., Chicago, Ill.
Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo, Ohio
Riedel Glass Works, Inc., Jos., 261 Fifth Ave., New York, N. Y.
St. Charles Technical Laboratories, Inc. 10 State Ave., St. Charles, Ill.

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Alden Products Co., 117 Main St., Brockton, Mass.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Camden Wire Co., Camden, N. Y.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Hope Webbing Co., Providence, R. I.
New England Electrical Works, Lisbon, N. H.
Roebling's Sons Co., John A., Trenton, N. J.

NICKEL and NICKEL ALLOY TUBING

Admak Mfg. Co., Irvington, N. J.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro Mass.
International Nickel Co., 67 Wall St., New York, N. Y.
Summerill Tubing Co., Bridgeport, Pa.
Superior Tube Co., Norristown, Pa. (See page 11.)

PAPER TUBES and TUBING

American Paper Tube Co., Hazel St., Woonsocket, R. I.
Cleveland Container Co., 10630 Berea Rd., Cleveland, Ohio
Cross Paper Products Corp., 2595 Third Ave., New York, N. Y.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
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Manufacturing

Firms like Puerto Rico

Advantages in taxes, duties, and labor make up for wages that are a bit higher than other offshore sites

by Ray Connolly, Washington bureau manager

In the scramble to remain cost-competitive in expanding global electronics markets, U.S. manufacturers have added Puerto Rico to the emigration to offshore locations that began years ago with Hong Kong and Taiwan.

In the 3,400-square-mile rectangle that lies at the northeastern end of the Caribbean Sea, there are now more than 165 plants manufacturing electronics and electrical products. That represents a growth of more than a hundred-fold since 1960. Even after taking away from that list the makers of electrical power machinery and comparable products, the remaining electronics producers in Puerto Rico number more than 75.

General Electric Co. tops the list of electrical/electronics producers with 19 separate operations, although these are largely turning out straightforward switchgear, circuit breakers, meters, and measuring instruments. Nevertheless, GE is recorded by the Economic Development Administration of Puerto Rico as having two strictly electronics operations. Both started in 1966, one turning out leak detectors at GE Instrument Corp. at Caguas, and the other, devices at GE Pilot Devices Inc., Vega Alta.

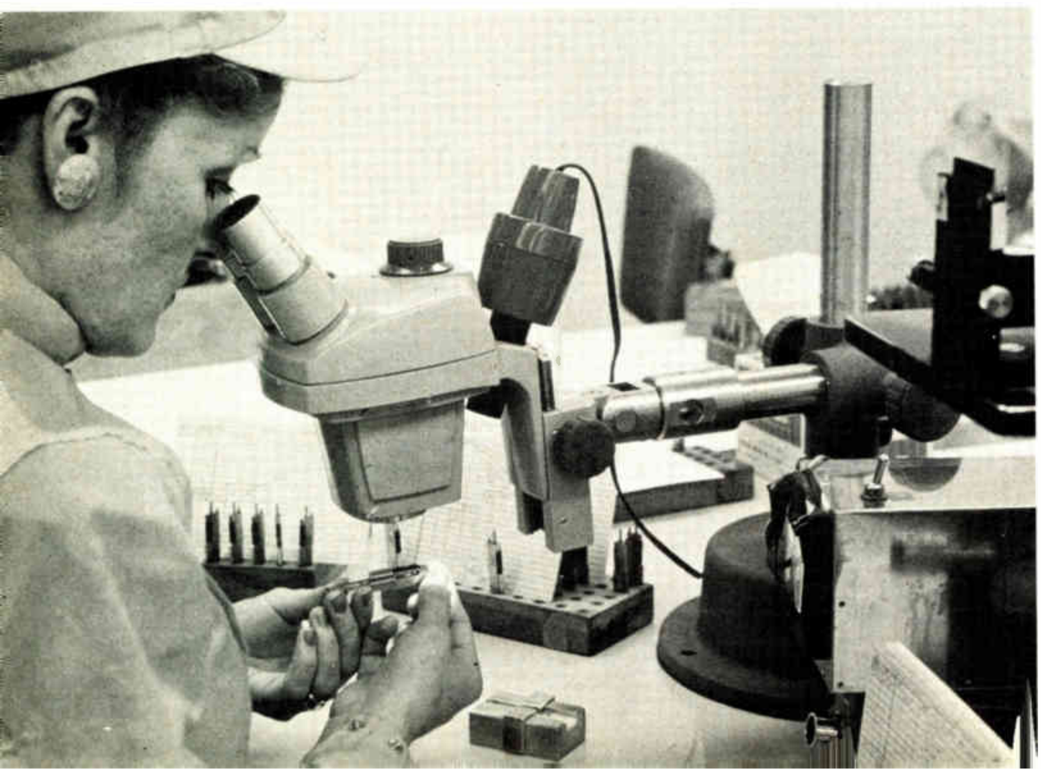
Biggest. But among purely electronics manufacturers, computer-maker Digital Equipment Corp. of Maynard, Mass., tops Puerto Rico's list. Since it started making digital circuit modules in July 1968 at San German, DEC has expanded its operation there to 165,000 square feet, and it is bringing another 135,000 square-foot facility on line in July at a 55-acre site on the island's northwest corner in Aguadilla. All told, DEC says it now employs some 1,600 persons in Puerto Rico to work on its PDP-8 and PDP-11 mini-computers.

The Puerto Rican commonwealth flaunts the impressive growth numbers regularly in its effort to lure other manufacturers to its shores. Shipments of electronic and electrical products to the mainland alone totaled nearly $200 million in 1973, reflecting a growth of nearly 15% from the year before. In addition, Puerto Rico exports roughly 10% more of its manufactures in these technologies to other markets.

Much of the island's growth as a haven for electronics manufacturers has come in the past five to six years, even though Puerto Rico's determination to expand and improve its economy has its roots in Operation Bootstrap, which began in the early 1950s.

Japan. But Puerto Rico's appeal to electronics manufacturers has not been limited to the U.S. variety, as Matsushita Electric Corp. has demonstrated. Beginning in June 1965 at Caguas with the assembly of radios and stereo equipment, the Osaka-based manufacturer has undergone six expansions on the Caribbean island. One of these included a move up to production of television receivers in August 1971 in a step that industry competitors interpret as offering the producer of Panasonic receivers the double advantage of a low-cost labor market and duty-free shipments to the mainland at a time when U.S. criticism of imports of Japanese home-entertainment products was rising.

Overall, 80% of the island's electronics and electrical equipment plants are affiliated with mainland



Delicate work. Bell & Howell employee precision-balances galvanometer at the firm's plant in Carolina, Puerto Rico. Also produced there are oscillograph sensors.

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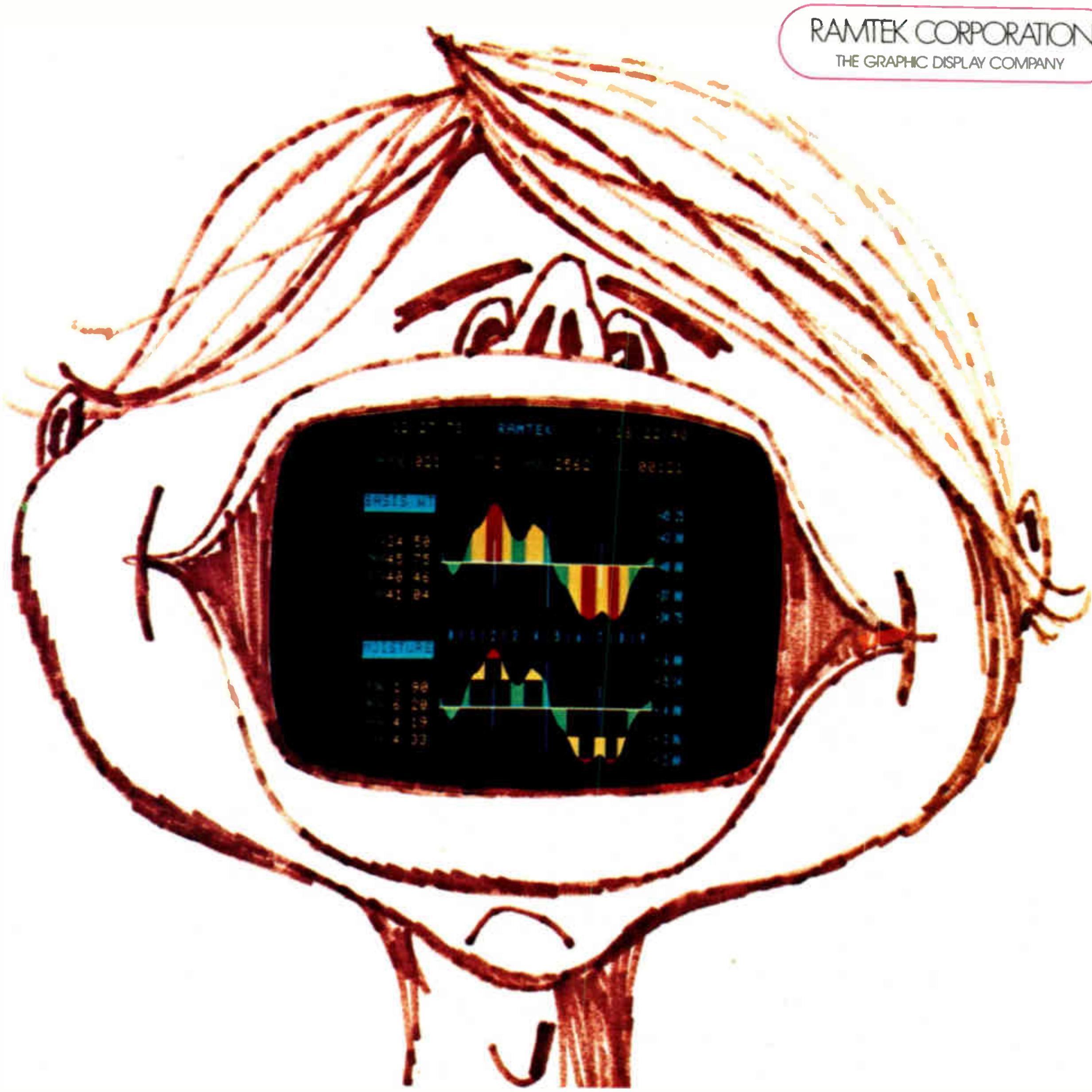
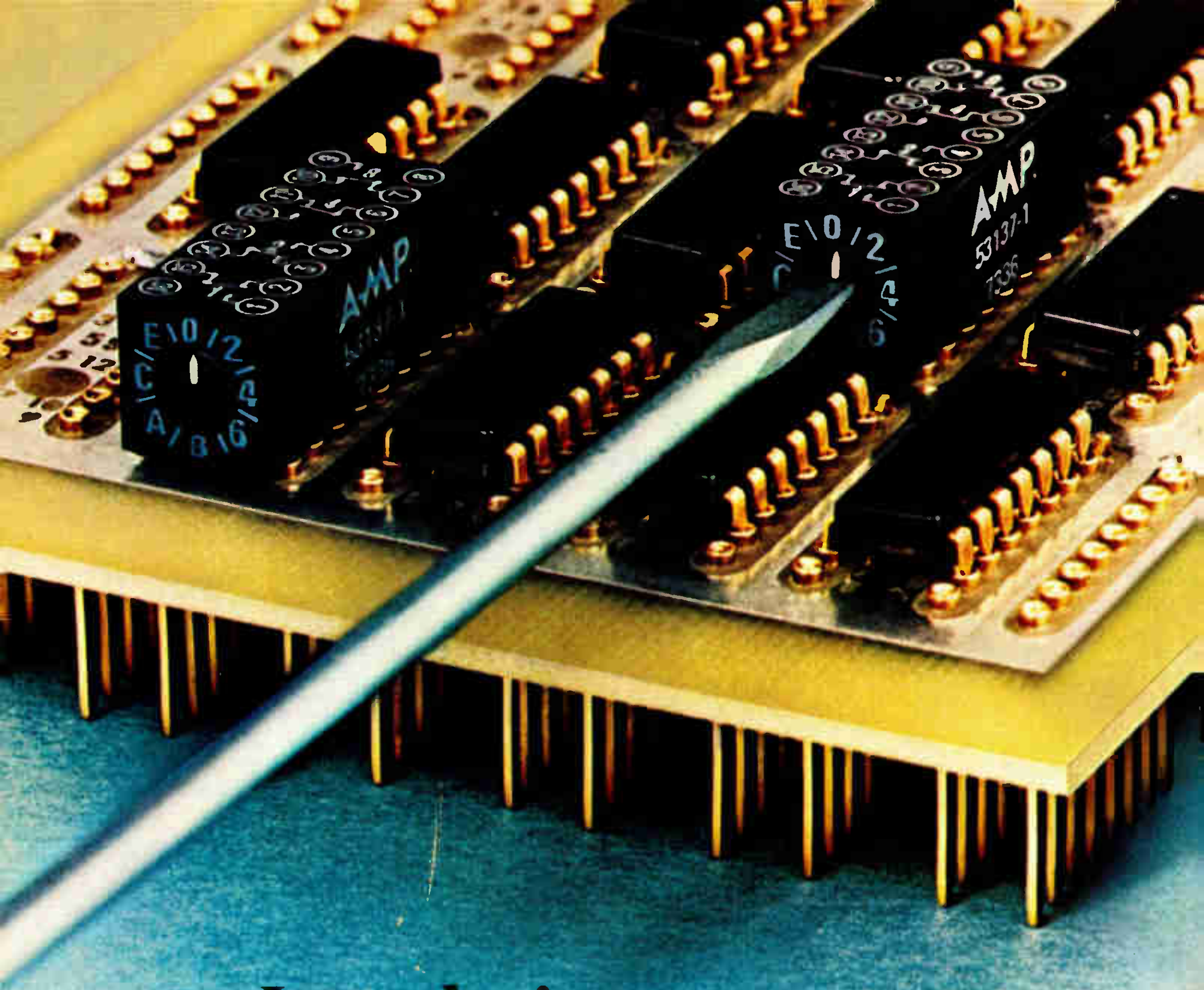
Or, for some rather startling information about our new systems, contact: Ramtek Corporation, 292 Commercial Street, Sunnyvale, California 94086. Telephone: (408) 735-8400.

RAMTEK CORPORATION
THE GRAPHIC DISPLAY COMPANY



Circle 77 on reader service card



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U.S. companies, 15 of which have more than one operation there. Three others, including Matsushita, are subsidiaries of non-U.S. companies, while the remainder are locally owned.

Incentives. What appeal does Puerto Rico hold for manufacturers? Generally, there are three—low taxes, an abundant supply of low-cost labor, and U.S.-supported training assistance. For just about everyone that has started manufacturing there, these incentives offset what some companies regard as a limited literacy rate and problems with worker reliability and training.

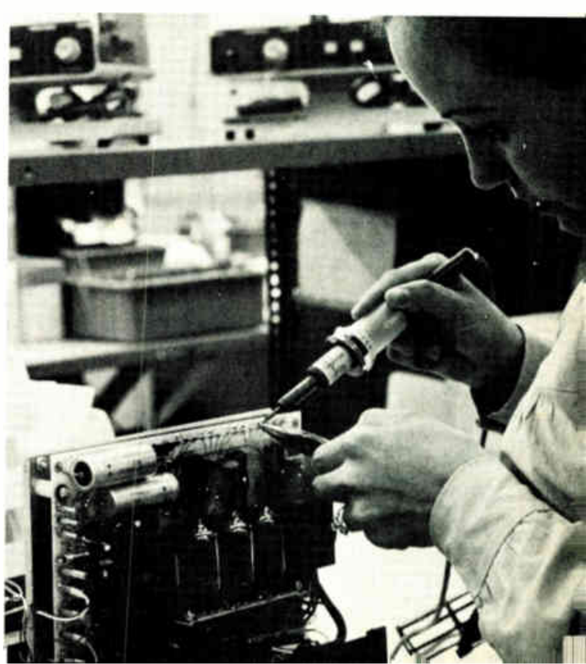
Topping the list of advantages, of course, is Puerto Rico's long-standing freedom from U.S. Federal income taxes—corporate, as well as personal—which manufacturers can apply to their island operations. Moreover, the commonwealth's Industrial Incentive Act of 1963 grants companies beginning or expanding operations there a 100% exemption on Puerto Rican taxes of all types—including income, property, and municipal, as well as license fees—for a period of 10 to 25 years, depending on plant location. The area around the capital of San Juan, for example, qualifies only for the 10-year exemption, while less developed areas, such as San German near the southwestern end of the island where DEC and three other companies operate, qualify for a 17-year exemption.

Labor. Of Puerto Rico's labor force of 926,000, about 2%, or 20,000, have jobs in electronics and electrical-equipment plants. And most of these—some 87%—are production workers. "All our engineering and design work is done in the United States," says DEC's general manager, Richard Esten. That situation is typical of the electronics industries throughout the island.

The minimum wage on the island is $1.60 an hour—well above that of many other offshore manufacturing locations, but still less than the $2.25 an hour prevailing in the continental U.S. Similarly, average hourly earnings crept up to $2.28 last year from $2.15 the year before, yet these are still only 58% of the floor in the U.S., and, in the opinion of one Government economist in Washington, "These relatively higher costs compared, say, to Taiwan or Korea, are offset by the breaks in taxes, transportation, and no duties."

The need for jobs on Puerto Rico, where unemployment hovers between 12% and 13%, and the fact that half the labor force is younger than 35, also is promoted by the island government in its industrial-development drive. Some manufacturers are concerned that bilingualism is not more widespread and that the average training period for workers is longer than it is on the mainland. But others say workers, once trained, are productive.

Boosters note that there is Federal support for pre-employment and on-the-job training under the 1962 Manpower Development and Training Act. DEC's Esten says that his operation is beginning to receive manpower-training assistance. Federal training support, designed for areas with high chronic unemployment, provides, for example, a program for training apprentices in skilled trades at wages lower than prevailing industry minimums. In Esten's view, the Puerto Rican labor force "is excellent." At the Chicago headquarters of Motorola Inc., which makes mobile and marine radios at Motorola Telcarro de Puerto Rico and components at Motorola Semimetales de Puerto Rico, both located at Vega Baja, the company says only, "Generally, we are



Easy does it. Worker performs soldering operation on a Beckman Instruments pH meter. Company has had plant in Carolina, Puerto Rico, since 1967.

happy," and adds, "we are experiencing no difficulties" with Puerto Rican operations.

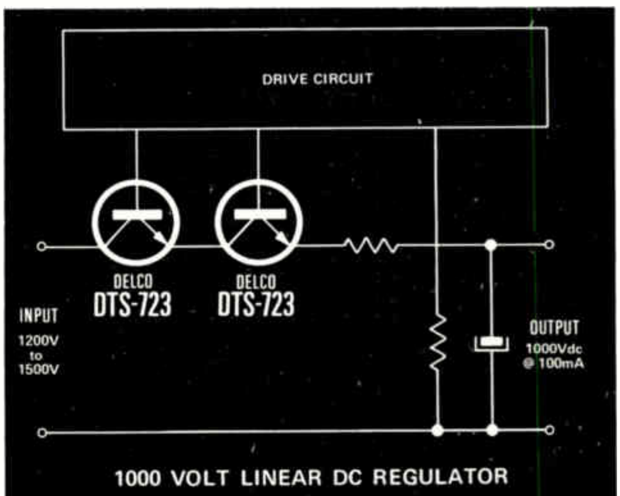
Signals? Does this mean that Motorola or any of the 15 multiplant electronics operations on Puerto Rico is less than happy with its decision? "I doubt it very much," argues one Labor Department official tracking the island's economic development. "Anyone who responds coolly to inquiries about their Puerto Rican operations," he muses, "is more likely just sending out signals that they know they have a good thing going and are not enthusiastic about sharing that knowledge."

Unlike Taiwan and other better-known offshore assembly sites, Puerto Rico has no one area of high concentration in electronic products. The commonwealth government's product index embraces 28 categories of electronics, ranging from DEC's computer parts to Matsushita's TV receivers. And between these fall the potentiometers and other components made by Bourns Inc. of Riverside, Calif., at six Puerto Rican operations; the measuring instruments and parts made at three sites by Weston Instruments Inc. of Newark, N.J.; the heads fo· drum, disk, and magnetic-tape drives, printed-circuit boards, and core memories made by Applied Magnetics Corp., Goleta, Calif., at four operations, as well as the magnetic sensors and passenger-seat controls made at Vega Baja by Instrument Systems Corp., Jericho, N.Y.

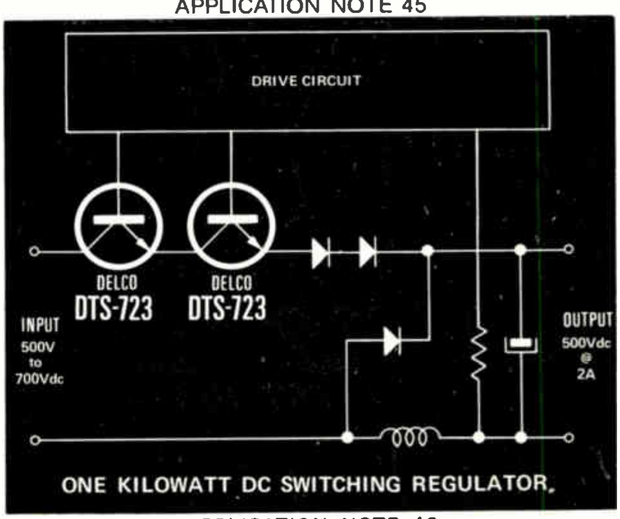
Are there no serious problems, then, for electronics manufacturers on Puerto Rico? Apparently not. Few specify anything, other than the generally longer period for training new employees and occasional complaints about "getting things on and off the island," even by air freight, which most electronics shippers use. Beyond that, however, perhaps typical is the view of DEC's Richard Esten, expressed when asked if he had to decide on a Puerto Rico plant investment, would he do it again? "No question about it," Esten responds. "Absolutely." □

NEW VALUES HIGH ENERGY

TYPE	I_C(max.)	V_{CEO}	V_{CEV}	$V_{CEO\,(sus.)}$	$V_{CE\,(sat.)}$ @ I_C, I_B	Power Dissipation (max.)	h_{FE} min./max. @ I_C, V_{CE}
DTS-701	1.0 Amp	800V	—	600V	—	50W	20/— @ 150mA, 5V
DTS-708	3.0 Amp	900V	900V	600V	2.0 max. @ 1 amp, 250mA	50W —	—
DTS-709	3.0 Amp	900V	900V	600V	1.0 max. @ 2A, 800mA	50W	—
DTS-710	3.0 Amp	900V	—	600V	—	50W	10/50 @ 150mA, 5V
DTS-712	3.0 Amp	900V	1200V	700V	—	50W	2.5/— @ 2.0A, 5V
DTS-714	3.0 Amp	900V	1400V	700V	—	50W	2.5/— @ 2.0A, 5V
DTS-723	3.0 Amp	1000V	1200V	750V	0.8 max. 1.0 amp, 250mA	50W	10/— @ 500mA, 5V
DTS-801	2.0 Amp	800V	—	700V	—	100W	20/ @ 200mA, 5V
DTS-812	5.0 Amp	900V	1200V	700V	—	100W	2.2/ @ 3.5A, 5V
DTS-814	5.0 Amp	900V	1400V	700V	—	100W	2.2/ @ 3.5A, 5V



APPLICATION NOTE 45



APPLICATION NOTE 46

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Some are specifically designed for use in high voltage switching circuits where inductive loads or fault conditions pose problems. Some are ideal for linear regulators and power amplifiers.

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The circuit diagrams in this ad will give you a quick reading of how these ten transistors can meet your needs.

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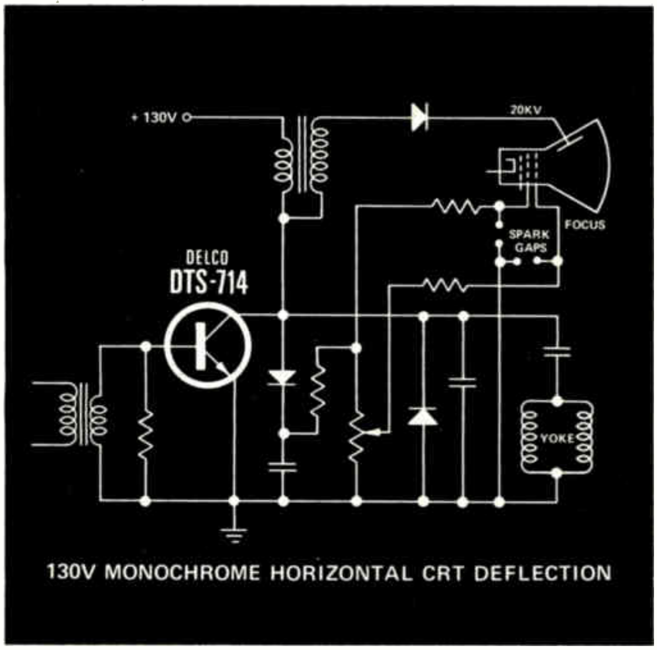
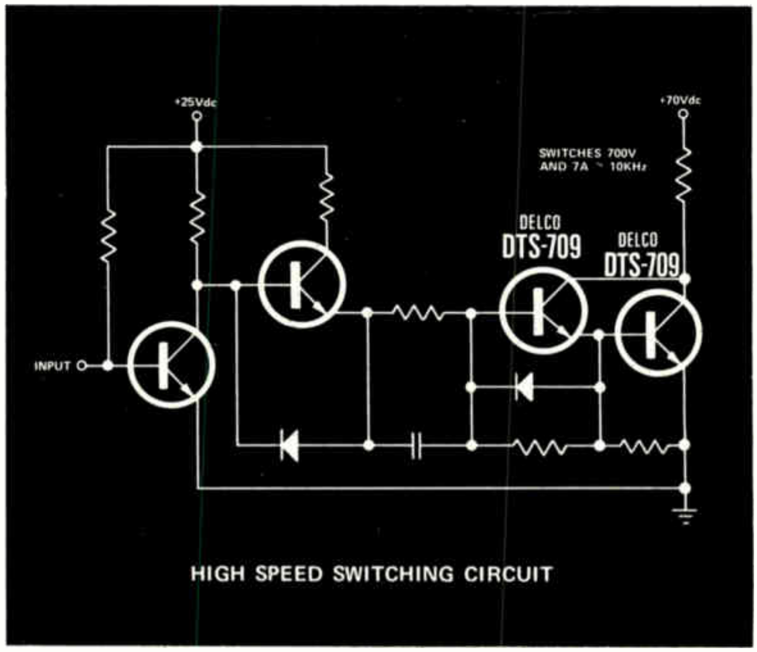


130V MONOCHROME HORIZONTAL CRT DEFLECTION



HIGH SPEED SWITCHING CIRCUIT

APPLICATION NOTE 54

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All it takes to tailor the characteristics of our new HA-2720/2730 is one external resistor. This provides a master bias setting which will establish the desired current-flow through the devices.

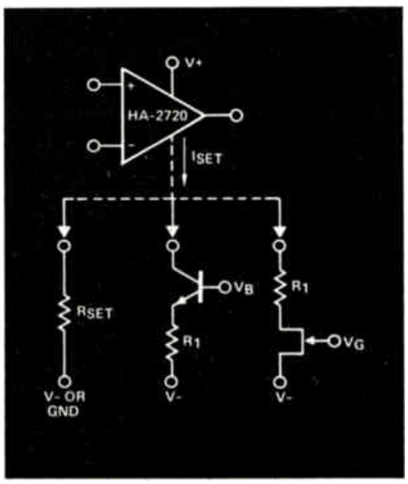
As a result, critical parameters such as bias currents, supply currents, bandwidth, slew rate, input noise, and others can be optimized to meet your particular needs. And because the devices have such a wide power supply range (± 1.2V to ± 18V) they can be used in an almost unlimited variety of linear designs.

A single programmable op amp, the HA-2720 is a direct replacement for many currently available op amps, yet it offers superior performance features over all of them. Among these are a wider range of programming, higher slew rate and bandwidth at low power levels, superior output current, and lower noise current. The HA-2730 is a dual monolithic version of the HA-2720 with identical performance features.

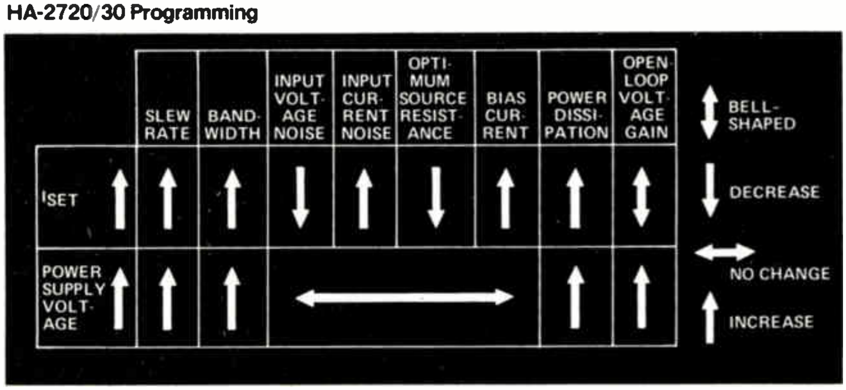
For the user these devices offer substantial benefits. First, they are highly reliable because they are short-circuit protected and have internal compensation with classical frequency response. They also provide you with considerable economy because the wide range of programming possible allows you to standardize your op amp inventory and change parameters as needed. Finally, by modulating the set current terminal you can minimize systems components and obtain such applications as VCO's, Wien bridge oscillators, and waveform generators.

Among other applications are low power instrumentation, portable battery operated instruments, active filters, and hearing aids. For details see your Harris distributor or representative.

Typical Biasing Circuits



HA-2720/30 Programming



Features

Wide range A.C. programming

Slew rate	0.06 to 6V/μs
Gain x Bandwidth	5KHz to 10MHz

Wide range D.C. programming

Power supply range	± 1.2V to ± 18V
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Input bias current	0.4 to 50nA
Output current up to 15mA	

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National LM 4250
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} HA-2720

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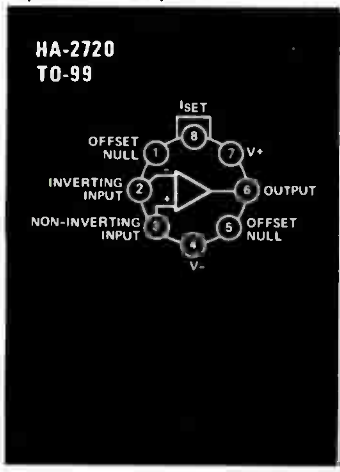
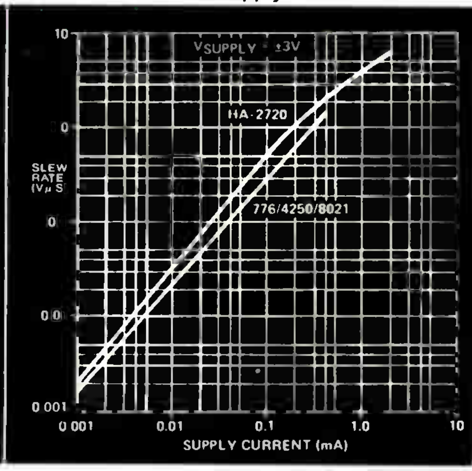
HA-2735	0°C to +75°C	$ 7.15
HA-2730	-55°C to +125°C	$16.50
Supplied TO-116		

mable Op Amps for Solutions

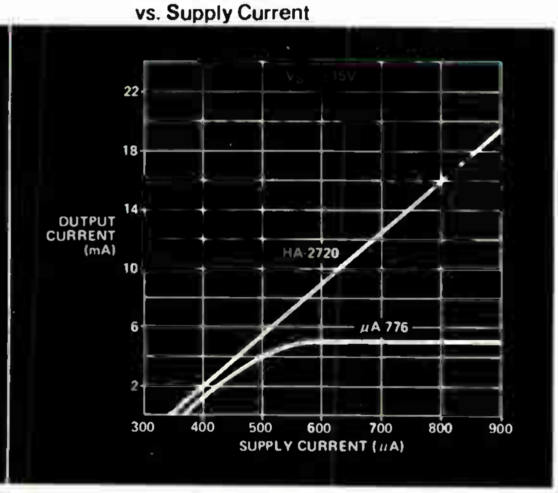
HA-2720 Single Programmable Operational Amplifier



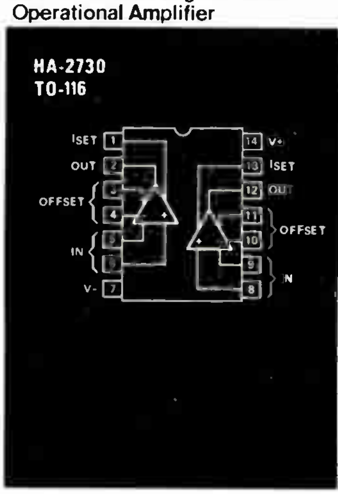
Slew Rate vs. Supply Current



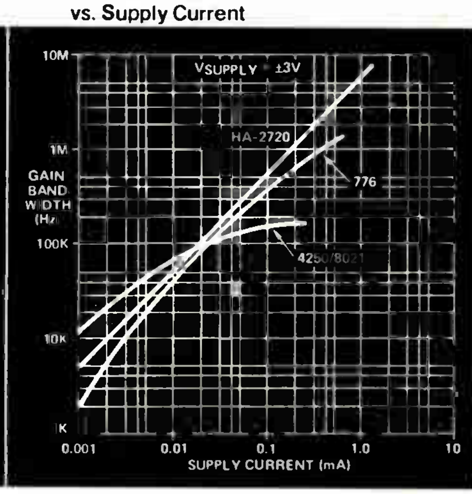
Output Current vs. Supply Current



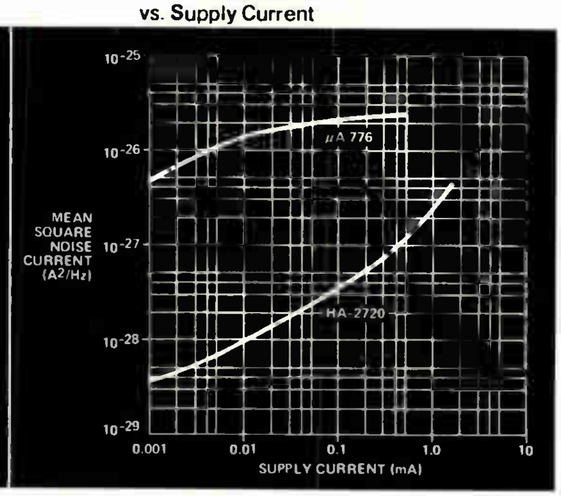
HA-2730 Dual Programmable Operational Amplifier



Gain Bandwidth Product vs. Supply Current



Input Noise Current vs. Supply Current



Above comparative data curves were experimentally derived or extrapolated from published data sheets where available.

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see Finishes

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duPont Plastic Dept., Arlington, N. J.
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WINDINGS—see Coils

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Habirshaw Cable & Wire Corp., 40 Wall St., New York, N. Y.
Hatfield Wire & Cable Co., Hillside, N. J.
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Okonite Co., Passaic, N. J.
Packard Electric Div., General Motors Corp., Warren, Ohio
Paranite Wire & Cable Corp., Jonesboro, Ind.
Phelps Dodge Copper Products Corp., American Copper Products Div., 40 Wall St., New York, N. Y.
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Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
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Rome Cable Corp., Rome, N. Y.
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Simplex Wire & Cable Corp., 79 Sidney St., Cambridge, Mass.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
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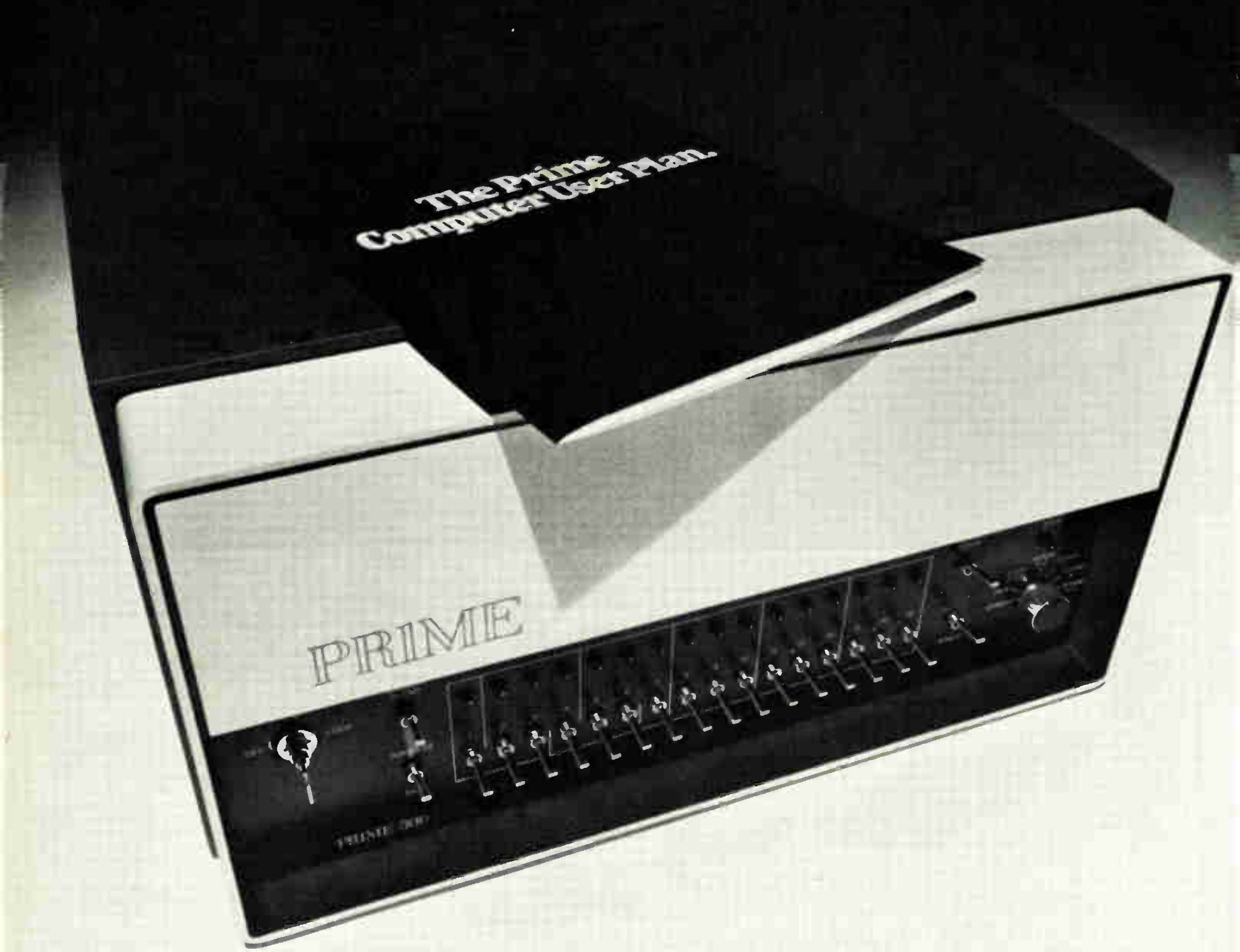

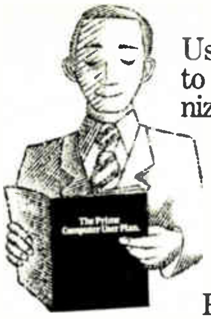

The Prime Computer User Plan brings common sense to buying a computer. It recognizes the simple fact that your needs might change someday.

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We consider The Plan a new way to buy, use and upgrade computer systems. We also give you the systems to consider: The Prime 100, 200 or 300. The chart below is a preview of what to expect in each.

Standard Processor Features

Processor	Features
Prime 300 Central Processor (1 board)	• Virtual Memory – automatic paging, mapped address translation to 256K words, restricted execution mode, and memory protect. • Stack Procedure Instructions • Micro Verification Routines** • Hardware Multiply/Divide and Double Precision Arith.* • DMC/DMT Capability* • Automatic Program Load From Input Devices (PTR, TTY, CR, MT, Disk)*
Prime 200 Central Processor (1 board)	• Memory Byte Parity • Processor Byte Parity • Full Addressing Modes – direct, indirect, and indexed in both sectored and relative modes • Virtual Instruction Package (VIP) – automatic trapping of unimplemented instructions and substitution of functionally equivalent software subroutines.
Prime 100 Central Processor (1 board)	• 8-Channel Programmable DMA • 4 Channel Full Duplex Asynchronous Serial Interface • Multi-level Vectored Priority Interrupt System

* Optionally available on Prime 100 and 200
**Optionally available on Prime 200

The chart suggests there's a little 300 in every Prime computer. Naturally, we planned it that way. Our 300 is just the reverse of the big box with a little computer inside.

Other 300 features will tell you just how big it is. For instance, there's high-speed MOS memory with 32K words per board. Up to 256K words per system. There's floating point arithmetic and writable control store, too. In short, there's everything you'll need in the computer you can plan with. Work out a multi-function system or plan a multi-user arrangement. The diagram that follows is just one way to go.

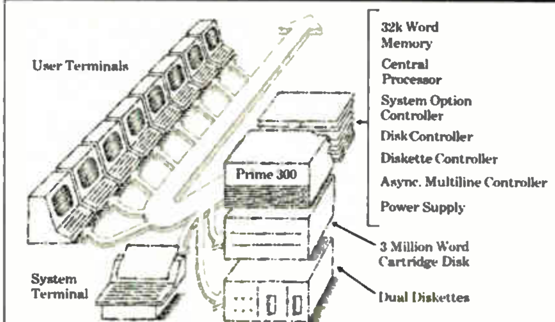
The Prime 300 supports a multi-user, virtual memory Disk Operating System (DOS VM) and a foreground/background Real Time Operating System (RTOS VM).

A Prime 300 with virtual memory easily accommodates over a dozen users. What's more, each is guaranteed 64K words of virtual memory available to program in FORTRAN, BASIC, Macro Assembler and Micro Assembler.

The system files and paging space are all provided by cartridge disk. Our new diskettes offer low cost storage for personal user files.

A Prime 300 is good. How good can best be seen in The Plan. It shows how to upgrade from the 100 right on to the 300. In the process, you don't change software. The time and expense of reprogramming are gone. You can also use the 300 as a software development system. The software will run on 100's or 200's without modification. The Plan guarantees this kind of system compatibility.

The Plan also goes into system integrity features. Memory Byte Parity and Processor Byte Parity are standard in the Prime 300. Micro-verification routines (also standard) and controller loop-back allow you to isolate faults to a single board.



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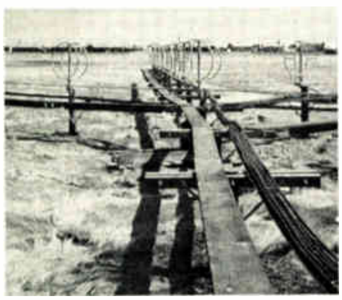

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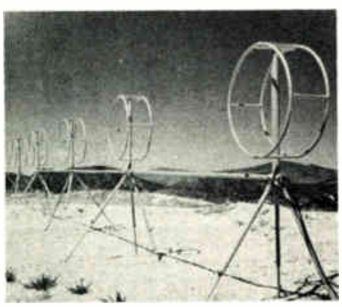

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Optical waveguides look brighter than ever

Optical telecommunications systems could be practical today now that low-loss optical waveguides can be produced; eventual cost-competitiveness with wire and cable is promised

by F.L. Thiel and W.B. Bielawski, *Corning Glass Works, Corning, N.Y.*

☐ Optical waveguides are important transmission media of the future. Their promise of large bandwidths and freedom from crosstalk and interference has encouraged years of research, and this investment is now on the verge of paying off in wideband cable with low enough losses and low enough costs to allow cost-effective data links (Fig. 1) to be built.

Optical frequencies can carry far more information than the much lower microwave frequencies. Hundreds of optic fibers, each carrying up to 1,000 telephone conversations, may be run in one cable with minimal crosstalk, complete electrical isolation, and immunity to external electrical noise and interference with significant frequency response advantages over coaxial cable (Fig. 2). Moreover, the medium should become directly cost-competitive with coaxial cable and later even with twisted-wire pairs, since technical advances are decreasing the cost of fibers while the cost of the raw materials of wire and cable are rising.

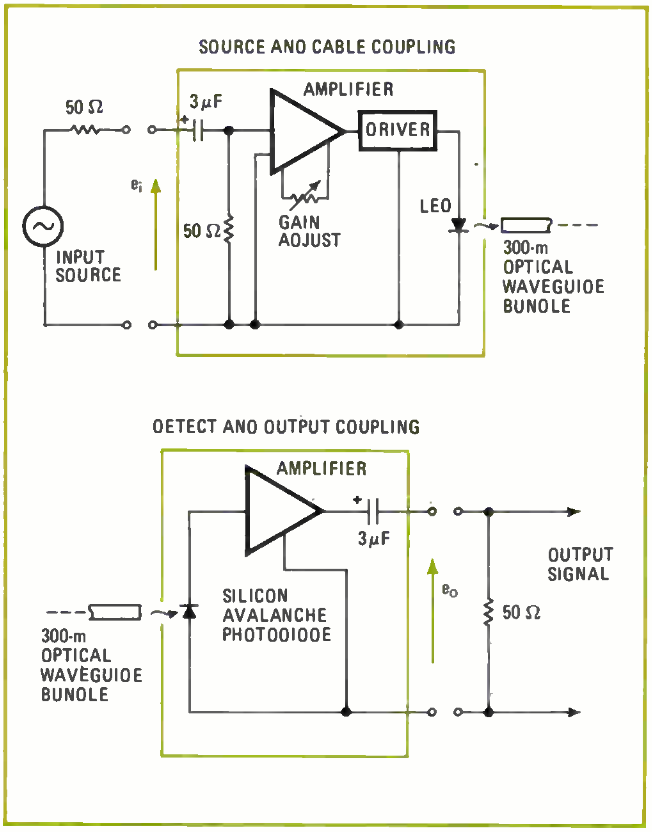
Already the main thrust of fiber-optic engineering has shifted away from investigative research and toward system development and production. For instance, Corning Glass Works of Corning, N.Y., has recently signed agreements with several companies to develop waveguides for an optical telecommunications system. A pivotal event in the growth of R&D in optical communications was the production of several hundred meters of low-loss (decibels per kilometer) waveguide by Corning Glass Works in 1970.

Concepts for long-range use of optical waveguides high in telephone system hierarchies, where bandwidths in excess of those obtainable with millimeter waveguides will be required, have progressed to the point where optical waveguides should be applicable throughout the telephone system. The same advantages, outlined in Table 1, hold promise of applications in the cable television, computer, military, process control, and instrumentation fields.

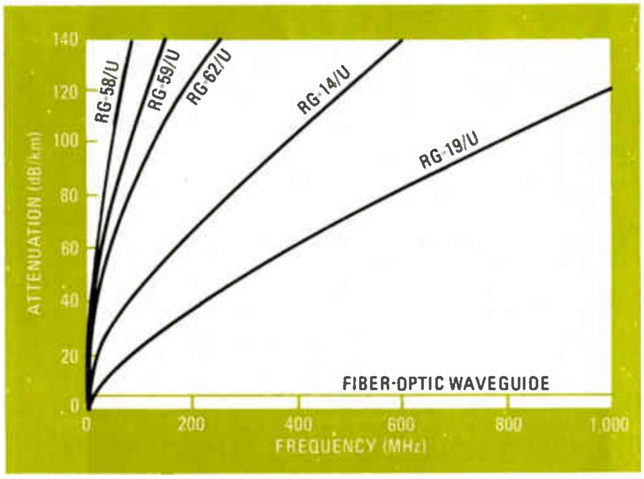
Designing an optical link

An optical link's performance can be predicted from the parameters of its component devices—a signal-modulated light source, coupled to a cable, coupled to a photodetector. For instance, bandwidth is determined by the input light source or its pre-amplifier or driver, by the dispersion in the optical waveguide, or by the detector or its post-amplifier. Length of a link may be limited by input source power, input coupling efficiency, attenuation in the waveguide bundle, detector responsivity, or detector noise.

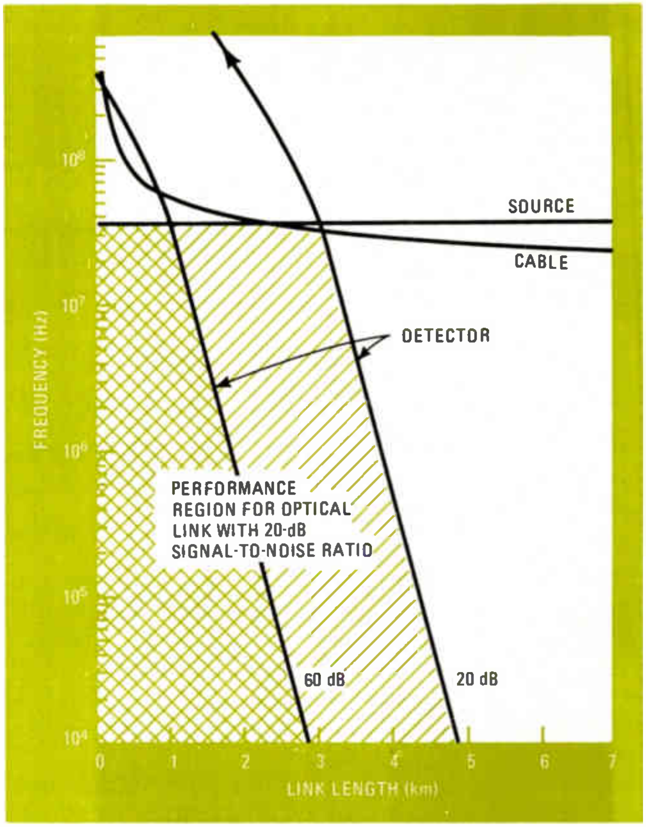
In the design of a link, the potential performance limitations of all its components must be viewed together, so the performance achievable by the link can be rapidly assessed. It is helpful to plot bandwidth versus link



1. TV link. Television signal intensity-modulates the LED. After transmission down the cable, the detector converts this light intensity variation back into electrical modulation. Addition of the drive and receiver electronics is all that is necessary to convert a standard coaxial system into an optical cabling system.



2. Fibers versus coaxial cable. Optical waveguide exhibits a flat response and temperature stability over a wide temperature range, unlike coaxial cable. Coaxial links often require compensation of the roughly square-root dependence of their attenuation on frequency.



3. Optical links' limitations. Performance limits for optical links are set by device parameters—the source, waveguide, and detector characteristics. Modulation (source) affects signal transmission bandwidth. Dispersion (waveguide) limits bundle length due to pulse broadening. The signal-to-noise ratio of the detector sets the lower limit on signal strength.

length as in Fig. 3, in which three types of curves form boundaries on the region of acceptable link performance. (The specific values chosen in plotting these curves were measured in the laboratory or derived from manufacturers' data sheets.)

The first curve in Fig. 3, labelled source, shows a 35-megahertz limit on bandwidth, independent of link length. This is typical of the modulation limit of the fastest commercial infrared-light-emitting diodes—other circuitry in the link can generally be made with a larger bandwidth and therefore does not set a limit to modulation bandwidth.

The second curve, labelled cable, shows the 3-decibel bandwidth limitation imposed by optical-waveguide dispersion (see "Attenuation and dispersion," p. 91) and was calculated from a pulse broadening of 1.5 nanoseconds per kilometer, such as might be measured with an injection laser as source. Since this data would include both an intermodal (multimode group relay) dispersion component and a material dispersion component, the latter was scaled appropriately to account for an assumed LED line width of 400 angstroms. (Multimode group delay dispersion refers to the varied times of arrival of the different wavelengths emitted at one time by a light source; with each wavelength or mode is associated a group of photions, which travels at a different speed from groups associated with other wavelengths.) Dependence of link length on pulse broadening was assumed to be linear for lengths up to 0.5 km and to vary as the square root of length beyond that distance. The assumptions on which this calculation was based are representative of certain multimode waveguides with graded index profiles.

The third type of constraint, shown in Fig. 3 as a pair of curves labelled 60 dB and 20 dB, includes all the factors which limit signal-to-noise ratio at the detector. The signal-to-noise curves assume a relatively conservative 25-dB coupling loss into the hexagonally close-packed fiber bundle termination. Waveguide bundle attenuation is taken as 10 dB/km and the source is a Lambertian LED with an output power of 10 milliwatts and a 0.46-millimeter diameter. The minimum discernible signal or noise equivalent power at the detector in Fig. 3 is derived from manufacturers' data for a silicon avalanche photodiode with a gain of 100 and a following transimpedance amplifier.

The curve derived in this way represents a small-signal analysis in which detector shot noise, excess multiplication noise, the thermal noise of bias resistors, parasitic detector series resistance, and amplifier noise terms have all been included.

Amplifier open-circuit gain is assumed to be very large throughout the frequency range of interest. Quantum efficiency of the detector is assumed to be 50% throughout the frequency range of interest. All other parameters are extracted or calculated from manufacturers' data.

To calculate the 60-dB curve in Fig. 3, it is first necessary to find the power required at the detector. This power is the value from Fig. 4 (e.g., 1.5×10^{-9} watts at 10 MHz), increased by a factor of 1,000 to give a 60-dB signal-to-noise ratio (e.g., 1.5×10^{-6} W at 10 MHz). This power is compared to the available power coupled into the waveguide bundle at the input (30×10^{-6} W in this case). The attenuation that can be accepted in the optical-waveguide bundle itself (e.g., $10 \log_{10} 30/1.5 = 13$ dB) is converted to link length from the assumed attenuation of 10 dB/km (i.e., 13 dB/km = 1.3 km). It is this computed length, monotonically decreasing with increasing frequency, that is plotted in Fig. 3.

The 20-dB curve is obtained in the same manner except that the desired signal-to-noise ratio at the detector is taken as 20 dB.

As the analysis of Fig. 3 shows, the region of acceptable link performance and its boundaries are defined by the system components. For short link lengths, the maximum LED modulation rate limits performance. As link length increases, dispersion in the optical waveguide

Attenuation and dispersion in optical waveguides

There are two types of attenuation in optical waveguides: absorption and scattering. Absorption attenuation is principally attributable to impurities present in the waveguide glass, including transition metal and OH ions. Existing waveguide processes have reduced impurities to a level of a few parts per billion.

Scattering attenuation is caused primarily by thermal and concentration fluctuations, but it may also include inhomogeneities and artifacts introduced in the waveguide manufacturing process. Scattering is dependent on the operating wavelength and generally decreases with increasing wavelength. In a waveguide having a total attenuation of several decibels per kilometer, absorption and scattering account for comparable fractions of the total attenuation in the 800-nanometer region. The lowest attenuation achieved thus far has been 2 dB/km at 1.06-micrometer wavelength. At this level, most of the attenuation is scattering attenuation.

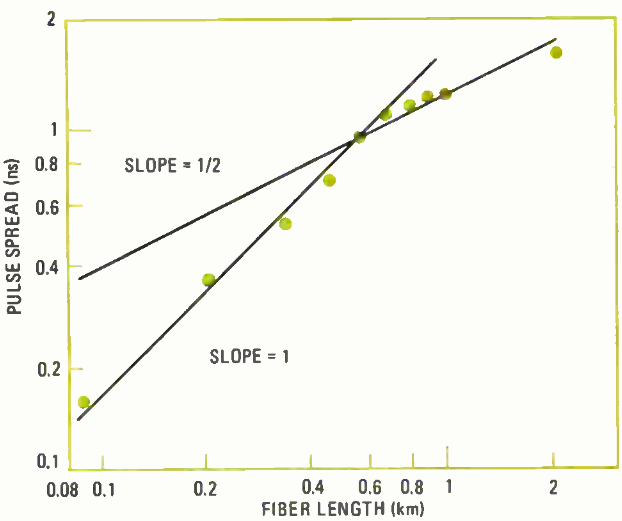
An important consideration in using optical waveguides is the choice of operating wavelength. Two regions of low attenuation compatible with available optical sources are between 800 and 900 nm (GaA1As diodes) and at 1.06 μm (neodymium YAG Lasers). Operation at wavelengths approaching the ultraviolet (below 0.5 μm) will result in significantly higher attenuation due to the intrinsic Rayleigh scattering and ultraviolet absorption present in all glasses. Operating at far infrared wavelengths (above 1.1 μm) will result in increased attenuation due to absorption bands of OH including the fundamental peak at 2.7 μm and its tail and overtones at shorter wavelengths. Between 0.7 and 1.1 micrometers, the bulk of any absorption above 2 dB/km is due to OH absorption. Elimination of residual fiber water content leaves scattering as the major loss mechanism.

Waveguide material properties and the spectral width of the light source are the fundamental determinants of bandwidth capability of optical waveguides. Bandwidth is further modified by the waveguide structure and factors related to the excitation and detection conditions and modal characteristics of the waveguide.

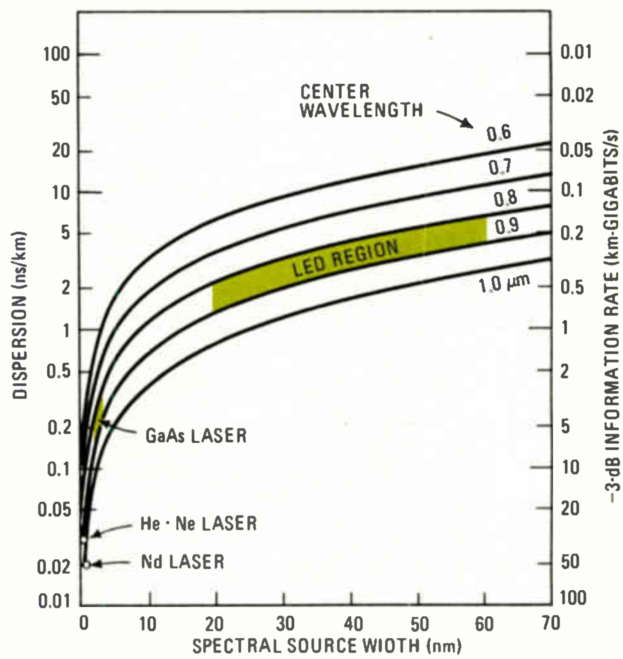
For silica, material dispersion alone results in pulse spreading on the order of picoseconds in 1 km. Pulse spreading is markedly affected by the spectral width of the source. For LEDs, depending upon a particular design's characteristics, spectral width results in pulse spreading from just below 1 nanosecond to nearly 5 ns on 1 km of optical waveguide. A spectrally narrower, solid-state injection laser decreases the pulse spreading by approximately one order of magnitude.

The most important factor related to the waveguide structure is the shape of the index profile. Some multimode fibers are characterized by a "step" index profile. Difference in path length for a straight-through ray and a critical ray causes pulse spreading proportional to aperture and length of fiber. Depending on waveguide parameters, this effect sets the waveguide bandwidth capability at some level below 10^8 bits per second over 1 km.

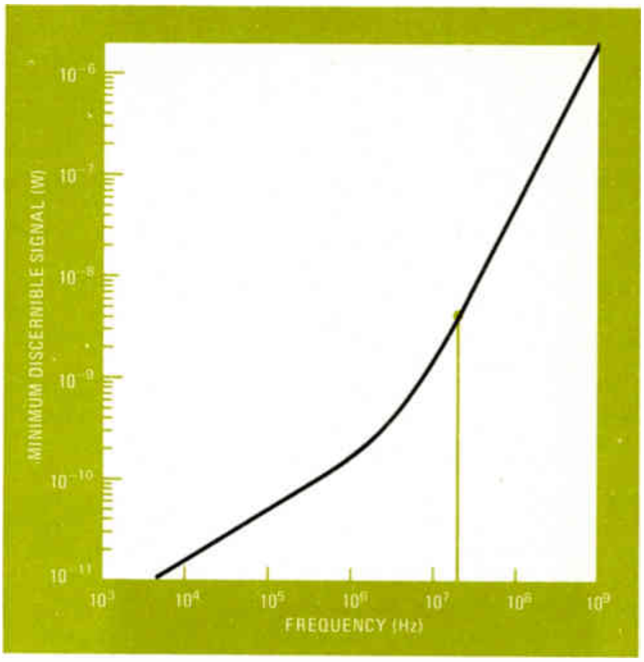
Path length can be equalized by properly shaping the index profile. Experimental multimode waveguides with an approximately parabolic index profile have shown pulse spreading as low as 1 ns in a 1-km length. In some waveguide fibers, mode-mixing effects account for the very beneficial change in shape from a linear dependence on distance of pulse spreading over short distances to a square-root-of-the-length dependence for distances greater than about 500 meters.



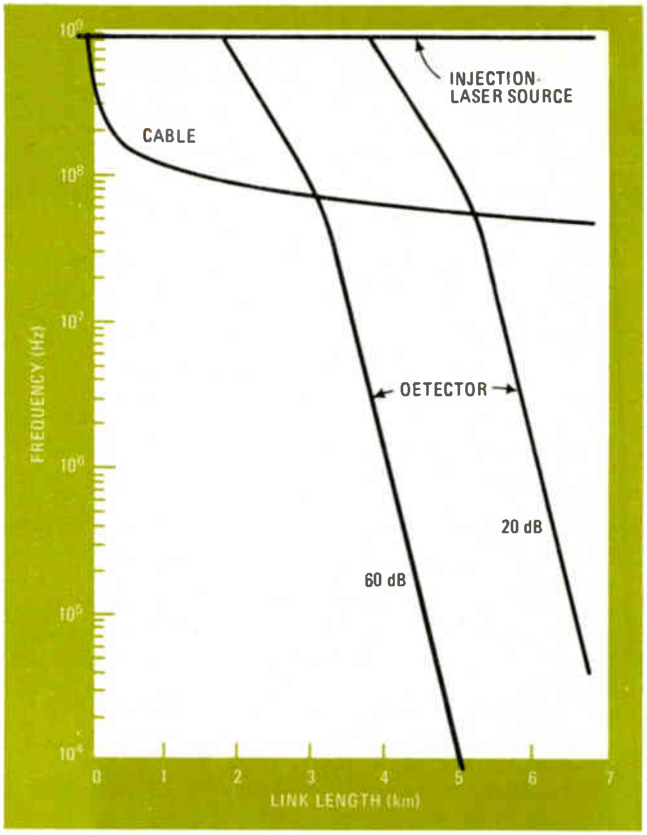
A. Losses over long transmission distances can be minimized if a fiber's index of refraction is tapered properly from core to cladding. The loss is proportional to cable length over short distances to the square root of the length beyond 5 kilometers.



B. Both geometric and material dispersion spread an optical pulse as it propagates down a fiber. Dispersion is a function of center operating wavelength and the source optical bandwidth.



4. Good viewing. The minimum signal that can be detected with a typical avalanche photodiode and preamplifier combination is about 10 nanowatts at 30 megahertz.



5. Laser alleviation. An injection-laser source would, by reason of its narrow emission line width, greatly reduce dispersion and increase allowable link length and data rate. These sources are not yet commercially available in room-temperature cw versions.

forms the limit on 3-dB bandwidth. At some length, performance is held back by the combined effects of limited input power, attenuation, and detector sensitivity and noise.

Note that a 100× increase in source power, or a 100× increase in source coupling efficiency, or a 100× decrease in detector noise would move the 60-dB curve to the position now occupied by the 20-dB curve and move the 20-dB curve correspondingly to the right. However, a change in waveguide attenuation from 10 dB/km to 2 dB/km would move these curves to the right by a distance factor of 5. Thus, extremely low values of attenuation (2 dB/km) have been achieved in optical waveguides, and such values pay handsome dividends where longer distances are required, especially if these can be achieved at reasonable cost.

It is interesting to speculate on what would happen if a suitable injection-laser source capable of continuous-wave operation at room temperature were available. Assuming such a source could couple 10 milliwatts of power at 900 nanometers into a single multimode fiber and could be modulated at rates up to 1 GHz, with line width of 25 angstroms, and if all other assumptions in Fig. 3 remain unchanged, the performance shown in Fig. 5 would result. Because the laser line width is much narrower, dispersion is much less marked than when a relatively wideband LED is used as a source. The most striking change is that dispersion, rather than source modulation, becomes the performance limit throughout much of the useful operating range.

Source coupling

The maximum amount of power that can be coupled from a source into an optical waveguide bundle can be calculated from measurable properties of the source and bundle. In addition to geometrical parameters, a knowledge of the radiance of the source as a function of position and angle is another essential requirement.

For example, consider a surface-emitting LED as the source and an hexagonally terminated close-packed 19-fiber bundle as the receiver. The source, as viewed from the exterior, might typically have an emitting area 0.46 mm in diameter. Its emission will be Lambertian—the radiance is constant when viewed from any direction in the forward hemisphere. The total power, R_s, emitted from the LED can be given by:

$$P_s = N_s A_s$$

where N_s is the source radiance and A_s its emitting area.

The power accepted by the waveguide bundle, P_b, can be given as:

$$P_b = N_b A_b \pi \gamma^2$$

where N_b and A_b are the radiance and area of the bundle, respectively, and γ is the acceptance angle.

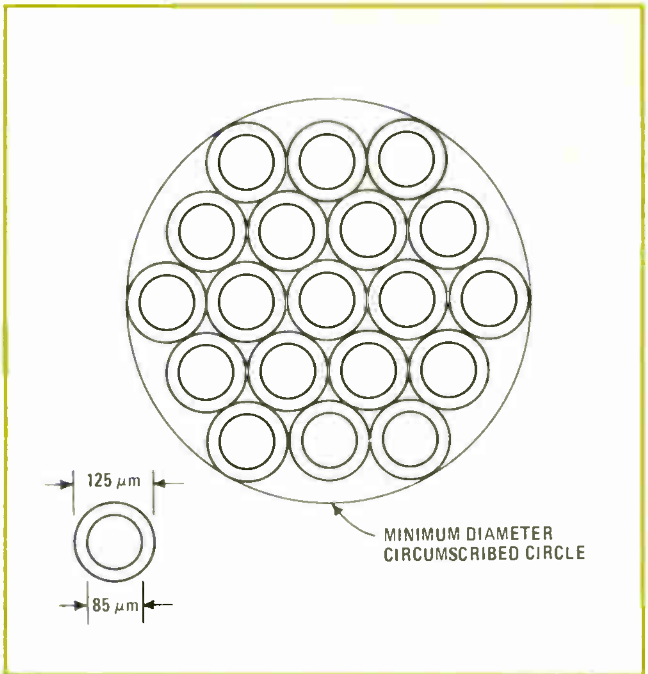
Now by the principle of conservation of radiance, N_b is at best equal to N_s. Therefore:

$(P_b/A_b)\pi\gamma^2$ *is equal to or less than* $P_s/(A_s\pi)$

and the maximum coupling efficiency is:

$$P_b/P_s = \gamma^2(A_b/A_s)$$

The light-accepting area of the bundle, A_b, is just the cross-sectional areas of all of the cores within the bundle. However, the best one can do with a simple optical system is to place the LED emission within a circle



6. Circle into hexagon. The bundle consists of 19 fibers, ending in a hexagonal metal connector. Along its length, however, the bundle has a circular PVC jacket. The minimum coupling loss is 19 dB.

circumscribed about the light-accepting area. Thus $A_b = fA_c$, where A_c is the area of the circumscribed circle and f is termed the packing fraction.

Figure 6 shows the end of an hexagonally terminated close-packed 19-fiber bundle. Each fiber has an acceptance angle $\gamma = 0.14$ rad and is 125 μm in diameter, with a light-accepting core that is 85 μm in diameter. The minimum-diameter circumscribed circle is also shown.

The coupling efficiency calculated from the above parameters is $P_b/P_s = 1.3\%$. Equivalently, the coupling loss is 19 dB. Of this loss, 4.0 dB is attributable to the packing fraction of 40%.

Since 19 dB is the minimum coupling loss achievable for the assumed source and bundle with a simple optical system, the assumption used in the text is assessing link performance was a more conservative 25 dB.

A brilliant future

Future developments should have much more dramatic results. Potentially, opto-cabling is capable of providing not just a high-performance, cost-effective alternative to wire and coax but radically new system capabilities for designers.

A 300-meter 10-MHz link is well within the limits of existing technology and should be producible and serviceable. Over-all link performance is the result of degradation introduced at every component of the system, while the fiber bundles themselves allow data transmission bandwidth of one gigabit or more.

An experimental data link, shown in Fig. 7, was built and evaluated. Adjustable gain of the input amplifier was provided to compensate for variations in performance caused by changed bundle lengths or unit-to-unit variations in sources, bundles, or detectors.

The LED used in the system was biased in the middle of its operating range, although this can be easily modified for an application involving only unipolar inputs. It was protected from being overdriven by saturation of the input amplifier. Table 2 lists the fixed parameters of the link. Data was taken with a 50-ohm load. Figure 8, which shows typical insertion gain (output divided by input) characteristics versus frequency of the system, demonstrates prototype performance, although at the present time optical fiber links can only compete with coaxial cable over very long distances.

TABLE 1 CHARACTERISTICS OF OPTICAL WAVEGUIDES

Optical	Low-loss, broadband transmission Extended amplifier spacing over coax Low cost per channel Upgradable capacity with source detector improvements
Mechanical	Small diameter, low weight, flexibility Low installation costs Limited duct space requirements
Environmental	Durable under adverse temperatures, chemicals, and radiations Provides circuit isolation Non-shorting Immune to electromagnetic interference or impulse induced errors Difficult to tap

However, optical waveguides are potentially applicable throughout the telecommunication system hierarchy. The higher the channel density, the more favorable the figure of merit for the installed cost per channel mile. In fact, system designers may well choose to design fewer layers of system hierarchy because waveguides, when carrying a large number of channels, will not represent a significant system cost.

The upper boundary of optical waveguide penetration into telecommunication systems will probably be determined by a complex tradeoff among the output power and modulation rate of feasible sources, such waveguide properties as attenuation, bandwidth, aperture, and the cost of multiplex and input/output electronics. The lower boundary will be determined primarily by waveguide cost in comparison to conductors such as twisted-wire pairs. Although development work continues, and a large investment in production facilities will be required, it is reasonable to expect optical waveguides eventually to become directly cost-competitive with communication wire.

Categories of applications

Five major applications categories for low-loss optical waveguide conductors are listed in Table 3.

Use of optical waveguides in telephone transmission clearly represents their largest potential application. The principal motive here would be the economy deriving from their large bandwidths and low attenuation. Small size and bending radius are also important where the available duct space is limited, as in most major cities and even more acutely in areas like office or data processing complexes. Minimal crosstalk and noninterference are also important.

In telephone systems, waveguide cables will consist of

Low-loss optical waveguides

Crucial to any telecommunications application is the availability of quantities of low-loss waveguides. Corning makes two forms of low-loss optical waveguide. One is Kinar-coated waveguide bundles characterized by total attenuation below 30 dB in standard lengths of 1 kilometer. The other is fiber-optic bundles, consisting of 19 fibers packaged in a PVC jacket, which have a total attenuation of 30 dB/km in lengths of 500 meters.

Currently available bundles are intended for laboratory work and demonstrations of system feasibility, and not as practical field cables. Development has, however, begun on waveguide packing techniques to yield conductors with handling properties comparable to those of small-diameter coaxial cable.

Individual multimode fiber parameters are:

- An outer diameter (coated) of 135 micrometers.
- A core diameter of 85 micrometers.
- A core refractive index of 105.
- A numerical aperture (size of the half angle of the acceptance core) of 0.14. (The square of the numerical aperture is a measure of the light-accepting capacity of a fiber.)
- Attenuation at 820-nm wavelength of 30 dB/km.

Fiber bundles of multimode optical waveguides available in the 500-meter maximum length have an outside diameter of 3 mm and an attenuation of 30 dB/km at an 820-nm wave length.

up to several hundred fibers, each used as a separate physical channel. Present multimode fibers would be suitable, now that their bandwidth capability has reached several hundred megabits per second in 1-km lengths. However, a key component, which is required if optical waveguides are to be fully exploited in high-data-rate telephone transmission, is a high-bandwidth source capable of coupling enough power into a single fiber to achieve long-distance transmission. The preferred source would be a continuous-wave, room-temperature, reliable, solid-state injection laser, though improved light-emitting diodes may prove adequate for some applications.

Suitable cables must be developed, and their long life (20 to 40 years) proven. Splicing ability and provision for carrying dc currents needed for signaling and repeater power supplies are two additional developmental problems receiving attention in several laboratories.

The broad-network category of optical waveguide applications includes CATV and interactive-CATV ranging from the "wired city" concept to a variety of dedicated communications networks for use in education, hospitals, commercial, industrial, and military environments. The larger bandwidth and low attenuation of an optical link could carry several dozen TV channels, and repeaters could be spaced several miles, instead of half a mile, apart. In addition to obvious cost savings, this reduction in repeater requirements also proportionately decreases accumulated distortion, noise, and phase and amplitude nonlinearities. No appreciable change in the transmission characteristics of optical waveguides is found over the ordinary range of operating temperatures, nor is frequency or delay compensation likely to be needed, further simplifying the amplifier and minimizing its cost.

The principal barrier to the development of broadband networks is, again, lack of a waveguide-compatible source suitable for analog transmission of many video channels. Solid-state injection lasers that operate continuously at room temperature, although under development, are not commercially available. Existing LEDs, in addition to having marginal modulation rates and inadequate power, are relatively nonlinear and are therefore unsuitable for transmission of multichannel analog TV signals.

Computer applications

Computer systems for general data processing, industrial process control, and military applications, on the other hand, could make immediate use of optical waveguides.

Proposed applications include the interconnection of the principal peripherals to the central processing unit in large computer systems, or the interconnection of CPUs to remote interactive terminals in dispersed systems for data processing, process control, command and control, general communications, or instrumentation. In addition to benefiting from low attenuation, large bandwidth, and low cost, engineers involved in applying optical waveguides to computer systems anticipate reaching an equalized system-transfer-rate, which will give them new systems options for centralized processing and storage, buffering, reformatting, and display refreshing.

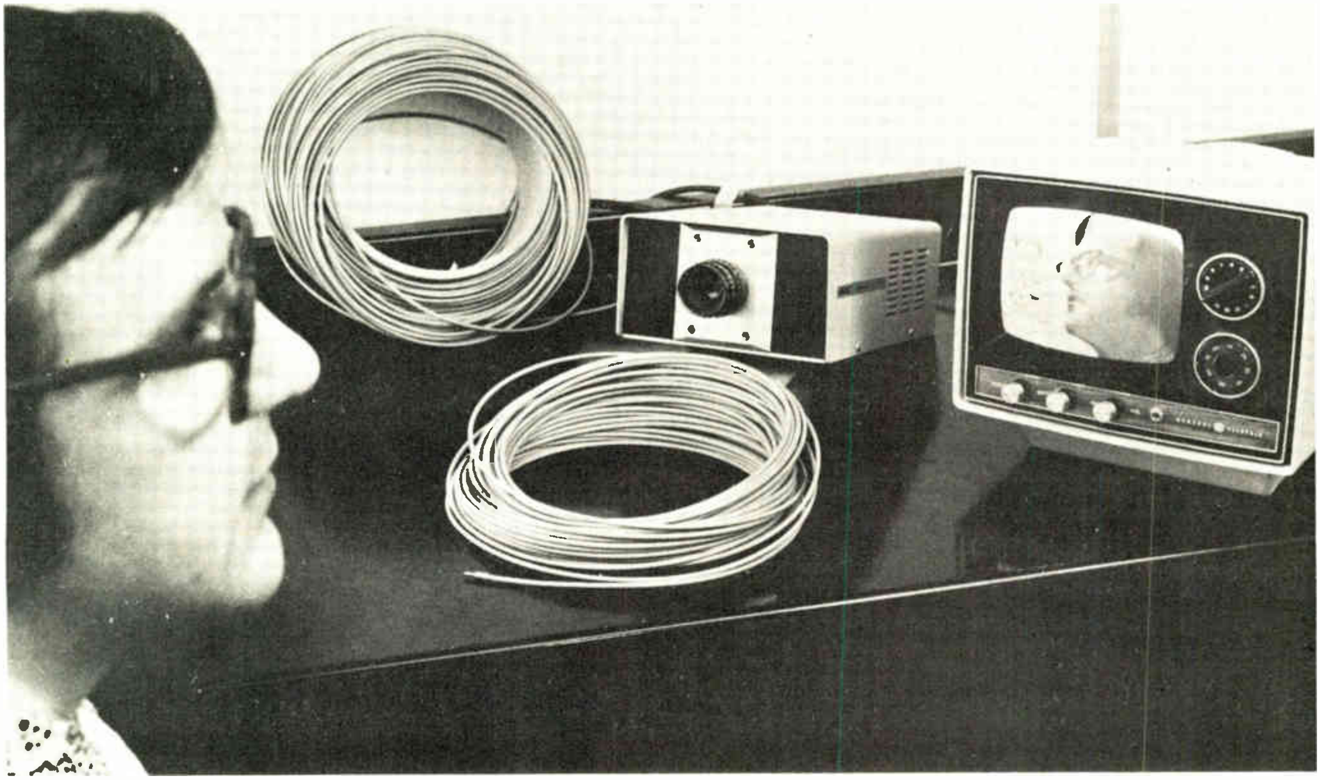
But in this context perhaps the dielectric nature of optical waveguides is their most important feature, especially relative to process control and systems for use in electromagnetically adverse environments. It results in immunity to dc- and rf-induced noise, elimination of ground loops and ground plane noise, immunity to electromagnetic pulse (EMP), minimal crosstalk, and a high degree of intrinsic data security. From a systems standpoint, these properties make optical waveguides especially attractive for applications requiring low error rates and appreciable bandwidth or distance—a combination of requirements that conventional conductors find it most difficult to meet in any real-time system where the effective system error rate cannot be improved by "retry/retransmit" techniques.

In addition to providing a moderate-cost cable that is

TABLE 2. OPTICAL LINK SPECIFICATIONS

Input impedance	50 Ω
Maximum input voltages	±1 V
Input amplifier gain adjustment range	>15 dB
Output impedance	≤10 Ω
Output noise voltage*	1 mV_{rms}

*Measured with transmitter and receiver energized, with no input voltage applied; quoted value is true rms noise voltage for the full operating bandwidth.



7. Linked with light. A 300-meter link was constructed from readily available components. Aside from cost competitiveness with high-grade coaxial cable, the glass fibers are immune to interference, have negligible crosstalk, and are impervious to chemical and electrical environments that would seriously degrade performance of standard coaxial cables.

easy to install and repair, waveguides in computer applications could also take advantage of improved sources, especially with respect to radiance and bandwidth. Integrated source/detector packages for duplex operation would also be desirable. Fortunately, the required improvements are of the "engineering development" type—they do not hinge on inventions. They will undoubtedly result in increased cost effectiveness and applicability of waveguide links, but are not prerequisite to applications development work, which can be based on immediately available components.

Instrumentation

The broad array of instrumentation applications that has been proposed for optical waveguides can be classified into five groups—laser/optical, electronic, nuclear, electrical, environmental, and medical/dental.

Optical replacements for coaxal cable in large bandwidth applications could provide inexpensive, interference-free, instrument-to-instrument hookups. In optical instrumentation systems, for example, especially those involving lasers and integrated optical components, optical waveguides have already been used as interconnection cables, making beam-shuttling and -coupling more convenient and allowing experimental equipment configurations not possible before.

In nuclear instrumentation, signals often originate in optical form, and here the bandwidth of optical waveguide may permit acquisition of signals that could not otherwise be captured. This area is being investigated by several nuclear research laboratories.

In electrical power generation and distribution systems, the most pressing requirement is for emi-free electrically isolated links for signalling when to execute process changes and for error-free reporting on the status of the power apparatus. Corning has been studying the power-handling capabilities of fibers for these purposes.

In spectral sensing—the identification of atmospheric contaminants by their characteristic optical spectral wavelengths—for pollution control or other forms of environmental monitoring, waveguides would be used primarily in conjunction with existing optical systems as interconnect cables or to establish bypass or calibration paths.

Medical/dental applications of optical waveguides are of both technical and human interest. Several system concepts, often laser-based and utilizing both the data-transmission properties of fibers and their power-handling capabilities have been proposed for surgical, therapeutic or preventative procedures. Some are already in use. But the effectiveness of many such procedures could be greatly enhanced if a flexible and compact delivery system were available to separate the patient and the apparatus, i.e, laser. Certain procedures such as body-cavity examination or internal surgery, almost demand a flexible delivery system.

Of specific interest for medical/dental applications, as well as for certain industrial applications, is the fact that solid glass waveguides can support surprisingly high power levels ranging up to tens of megawatts per square centimeter.

A problem common to all five instrumentation areas,

Walker Bros., Conshohocken, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.
Whitney Blake Co.—see Graybar Electric Co.
York Insulated Wire Works Div. of General Electric Co., York, Pa.

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Acme Wire Co., New Haven, Conn.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Brass Co., Waterbury, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester), Boston, Mass. (See page 166.)
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton, N. J.
Electric Auto-Lite Co., Wire Div., Port Huron, Mich.
Gavitt Mfg. Co., Brookfield, Mass.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Keystone Steel & Wire Co., Peoria, Ill.
New England Electrical Works, 365 Main St., Lisbon, N. H.
Roebling's Sons Co., John A., Trenton, N. J.
Spargo Wire Co., 255 E. Railroad Ave., Rome, N. Y.

HIGH VOLTAGE WIRE

Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y. (See page 31.)
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester), Boston, Mass. (See page 166.)
Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton, N. J.
Diamond Wire & Cable Co., 128 E. 16th St., Chicago Heights, Ill.
Driver-Harris Co., Harrison, N. J.
Driver Co., Wilbur B., Riverside Ave., Newark, N. J.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
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Industrial Pyrometer & Supply Co., 142 Hack St., Alton, Ill.
Jeliff Mfg. Corp., C. O., 200 Pequot Ave., Southport, Conn.
National Electric Products Corp., Fulton Bldg., Pittsburgh, Pa.
Okonite Co., Canal St., Passaic, N. J.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Rhode Island Insulated Wire Co., 50 Burnham Ave., Providence, R. I.
Rockbestos Products Corp., 309 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., Trenton, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Whitney Blake Co.—see Graybar Electric Co.
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Alden Products Co., 715 Center St., Brockton, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y. (See page 31.)
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester) Boston, Mass.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Insulated Wire & Cable Co., Trenton, N. J.
Electric Auto-Lite Co., Wire Div., Port Huron, Mich.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Insulated Wire Corp., 53 Park Pl., New York, N. Y.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago, Ill.
Lowell Insulated Wire Co., 171 Lincoln St., Lowell, Mass.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Plastoid Corp., 17 Vandewater St., New York, N. Y.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
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Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y. (See page 31.)
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Bradford, Kyle & Co., Plymouth, Mass.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
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Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton, N. J.
Electric Auto-Lite Co., Wire Div., Port Huron, Mich.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Holyoke Wire & Cable Corp., 720 Main St., Holyoke, Mass.
Kennecott Wire & Cable Co. (Phillipsdale), Providence, R. I.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago, Ill.
Massachusetts Electric Mfg. Co., 11 Margin St., West Lynn, Mass.
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Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.
Winsted Div. of Hudson Wire Co., Winsted, Conn. (See page 97.)

RESISTANCE and FILAMENT WIRE

Alloy Metal Wire Co., 13th St. & Pennsylvania Ave., Moore, Pa.
American Brass Co., Waterbury, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Cohn, Sigmund, 44 Gold St., New York, N. Y. (See page 148.)
Driver Co., Wilbur B., 150 Riverside Ave., Newark, N. J.
Driver-Harris Co., 201 Middlesex St., Harrison, N. J.
Hoskins Mfg. Co., 4447 Lawton Ave., Detroit, Mich.
Jelliff Mfg. Corp., C. O., 200 Pequot Ave., Southport, Conn.
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Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa. (See page 147.)
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa. (See page 176.)

ELECTRICAL INSTRUMENTS

Adapters

TEST ADAPTERS

Alden Products Co., 117 Main St., Brockton, Mass.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Million Radio & Television Labs., 685 W. Ohio St., Chicago, Ill.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Triplett Electrical Instrument Corp., 286 Hermon Rd., Bluffton, Ohio.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.

Ammeters

see Meters

Analyzers

CIRCUIT ANALYZERS

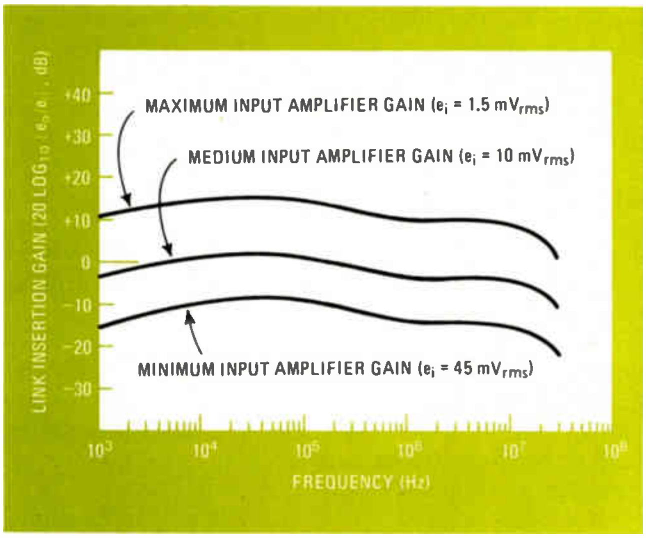
Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Electrical Research Products Inc., 76 Varick St., New York, N. Y.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
H-W Mfg. Co., 3124 Larga Ave., Los Angeles, Cal.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Jones-Orme Co., 1645 Hennepin Ave., St. Paul Minn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mt. Carmell, Ill.
Million Radio & Television Laboratories, 1617 N. Damen Ave., Chicago, Ill.
Morrison Co., J. L. D., Silver Spring, Md.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

TABLE 3: MAJOR CATEGORIES OF APPLICATIONS FOR LOW-LOSS WAVEGUIDE CONDUCTORS			
Application	Principal Functions	Key Advantages	Still to be Developed
Telephone	Intercity trunks Interoffice trunks Local loops	High bandwidth Infrequent repeater spacing (low attenuation) Small size	High-radiance source for single-fiber operation Cable structures
Broadband networks	CATV Wired city (community) Dedicated communication networks	Increased amplifier spacing Simpler transmission-line characteristics (probably no need for frequency and delay compensation) Non-interference (security)	High-bandwidth, linear source Inexpensively packaged fibers
Computer	Dispersed system Intrasystem wiring	Equalized transfer rate Immunity to interference	Improvement desired in source bandwidth and radiance
Process control and instrumentation	Computer-based industrial process control Instrumentation	Immunity to interference Unique properties	Desired an array of compatible input/ output transducers
Military	Internal wiring of weapons systems Tethers for instrument packages attached to weapons/surveillance systems	Immunity to emi/emp Intercept security Size/weight	Specialty cable structures Compatible interconnection hardware

however, is that the transducers developed for communications purposes are often ineffective in instruments. Many conventional instrumentation transducers, which generally convert some nonelectric phenomenon into an electrical signal, also may prove inappropriate.

Military uses

The military and Government agencies in general are major users of all types of communications. The principal military applications lie in the internal wiring of weapons systems, whether in aircraft, helicopter, ship, or submarine, and in the external wiring for instrument packages attached to, suspended from, or towed by the weapon system. Both categories include data-link and data-bus configurations. Also of interest to the military are various tethers, like those for missiles, torpedoes, and for surveillance systems operated from shore, aircraft, ship or submarine.



8. Visible performance. The system shown schematically in Fig. 1 showed no input-to-signal reduction at maximum amplifier gain, up to 30 MHz. Increasing the input amplifier gain allowed smaller input signals (e_i). For a fixed input the output varies by about +50% to -50% to -40°C to +60°C temperature range.

Probably more than anyone else, the military is interested in the optical waveguide's immunity to electromagnetic interference (emi) and electromagnetic pulse (emp). Almost as important to the military are the small size and light weight, plus probably the noncatastrophic failure mode of optical-waveguide connectors, the optical waveguide conductors' gradual loss of capability under emergency conditions like on-board fire, and their safety and intercept security. Several development programs involving essentially all of the key properties of optical waveguides are currently under way [*Electronics*, Dec. 20, 1973, p. 30].

To satisfy military requirements, however, some special packaging techniques will have to be developed. Often, the proposed cable structures are different from those being developed for civilian purposes. As in other areas of application, complete interconnection hardware must be made available, meeting military environmental requirements and having repair and service capabilities. □

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S.E. Miller, E.A.J. Marcatili, and Tingye Li, "Research Toward Optical-Fiber Transmission Systems," Proc. IEEE, Vol. 61, No. 12, 1973, pp. 1,703–1,751.

J.D. Crow, "Power Handling Capability of Glass Fiber Lightguides," to be submitted to Applied Optics Letters.

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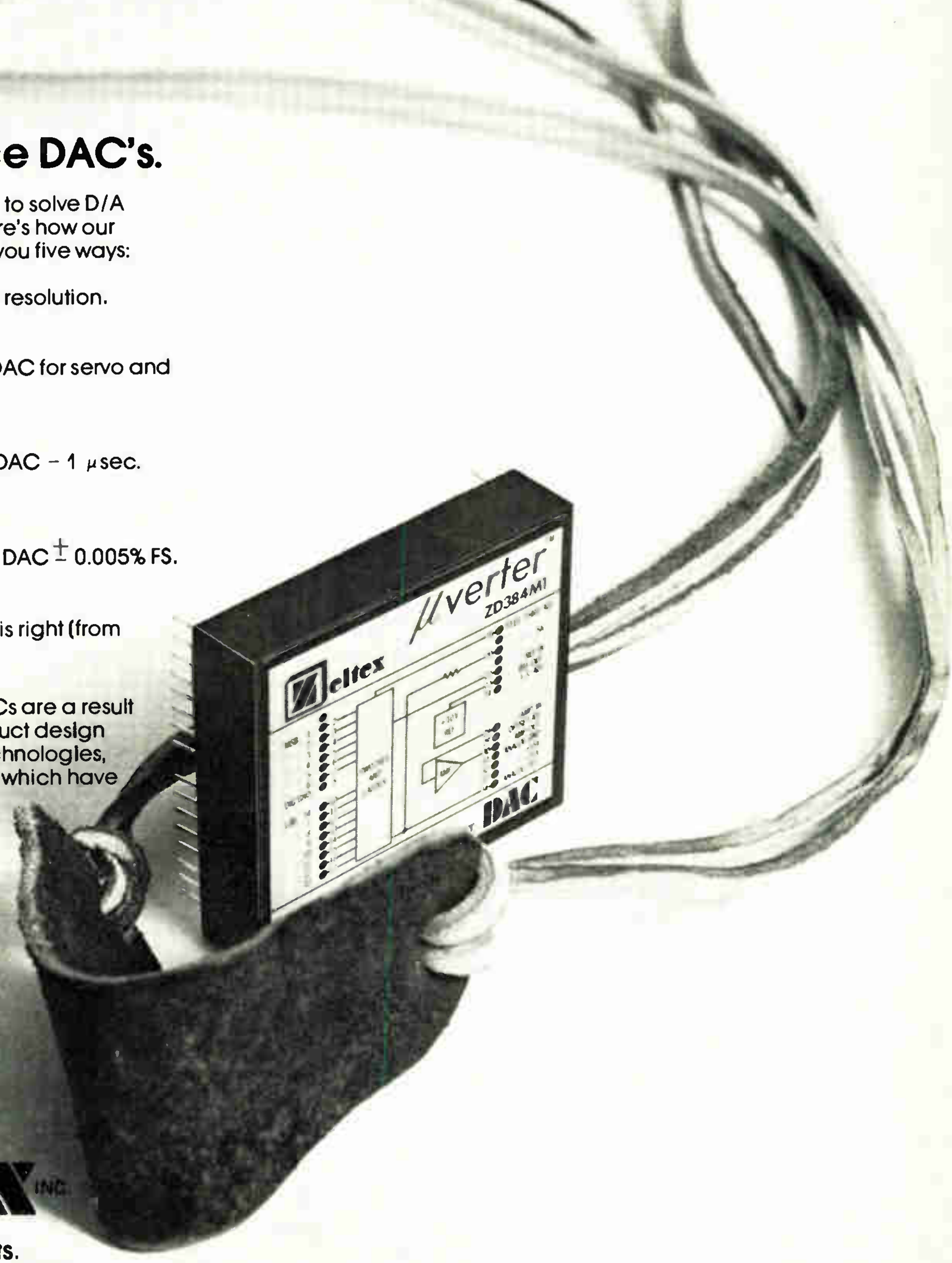


Zeltex INC.

The Micro Giants.

Circle 97 on reader service card

Ordinary cassette recorder can be full-time phone monitor

by G. Breindel
University of Washington, Seattle, Washington

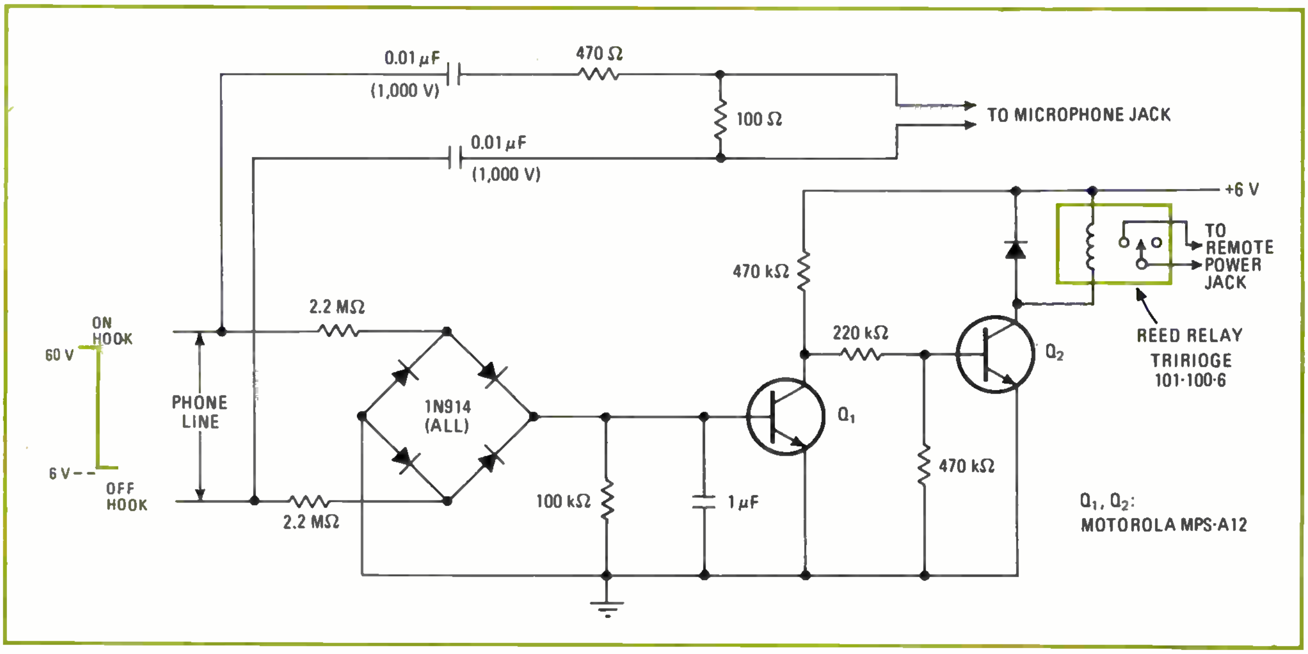
A simple circuit can convert an inexpensive conventional cassette-type recorder into a telephone recorder that automatically tapes all incoming and outgoing calls. Parts cost is less than $5, and there's no need to modify the recorder's internal circuitry. The circuit will work, provided that the recorder has a microphone (audio in) jack and a remote power jack (a jack for the remote control of power to the recorder's internal circuitry).

Besides automatically taping all calls, the circuit makes a recording (in pulse or tone format) of all the numbers dialed from the line to which it is connected. It acts as only a negligible load on the phone line, and it draws very little current when the phone is not in use. Even so, such a phone-line attachment should be approved by your local telephone company.

When the phone receiver is on the hook, transistor Q_1 is on while transistor Q_2 is off. When the receiver is off the hook, the phone-line voltage drops to less than 10 volts. Transistor Q_1 now turns off and transistor Q_2 turns on, energizing the reed relay, which shorts the recorder's remote jack and starts the recording process.

The diode bridge permits the circuit to be connected to the phone line without regard to polarity. The two capacitors provide the necessary audio coupling while isolating the recorder from the phone line. Power for the circuit can be obtained from the recorder's own battery supply (four type-D cells) or from a separate 6-v battery.

To comply with phone company regulations, a tone should be heard on the line every 15 seconds. This can be easily accomplished by adding a couple of unijunction transistors to the circuit. □



On the line. Economical circuit automatically activates a standard cassette recorder so that the recorder tapes all calls, as well as the numbers dialed. A pair of Darlington transistors is used to switch the reed relay that controls the recorder's remote power jack. The diode bridge allows the circuit to be hooked up to the phone line without concern for polarity. A tone beep signal can be added easily.

State-variable filter uses only two op amps

by Charles Croskey
Pennsylvania State University, University Park, Pa.

One of the more useful circuits for an active filter design—the state-variable active filter—can be somewhat expensive to build because it normally requires three operational amplifiers. Two of these op amps function as integrators, while the third is used as an inverter, since a difference integrator has been rather difficult to make with a normal op amp.

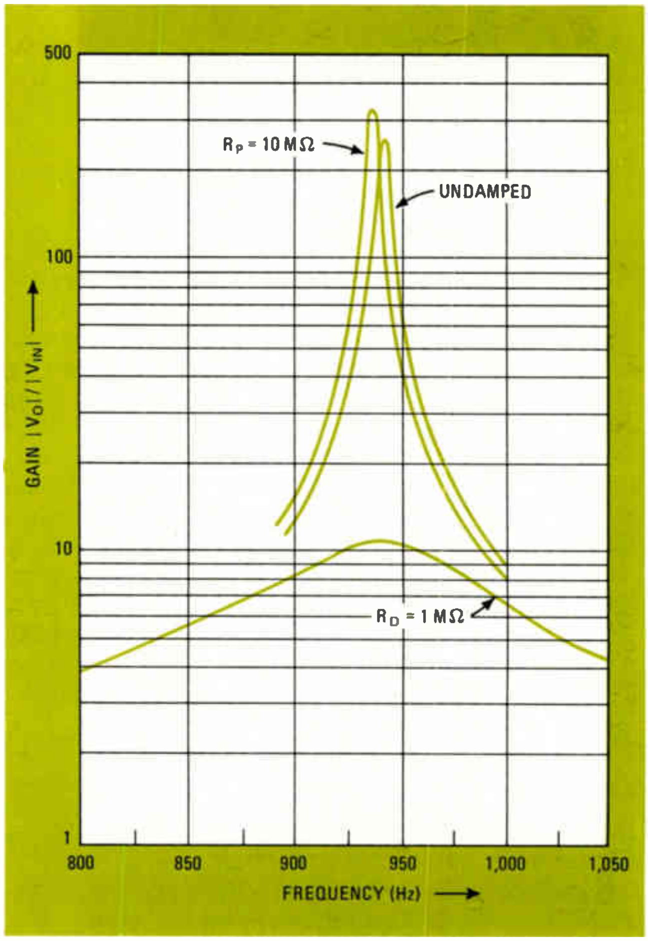
The state-variable filter in the diagram, however, requires only two op amps. The circuit takes advantage of the recently introduced integrated quad amplifiers, such as Motorola's MC3401 and National's LM3900, which respond to a current difference instead of a voltage difference. Such amplifiers permit a difference integrator to be built simply.

The center frequency of the filter's bandpass function is still determined by the usual relationship of:

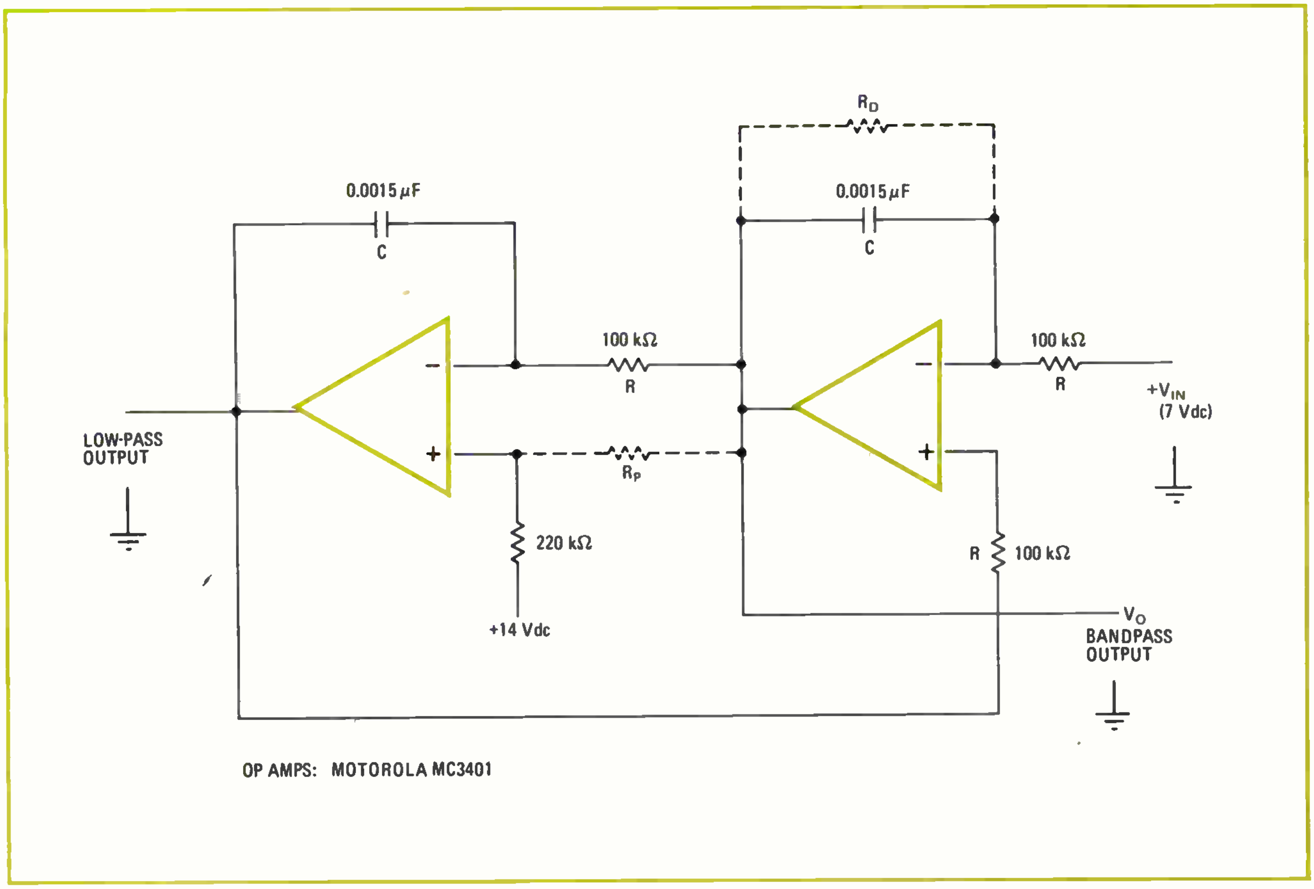
$$\omega_o = 1/RC$$

For the circuit values shown here, the center frequency is approximatley 940 hertz. The filter's damping factor, and therefore its Q value, can be adjusted by resistors R_D and R_P. To increase the Q value, some positive feedback can be added through resistor R_P; to decrease the Q value, resistive damping can be added by means of resistor R_D. As can be seen from the gain curves drawn in the figure, the Q value rises to 260 from a nominal (undamped) value of 248 when a 10-megohm resistor is used for R_P. Or if a 1-megohm resistor is used for R_D, the filter's Q value drops to 9.3.

Since the circuit requires only half of a quad amplifier package, the remaining two op amps can be employed as another filter or for additional gain. The filter also provides a low-pass output. □



Eliminating an op amp. This state-variable active filter employs only two op amps, instead of the three normally required. The usual inverter amplifier can be eliminated because the two op amps are connected as difference integrators. To adjust the filter's Q, resistor R_D or resistor R_P can be added to the circuit. The gain curves show both damped and undamped responses for the filter.



Winking LED notes null for IC-timer resistance bridge

by James A. Blackburn
Wilfrid Laurier University, Waterloo, Ont., Canada

A resistance bridge that makes use of the popular 555-type IC timer operates without requiring the usual combination of a meter and an amplifier. Moreover, the circuit's sensitivity does not depend on the unknown resistance. And since a light-emitting diode is used for visual indication, there's no need to worry about shock-isolation for a meter movement. Two possible applications for the bridge are as a thermometer (where the unknown could be a thermistor) or as a photometer (where the unknown could be a photoresistor).

The color block in the diagram shows where unknown resistor R_X is inserted in the bridge. When the resistance of the dual potentiometer is increased, the brightness of the LED also steadily increases. Then, at a particular setting of the potentiometer (R_{POT}), the LED's brightness is suddenly halved. The ratio of R_{POT}:R_X at which this winking occurs is determined solely by the properties of the two IC timers.

The first timer ($TIMER_1$) operates in its astable mode and, therefore, is free-running. Its output (signal A) is low for a period of $T_1 = 0.693R_XC$ seconds and high for a period of $T_2 = 0.693(R_X+R_{POT})C$ seconds. The output from $TIMER_1$ is differentiated and then used to trigger the second timer ($TIMER_2$), which is operating in its monostable mode.

(To simplify the analysis, both timing capacitors are assumed to be equal, and the dual pot is assumed to track without error. In addition, the triggering spikes are considered to be of negligible width compared to period T_1.)

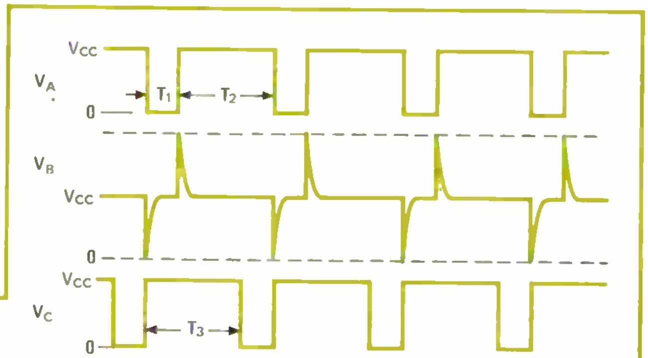
As R_{POT} is increased, the periods of signals A and B become longer, and the on-time of $TIMER_2$ ($T_3 = 1.1R_{POT}C$) starts to increase at a slightly faster rate. This means that the duty cycle of signal C is getting larger, and the LED will appear to grow brighter.

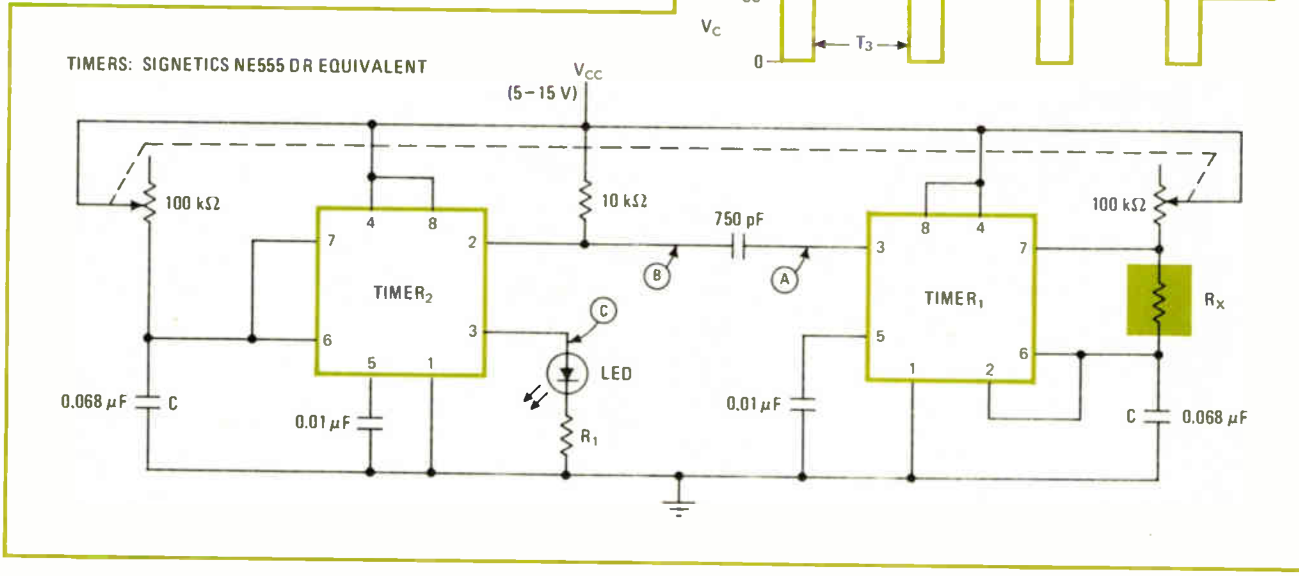
A closer look at the waveforms reveals that when period T_3 is just slightly less that T_1+T_2, the duty cycle of signal C is nearly 100%. But when T_3 is slightly greater than T_1+T_2, the duty cycle of the signal C drops to 50% and, at the same time, the frequency of this signal decreases to half the frequency of signal A. This happens because $TIMER_2$ locks out trigger pulses while its output is still high and, therefore, ignores all alternate negative-going spikes.

Further increases in R_{POT} cause the duty cycle of signal C to rise again slowly from 50% to a limiting value of 79.4%. The abrupt transition from 100% to 50% occurs when $R_{POT} = 3.406R_X$, making the calibration of this resistance bridge intrinsically linear. Circuit performance is limited by the desired upper and lower operating frequencies and the width of the triggering pulses.

For the component values shown, the circuit can operate over a fairly wide range of unknown resistance values—from 1 kilohm to 100 kilohms. The value selected for the LED's current-limiting resistor, R_1, depends on the supply voltage used. □

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





Getting a null in a wink. Resistance bridge indicates a null when the LED's brightness is halved, so that the LED appears to wink. $TIMER_1$ operates as an astable multivibrator, while $TIMER_2$ is a monostable. As the resistance of the dual pot increases, the output duty cycle of $TIMER_2$ also increases, making the LED grow brighter. When $R_{POT} = 3.406R_X$, this duty cycle is halved, and the LED winks.

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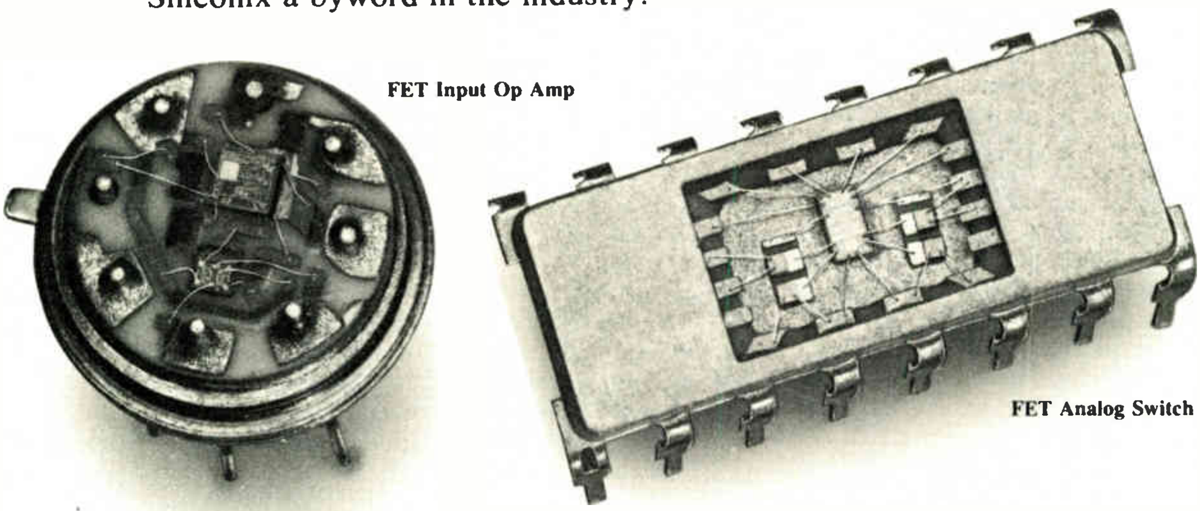

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Circle 101 on reader service card

Computer analyzes rf circuits with generalized Smith charts

Designers now have a powerful tool to perform the complex calculations needed to investigate circuit sensitivities and stability margins; scattering-parameter values are plotted relative to circuit impedances

by George D. Vendelin, Will Alexander, and Daniel Mock, *Fairchild Semiconductor, Transistor division, Palo Alto, Calif.*

☐ Since they were first described in January 1939 by Phillip H. Smith in *Electronics*, conventional Smith charts have been universally applied to analyzing the behavior of radio-frequency circuits. More recently, an extension of the Smith-chart concept, the generalized chart, has been developed to give the designer even more capability in building and analyzing rf circuits.[1]

Conventional Smith charts are composed of plots on the impedance plane, Z, that measure the impedance in terms of real and imaginary components (See "Graphic design review," p. 104). Generalized Smith charts, however, contain plots of the Z plane on the scattering-parameter (S-parameter) plane. This conversion from one plane to another can be described mathematically by a bilinear transformation between any network S-parameter and a network impedance parameter.

The generalized Smith chart is an extremely powerful tool for investigating circuit sensitivities and stability margins. But, until now, the charts have been rarely used because of the mathematical complexity involved in the conversion. However, computer-programing methods, coupled with plotter routines such as the one described here, make the generalized Smith chart readily available to designers.

The generalized Smith chart can be adapted to any problem that can be solved by mapping on the S-parameter plane. What's more, the relatively low cost, simplicity, and versatility of this approach is a welcome addition to the designer's tool kit.

Not only does this technique permit fast, easy analysis of narrowband amplifiers, oscillators, and package parasitics—the examples illustrated in this article—but the charts can also be used to analyze noise parameters, broadband amplifiers, and stability factors.

Following a basic approach similar to the one presented here, the designer can plot generalized Smith charts by modifying any computer program capable of analyzing rf circuits that are characterized by two-port scattering parameters. To illustrate the procedure and demonstrate its usefulness with examples, Fairchild's Speedy computer program,[2] which can be rented on the General Electric Mark III Information network,[3] has been used.

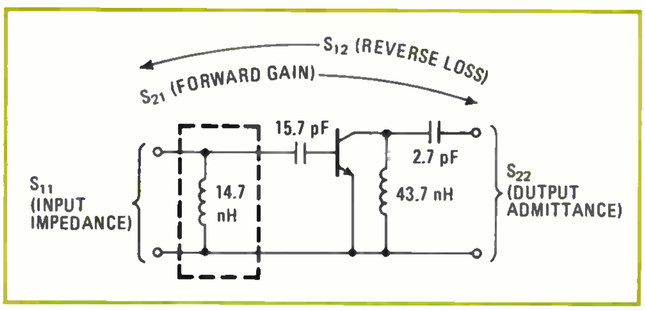
The general approach

Using any microwave-analysis program that handles S-parameters, the designer feeds necessary circuit values into the computer. Usually, each passive circuit component is described by its nominal specified value, and the transistors are described by their S-parameters.

For a conventional circuit analysis, the computer usually calculates the over-all S-parameters as a function of frequency, although many other computed output options are usually available.

However a routine can readily be added to these programs to plot any S-parameter on a 7-inch-diameter polar-coordinate system. The program is now also capable of plotting the generalized Smith chart at a single specified operating frequency by employing a simple programing technique.

To do this, consider that the outer rim of the Smith chart is a plot of all pure reactances between minus and



1. Input sensitivity. One-stage amplifier is analyzed for sensitivity to changes in shunt input impedance. For the analysis, variations in scattering parameters for the over-all circuit are computed and plotted on generalized Smith charts as a function of variations in shunt reactance at the input.

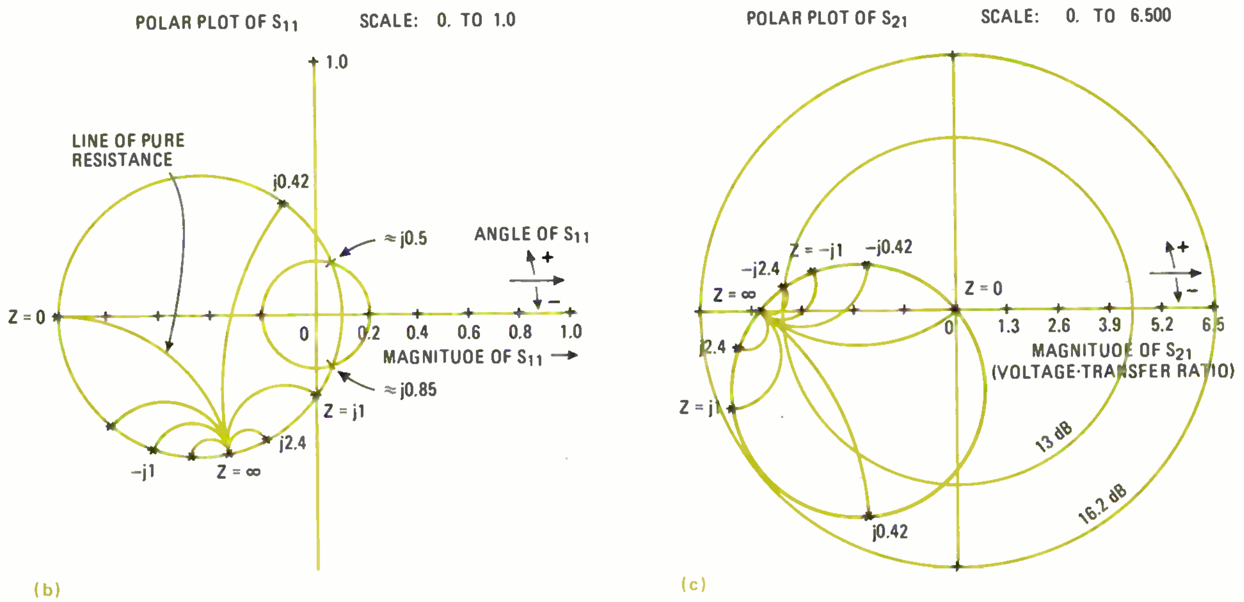
```
AMP          12:22EDT          07/03/73

  5    SST,CC,50,2950
 10    SCE,CC
 97    PRNT,SP
 99    250,2000,250,1,4
100    .65,-123.5,5.0,179.5,.066,-175.3,.28,-74.1
```

2. Speedy input. Input instructions are for the circuit of Fig. 1 when using the Speedy program. Line 10, according to the format of line 100, inputs scattering parameters for a transistor equivalent to all components in Fig. 1, except the shunt input coil. The input coil is replaced by a short-circuited stub and entered into the computer via line 5 of the program

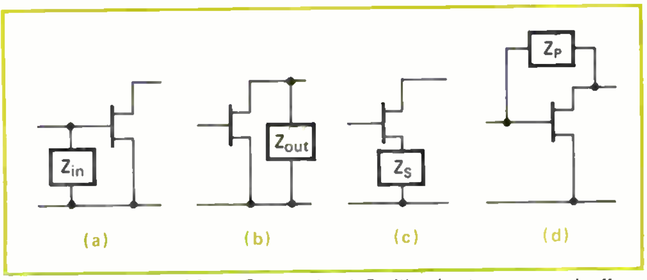
• • • OVER-ALL S-PARAMETERS • • •

Z	FREQ (MHz)	S_{21} (dB)	S_{11} MAG ANGLE	S_{21} MAG ANGLE	S_{12} MAG ANGLE	S_{22} MAG ANGLE	k FACTR
j0.42	250.0	15.41	0.44/ 104.1	5.90/−114.5	0.078/−109.3	0.38/−163.3	1.14
j1	500.0	15.96	0.30/ −87.8	6.28/−156.7	0.083/−151.5	0.09/−103.5	1.14
j2.4	750.0	14.92	0.53/−112.5	5.57/−172.0	0.074/−166.8	0.20/ −72.9	1.14
∞	1000.0	13.98	0.65/−123.5	5.00/ 179.5	0.066/−175.3	0.28/ −74.1	1.14
−j2.4	1250.0	13.00	0.73/−131.7	4.47/ 172.7	0.059/ 177.9	0.34/ −77.4	1.14
−j1	1500.0	11.64	0.81/−140.2	3.82/ 165.4	0.050/ 170.6	0.40/ −82.0	1.14
−j0.42	1750.0	8.77	0.91/−152.6	2.74/ 154.5	0.036/ 159.7	0.47/ −90.1	1.14
0	2000.0	−31.94	1.00/−179.8	0.03/ 129.9	0.000/ 135.1	0.58/−110.4	1.14

(a)



3. Generalized Smith charts. Computed S-parameters for the over-all circuit of Fig. 1 are listed as a function of changes in shunt input impedance (a). Generalized Smith charts for S_{11} and S_{21} are plotted in (b) and (c), respectively.



4. Package parasitics. Generalized Smith charts are used effectively in studying the sensitivities to parasitics of a microwave field-effect transistor at its (a) shunt input impedance, (b) shunt output impedance, (c) common-lead feedback, and (d) gate-drain feedback.

plus infinity. Since the locus of points for impedance values of a lossless short-circuited transmission-line stub will traverse the outer rim of the Smith chart as the frequency at the terminal of the stub is varied, such a transmission-line element can be used to simulate any reactance for the circuit component of interest. S-parameters for the over-all circuit can then be computed for each of, say, eight impedance increments simulated by the short-circuit stub, and these parameters can then be plotted on a polar-coordinate system.

A convenient transmission-line element is a 50-ohm stub that is one-quarter wavelength long at some chosen frequency, say, 1 gigahertz. The choice of this frequency

(a)	10	SST, CC, 50, 2950
	20	SCE, CC
	97	PRNT, SP
	99	250, 2000, 250, 1, 4
	100	.83, −50, 1.16, 126, .025, 54, .86, −16
(b)	10	SCE, CC
	20	SST, CC, 50, 2950
	97	PRNT, SP
	99	250, 2000, 250, 1, 4
	100	.83, −50, 1.16, 126, .025, 54, .86, −16
(c)	10	THRU, S1
	20	SCE, EA
	30	SST, EB, 50, 2950
	40	SSAB, C1
	97	PRNT, SP
	99	250, 2000, 250, 1, 4
	100	.83, −50, 1.16, 126, .025, 54, .86, −16
(d)	10	THRU, S1
	20	SCE, EA
	30	THRU, S2
	40	SST, CC, 50, 2950
	50	RP, CC, −50
	60	BRAS, C2
	70	THRU, EB
	80	PPAB, C1
	97	PRNT, SP
	99	250, 2000, 250, 1, 4
	100	.83, −50, 1.16, 126, .025, 54, .86, −16

5. Computer talk. Data for the four circuit configurations of Fig. 4 is entered into the computer via the Speedy program, as shown in the above circuit files. Generalized Smith charts for each configuration are plotted in Figs. 6 through 9, respectively.

Graphic design review

The skill with which an rf-circuit designer uses the generalized Smith chart depends largely on his ability to read and interpret data plotted on the conventional Smith chart, as well as his ability to interpret plots of S-parameter data on a polar-coordinate system. It is therefore worthwhile to briefly review a few of the more important properties of each of these graphic-design techniques.

The conventional Smith chart is a graphic representation of all possible impedances, both real and imaginary, that might be encountered at a port of an rf circuit. Generally, impedance values that are calibrated on the chart are normalized to the characteristic impedance of the transmission line that is being used—often 50 ohms.

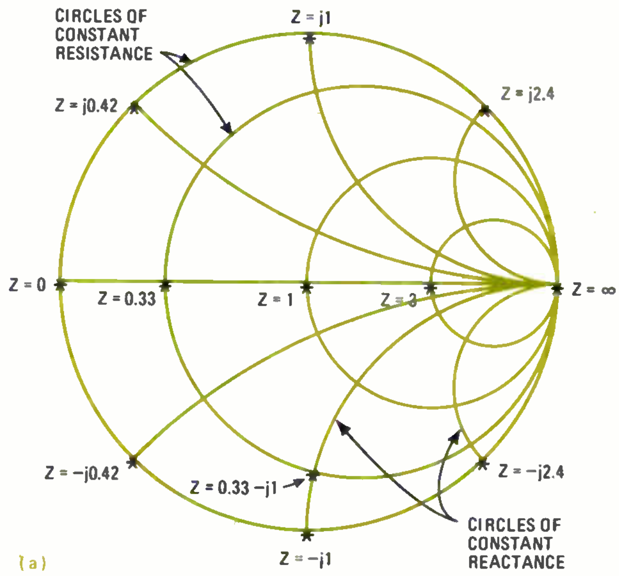
Points within the top half of the circle represent impedances with an inductive, or positive, reactance component. Similarly, points within the lower semicircle represent impedances with a capacitive, or negative, reactance component. Points along the outside edge of the circle represent pure reactances, while the horizontal line through the center of the chart is a locus of points of pure resistance. The center of the circle corresponds to a resistance equal to the characteristic impedance of the transmission lines used in the circuit.

The right-hand extreme of the chart is the point of infinite impedance, or an open circuit, while the left-hand extreme is the point of zero impedance, or a short circuit. Finally, circles about the center point are curves of constant-voltage-reflection coefficient, while radial lines are lines of constant-reflection-coefficient angle.

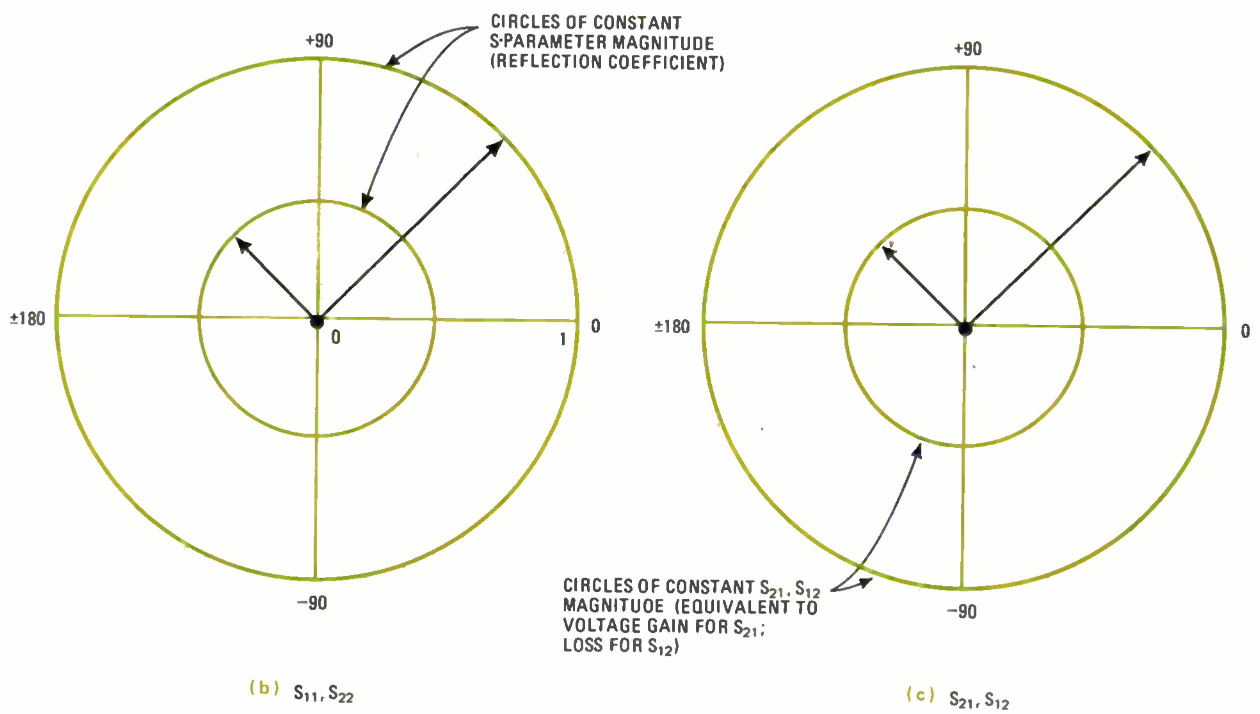
The plotting of S-parameters on polar coordinates is best illustrated by considering separately graphs for terminal parameters S_{11} and S_{22}, and for transfer parameters S_{21} and S_{12}.

Actually, points on the polar-coordinate plot of S_{11} and S_{22} correspond exactly to the points on a Smith-chart plot of the same diameter (i.e., one plot can be superimposed on the other). The only difference is that axes on the Smith chart are constructed in terms of real and imaginary components of impedances, whereas on the S_{11} and S_{22} plots, the axes are constructed in terms of reflection-coefficient magnitude and angle.

Polar-coordinate plots for transfer parameters S_{21} and S_{12}, however, are somewhat different. For the forward-transfer parameter, S_{21}, circles around the origin are contours of constant gain. For the reverse-transfer parameter, S_{12}, circles around the origin are contours of constant attenuation, since this parameter is usually less than unity.—Ed.



PLOTTING NORMALIZED IMPEDANCES ON A SMITH CHART



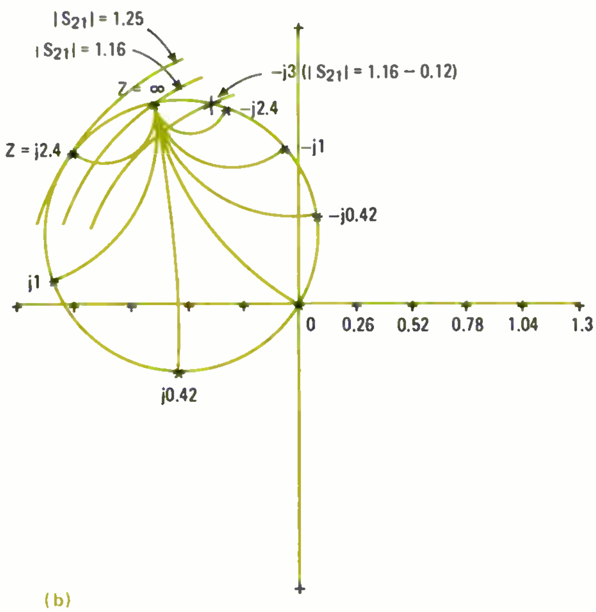
PLOTTING S-PARAMETERS ON POLAR COORDINATES

* * * OVER·ALL S·PARAMETERS * * *

Z	FREQ (MHz)	S_{21} (dB)	S_{11} MAG ANGLE	S_{21} MAG ANGLE	S_{12} MAG ANGLE	S_{22} MAG ANGLE	k FACTR
j0.42	250.0	− 4.13	0.95/ 125.9	0.62/−151.1	0.013/ 136.9	0.88/−15.8	1.70
j1	500.0	1.06	0.84/ 57.2	1.13/ 174.4	0.024/ 102.4	0.87/−16.	1.70
j2.4	750.0	1.97	0.80/ −5.4	1.25/ 146.1	0.027/ 74.1	0.86/−1[illegible].3	1.70
∞	1000.0	1.29	0.83/ −49.9	1.16/ 126.0	0.025/ 54.0	0.86/−16.0	1.70
−j2.4	1250.0	− 0.11	0.88/ −82.7	0.99/ 110.4	0.021/ 38.4	0.86/−15.7	1.70
−j1	1500.0	− 2.36	0.93/−111.3	0.76/ 95.9	0.016/ 23.9	0.86/−15.4	1.70
−j0.42	1750.0	− 6.84	0.98/−141.5	0.45/ 79.8	0.010/ 7.8	0.87/−15.2	1.70
0	2000.0	−50.53	1.00/−179.8	0.00/ 58.7	0.000/ −13.3	0.87/−15.3	1.80

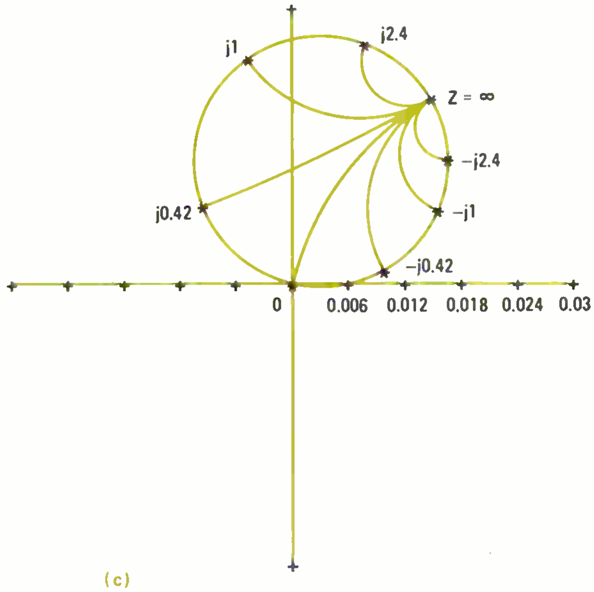
(a)

POLAR PLOT OF S_{21} SCALE: 0. TO 1.300



(b)

POLAR PLOT OF S_{12} SCALE: 0. TO 0.030



(c)

6. Shunt input load. A listing of over-all circuit S-parameters for the circuit of Fig. 4(a) is used, along with generalized Smith charts for S_{21} (b) and S_{12} (c), to aid in the analysis of the circuit's sensitivity to changes in shunt input impedance. Charts for terminal parameters S_{11} and S_{22} are omitted, since these parameters are essentially unchanged because of low feedback (note the data in the listing).

is completely arbitrary and should not be confused with the operating frequency of the circuit that is being analyzed.

By stepping the frequency (for this element only) from 250 to 2,000 MHz in 250-MHz steps, the outer rim of the Smith chart will be traversed in eight equal steps. A generalized Smith chart can be made by listing and then plotting the S-parameters of the over-all circuit for each of the eight impedances that are simulated by the circuit element.

The tabular listing is necessary to aid in identifying the location of the point on the S-parameter plane corresponding to the point where the impedance of the circuit element of interest is infinite, which is 1 GHz. Consistent with the conventional Smith chart shown on page 104, all of the contours of constant reactance terminate at this point. The center of the generalized Smith chart, corresponding to a normalized resistance of unity, must be computed by a separate computer calculation with $R = Z_o$ substituted for the element of interest.

Charting a 400-MHz amplifier

Details of the plotting technique can be clarified by working out specific application examples. Consider first the transistor amplifier in Fig. 1, which has already been designed and optimized for a maximum gain at an operating frequency of 400 MHz.

Since, in practice, the shunt input inductance of 14.7 nanohenries is difficult to realize precisely, it is desirable to determine the effect of changes in the coil's impedance on the circuit's S-parameters—especially S_{21}, which defines the circuit's gain, and S_{11}, the circuit's input impedance. The generalized Smith chart shows these interrelationships graphically.

To simulate the amplifier on the computer, a circuit

HARMONIC ANALYZERS

Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
Scientific Apparatus Co., 4 Landscape Ave., Yonkers, N. Y.
United Transformer Co., 150 Varick St., New York, N. Y.

NOISE ANALYZERS

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Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Deutschmann Corp., Tobe, Canton, Mass.
Electrical Research Products, Inc., 195 Broadway, New York, N. Y.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
RCA Mfg. Co., Camden, N. J.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Televiso Products, Inc., 2400 Sheffield Ave., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.

TRANSMISSION ANALYZERS

Daven Co., 158 Summit St., Newark, N. J.

Bridges

ELECTRICAL MEASUREMENT BRIDGES

see also Analyzers also Testers

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Communication Measurements Laboratory, 136 Liberty St., New York, N. Y.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa. (See page 6.)
Solar Mfg. Corp., Bayonne, N. J.
Standard Apparatus Co., S. Wentworth Ave. & 51st St., Chicago, Ill.
Supreme Instruments Corp., Greenwood, Miss.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.

Forks

ELECTRICALLY DRIVEN TUNING FORKS

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Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.

Galvanometers

see Meters

Generators

SIGNAL GENERATORS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Bendix Marine Products Div., Bendix Aviation Corp., 754 Lexington Ave., Brooklyn, N. Y.
Boonton Radio Corp., Boonton, N. J. (See page 126.)
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Ferris Instrument Corp., Boonton, N. J. (See page 174.)
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Measurements Corp., Boonton, N. J. (See page 159.)
Million Radio & Television, 1617 N. Damen Ave., Chicago, Ill.
Monarch Mfg. Co., 2014 N. Major Ave., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Radex Corp., 1328 Elston Ave., Chicago, Ill.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Superior Instruments Co., 227 Fulton St., New York, N. Y.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instru. Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.

SQUARE WAVE GENERATORS

General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Measurements Corp., Boonton, N. J.

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CAPACITOR LEAKAGE INDICATORS

Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

NEON INDICATORS

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Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.

POWER LEVEL INDICATORS

see Meters

Clough-Brengle Co., 501 Broadway, Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Monarch Mfg. Co., 2014 N. Major ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

VOLUME INDICATORS—see Meters

Meters

AMMETERS

Bristol Co., Waterbury, Conn.
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.
Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland, Ohio
De Jur-Amsco Corp., 6 Bridge St., Shelton, Conn.
Engelhard, Inc., Charles, 90 Chestnut St., Newark, N. J.
Esterline-Angus Co., (Speedway City), Indianapolis, Ind.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
J B L Instrument Co., Darby, Pa.
King-Seeley Corp., Ann Arbor, Mich.
Leeds & Northup Co., 4970 Stenton Ave., Philadelphia, Pa.
Norton Electrical Instrument Corp., 79 Hilliard St., Manchester, Conn.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill. (See page 44.)
Superior, Instruments Co., 227 Fulton St., New York, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. (See page 4.)
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J. (See page 125.)
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.
Winslow Co., 9 Liberty St., Newark, N. J.

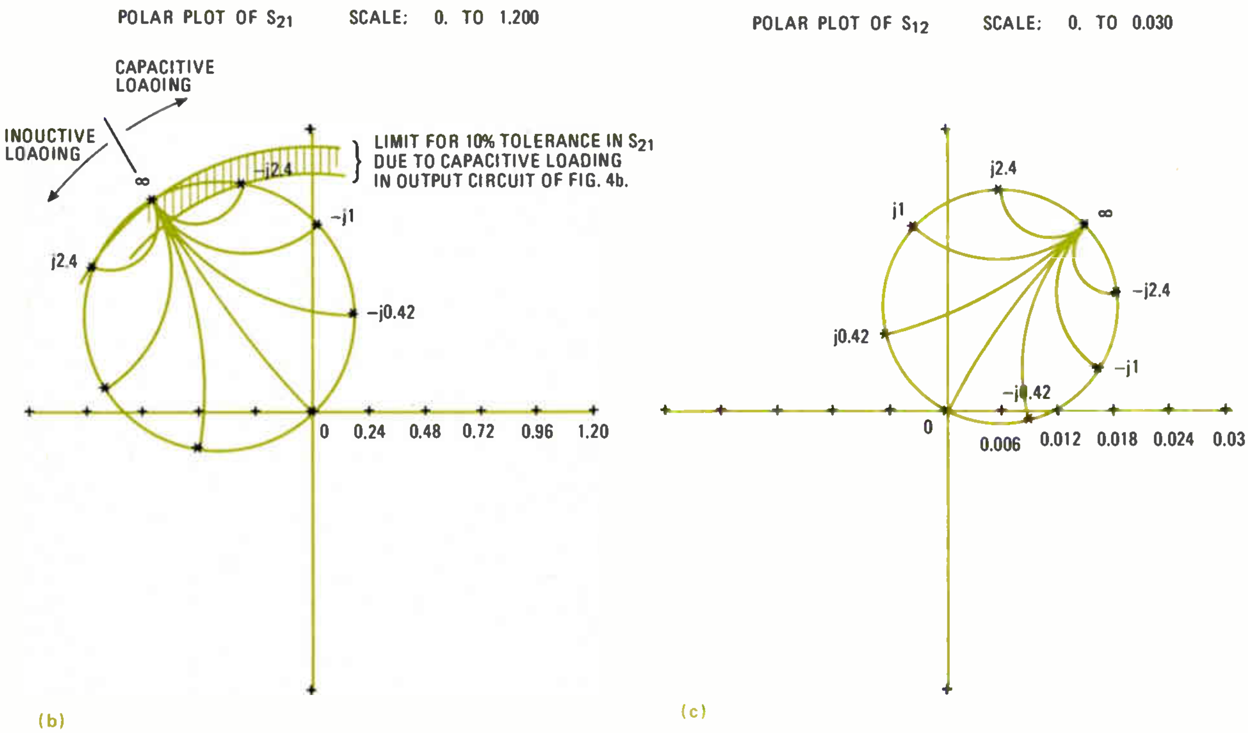
FREQUENCY METERS

Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.

• • • OVER-ALL S-PARAMETERS • • •

(a)

Z	FREQ (MHz)	S_{21} (dB)	S_{11} MAG ANGLE	S_{21} MAG ANGLE	S_{12} MAG ANGLE	S_{22} MAG ANGLE	k FACTR
j0.42	250.0	−6.02	0.84/−49.5	0.50/−161.9	0.011/126.1	0.98/ 132.6	1.70
j1	500.0	−0.79	0.84/−49.9	0.91/ 172.1	0.020/100.1	0.92/ 81.7	1.70
j2.4	750.0	1.09	0.84/−50.1	1.13/ 147.7	0.024/ 75.7	0.87/ 31.0	1.70
∞	1000.0	1.29	0.83/−50.0	1.16/ 126.1	0.025/ 54.1	0.86/ −15.9	1.70
−j2.4	1250.0	0.35	0.83/−49.7	1.04/ 106.2	0.022/ 34.2	0.89/ −58.1	1.70
−j1	1500.0	−1.89	0.83/−49.3	0.80/ 86.8	0.017/ 14.8	0.94/ −97.5	1.70
−j0.42	1750.0	−6.81	0.83/−49.1	0.46/ 66.4	0.010/ −5.6	0.98/−137.1	1.70
0	2000.0	−51.43	0.84/−49.1	0.00/ 43.5	0.000/−28.5	1.00/−179.8	1.80



7. Shunt output load. Generalized Smith charts for shunt loading at the transistor output show that output loading has virtually the same effect on S_{21} and S_{12} as shunt loading at the input, as indicated in Fig. 6(b). Notice, however, that gain (S_{21}) cannot be increased by inductive loading at the output as it is by inductive loading at the input (the gain approximates its maximum value at Z - ∞).

file is constructed by replacing the input coil by a short-circuit stub. The S-parameters of an equivalent circuit, excluding the input coil, must be computed at the 400-MHz operating frequency and the results entered into the circuit file.

Input instructions for such a circuit when using the Speedy program are shown in Fig. 2. Instruction line 5 is entered to substitute the value of the 50-ohm short-circuited stub for the 14.7 nH of the shunt coil (2,950 mils is one-quarter wavelength for the stub at 1 GHz). Line 10 gives the value for the dummy transistor, which defines the remainder of the circuit, and S-parameters are stored in line 100. Line 97 is the print and plot command. Line 99, in the Speedy format, gives the start frequency, stop frequency, step frequency, number of transistors, and data option 4, which keeps the transistor S-parameter data fixed for all frequencies that will be used in the analysis.

The computed S-parameters for the over-all circuit are listed in Fig. 3(a). The frequencies correspond to reactance values from minus infinity to plus infinity for the input-shunt element. All four S-parameters may be plotted as generalized Smith charts. For this example, however, S_{11} and S_{21}, which are of primary interest, are plotted in the generalized Smith charts of Fig. 3.

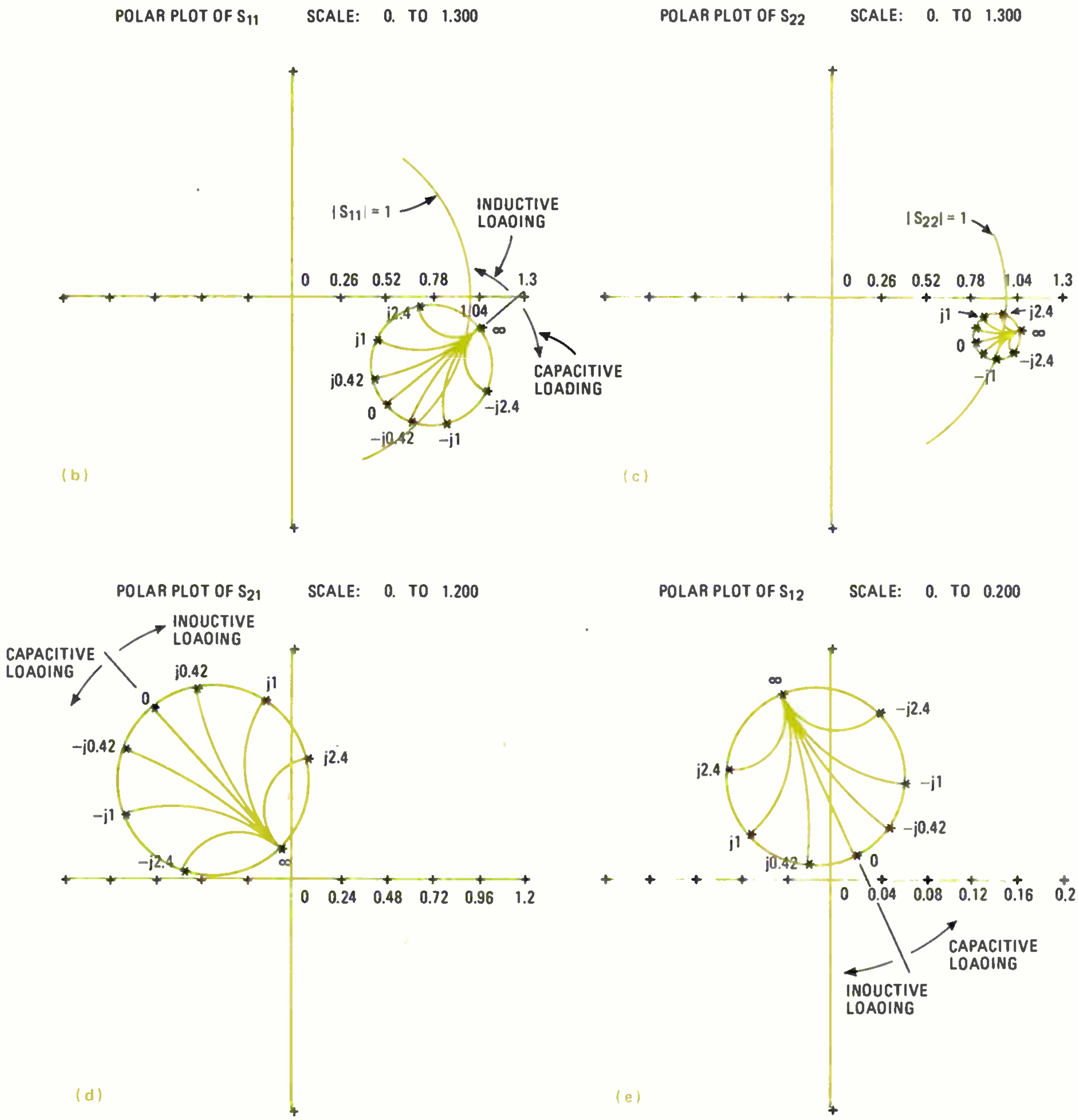
The generalized Smith chart is always a Smith-chart circle plotted on the complex S-parameter plane. As in the conventional Smith chart, lines of constant reactance meet at the point of infinite impedance, which occurs at a frequency of 1 GHz. For the original coil design of 14.7 nH, $Z/Z_o = j\omega L/50 = j0.74$.

Notice that the geometry of the generalized Smith chart is a distortion of the conventional chart. To be sure, the boundary points of pure reactance form a perfect circle for the circumference of both charts. But, although the contours of constant reactance are sym-

* * * OVER-ALL S-PARAMETERS * * *

Z	FREQ (MHz)	S_{21} (dB)	S_{11} MAG ANGLE	S_{21} MAG ANGLE	S_{12} MAG ANGLE	S_{22} MAG ANGLE	k FACTR
j0.42	250.0	0.99	0.66/−45.8	1.12/113.2	0.031/144.3	0.85/−12.2	1.89
j1	500.0	−0.13	0.56/−28.9	0.99/ 98.7	0.078/148.1	0.87/ −8.0	1.00
j2.4	750.0	−3.40	0.70/ −7.4	0.68/ 81.9	0.132/131.6	0.95/ −5.8	0.77
∞	1000.0	−15.28	1.05/ −9.0	0.17/103.8	0.171/104.3	1.06/ −9.0	1.00
−j2.4	1250.0	−4.60	1.25/−25.4	0.59/173.2	0.160/ 74.4	1.06/−15.8	−0.02
−j1	1500.0	−0.33	1.18/−39.4	0.96/155.2	0.114/ 52.4	0.98/−19.2	0.05
−j0.42	1750.0	0.98	1.01/−47.4	1.12/139.4	0.066/ 40.8	0.90/−18.7	0.38
0	2000.0	1.29	0.83/−50.0	1.16/126.1	0.025/ 53.7	0.86/−16.0	1.69

(a)

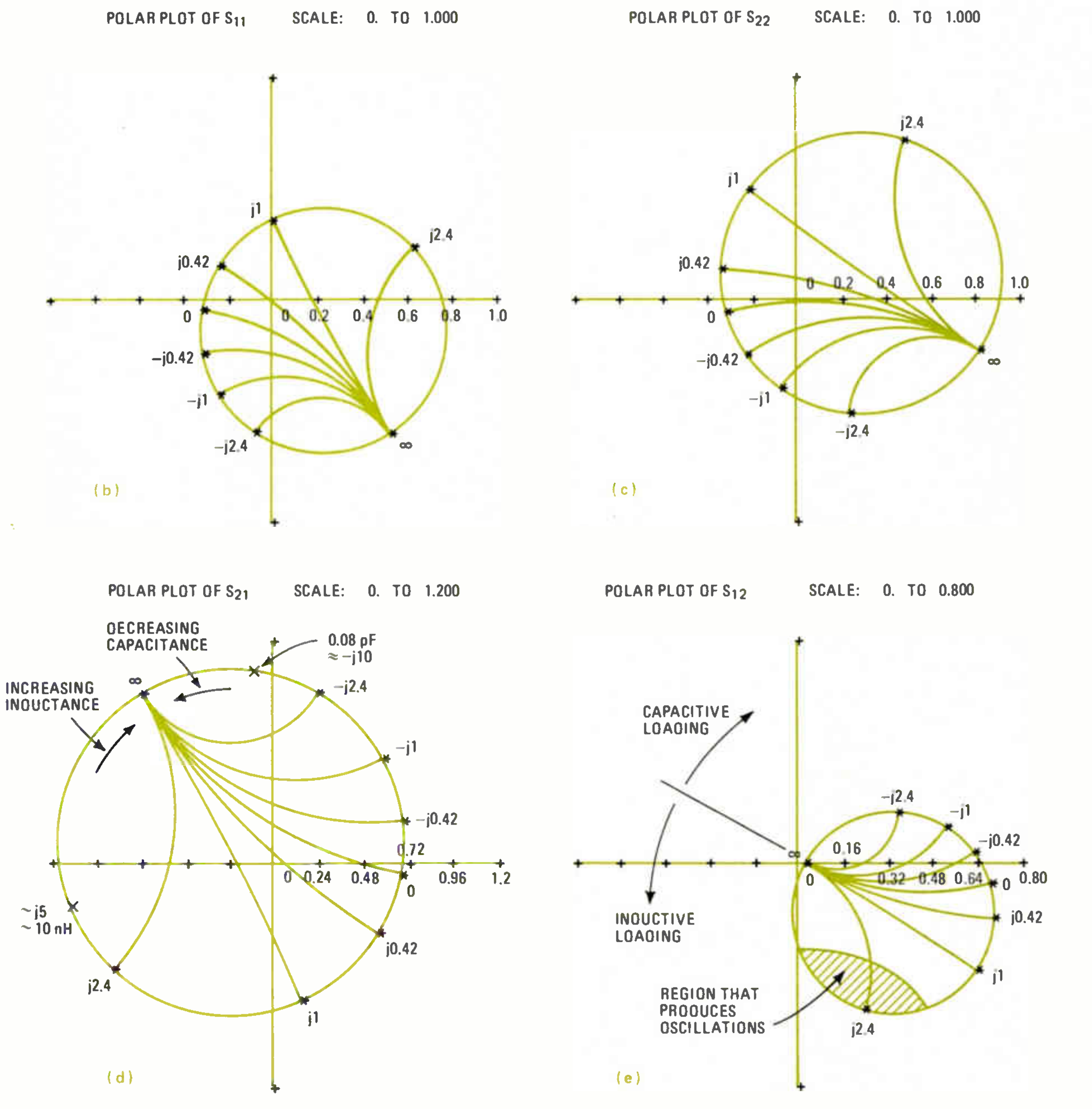


8. Common-lead feedback. Charts for the common-lead-feedback circuit of Fig. 4(c) show that parasitic inductive loading in the common-lead circuit can seriously degrade maximum stable voltage gain, $S_{21}/_{12}$. For example, by replacing a short circuit (Z = 0) in Fig. 4(c) with an inductance of only 0.8 nH (Z = j0.42), the maximum stable gain is reduced from 46.5 to 36.2 or from 16.7 dB to 15.6 dB.

• • • OVER-ALL S-PARAMETERS • • •

Z	FREQ (MHz)	S_{21} (dB)	S_{11} MAG ANGLE	S_{21} MAG ANGLE	S_{12} MAG ANGLE	S_{22} MAG ANGLE	k FACTR
j0.42	250.0	−3.34	0.27/ 151.7	0.68/ −33.7	0.738/−15.6	0.37/ 153.3	0.95
j1	500.0	−2.57	0.34/ 90.9	0.74/ −76.8	0.753/−31.9	0.53/ 111.7	0.73
j2.4	750.0	0.23	0.67/ 22.6	1.03/−147.5	0.591/−65.9	0.86/ 56.2	0.21
∞	1000.0	1.29	0.83/ −49.8	1.16/ 126.2	0.023/ 53.7	0.86/ −15.8	1.79
−j2.4	1250.0	−0.40	0.64/ −93.9	0.95/ 72.7	0.411/ 29.0	0.57/ −65.1	0.76
−j1	1500.0	−1.72	0.49/−120.1	0.82/ 41.7	0.563/ 13.9	0.41/ −99.8	0.90
−j0.42	1750.0	−2.57	0.39/−142.3	0.74/ 18.0	0.643/ 3.8	0.33/−132.6	0.97
j0	2000.0	−3.13	0.31/−168.2	0.70/ −5.1	0.697/ −5.1	0.31/−168.2	1.00

(a)



9. Gate-drain feedback. By computing and listing stability factor k, generalized Smith charts can be used to aid in designing oscillators. From the listing (a), it appears that oscillatory conditions could be produced for a feedback inductance of about 5 mH (j2.4), where the stability factor has been reduced to its lowest value of 0.21. The designer could then perform finer calculations for the exact oscillatory conditions.

metrical in the conventional chart, they are usually not in the generalized Smith-chart plot. Consequently, the straight line of pure resistance that bisects the outer circle of the conventional Smith chart usually comes out as a curved line when plotted on the generalized chart (as in Fig. 3b).

Two key characteristics of the Smith chart, however, are presented in the generalized plots. First, all circles of constant resistance are maintained as circles. Also, all intersecting lines on both charts intersect at right angles.

Several interesting conclusions follow from the generalized Smith charts of Fig. 3. As seen in Fig. 3(a), the magnitude of S_{11}, which is the same thing as the input-reflection coefficient at the input of the over-all circuit, is below 0.2 for a normalized inductance between j0.5 and j0.85.

Operating in a circuit with a characteristic impedance of 50 ohms, this corresponds to an impedance between j25 and j42.5 ohms. At the 400-MHz operating frequency, this further translates to an inductance of 10 to 17 nH. Since a reflection coefficient of 0.2 represents an amplifier with a good impedance match, the amplifier would be relatively insensitive to a change of 10 to 17 nH in the inductance of the input shunt coil.

Also, from Fig. 3(c), the circuit's voltage gain, or S_{21}, is greater than 4.47 (13 dB) for any inductance greater than 6 nH (j0.3). If the inductor is omitted—that is, impedance is infinite—a gain of 14 dB can be achieved, but as shown in Fig. 3(b), the input match is poor. Other network sensitivities can be found by printing plots for S_{12} or S_{22}, and the effects of changes in other circuit elements can be similarly analyzed.

FET-chip parasitics

A second application example demonstrates the capability of the generalized Smith chart to describe the influence of package parasitics on the performance of a 4-GHz field-effect-transistor chip. From this analysis, methods for optimizing gain, unilateralizing the device, optimizing stability, and designing oscillators can be visualized. The four circuit configurations in this example (Fig. 4) can be entered into the computer via the Speedy program as shown in Fig. 5.

The influences on the over-all circuit's S-parameters by changes in the transistor's input impedance (see Fig. 4a) and output impedance (see Fig. 4b) are shown in Figs. 6 and 7, respectively. Only charts for the transfer parameters (S_{21} and S_{12}) are shown, since the terminal parameters (S_{11} and S_{22}) are essentially unchanged because of the low feedback. Much information can be obtained from these charts. Although the maximum stable gain, defined as $|S_{21}/S_{12}|$, cannot be improved, both S_{21} and S_{12} can be adjusted by using either input or output shunt loading.

From Fig. 6(b) and the listing of Fig. 6(a), for example, it is seen that $|S_{21}|$ for the circuit in Fig. 4(a) can be increased by replacing the open circuit at the input (j∞) by a shunt inductance of about 5 nH (j2.4). And Fig. 7(b) illustrates that a corresponding increase in gain (S_{21}) cannot be achieved by shunt inductive loading at the output.

Similarly, the influence of input and output parasitic shunt capacitances can be estimated from these charts and the S-parameter listings. Notice from Fig. 6(b) that, to maintain a change of less than 10% in transfer parameter S_{21} (i.e., $|S_{21}| = 1.16 \pm 0.12$), the stray input capacitance must be limited to less than about 0.25 picofarads (−j3). Likewise, Fig. 7(b) indicates that the stray output capacitance must be kept below 0.33 pF (−j2.4) for a tolerance of less than 10% in the S_{21} parameter.

The charts for the common-lead feedback case (defined in Fig. 4c) are plotted in Fig. 8. Notice that both S_{11} and S_{22} can be made greater than unity by capacitive loading in the common lead of about 0.33 pF (−j2.4). When the S_{11} or S_{22} reflection coefficient has a value greater than unity, the transistor is oscillating and presents a negative resistance at that circuit port.[4]

Usually, inductive loading seriously degrades S_{21} and S_{12}, and it also degrades gain (Fig. 8d and 8e). For example, by replacing a short circuit (Z = 0) in Fig. 4(c) with an inductance of 0.8 nH (j0.42), the maximum stable gain, S_{21}/S_{12}, is degraded from 46.5 to 36.2, or from 16.7 dB to 15.6 dB. A more detailed study of these charts will show design conditions for such objectives as unilateralizing the device (minimizing S_{12}) or maximizing the gain (S_{21}).

Charts for the gate-drain feedback case (defined in Fig. 4d) are presented in Fig. 9. Notice from Fig. 9(d) that, for a minimal effect on gain S_{21}, the feedback capacitance must be maintained below 0.08 pF (−j10), or the inductance must be kept greater than 10 nH (j5).

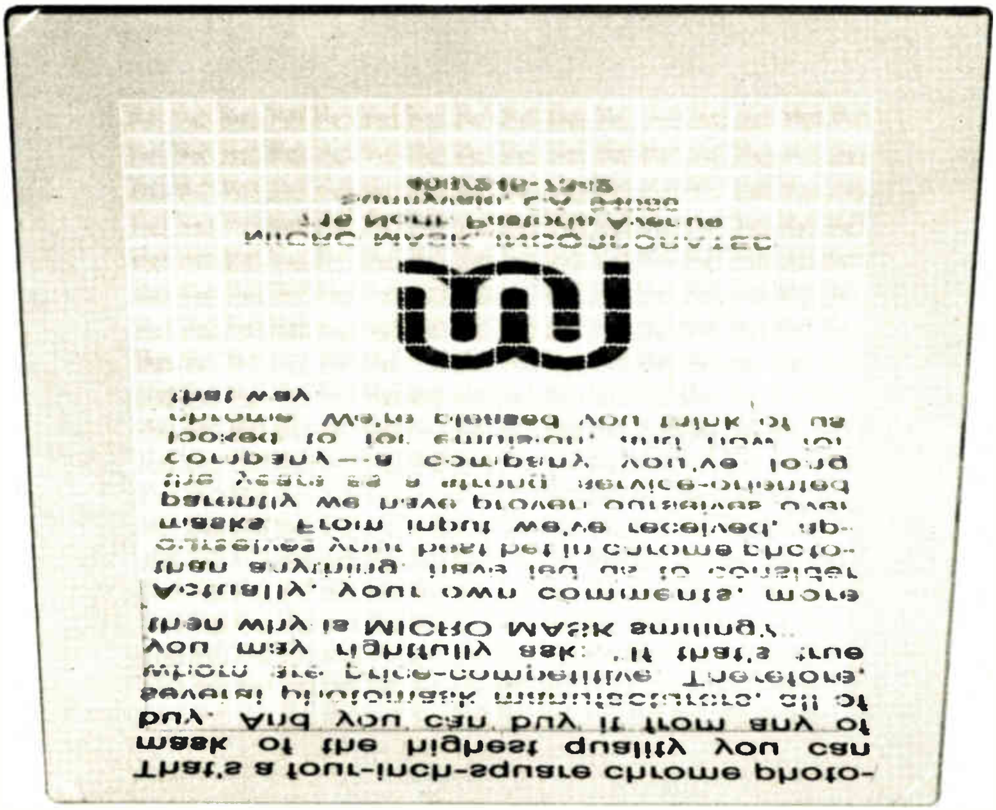
Such a circuit is often analyzed in oscillator designs. The stability factor, k, in Fig. 9(a) is computed for all eight feedback-impedance conditions. Generally, the lower the value for k, the greater the chance for circuit oscillation, and any configuration that produces a value for k of that is equal to unity or greater will not produce oscillations.

From Fig. 9(e) and the listing of Fig. 9(a), it appears that oscillatory conditions could be produced for a feedback inductance of about 5 nH (j2.4), where the stability factor k has been reduced to its lowest value of 0.21. This relatively crude guide is only a first step in oscillator design. More refined data could be gained by computing more detailed S-parameter points in the region around Z = j2.4 and by applying other tests for optimum oscillating conditions. With the aid of the generalized Smith chart, however, the designer would not have accomplished even this first step in a reasoned approach to oscillator design.

The few applications for generalized Smith charts presented here only begin to illustrate the extent that this new design tool may be applied. With the increased use of scattering-parameters to specify circuit components and the availability of instruments to measure such quantities, the rf engineer is sure to enlist the aid of the computer more and more to plot generalized Smith charts in his circuit designs. □

REFERENCES

1. George E. Bodway, "Circuit Design and Characterization of Transistors by Means of Three Port Scattering Parameters," Microwave Journal, May 1968.
2. A 26-page booklet that describes the use of the Speedy program is available, free of charge, from Fairchild Semiconductor, Transistor division, 464 Ellis St., Mountain View, Calif. 94040.
3. Information on obtaining access to the G. E. Mark III Information Network is available from General Electric Co., Information Services Dept., 1120 San Antonio Rd., Palo Alto, Calif. 94304.
4. Phillip H. Smith, *Electronic Applications of the Smith Chart*, Chapter 12, McGraw-Hill Book Co., New York, N.Y.



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Twelve-bit microprocessor nears minicomputer's performance level

Microprogramed central processing unit on a single chip can handle 12 bits in parallel, respond to eight levels of interrupt, and use an asynchronous bus for both internal and external communications

by Tadaaki Tarui, Keiji Namimoto, and Yukiharu Takahashi, *Tokyo Shibaura Electric Co., Tokyo, Japan*

☐ A recently developed microprocessor offers a level of performance generally considered beyond the capabilities of even these versatile devices. Among its many powerful functions are a maskable eight-level interrupt and direct memory-access capability.

Like other microprocessors introduced during the past two years, the Toshiba TLCS-12 is fabricated in the form of an MOS large-scale integrated circuit. One of its unusual features is its 12-bit word length, whereas words in other common microprocessors are limited to 4 or 8 bits. Furthermore, the TLCS-12 is organized around a common asynchronous bus, through which the functional units on the chip communicate with each other and also with external memory, input/output registers, and other system elements.

Other significant features include a microprogram in a read-only memory within the microprocessor chip itself, an internal clock generator, and bit-handling instructions capable of modification for indexing and indirect addressing, an automatic start capability, and eight general registers.

The TLCS-12 can not only handle interrupts, but after an interrupt has been processed, the microprocessor can restore to a general register the previous program-status word from temporary storage in the main memory to resume the interrupted program. Although this concept was first used in large computers about 10 years ago, this is the first time it has been used in a microprocessor.

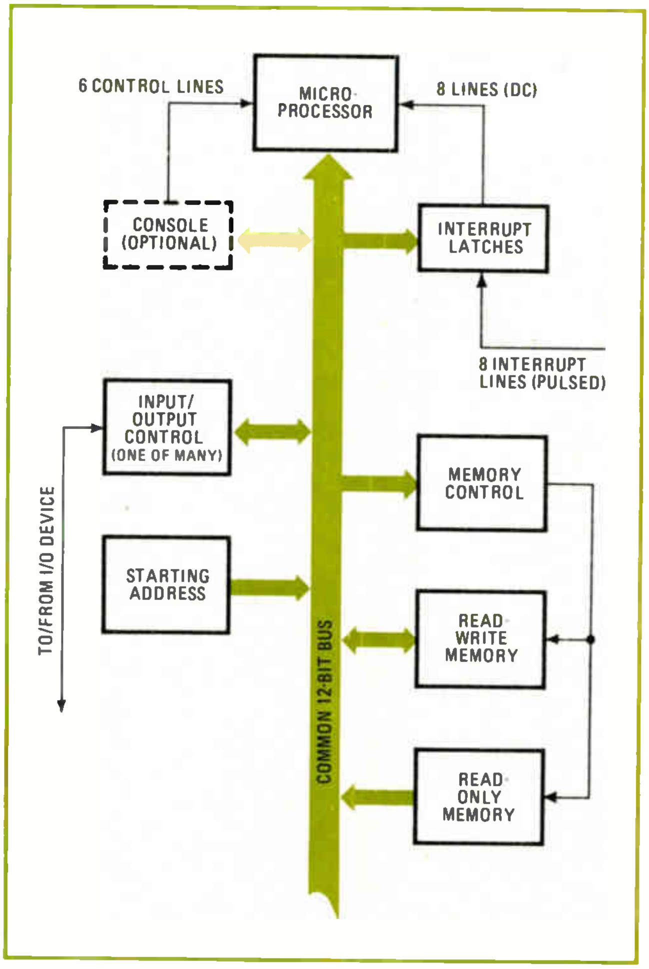
The 12-bit bidirectional bus contained in the microprocessor itself is also the backbone of the system built around the microprocessor. Data and addresses are both transferred along this bus, but not at the same time. The microprocessor, all memory chips, and input/output registers are connected to the common bus and communicate with one another along it asynchronously, so that devices of any speed can be used.

As shown in Fig. 1, a useful microcomputer system requires several ICs in addition to the TLCS-12 microprocessor. A minimum system configuration consists of one microprocessor, three memories, and one memory control unit. The memories may be either read-write, read-only, or a combination. For efficiency and convenience, input/output controllers, an interrupt register, and a control console can be added. The system operates through a range of -40°C to +125°C.

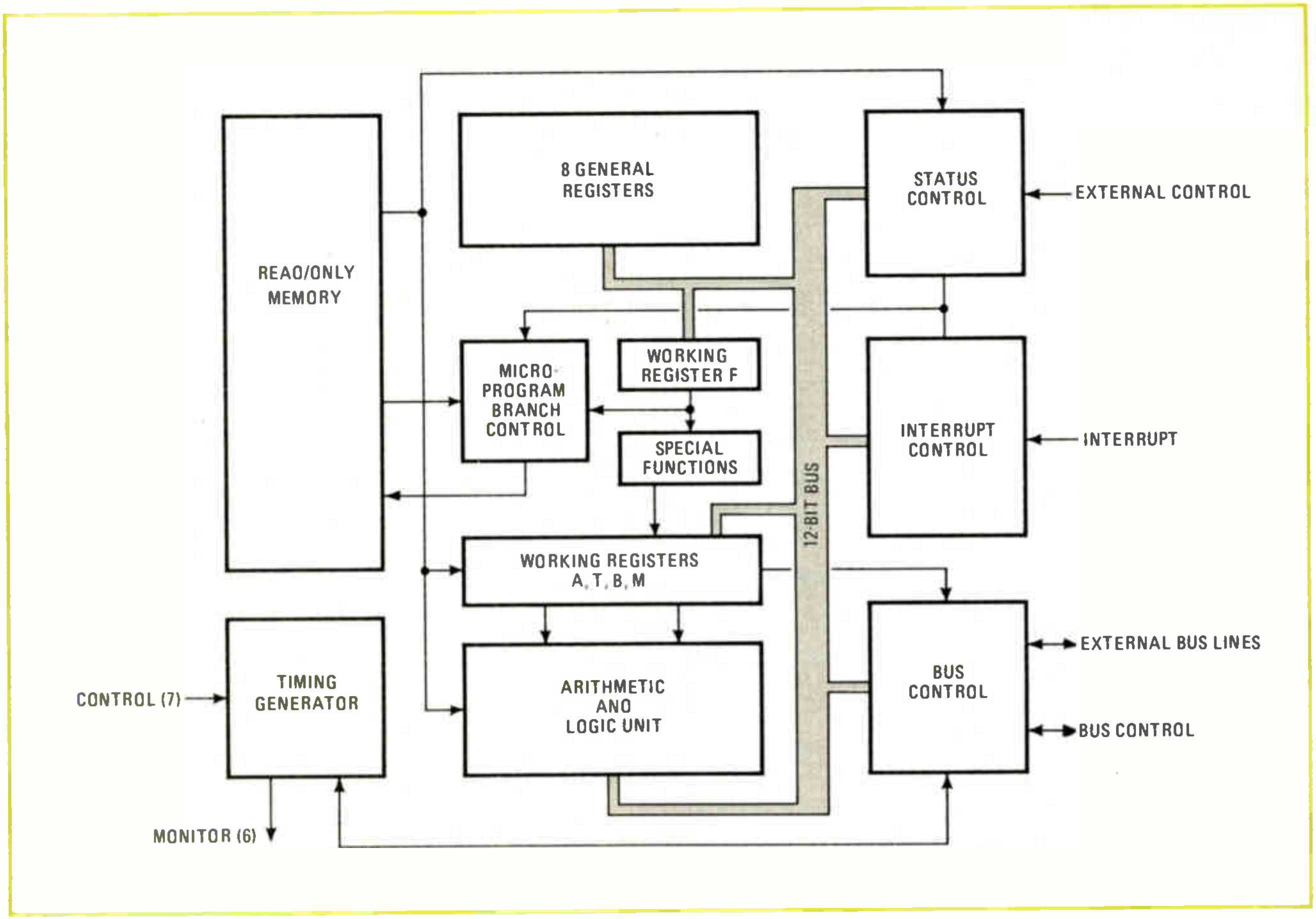
All these devices are mounted in dual in-line packages, and all except the interrupt latches are made with p-channel silicon-gate enhancement/depletion technology. On each chip, those circuits that drive the bus have three-level outputs so that they can be disconnected when not in use.

Central processor has ROM control

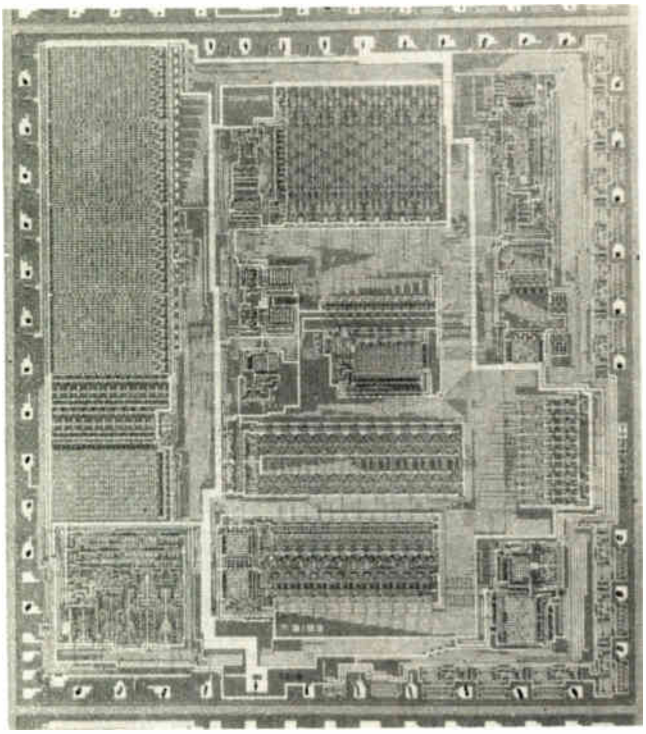
The microprocessor itself is a fully parallel 12-bit processor on a chip. It contains a 12-bit parallel arithmetic and logic unit with fast-carry logic and five working reg-



1. Spine. The 12-bit bidirectional bus (color) communicates with external devices and also interconnects functional units within the microprocessor itself, transferring both data and addresses.



2. Microprocessor details. This block diagram is also a key to the photo (Fig. 3). Arithmetic and logic unit (bottom center) performs most major functions of device, under control of microprogram in read-only memory (top left).



3. Microprocessor chip. The 12-bit bus, which interconnects the section of the chip and external devices as well, is visible as a set of more or less vertical zigzag lines, just right of center.

isters, a 4,000-bit microprogram in a read-only memory, eight 12-bit general-purpose registers, a timing generator, and an external bus controller. The functional blocks shown in the block diagram (Fig. 2) and also visible in the photograph (Fig. 3) are interconnected via the 12-bit bus, which zigzags up and down slightly to the right of the center of the photograph.

Fast-carry logic divides the bits of a computer word into groups and generates the carry from group to group. In the TLCS-12, the groups contain 1 bit, 3 bits, 4 bits, 3 bits, and 1 bit, respectively (Fig. 4), generating a carry substantially more quickly than would a simple bit-to-bit carry, which, however, is used within the groups. The bit-to-bit carry out of any bit position depends, in part, on the carry into that position; thus, under certain circumstances, a single carry can ripple from the least-significant-bit position along the full length of the word. Enough time must be allowed for an add operation to permit this ripple carry. But with carry look-ahead, the ripple occurs in parallel in separate groups, which speeds up the add operation accordingly.

Had the groups all been the same length in the TLCS-12, as they have been in many other processors over the past 15 years or so, circuit fan-in and fan-out would have been so large that circuit propagation delays, which depend on fan-in and fan-out, would have canceled the reduction in carry-propagation time.

The five working registers are designated A,T,B,M, and F. The F register usually contains the instruction to be executed; the A and T registers drive one input of the arithmetic unit, and the B and M registers drive the other input. All five of these registers are loaded from the internal bus, and the arithmetic unit's output is returned to the bus.

Of the eight general-purpose registers, seven are available to the user, and the eighth is reserved for the program-status word, which stores information about the current state of the microprocessor and the program being executed—for example, the address of the next instruction, the status of various indicators in the microprocessor, and so on.

As a rule, whenever an interrupt occurs, the program-status word is replaced by another word that defines the state of the microprocessor for the servicing of that interrupt. When the interrupt is out of the way and the microprocessor can return to its main program, the original status word is brought back from the main memory, where it had been temporarily stored, and replaced in the register.

A special-function unit generates address components, shifts data to the left or right, or identifies bit positions to be processed by subsequent microinstructions. An external bus-control unit links the microprocessor to other ICs in the system by transmitting and receiving timing signals that coordinate unrelated clock frequencies and phases in separate chips.

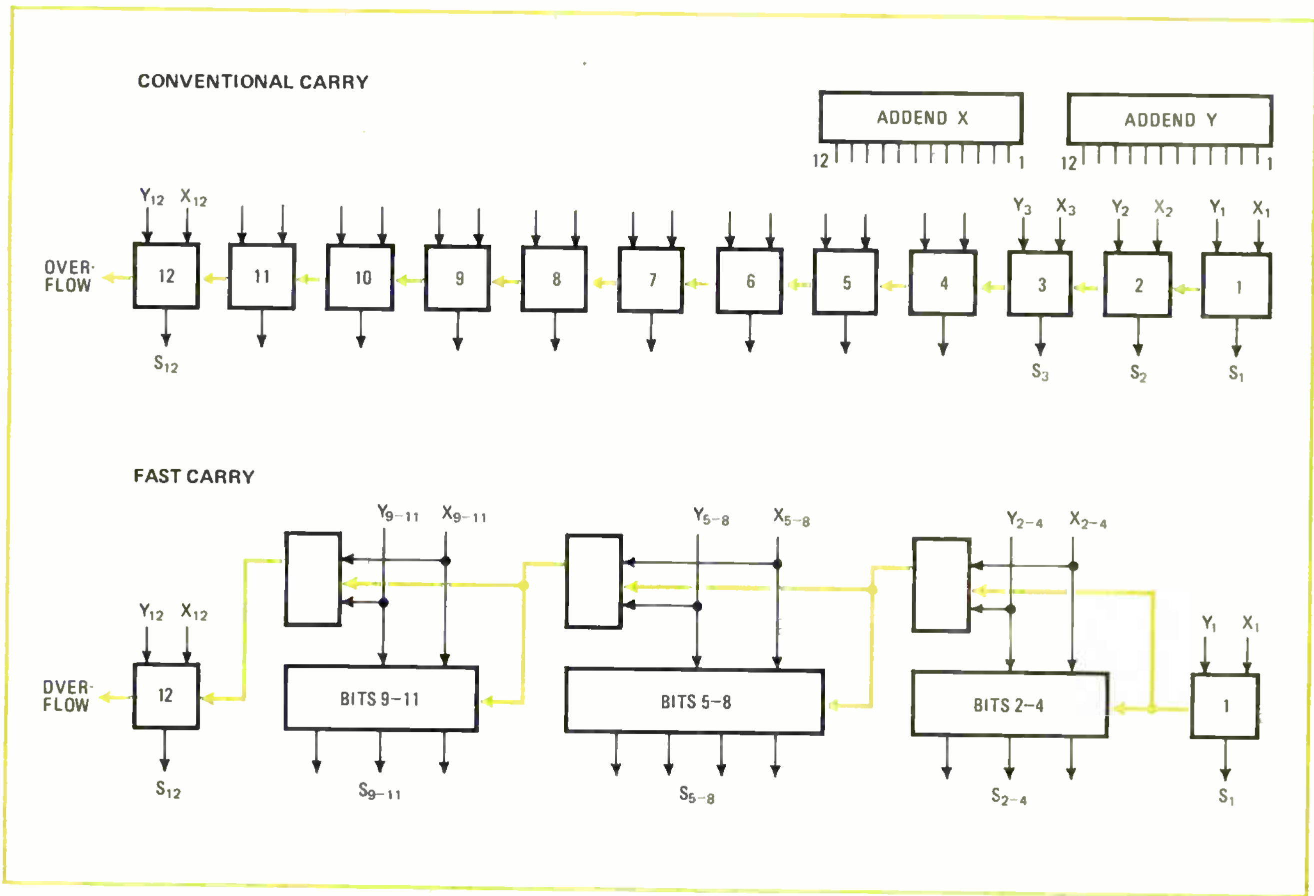
The microprogram, which defines the microprocessor's basic characteristics, is stored in a read-only memory from which it controls the data paths everywhere in the microprocessor during every machine cycle—as in most microprogram-controlled computers. Each microinstruction is 29 bits wide and is divided into several fields or micro-orders. Up to 128 microinstructions can be installed.

The entire microprocessor contains approximately 11,000 p-channel MOS transistors on a chip measuring 5.5 by 5.9 millimeters, in a 42-pin DIP. Logic transistors operate in enhancement mode, and load transistors in depletion mode; a single 5-volt power supply drives both. For the output-driver circuits, which have three-state outputs for connection to the bus, both +5 and -5 V are necessary. All circuits are made with silicon-gate transistors with a channel length of 6 micrometers—compared to 8 or 10 μm in most p-MOS transistors.

This small size is made possible, in part, by the use of silicon instead of metal for the gate and in part by the use of a new process for growing the doped polysilicon layer. In fabrication, boron-doped polysilicon is used for low sheet resistance and high growth rate. The necessary impurities are added to both the enhancement-mode and depletion-mode transistors by an ion-implantation process.

External circuits are conventional

None of the other circuits that go with the TLCS-12 microprocessor are particularly unusual. The read-write memory, for example, is a static 512-bit device, organized as 128 words of 4 bits each; its access time is 300



4. Fast-carry logic. By generating a carry signal from groups of bit positions instead of singly, the carry can be propagated along the full word length more quickly, sharply decreasing the time required for arithmetic operations.

nanoseconds, and it dissipates 400 milliwatts.

The external read-only memory, while unusual, is not original with this system. It is a reprogramable stacked-gate MOS device, based on the floating-gate avalanche-injection principle, but provided with an overlying control gate. In this technology, the gates of the MOS transistors are buried in a layer of oxide and remain unconnected to any external signal, but a control gate is further provided on the top. When a large negative signal is applied to the source and drain of the transistor, and a large positive signal is applied to the control gate, negative carriers are injected into the buried gate by an avalanche effect.

When the signal is removed, an excess of negative carriers remains in the gate, opening a conducting channel in the n-type substrate. The excess remains until the gate is irradiated with ultraviolet light, which discharges the gate and permits the memory to be reprogramed. The chip used in the Toshiba system can be programed in 5 seconds; after programing, its access time is 600 ns and its dissipation 400 mw.

Data is transferred between the microprocessor and either a read-write or a read-only external memory by the memory-control unit, which responds to the control signals on the bus that originate in the microprocessor's bus-control unit. The memory-control unit generates address, read/write, and chip-select signals for the memories themselves. A similar unit performs similar functions with respect to input/output units. The two controls differ primarily in their address range and the timing, since many units– particularly those used with microprocessors–transmit data quite slowly.

Because the processor, in general, can't respond instantly to an interrupt, and since interrupts are usually transient signals from input/output units, some means is required to catch and hold interrupts until the microprocessor can respond to them. This function is performed by the interrupt-latch unit, which is simply an array of eight latches that can be set by the external interrupt and reset by the microprocessor. Masking, if and when appropriate, is performed inside the microprocessor, and is therefore not part of the latch unit's function.

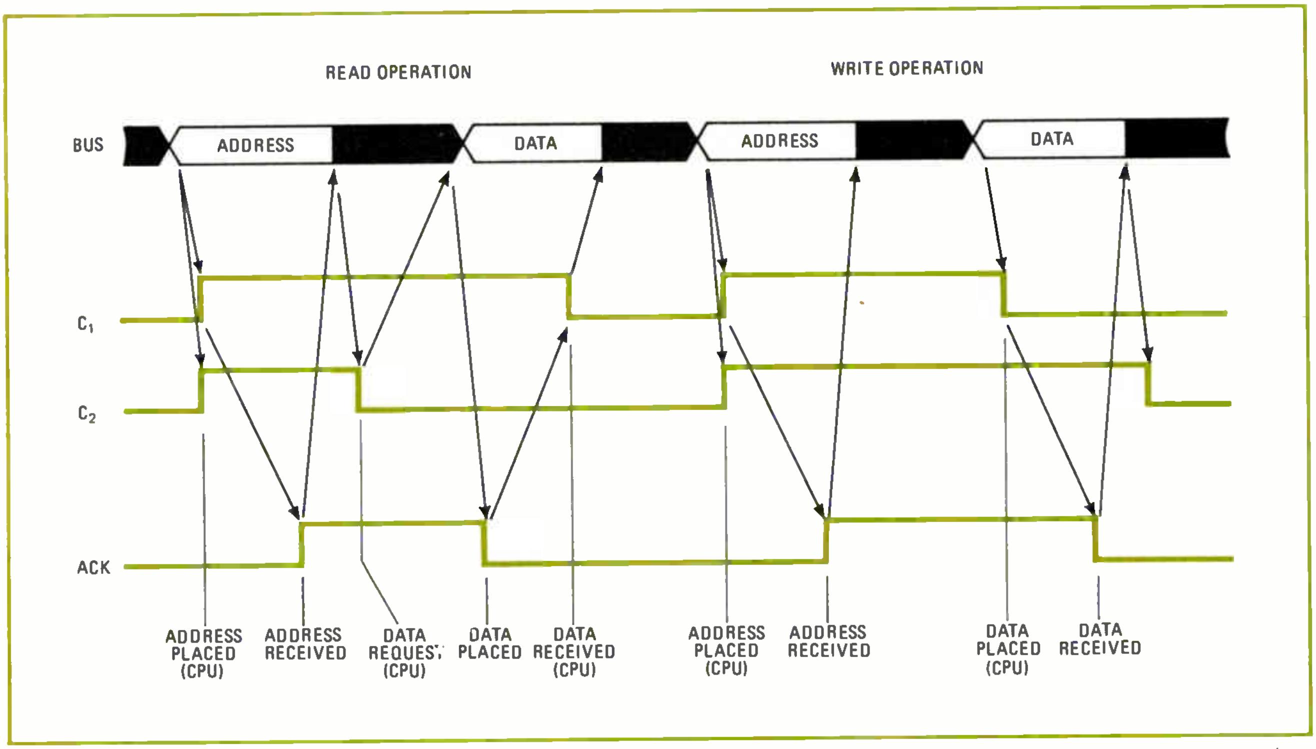
Input and output buffering is handled in the input/output register, which is actually a pair of registers–one for 4 bits and one for 8 bits. These have independent control signals and can therefore be used separately for different devices, or they can be connected to parallel for use with a single unit that transmits 12-bit words.

Instruction set is microprogramed

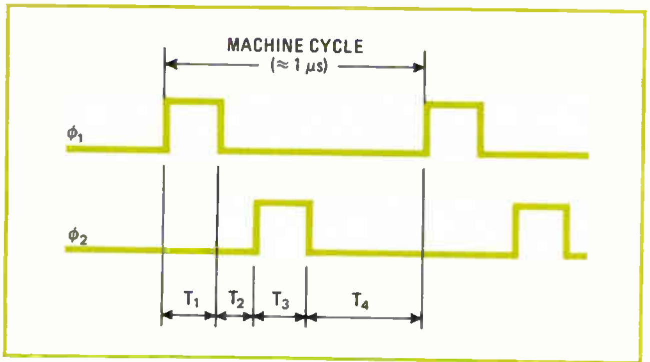
As in all microprogramed computers, the instruction set can be changed by altering the microprogram. However, as with all microprograms stored in ROMs, such alterations are uneconomical because of the cost of changing masks, except when large quantities of microprocessors are built with the new instruction set. (The ROM in the microprocessor is not to be confused with the PROM in a separate IC.)

The standard instructions used in the TLCS-12 are of four types: two-operand instructions, one-operand instructions, branch instructions, and complex types. Two-operand instructions include address modification through either indirect addressing or indexing. Address modification applies only to the second operand; both operands refer to general registers, which are assumed to have been previously loaded.

Examples of two-operand instructions are LOAD, ADD, SUBTRACT, and SWAP. Single-operand instructions work



5. Handshaking. Every event involving the bus must await an overt response from a device connected to the bus, in a sequence sometimes called "handshaking." Thus, its operation is kept independent of all internal device timings.



6. Internal timing. Microprocessor generates its own clock signals, skewed into four phases. During T_1, the results of the preceding cycle are placed into internal registers. Microprogram branch control is set up during T_2, and following that, the proper microinstruction is placed in the ROM output register during T_3. The microinstruction is executed during T_4; if the instruction calls for the use of the external bus, the clock is stopped in this phase.

with either the contents of a general register or a single bit in that register. They include such operations as SHIFT, INCREMENT or DECREMENT, and, among bit-oriented instructions, SET, CLEAR, INVERT, and TEST.

Branch instructions include, of course, the unconditional branch and conditional branches that rely on the results of prior instructions, such as BRANCH ON PLUS, BRANCH ON ZERO, and so on. Finally, most of the complex instructions include two or more simple steps in one instruction. Examples are CLEAR AND INCREMENT, CLEAR AND COMPLEMENT, and COMPLEMENT AND INCREMENT.

The total instruction set of the TLCS-12 contains about 108 instructions, some of which are very powerful. As in many other processors, the exact number of instructions depends on whether certain variations are counted separately. Thus the performance of the microprocessor approaches that of standard minicomputers, and the unit can do many kinds of jobs with fewer steps than can most other microprocessors.

Implementing the eight-level interrupt

Because the eight interrupt lines into the microprocessor have independent priorities, an interrupt on any one of them is accepted when the corresponding mask bit is 1 and no higher-priority interrupt is being requested. The mask bits are part of the program-status word previously mentioned.

An extra mask bit can mask all the interrupt lines at once, as when the microprocessor is itself busy with a critical and perhaps time-dependent task. Recognizing the interrupt (when not masked), choosing the highest-priority request, and linking the interrupt service routine to and from the main program are controlled by the hardware, not by the microprogram.

Interrupt capability in the microprocessor places certain restrictions on the use of external memory to guarantee that a place is always available to store a program-status word without wiping out something else that might still be needed. In the TLCS-12, the highest priority interrupt always causes the current program-status word to be exchanged with a new program-status word that is kept in location 8.

Adjacent locations are reserved for lower interrupt levels; in an application requiring all eight interrupts, locations 8 through 15 must be reserved. Where fewer interrupt levels are used, less space in memory is needed, but the reserved space always begins at memory location 8.

The asynchronous bus, both inside and outside the microprocessor, is completely under microprocessor control. A request for bus operation, issued by the microprogram, starts the bus controller on the chip. First, the controller stops the microprocessor's internal clock, and then runs the bus asynchronously with two output signals and one input signal. The two output signals, called C_1 and C_2, rise at the same time, indicating that an address to an external device (memory or input/output) is on the bus. As shown in Fig. 5, the receipt of this address by the appropriate device is acknowledged by the rise of the incoming ACK line to the bus controller. At this time, the microprocessor can remove the address from the bus; if C_2 falls while C_1 stays up, the device is requested to place data on the bus for the microprocessor to read. When the device responds to the request, it drops ACK. Then, when the microprocessor has the data, the controller drops C_1, and the device is free to release the bus.

On the other hand, when the microprocessor removes the address from the bus and leaves both C_1 and C_2 up, it is preparing to send data to the device in a write operation. After the address has been replaced by the data, C_1 falls while C_2 stays up, requesting the previously addressed device to pick up the data. The device acknowledges receipt by dropping ACK, after which the bus controller can release the bus, drop C_2, and generate a restart pulse for the microprocessor clock. Normal operation is resumed.

External control

Although the microprocessor ordinarily runs under internal control, it can also be controlled from a manual console for diagnostic purposes, program debugging, and the like. Seven control schemes cause, respectively, a single instruction to be executed, the program counter (part of the program-status word) to be set to a number previously placed on the bus, the contents of the pro-

Defining the terms

In this article, the word "microprocessor" refers to a complete processing unit on one large-scale integrated circuit. In some circles, the word refers to that particular collection of logic, in IC form or otherwise, that is controlled by a microprogram.

At one point, a reference is made to a condition code, a particular bit in a program status word, as the basis for a conditional branch. Unfortunately, these two similar terms can be easily confused, although they have only a tenuous relationship to one another.

Conditional branch instructions can be defined for any of a large number of conditions, such as positive, zero, or negative results of a preceding operation, the zero or nonzero state of a register, and many more. The condition code is only one such condition.

Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Bliley Electric Co., Erie, Pa.
Bristol Co., Waterbury, Conn.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass. (See p. 109.)
Burnett, Wm. W. L., 4814 Idaho St., San Diego, Cal.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Doolittle Radio, Inc., 7421 Loomis Blvd., Chicago, Ill. (See page 142.)
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Lampkin Laboratories, Bradenton, Fla. (See page 181.)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Lavoie Laboratories, 656 Broadway, Long Branch, N. J. (See page 166.)
Millen Mfg. Co., 150 Exchange St., Malden, Mass.
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De Jur-Amsco Corp., 6 Bridge St., Shelton, Conn. (See page 128.)
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
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Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
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Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
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Hoyt Electrical Instrument Works—see Burton-Rogers Co.
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Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
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Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. (See page 4.)
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

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Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

POWER LEVEL METERS—see Indicators

"Q". METERS

Boonton Radio Corp., Boonton, N. J. (See page 126.)

THERMOCOUPLE METERS

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Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Roller-Smith Co., Bethlehem, Pa.
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Therm-Electric Meters Co., Ithaca, N. Y.
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Ferris Instrument Corp., Boonton, N. J.
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General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal. (See page 92.)
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
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Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill. (See page 173.)
Ballantine Laboratories, Inc., Boonton, N. J. (See page 172.)
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.
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Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Englehard, Inc., Charles, 90 Chestnut St., Newark, N. J.
Esterline-Angus Co., (Speedway City), Indianapolis, Ind.
Etna Electric Works, 410 E. 15th St., New York, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Ferris Instrument Corp., Boonton, N. J. (See page 174.)
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass. (See page 101.)
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
J B L Instrument Co., Darby, Pa.
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
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Million Radio & Television, 1617 N. Damen Ave., Chicago, Ill.
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Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
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Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. (See page 4.)
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J. (See page 38.)
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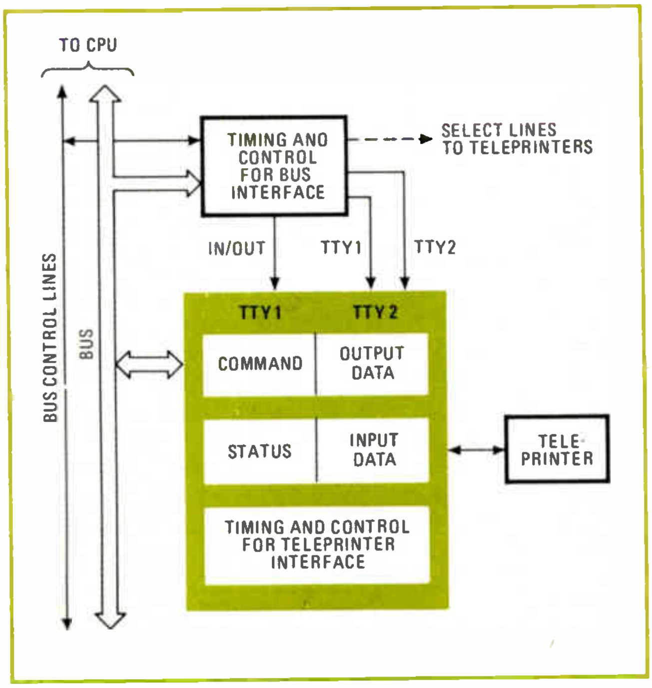
VOLUME INDICATOR METERS

Amplifier Co. of America, 17 W. 20th St., New York, N. Y.



7. Input/output control. For a teleprinter, controller includes two registers for inbound and outbound data. Portions of the same physical registers, which nevertheless have different addresses, hold control and status information. Timing and control section responds to bus-control signals, guides data to and from the teleprinter itself, and generates interrupts for the microprocessor.

gram counter to be placed on the bus (thus permitting the operator to designate what instruction is to be executed next in the program), the contents of a specified memory location to be read or written, or a single microinstruction to be executed during a test. Last but not least, of course, is the NORMAL RUN signal.

This NORMAL RUN command assumes that the microprocessor has been previously initialized—that the various control flip-flops specify a normal state for the processor, that the address of an executable instruction is in the program counter, and that all necessary data and instructions are available for the microprocessor's use. This initialization process, necessary every time the microprocessor is started, is executed by an automatic-start sequence that is built into the microprocessor. The automatic-start sequence is designed for use in a system that does not include a manual console—that is, in fixed-program applications.

Initializing the system

A short-duration pulse applied to the microprocessor's initialization terminal resets all the flip-flops, loads the program counter with the contents of memory location 4095, and clears the remainder of the program-status word. To utilize this sequence, the address of the first instruction in the program must previously have been stored in location 4095, a step easily taken by any program-preparing software. The address 4095, in binary, is a string of 12 1s, or every bit in a word turned on; this location, like those reserved for interrupt processing, is not available to the user.

An internal clock generator in the microprocessor produces a two-phase timing signal skewed in such a way as to provide four phases, as shown in Fig. 6. If an operation calls for the use of the bus, the microprocessor stops during interval T_4, the length of which is therefore variable.

Without bus operation, the complete cycle lasts about 1 μs; with the bus, an extra 3 to 5 μs is added for reading and 2 to 3 ns for writing. The exact time depends on many factors, such as memory speed, bus capacitance, bus-driver capability, and so on—all absorbed by the asynchronous control of the bus. The extra time is added during interval T_4, which is where the clock always stops for a bus operation.

For most ordinary operations, seven to 10 machine cycles are necessary when only the general registers are used; one extra cycle is needed for a read operation (plus the delay of the asynchronous bus). If the addresses are indexed, two or three extra cycles within the microprocessor are needed, and the read operation takes three extra cycles instead of one. For more complex tasks, such as MULTIPLY, as many as 40 machine cycles are required, or 43 with indexing.

An additional advantage of the internal clock generator in the TLCS-12 is its automatic frequency compensation with temperature. As the ambient temperature increases, the logic circuits in the microprocessor slow down, and delays within the circuits are increased. But the clock slows down to the same degree, tracking the changes in circuit delay. However, this advantage has a tradeoff. It is impossible to measure time precisely by counting machine cycles, instruction executions, or the like, because the execution time varies with the temperature.

Interfacing input/output

All input/output devices communicate with the microprocessor through the common bus. Between the actual device and the bus, however, a device-control unit is necessary. In general, the control unit consists of one or more buffer registers that can be the same kind for all controllers—the kind shown in Fig. 7, for example—plus timing and control circuits that are tailored to the particular kind of device. These control circuits could, for instance, respond to the C_1 and C_2 bus-control signals and generate the ACK signal to the bus controller; they would also select, time, and otherwise control the device itself.

A typical device-control unit (Fig. 7) would control a teleprinter—a Teletype model ASR-33 is commonly used. This controller uses two 12-bit buffers— one for input and one for output. Since the data to and from teleprinter requires only 8 bits, the buffers have 4 bits in each direction to spare, which in this design are utilized for command and status information.

The 8-bit part and the 4-bit part have different addresses to distinguish them for the bus controller in the microprocessor. One or the other 12-bit register is specified by an additional IN/OUT signal generated by the control circuitry in response to the fall of C_1 and C_2, whichever is first. The control circuitry could also generate an interrupt signal when data arrives from the teleprinter in the data-input register. The interrupt routine, in this case, would include a READ instruction to transfer the data from the register to the microprocessor. □

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GENERAL ELECTRIC

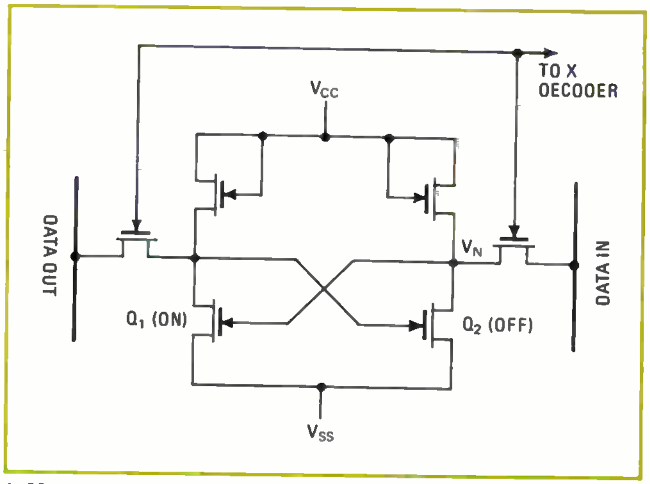
Reducing the power drain of semiconductor static RAMs

by B.W. Martin and J.A. Roberts
Microsystems International Ltd., Ottawa, Canada

A semiconductor memory requires continuous power to preserve the integrity of stored data while the memory is in its standby storage mode. By pulsing the power supply, the memory's power drain can be reduced considerably. This approach is particularly advantageous for static memories because their normally low power drain can be made even smaller. Most of the power supplied to a static memory is consumed in its storage array and not in its decoders or read/write circuitry.

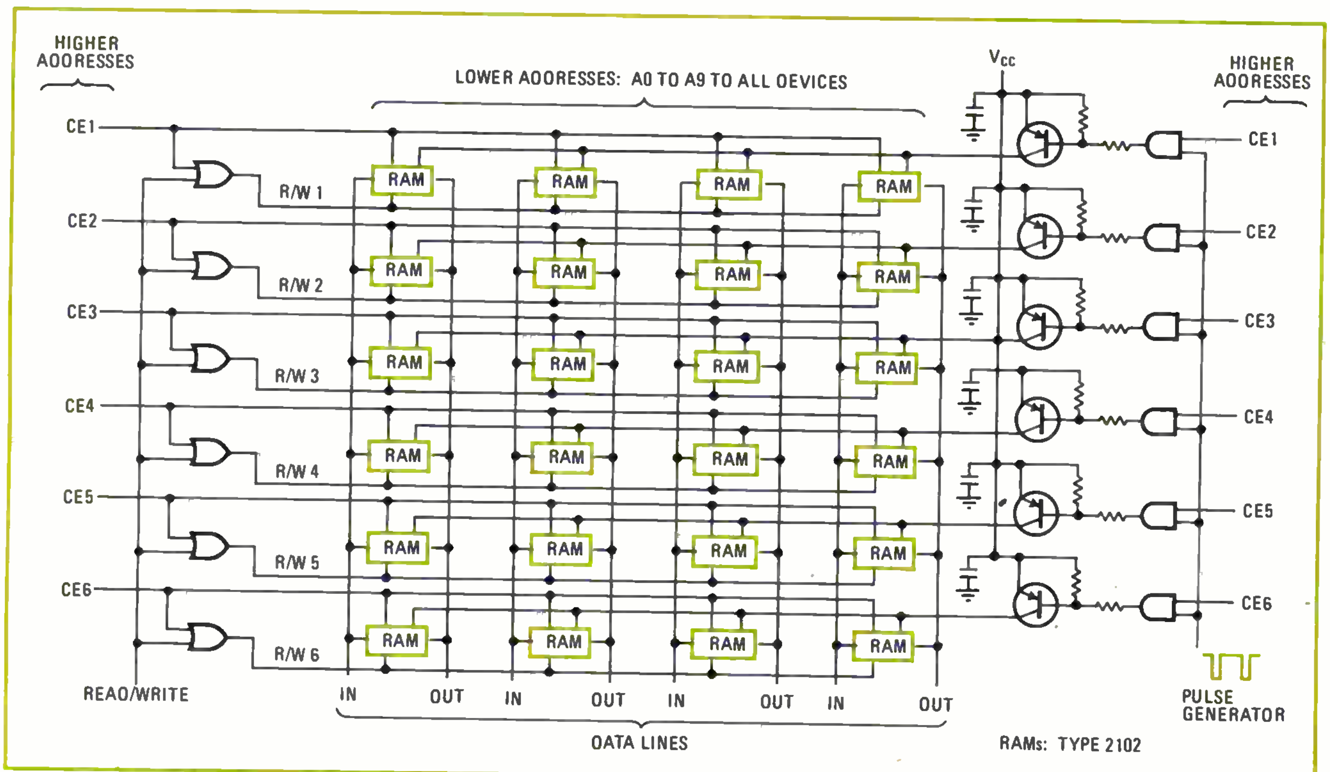
As an example, let's develop a low-drain standby-power circuit for the widely used type-2102 n-channel static random-access memory. This device is a 1,024-by-1-bit array that typically consumes 150 microwatts per bit. Because most of the power supplied to this RAM is needed by its storage circuitry, techniques that simply switch off the power to its peripheral circuitry are of little use.

As shown in Fig. 1, the RAM's basic storage cell is a bistable flip-flop that has a dc path to ground on one side. To reduce standby power, the current consumed in this path must be minimized while still maintaining data integrity.



1. Memory storage cell. Basic storage cell of n-channel static RAM is a bistable flip-flop. Node voltage V_N must be greater than the threshold of transistor Q_1 to prevent loss of data. When there is no standby power, leakage current causes voltage V_N to decrease.

Because leakage current increases with rising temperature, data integrity is most severely threatened at elevated temperatures. During the off-time of a power pulse, node voltage V_N decreases due to leakage current, particularly leakage from the node to the substrate. If this node voltage approaches or falls below the



2. Minimizing standby-power drain. Pulsing standby power for memory array maintains data integrity while significantly decreasing power consumption. To reduce noise pickup on the pulsed power line, the switching transistors are mounted on the same board as the memories.

threshold voltage of transistor Q_1, the data is lost.

When supply voltage V_{CC} is 4.75 volts, data integrity can be maintained if the on-time of V_{CC} is 5 microseconds and the off-time is 145 μs. At room temperature, the RAM will draw a typical current of 1.1 milliamperes, which represents a power consumption of only 5.2 milliwatts and a power reduction of 96%.

If V_{CC} is decreased to 3.5 v, with an on-time of 10 μs and an off-time of 70 μs, the integrity of the data can still be maintained. Now, the average current drawn at room temperature is 1.5 mA, the power consumed is 5.25 mw, and the power reduction is still 96%. This latter approach is useful in emergency situations because it permits a lower standby battery voltage to be used.

In many systems, decoupling capacitors are connected across the memory power rail to reduce noise. While this is acceptable when the rail voltage is not pulsed, certain factors should be considered when dealing with a pulsed rail supply.

In the standby mode, the magnitude of the supply-voltage pulse height and pulse width are critical. A typical type-2102 RAM has a maximum capacitance of 500 picofarads from the V_{CC} supply line to ground. The addition of decoupling capacitors on the order of 0.01 microfarad could increase the power-rail capacitance to such an extent that the pulsed power supply cannot drive the load fast enough to reach the required voltage in the time allowed by the input pulse.

A practical solution is to mount the switching transistors that are used to get the pulsed power on the same board as the memory; this reduces noise pickup on the pulsed line. To reduce noise, decoupling capacitors can be mounted on the unswitched side of the switching transistors, where the V_{CC} supply voltage remains constant.

A typical standby power system for a 6,144-by-4-bit memory array is shown in Fig. 2. The CE1 through CE6 inputs are the higher address lines that select the major array row desired. (A major row is selected when a CE line is logic 0.) Since all other rows are deselected, the read/write lines to these minor rows are in a read mode (logic 1). The CE lines also control the V_{CC} supply to the over-all array so that only the unselected rows are pulsed at the required duty rate. The lower address lines, A0 through A9, run to all the memories in the array. Therefore, when a particular row is being addressed, the same address will appear at all unselected rows. (A changing address has little effect on the power consumption of a type-2102 RAM.)

The duty cycles suggested here for the pulsed standby power are the minimum allowable if the memory is to operate over a temperature range of 25°C to 70°C. Even shorter duty cycles can be used if the memory is not expected to encounter high ambient operating temperatures. And if complementary-MOS devices are employed for the logic gates, additional power savings can be realized. Naturally, the duty cycles selected should be appropriate for the specific devices being used. □

Operating a logic gate as a flip-flop

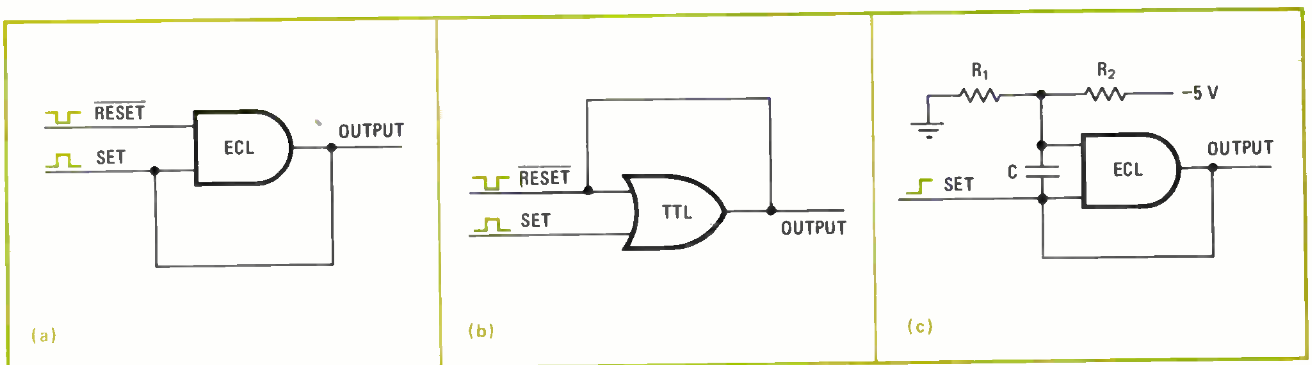
by William Wilke
University of Wisconsin, Madison, Wis.

Did you ever need just a single flip-flop, and find that all you have left on your circuit board is one unused gate? Or, perhaps space is your problem—you have room for one more gate, but can't fit a flip-flop.

Here's a way to make that unused gate behave as though it were a flip-flop. The technique relies on the wired-AND capability of a TTL gate, and the wired-OR capability of an ECL gate.

If the outputs of two or more TTL gates are tied together, then the resulting wired-AND connection will go high only when the outputs of all the gates are high. Similarly, if the outputs of two or more ECL gates are joined together, the resulting wired-OR junction will become high when any one of the gate outputs go high.

An ECL AND gate (a), then, that has its output tied back to one of its inputs will act like a flip-flop. The gate's RESET input is normally high, and a negative-going pulse on this RESET input causes the gate's output to go low. On the other hand, a positive-going pulse at the



Getting a bistable from a gate. Wired-OR connection (a) from the output of an ECL AND gate to one of its inputs permits the gate to function as a flip-flop. For a positive SET pulse, the output is high; for a negative RESET pulse, the output is low. Similarly, a TTL OR gate (b) with a wired-AND connection to one of its inputs also acts as a flip-flop. A simple RC network (c) can be added to produce a one-shot.

SET input will make the output go high. The wired-OR connection at the output will keep the SET line high, thus latching the gate until the next RESET pulse comes along. (Note that the SET input is forced high, a condition that may be unacceptable for some circuits.)

A TTL OR gate (b) that has an open-collector output can be made to operate similarly. In this case, the gate's output is tied to its RESET input line. For the single-gate TTL flip-flop, a negative-going RESET input pulse causes the output to go low, and a positive-going SET input pulse produces a high output.

With a slight modification, the flip-flops can be operated as one-shots. The circuit of (c) shows what this easy-to-add modification looks like for the ECL AND gate.

The one-shot is triggered by a positive-going edge at its SET input. This keeps both inputs high until the capacitor has discharged through resistor R_1. The two resistors, R_1 and R_2, form a voltage divider that is connected between ground and -5 volts to bias the gate's input lines to a logic low. (For the TTL one-shot, resistor R_2 can be eliminated.)

Both flip-flops and the one-shot have an interesting and rather unusual feature—there is no gate delay between one of the inputs and the output. Either flip-flop does have one important limitation, however—one of its input lines is forced to follow the output. □

Isolator circuit permits scope to check ungrounded voltages

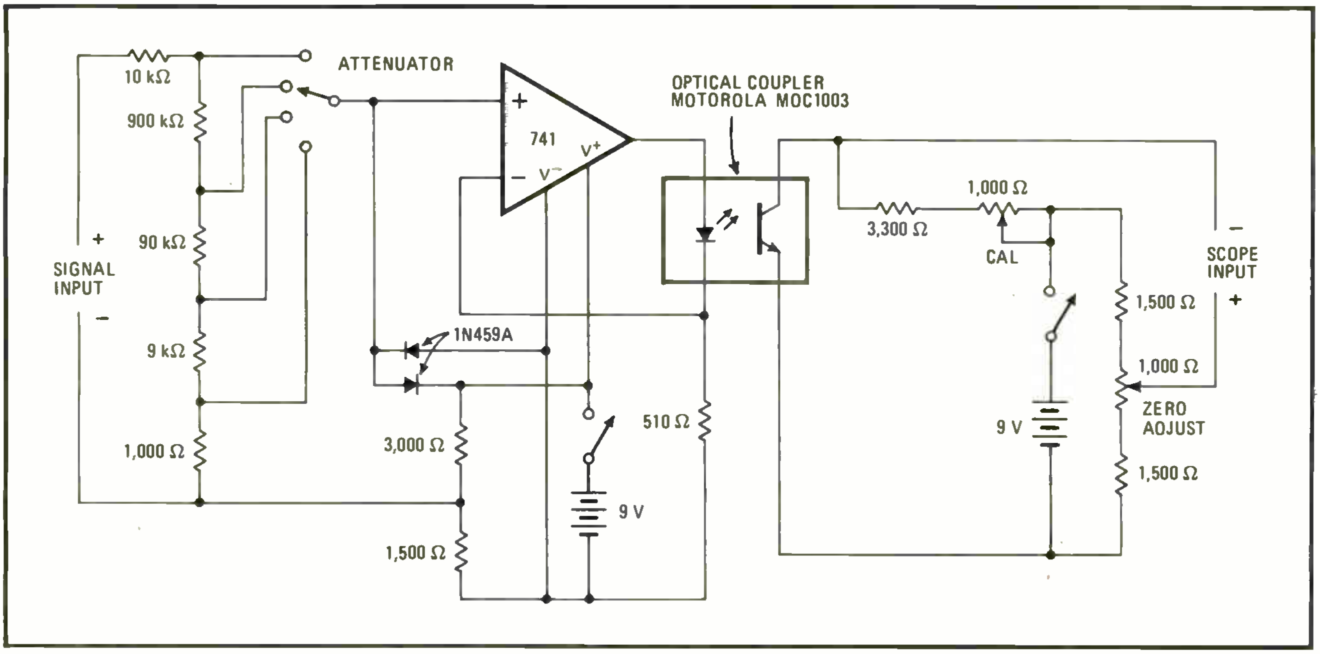
by Richard K. Dickey
California Polytechnic State University, San Luis Obispo, Calif.

Measuring low-level voltages in circuits that are not referenced to ground can be rather difficult. But a special oscilloscope isolator circuit allows a grounded scope to be used for observing small voltages—including their dc levels—in ungrounded circuits.

With this isolator, even common-mode potentials as high as 500 volts will have no effect on the measurement of differential potentials as low as 0.1 v. The circuit is particularly suitable for measuring SCR gate-to-cathode voltages and thyratron grid-to-cathode voltages in motor-control circuits, where the cathodes are typically removed from ground by 120 v ac.

The isolator circuit is divided into two sections, which are separated by the insulating barrier of an optical coupler. The input section consists of a precision decade step attenuator, limiting diodes, and an operational amplifier. The op amp employs current feedback so that the current supplied to the LED of the optical coupler is linearly proportional to the input voltage but offset by one-half of the full signal range. The circuit's output section contains the phototransistor of the optical coupler and a balancing network, which assures that the circuit's output voltage will be zero when the signal voltage is zero.

For maximum safety, the two sections should be assembled in a plastic box, with a plastic barrier separating the two, except for the connections to the optical coupler. The isolator's operating bandwidth is limited to the audio range by the 741-type op amp. A wider-bandwidth op amp will improve the frequency response. □



Floating input. Oscilloscope isolator circuit is ideal for measuring small voltages in ungrounded circuits. Differential potentials as low as 0.1 volt can be discerned out of common-mode potentials as large as 500 V. An optical coupler separates signal and scope inputs.

Engineer's newsletter

How to take a temperature digitally

Often it's nice to measure analog quantities digitally. Well, measuring temperature digitally is duck soup—**a digital thermometer is as close as your nearest digital multimeter and a conventional rectifier diode.** The constant current generated when the meter measures the diode's forward resistance provides a linear resistance function of temperature.

According to James B. Ricks of Bell and Howell Schools in Chicago, a Fluke model 8000A multimeter and a type 1N4004 diode produce **the linear function: °C = 290 - 0.473R, where R is the diode's forward resistance with the meter set to its 2-kilohm range.** Several other meters and diodes can be calibrated similarly.

It's simple. First, solder small flexible leads at the diode body and cut off the excess diode leads. **Then calibrate the meter-and-diode combination with cold water, hot water, and a laboratory thermometer.** If necessary, the lead wires can even be coiled at the diode to reduce their resistance temperature coefficient.

Have readers any other bright ideas for converting analog into digital measurements? They should be sent to *Electronics*, to the attention of Laurence Altman.

More on matching scopes to pulses

Using the rule of thumb that relates an oscilloscope's rise time (t) to its bandwidth (f) by the formula ft = 0.35, a Jan. 10 newsletter on this page showed that an everyday 35-megahertz scope is good enough for a quick look at pulses with rise times as fast as 10 nanoseconds. But **for making accurate rise-time measurements,** Bill Klade of Tektronix Inc. reminds us that you'll need **a much faster scope—with a rise time that's at least a fifth of that of the pulse being measured.** For a 10-ns pulse, that means a scope with a bandwidth of 175 MHz, yielding a measurement with an error of approximately 2%.

Aid with first aid

You may have a first-rate process or manufacturing facility, but is it safe? A recent Occupational Safety and Health Act survey indicates that **more than 50% of companies it surveyed lack even an adequate first-aid program,** let alone speedy access to professional medical personnel. **Fate Associates will survey your plant, determine your first-aid needs,** prepare courses, and supervise monthly meetings. For a free survey, contact Fate Associates Inc., 985 Patton St., North Brunswick, N.J.

Hi rel comes to more C-MOS

Designers of military systems who've been trying to exploit the low power and easy-to-use aspects of complementary MOS have had trouble getting a large enough variety of standard parts that satisfied their high-reliability requirements. But they can now take heart: RCA has **qualified virtually its entire family of 4,000 COS/MOS circuits,** processing them in accordance with Mil Std 883 and Mil M 38510.

Less power to the system

In line with the nation's concern with saving energy, this section is on the lookout for **design ideas that conserve power** in circuits and/or systems. Got any you'd like to send us?

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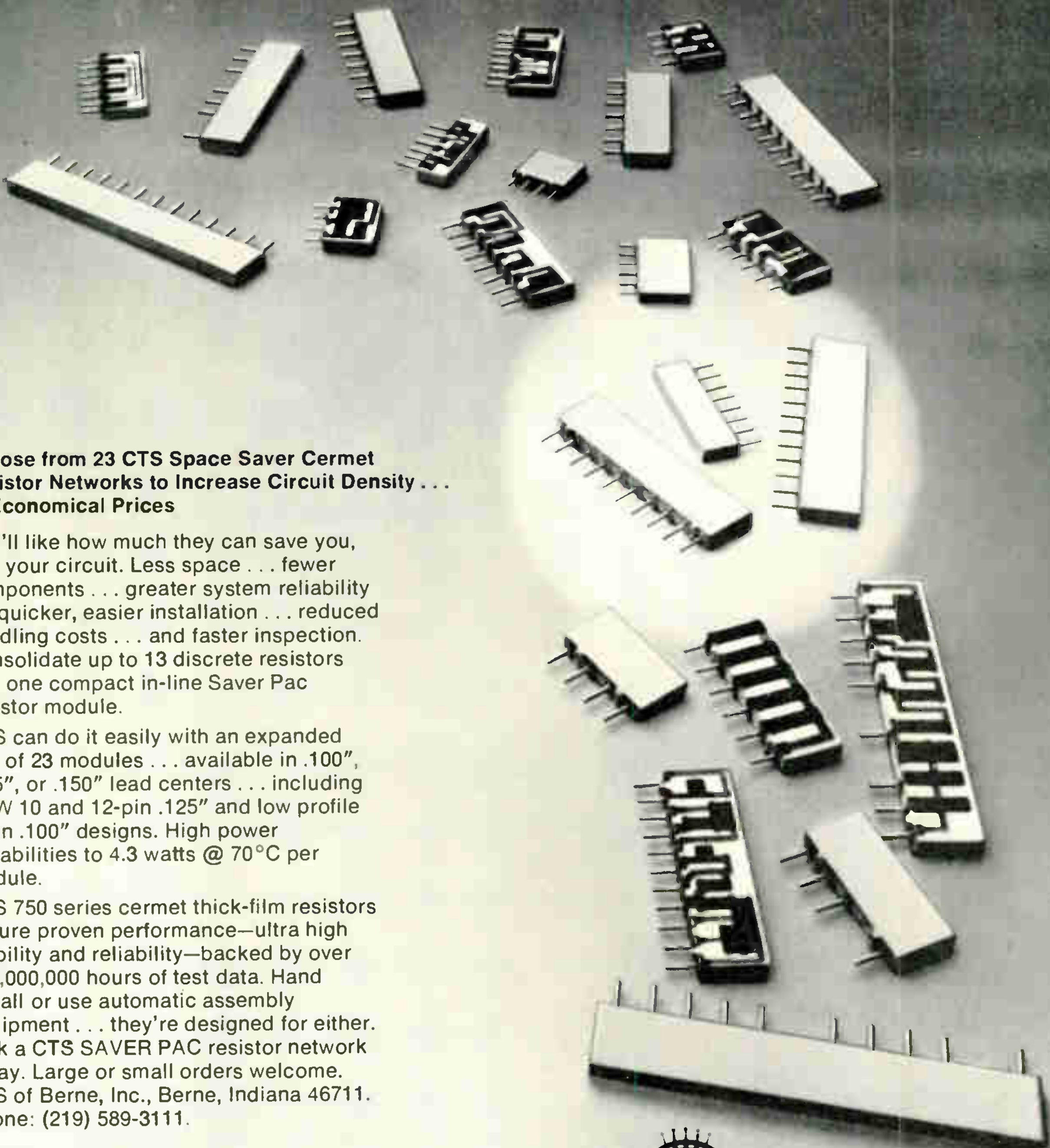

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Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

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Esterline-Angus Co. (Speedway City), Indianapolis, Ind.
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J B L Instrument Co., Darby, Pa.
Leeds & Northrup Co., 4918 Stenton Ave., Philadelphia, Pa.
Norton Electrical Instrument Co., Manchester, Conn.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Sangamo Electric Co., Springfield, Ill.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
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Microammeters

see Ammeters

Microfaradmeters

see Bridges

Milliammeters

see Ammeters

Multipliers

VOLTMETER MULTIPLIERS

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General Electric Co., Schenectady, N. Y.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.

Ohmmeters

see Meters

Oscillators

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Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
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Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Electronic Products Co., St. Charles, Ill.
Ferris Instrument Co., Boonton, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal. (See page 92.)
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 123 Wayne Ave., Dayton, Ohio. (See page 161.)
Leeds & Northrup Co., 4970 Stenton Ave., Cleveland, Ohio
Lepel High Frequency Laboratory, Inc., 39 W. 60th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
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Ferris Instrument Corp., Boonton, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
Jackson Electrical Instrument Co., 123 Wayne Ave., Dayton, Ohio. (See page 161.)
McFarlin Co., 29 W. Marion Ave., Youngstown, Ohio
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
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Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Turner Co., 909 17th St., N. E., Cedar Rapids, Iowa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Oscilloscopes

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Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J. (See p. 118.)
Electro-Medical Laboratory, Inc., Holliston, Mass.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Fredericks Co., George E., Bethayres, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass. (See page 101.)
Heiland Research Corp., Club Bldg., Denver, Col.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
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Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
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see Meters

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Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
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Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Solar Mfg. Corp., Bayonne, N. J.

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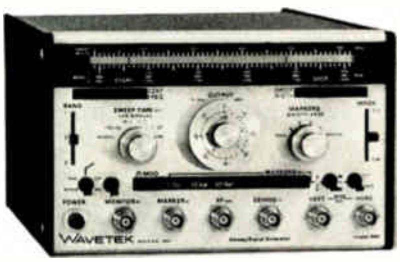

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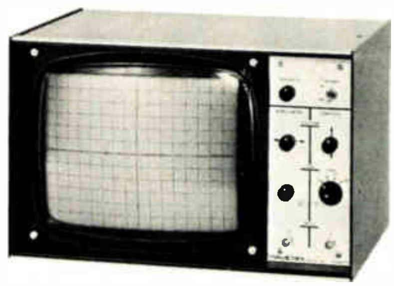


LEDs go up in size, down in price

Optical stretching technique in one-chip-per-segment readouts makes gallium-arsenide-phosphide diodes more competitive for half-inch displays

by Michael J. Riezenman, Instrumentation Editor

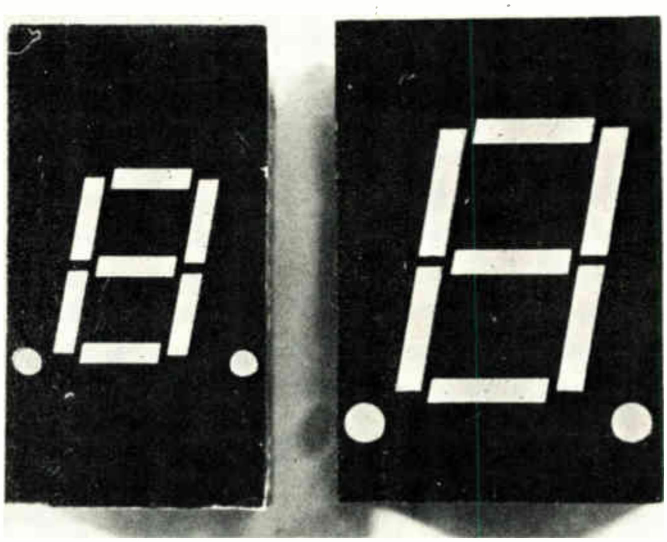
The big obstacle keeping light-emitting-diode displays from penetrating the large-digit market in a big way has been the high cost of large LEDs. Gallium arsenide phosphide is an expensive material, and a display that needs a lot of it necessarily costs a lot of money.

Now, two companies—Hewlett-Packard and Fairchild—are using a material-saving technique to build LED displays in the half-inch-high range at costs of about $2.50 per digit in quantities of 1,000.

About a year ago, makers of GaAsP LED displays began to use the light-spreading packaging techniques long used to cut costs of gallium-phosphide displays by reducing the amount of semiconductor material needed to form each digit. Instead of using a piece of material, say 0.1 in. long, to make a segment of that length, the optically stretched digit uses a tiny chip of material and spreads its light output along the length of a glowing plastic bar [*Electronics*, March 15, 1973, p. 65].

Until now, optical stretching has been limited to digits about 0.3 in. high because of difficulties in getting sufficient brightness and uniform lighting of larger segments. Actually, at least one manufacturer offers an optically stretched 0.6-in. display, but it uses two chips per segment, thus doubling the number of chips per digit, doubling the number of bonds per digit, and doubling the voltage drop for each segment.

The two new devices—Fairchild's FND-500 and Hewlett-Packard's 5082-7750—are both single-chip-per-segment displays. The Fairchild entry measures exactly 0.5 in. high, while H-P chose the oddball-sounding size of 0.43 in., which results in a digit with exactly twice the viewing area of the company's earlier 0.3-in. digit (see photo).



Big difference. Increase in height from 0.3 to 0.43 inch may not sound big, but the larger of these H-P readouts—shown unenergized—has twice the area of the smaller.

The FND-500 uses a light-pipe packaging technique in which the light from a 20-mil GaAsP chip is led down a gold-plated pipe to a plastic rectangle which has a fly's-eye lens molded on its back. The 5082-7750 doesn't need a lens; it simply diffuses the light coming out of the chip by means of what is called a "pseudo-light-pipe" design. One result of these different approaches is the difference in viewing angle and brightness between the two units.

The Fairchild FND-500 has a minimum axial luminous intensity of 240 microcandela, typical, 600 μcd, and a viewing angle to half intensity of ±25°. The H-P 5082-7750 has a minimum axial luminous intensity of 150 μcd, typical, 250 μcd, and a viewing angle to half intensity of ±55°. For both units, the intensity specification is for a single segment at a current of 20 milliamperes.

Of course, the big news is price. For quantities of 100 to 999 units, the Fairchild display is $2.95 each, and the H-P device goes for $3.50. For 1,000 and up, the FND-500 drops to $2.65 each, and the 5082-7750 comes down to $2.50 each. And, while larger-quantity prices are negotiated individually, company spokesmen have indicated that prices would drop below $2 for quantities in excess of 10,000.

Fairchild Microwave and Optoelectronics Division, 4001 Miranda Ave., Palo Alto, Calif. 94303 [338]

Inquiries Manager, Hewlett-Packard Co., 195 Page Mill Road, Palo Alto, Calif. [339]

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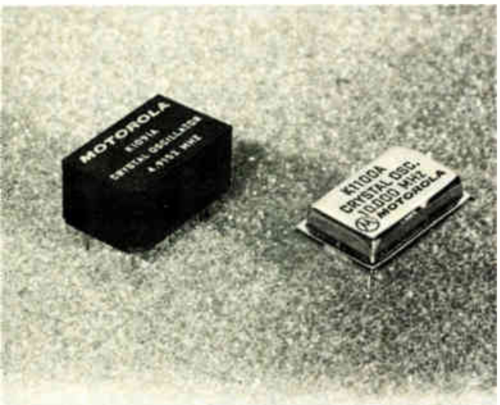


height of only 0.200 inch, allowing its use on printed-circuit cards with no loss of board spacing. The all-solid-state oscillator also is more reliable and can be produced in volume at lower costs than earlier DIP clocks, points out Calvin G. Chopp, marketing manager for the department.

"We can get to 4 megahertz using integrated circuits and the fundamental mode of the crystal," Chopp says. But the thick-film technique has also allowed the firm to add divider circuits to the package, extending the frequency down as low as 250 kilohertz. The new hybrid clock oscillator, called the K1100A, available in any discrete frequency from 250 kilohertz to 20 megahertz, requires a supply of +5 volts and drives standard transistor-transistor logic with a fan-out of as many as 10 gates. Frequency stability is within ±0.01% over 0°C to 70°C, acceptable for most data-communications logic-timing applications. This tolerance includes calibration at 25°C, stability over operating temperature range, stability versus input-voltage change, and stability versus load change and aging.

So enthusiastic is Motorola about the high-volume requirements for timing sources in the fast-growing data-communications market that it has gradually phased out or sold off all its other oscillator products, including ovenized oscillators, non-DIP clock oscillators, and its line of temperature-compensated crystal oscillators.

In the new oscillators, all crystals are plated with gold to ensure long-term stability, and Motorola has added rigid temperature-cycle, shock, vibration, and humidity tests to the specifications. All units are leak-tested.

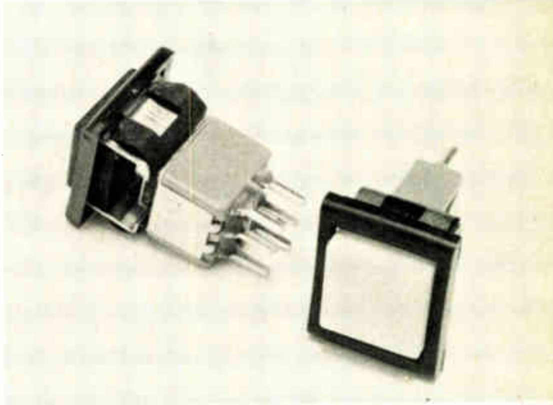
Price in quantities of 10,000 for frequencies from 4 to 20 MHz will be around $8.50; single-piece price for any frequency is $75. In volume production now, Motorola stocks units for frequencies of 4, 4.0152, 5, 10, and 20 MHz; delivery time for production quantities of devices operating at any other frequency is six to eight weeks.

Motorola Communications division, Component Products department, 2553 N. Edgington St., Franklin Park, Ill. 50131 [341]

Push-button switches built for snap-in installation

Designed for use in low-power circuits, a new line of push-button switches from C&K Components Inc., Watertown, Mass., allows easy snap-in installation. The bezel-mounted switches come in two versions—single-pole, double-throw and double-pole, double-throw—that snap into panels ranging from 0.0682- to 0.125-inch thick. The push-button cap itself is 0.470 in. square, while the bezel mount is 0.615 by 0.765 in. and extends 0.090 in. above the panel face.

The switches, which come in nine colors, have a contact rating of 1 ampere resistive load at 128 volts ac



and 28 v dc. Insulation resistance is a minimum of 1,000 megohms, and dielectric strength is 1,000 v rms at sea level. Electrical life is 60,000 cycles minimum at full load; mechanical life is at least 100,000 cycles.

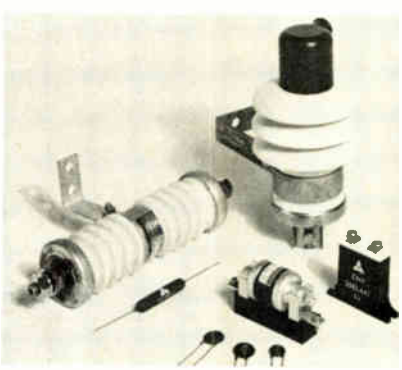
The caps and bezels are made of nylon; the movable contact is beryllium copper with 18-karat gold-plated contact. The other contacts are brass with 18-karat gold inlay, also plated with gold.

The price ranges downward to $1.87 each in large quantities.

C&K Components Inc., 103 Morse St., Watertown, Mass. 02172 [342]

Surge absorber withstands from 500 to 20,000 amperes

Designed to protect solid-state components from damage, a ceramic surge absorber, designated ZNR for zinc-oxide nonlinear resistor, can withstand currents from 500 to 20,000 amperes at 8 to 20 microseconds in surge waveform. Aimed at replacing gap-type arrestors and silicon-carbide varistors, the surge



absorber is said to have a quick discharge response and no dual current. Applications include protection of transistors, SCRs, and communications equipment.

Panasonic (Matsushita), 200 Park Ave., New York, N.Y. 10017 [343]

Pressure transducers range from 0 to 2 to 5,000 psi

A line of integrated pressure transducers is designed for a wide variety of applications, including automotive and aircraft supervisory systems. Designated the TQ and ITQ series, the devices offer ranges from 0–2 to 500 psi gage, differential and absolute. Typical full-scale unamplified output is 100 to 250 millivolts. An amplified version is offered with a 0- to 5-volt output. Price is $44.50 each, dropping to as low as $10 in volume.

Kulite Semiconductor Products Inc., 1039 Hoyt Ave., Ridgefield, N.J. 07657 [344]

Electrolytic capacitors come in lug, wire-wrap versions

A line of general-purpose can-type aluminum electrolytic capacitors is available with either lug terminals, designated type L, or with wire-wrap terminals, designated type LW. Both come in single and multisection versions. The capacitors offer explosion-proof venting and a minus-terminal for insulation of the ground connection from the chassis. Capacitances in single-section devices include 33, 47, 100, 150, 220, 330, 470, and 1,000 μF. Double-section types offer values of 10/10, 22/22, 33/33, 47/47, 100/100, and 220/220 μF, while the multi-

section types offer 10/10/10, 22/22/22, 33/33/33 and 47/47/47 μF, plus combinations of these values.

International Importers Inc., 2242 South Western Ave., Chicago, Ill. 60608 [345]

Digital output transducer can feed 5 HTL inputs

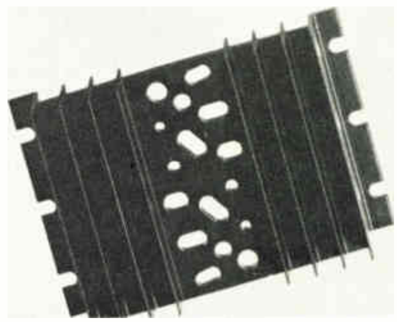
The model 4-0021 digital-output transducer is an active magnetic-type device that provides high-

threshold logic-output signals capable of feeding up to five HTL inputs. The model 4-0021 is designed specifically for computer-peripheral equipment and speed-sensing applications, where a precise signal-to-noise ratio is required. Price is $39.

Controls Division, Airpax Electronics, 6801 W. Sunrise Blvd., Fort Lauderdale, Fla. 33313 [346]

Heat sink provides 'universal' hole-pattern

The series-6500 heat sink is available with a "universal" hole-pattern that will accomodate seven of the most widely used packages for semiconductor devices: TO-3, TO-66 (both with or without sockets), TO-36, 10/32-inch and ¼-inch stud



Free flexcircuit calculator.

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6. Temperature rise versus current.

A simple slide rule is built into the calculator plus inch/centimeter conversion scales and resistivity conversion chart from copper to other conductive materials. Calculator measures 8⅜" long by 3⅛" wide.

Supplies are limited so request your free calculator on your company letterhead from: Electrical Products Division, G. T. Schjeldahl Company, Highway 3 North, Northfield, Minnesota 55057.

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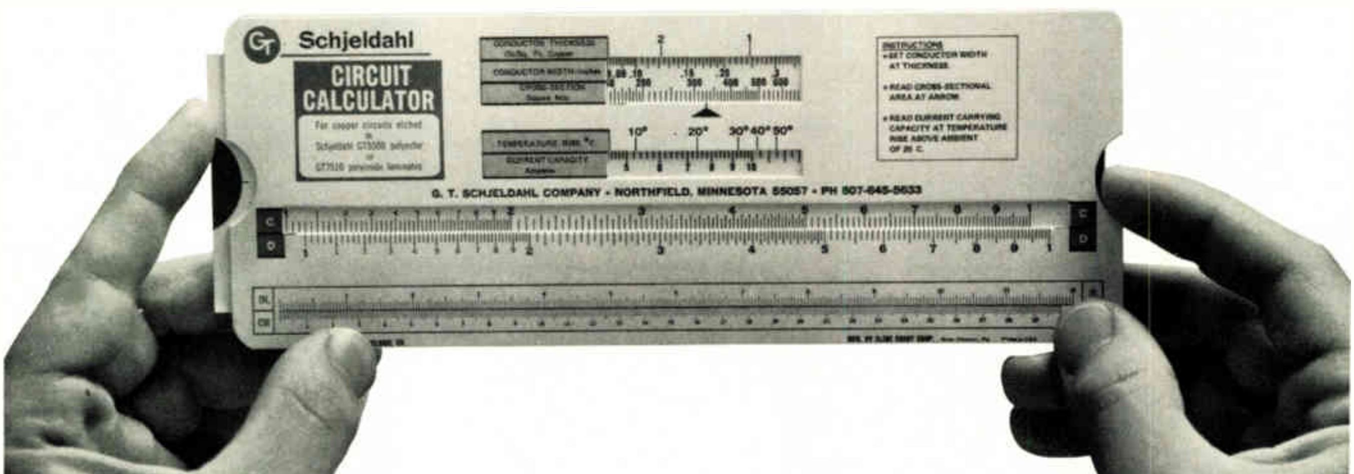


For the name of your nearest GTS representative call toll free 800-645-9200. In New York State call collect 516-294-0990.

mounts, and two plastic packages. The mounting flanges provide six instead of two mounting notches.

Thermalloy Inc., 2021 W. Valley View Lane, Dallas, Texas 75234 [348]

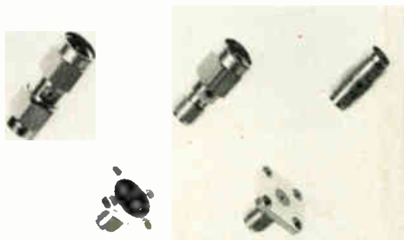
Reed relays stand off 250 V at 10^{10} ohms

Compatible with dual in-line packages, the series 270 reed relays have coils that can be gated by TTL or DTL levels with 9 milliamperes at 4.5 volts. Contacts are rated at 10 VA. Pin 14 can be bused as the supply voltage, and pin 7 as ground, or alternate pin patterns can be specified. The relays, which stand off 250 volts at 10^{10} ohms, carry 1 A or switch 120 V ac, plug into DIP sockets or wire-wrap boards, and mount on pc boards.

Cosar Corp., 3121 Benton St., Garland, Texas 75042 [347]

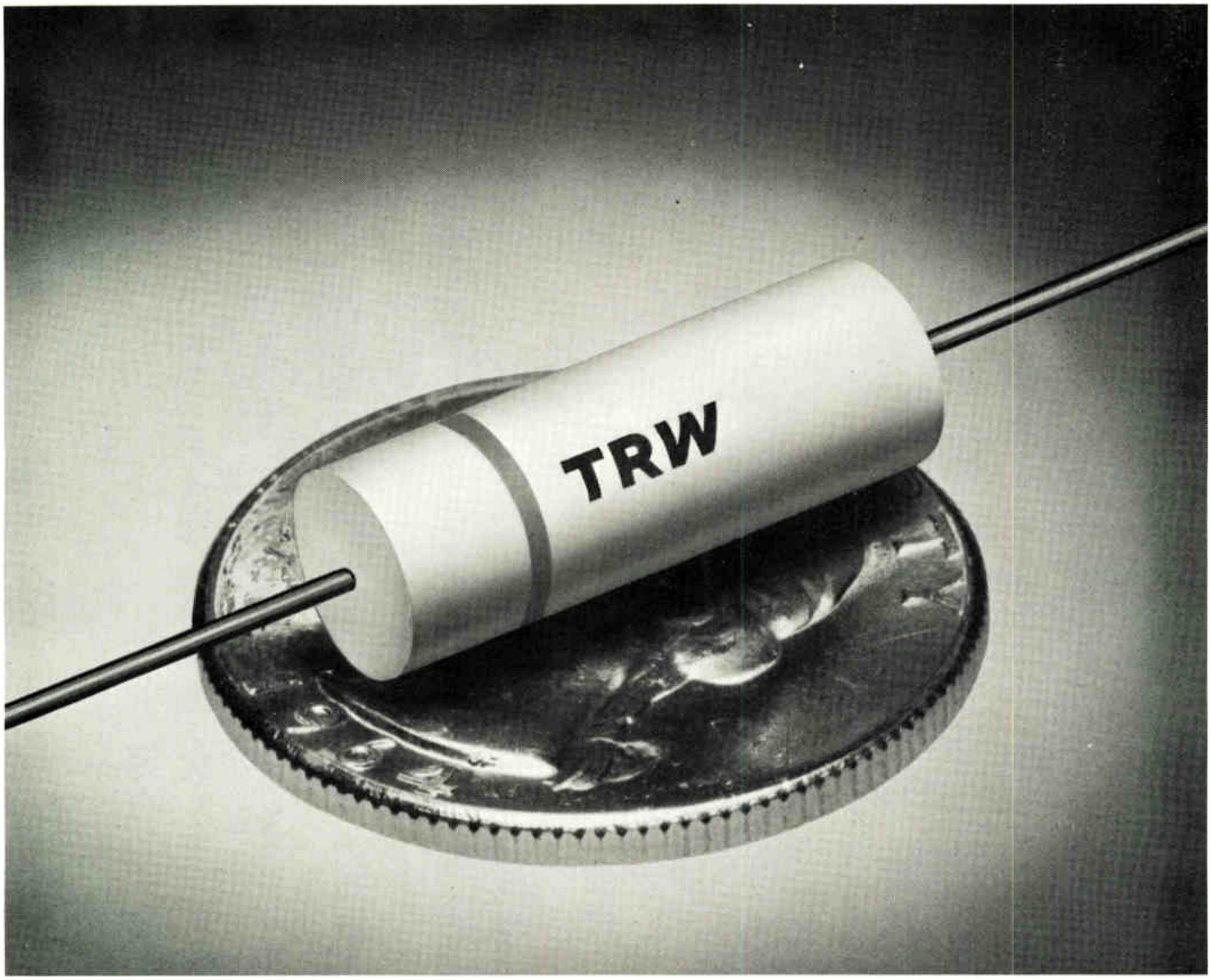
Tiny dc-block connectors eliminate separate units

A miniature dc-block connector eliminates the need for a separate dc-block component when joining transmission lines or modules. The devices are designed for a wide variety of applications, including diode switches, attenuators, modulators and phase shifters. A disk capacitor



is incorporated into a coaxial connector so that a single unit can be used to block the flow of dc or video current while permitting rf and higher frequencies to pass with negligible attenuation or reflection. Price ranges from $3.50 to $7 in 1,000-lots.

Omni Spectra Inc., 24600 Hallwood Court, Farmington, Mich. 48024 [349]



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General Radio Co., 30 State St., Cambridge, Mass.
Hallicrafters Co., 2611 Indiana Ave., Chicago, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass. (See page 165.)
Rosen & Co., Raymond, 32nd & Walnut Sts., Philadelphia, Pa.

INDUCTANCE STANDARDS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
New York Transformer Co., 51 W. Third St., New York, N. Y.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.

RESISTANCE STANDARDS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
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., (See page 6.)
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.

Testers

BATTERY TESTERS

Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Rascher & Betzold, 835 Orleans St., Chicago, Ill.
Rieker Instrument Co., 1919 Fairmount Ave., Philadelphia, Pa.
Ruth Class Div., Kimble Glass Co., Conshohocken, Pa.
Testrite Instrument Co., 57 E. 11th St., New York, N. Y.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

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Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Solar Mfg. Corp., Bayonne, N. J.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

HIGH VOLTAGE TESTERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Miller Co., Bertrand F., Trenton, N. J.
Minerallac Electric Co., 25 N. Peoria St., Chicago, Ill.
Raytheon Mfg. Co., Waltham, Mass.
Roller-Smith Co., Bethlehem, Pa.
Slayter Electronic Div., Owens-Corning Fiberglas Corp., 26 W. Market St., Newark, Ohio.
States Co., 19 New Park Ave., Hartford, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

TUBE TESTERS

Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Dayco Radio Corp., 915 Valley St., Dayton, Ohio
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio. (See page 161.)
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill. (See page 44.)
Standard Technical Devices, Inc., 3008 Ave. M., Brooklyn, N. Y.
Superior Instruments Co., 227 Fulton St., New York, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

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Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Electric Service Supplies Co., 17th & Cambria Sts., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
J B L Instrument Co., Darby, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Miller Co., Bertrand F., Trenton, N. J.
Radio Design Co., 1353 Sterling Pl., Brooklyn, N. Y.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Standard Transformer Co., 140 Dana St., N.E., Warren, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
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Bristol Co., Waterbury, Conn.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Field Electric Instrument Co., 2258 Morris Ave., New York, N. Y.
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General Radio Co., 30 State St., Cambridge, Mass.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.
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Wattmeters

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Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
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Zenith Radio Corp., 6011 Dickens Ave., Chicago, Ill.

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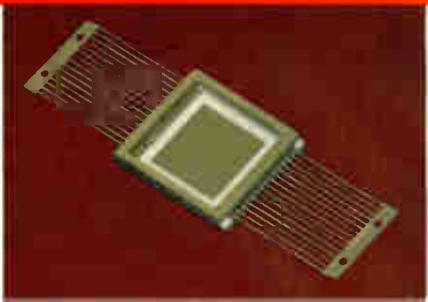

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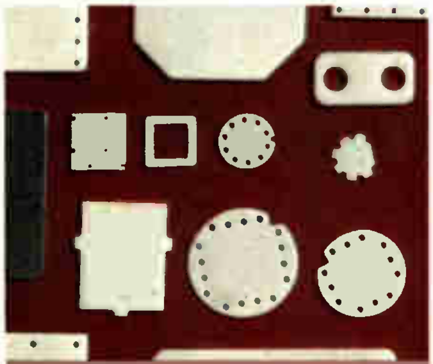

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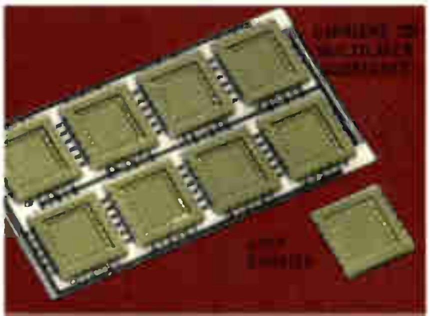

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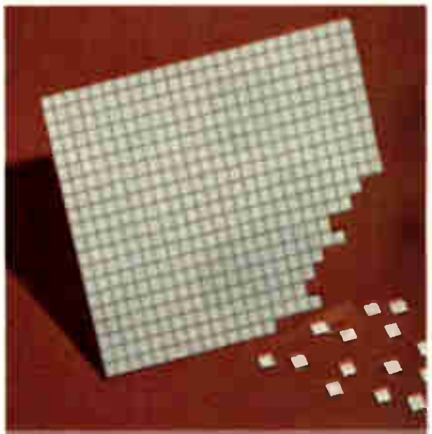

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Instruments

Pulser offers 0.01-Hz rate

Broad-applications generator can produce repetition rates as high as 10 MHz

Many new pulse generators are being designed for higher and higher repetition rates, as might be expected with the growth in use of high-speed logic. However, one new instrument is bucking that trend. It is the model P12, to be introduced by Interstate Electronics Corp. at IEEE Intercon 74.

Although producing repetition rates as high as 10 megahertz, the P12 has a lower limit of 0.01 hertz. Most generators in the range bottom out two decades higher at 1 Hz. The low frequency is especially suited for such biomedical applications as simulating heart beats, and other biological functions. It can also be used in geophysical and general-purpose applications.

The P12 has two separate outputs, one positive-going and one negative-going, each with separately adjustable amplitude. The amplitude is continuously adjustable from 1 to 10 volts into a 50-ohm load.

The repetition rate is set in nine ranges from 0.01 Hz to 10 MHz, and a continuous vernier covers a 10-to-1 range. Pulse width is set from 50 nanoseconds to 1 second in eight ranges, again with continuous vernier. Delay specifications are identical to those of the pulse width—50 ns to 1 s. Rise and fall times are shorter than 5 ns, and overshoot, preshoot, and ringing are less than 5% of the pulse amplitude.

Several modes are provided: normal, with the internal clock providing triggering; double pulse to 5 MHz, giving a maximum 10-MHz effective output range: square-wave, with a maximum of 5 MHz, and external triggering to 10 MHz from a +2-to-+5-V, positive- or negative-going signal. A single pulse can also be generated, by a push button on the front panel. The signal can also be synchronized externally. A normal/complement push button reverses the output simultaneously from the normal output to its complement. Auxiliary outputs are provided for sync-output signals (0 to +2 V into 50 ohms, 15-ns width), and clock output, which is similar in characteristics.

The P12 operates on 100, 115, 200, or 230 V, and it draws 30 VA at 50 to 400 Hz ac. The generator is 222 millimeters wide, 270 mm deep, and 85 mm high. It weighs 4 kilograms. A rack-mountable version is also available. The unit is priced at $470.

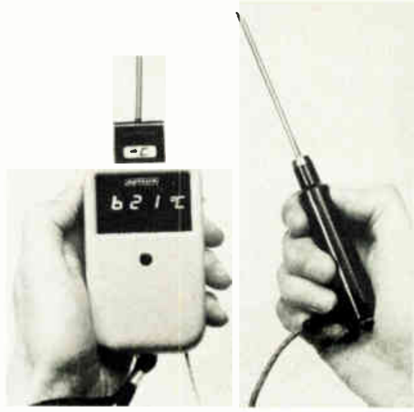
Interstate Electronics Corp., P.O. Box 3117, Anaheim, Calif. 92803 [351]

Digital-readout thermometer weighs only 8 ounces

For about 10 years, Britain's Kane-May Ltd. has made electronic thermometers with meter readout, but it is taking advantage of IEEE time to show off its first digital-readout instrument. The thermometer, which will be exhibited next week at Intercon 74, reads out from -55° to +999°C without range switching, using light-emitting diodes to display the temperatures.

The big reason for moving to digits is that a meter-type scale covering an equivalent range would have to be very large to be readable to equal resolution—1°—or else to have a lot of switched ranges in it. Digital readout also gets the bulk of the unit down to pocket size—4.5 by 2.5 by 1.5 inches. Weight of the unit is 8 ounces—including dry batteries that power it.

Inside are a thermocouple sensor,



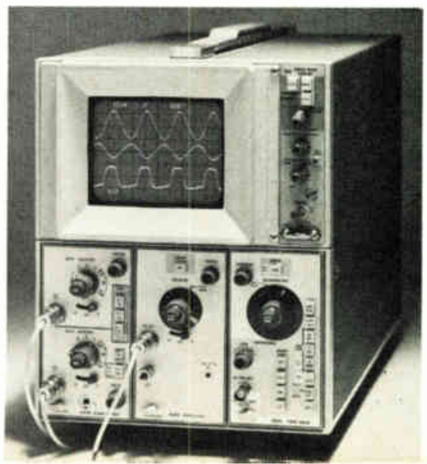
an analog-to-digital converter, MOS logic, and a small number of discrete items. There are three standard probes: chisel-end, flat-end, and a tube for holding liquids. The most likely use in electronics technology is in laboratories to check temperatures of heat sinks, transistor cans, and things like that. However, Ernest May, Kane-May managing director, expects to sell it for laboratory and production use throughout industry.

It's likely to cost between $200 and $250. Currently some pre-production instruments have been made but volume production has not yet begun.

Kane-May Ltd., Welwyn Garden City, England [352]

Variable persistence added to oscilloscope line

A 60-megahertz oscilloscope, the model 5403/D41, allows the user to change the length of time a trace persists on the CRT from five minutes to an hour. The new addition to the 5000 line of scopes can easily measure low repetition rates, and, for applications requiring maximum



writing speed, the unit has an integrating or halftone mode of operation. In this mode, it is possible to achieve writing speeds ranging from 0.1 division per microsecond with viewing time of 5 minutes, to five divisions/μs with viewing time of 15 seconds. Erase time is 0.5 second. The unit is priced at $1,925 without CRT and $2,275 with CRT.

Tektronix Inc., Box 500, Beaverton, Ore. 97005 [353]

Miniature power meter covers 10 MHz to 13.7 GHz

The model 8400 miniature power meter is designed for laboratory or field use to make rf measurements from 10 megahertz to 13.7 gigahertz. The unit is available with any of three interchangeable 5-ohm mounts, each having a 20-decibel dynamic range, covering a full-scale

power range from 100 microwatts to 100 milliwatts. A 75-ohm mount is also available for CATV applications. Full-scale accuracy is within ±3%. Price of the meter is $350; the mounts are $150 each.

Narda Microwave Corp., Plainview, N.Y. 11803 [354]

Autoranging multimeter offers 1-microvolt sensitivity

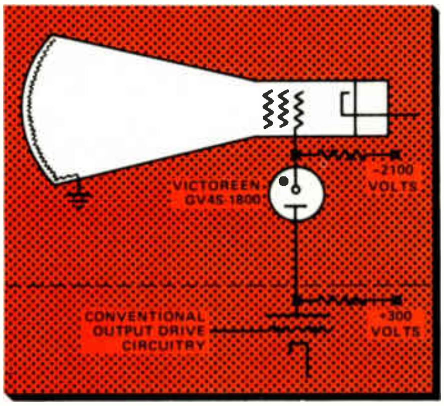
Featuring an autoranging capability, the model DMM-51 multimeter provides 24 ranges with a sensitivity of 1 microvolt and accuracy within 0.004%. Measurement capabilities include five dc ranges from 0.1 v to 1,000 v, and five dc-ratio ranges from 0.100000:10 to 1,000.00:10 full

Problem solving... with Victoreen High Voltage Technology

1 UNORTHODOX CRT DRIVE

How did we meet ever-expanding requirements for increased bandwidth and lower power consumption, coupled with the availability of high-voltage zener-type diodes (Victoreen Corotrons)? With an unorthodox drive scheme for CRT's.

Basically, this scheme is a mirror-image of the conventional method. Instead of supplying the CRT anode with very high voltage, we ground the anode and supply a drive signal, riding at approximately — 1800 volts, to the grid. The advantages? Being direct-coupled there are no reactive components to limit high-end frequency response or cause roll-off



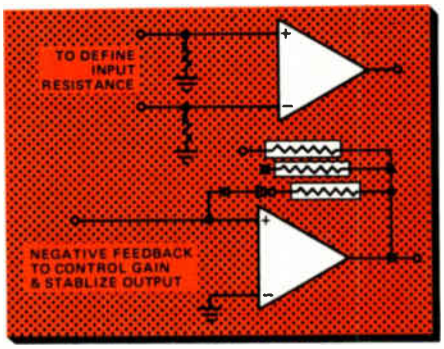
at the low end. Second, the face plate of the CRT does not build up static charges which can distort the display.

Even though the Corotron operates in the corona mode of discharge, it has no voltage jumps or jitters. Corotrons are not tied to "natural" operating voltages and are adjustable in manufacture from 350 to 30,000 volts. Corotrons also have a positive regulation curve eliminating possible relaxation oscillation.

2 FROG MUSCLES TO BRAIN WAVES

Colleges and universities, medical research laboratories and a number of R&D firms are faced daily with the need for controlled high-amplification of a wide variety of extremely low level signals. Such signals are derived from frog-muscle experiments, brain-wave measurements, cardiac research, avalanche-breakdown, currents in ionization chambers as well as from a range of constant-current sources.

The operational amplifier provides the amplification required because of theoretical infinite-gain characteristics. However, at full gain an op-amp tends to be unstable and go into oscillation; further, amplified signals are difficult to fully analyze if the gain is unknown.



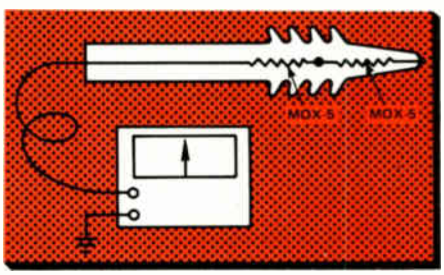
Victoreen MINI-MOX resistors are used widely to modify op-amp characteristics to: 1. Stabilize output and eliminate oscillation. 2. Define gain so measurements can be quantified. 3. Restrict bandwidth to the region of specific interest.

Smaller than a conventional resistor and compatible with a TO-3 can, MINI-MOX resistors are ideal for highly-stable, low-level, miniature electronic circuitry.

They typically have a voltage coefficient of —5 ppm/volt, full-load drift of less than 2% in 1000 hours, temperature coefficient of 100 ppm, and a Quantech noise of less than 1.5 μV/volt at 20M ohms. They are available in values from 100K to 10,000M ohms in 1, 2, 5 and 10% tolerances.

3 A PROBE FOR HIGH POTENTIAL

Two Victoreen MAXI-MOX resistors used in series can serve as a probe in radar circuitry capable of measuring voltages up to 60,000 volts. The probe, compatible with a number of voltmeters of different manufacture, has both short- and long-term stability. Short-term stability assures negligible drift and fluctuation



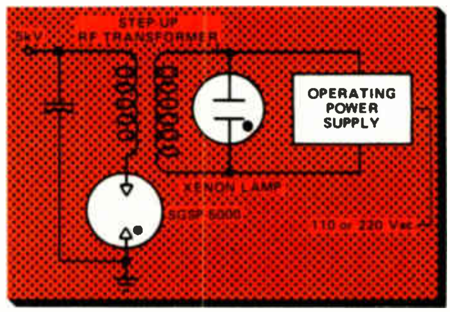
during measurement, while long-term stability maintains the original calibration accuracy of the probe.

Each MOX-5 resistor used in the probe has a maximum operating voltage of 37,500 volts with a power rating of 12½ watts. The voltage coefficient is 1 ppm/volt over the complete voltage range of the MOX-5, while the temperature coefficient is better than 300 ppm from —55° to 125°C.

MAXI-MOX resistors have full-load drift less than 1% in 2000 hours of operation, and are available in tolerances of 1, 2, and 5% in values from 10K to 2,500M ohms. A silicone varnish conformal coating provides environmental protection while allowing a maximum hot-spot temperature of 220°C. In addition, it is compatible with commonly-used potting compounds.

4 SPARK GAPS SPARK INTEREST

Victoreen SGSP spark gaps normally protect electrical circuits from damage from transient voltage spikes; however, Optical Radiation Corporation, Azusa, Ca. uses them to ignite a Xenon lamp in a theatrical lamphouse to project motion pictures. Xenon lamps provide two



advantages; one, being very small and brilliant, light radiation is easier controlled; second, efficiency is higher, so smaller lamphouses with greater output result. The design won the company an Academy Award in technical achievement.

In operation, the capacitor is charged until the SGSP-5000 breaks down. The stored energy is released through the transformer primary, producing a very high voltage pulse in the secondary which ignites the Xenon lamp. This provides an extremely reliable method of starting the lamp. Once ignited, operation is sustained by a lower-voltage line operated power supply.

Victoreen Instrument Division of VLN Corp.
10101 Woodland Avenue
Cleveland, Ohio 44104

VICTOREEN

scale. In addition, optional measurements, at extra cost, include four ac ranges from 1 v to 1,000 v, four ac/dc ratio ranges from 1.00000:10 to 1,000.00:10 full scale, and six resistance ranges from 0.100000 kilohm to 10,000 kilohms. Price is $795.

California Instrument Co., 5150 Convoy St., San Diego, Calif. 92111 [355]

Voltage-variable delay lines are electrically adjustable

Wideband, ultralinear delay lines provide adjustable time delay over ±20% or more of the nominal value by variation of a bias voltage, which is applied to varactor diodes that supplement fixed capacitors in the network. Typical applications include automatic timing correction in video broadcast tape recorders, delay-tracking in navigational radar, and pulse-width modulation in phase-locked loops for instrumentation.

Kappa Networks Inc., 165 Roosevelt Ave., Carteret, N.J. 07008 [357]

Transient-capture recorder is oscillograph add-on

A transient-capture recorder for use with recording oscillographs is a continually operating device that provides readout of the captured event and the information leading up to that event. This is accom-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plished by using a trigger level to stop the recording process, which freezes data in the machine's memory. The total record time in the memory is then divided between the pre-transient time and the post-transient time. The unit also records signals in digital form and samples the input analog signal voltage, storing the information and converting the digital signal back to an analog voltage for readout.

Hathaway Industries Inc., Tulsa, Okla. [356]

Function generator offers waveforms at 0.1 Hz to 1 MHz

A function generator, the model 190, offers a full range of waveforms from 0.1 hertz to 1 megahertz. The instrument produces sine, square,

triangle, pulse, and ramp waveforms. Provision for voltage-controlled frequency, input, dc-offset, and TTL-pulse output are also offered. The portable instrument measures 7⅜ by 2⅞ by 8½ inches and weighs about two pounds. Price is $245.

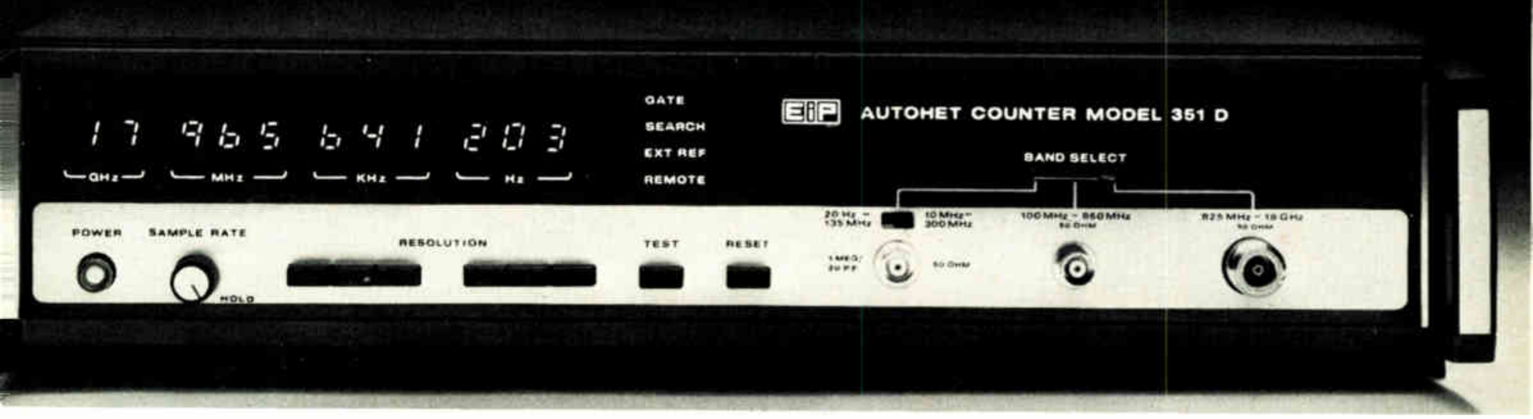
Exact Electronics Inc., Box 160, Hillsboro, Ore. 97123 [358]

Microprobe thermometer is accurate to 1°C

Temperatures of beam-lead devices, flip chips, and miniature components can be measured with the model BAT-7R contact thermometer. The unit, which gives almost instant readings, can use thermocouples as small as 0.005 inch. The instrument has a MOSFET chopper stabilizer and a built-in temperature reference. Four ranges on the meter cover from 0°C to 400°C, and ac-

You can't get FM tolerance and high sensitivity together.

But we can.



Several years ago, EIP introduced the first Autohet frequency counter.

HP soon followed with their version of an automatic counter.

We had chosen to automate the heterodyne method of determining precise frequencies. They had taken the transfer oscillator approach.

We ended up FM tolerant. They ended up with more sensitivity.

What happened?

If you were in the communications industry, you would need our counter to measure typically encountered signals with large amounts of frequency modulation.

If you required a counter to measure unusually low-level signals, HP had it.

And if you needed both FM tolerance *and* high sensitivity, you either bought both counters (for about $10,000), or *you* had had it.

An Impossible Counter.

Last month, we introduced our new 350D. FM tolerance has been improved by 400% to a worst case of 40 MHz peak-to-peak deviation. Its sensitivity (−25 to −30 dBm) permits measurement of extremely low level signals.

Now. If you require both FM tolerance *and* sensitivity, you can get both in one counter (for about $5,000).

Impossible? HP would like to think so.

We've even added a new feature you'll like. Our 11 digit display is now LED solid state. Extremely reliable. Easy to interpret. And our unique display blanking facility allows you to eliminate the 6 least significant digits.

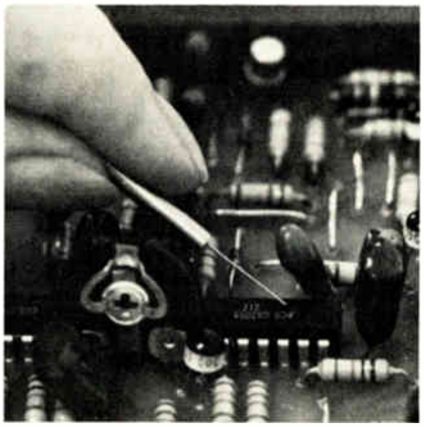
Our 350D (*20 Hz to 12.4 GHz*) costs $4,700. Our 351D (*20 Hz to 18 GHz*) costs $5,100.

Call Bob Mangold collect at (408) 244-7975. Or, for Europe, contact Andre Mathot in Brussels at (02) 41 45 50. Ask about this "impossible" counter.

EIP
A DANALAB COMPANY
3130 ALFRED ST. SANTA CLARA, CA 95050 ®

Others measure by us.

New products



curacy is within 1°C. Price is $355. A second model with a temperature range from −10° to +175°C is available for $295.

Bailey Instruments Co., 515 Victor St., Saddle Brook, N.J. 07662 [359]

Illumination meter spans 1.2 to 1,200 foot-candles

Priced at $345, the model 615 illumination meter covers from 1.2 to 1,200 foot-candles at 0.02 foot-candle per division. The wide range is made possible by a battery-operated amplifier circuit whose power is pro-

vided by a 9-volt transistor battery that the company expects will last more than a year. There are seven ranges on the unit, in addition to a battery-check position and an internal lock that prevents the cover from closing unless the switch is in the off position. The portable instrument weighs less than 2 pounds.

Weston Instruments Inc., 614 Freylinghuysen Ave., Newark, N.J. 07114 [360]

Automatic Alarms, Inc., Youngstown, Ohio
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Lumenite Electric Co., 37 W. Van Buren St., Chicago, Ill.
O. B. McClintock Co., Minneapolis, Minn.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Worner Products Corp., 1019 W. Lake St., Chicago, Ill.

Amplifiers

AUDIO FREQUENCY AMPLIFIERS

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.
Audio Development Co., 2833 13th Ave., S. Minneapolis, Minn.
Ballantine Laboratories, Inc., Boonton, N. J.
Bogen Co., David, 663 Broadway, New York, N. Y. (See page 174.)
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Chicago Sound System Co., 2124 S. Michigan Blvd., Chicago, Ill.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Electrical Research Products, Inc., 76 Varick St., New York, N. Y.
Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
Gabel Mfg. Co., John, 1200 W. Lake St., Chicago, Ill.
Gates Companies, Quincy, Ill.
General Communication Products Co., Lexington Ave. at Vine, Hollywood, Cal.
General Radio Co., 30 State St., Cambridge, Mass.
Gibbs & Co., Thomas B., 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.)
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Jack Mfg. Co., Charles, 420 Lehigh St., Allentown, Pa.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
National Union Radio Corp., 15 Washington St., Newark, N. J.
National Co., 61 Sherman St., Malden, Mass.
National-Dobro Corp., 400 S. Peoria St., Chicago, Ill.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Cal.
Norwalk Transformer Corp., South Norwalk, Conn.
Operadio Mfg. Co., St. Charles, Ill.
Pacent Engineering Corp., 79 Madison Ave., 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. 17th St., New York, N. Y.
Rowe Industries, 3120 Monroe St., Toledo, Ohio
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Spokane Radio Co., 611 W. First Ave., Spokane, Wash.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Terminal Radio Corp., 85 Cortlandt St., New York, N. Y. (See page 176.)
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Vega Co., 155 Columbus Ave., Boston, Mass.
Webster Electric Co., Clark & DeKoven Aves., Racine, Wis.
Western Electric Co.—see Graybar Electric Co.

Analyzers

COLOR ANALYZERS

Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Electronic Products Co., St. Charles, Ill.
Ess Instrument Co., 30 Irving Pl., New York, N. Y.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Jarrell-Ash Co., 165 Newbury St., Boston, Mass.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Saxl Instrument Co., 42 Weybosset St., Providence, R. I.
Sheldon Electric Corp., 100 Fifth Ave., New York, N. Y.
United Cinephone Corp., Torrington, Conn.
Woermann-Schuchhardt, Inc., 17 W. 17th St., New York, N. Y.

SURFACE ANALYZERS

Brush Development Co., 3311 Perkins Ave., Cleveland, O. (See page 22.)
Physicists Research Co., 343 S. Main St., Ann Arbor, Mich.

Apparatus

GEOPHYSICAL APPARATUS

see also Geophones

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Geophysical Instrument Co., 1315 Half St., S.E., Washington, D. C.
Heiland Research Corp., Club Bldg., Denver, Colo.
Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Cal.

Books

TECHNICAL, ELECTRONICS and RADIO BOOKS

Blakiston Co., 1012 Walnut St., Philadelphia, Pa.
MacMillan Co., 60 Fifth Ave., New York, N. Y.
McGraw-Hill Book Co., 330 W. 42d St., New York, N. Y. (See page 180.)
Maedel Pub. House, 593 E. 38th St., Brooklyn, N. Y. (See page 157.)
Radio Technical Pub. Co., 45 Astor Pl., New York, N. Y.
Rider, John F., 404 Fourth Ave., New York, N. Y.
Ronald Press Co., 15 E. 26th St., New York, N. Y.
Van Nostrand Co., D., 250 Fourth Ave., New York, N. Y.
Wiley & Sons, John, 440 Fourth Ave., New York, N. Y.

Chimes

CHIMES and BELLS

Jack Mfg. Corp., Charles, 420 Lehigh St., Allentown, Pa.
Rangertone, Inc., 73 Winthrop St., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.

Colorimeters

PHOTO-ELECTRIC COLORIMETERS

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Coleman Electric Co., 310 Madison St., Maywood, Ill.
Electronic Products Co., St. Charles, Ill.
Emby Products Co., 1800 W. Pico Blvd., Los Angeles Cal.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Frober-Faybor Co., Chagrin Falls, Ohio
Jarrell-Ash Co., 165 Newbury St., Boston, Mass.
Klett Mfg. Co., 179 E. 87th St., New York, N. Y.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Saxl Instrument Co., 42 Weybosset St., Providence, R. I.
Scientific Glass Apparatus Co., Bloomfield, N. J.
United Cinephone Corp., Torrington, Conn.
Woermann-Schuchhardt, Inc., 17 W. 17th St., New York, N. Y.

Controls

ACIDITY and ALKALINITY CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

BLEACHING PROCESS CONTROLS

Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.

DOOR OPENER CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.

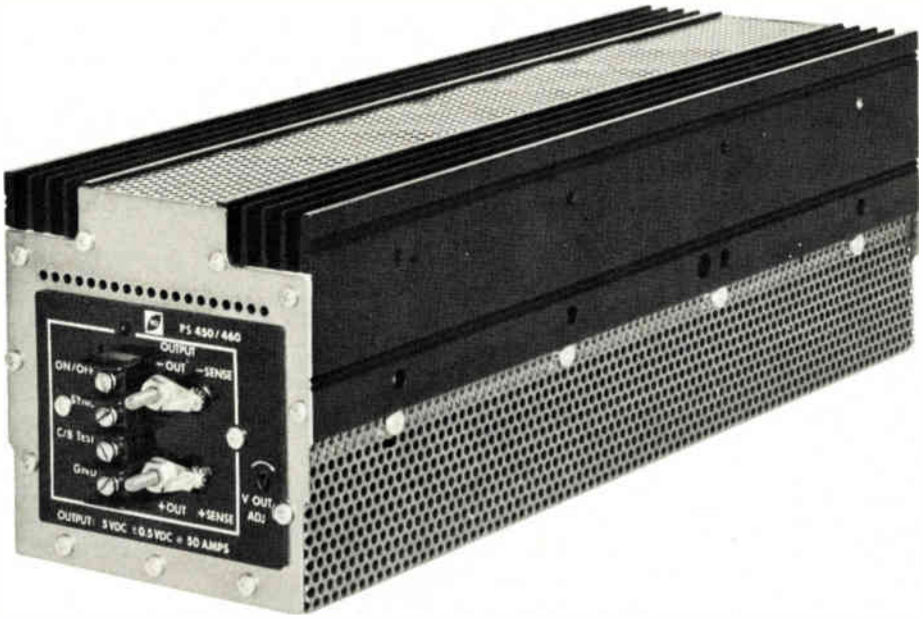
DRINKING FOUNTAIN CONTROLS

Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.

FURNACE CONTROLS

Brooke Engineering Co., 4517 Wayne Ave., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

now 50 amps from the leader in 20 kHz switching power supplies



RO introduces its newest high efficiency 20 kHz switching power converters; series 400. It comes in 5V at 50 amps or other single or dual voltages up to 300 watts. Efficiencies are 65% at the 5V level and reach 80% at higher voltages. Inputs can be AC or DC. 48 VDC input is standard for the telecommunications industry. Units are parallelable without limit by simply strapping the outputs together.

This series is the latest in a line of 20 kHz converters that RO has produced over 6 years of from 5 to 300 watts. Over 20,000 units delivered in this period make us the leader in "switchers."

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New products

Semiconductors

LEDs seek new markets

Fast infrared diodes are aimed at optical coupling, TV transmission, other uses

It may seen strange for still another company to enter the light-emitting-diode market, but International Rectifier is doing just that, and its new infrared-emitting units are matched to the characteristics of

fiber optics. IR expects the devices to be used in computer, industrial, and consumer products.

"We are already involved in very-high-speed switching of SCRs," says David Cooper, vice president of sales and engineering, "and it's natural for us to make couplers that trigger the SCRs. To make very-high-speed, very-high-voltage couplers, however, we need fast, high-output LEDs." Also, IR's Crydom division is a major supplier of solid-state relays that use optical couplers. And, Cooper says, his company is working with makers of cable-television equipment on TV-transmission devices.

IR's new LEDs are an order of magnitude faster than comparable devices on the market, and their spectral output more nearly matches the minimum-loss wavelength of fiber-optic cables, says Cooper. The diodes have rise times of 80 nanoseconds at 100 milliamperes (50 ns at lower levels), compared to typical speeds of 300 to 400 ns.

This makes them usable for transmitting such high-frequency signals as television, and the devices' peak spectral output of 882 nanometers closely matches the minimum-transmission-loss wavelength of fiber-optic cables, typically 800 to 850 nm. At this wavelength, the transmission loss is as low as 40 dB per kilometer over a widely used cable. Other devices have outputs that peak as high as 950 nm, where the loss is as much as 110 dB/km. Bandwidth is 10 MHz at 3 dB.

Cooper says that a proprietary production process has produced a gallium-arsenide compound that has new properties that provide these device characteristics. He says the high speed is partly a result of low capacitance (150 picofarads), but also because of transmission through the upper layers of the chip.

The devices can be operated from -65°C to 125°C. Power dissipation at the ambient temperature of 25°C is 180 milliwatts. Maximum forward current at ambient temperature of 25° is 100 mA. Peak pulse current is 10 A at a pulse width of 1 microsecond at 200 pulses per second. Reverse breakdown voltage is a minimum of 2 V, and the maximum forward voltage is 1.8 V. Total radiation-power output at 100 mA is typically 1.8 to 5.4 mW for different devices. Cooper also claims that the devices exhibit better stability than other devices, with lower output drop as the temperature rises.

The devices are offered in modified TO-46 and pill packages at prices of $1.30 to $3.68 in quantities of 100. Other cases will be offered in the future.

International Rectifier, Semiconductor Division, 233 Kansas St., El Segundo, Calif. 90245 [411]

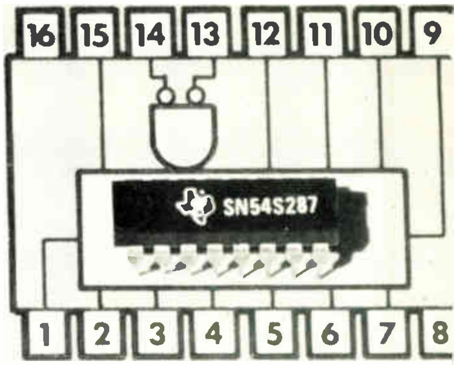
1,024-bit programable ROM offers fast access

As its first serious attempt in the fast-growing market for programable read-only memories, Texas Instruments has chosen to second-source the industry-standard 1,024-bit PROM, with a couple of extras for high performance at a low price.

The TI part uses a new fusing

technology "that's small, fuses very quickly, and gives us a very high rate of programability," says Richard L. Horton, market development manager for digital ICs at TI's Houston facility.

The metal fuse link, which is proprietary, is not nichrome or aluminum, Horton emphasizes, but "something that is innate in the Schottky process. We use it in all



our Schottky products."

Programability is factory-tested, says Horton: "We've added an extra bit to every word, and we fuse that internally to verify programability." In fusing, logic "highs" at selected locations in the 256-by-4-bit device are changed to permanent logic "lows." Links typically fuse in 1 millisecond.

The PROM, which comes in two series, designated the 54S and 74S, uses fully decoded pnp inputs to reduce input current requirements to less than −0.25 milliampere—about an eighth of a normalized load factor—and is fully TTL-compatible. It features full Schottky clamping for fast typical access times of 15 nanoseconds from enable and 40 ns from address. In addition, the PROM is available in a choice of output configurations: model 74S287 has three-state outputs for more new system designs, and the model 74S387 is an open-collector-output part.

Both 74S PROMs, in the 16-pin plastic dual in-line packages, are available from stock at $19.20 in quantities from 100 to 999. The military version, the 54S series, will be introduced later this year, and a

An offshore plant will reduce your electronics manufacturing costs.

On paper.

The competitive challenge of imports hasn't hit any market harder than electronics. An offshore plant with low labor rates seemed to offer a convincing way to regain the profitability edge. Until the plant was built and local realities set in. Restrictive labor regulations, stretched logistics, and unfamiliar conditions all tended to eat up those paper profits. It didn't really take a palace revolution to put you in the red.

Universal Instruments Corporation has quietly pioneered a different approach to help you combat the stacked deck of import price competition in electronics. We reasoned that if we could take the handwork out of electronic assembly, you could avoid the pitfalls of chasing cheap labor around the world to keep your manufacturing costs down.

Now, computer-controlled automated assembly systems developed and refined by Universal over the past 15 years are providing a better answer to imports—in markets as diverse as color television and seat belt interlock systems.

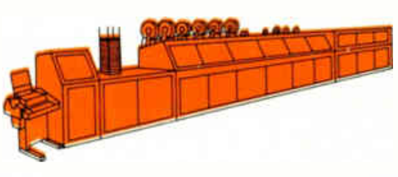
For example: a flexible complex of Universal sequencers and component insertion machines controlled by worker and supervisory computers adjusts rapidly to meet changes in production schedules at a major U.S. electronics manufacturer. To keep their plant competitive by turning out 85,000 circuit modules—enough for more than 10,000 color TV sets—per day.

For the new generation of automotive electronics, the Universal In-Line Assembly System can put together circuit boards for digital clocks, anti-skid controls, fuel injection and other devices faster and more economically than any other system. It can assemble approximately 1,260,000 boards per 10-month seven-hour single-shift production year. A production advance that enables electronics and auto makers to meet this high volume demand—profitably—at home.

Then there's the flexible new "Quadrasert" that handles circuit boards automatically, computer-controlled wire termination systems, and the "Multisert" system that inserts up to ten components at once. Plus emerging production technology developments from Universal to help make your present domestic production at least as cost-effective as past offshore production. Even in 1985, when U.S. manufacturers will need over one billion circuit boards.

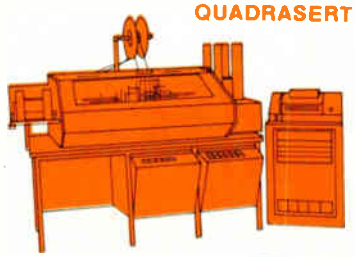
Because we know there's no way except better technology to keep all of us in the electronics business.

IN-LINE SYSTEM



The most cost-effective system available for high volume circuit board production.

QUADRASERT



Combining automated board handling with moving table insertion for added flexibility in high volume circuit board production.

EXPANDABLE SEQUENCER

Add-on flexibility from 20 to 95 stations permitting growth without production obsolescence in your component sequencing operation.

Write or call us today for complete technical literature and production specifications on these and other Universal systems—including a wide line of insertion machines, sequencers, and wire wrap systems—as well as information on our extensive contract facilities for electronic assembly.

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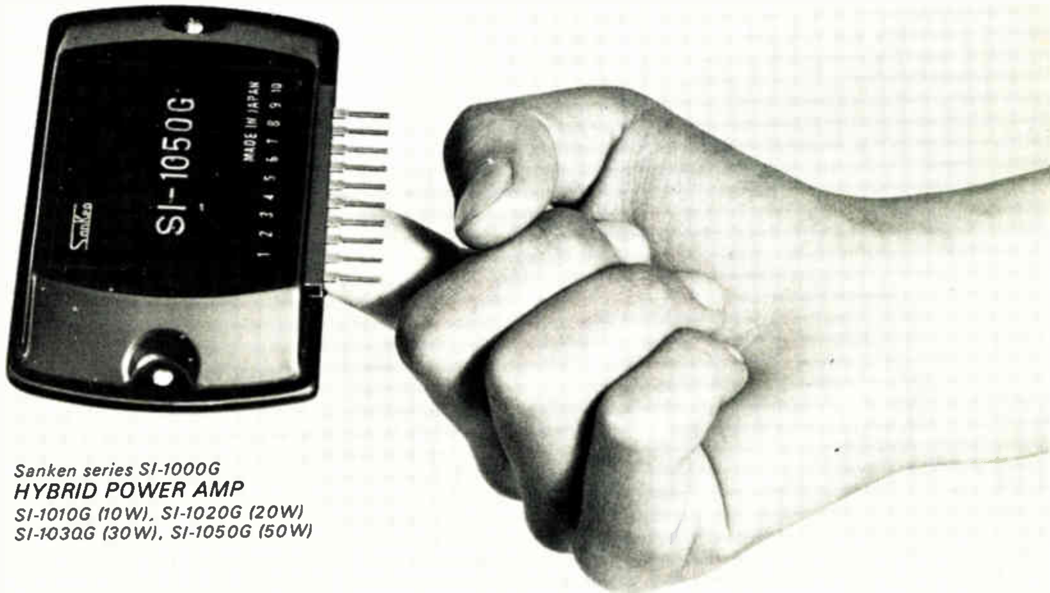
A 50W AUDIO AMP À LA SANKEN



Sanken series SI-1000G
HYBRID POWER AMP
SI-1010G (10W), SI-1020G (20W)
SI-1030G (30W), SI-1050G (50W)

Sanken self-contained hybrid power amp series streamlines Hi-Fi, stereo, musical instruments and public address equipment. The circuit employs high-reliability flip-chip transistors and passivated-chip power transistors with excellent secondary breakdown strength. Features quasi-complimentary class B output and operates from a single or split power supply. Built-in current limiting is provided for SI-1030G and SI-1050G.

CHARACTERISTICS	SI-1010G	SI-1020G	SI-1030G	SI-1050G
Maximum rms Power	10W	20W	30W	50W
Supply Voltage	34V or ±17V	46V or ±23V	54V or ±27V	66V or ±33V
Harmonic Distortion at Full Output	0.5% max.			
Input Voltage	0.30V typ.	0.42V typ.	0.52V typ.	0.70V typ.
Voltage Gain Full Feedback (P_O=1W)	30dB typ.			
Input Impedance	40,000 ohms typ.			
Output Impedance (P_O=1W)	0.2 ohm typ.			
Signal to Noise Ratio (Input Shorted)	90dB typ.			
Frequency Range (P_O=1W)	20Hz to 100kHz			
Power Bandwidth (−3dB)	20Hz to 20kHz			
Operating Temperature	−10°C to +70°C	−20°C to +80°C		
Storage Temperature	−25°C to +85°C	−30°C to +100°C		
At 25°C ambient, 1kHz, R_L=8 ohms				

Contact our representatives for more technical details.

Sanken ELECTRIC CO., LTD.

SANKEN ELECTRIC COMPANY, LTD.
1-22-8 Nishi-Ikebukuro, Toshima-ku, Tokyo, 171 Japan
Telex: 0272-2323 (SANKEN J) Cable: SANKELE TOK Phone: 986-6151

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Australia: Tristate Electronics Pty. Ltd., Mascot N.S.W. 2020 Phone: 669-2657

Brazil: Industria Eletronica Anritsu Ltda., Sao Paulo Phone: 35-6308

Canada: Len Finkler, Ltd., Ontario Phone: 630-9103

Denmark: Elmatok Ltd., Ullerslev Phone: 09 35 14 46

Finland: Ky L. I. Lucander Kb, Helsinki Phone: 574-750

France: Tradelec, Paris Phone: 533 00.40

F. R. Germany: Ernst Roederstein GmbH, Landshut Phone: 0871-3085

Israel: Bet K. D. M. Ltd., Tel-Aviv Phone: 53517, 56952

Italy: Metroelettronica S.A.S., Milan Phone: 546.26.41

Mexico: Tecnoceramica S.A., Mexico City Phone: 561-23-67

Netherlands: Metronix B.V., Harderwijk Phone: 03410-2486

New Zealand: David J. Reid (N.Z.) Ltd., Auckland Phone: 499-089

Norway: Therma Technical Agencies, Haslum Phone: 533322

Rep. of China: Development Enterprise Co., Ltd., Taipei Phone: 335412, 361001

South Africa: M.T.S. Desselss (1954) (Pty.) Ltd., Johannesburg Phone: 21-7671

Spain: Industesa, Barcelona Phone: 245 16 12

Sweden: Aug. Eklow AB Stockholm Phone: 230620

Switzerland: Dewald AG Zurich Phone: 051-451300

U.S.A.: Airpax Electronics Inc., Florida Phone: 305-587-1100

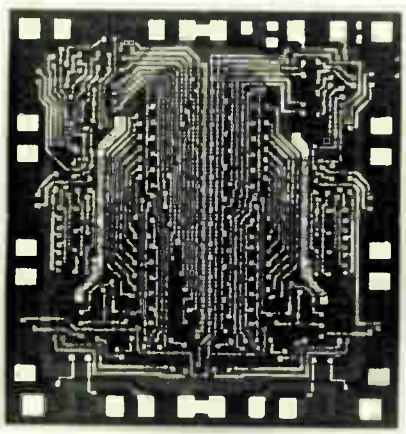
Circle 150 on reader service card

2,048-bit PROM using the same fusing technology will be announced by the company during the second half of the year.

Texas Instruments, Inquiry Answering Service, P.O. Box 5012, M/S 308, Dallas, Texas, 75222 [412]

Register file reads and writes at the same time

A 16-bit multiport register file, organized as 8 words by 2 bits, is able to read 4 bits and write 2 bits at the same time. Designated the model MC10143L, the random-access memory uses MECL-10,000 levels and has a complexity equivalent to 110 gates. Access time to any 4 bits is 10 nanoseconds. The device not only has the ability to access any two 2-bit words for read while writing a third word, but can perform two read operations and a write operation simultaneously. Write operations can also be made prior to, at the same time, or after read operations. ECL outputs are capable of driving transmission lines directly. Outputs can be wire-ORed together, or several register files can be combined on a bus line. Power dissipation is 610 milliwatts, and the unit is supplied in a 24-pin dual in-line package. Price is $29 in 100-lots.



Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. 85036 [413]

Power transistor switches at less than 100 ns

Suitable for industrial and military applications, the model 2N5189 power transistor is an npn device for use as a core or line driver in data-processing equipment. The unit is a double-diffused epitaxial device with an improved interdigitated geometry, and the structure provides low saturation voltages and high speed. The transistor can be used in any application requiring a collector current to 1 ampere with total switching speeds of less than 100 nanoseconds. Price for the basic device, rated at 35 volts, is 82 cents for 1 to 99 pieces and 60 cents for 100-lot quantities. A 100-volt version, called

the KP3540, is priced at $1.25 each for 1 to 99 pieces and 95 cents in quantities of 100. Production quantities are available in six weeks.
Kertron Inc., 7516 Central Industrial Dr., Riviera Beach, Fla. 33404 [414]

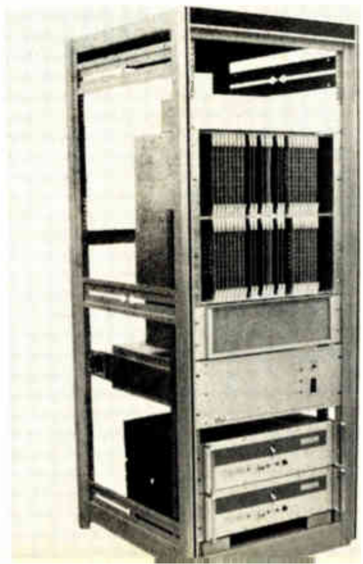
Power transistors deliver to 100-A peak current

Two series of industrial power transistors offer peak currents of either 70 amperes or 100 amperes. Each of the npn devices is available in a TO-3 or TO-63 can; both are constructed with a single planar chip. Typical applications are in power supplies, motor drivers, and as SCR replacements. The devices, rated at 70 amperes, are priced at $35 each in lots of 100.

Solitron Devices Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. 33404 [416]

Semiconductor memory has 1.28-gigabit/s data rate

Consisting of two independent bipolar memories, each 8,000 words by 16 bits, a semiconductor memory offers a 1.28-gigabit-per-second data



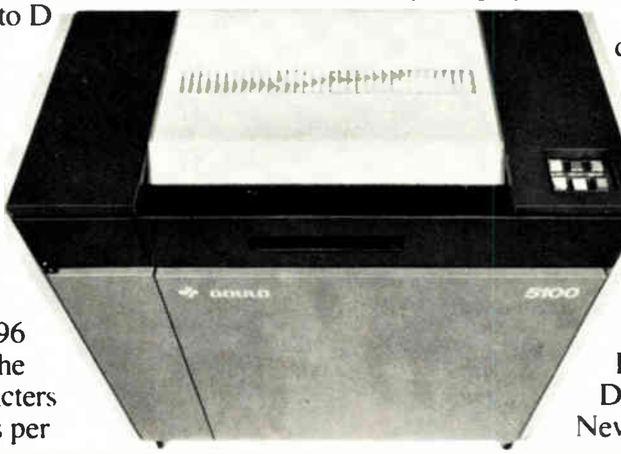
Cramped for space in your production of computer-generated graphics? Stretch out on the king-size 22-inch bed of the new Gould 5100. In fact, the Gould 5100 gives you the widest plotting capability at the fastest speed of any electrostatic unit. With a price/performance ratio superior to every other printer/plotter on the market.

The Gould 5100 has been specifically designed for scientific and engineering work where speed is essential, and where the ability to print out such materials as seismographic charts and A to D size drawings is required.

And it's absolutely loaded with features. 22-inch wide roll paper. Up to 3 inches per second in graphics mode. Resolution of 100 dots per inch horizontally and vertically. Superior density of plotter output.

What's more, the optional 96 ASCII character set allows the Gould 5100 to print 264 characters across the page at 1200 lines per minute. Direct on-line interfaces are available for IBM System/360 and IBM System/370 computers as well as for most mini-computers.

And Gould software is the most efficient and flexible available anywhere. In addition to the basic software package that emulates the widely accepted Calcomp graphics package, specialized engineering, drafting, scientific and business graphic software enables your computer to efficiently handle the most sophisticated computer graphics.



Built with traditional Gould quality, and backed by Gould's own reliable service, the Gould 5100 will greatly expand the efficiency and throughput of your production of computer-generated graphics. Let our Pete Highberg or Bill Koepf prove it to your satisfaction. Get in touch with them now at Gould Inc., Dept. E 3, Data Systems Division, 20 Ossipee Road, Newton, Massachusetts 02164.

The new Gould 5100 printer/plotter. It lets you work out on the biggest bed in the business.

DATA SYSTEMS DIVISION

GOULD

rate. One memory can be read while the other is loaded or vice versa. An alternate mode is to operate both memories in parallel, forming a single 16,000-word-by-1-bit memory system.

Intel Memory Systems division, 345 Middlefield Rd., Mountain View, Calif. 94041 [415]

Two-wire transmitter is aimed at signal transmission

Designed for signal-transmission applications in process control, instrumentation, and data-acquisition systems, the LH0045 two-wire transmitter is a linear integrated circuit that accepts a voltage signal from a sensor, converts it into a current, and transmits the current down a twisted pair to a receiver. The same twisted pair provides the device with supply voltage, making the unit desirable for remote sensing applications. The LH0045 is intended for use with various sensors, and so it can link with thermocouples, strain gauges, and thermistors. Price in 100-lots is either $18.50 or $21.50, depending on packaging.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [417]

Circuit links MOS and TTL data buses

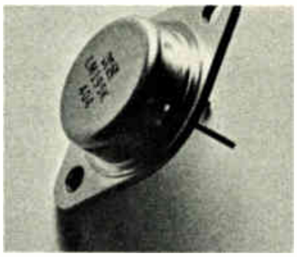
A dual, bidirectional bus-interchange element interfaces MOS and TTL data buses. Called the model 8T30, the unit can exchange data in half-duplex transmission mode from a party-line TTL or DTL bus to an MOS, TTL, or DTL transceiver port. Each half of the 8T30 interchange element is conditioned by common receive and transmit-enable controls for six modes of operation. Both sets of transmit-output and receive-input pins act the same way—typically routing data from the party line to transceiver ports. The price of the model 8T30 is $1.88 each in quantities of 100.

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086

BREAKTHROUGHS. $1.50 AND UP.

(1) The universe's very first and only transistor that's an IC.

Old style power transistors join the buggy whip because LM 195/295/395 are blow out proof. (just $4.95 for the LM 395—all prices in batches of 100 plus.)

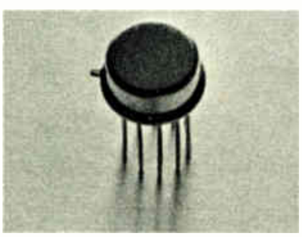


The first transistors that are blow out proof and short circuit proof.

And if that doesn't blow your mind, how 'bout...

(2) A proprietary timer in which the output is short circuit proof.

The output state of LM 322 can be inverted, eliminating the need for external circuits. Another thing that should have an effect on you is that inputs on the trigger terminal after it's triggered have no effect on the timer output. ($1.50*)

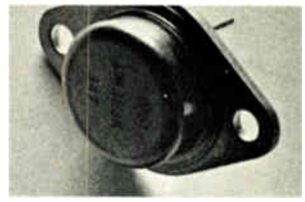


The first timers with a short circuit proof output.

(3) A 3-amp IC regulator.

Another first.

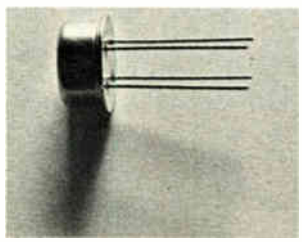
The number is LM 323, and it's a logical extension of the self-protected 3 terminal regulator field which guess-who has pioneered. ($6.75*)



The first 3-amp positive IC regulator.

(4) An IC temperature transducer.

Linear sensor, amplifier and a stable voltage reference all on a single monolithic IC chip.



The first temperature transducer on a chip.

And they read out in real temperature (degrees Kelvin) instead of ohms. So when someone asks you how hot the whatchamacallit is you don't have to tell them 14 ohms. ($13.35*)

Pens ready?

LX5600AH/LX5600H and LX5700AH/LH5700H.

Buy 'em quick 'cause we can use the money. Or, for the stubborn among you, details are available from National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, California 95051.

*In batches of 100 plus.

NATIONAL

National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051; Scottsdale, Ariz. (602) 945-8473; Mountain View, Calif. (415) 961-4740; Sherman Oaks, Calif. (213) 783-8272; Tustin, Calif. (714) 832-8113; Miami, Fla. (305) 446-8309; Chicago, Ill. (312) 693-2660; Indianapolis, Ind. (317) 255-5822; Lenexa, Kan. (816) 358-8102; Glen Burnie, Md. (301) 760-5220; Burlington, Mass. (617) 273-1350; Farmington, Mich. (313) 477-0400; Minneapolis, Minn. (612) 888-4666; Englewood Cliffs, N.J. (201) 871-4410; Syracuse, N.Y. (315) 455-5858; Dayton, Ohio (513) 434-0097; Dallas, Tex. (214) 233-6801.

HEAT TREATING CONTROLS

Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edingburgh Ave., Los Angeles, Cal.
General Electric Co., Schenectady, N. Y.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

LIGHTING CONTROLS

Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
General Control Co., 243 Broadway, Cambridge, Mass. (See page 171.)
General Electric Co., Schenectady, N. Y.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

MOTOR or GENERATOR CONTROLS

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
Andrews & Perillo, Inc., 3930 Crescent St., Long Island City, N. Y.
Burlington Instrument Corp., Burlington, Iowa
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Control Co., 243 Broadway, Cambridge, Mass. (See page 171.)
General Electric Co., Schenectady, N. Y.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.

PACKAGE WRAPPING CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PAPER TRIMMING and SLITTING CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PHOTOGRAPHIC PROCESS CONTROLS

General Control Co., 243 Broadway, Cambridge, Mass.
Industrial Timer Corp., 117 Edison Pl., Newark, N. J.
Intercontinental Marketing Corp., 95 Madison Ave., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

PRINTING REGISTER CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Emby Products Co., 1800 W. Pico Blvd., Los Angeles, Cal.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

REMOTE CONTROLS

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Electric Indicator Corp., 21 Parker Ave., Stamford, Conn.
Electrimatic Corp., 2100 Indiana Ave., Chicago, Ill.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Elsbert Mfg. Co., 910 W. Lake St., Chicago, Ill.
Foxboro Co, Neponset Ave., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Hanlon-Waters, Inc., Tulsa, Okla.
Hart Mfg. Co., 11 Bartholomew Ave., Hartford, Conn.
Hays Corp., 925 Eighth Ave., Michigan City, Ind.
H-B Instrument Co., 2520 N. Broad St., Philadelphia, Pa.
Illinois Engineering Co., Racine Ave. & 20th Pl., Chicago, Ill.
International Filter Co., 325 25th Pl., Chicago, Ill.
Kollsman Instrument Div., Square D Co., 8008 45th Ave., Elmhurst, N. Y.
Kurman Electric Co., 241 Lafayette St., New York, N. Y.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Meissner Mfg. Co., Mt. Carmel, Ill.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Photobell Corp., 116 Nassau St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago, Ill.
Scientific Instrument Co., 1441 Walnut St., Berkeley, Cal.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Taylor Instrument Companies, 100 Ames St., Rochester, N. Y.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.
Zenith Electric Co., 835 S. Wabash St., Chicago, Ill.

TEMPERATURE CONTROLS

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
General Electric Co., Schenectady, N. Y.
Illinois Testing Laboratories, 420 N. La Salle St., Chicago, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Spencer Thermostat Co., 1404 Forest St., Attleboro, Mass. (See page 111.)
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

THICKNESS CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Magnetic Gauge Co., 60 E. Bartges St., Akron, Ohio
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.

TRAFFIC CONTROLS

American Gas Accumulator Co., Elizabeth, N. J.
Eagle Signal Corp., Moline, Ill.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

VIBRATION CONTROLS

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

WEFT STRAIGHTENING CONTROLS

General Electric Co., Schenectady, N. Y.

WELDING CONTROLS

see Timers

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Counters

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Clare Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Photobell Corp., 116 Nassau St., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

Detectors

PINHOLE DETECTORS

General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Devices

GRADING DEVICES

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
General Control Co., 243 Broadway, Cambridge, Mass.

KEYING DEVICES

Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.

MACHINE SAFETY DEVICES

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
General Control Co., 243 Broadway, Cambridge, Mass.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

WEIGHING DEVICES

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
General Control Co., 243 Broadway, Cambridge, Mass.
Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

Diathermy

DIATHERMY APPARATUS

American Systocope Makers, Inc., 1241 Lafayette Ave., Bronx, N. Y.
Battle Creek Equipment Co., 32 N. Washington Ave., Battle Creek, Mich.
Birtcher Corp., 5087 Huntington Drive, N., Los Angeles, Cal.
Burdick Corp., Milton, Wis.

New products

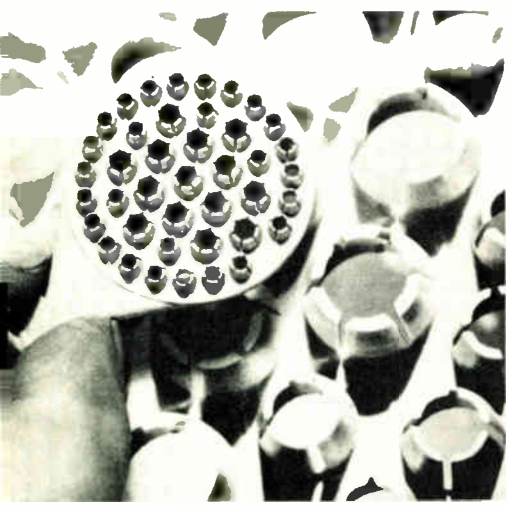
Packaging & production

Thermoplastic is easy to mold

New compound can be processed with standard injection-molding equipment

Among major claims for a new thermoplastic molding compound developed by the Carborundum Co. is ease of processing. The copolyester, designated Ekkcel I-2000, is said to mold well in standard injection-molding equipment, in addition to possessing desirable physical and electrical properties. What's more, the moisture absorption of the molded part is very low.

Ekkcel I-2000 can be processed in



injection-molding equipment that is capable of barrel temperatures of 725°F to 750°F and of injection pressure ranging from 6,000 to 8,000 pounds per square inch. For best properties, a hot mold—at 350°F to 400°F—is recommended, although, in some instances, an ambient-temperature mold may be used.

The molding compound is said to be well suited for manufacture of such connector components as the molded insert shown above. Because Ekkcel I-2000 has low friction and good wear properties, Carborundum says that it is suitable for motor bearings and for a wide range of other applications requiring high strength at elevated temperatures.

The molded material retains its physical and electrical properties at temperatures in excess of 500°F, the company says. Moisture absorption is less than 0.025% after 24 hours in boiling water. The material is nonburning, having a limiting oxygen of 37, and it meets Underwriters Laboratories specification VE-O. It is also being tested for use in manufacture of printed-circuit boards.

Sample quantities of Ekkcel I-2000 is priced at $24 per pound.

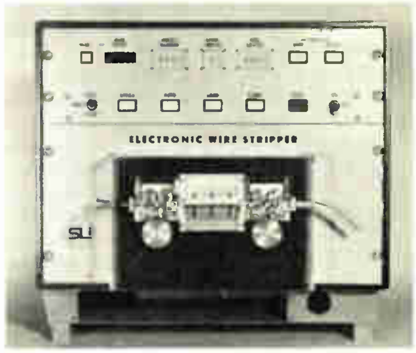
The Carborundum Co., P.O. Box 337, Niagara Falls, N.Y. 14302 [391]

Automatic wire strippers use digital controls

Automatic wire strippers are generally operated by compressed air, but not Standard Logic's new EWS-6K. It uses solid-state digital control and a feed/cut/strip mechanism operated by precision stepping motors. The machine operates at 6,000 wires per hour without the noise generally associated with pneumatic strippers. The electronic controls and simplified electromechanical system should also mean reduced wear and better reliability, predicts Bruce L. Billington, vice president of marketing.

Cut- and strip-length of the wires is determined by panel thumbwheel switches, rather than the usual internal analog adjustments. The wire length can be 2.5 to 99.9 inches, selectable in 0.1-in. increments. The strip can be as long as 1.5 in., also in 0.1-in. increments, excluding 0.1 and 0.2 in., which aren't generally required. Wires of 24 to 30 AWG sizes can be used; other sizes are optional. The unit operates at a maximum stripping rate of 6,000 2.5-in. wires per hour, and 4,000 6-in. wires per hour.

Besides the digital selection of wire and strip length, a front-panel selector presets the number of wires to be stripped. The operation stops automatically after the selected number of wires have been stripped,



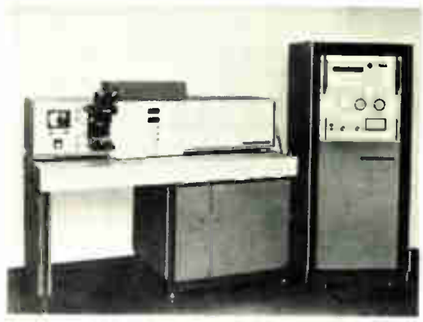
and a digital readout displays the number of wires stripped at any point. Three operating speeds are provided, and fault indicators are included for wire feed and blade cycle. The blades are made of heat-treated tool steel.

The EWS-6K, 20 in. wide by 18 in. high by 20 in. deep, weighs 105 pounds, and operates on 90 to 250 volts at 50 or 60 hertz. Price is $3,995, and delivery time is six weeks.

Standard Logic Inc., 2215 S. Standard Ave., Santa Ana, Calif. 92707 [401]

Ceramic scriber handles substrates to 4½ inches

The model KSS4 laser scribing system handles ceramic substrates measuring up to 4½ inches square. The machine is specially designed for large runs and features oversized chucks and a prealignment station,



which allows the operator to align one substrate while the other is being scribed. Other features include an automatic loading stage with a longer travel distance, closed-circuit TV for verification of scribing

accuracy, a split-field microscope, and optional back-side scribing capability.
Korad Division, Hadron Inc., 2520 Colorado Ave., Santa Monica, Calif. 90404 [393]

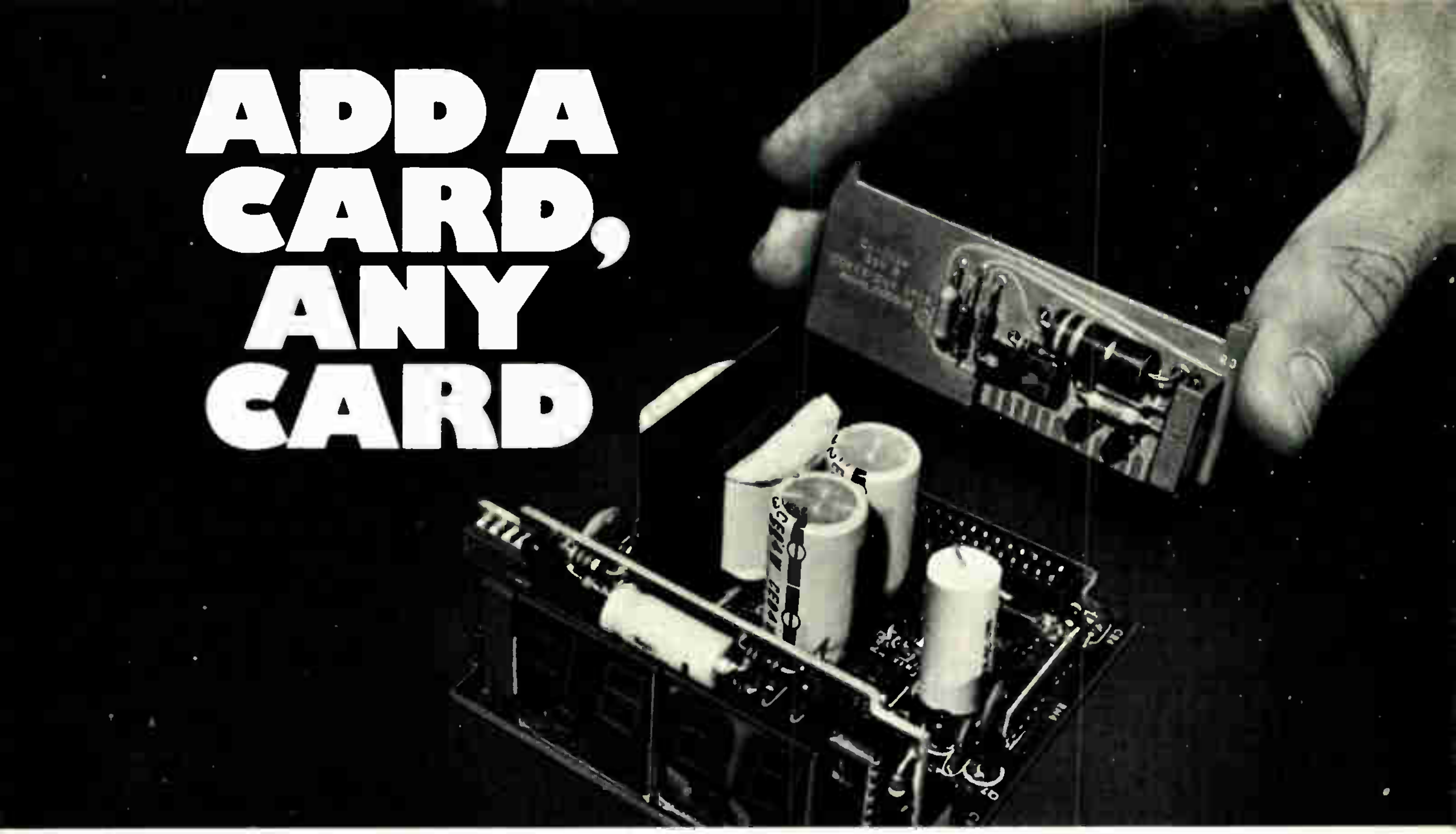
Laboratory furnace has 0 to 2,000°F range

For laboratory heat-treatment applications, the model Mark 16 laboratory furnace offers temperature control within ±1% over the range from 0 to 2,000°F. The heating element is made out of a chrome-

nickel-aluminum alloy. There are two heating chambers available, one measuring 4 by 4 by 10 inches, and the other, 8 by 4 by 8 in. The unit is transistorized, and the transistors are grouped into modules for easy repair.
The J.M. Ney Co., Bloomfield, Conn. 06002 [394]

Stereomicroscope has wafer-illumination attachment

The model M7 zoom stereomicroscope is available as a three-dimensional scope with an attachment camera, 35mm and Polaroid backs. Available as an accessory is a wafer-illumination device, which provides vertical light for characteristic color effects on semiconductor devices. The unit itself has a depth-of-field adjustment at any given power, and powers range from 3× to 124×. Price for the stereomicroscope alone



The first DPM that transforms into your own product by simply plugging in a P.C. card.

AN2553/AN2533 DESIGN SPECIFICATIONS

ANALOG INPUT	
Configuration:	Bipolar balanced symmetrical differential inputs
Dynamic Input Impedance:	1000 megohms nom
Common Mode Rejection Ratio:	80 dB standard, up to 160 dB optional
ACCURACY/STABILITY	
Accuracy:	0.05% of reading ±1 count
Range Tempco:	35 ppm of reading
CONVERSION TECHNIQUE	Dual-slope integration
DISPLAY	.55″ 7 seg. Sperry or .5″ L.E.D.
DIGITAL SIGNALS	
Logic Levels (all inputs and outputs):	External Blanking, Hold, Overload, Clock, Latch, Carry, EOC, Polarity
UNIVERSAL POWER INPUTS:	100, 117, 220, and 240 VAC RMS ±10% 49 to 63Hz @ 2W
Operating Temperature:	−10°C to +60°C
Dimensions:	DIN-STANDARD, 96mm bezel width x 48mm bezel height, 95.4mm max depth

NOTE Model AN2553 offers additional capabilities

$89.00 Base Price AN2533 quantity 100

- ☐ Universally powered
- ☐ True differential inputs
- ☐ Low power consumption
- ☐ DIN Int'l Std. case size
- ☐ Surprisingly low cost
- ☐ Bright self-illuminating display
- ☐ High reliability

Build any required circuit on the uncommitted analog interface card we furnish. Then just plug it into the special powered signal interface connector in our AN2553 3½-digit DPM. It's that easy to incorporate the value-added options that make your product more profitable. ..or specify application requirements, and we'll build them in before shipment.

Either way, you can get interface and signal conditioning flexibility never available before—including linearized thermocouple cold-junction compensation, load cell transducer excitation, auto ranging, current shunts, active multiple filtering–virtually any functional add-on, in fact, that you need. And, because the circuit card fits right in the internationally accepted DIN standard package your system or instrument is simplified and much more economical and there's less to debug.

We've put in power and space for an optional digital circuit card, too. So you can add isolated and buffered parallel BCD output, linearization, and set point control . . . go all the way and expand the basic DPM up to the subsystem level—at the lowest cost.

Don't need all the flexibility? Order the even more economical, general-purpose, basic AN2533. Fill *all* your 3½ digit DPM needs with the exceptionally high quality and reliability ensured by premium-components, worst-case design techniques, low parts count, and the cool-running generously derated operation that has made Analogic the number one supplier of OEM digital panel instrumentation in the whole world.

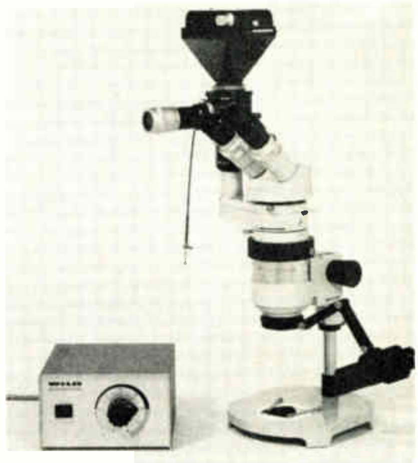
Write for more information: Analogic, Audubon Rd., Wakefield, Mass. 01880; phone (617) 246-0300.

Northeast, 617-235-2330, 203-966-2580, 315-466-0220, 201-652-7055, 212-947-0379
Mid Atlantic, 215-272-1444, 215-687-3535, 703-790-5666, 301-252-8494
Midwest, 314-895-4100, 913-362-0919, 216-267-0445, 513-434-7500, 313-892-2500, 412-892-2953, 312-283-0713, 414-476-1500, 317-844-0114
South, 713-785-0581, 214-620-1551, 305-894-4401, 919-227-3639, 205-534-9771, 305-773-3411, 813-867-7820
West, 303-744-3301, 505-523-0601, 602-946-4215, 505-292-1212, 714-540-7160, 415-398-2211, 206-762-7664, 503-643-5754,
Canada, 613-836-4411, 604-688-2619, 416-499-5544, 514-636-0525, 902-434-3402

ANALOGIC®

. . . The Digitizers

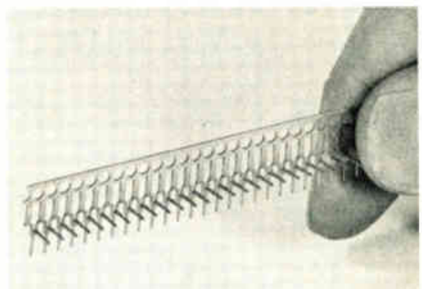
Circle 161 on reader service card



is below $2,700, the company says.
Wild Heerbrugg Instruments Inc., Farmingdale, N.Y. 11735 [395]

Right-angle contact strip eliminates plastic housing

A TS right-angle contact strip is designed for connecting component or daughter boards to printed-circuit-board backplanes. The contact strip is simply reflow-soldered to the



backplane, and the salvage strip is removed—a molded plastic housing is not required. The TS strips are made of brass and preplated tin and are supplied in varying strip lengths on 0.100-inch centers. Applications are in computers and peripherals.
Burndy Corp., Norwalk, Conn. 06582 [396]

IC socket is made for 36-lead LSI devices

An integrated-circuit socket designed for use with 36-lead LSI devices has low insertion force and low

The first name in sweep generators is also no. 1 in price/performance value.

Telonic Sweep Generators have a lot more built into them than just components. For example — more experience and application know-how than you'll find in any instrument; operating features we've incorporated from talking to hundreds of users; dependability based on designs that are field-proven in thousands of locations. Today, Telonic sweepers give you a lot more than just specs. They give you maximum instrument for your investment.

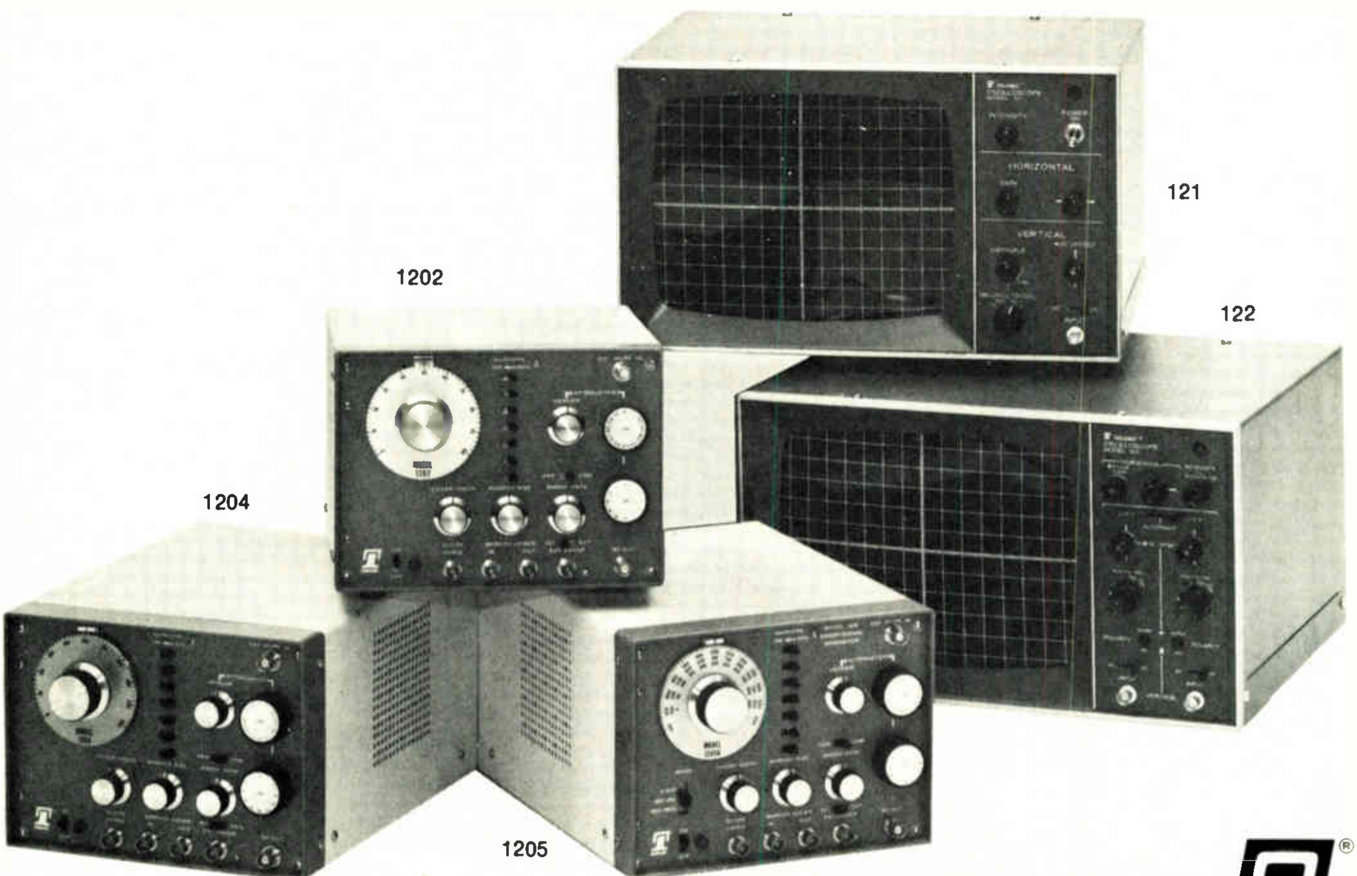
SWEEP GENERATORS

	Model 1202	Model 1204	Model 1205
Frequency (MHz)	.1-100	1-500	1-1500
Sweep Width (MHz)	.1-100	.2-500	.2-600
Output (dBm)	+13	+10	+7
Flatness (dB)	±.25	±.25	±.50
Linearity (%)	2	1	1
Markers	Single and Harmonic		
Circuits	Solid State/Modular		
Price	895	1095	1395

DISPLAY OSCILLOSCOPES

	Model 121	Model 122
Modes	Single Trace	Dual Trace
CRT	11" Diagonal	
V Bandwidth (kHz)	15	
H Bandwidth (kHz)	1	
V Sensitivity/div.	1, 10, 100 mv, 1v	
H Sensitivity/div.	100 mv	
Input Imped.	10 K ohms	
Price	495	695

Who was it that said, "investigate before you invest"? We have a new 60-page catalog on sweepers, oscilloscopes, and detectors. We would like you to investigate it, it's free.



TELONIC INDUSTRIES, INC.
21282 Laguna Canyon Road • Laguna Beach, Calif. 92652
Tel: 714 494-9401 • TWX: 910 596-1320

contact resistance. This is achieved by the use of a hinged cover that clamps over the IC after it has been placed in position. The cover, when fitted, applies side pressure to the contacts, forcing them against the legs of the IC, giving a contact resistance of 10 milliohms. Another benefit is that circuits can be inserted and withdrawn from the socket at high speeds without damage to the leads. Price is $3.40 in small quantities and $2.40 for 500 pieces.
Jermyn, 712 Montgomery St., San Francisco, Calif. 9411 [397]

Card-edge connectors provide versatility

Four new card-edge connectors, part of the Scotchflex series, are designed to provide versatility of design to the engineer. The connectors are now available with 20, 26, 34, or 40 contacts, in addition to the previously offered 50 contacts. The double-sided devices can be used with circuit boards ranging in thickness from 0.054 to 0.071 inch. Contacts are spaced on 0.100-inch centers and mate with Scotchflex cables with conductors on 0.050-inch centers.
3M Co., Box 33600, St. Paul, Minn. 55133 [398]

Strip sockets offer 8.3-milliohms resistance

Three strip sockets with four, nine and 12 pins are printed-circuit-type units providing an insulation resistance of 1 × 10^6 megohms minimum. Contact resistance is initially 8.3 milliohms, rising to 10 milliohms after 100 insertions. Breakdown voltage between adjacent contacts is 1,150 volts rms. Areas of application include 8-, 18-, and 24-pin DIPs, resistor networks, analog-to-digital and digital-to-analog converters, optical couplers, and display systems. Delivery of the strip sockets is from stock.
Jolo Industries Inc., 11861 Cardinal Circle, Garden Grove, Calif. 92643 [399]

de Forest Laboratories, Lee, 5106 Wilshire Blvd., Los Angeles, Cal.
Ecco High Frequency Corp., 120 W. 20th St., New York, N. Y.
Fischer & Co., H. G., 2323 Wabansia Ave., Chicago, Ill.
Fischer Corp., 673 Ivy St., Glendale, Cal.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Hanovia Chemical & Mfg. Co., N. J. R. R. Ave. & Chestnut St., Newark, N. J.
Herz-Lasker Corp., 17 W. 60th St., New York, N. Y.
High Tension Corp., 118 W. 22d St., New York, N. Y.
Lektra Laboratories, Inc., 30 E. Tenth St., New York, N. Y.
Lepel High Frequency Laboratories, Inc., 39 W. 60th St., New York, N. Y.
Majestic Surgical Instrument Co., 2608 N. Cicero Ave., Chicago, Ill.
McIntosh Electrical Corp., 223 N. California Ave., Chicago, Ill.
Mueller & Co., V., 408 S. Honore St., Chicago, Ill.
Peerless Laboratories, Inc., 115 E. 23d St., New York, N. Y.
Rose Mfg. Co., E. J., 727 E. Gage Ave., Los Angeles, Cal.
Sharp & Smith, Hospital Div., A. S. Aloe Co., 1813 Olive St., St. Louis, Mo.

Electrocardiographs

Beck-Lee Corp., 630 W. Jackson Blvd., Chicago, Ill.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Electro-Medical Laboratory, Inc., Holliston, Mass.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Herz-Lasker Corp., 17 W. 60th St., New York, N. Y.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
Mueller & Co., V., 408 S. Honore St., Chicago.
Sanborn Co., 39 Osborn St., Cambridge, Mass.

Equipment

DRAFTING ROOM EQUIPMENT

All-Steel-Equip Co., 641 John St., Aurora, Ill.
Alteneder Co., Theo., 1217 Spring Garden St., Philadelphia, Pa.
Arkwright Finishing Co., Turks Head Bldg., Providence, R. I.
Brown & Sharpe Mfg. Co., 235 Promenade St., Providence, R. I.
Bruning Co., Charles, 4700 Montrose Ave., Chicago, Ill.
Calibron Products, Inc., West Orange, N. J.
Cardinell Corp., Montclair, N. J.
Carter's Ink Co., Kendall Square, Boston, Mass.
Coxhead Corp., Ralph C., 333 Sixth Ave., New York, N. Y.
Dietzgen Co., Eugene, 2425 Sheffield Ave., Chicago, Ill.
Dixon Crucible Co., Joseph, Jersey City, N. J. (See page 171.)
Drafto Corp., Pressler Ave., Cochranton, Pa.
Dremel Mfg. Co., 14th & Clark Sts., Racine, Wis.
Eagle Pencil Co., 703 13th St., New York, N. Y.
Emmert Mfg. Co., Waynesboro, Pa.
Eraser Co., 936 University Block, Syracuse, N. Y.
Faber Co., A. W., 41 Dickerson St., Newark, N. J. (See page 29.)
Faber Pencil Co., Eberhard, 37 Greenpoint Ave., Brooklyn, N. Y.
Hamilton Mfg. Co., Two Rivers, Wis.
Higgins Ink Co., 271 Ninth St., Brooklyn, N. Y.
Holliston Mills, Inc., Norwood, Mass.
Hunt & Son Co., C. B., Salem, Ohio
Keuffel & Esser Co., 303 Adams St., Hoboken, N. J. (See page 3.)
Koh-I-Noor Pencil Co., 373 Fourth Ave., New York, N. Y.
Lyon Metal Products, Inc., 1933 Montgomery St., Aurora, Ill.
Ozalid Products Div., General Aniline & Film Corp., 25 Ansco Rd., Johnson City, N. Y.
Paragon-Revolute Corp., 77 South Ave., Rochester, N. Y.
Pease Co., C. F., 2679 W. Irving Park Rd., Chicago, Ill.
Post Co., Frederick, 3650 Avondale Ave., Chicago, Ill.
Shaw Blue Print Machine Co., 11 Campbell St., Newark, N. J.
Speidel & Co., Chas. W., 112 N. 12th St., Philadelphia, Pa.
Stafford, Inc., S. S., 607 Washington St., New York, N. Y.
Starrett Co., L. S., 165 Crescent St., Athol, Mass.
United States Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Universal Drafting Machine Co., 1426 W. Third St., Cleveland, Ohio
Weber Co., F., 1220 Buttonwood St., Philadelphia, Pa.
White Dental Mfg. Co., S. S., 10 E. 40th St., New York, N. Y.
Wickes Bros., 512 N. Water St., Saginaw, Mich.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.
Wood-Regan Instrument Co., Nutley, N. J.
Wright, Inc., L. G., 6205 Carnegie Ave., Cleveland, Ohio

Gases

GASES, RARE

Linde Air Products Co., 304 E. 42nd St., New York, N. Y. (See page 175.)

Indicators

POSITION INDICATORS

Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Bendix Marine Products Div., Bendix Aviation Corp., 754 Lexington Ave., Brooklyn, N. Y.
Boston Auto Gage Co., 70 West St., Pittsfield, Mass.
Electric Indicator Corp., 21 Parket Ave., Stamford, Conn.
Electric Speed Indicator Co., 16313 Laverne Ave., Lakewood Ohio
Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Pioneer Instrument Div. of Bendix Aviation Corp., Bendix, N. J.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PRESSURE INDICATORS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Commercial Engineering Laboratories, 4612 Woodward Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
RCA Mfg. Co., Camden, N. J.

SMOKE DENSITY INDICATORS and RECORDERS

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brooke Engineering Co., 4517 Wayne Ave., Philadelphia, Pa.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Ess Instrument Co., 30 Irving Pl., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Television Corp., 70 Brookline Ave., Boston, Mass.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Lumenite Electric Co., 37 W. Van Buren St., Chicago, Ill.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
McNeil Engineering Equipment Co., T. W., 4057 W. Van Buren St., Chicago, Ill.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Preferred Utilities Mfg. Corp., 31 W. 60th St., New York, N. Y.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Intercommunicators

American Television Corp., 130 W. 56th St., New York, N. Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Audio Development Co., 2833 13th Ave., S. Minneapolis, Minn.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Bank's Mfg. Co., 1105 W. Lawrence Ave., Chicago, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bendix Aviation, Ltd., North Hollywood, Cal.
Bogen Co., David, 663 Broadway, New York, N. Y. (See page 174.)
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Cal.
Communication Equipment & Engrg. Co., 504 N. Parkside Ave., Chicago, Ill.
Connecticut Telephone & Electric Corp., 70 Britannia St., Meriden, Conn. (See page 103.)
De Wald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Electronic Products Co., St. Charles, Ill.
Gibbs & Co., Thomas B., 900 W. Lake St., Chicago, Ill.
Intercall Systems, Inc., Fifth & Norwood, Dayton, Ohio
Karadio Corp., 2233 University Ave., St. Paul, Minn.
Lake Mfg. Co., 2323 Chestnut St., Oakland, Cal.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
Newcomb Audio Products Co., 2815 S. Hills St., Los Angeles, Cal.
Operadio Mfg. Co., St. Charles, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio Recepter Co., 251 W. 19th St., New York, N. Y.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17th St., New York, N. Y.
Select-O-Phone Co., 1012 Eddy St., Providence, R. I.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Webster Electric Co., Clark & De Koven Aves., Racine, Wis.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Irons

ELECTRIC SOLDERING IRONS

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
Adrola Corp., Adrola Bldg., Port Jefferson, N. Y.
All Rite Co., Morgan & First Sts., Rushville, Ind.
American Electrical Heater Co., 6110 Cass Ave., Detroit, Mich.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Cole Radio Works, 86 Westville Ave., Caldwell, N. J.
Dominion Electrical Mfg. Co., 22 Elm St., Mansfield, Ohio
Drake Electric Works, 3656 Lincoln Ave., Chicago, Ill.
Dual Remote Control Co., 31776 W. Warren St., Wayne, Mich.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Electric Soldering Iron Co., 205 W. Elm St., Deep River, Conn.
General Electric Co., Schenectady, N. Y.
Hexacon Electric Appliance Corp., 163 W. Clay Ave., Roselle Park, N. J.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Jackson Electro Corp., 625 Broadway, New York, N. Y.
Kay Co., J. H., 121 Second St., San Francisco, Cal.
Landers, Frary & Clark, 47 Center St., New Britain, Conn.
Lenk Mfg. Co., Newton Lower Falls, Mass.

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Circle 166 on reader service card

Communications

Tone encoder's distortion is low

Module for phone uses also minimizes variations in output amplitude

Telephone-tone encoders, which are frequently merely oscillators to which logic, switching, amplifiers, and other components have been added, have been plagued by such problems as a high level of distortion and wide variations in output amplitude. Now, Frequency Devices Inc., Haverhill, Mass., has introduced the model 510 telephone tone-encoder module, which contains all the necessary components and keeps distortion and variations in output-amplitude low.

The encoder, which is used to produce frequencies for automatic dialing of Touch Tone telephones, as well as telephone-test equipment and data-communications systems that transmit over telephone lines, consists of two separately programable oscillators, two separate gating circuits, and an output-summing amplifier.

Alan E. Schutz, director of engineering, says the 510 uses one resistor-capacitor oscillator to produce low-tone and one to produce high-tone frequencies, which—when combined with a novel filter technique—hold distortion to only 1%. Oscillator one produces four frequencies of 697 hertz, 770 Hz, 852 Hz, and 941 Hz, while oscillator two produces frequencies of 1,029 Hz, 1,336 Hz, 1,446 Hz, and 1,633 Hz, the frequencies used by the Bell System. Each tone consists of a combination of one high and one low frequency, so the 510 can produce a total of 16 tone pairs.

Both frequencies and output gating are externally programable with TTL-compatible logic inputs that drive internal semiconductor switches. Six digital bits produce the desired frequency: two bits control the output of oscillator one, two bits control oscillator two, and two bits gate the oscillator outputs to the output-summing amplifier.

Schutz says most encoders don't have any gates, but the Frequency Devices unit uses two gates—one for each oscillator. Tones are produced in bursts. The Bell System requires 50 milliseconds of tone and 50 ms of silence, and the gates are used to turn off the tone. With two gates, both oscillators can be reached, or one oscillator can be gated to test decoders at the other end of the line. The two gates can also be tied together to look like one gate.

Amplitude is 2.4 volts rms from each oscillator, amplitude stability is 1 decibel, and output impedance is 10 ohms. Output is protected against short circuits. The oscillators settle to frequency within half a cycle after they are switched; the amplitude-transient-time constant is 10 ms.

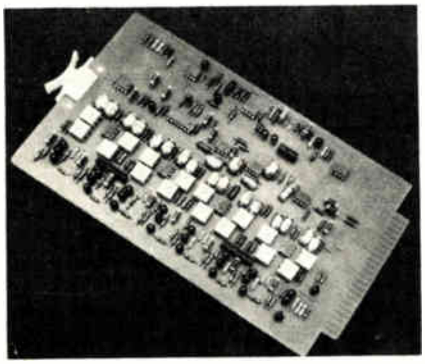
Since the gating controls do not introduce transients in the oscillator outputs, the amplitude and frequency transients can be eliminated by gating the outputs off before switching frequencies and gating them back on after the transients are over, an operation that takes 15 ms. Output-gating isolation is typically 70 dB when the output gates are off, enabling the receivers to respond to a wide amplitude of frequencies. Frequency tolerance is set to better than 0.2% and is better than 1% over the range of 0°C to 70°C.

The module measures 2 by 3 by 0.4 inches and requires supplies of ±15 volts at 10 milliamperes, and +5 V at 40 mA. Price of the 510 is $85 each in quantities of 1 to 9 and $55 each in lots of 100. Delivery time is stock to two weeks.

Frequency Devices Inc., 24 Locust St., Haverhill, Mass. 01830 [371]

Touch Tone frequencies select remote relays

The CM7200 line of tone-keyed receivers allows one or more remote relays and similar on-off devices to



be selected and actuated from an ordinary Touch Tone telephone set. Touch Tone frequencies can be decoded or not, depending on the application. The short-circuit-protected output can drive relays or TTL/C-MOS circuits. The CM2700 receivers are immune to voice interference, due to use of adaptive amplitude-ratio control and multiple timing circuits. According to the company, the interference level is about 100 times lower than in most other receivers. Prices of the units start at $150 in quantities of 100.
Mitel Canada Ltd., 39 Leacock Way, Kanata, Ont., Canada [373]

Transmission/noise tester includes an oscillator

The model 1110A transmission/noise test set measures transmission level, frequency, metallic noise, notched noise, and noise to ground. The unit includes a tunable oscillator and offers two digital displays for simultaneous measurement of the level and frequency of an incoming test tone. Transmit circuitry is separate from the receiver circuitry, so the 1110A can send test tones at the same time it is measuring the signal being received.

Telecommunications Technology Inc., 555 Del Rey, Sunnyvale, Calif. 94086 [375]

Modem operates to 1,800 bits per second

A multispeed synchronous modem, the model 1800S, offers six strap-selectable operating rates of 1,800, 1,200, 900, 600, 300, and 150 bits per second. The modems operate in half-duplex, full-duplex, or simplex mode over dedicated lines or dial networks using data couplers. A narrow-band carrier detector in the 1800S can be strapped to respond

only to a mark tone from the remote modem or to both mark and space tones. The 1800S is built on a single printed-circuit card.
Penril Data Communications Inc., 5520 Randolph Rd., Rockville, Md. 20852 [374]

Transmission-test set measures audio systems

The model 12C, a solid-state transmission-test set, measures transmission gain or loss, line noise, and

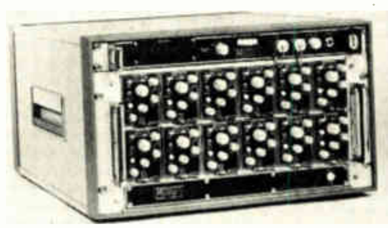
distortion in audio-frequency systems. The unit provides direct readings of the audio-frequency characteristics of passive or active components, such as amplifier transmission lines, networks, filters, transformers, and attenuators. The

model 12C has a variable-frequency oscillator that covers from 5 hertz to 55 kilohertz in four ranges.

Edison Electronics division, McGraw-Edison Co., Grenier Field, Manchester, N.H. 03103 [380]

Vhf/uhf receiver system designed for surveillance

The model RS-180A receiving system, designed for surveillance and frequency-management applications, offers a-m and fm reception from 20 to 1,000 megahertz. The customer can select a single i-f bandwidth for each receiver. In the 20- to 80-MHz range, i-f bandwidths of 10, 20, and 50 kHz are available; over the 30- to 250-MHz range, one



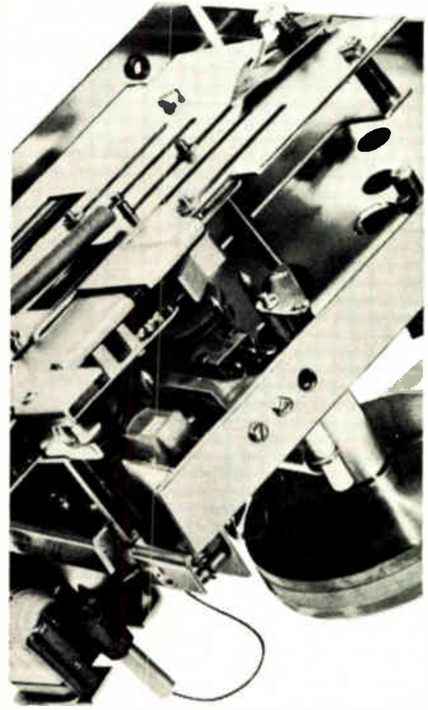
of five bandwidths can be selected, and seven bandwidths can be selected between 220 and 1,000 MHz. The system is available with equipment frames for mounting six or 12 receivers.

Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, Calif. 94304 [379]

Responders are used in trunk-transmission testing

Code 105 responders, for use in automatic trunk-transmission testing, are designated the 1050 series. They are compatible with ATMS, Trace, Carot, or equivalent controllers. They will measure 1,000 hertz and transmit 1,000 hertz to the measuring unit. The responders provide two-way noise and transmission measurements on trunks and are easy to install.

Northeast Electronics Corp., Airport Rd., Concord, N.H. 03301 [378]



New products/materials

A line of Eccoamp electrically conductive adhesives, coatings, and casting resins has a conductivity lower than that of metals and offers certain advantages, the company says, over metallic conductors. These include: easier bonding to metals such as nichrome and aluminum in soldering applications and elimination of the need for high-temperature bonding. The products are said to have high thermal conductivity in comparison with most plastic materials.
Emerson & Cuming Inc., Canton, Mass. 02021 [476]

A potting and sealing compound called Nordbak cures in four minutes at 200°F. Available in one package, the material is suited for production-line use in temperature-sensitive devices. It remains stable at room temperature for six months or more. Nordbak epoxy 9945 has a viscosity of 14,000 centipoise per second at 25°C and, when cured, it gives a tensile strength of 3,000 pounds per square inch.
Rexnord, Nordberg Machinery Group, Brookfield, Wis. 53005 [477]

Clad-a-tive is the designation for a combination of micro-thin copper foil and a standard epoxy-glass laminate that adapts to existing printed-circuit production methods. The base material requires less etch time than other laminates, the company says, and breakdown is less likely. The material makes possible 5-mil lines with 5-mil spacing. In addition, ragged edges and solder slivers are eliminated.
Fortin Laminating Corp., 1323 Truman St., San Fernando, Calif. 91340 [478]

A low-alloy gold electroplating process specifically developed for printed-circuit boards, contacts, switches, and electronic components is called Autronex SN80. The acid-type process produces white tin-gold coatings with a hardness range from 160 to 240 knoop. The process will also maintain an 80% gold purity in deposits under normal electroplating-control procedures.
The Sel-Rex Co., 75 River Rd., Nutley, N.J. 07110 [479]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EASTERN REGION — Mr. William Whitehead, Suite 307 — 88 Sunnyside Blvd., Plainview, N.Y. 11803 · (516) 822-4240
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New literature

Semiconductor coolers. Wakefield Engineering Inc., Audubon Rd., Wakefield, Mass. 01880. A short-form catalog describes products for cooling semiconductors. These include heat sinks for single- or multiple-device mounting, cup clips for mounting TO-5 or TO-18 cases to chassis or heat sinks, clamps, bus blocks and plates, aluminum extrusions, thermal joint compounds, and conductive epoxy. Circle 421 on reader service card.

Miniature connectors. A six-page catalog from B & W Associates Inc., 21 B Street, Burlington Mass. 01803, provides information on a line of miniature precision connectors for coaxial and strip transmission lines. The catalog gives information on semirigid, flexible and stripline versions. [422]

Terminal inserter. Molex Inc., 2222 Wellington Ct., Lisle, Ill. 60532, has issued a brochure describing automated equipment for inserting terminals in printed-circuit boards. Described are the company's vibrator multipinsetter and a single pinsetter. [423]

Potentiometers. A guide to potentiometers and variable resistors is available from Electrical Research Association, Cleeve Rd., Leatherhead, Surrey, England. More than 2,000 components from 100 different manufacturers are covered by specifications, charts and tables. Price is about $50. [424]

Bobbin coil winder Stevens Manufacturing Co., 6001 N. Keystone Ave., Chicago, Ill. 60646. Technical bulletin 74A describes an automatic production machine that winds all types of multilayer random-wind bobbin coils and single-layer solenoids up to 4 inches in diameter and up to 2 in. long that use wire sizes 14 to 40. [424]

Rectifiers. A line of 800-ampere Hockey-Puk power silicon rectifiers, the 801PD and 801PD-B series, is described in a data sheet available from the Semiconductor division,

6560/3101A

64 BIT RAM

The 3101A now has a real second source. The new 6560/3101A 64-bit RAM is just one of an expanding family of Random Access Memories from MMI.

You know the 3101A; now meet the 6560N/3101A. 35ns access time. Plastic package. And a new, lower price. $4.50 (100-999).

Also meet the new 6561N, a 3101A with three-state logic outputs. This commercial part (0°-70°C), with 35ns access time, also comes to you at the same low price. $4.50 (100-999).

And mil versions of the 3101A, too: the 5560D open collector and 5561D three-state version. Both feature a ceramic package, 50ns access time and the same low price: $8.00 (100-999).

Call your nearest MMI field sales office, rep or franchised distributor and give him your P.O. number. If you don't remember 6560, just ask for it by its last name. Monolithic Memories, Inc., 1165 East Arques Avenue, Sunnyvale, California 94086, (408) 739-3535/TWX 910-339-9229.

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New literature

International Rectifier Corp., 233 Kansas St., El Segundo, Calif. 90245 [425]

Relays. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. 91343. A 32-page catalog describes the company's line of relay and choppers (analog switches) including reed relays, choppers, and chopper drivers. [426]

Substrate cutter. A revised edition of product bulletin 5000 from Aremco Products Inc., Box 429, Ossining, N.Y. 10562, describes the Accu-Cut 5000 substrate-cutting system. The brochure provides information on a new vacuum-holding fixture used to permit scribing of silicon wafers. [427]

Circulators. Trak Microwave Corp., 4726 Eisenhower Blvd., Tampa, Fla. 33614, has issued a catalog describing the company's line of circulators and other ferrite products. [428]

Rotary switches. An engineering handbook on miniature rotary switches is being offered by RCL Electronics Inc., 700 S. 21st St., Irvington, N.J. 07111. Included are layout diagrams for pc-terminal switches, millimeter conversions, and charts. [429]

Card-edge connectors. Elco Corp., Maryland Rd. and Computer Ave., Willow Grove, Pa. 19090, has published a catalog describing press-fit card-edge connectors. [430]

DIP inserter. Synergistic Products Inc., 1902 McGaw Ave., Irvine, Calif. 92705. The EconoDip line of automated DIP-insertion machines is described in a data sheet, which provides specifications and general information. [431]

Materials. Emerson & Cuming Inc., Dielectric Materials division, Canton, Mass. 02021. A brochure describing the Eccoamp line of electrically conductive products gives properties and applications for 11 types of conductive solders and adhesives, six types of coatings, and a conductive casting resin. [432]

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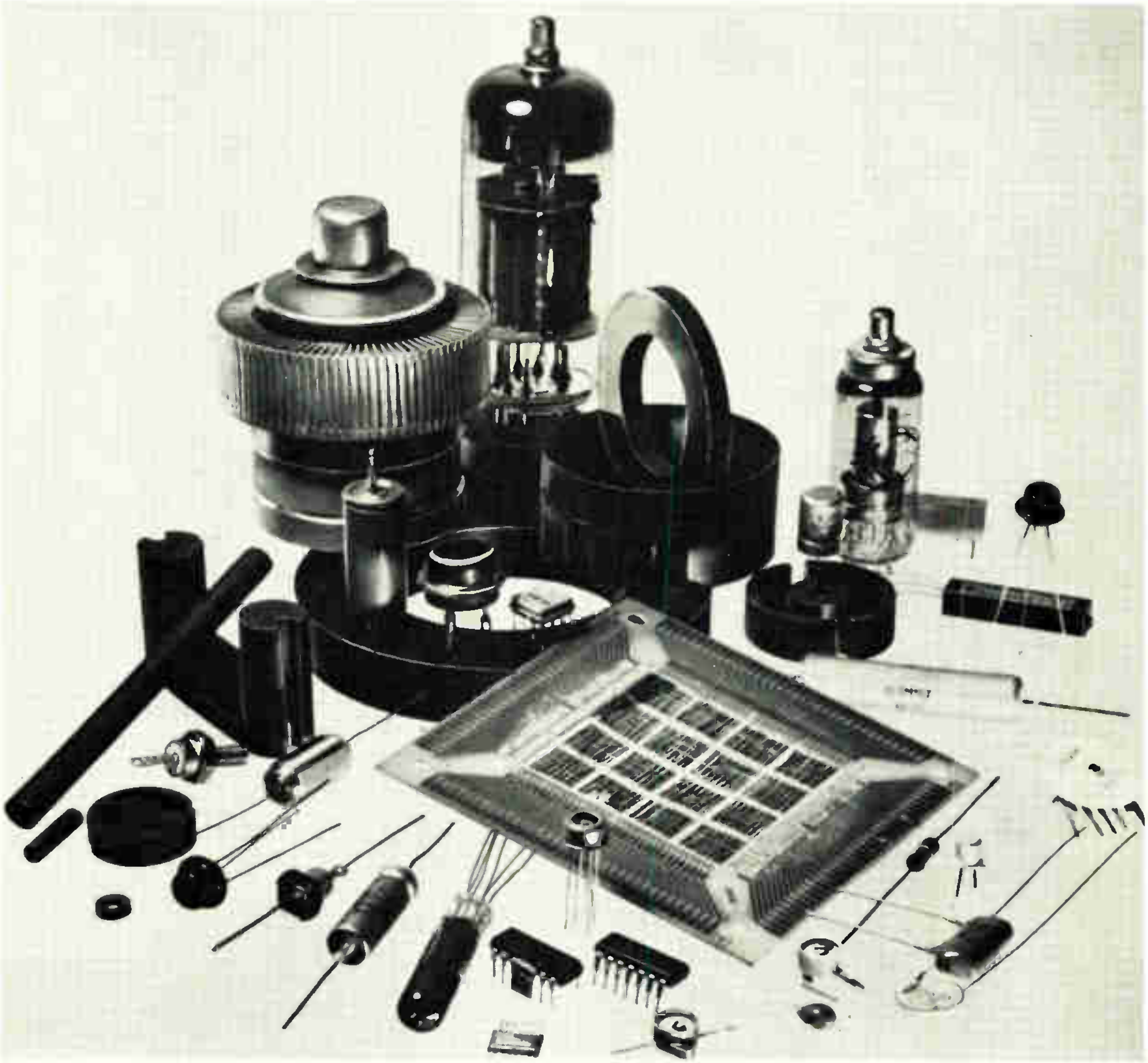

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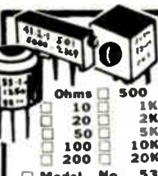

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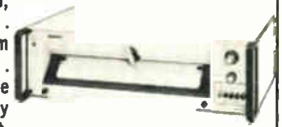

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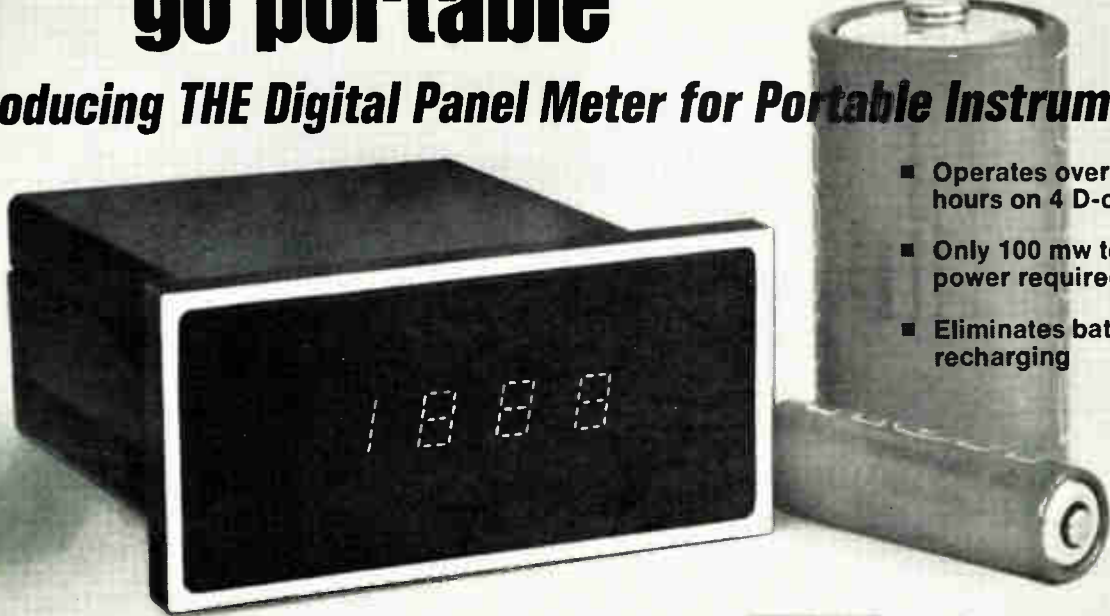

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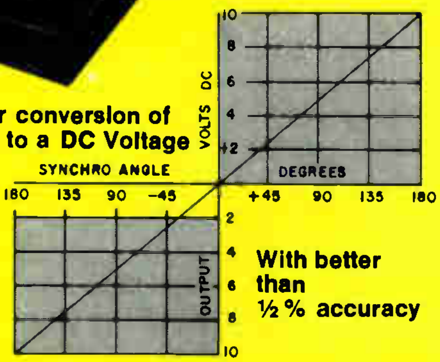

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Other units are available at different power and voltage levels as well as wider temperature ranges. Information will be furnished upon request.

SOLID STATE SINE-COSINE SYNCHRO CONVERTER - NON VARIANT

This new encapsulated circuit converts a 3 wire synchro input to a pair of dc outputs proportional to the sine and cosine of the synchro angle independent of a-c line fluctuations.

- Complete solid state construction.
- Operates over a wide temperature range.
- Independent of reference line fluctuations.
- Conversion accuracy — 6 minutes.
- Reference and synchro inputs isolated from ground.

Specifications Model DMD 1508-2

Accuracy: Overall conversion accuracy 6 minutes. Absolute value of sine and cosine outputs accurate to ±30MV

Temperature Range:
Operating —40°C to +85°C
Storage —55°C to +125°C

Synchro Input: 90V RMS ±5%LL 400Hz ±5%

DC Power: ±15V DC ±10% @ 50MA

Reference: 115VRMS ±5% 400Hz ±5%

Output: 10V DC full scale output on either channel @ 5ma load

Temperature coefficient of accuracy:
±15 seconds/°C avg. on conversion accuracy
±1 MV/ °C on absolute output voltages

Size: 2.0″ x 1.5″ x 2.5″

Units are available with wider temperature ranges and 11.8V LL, 26V reference synchro inputs. Information will be supplied upon request.

4 QUADRANT MAGNETIC ANALOG MULTIPLIER

DC x DC = DC OUTPUT

#MCM 1478-1

Product Accuracy is ±½% of all theoretical product output readings over Full Temperature Range of −55°C to +125°C.

Maximum Output Error for Either
X = 0, Y = 10V
Y = 0, X = 10V
X = 0, Y = 0
would be ±2 MV over Entire Temperature Range.

Specifications Include:

Transfer Equation: E = XY/10
X & Y Input Signal Ranges: 0 to ±10V peak
Maximum Static and Dynamic Product Error: ½% of point or 2MV, whichever is greater, over entire temperature range
Input Impedance: X = 10K, Y = 10K
Full Scale Output: ±10V peak
Minimum Load for Full Scale Output: 2000 ohms
Output Impedance: Less than 10 ohms
Bandwidth: 1000Hz
DC Power: ±15V, unless otherwise required, at 20ma
Size: 1.3″ x 1.8″ x 0.5″
Output is short circuit protected

Circle 901 on reader service card

There is No Substitute for Reliability

GENERAL MAGNETICS • INC
135 Bloomfield Ave., Bloomfield, New Jersey 07003 - Tel. (201) 743-2700

Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Communications Co., 2700 Ponce de Leon Blvd., Coral Gables, Fla.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Electronic Specialty Co., 3456 Glendale Blvd., Los Angles, Cal.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hallicrafters Co., 2611 Indiana Ave., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Jefferson-Travis Radio Mfg. Corp., 380 Second Ave., New York, N. Y.
Karadio Corp., 2233 University Ave., St. Paul, Minn.
Lear-Avia, Inc., 1718 Broadway, Piqua, Ohio.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
National Co., 61 Sherman St., Malden, Mass.
Radio Frequency Laboratories, Inc., Boonton, N. J.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Smith Co., Maxwell, 1027 N. Highland Ave., Kearny, N. J.
Sparks-Withington Co., North St., Jackson, Mich.
Taylor Airphone Products, Inc., Municipal Airport, Long Beach, Cal.
Western Electric Co.—see Graybar Electric, Co.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilcox Electric Co., 3947 State Line, Kansas City, Mo.

AMATEUR RECEIVERS

Abbott Instrument, Inc., 8 W. 18th St., New York, N. Y. (See page 153.)
Echophone Radio Co., 201 E. 26th St., Chicago, Ill.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Hallicrafters Co., 2611 Indiana Ave., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Pierson-De Lane, Inc., 2345 W. Washington Blvd., Los Angeles, Cal.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Radio Mfg. Engineers, Inc., 111 Harrison St., Peoria, Ill.
Radio Transceiver Laboratories, 120-03 Jamaica Ave., Richmond Hill, N. Y.
RCA Mfg. Co., Camden, N. J.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Tefft Radio Co., Plymouth, Mich.
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

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Cavalier Motors Associates, Ltd., 1028 Linden Ave., Baltimore, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Crosley Corp., 1329 Arlington St., Cincinnati, Ohio
Delco Radio Div., General Motors Service, Kokomo, Ind.
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Karadio Corp., 2233 University Ave., St. Paul, Minn.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Radio Products Corp., 3800 W. Cortland St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Sonora Radio & Phonograph Corp., 2926 W. Washington St., Chicago, Ill.
Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago, Ill.
Trav-ler Karenola Tele Corp., 1036 W. Van Buren St., Chicago, Ill.
Trebor Radio Co., Pasadena, Cal.
Warwick Mfg. Co., 1700 W. Washington Blvd., Chicago, Ill.
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

FACSIMILE RECEIVERS

Finch Telecommunications, Inc., Passaic, N. J.
RCA Mfg. Co., Camden, N. J.

FREQUENCY MODULATION RECEIVERS

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Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Espey Mfg. Co., 305 E. 63d St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Freed Radio Corp., 39 W. 19 St., New York, N. Y.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hallicrafters Co., 2611 Indiana Ave., Chicago, Ill.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Meissner Mfg. Co., Mt. Carmel, Ill.
National Co., 61 Sherman St., Malden, Mass.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Pierson-De Lane, Inc., 2345 W. Washington Blvd., Los Angeles, Cal.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Scott Labs Inc., E. H., 4450 Ravenswood Ave., Chicago, Ill.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Stewart-Warner Corp., 1826 Diversey Pkwy, Chicago, Ill.
Stromberg-Carlson Telephone Mfg., 100 Carlson Rd., Rochester, N. Y.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

HOME RECEIVERS

Air King Radio & Television, 1523 63d St., Brooklyn, N. Y.
Andrea Radio Corp., 4820 48th Ave., Woodside, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Automatic Radio & Television Co., 122 Brookline Ave., Boston, Mass.
Bell Radio & Television, 125 E. 46th St., New York, N. Y.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Brunswick Radio Div., Mersman Bros. Corp., 206 Lexington Ave., New York, N. Y.
Calvert Motors Associates, Ltd., 1028 Linden Ave., Baltimore, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Continental Radio & Television Corp., 3800 Cortlandt St., Chicago, Ill.
Crosley Corp., 1329 Arlington St., Cincinnati, Ohio
Delco Radio Div., General Motors Service, Kokomo, Ind.
De Wald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Electrical Research Lab., Inc., 2020 Ridge Ave., Evanston, Ill.
Electromatic Distributors, Inc., 88 University Pl., New York, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Espey Mfg. Co., 305 E. 63d St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Freed Radio Corp., 39 W. 19th St., New York, N. Y.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
General Television & Radio Corp., 1240 N. Homan Ave., Chicago, Ill.
Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles, Cal.
Grebe Mfg. Co., 70 Washington St., Brooklyn, N. Y.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Kadette Radio Corp., 310 First National Bldg., Ann Arbor, Mich.
Laurehk Radio Mfg. Co., 3918 Monroe Ave., Wayne, Mich.
L'Tatro Mfg. Co., 417 W. Water St., Decorah, Iowa
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Majestic Radio & Television Corp., 2600 W. 50th St., Chicago, Ill.
Marconiphone, Inc., 679 Madison Ave., New York, N. Y.
Meissner Mfg. Co., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Mitchell Mfg. Co., 1550 N. Dayton St., Chicago, Ill.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Packard Bell Co., 1320 S. Grand Ave., Los Angeles, Cal.
Paramount Radio Corp., 967 22d St., Oakland, Cal.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Radio Products Corp., 3800 W. Cortland St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Recordovox Inc., 80 Cortlandt St., New York, N. Y.
Remler Co., 2101 Bryant St., San Francisco, Cal.
Scott Labs Inc., E. H., 4450 Ravenswood Ave., Chicago, Ill.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Sillcox Radio & Television Co., 60 Wall Tower, New York, N. Y.
Sonora Radio & Phonograph Corp., 2926 W. Washington St., Chicago, Ill.
Sparks-Withington Co., Jackson, Mich.
Stewart-Warner Corp., 1826 Diversey Pkwy, Chicago, Ill.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Trav-ler Karenola Tele Corp., 1036 W. Van Buren St., Chicago, Ill.
Trebor Radio Co., Pasadena, Cal.
Walsh, Lincoln, 34 DeHart Pl., Elizabeth, N. J.
Warwick Mfg. Co., 1700 W. Washington Blvd., Chicago, Ill.
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